DISTRIBUTION OF THE INVASIVE SPINY-CHEEK CRAYFISH (*ORCONECTES LIMOSUS*) IN THE CZECH REPUBLIC. PAST AND PRESENT

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ABSTRACT

The American spiny-cheek crayfish, *Orconectes limosus*, was first introduced into European waters in 1890. The first literature record about the occurrence of *O. limosus* on the territory of the Czech Republic was published almost 100 years later – in 1989. The presence of this species in Czechia, however, was first recorded already in the 1960s, when crayfish were observed in the dead arms and pools adjacent to the river Elbe (Labe) in Central Bohemia. In the following few decades the spiny-cheek crayfish has spread into several larger rivers of the Elbe watershed and some of their smaller tributaries. The eastern part of the country (mostly belonging to the watershed of the river Morava) has not yet been colonised by this species. *O. limosus* can be found in lower reaches of a number of watercourses of a low stream order, but does not seem to penetrate far upstream in such localities. Its distribution in standing waters is largely the result of intentional human-mediated translocations. The long-term coexistence of *Orconectes* and native crayfish species has not yet been recorded, although both introduced and native crayfish at least occasionally come into contact. As *O. limosus* is a major carrier of the crayfish plague on the Czech territory, and crayfish plague outbreaks have been recently recorded, the dynamics of *Orconectes* invasion deserves careful monitoring in the future.

Key-words: *Orconectes limosus*, spiny cheek crayfish, invasive species, distribution, crayfish plague, Czech Republic.

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DISTRIBUTION DE L'ÉCREVISSE INVASIVE (*ORCONECTES LIMOSUS*) EN RÉPUBLIQUE TCHÈQUE. PASSÉ ET PRÉSENT

RÉSUMÉ

L'écrevisse américaine, *Orconectes limosus*, a été introduite en Europe en 1890. Les premiers écrits relatant la présence d'*O. limosus* sur le territoire de la République tchèque ont été publié presque 100 ans plus tard, en 1989. Cette espèce a déjà été observée en Tchéchie cependant, dans les années 60, dans les bras morts et les plans d'eau adjacents à la rivière Elbe (Labe) en Bohème centrale. Dans les décennies suivantes, l'écrevisse américaine a colonisé d'autres grands cours d'eau du bassin de l'Elbe, et quelques-uns de leurs plus petits affluents. La partie orientale du pays (correspondant principalement au bassin de la rivière Morava) n'a pas encore été colonisée par cette espèce. *O. limosus* est présente dans les parties les plus basses d'un certain nombre de cours d'eau d'ordre hydrographique faible, mais elle ne semble pas remonter très en amont des cours d'eau. Sa répartition dans les eaux calmes est largement le résultat des transports effectués par l'homme. La coexistence au long-terme d'*Orconectes* et des espèces natives d'écrevisse n'a pas encore été établie, bien que les écrevisses natives et les écrevisses introduites se retrouvent au moins occasionnellement en contact. L'écrevisse *O. limosus* étant le principal vecteur de la peste de l'écrevisse sur le territoire tchèque, et des cas de peste de l'écrevisse ayant été récemment enregistrés, la dynamique de l'invasion de l'*Orconectes* doit être soigneusement suivie dans le futur.

Mots-clés : *Orconectes limosus*, écrevisse américaine, espèce invasive, distribution, peste de l'écrevisse, République Tchèque.

INTRODUCTION

The crayfish plague, caused by the oomycete *Aphanomyces astaci*, was accidentally introduced to Europe in the 1860's (VOGT, 1999). The disease quickly spread over a large part of European water bodies and the numbers of native crayfish were dramatically reduced. The attempts to replace the lost populations, and to substitute sensitive species with those resistant to the disease, led to a number of intentional introductions of non-native crayfish to Europe (HENTTONEN and HUNER, 1999). The introduced species were *Astacus leptodactylus* (native to the eastern part of Europe and the Near East, sensitive to the plague) and the North American species *Orconectes limosus*, *Pacifastacus leniusculus* and *Procambarus clarkii*. The presence of non-native species on the continent caused, however, a number of unexpected additional problems. The crayfish from North America often carry the crayfish plague pathogen or other diseases and may transmit them to the native populations (VOGT, 1999). Therefore, with the spread of non-native species in recent decades, the crayfish plague outbreaks are again gaining in intensity (HOLDICH, 2003).

Furthermore, the indigenous crayfish can also be displaced through direct interactions or competition for resources with the non-native species (HOLDICH, 1999). American crayfish are usually characterized by high growth rates, early maturity and large amounts of offspring, but also short life spans and high mortality rates. They are often aggressive and tolerate deteriorated habitat conditions (LINDQVIST and HUNER, 1999). Some of them (especially *Procambarus clarkii*, in Britain also *Pacifastacus leniusculus*) can cause large damages in agricultural and recreational areas by burrowing (HOLDICH, 1999).

Out of five species of crayfish present in the wild in Czechia (POLICAR and KOZÁK, 2000), only two are native: the noble crayfish, *Astacus astacus*, and the stone crayfish, *Austropotamobius torrentium*. Both of them are protected by law as critically endangered species. The rest of the crayfish species present in the country have been either

intentionally introduced (*Astacus leptodactylus, Pacifastacus leniusculus*) or colonised the area naturally from another region (*Orconectes limosus*). The narrow-clawed crayfish, *Astacus leptodactylus*, was introduced to Czechia at the end of the 19th century in order to replenish the reduced native populations of the noble crayfish. Since then, it became an integral part of the local fauna, and its populations are scattered all over the country (ĎURIŠ and HORKÁ, 2001).

The signal crayfish, *Pacifastacus leniusculus*, was brought to the Czech territory from Sweden in the 1980s for aquaculture purposes. Its acclimation at most localities was unsuccessful, but the population near the town Velké Meziříčí has established itself successfully and specimens from that area have been later transferred to several other places in the country (POLICAR and KOZÁK, 2000). The distribution of this species still remains restricted to only a few localities.

The most widespread non-native species in the Czech Republic is the spiny-cheek crayfish, *Orconectes limosus*. It was first intentionally introduced to Europe in 1890, when about 100 specimens from Pennsylvania were released to a fishpond in Barnowko (Berneuchen, Western Pommerania; currently in Poland close to the German border) (KOSSAKOWSKI, 1966; HAMR, 2002). In 1895, an additional but unsuccessful attempt was made to introduce this crayfish from New York to France (KOSSAKOWSKI, 1966). The original locality in Poland therefore seems to be the only source of *Orconectes limosus* populations on the European territory. Since the first introduction, this crayfish has spread naturally or by secondary translocations to over 15 European countries, including the Czech Republic and its neighbours – Poland, Germany, and Austria (HENTTONEN and HUNER, 1999; HOLDICH, 2003). Its presence in Slovakia has not been confirmed so far (STLOUKAL and HARVÁNEKOVÁ, 2005).

