FOLIA MALACOLOGICA
Folia Malacol. 23(4): 243–261
ISSN 1506-7629
The Association of Polish Malacologists
Faculty of Biology, Adam Mickiewicz University
Bogucki Wydawnictwo Naukowe
Poznań, December 2015
http://dx.doi.org/10.12657/folmal.023.021

AQUATIC MOLLUSC FAUNA OF THE OHŘE RIVER – AN IMPORTANT SITE OF *UNIO CRASSUS* PHILIPSSON, 1788 (BIVALVIA: UNIONIDAE) IN NORTHWESTERN BOHEMIA

LUBOŠ BERAN

Nature Conservation Agency of the Czech Republic, Regional Office Kokořínsko – Máchův kraj Protected Landscape Area Administration, Česká 149, CZ–276 01 Mělník, Czech Republic (e-mail: lubos.beran@nature.cz)

ABSTRACT: Mollusc communities of the Ohře (Eger) River, which drains a large part of northwestern Bohemia, were studied. In total, 43 freshwater mollusc species (22 gastropods, 21 bivalves) were found at 56 sites. The richest malacofauna (31 species) was recorded in the lower river section. One empty shell of *Margaritifera margaritifera*, a species regarded as critically endangered in the Czech Republic, was found. There are no previous records of this bivalve in the Ohře River and its tributaries, and its recent occurrence there is unlikely. *Planorbis carinatus, Unio crassus, Pseudanodonta complanata, Pisidium amnicum* and *P. moitessierianum*, endangered in the Czech Republic, were recorded. The population of *U. crassus* is the largest in northwestern Bohemia and one of the largest in the Czech Republic. It is divided in two parts by the Nechranice dam lake. Likewise, populations of other species are negatively affected by the dam, as well as by the pollution and watercourse alteration. In some sites the muskrat (*Ondatra zibethicus*) was observed to predate on unionids and especially on *U. crassus*. The occurrence of five alien species (*Potamopyrgus antipodarum*, *Physella acuta*, *Gyraulus parvus*, *Corbicula fluminea*, *Dreissena polymorpha*) was confirmed. A gradual invasion of *C. fluminea* was observed; the species is predated by an unidentified animal, probably also muskrat.

KEY WORDS: Ohře (Eger) River, molluscan assemblages, endangered species, *Margaritifera margaritifera*, *Unio crassus*, invasive species, *Corbicula fluminea*

INTRODUCTION

The mollusc fauna of the Czech part of the Ohře (Eger) River was of interest to malacologists already 150 years ago. SLAVÍK's (1868) record of *Unio crassus* in the Ohře River in Louny is probably the first information on the river's freshwater molluscs. Twenty five years later, ULIČNÝ (1892–1895) mentioned the same species together with other molluscs. All the published and unpublished data on the occurrence of freshwater gastropods till 1990 were summarised in FLASAR (1998). BERAN (1998) studied the lower section of the Ohře River and found only old shells of *Unio crassus,* but later he documented rare occurrence of this bivalve at several sites of the Ohře River (BERAN 2001). Several oxbows of the Ohře River near Doksany were also studied (BERAN 2005a). The lower section of the river was repeatedly visited during the last 15 years, and later also its middle and upper sections were explored; this is the reason for summarising the recently obtained data from the Ohře.

The main objective of this study was to expand the knowledge about mollusc communities of the Czech part of this river, with special reference to the population of *Unio crassus*, as well as other endangered or rare molluscs, and on the other hand on invasions of non-native gastropods and bivalves.

STUDY AREA

The Ohře River originates near Wiesenstadt in Germany at the altitude of 752 m, it flows through Lake Weissenstadt and after 35 km crosses the border into the Czech Republic. After 300 km it falls into the Labe (Elbe) River in Litoměřice at 143 m a.s.l. The river drains a large part of nortwestern Bohemia. The average annual discharge before the outlet into the Labe River is 37.9 m³/sec (VLČEK 1984). The river was only partly changed and canalised. The Skalka dam lake was built in the upper section while the Nechranice dam lake (1,338 ha) was built in the middle section. Both reservoirs changed the river's character for a long distance below the dams.

