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Further Evidence of Naturalisation of the Invasive Fish *Perccottus glenii* Dybowski, 1877 (Perciformes: Odontobutidae) in Germany and Necessity of Urgent Management Response

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Abstract: The invasive alien fish *Perccottus glenii* Dybowski, 1877 originates from the Far East of Eurasia and is rapidly expanding its geographical range in other areas including Europe. Recently, this species was detected in the upper part of the Danube river basin. We confirm, based on field data from 2014, the long-term existence of a stable population of this invasive fish in a lake in Charlottenhofer Weihergebiet Integral Natural Reserve. Further, this is the first documented record of *P. glenii* outside this lake, and namely in Siegenbach Stream, which connects the lake with the Naab River. The river is a left tributary of the Danube River with known presence of *P. glenii*. These data confirm spreading of the invasion from the reserve and beginning of forming of the Upper-Danube (Bavarian) invasive subrange of this alien species. Urgent management measures at local and regional levels are necessary to prevent further dispersion of this undesirable invasive species.

Keywords: Amur sleeper, biological invasions, Chinese sleeper, the Danube River

Introduction

Fish fauna demonstrates remarkable transformations in many regions of Europe (*e.g.,* Grabowska *et al.* 2010, Lusk *et al.* 2010, Rabitsch *et al.* 2013b, Zorić *et al.* 2014), as well as in Europe as a whole (Holcik 1991, Lehtonen 2002, Gerardi *et al.* 2008). One of the new invaders in the Danube River region is the invasive alien species *Perccottus glenii* Dybowski, 1877 (Odontobutidae). Its widespread distribution in this region has been confirmed by multiple records (Koščo *et al.* 1999, Harka *et al.* 2003, Jurajda *et al.* 2006, Simonović *et al.* 2006, Hegediš *et al.* 2007, Nastase 2008, Polacik *et al.* 2008, Popa *et al.* 2006, Covaciu-Marcov *et al*. 2011, Jarić *et al.* 2012, Kvach 2012, Takács, Vitál 2012, etc.). The first introduction in European water bodies was in 1916; there were also several other long-distance introductions throughout Europe (Reshetnikov, Ficetola 2011). For example, a detailed spatio-temporal analysis of distributional data showed that this fish was introduced in Western Ukraine at the end of 1960s and this region became a center of secondary distribution of this dangerous invasion, spreading to the basins of Dniester, Dnieper, Vistula, Southern Bug and Danube Rivers on the territories of Ukraine, Poland, Slovakia, Hungary, Croatia, Serbia, Romania, Moldova and Bulgaria (reviewed by Reshetnikov 2013).

Shallow well-vegetated isolated lakes, ponds, drainage ditches and oxbows are important reserve of biological diversity for many systematic groups

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of aquatic and semi-aquatic animals. Colonisation of such water bodies by rotan (or the Amur sleeper) leads to remarkable simplification of ecosystem taxonomic structure as rotan represents a special threat for macroinvertebrates, small-sized fish and amphibians; it may also decrease the effectiveness of aquaculture ponds through consuming large number of young fish (Reshetnikov 2003, 2004, 2013). This fish may harbour more then 100 parasite species in invaded regions and is, therefore, a vector for introduction of some parasite species, the so-called co-invaders (Sokolov *et al*. 2012, 2014).

The upper part of the Danube River Basin (including the German part) is located within climatic parameters that are rather favourable for the populations of the rotan, with no geographic barriers between earlier colonised areas and the Upper Danube River region (Reshetnikov, Ficetola 2011). Risk assessment publications regard this species as a candidate for possible invasion in German water bodies (Wolter 2008, Nehring *et al.* 2010; Rabitsch *et al.* 2013a). We are aware about short-term presence of *P. glenii* in aquariums of German scientists and aquarists in 1960s (Schenke, Grabow 1965). Fortunately, this had no negative consequences for European nature because the fish was not released into the wild. The first introduction of the rotan in water bodies in Germany happened in the early 2000s, the first documented record is from 2008 (Reshetnikov, Schliewen 2013). The mentioned records were restricted to the system of large semi-natural lakes in Charlottenhofer Weihergebiet Integral Natural Reserve. These lakes are used for supporting local biological diversity, especially bird species, as well as for extensive breeding of commercial fish species. The rotan could be casually transported to those lakes together with commercial aquatic species (Reshetnikov, Schliewen 2013).

The aim of the present study is to verify the current status of the rotan population in Charlottenhofer Weihergebiet Reserve and to inspect an adjacent stream, which connects the lakes and the river system.

Material and Methods

The inspected water bodies are located in Charlottenhofer Weihergebiet Integral Natural Reserve located in the drainage of the Upper Danube River in Bavaria, Germany. The ponds are 0.7–1.0 m deep and some are well-vegetated. We used landnets for sampling. The collected individuals were stored in 96% ethanol. For analysis of the Amur sleeper expansion within a separate river basin, we followed classification of stages (i-v) as suggested by Reshetnikov (2013). For describing the process of large-scale expansion in the region, we used terms (initial population, centre of secondary distribution, subrange) previously explained and applied by Reshetnikov (2013).

