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First record of the invasive spine-cheek crayfish *Orconectes limosus* (Rafinesque, 1817) (Crustacea: Cambaridae) in the Bohemian Forest (South Bohemia, Czech Republic)

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Abstract
The American spiny-cheek crayfish *Orconectes limosus* (Rafinesque, 1817) was found in the Lipno Reservoir in July 2006. This is the most southerly situated record of the species in the Czech Republic, and also the site with the highest altitude in the country (726 m a.s.l.). The nearest known site with the presence of this crayfish is approximately 100 km downstream the Vltava River; it is therefore likely that this species was actively introduced by humans. As various Czech populations of this invasive species, including those from the Vltava River, have been proven to carry the crayfish plague pathogen, the presence of *O. limosus* in the Bohemian Forest potentially poses a serious threat to the native crayfish, and its future spread should be monitored.

Key words: *Orconectes limosus,* Lipno Reservoir, invasive species, crayfish plague, Czech Republic

Introduction

The American spiny-cheek crayfish *Orconectes limosus* (Rafinesque, 1817) is among the most widely distributed non-indigenous crayfish species in Europe (Souty-Grosset et al. 2006), and is also the most widespread non-native crayfish in the Czech Republic. Since its introduction to Europe in 1890, it has successfully spread to many countries thanks to its high fecundity and fast development (e.g., Kozák et al. 2006), good migratory capability, as well as tolerance to degraded environmental conditions such as low oxygen concentrations and pollution (Lindqvist & Huner 1999). Although it is a relatively small-bodied crayfish, it is able to compete successfully with native European species because it is aggressive (Lindqvist & Huner 1999) and able to resist and transfer the crayfish plague pathogen (Kozubíková et al. 2006). More details about the biology and ecology of the spiny-cheek crayfish can be found in Hamr (2002), Souty-Grosset et al. (2006), or Filipová et al. (2006a).
The first record of this invasive species in the Czech Republic was published at the end of the 1980s (Hajer 1989) but it seems to have been present in the Czech stretch of the Elbe River and adjacent pools already in the 1960s (Kozák et al. 2004, Petrusek et al. 2006). The recent distribution of this crayfish includes most of the Elbe River, parts of the Vltava River (including the Orlík and Kořensko Reservoirs), lower reaches of various tributaries of these two rivers, and a number of isolated populations in both running and stagnant waters (ponds,

sand-pits, quarries) (Petrusek et al. 2006, Filipová et al. 2006a). Until now, it has never been recorded in the Bohemian Forest.

Material and Methods

In 2005 and 2006, the first author of this paper studied aquatic mollusc communities of the Lipno Water Reservoir (Bohemian Forest, Southern Bohemia, Czech Republic; 48°48'–48°38' N, 13°58'–14°14' E). This reservoir, built in 1960 on the upper Vltava River upstream of the town of Vyšší Brod at an altitude 726 m a.s.l., is the largest water body in the Czech Republic, with a surface area of 4870 ha (Vlček et al. 1984). It is long (48 km) but relatively shallow, with a maximum depth 21.5 m and an average depth of 6.5 m.

Altogether 18 sites, distributed along the whole shoreline of the reservoir, were sampled for aquatic molluscs (details on all examined sites see Beran & Dvořák 2006). The sampling consisted of washing the submerged littoral vegetation or sediments with a metal sieve (a kitchen strainer, diameter 20 cm, mesh size 0.5–1 mm) in combination with manual examination of stones, wood and litter (e.g., plastic bags and bottles). Sampling at each locality took around 30–60 minutes. While this approach does not specifically search for the presence of crayfish, suitable crayfish shelters are inspected, and therefore crayfish are often recorded at localities where they occur (Beran 2003).

Site with the occurrence of *Orconectes limosus*

Černá v Pošumaví, Lipno Reservoir, artificially strengthened shoreline with a road between Černá v Pošumaví and Hůrka (48°44'21" N, 14°06'03" E); altitude 726 m a.s.l.; code of the mapping field for faunistic grid mapping: 7250. Sampling date: 20 July 2006; surface water temperature: 25–26ºC.