A brief overview of the distribution of *Orconectes limosus* in the Czech Republic has already been included in the study of KOZÁK *et al.* (2004); however, no detailed information on the localities was given. The aim of the present study is to summarise available records on the history of the invasion of *Orconectes limosus* on the territory of the Czech Republic, present up-to-date data on its current distribution, and analyse types of water bodies this species occupies.

METHODS

The review of the distribution of *Orconectes limosus* on the territory of the Czech Republic in the past (up to 2000) is based on available literature data, mostly published in local journals inaccessible to the international scientific community.

The present distribution of this species was assessed mainly from the long-term activities aimed at collecting data on the distribution of all crayfish species in the country. During the last five years, a number of localities with *Orconectes* presence reported in the past were repeatedly re-sampled.

Additionally, we present here the data on *Orconectes limosus* from an intensive mapping of crayfish distribution, which was carried out by the Agency for Nature Conservation and Landscape Protection of the Czech Republic in 2004-5. The mapping covered running waters in most of the country (over 90% of the surface area, and over 90% of all watercourses except of the smallest ones). Small to medium watercourses were examined for crayfish presence every 3 kilometres, starting 100 m above the confluence with the higher-order stream, and continuing upstream up to the stream source. At each locality, an approximately 100 m long stretch of the stream was inspected, and shelters suitable for crayfish were searched. Larger rivers were sampled every 4-7 kilometres (depending on the habitat suitability) using the baited traps. At least three traps containing fresh fish meat as bait were left overnight at each site, in a slow-flowing part of the river in

deeper water close to the river bank. Traps were collected in the morning and checked for crayfish presence. Altogether, over 9,000 profiles on small streams, and over 350 on large rivers, were inspected during the mapping project.

We also used information provided by the general public (e.g. scuba divers) in cases when the identification of the species was unambiguous or photodocumentation was available. For each locality, we present the date (if available) or year(s) of observation and the character of the habitat (stagnant/running water, type of the water body). Additionally, we include the literature data on observations of this species from 2001 to present.

For populations from running waters, we calculated the distance from the mouth of the river/stream and the stream order, using the GIS data on the hydrological network of the Czech Republic (T.G.M. WRI Hydroecological Information System, http://heis.vuv.cz). To be able to compare the position of localities and tributaries of the river Elbe, we use the distance from the German border rather than standard river kilometres, as there are several overlapping kilometric systems in use on the Czech stretch of this river. A distribution map, using a standard grid for faunistic mapping recommended for the territory of the Czech Republic (BUCHAR, 1982), was compiled using the data from all accessible sources. Recent records (after 2000) and pre-2000 historical localities with *Orconectes* not recorded later are distinguisher by colour.

RESULTS

Historical data

Published records of *Orconectes limosus* on the territory of the Czech Republic prior to 2001 are listed in Table I. The first effort to introduce this species to the region had been already made at the turn of the 20th century but with no success (MATĚNA, 1995). Its presence was first reported in the literature by HAJER (1989). The spiny-cheek crayfish was repeatedly observed in the river Elbe (Labe) in the surroundings of the town Ústí nad Labem, approximately 40 km upstream from the German border, since at least the mid-1980s. By that time it had probably also penetrated to the river Bílina (left-side tributary of the Elbe). Between 1987 and 1988, the crayfish were also found in Čelákovice, 146 km upstream from the border (SAMEK, pers. comm.). Since then, the species has been recorded in a wide range of localities in the western part of the country (HAJER, 1990, 1994; BERAN, 1995, 2003; KOZÁK *et al.,* 2004).

The spiny-cheek crayfish had most likely immigrated into the region naturally through the river Elbe (KOZÁK *et al.,* 2004). It seems, however, that the *Orconectes* invasion had gone undetected for a long time. According to the record of an amateur fisherman (MATOUŠ, 1995), already in the 1960s small crayfish were present in high densities in dead arms and pools adjacent to the river near Štětí, about 80 km upstream from the border with Germany. The identity of these crayfish as *O. limosus* is beyond doubt for several reasons: the author described them as small (no more than 8 cm long) aggressive crayfish often exhibiting daytime activity, and these crayfish had been apparently able to tolerate heavily polluted water of the Elbe in the 1960s (MATOUŠ, 1995). *Orconectes* is still present in the same area (Tables I, II).

Following his first report on *Orconectes* presence in Czech waters, HAJER (1994) reported the occurrence of the spiny-cheek crayfish in a number of rivers of the Elbe watershed. The indicated populations were often located far from the confluence of the particular river with the Elbe or Vltava (see Table I). The most significant are records of the presence of *Orconectes* in higher reaches of the rivers Ohře (km 90), Sázava (km 162), Berounka (km 139) and its tributaries, or Vltava (km 240) (HAJER, 1994). Apart from the latter, the presence of *O. limosus* in such distant parts of these rivers has not been confirmed later. Such areas are marked in Figure 1 by open circles.

Present status

The localities where *Orconectes limosus* was recorded since 2001 are listed in Table II, and shown in Figure 1. Although the list certainly does not include all water courses and bodies with the presence of this species on the territory of the Czech Republic, it gives a reasonable picture of the current distribution of the species. The spiny-cheek crayfish is mainly present in the western part of the country (Elbe watershed). The core of its distribution still remains in the river Elbe (including various adjacent oxbows and pools). It occurs in the whole navigable part of this river (which is almost completely canalised) from the border with Germany to the town Pardubice (240 km from the German border) but probably in lower densities also further upstream. The population of *O. limosus* was recorded also in the town Jaroměř (289 km upstream from the border) in the Elbe and two of its tributaries (Úpa and Metuje). However, according to local fishermen as well as