Fifty six study sites were located in the Czech part of the Ohře River including the two canals (mill races) and the Nechranice dam lake (Fig. 1, Appendix 1). The studied part of the river was divided into five sections:

- Ohře I – Ohře River between the Skalka dam lake (near the Czech-German boundary) and the Nechranice dam lake (Fig. 2),
- Ohře II – Nechranice dam lake,
- Ohře III – Ohře downstream of the Nechranice dam lake (Fig. 3),
- Malá Ohře – canal (mill race) of the Ohře River between Libochovice and Budyně nad Ohří,
- Brozanský náhon – mill race between Hostěnice and Brozany nad Ohří.

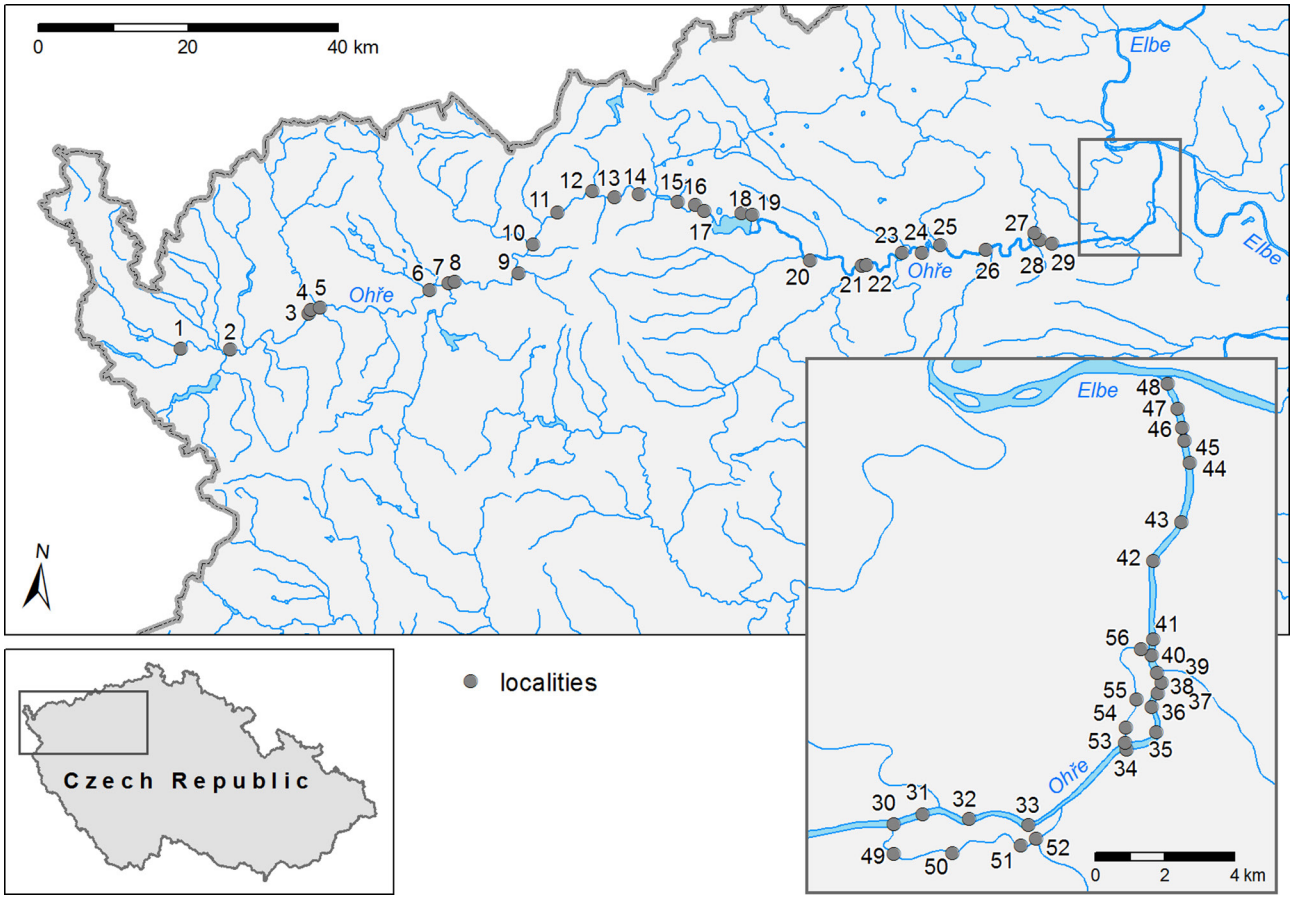

Fig. 1. Map of the Ohře River with the sampling sites. Fot details see Appendix 1. Drawing: HELENA KAŇKOVÁ