Results and Discussion

In total, 30 young-of-the-year individuals with total length (TL) 22-38 mm and several elder individuals up to 110 mm were studied. They were caught in semi-natural pond # 11, or Brundlweiher (49°21′57″N; 12°10′12″E), on 18th August, 2014 in Charlottenhofer Weihergebiet Integral Natural Reserve. The size distribution of the studied rotan individuals confirmed reproduction and hence long-term stability of the local population of this species known at least since the early 2000s.

We also collected samples from Siegenbach Stream (49°21′57″N; 12°08′19″E), which connects the studied lake and the Naab River (left tributary of the Danube River). We recorded a rotan specimen with TL=100 mm. Our record of the invasive fish *P. glenii* in a water course connecting the lake with numerous population of that species to the river system of the Upper Danube River drainage confirms that (i) the aquaculture ponds of the reserve represent an open (non-isolated, non-enclosed) ecological system; (ii) the expansion of this species is not limited within the Charlottenhofer lakes anymore; these lakes became a centre of secondary distribution of rotan; (iii) the presence of the rotan in a stream of this part of the basin of the Danube River may be regarded as the beginning of the formation of the new Upper-Danube (Bavarian) subrange of this invader. The risk of further distribution of *P. glenii* from the Bavarian source of the secondary distribution, together with information about ecological corridors and countries under risk, was analysed earlier by Reshetnikov, Schliewen (2013).

Typically, aquaculture water bodies are constructed on a natural water stream or canal. That water stream is used as a water source for the fish pond, while the surplus of water goes into the flood plain of the same stream. Reliable separation of larvae and small-sized young fish individuals from exiting water flow is a difficult task. Previous multi-year studies showed that aquaculture ponds with populations of rotan became centres of secondary distribution in many regions of the current range of this invader. For example, initial populations of the rotan appeared in the Gusinoe Lake (Baikal Basin, Russia), Ilev fish farm (Volga Basin, Russia), as well as Sambor and Lisnevichi fish farms (Dniester Basin, Ukraine) as

a result of unintentional transportation of rotan together with commercial fish species, and later became sources of secondary distribution of this species (Pronin 1982, Kuderskiy 1980, Reshetnikov 2013). At least 50% of the recent introductions of rotan in Eastern and Central Europe outside of the main part of the Western Ukrainian subrange are restricted to aquaculture facilities and hence may be consequences of fish stocking activities of those farms (Reshetnikov, Schliewen 2013). Like the majority of similar ponds, rotan-infected water bodies in Charlottenhofer Weihergebiet represent an open system and became a centre of its secondary distribution. Presently, we cannot claim that the process of colonisation of the Naab river basin by rotan is at its early stages. Indeed, Reshetnikov (2013) highlighted the existence of an unavoidable time span between the actual appearance of rotan and it being located and recorded. Therefore, the first stages of rotan distribution within a river system may be called *hidden*. Commonly, rotan is recorded at stage (v) described as "high population density in oxbow lakes and comparatively rapid systematic colonisation of the river flood-plain habitats downstream" (for description of stages, see Reshetnikov 2013). Monitoring of water bodies in the region of the expanding Bavarian subrange of rotan is needed in order to be able to assess the stage of colonisation within the drainage of the Naab River. Urgent actions for control of rotan distribution are necessary.

The importance of control of rotan expansion at regional level and listing of measures against this species were discussed earlier (*e.g.* Zaloznych 1984, Reshetnikov, Ficetola 2011: 2977). Though this species is well-known as a factor for destroying ecosystems of small isolated lentic water bodies (Manteifel, Reshetnikov 2001; Reshetnikov 2003), no conservation efforts were performed against it at a large-scale level (*i.e.* country level or European level). In view of its high invasive potential and drastic consequences for European freshwater ecosystems (Reshetnikov, Ficetola 2011, Reshetnikov 2013), we suggest including this species in the "List of invasive alien species of Union concern" (European Community 2014) and underline the necessity of urgent comprehensive conservational measures at the country and European levels. The long European canals (interconnecting main European river basins) may be pathways for expansion of this invader to yet non-invaded Western European countries. The role of these canals was highlighted as possible corridors for future distribution of rotan for the first time in 2005 (Reshetnikov 2005). Since then, the invasive range of rotan moved remarkably westwards and it threatens to penetrate the trans-European canals. Even if we have no certain evidence of rotan migrations through large canals within West-Ukrainian subrange (Semenchenko *et al.* 2011, Reshetnikov 2013: 203), we should consider the establishment of electric migration barriers or other technical solutions for preventing potential rotan moving through those canals further in western direction.

The information about the new records of *P. glenii* on the territory of Germany was provided to the Federal Agency for Nature Conservation (Bonn, Germany). We hope that our study will serve as an initial impulse for urgent measures on the protection of natural ecosystems against the expansion of *P. glenii* in Germany and in other European countries.

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