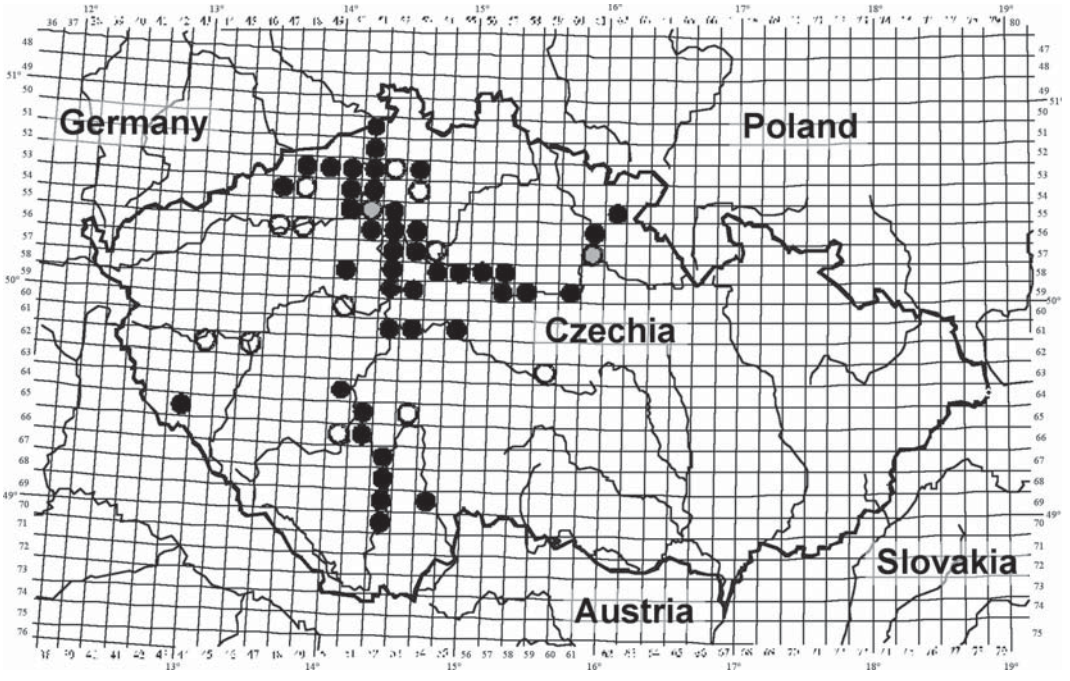

Figure 1

Currently known and previously recorded localities of *Orconectes limosus* marked on a standard grid used for the faunistic mapping in Czechia (each square corresponds to 10' of longitude and 6' of latitude, i.e. approx. 11 × 11 km).
black circle: presence in the square confirmed after 2000,
grey circle: historical record (up to 2000) with very likely continuous presence,
open circle: records up to 2000 not confirmed later.

Figure 1

Sites de présence d'*Orconectes limosus*, passée ou actuelle, localisés sur une grille standard utilisée pour la cartographie faunistique en Tchéquie (chaque carré correspond à 10' de longitude et 6' de latitude, i.e. approximativement 11 × 11 km).
rond noir : présence dans le carré confirmée après 2000,
rond gris : présence ancienne (jusqu'à 2000) avec présence actuelle très vraisemblable,
cercle vide : présence jusqu'à 2000, non confirmé ultérieurement.

the river management authorities (ŠPAČEK, pers. comm.), the spiny-cheek crayfish had been intentionally stocked in this area.

Larger watercourses (of 6th or higher stream order) with the certain presence of the spiny-cheek crayfish include Ohře, Vltava, Jizera, Mrlina, Cidlina, Doubrava, Metuje, and Úpa (all tributaries of the Elbe), and Otava, Lužnice, Sázava, and Malše (tributaries of the Vltava). The presence of this species may be presumed also in the Lomnice and other rivers and streams partially flooded by Vltava reservoirs, and in various larger tributaries of the Elbe.

In most of the above-mentioned rivers, the crayfish presence was confirmed in their lower reaches but recent data from upper reaches are lacking. The notable exceptions are: 1) the Vltava where the spiny-cheek crayfish is present in its lower part (from Prague downstream to the river Elbe), in several reservoirs in its middle section, and reaches upstream to the town České Budějovice (240 km from the confluence); 2) the Sázava, a tributary of the Vltava, where the crayfish seem to be present at least 50 km upstream from its confluence with the Vltava. Another such river is the Úpa in north-east Bohemia, with *Orconectes* over 30 km upstream from the Elbe. The latter case is known, however, to be a result of human introduction (ŠPAČEK, pers. comm.).

Orconectes limosus was found also in a number of smaller streams (i.e. those with a low stream order), which join larger rivers. In these cases the crayfish usually stay very close to the confluence with the major watercourse (less than 3 km, usually only a few hundred meters), and do not penetrate far upstream. The relationship between the stream order and the maximum distance of recorded *Orconectes* presence from the stream mouth is shown in Figure 2. (In cases of small streams joining other watercourse first, the total distance to the nearest larger river with presumed or confirmed *Orconectes* presence was calculated.)

Additionally, this species is found in several standing waters. Some of them, especially flooded sandpits and quarries, have no surface inflow or outflow. Several other standing waters are connected to watercourses, and crayfish may penetrate into them. This has certainly happened at three places (the flooded surface coal mine Barbora and its ouflow; the mining water reservoirs Kateřina and Modlany and their connecting channel; and the large fishpond Velký rybník on the stream Pšovka). At some other places similar relationships between *Orconectes* populations in standing water bodies and adjacent streams may be suspected. All such cases belong among the exceptions where the spiny-cheek crayfish is present in a watercourse of a low stream order (1-4) relatively far (more than 10 km) from the confluence with a major river. These cases are marked in Table II by "+" followed by a superscript numerical code, which identifies corresponding records from running and standing waters.

DISCUSSION

According to the results of the intensive mapping effort, the spiny-cheek crayfish on the territory of the Czech Republic is as yet present only in the Elbe watershed. The area drained by the Morava, covering most of the eastern part of the country, has not been colonised yet, nor the upper part of the watershed of the Odra (Oder), which extends into the Czech territory. There is a certain likelihood that the spiny-cheek crayfish may naturally reach lower reaches of the Morava by upstream migration from the Danube. Not only this species is present in the Danube in Austria (PÖCKL, 1999) and in Hungary where it is actively spreading (PUKY, 2000; PUKY *et al.,* 2005), but it has been already sparsely found directly in the lower reaches of the Morava in Austria, approximately 30 km downstream from the Czech border (PÖCKL and PEKNY, 2002). Other potential sources from where this species might be transferred to the Morava watershed are located in watersheds of

the Odra (Oder) and the Wisla (Vistula) in Poland (KOZÁK *et al.,* 2004), or of the Elbe. In those cases the natural spread of the crayfish is unlikely as they would have to cross the watershed divide. However, the spiny-cheek crayfish may be stocked by humans intentionally or transferred unintentionally from any other locality.