Fig. 2. Ohře River in Sokolov: upper section (Ohře I, site 5). Photo: LUBOŠ BERAN

Fig. 3. Ohře River in Radovesice: lower section (Ohře III, site 31). Photo: LUBOŠ BERAN

MATERIAL AND METHODS

Fieldwork was carried out in 2000–2014. Freshwater molluscs were mainly sampled by washing vegetation or sediments on a metal sieve (diameter 20 cm, mesh size 0.8 mm), combined with collecting by hand, searching the surface of stones, wood and artificial materials (e.g. plastic bags and bottles). Unionidae were sampled by means of visual inspection of suitable habitats while wading upstream and searching for live molluscs or recently dead individuals (nacreous shell layer still lustrous, periostracum coloured). Places with fine sediment were searched by hand. The time spent at each site varied from approximately 40 to 90 minutes and depended on the character of the site. The main aim was to explore most of the different microhabitats, even at the expense of statistically more comparable methods. More attention was usually paid to the presence of unionids and especially *U. crassus*. The numbers of recorded individuals were noted (only estimation was mentioned in the case of more abundant species) and are presented in Appendix 2. The abundance of some species was converted to density per larger unit area. All live individuals of *U. crassus* were measured and released into the habitat. In the case of more abundant populations these data were used to study the size structure.

The molluscs were identified based on their shell and/or genital characters. Specimens for dissection were killed in hot water and then fixed in 70% ethanol. No specimen of legally protected species (*U. crassus, U. pictorum, Anodonta cygnea*) was killed. Selected shells of endangered or rare species are deposited in the author's collection. The classification used follows HORSÁK et al. (2013).

RESULTS

MOLLUSC COMMUNITIES

In total, 43 freshwater mollusc species were found in the Ohře River and its two canals: 22 gastropods and 21 bivalves. Thirty one species were recorded in the upper section of the river (Ohře I, upstream of the Nechranice dam lake), while in the lower section (Ohře III) the mollusc communities included 39 species. The malacoceonoses of both canals of the Ohře River were less diverse: 13 species were recorded in the canal Malá Ohře and 16 species in the Brozanský náhon. The fewest species (7) were recorded in the Nechranice dam lake (Ohře II).

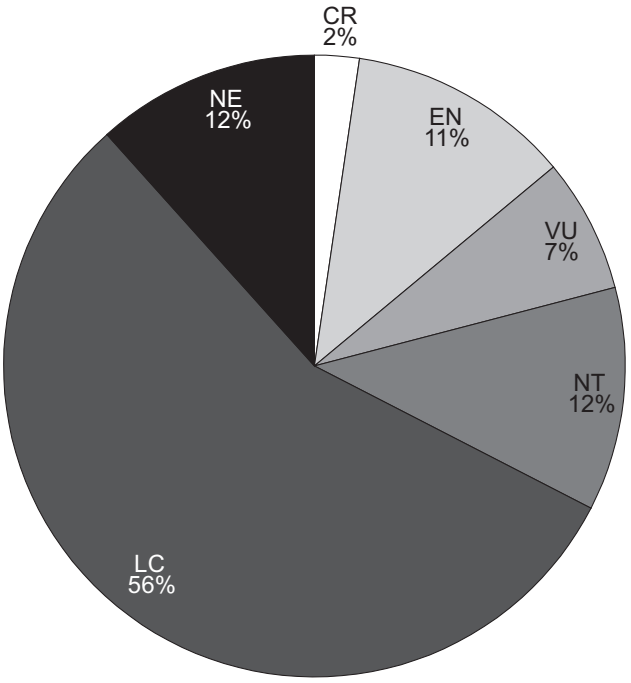

Fig. 4. Proportion of different species categories of the Red List: CR – Critically Endangered, EN – Endangered, VU – Vulnerable, NT – Near Threatened, NE – Not Evaluated

The lists of the studied sites and recorded species are shown in Appendices 1 and 2.