The riverbed at this locality was steep, covered by loosely piled large quarry stones (over 20 cm in diameter, sometimes much larger). Crevices among the stones offered many suitable shelters for crayfish. No fine sediment or macrophyte vegetation was present. About 10 larger rocks were inspected during the sampling.

Results

Two individuals of *Orconectes limosus* were found at the above-listed locality under the stones at a depth of 20–30 cm. They were caught and identified by L. Beran, and released after determination. Both individuals were adult males, shortly after moulting – i.e. with a soft carapace cuticle, and no attached epibiotic organisms. The body length (rostrum-telson) of both individuals was estimated to be 60 mm (exact measurements were not taken).

No other spiny-cheek crayfish were found in 2005 or 2006 during the survey of aquatic molluscs at the 17 remaining sites in the Lipno Reservoir, nor at 29 other sites in the surroundings of the reservoir, including one site in the Vltava River below the reservoir dam, and one in the Lipno II Reservoir further downstream (Beran & Dvořák 2006).

Discussion

This is the most southerly situated record of the spiny-cheek crayfish in the Czech Republic. The nearest known occurrence of this crayfish is approximately 35 km away, in the Vltava River near České Budějovice (Petrusek et al. 2006). However, this represents a distance of around 100 river kilometres downstream, and several significant migration barriers, including two dams at least 10 m in height, separate České Budějovice from the Lipno Reservoir.

It is therefore very unlikely that *O. limosus* could have spread naturally into the reservoir. If that had been the case, the species would have probably already been recorded at other studied sites in the reservoir or downstream in the river. The most likely cause of the colonisation of the Lipno Reservoir is intentional human-mediated introduction, which has facilitated the spread of the spiny-cheek crayfish into a number of Czech standing waters, and is suspected in the presence of this species in middle parts of the Vltava River (Petrusek et al. 2006).

The Lipno Reservoir is the highest-altitude locality (725 m a. s. l.) where the spiny-cheek crayfish has been recorded in the Czech Republic. This is not particularly surprising, as a large reservoir such as Lipno provides suitable environmental conditions for a number of aquatic invertebrates otherwise distributed in lower elevations. The same phenomenon, with Lipno being the highest known locality of a species in the country, has also been documented for the non-native gastropod *Menetus dilatatus* (Gould, 1841) (Beran 2005) and several other molluscs (Dvořák & Beran 2004).

This finding is the first record of the spiny-cheek crayfish species in the Bohemian Forest. The only other known population of an invasive American crayfish species in the region, the signal crayfish *Pacifastacus leniusculus* (Dana, 1852), can be found in the very north of Bohemian Forest, in the Kouba stream near Sruby on the border with Germany (Filipová et al. 2006b). Both American species represent a potential threat to native crayfish species, as they may spread the crayfish plague, a disease lethal for non-European crayfish. Some of the most likely sources for the Lipno population, crayfish from the Orlík and Kořensko Reservoirs on the Vltava River, are certainly carriers of the plague pathogen, *Aphanomyces astaci* Schikora, 1903 (Kozubíková et al. 2006, Filipová et al. 2006a). This is also true for other Czech spiny-cheek crayfish populations (Kozubíková et al. 2006).

The presence of this American species in the Bohemian Forest is therefore highly undesirable, especially as a population of the native noble crayfish *Astacus astacus* (Linnaeus, 1758) is present in the Lipno Reservoir (Trampota, pers. comm.), and a crayfish farm is located in its immediate vicinity in Nová Pec. Unfortunately, the eradication of an already established invasive crayfish population is virtually impossible. In principle, the two spiny-cheek crayfish individuals should have been killed instead of released back into the reservoir; however, it is unlikely that this would have had any significant effect on the population of this species – given the character of the locality, it is likely that significantly more individuals were already present.

Monitoring of the potential establishment and future spread of the spiny-cheek crayfish in the Lipno area, and analysing whether this population is a reservoir of the crayfish plague pathogen, may help in the preparation of efficient conservation measures for local crayfish populations. The further human-mediated spread of this species in the Bohemian Forest may be partially prevented by informing the local public, especially fishermen, about the threat posed by the non-indigenous American species to native crayfish.

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