The occurrence of this species in a number of isolated standing water bodies, especially flooded quarries or sandpits, is certainly, at least in some cases, caused by human-mediated translocations (especially by fishermen, recreational scuba divers etc., who admit to the stocking, being usually unaware of the potential danger of transferring non-indigenous species). Some populations present in running waters are also of anthropogenic origin. Apart from above-mentioned upstream section of the Elbe and its tributaries (Úpa, Metuje), one more recent case of crayfish stocking into a stream is confirmed (Drnovský stream, Central Bohemia; stocked in 2005 from a nearby village pond, most individuals were removed later during the year). Additionally, crayfish penetrate to inflows or outflows of standing waters, into which they may have been previously stocked artificially.

It is also possible that artificial stocking allowed this species to colonise reservoirs on the river Vltava, as the distribution pattern in this river (Figure 1, southern part of the country) does not seem to confirm the natural upstream spread of crayfish, and the reservoir dams (some of them over 50 m high) are significant migration barriers.

Scuba divers are certainly responsible for stocking of the spiny-cheek crayfish into the flooded quarry “Na skále” near Starý Klíčov (Mrákov, western Bohemia), which is a popular diving site. Currently it is inhabited by a very dense population of *O. limosus*, which is even supplied food by the local diving club. Additionally, a single specimen of the noble crayfish *Astacus astacus* was recorded in the same locality in December 2002, and several individuals of the narrow-clawed crayfish *Astacus leptodactylus* were found there between December 2002 and November 2003 (KOZÁK, unpublished). This confirms that various crayfish had been illegally released to the quarry multiple times.

The quarry Klíčov contains an isolated population of *Orconectes* relatively far from other localities of this species, and it is situated only about 10 km away from a stream where a population of the critically endangered stone crayfish *Austropotamobius torrentium* is found (KOZÁK *et al.,* 2002). The presence of *Orconectes* in the region is therefore highly undesirable, as there is a danger of potential transmission of the crayfish plague. The eradication of *Orconectes* population is virtually impossible; however, every effort should be made not to spread the species further.

Although *Astacus* spp. and *Orconectes* have been spotted at the above-mentioned locality, so far there is no evidence of the long-term coexistence of American and native species on the Czech territory – unlike some other countries where this was occasionally reported, e.g. in Finland where *Astacus astacus* and *Pacifastacus leniusculus* occurred in the same lake (NYLUND and WESTMAN, 2000) or in Austria, with *O. limosus* and *A. leptodactylus* in the same stretch of the river Morava (PÖCKL and PEKNY, 2002).

On the other hand, there is evidence for at least one case of crayfish plague transmission from *Orconectes* to the native species in recent years (KOZUBÍKOVÁ *et al.,* 2006). In the Pšovka brook (Central Bohemia, north of Prague) three crayfish species were found in the 1990s, each of them in a different part of the river – *Orconectes limosus* in the lower reach, *Astacus leptodactylus* further upstream and the native *Astacus astacus* in higher reaches of this brook (BERAN, 1995). According to a local fisherman, the spiny-cheek crayfish had been intentionally stocked to the fishpond Velký rybník near Střemy. An outbreak of a disease with typical crayfish plague symptoms in 1998-1999 practically eradicated the populations of both *Astacus* species but did not affect *Orconectes*. The spiny-cheek crayfish is still abundant in the brook, and the presence of the crayfish plague pathogen *Aphanomyces astaci* was detected in several specimens (KOZUBÍKOVÁ *et al.,* 2006).

Additional evidence of the presence of *Astacus astacus* and *Orconectes limosus* in the same water body is in the reservoir Orlík on the river Vltava. The American species is rather abundant in the reservoir but a specimen of the noble crayfish burrowing in the mud in the depth of several meters was photographed by a scuba diver in October 2003 (PETRUSEK, unpublished). However, it is not possible to conclude for how long such a coexistence may have lasted.

Czech populations of *Orconectes limosus* seem to be widely infected by the crayfish plague pathogen (KOZUBÍKOVÁ *et al., 2006*). Fortunately, the fact that the species does not seem to penetrate far upstream in small watercourses may protect some populations of native species (*A. astacus* and especially *Austropotamobius torrentium*) from the transmission of the plague by direct contact with its carriers. This is especially important, for example, for the Central Bohemian population of *A. torrentium*, which is present approximately 11 km upstream from the mouth of a stream directly joining an *Orconectes*-inhabited section of the river Elbe. A similar situation has also been recorded in Hungary in the streams of the Danube Bend region (PUKY and SCHÁD, 2006).

The limited ability of *O. limosus* to penetrate into small streams can be documented by the fact that in spite of an intensive monitoring effort, records of this species from streams up to the 5th stream order are usually limited to less than three kilometres from their confluence with a larger river (Figure 2, Table II). All exceptions from this pattern can be associated with a potential source population in a close-by standing water connected to the watercourse, or are known to be originally stocked by humans (indicated in Table II and Figure 2),

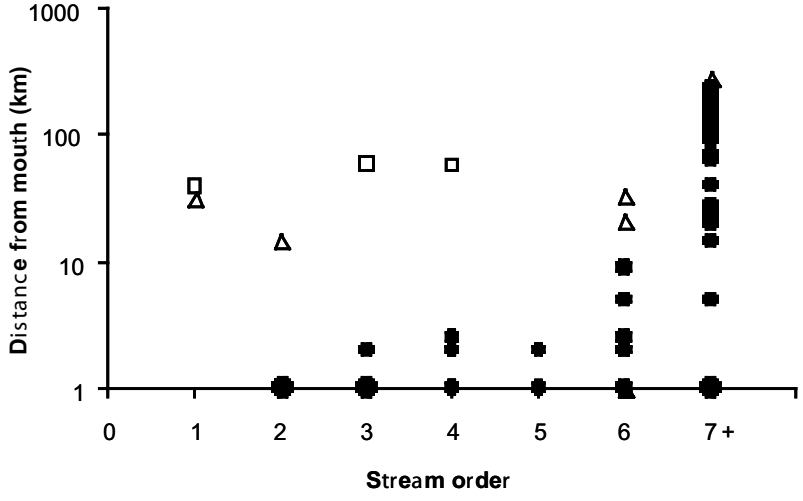

Figure 2

The relationship between the stream order and the distance of recent Czech *Orconectes* populations from the stream mouth (or nearest larger watercourse with presumed or confirmed presence of the species); the distance from the German border is used for the river Elbe. Large dots represent four or more sites. Populations originating with certainty from human stocking are marked by triangles, those spreading from adjacent standing waters by squares.