Potamopyrgus antipodarum, Bithynia tentaculata, Ancylus fluviatilis, U. crassus, Anodonta anatina, Sphaerium corneum, Pisidium nitidum and *P. subtruncatum* were recorded at more than half of the studied sites. *Radix balthica, Planorbis carinatus* and *Gyraulus parvus* were found only in the upper section of the Ohře River, while *Unio tumidus, Pseudanodonta complanata, Corbicula fluminea, Sphaerium rivicola, Pisidium amnicum* and *P. moitessierianum* were found only in the lowest part of the Ohře River including its canals.

ENDANGERED AND RARE MOLLUSCS

Several of the recorded species are rare and endangered in the Czech Republic (Fig. 4). Only one of the recorded species is critically endangered in the Czech Republic (BERAN et al. 2005): *Margaritifera margaritifera*. One empty shell was found at site 26. *P. carinatus, U. crassus, P. complanata, P. amnicum, P. moitessierianum,* recorded in the Ohře River, are listed in the Czech Red Data List (BERAN et al. 2005) as endangered. The occurrence of *U. crassus* is presented in the following chapter. *P. carinatus* was found in the upper section of the Ohře River while *P. complanata, P. amnicum* and *P. moitessierianum* were recorded only in the lowest section including the canals (see Figs 5 and 6). Abundant populations of *P. carinatus* were

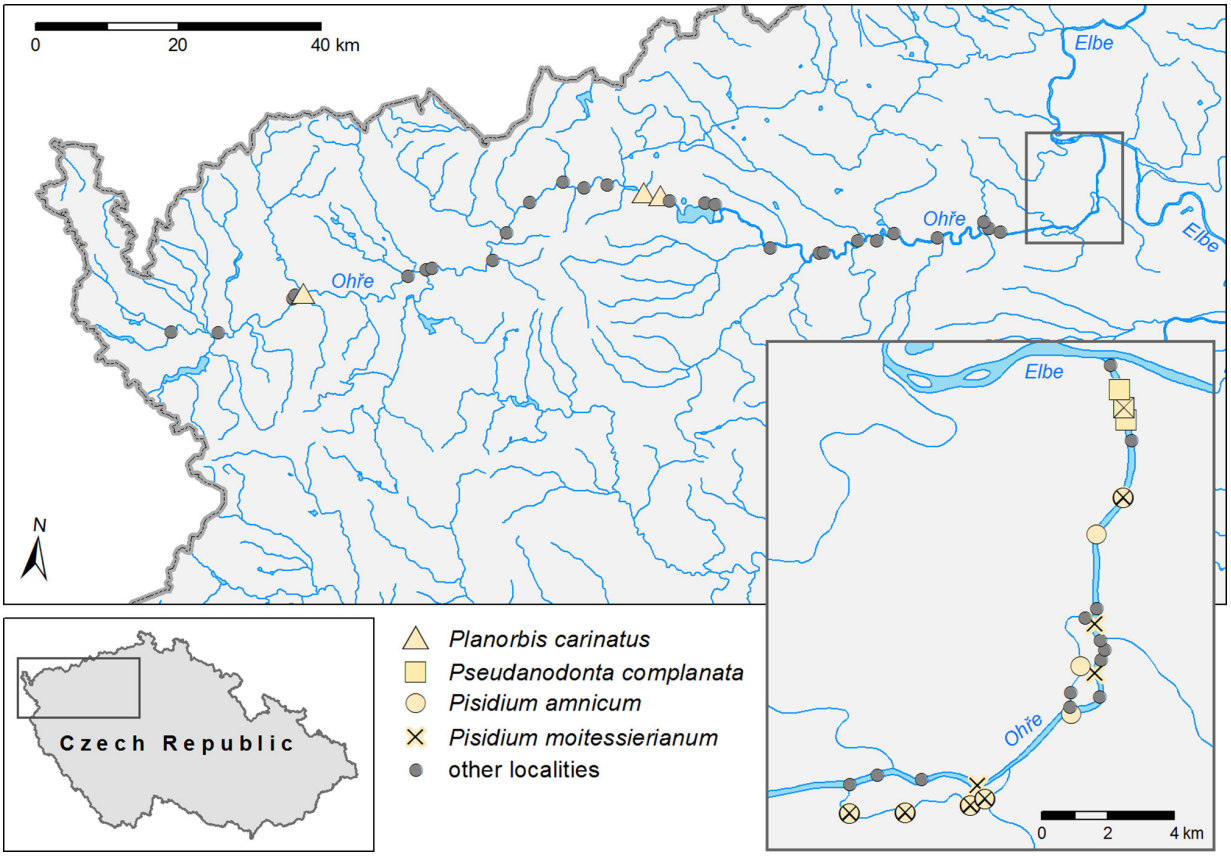

Fig. 5. Distribution of endangered species except *Unio crassus*. Drawing: HELENA KAŇKOVÁ