Figure 2

Relation entre l'ordre du cours d'eau et la distance des populations récentes d'*Orconectes* de l'embouchure du cours d'eau (ou du grand cours d'eau le plus proche avec présence supposée ou confirmée de l'espèce); la distance à la frontière allemande est utilisée pour l'Elbe. Les gros points représentent 4 sites ou plus. Les populations introduites avec certitude par l'homme sont indiquées par des triangles; celles qui se sont propagées à partir de plans d'eaux adjacents sont indiquées par des carrés.

Table I

Data on the presence of *Orconectes limosus* in the Czech streams and water bodies up to 2000. The river kilometres are given from the mouth, in case of the Elbe (Labe) from the border with Germany.
Parentheses after the name of a watercourse give the name of the river which it joins (marked by an arrow), and the river kilometre where the confluence is located. The sources are abbreviated as follows: H89, H90, H94 – HAJER, 1989, 1990, 1994; B95, B03 – BERAN, 1995, 2003; B06 – BERAN, in press; M95 – MATĚNA, 1995; AOPK – archive of the Agency for Nature Conservation and Landscape Protection, ZD – unpublished data of Z. Ďuriš.

Tableau I

Données sur la présence d'*Orconectes limosus* dans les rivières et les plans d'eau tchèques jusqu'en 2000. Les « kilomètres-rivière » sont indiqués depuis l'embouchure, et dans le cas de l'Elbe depuis la frontière avec l'Allemagne.
Entre parenthèses après le nom des cours d'eau sont indiqués les noms des cours d'eau dans lesquels ils se jettent (repérés par une flèche), et le kilomètre rivière de la confluence. Les références bibliographiques sont abrégées comme suit : H89, H90, H94 – HAJER, 1989, 1990, 1994 ; B95, B03 – BERAN, 1995, 2003; B06 – BERAN, sous presse; M95 – MATĚNA, 1995; AOPK – archive de l'agence pour la conservation de la nature et la protection des Paysages, ZD – données non publiées de Z. Ďuriš.

Table II

Localities where the presence of *Orconectes limosus* in the Czech Republic was recorded or reconfirmed between 2000 and 2005. River kilometres are given as in Table I, the value in parentheses gives the effective distance to the nearest watercourse with presumed or confirmed presence of *O. limosus*.
The column "source" refers either to initials of one of the authors (AP, LF, ZD, PK, TP, MS), literature data (V03 – VRZAL, 2003; B03 – BERAN, 2003; B06 – BERAN, *in press*), unpublished records of Luboš Beran (LB), data of the Czech Union for Nature Conservation from Nymburk (CSOP), mapping programme of the Agency for Nature Conservation and Landscape Protection (AOPK), or to reliable personal communications by those listed. An asterisk in the "distance from mouth" column indicates a population with known origin by human stocking, "+" followed by a number in superscript after the locality name indicates potential source populations in standing waters and the corresponding records of *Orconectes* in running waters.

Tableau II

Sites où la présence d'*Orconectes limosus* en République tchèque a été notée ou confirmée entre 2000 et 2005. Les « kilomètres-rivière » sont indiqués comme dans le tableau I, les valeurs entre parenthèses donnent la distance effective au cours d'eau le plus près où la présence d'*O. limosus* est supposée ou confirmée.
Les données de la colonne "source" se réfèrent soit aux initiales abrégées de l'un des auteurs (AP, LF, ZD, PK, TP, MS), à des données de la littérature (V03 – VRZAL, 2003; B03 – BERAN, 2003; B06 – BERAN, *in press*), aux travaux non publiés de Luboš Beran (LB), aux données de l'Union tchèque pour la Conservation de la Nature de Nymburk (CSOP), aux données du programme de cartographie de l'Agence pour la Conservation de la Nature et de la Protection des Paysages (AOPK), ou à des communications personnelles fiables des auteurs listés. Un astérisque dans la colonne « distance à l'embouchure » indiquent que la population a été avec certitude introduite par l'homme, « + » suivi par un nombre en exposé après le nom du site signale les populations potentielles d'origine dans les eaux calmes, et les populations correspondantes d'*Orconectes* dans les eaux courantes.

Tableau I

Watercourse / body	Nearest settlement	Latitude (N)	Longitude (E)	Date of observation	Stream order	Distance from mouth (km)	Source
Labe (Elbe): between Ústí nad Labem and Pardubice canalised (slow flow or standing), distances calculated from the border with Germany							
Labe	Hřensko	50°52'	14°14'	pre-1995	8	1	M95
Labe	Děčín	50°46'	14°13'	1991-2	8	15	H94
Labe	Ústí nad Labem	50°39'	14°03'	1988-92	8	38	H89, H94
Labe	Brná nad Labem	50°37'	14°05'	7.-9.05.88	8	43	H89, H90
Labe	Litoměřice	50°32'	14°08'	1991-2	8	65	H94
Labe	Roudnice	50°26'	14°16'	1991-2	8	82	H94
Labe	Račice	50°30'	14°22'	1991-2	8	93	H94
Labe	Mělník	50°22'	14°28'	1991-2	8	109	H94
Labe (adjacent pools)	Křivenice	50°25'	14°25'	05/06/98	8	100	B03
Labe	Neratovice	50°16'	14°32'	1991-2	7	122	H94
Labe	Čelákovice	50°10'	14°45'	pre-1995	7	146	M95
Labe	Nymburk	50°11'	15°03'	1991-2	7	168	H94
Labe	Poděbrady	50°08'	15°07'	1991-2	7	176	H94
Labe	Pardubice	50°03'	15°46'	1991-2	7	240	H94
Labe	Hradec Králové	50°12'	15°49'	1991-2	7	268	H94
tributaries in the watershed of Elbe: running waters							
Ploučnice (→ Elbe, km 14)	Benešov nad Ploučnicí	50°44'	14°19'	24/05/91	6	11	H94
Dolský potok (→ Fojtovický p., km 0.5; → Ploučnice, km 12; → Elbe, km 14)	Heřmanov	50°44'	14°18'	1991	2	< 1?	H94
Luční potok (→ Elbe, km 28)	Malé Březno	50°40'	14°10'	1991-2	4	< 1	H94
Homolský potok (→ Elbe, km 30)	Velké Březno	50°40'	14°08'	1991-2	3	< 1	H94
Bílina (→ Elbe, km 39)	Bílina,	50°33'	14°46'	1990?	6	< 5	H90
Bílina	Bílina, confluence with Syčivka	50°33'	14°46'	29/05/91	6	36	H94
Průčelský potok (→ Elbe, km 43)	Brná nad Labem	50°37'	14°05'	May 1988	2	< 1	H90
Tlučenský potok (→ Elbe, km 47)	Sebuzín	50°36'	14°05'	1991-2	2	< 1	H94
Ohře (→ Elbe, km 65)	Litoměřice	50°32'	14°08'	1991-2	6	< 1	H94
Ohře	Terezín	50°31'	14°09'	14/07/97	6	3	B03
Ohře	Bohušovice nad Ohří	50°30'	14°09'	1992, 1997	6	5	H94, B03
Ohře and its dead arm	Doksany	50°27'	14°10'	2000	6	9	B03
Ohře	Budyně nad Ohří	50°25'	14°07'	05/06/91	6	18	H94
Ohře	Louny	50°22'	13°48'	11/05/92	6	54	H94
Ohře	Žatec	50°20'	13°33'	1991-2	6	90	H94
Pšovka (→ Elbe, km 107)	Střemy	50°23'	14°33'	1994-8	2	14-15	B95, B06
Jizera (→ Elbe, km 141)	Benátky nad Jizerou	50°17'	14°50'	20/10/91	6	20	H94
Orlice (→ Elbe, km 268)	Hradec Králové	50°12'	15°49'	02/11/92	6	< 1	H94
river Vltava (→ Elbe, 109 km): conditions vary from running to standing water (headwaters of weirs, reservoirs)							
Vltava	Mělník	50°21'	14°29'	1991, 1999	8	< 1	H94, B03
Vltava	Vepřek	50°18'	14°20'	20/06/98	8	14	B03
Vltava	Kralupy	50°15'	14°19'	11/05/91	8	22	H94
Vltava	Praha (Prague)	50°07'	14°28'	1991-2, 1998-9, 2000	8	47	H94, P00, B05
Vltava (reservoir Orlík)	*not specified*	~49.5°	~14°	1994, 1998-9, 2000	8	145 - 180	M95, P00, H00
Vltava (reservoir Kořensko)	*not specified*	~49.2°	~14.4°	1994, 1998-9	7-8	200 - 209	M95, P00
Vltava (reservoir Hněvkovice)	*not specified*	~49°	~14.5°	1994	7	210 - 225	M95
Vltava	České Budějovice	49°58'	14°28'	26/10/92	7	240	H94
tributaries in the watershed of Vltava: mostly running waters							
Berounka (→ Vltava, km 63)	Beroun	49°58'	14°05'	14/10/92	7	35	H94
Berounka	Plzeň	49°45'	13°23'	27/10/91	7	139	H94
Úslava (→ Berounka, km 136)	Plzeň	49°45'	13°24'	27/10/91	5	< 5	H94
Mže (→ Berounka, km 139)	Plzeň	49°45'	13°22'	27/10/91	6	< 5	H94
Mže (reservoir Hracholusky)	Plešnice	49°47'	13°09'	1999	reservoir	24	AOPK
Radbuza (→ Berounka, km 139)	Plzeň	49°43'	13°23'	27/10/91	6	< 5	H94
Úhlava (→ Radbuza, km 5)	Plzeň	49°45'	13°23'	27/10/91	6	< 5	H94
Sázava (→ Vltava, km 78)	Havlíčkův Brod	49°36'	15°35'	15/10/92	6	162	H94
Otava (→ Vltava, km 169)	Písek	49°18'	14°08'	26/10/91	7	26	H94
Lužnice (→ Vltava, km 202)	Bechyně	49°17'	14°28'	1992	7	11	M95
Lužnice	Tábor	49°25'	14°40'	02/09/92	7	40	H94
Malše (→ Vltava, km 240)	České Budějovice	49°58'	14°28'	16/07/92	6	< 1	H94
other standing waters					**character of the locality**		
sandpit Lhota	Lhota	50°15'	14°40'	12/07/97	sandpit		B05
Proboštský rybník + other sandpits	Stará Boleslav	50°12'	14°39'	01/05/95	sandpit		B05
sandpit Ovčáry	Ovčáry	50°15'	14°37'	23/04/95	sandpit		ZD
Klíčov (quarry "Na skále")	Mrákov	49°24'	12°58'	1998	flooded quarry		ZD
Máchovo jezero	Doksy	50°35'	14°39'	1991-2	fishpond		H94
unspecified fishponds	Česká Lípa (region)	~50.5°	~14.5°	1991-2	fishponds		H94
pools and oxbows by the Elbe	Central to North Bohemia	wide area		1991-2	pools, dead arms		H94