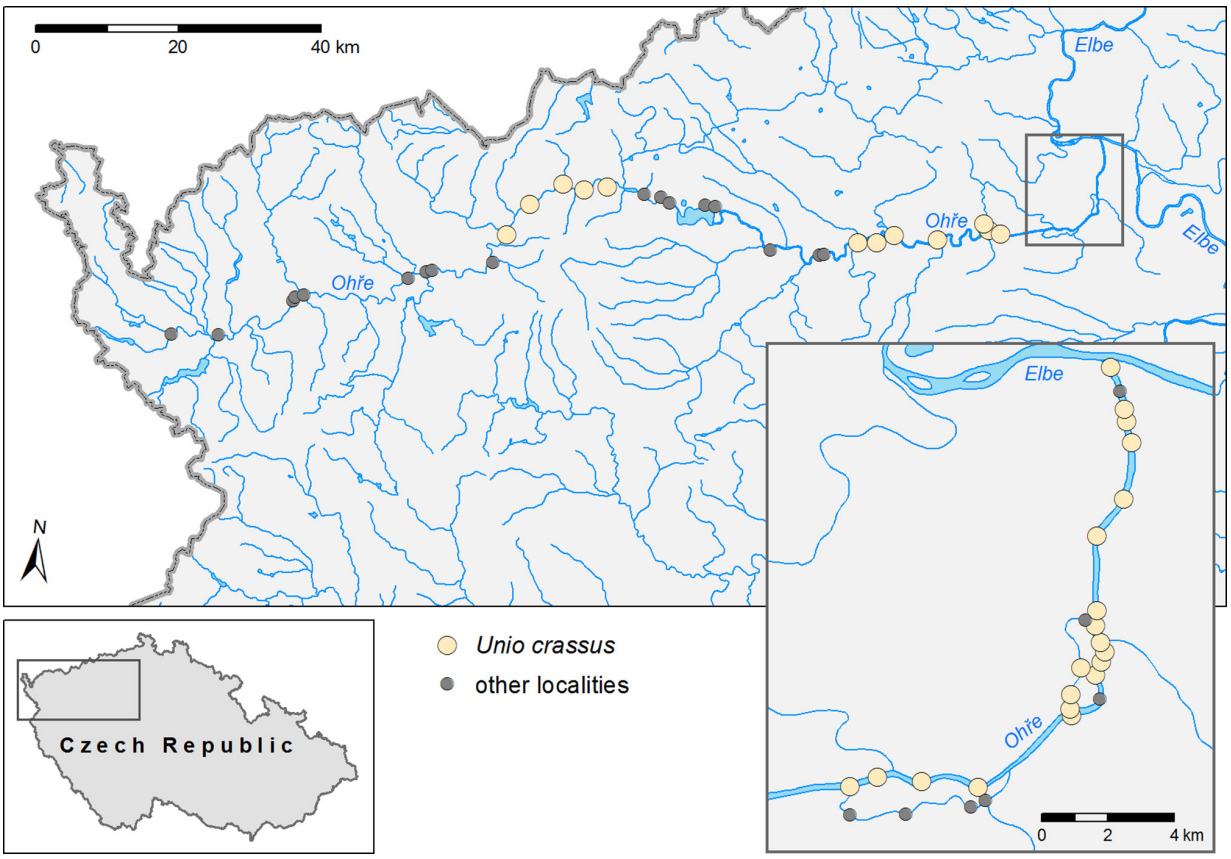

Fig. 6. Distribution of *Unio crassus*. Drawing: HELENA KAŇKOVÁ

found at three sites. Few specimens of *P. amnicum* and *P. moitessierianum* were found at five sites in the Ohře River and Brozanský náhon while more abundant populations occurred in the Malá Ohře canal. *P. complanata*, which is vulnerable or endangered in many European countries, was occasionally found at several localities in the lowest section of the Ohře River (sites 45–47). Another three species (*U. tumidus*, *A. cygnea*, *Pisidium hibernicum*) are listed in the Czech Red Data List as vulnerable, and five species (*Viviparus viviparus*, *Radix ampla*, *S. rivicola*, *Pisidium obtusale*, *P. supinum*) as near threatened (Fig. 4).

UNIO CRASSUS

Populations of this endangered mussel were found in two river sections. The first one is the Ohře River upstream of the Nechranice dam lake where the species was observed along a stretch of at least 25 km, with an abundant population between Klášterec nad Ohří and Stráž nad Ohří (sites 11–14), while upstream its occurrence was significantly less abundant (Appendix 2: Table 2). The second one is the lower river section from Postoloprty to the inflow into the Labe River (ca 70 km, sites 23–48). The species' density in the Ohře River was small, usually not exceeding 1 ind./m^2 and rather less than 1 ind./1 m of the watercourse. The highest density was observed at site 12 (28 ind./30×0.5 m) (Fig. 7). *U. crassus* and other bivalves were also found in deep parts of the watercourse. The bottom of the Ohře River upstream of the weir in Terezín in the lower river section was searched during the reconstruction of walls and waterfront at the depth of 2.5–3 m (Table 1). Similarly, the bottom downstream of the weir (depth ca 0.6–1 m) was examined. The survey was conducted at small sections (50–150 m^2) without water or with lower water level (Fig. 8). The results confirmed the small abundance of *U. crassus* and other unionids.

The size structure of the population differed between the two river sections (Fig. 9). Individuals with shell length 55–85 mm formed more than 82% of the sample from the lower section in 2012 while smaller (younger) specimens with shell length 45–65 mm dominated at the same site in 2003 and in the upper section.

Predation of unionids was observed at some sites, and was especially significant at two of them. More than 60 empty fresh shells of *U. crassus* were found at site 12 (Fig. 10). Three piles of fresh empty shells: 58 of *U. crassus*, 48 of *U. pictorum* and 39 of *A. anatina*, were found at site 34.

NON-NATIVE MOLLUSCS

Five non-native molluscs were recorded in the Ohře River (Fig. 11). *P. antipodarum*, an invasive species originating from New Zealand, was found at 35 sites while *Physella acuta* was recorded at only four sites. *Gyraulus parvus* which, together with the preceding species, represents the North American element in the Czech malacofauna, was found at only one site in the upper section of the Ohře. *Corbicula fluminea* is an alien species originating from southeastern Asia. Its occurrence was recorded in the lowest section of the Ohře River at eight localities, and its gradual invasion was observed during the study. Many piles of empty fresh shells of predated individuals were found at sites 41 and 56. The occurrence of *Dreissena polymorpha* was observed at eight sites at the Nechranice dam reservoir and in the Ohře River downstream of this reservoir; the species occurred very abundantly in the Nechranice dam reservoir.

Table 1. Abundance of unionids in Terezín: 1–3 – sections (150 m^2) without water upstream of the weir in Terezín (site 44), depth 2.5–3 m, 4–7 – sections (50 or 100 m^2) with lower water level downstream of the weir in Terezín (site 45), depth 1–1.5 m

	Place No.													
	1		2		3		4		5		6		7	
Species \ area [m^2]	150	1	150	1	150	1	50	1	50	1	50	1	100	1
Unio crassus Philipsson, 1788	14	0.09	11	0.07	5	0.03	13	0.26	2	0.04	6	0.12	3	0.03
Unio pictorum (Linnaeus, 1758)	87	0.58	18	0.12	13	0.09	1	0.02	1	0.02	1	0.02		
Anodonta anatina (Linnaeus, 1758)	106	0.70	125	0.83	51	0.39	19	0.38	17	0.34	14	0.28	1	0.01
Anodonta cygnea (Linnaeus, 1758)	1	0.006												
Pseudanodonta complanata (Rossmässler, 1835)											1	0.02	1	0.01
Number of specimens	208	1.40	154	1.00	69	0.46	33	0.66	20	0.40	22	0.44	5	0.05