Tableau II

Watercourse / body	Nearest settlement	Latitude (N)	Longitude (E)	Date of observation	Stream order	Distance from mouth (km)	Source
Labe (Elbe): between Ústí nad Labem and Pardubice canalised (slow flow or standing), distances calculated from the border with Germany							
Labe	Hřensko	50°52'	14°14'	2001-4	8	1	J. Špaček
Labe	Děčín	50°47'	14°12'	08/09/05	8	15	LF
Labe	Nebočady	50°43'	14°11'	02/07/03	8	20	ZD
Labe	Těchlovice	50°42'	14°12'	02/07/03	8	24	ZD
Labe	Malé Březno	50°40'	14°10'	16/07/03	8	28	ZD
Labe	Ústí nad Labem (Střekov)	50°39'	14°03'	02/07/03	8	40	ZD
Labe	Litoměřice	50°32'	14°09'	2002-3	8	64	B05, ZD
Labe (confluence with Luční potok)	Třeboutice	50°31'	14°12'	03/07/03	8	69	ZD
Labe	Štětí	50°27'	14°22'	03/07/03	8	94	ZD
Labe	Hněvice	50°27'	14°22'	01/10/04	8	95	ZD
Labe	Mělník	50°22'	14°28'	13/09/04	7	108	MS
Labe	Obříství	50°18'	14°29'	2001-5	7	115	ZD, PK, LF
Labe	Kostelec nad Labem (Jiřice)	50°14'	14°34'	22/05/04	7	126	ZD
Labe	Brandýs nad Labem	50°11'	14°40'	03/10/04	7	136	LB
Labe	Čelákovice	50°10'	14°45'	2001-4	7	146	AP
Labe (confluence with Farský potok)	Ostrá	50°10'	14°54'	22/05/04	7	155	ZD
Labe	Hradištko	50°10'	14°56'	2001, 2005	7	159	ZD, LF
Labe	Nymburk	50°11'	15°03'	2002	7	168	CSOP
Labe	Poděbrady	50°09'	15°06'	09/10/03	7	176	ZD
Labe	Kolín	50°02'	15°13'	04/07/03	7	193	ZD
Labe	Týnec nad Labem	50°02'	15°22'	20/04/02	7	205	B05
Labe	Valy	50°02'	15°37'	06/09/05	7	227	LF
Labe	Pardubice	50°03'	15°46'	2003-2005	7	239-241	ZD, LB
Labe	Jaroměř	50°03'	15°46'	2004	7	287 *	J. Špaček
tributaries of the river Elbe: running waters							
Kamenička (→ Elbe, km 10)	Boletice nad Labem	50°45'	14°11'	17/09/05	3	< 1	AOPK
Poustka (→ Elbe, km 18)	Dobkovice	50°43'	14°12'	26/09/04	3	< 1	AOPK
Lužecký potok (→ Elbe, km 28)	Povrly	50°40'	14°10'	26/09/04	3	2	AOPK
Luční potok (→ Elbe, km 28)	Malé Březno	50°40'	14°10'	17/09/05	4	< 1	AOPK
Modla (→ Elbe, km 63)	Lovosice	50°30'	14°04'	03/10/04	4	2	AOPK
Ohře (→ Elbe, km 65)	Bohušovice nad Ohří	50°30'	14°09'	2004, 2005	6	5	ZD, AOPK
Ohře	Doksany	50°27'	14°09'	2003, 2005	6	9	ZD, AOPK
Stará Ohře (→ Elbe, km 67) (side channel of Ohře)	České Kopisty	50°31'	14°10'	21/09/04	N/A	1	AOPK
Pšovka (→ Elbe, km 107)	Mělník	50°21'	14°30'	2002	3	< 1	V03
Pšovka [+1]	Střemy	50°23'	14°33'	1994-2005	2	14-16	V03,B06,AP
Pšovka: fishpond Velký rybník [+1]	Střemy	50°23'	14°33'	1994-2005	fishpond	15 *	B06,ZD,AP
channel between fishpond Malý Štampach and the Pšovka [+1]	Střemy	50°24'	14°33'	2002	N/A	N/A	V03, B06
Vraňansko-hořínský channel (connecting the Elbe, km 109 and the Vltava, km 11.4)	Vrbno	50°20'	14°27'	07/09/05	N/A	2	LB
Vraňansko-hořínský channel	Lužec nad Vltavou	50°20'	14°24'	13/09/05	N/A	7	LB
Vraňansko-hořínský channel	Vraňany	50°19'	14°22'	07/09/05	N/A	10	LB
Jizera (→ Elbe, km 141)	Nový Vestec	50°11'	14°44'	22/05/04	6	1	ZD
Vlkava (→ Elbe, km 159)	Kostomlaty nad Labem	50°10'	14°56'	22/09/05	4	< 2	AOPK
Výrovka (→ Elbe, km 163)	Písty	50°10'	15°00'	2002	5	< 2	CSOP
Liduška (→ Elbe, km 166)	Nymburk	50°10'	15°02'	22/09/05	2	< 1	AOPK
Mrlina (→ Elbe, km 168)	Nymburk	50°11'	15°04'	2002	6	< 2	CSOP
Cidlina (→ Elbe, km 180)	Libice nad Cidlinou	50°07'	15°11'	20/05/04	6	2,5	ZD
Bačovka (→ Elbe, km 182) and surrounding dead arms	Velký Osek	50°06'	15°11'	2002-4	4	2,5	CSOP, AOPK
Doubrava (→ Elbe, km 203)	Záboří nad Labem	50°01'	15°21'	20/05/04	6	1	ZD
Metuje (→ Elbe, km 287)	Jaroměř	50°20'	15°55'	22/05/05	6	< 1 *	AOPK
Úpa (→ Elbe, km 289)	Jaroměř	50°21'	15°56'	04/09/04	6	< 1 *	AOPK
Úpa	Slatina nad Úpou	50°27'	16°02'	04/09/04	6	21 *	AOPK
Úpa	Úpice	50°30'	16°01'	2004	6	33 *	J. Špaček

Tableau II (continued)

Watercourse / body	Nearest settlement	Latitude (N)	Longitude (E)	Date of observation	Stream order	Distance from mouth (km)	Source
river Vltava (→ Elbe, km 109): most localities located in reservoirs (standing water)							
Vltava	Vrbno u Mělníka	50°19'	14°27'	01/10/04	8	5	ZD
Vltava	Klecany	50°10'	14°24'	2001	8	37	ZD
Vltava	Praha - Suchdol	50°08'	14°24'	26/08/05	8	41	LF
Vltava (reservoir Orlík, confluence with Otava)	Zvíkovské Podhradí	49°26'	14°12'	11/07/01	8	169	PK
Vltava (reservoir Orlík)	Vůsí	49°24'	14°15'	2001-4	8	177	PK
Vltava (reservoir Orlík)	Temešvár	49°21'	14°16'	10/07/01	8	182	PK
Vltava (reservoir Orlík)	Strouhy	49°20'	14°17'	15/07/03	8	184	PK
Vltava (reservoir Orlík)	Jehnědno	49°18'	14°20'	15/07/03	8	191	PK
Vltava (reservoir Kořensko, confluence with Lužnice)	Neznašov	49°14'	14°23'	2001-4	8	202	PK, B05
Vltava	Týn nad Vltavou	49°13'	14°25'	06/05/02	7	205	B05
Vltava (reservoir Hněvkovice)	Purkarec	49°08'	14°27'	2001	7	217	PK
Vltava	Hluboká nad Vltavou	49°03'	14°27'	30/08/04	7	228	AOPK
Vltava (confluence with Malše)	České Budějovice	48°58'	14°28'	12/09/05	6-7	240-241	AOPK
tributaries in the watershed of Vltava: running waters							
Sázava	Davle	49°53'	14°24'	30/08/05	7	< 1	AOPK
Sázava	Luka pod Medníkem	49°52'	14°27'	30/08/05	7	5	AOPK
Janovický potok (→ Sázava, km 19; → Vltava, km 78)	Krusičany	49°48'	14°36'	2004	5	< 1	V. Horálek
Vlkančický potok (→ Sázava, km 49; → Vltava, km 78)	Pyskočely	49°53'	14°53'	2004	4	2	V. Horálek
Otava (→ Vltava, km 169)	Zvíkovské Podhradí	49°26'	14°12'	11/07/01	7	< 1	PK
Jickovický potok (→ Vltava, km 171)	Jickovice	49°27'	14°13'	15/09/04	2	< 1	PK
Hrejkovický potok (→ Vltava, km 177)	Vůsí	49°24'	14°16'	2001-5	4	< 1	PK
Velký potok (→ Vltava, km 184)	Strouhy	49°21'	14°18'	2001-5	2	< 1	PK
Novosedlský potok (→ Vltava, km 184)	Strouhy	49°21'	14°18'	05/09/04	2	< 1	TP
Chřešťovický potok (→ Vltava, km 185)	Chřešťovice	49°20'	14°18'	05/09/04	2	< 1	TP
Lužnice (→ Vltava, km 202)	Neznašov	49°14'	14°24'	06/05/02	7	1	B05
Bílinský potok (→ Lužnice km 5; → Vltava, km 202)	Vesce	49°16'	14°26'	14/10/04	3	< 1	AP
Malše (→ Vltava, km 240)	České Budějovice	48°58'	14°29'	12/09/05	6	< 2	PK, AOPK
running waters not directly connected to main areas of *Orconectes* distribution							
Loupnice [+2] (→ Bílina, km 56; → Elbe, km 39)	Záluží (below the pond)	50°33'	13°35'	23/10/04	4	< 1 (57)	AOPK
Loupnice [+2]	Horní Jiřetín (below the pond Vítěz)	50°34'	13°34'	22/10/04	3	3 (59)	AOPK
outflow from the quarry Barbora [+3]	Oldřichov u Teplic	50°38'	13°45'	16/07/03	1	< 1 (upstream) 39 (downstream)	ZD
artificial channel connecting water bodies Kateřina and Modlany [+4]	Modlany	50°39'	13°53'	25/09/05	N/A	< 1	AOPK
Drnecký potok (→ Šternberský p., km 4; → Červený, km 14; → Bakovský, km 10; → Vltava, km 14)	Drnek	50°12'	13°59'	21/08/05	1	4 (31) *	AOPK
Zlatá stoka [+5] (artificial channel connecting fishponds)	Třeboň	49°00'	14°46'	02/07/01	N/A	N/A	PK
other standing waters					**character of the locality**		
Klíčov (quarry "Na skále")	Mrákov	49°24'	12°58'	2002-4	flooded quarry		PK
Kojetice	Kojetice u Neratovic	50°14'	14°30'	2004-5	flooded quarry		AP, LF
Černice [+2]	Černice	50°34'	13°32'	2005	undermined depression		M. Holzer
Barbora [+3]	Oldřichov u Teplic	50°38'	13°45'	2003-5	flooded surface coalmine		ZD, LF
Kateřina [+4]	Soběchleby	50°40'	13°54'	25/09/05	mining water reservoir		AOPK
Modlany [+4]	Modlany	50°39'	13°53'	30/09/05	mining water reservoir		AOPK
sandpit Lhota	Lhota	50°15'	14°40'	2004-5	sandpit		ZD, AP, LF
sandpits Cítov	Vliněves	50°22'	14°27'	2004-5	sandpit		ZD, LF, LB
sandpit Ovčáry	Ovčáry	50°15'	14°37'	27/10/04	sandpit		ZD
Račice "channel" (rowing stadium)	Račice	50°27'	14°21'	2004, 2005	sandpit		ZD, AOPK
Stará pískovna	Provodín	50°37'	14°35'	13/09/04	sandpit		MS
sandpit near the airport Borek	Stará Boleslav	50°12'	14°40'	21/08/04	sandpit		ZD
Proboštský rybník + other sandpits	Stará Boleslav	50°12'	14°39'	2004-5	sandpits		ZD, LF
sandpit Ostrá	Ostrá	50°11'	14°54'	2001-2	sandpit connected to the Elbe		B05,CSOP
sandpit Píšťany	Píšťany	50°32'	14°04'	14/09/05	sandpit connected to the Elbe		AOPK
village pond	Smečno	50°11'	14°02'	July 2005	small pond		AOPK
pond in children camp	Střemy	50°23'	14°33'	09/04/04	small pond		B06
fishpond Štampach [+1]	Střemy	50°24'	14°33'	23/11/02	fishpond		B06
fishpond Koclířov [+5]	Lomnice nad Lužnicí	49°04'	14°41'	October 2005	fishpond		LF
fishpond by Říčanský potok	Praha - Dubeč	50°03'	14°35'	2004	fishpond		AOPK

The presence of the spiny-cheek crayfish close to the mouth of most small streams, however, does not necessarily indicate a viable population, as the source population may be in the adjacent larger river or reservoir, and crayfish may penetrate to the small watercourse only temporarily. This is apparent from the fact that *Orconectes* has not been found in a number of small tributaries of the Elbe where historical records exist, but could be found in similar streams in close vicinity (Tab. I, II).

There are more discrepancies between older published distribution data of *O. limosus* and our present results. A study on the distribution of the species in Czechia in the 1990s (HAJER, 1994) reported the occurrence of this crayfish in middle or upper reaches of various rivers where it has not been confirmed after 2000 (most open circles in Figure 1). Moreover, *Astacus astacus* currently lives in one location (the river Ploučnice in the town Benešov nad Ploučnicí; 50°44'N, 14°19'E) where *Orconectes limosus* had been reported in the 1990s. Similarly, the noble crayfish was found downstream of alleged *O. limosus* localities in the river Ohře. HAJER (1994) reported the spiny-cheek crayfish in the river Ohře from the town Litoměřice (at the confluence with the Elbe) to Žatec (88 km upstream from the Elbe). However, *A. astacus* was more recently found in Počedělice (44 km from the Elbe; ĎURIŠ, unpublished), and the presence of *Orconectes* was confirmed only downstream, in the village Doksany (9 km from the Elbe).

It is not clear whether the discrepancy of recent and older data has been caused by misidentification in the past, the downstream retreat of *Orconectes*, fragmentation of its populations during the last few years, or a reduction of *Orconectes* population density which subsequently prevented its detection. The combination of all these factors could play a role. For example, after extensive floods in 2002, the *Orconectes* density dropped considerably in the Elbe (ĎURIŠ *et al.,* 2006*;* ŠPAČEK, pers. comm.) as well as in adjacent flooded sandpits and dead arms, and the floods may have similarly affected the crayfish populations in large rivers elsewhere. In at least some cases, however, the reports from the mid-1990s seem to be erroneous.

CONCLUSIONS

Orconectes limosus is the most widespread crayfish of non-European origin in the Czech Republic. It has occupied a large part of the Elbe watershed and due to human-mediated translocations, it can also be found in a number of isolated water bodies and some small streams. However, the monitoring of its distribution revealed that the species usually stays only in the lower reaches of smaller streams or rivers and that there are significant differences between the recent distribution and the historical data on its occurrence. The species is able to carry the crayfish plague pathogen and transmit it to native species. Therefore, it is important to monitor its invasion in the Czech Republic also in the future.

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