Fig. 7. Specimens of *Unio crassus* found at site 12 in the upper section of the Ohře River. Photo: LUBOŠ BERAN

Fig. 8. A section with lower water level downstream of the weir in Terezín (site 45). Photo: LUBOŠ BERAN

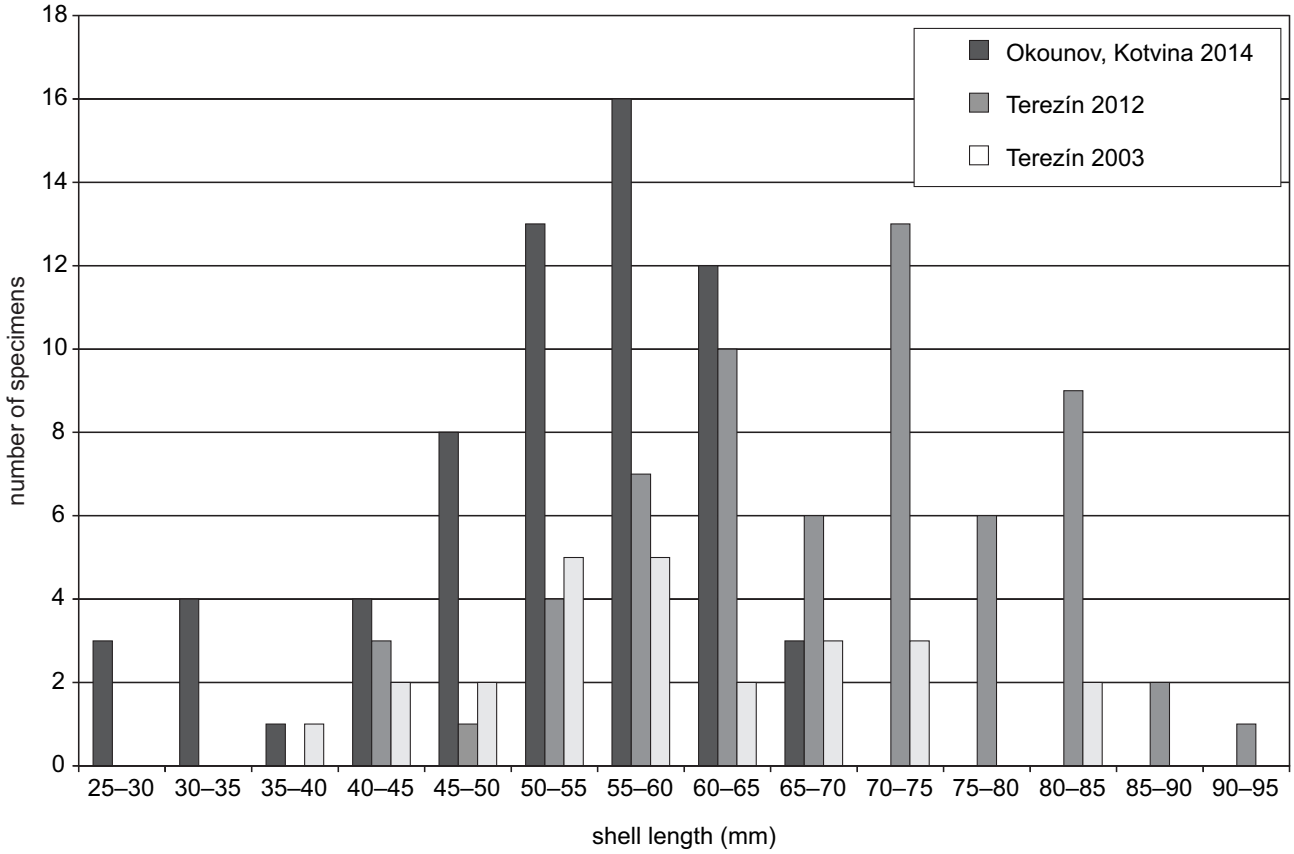

Fig. 9. Shell length of observed individuals of *Unio crassus*: first column – sites 12 and 13; second column – sites 44 and 45; third column – site 46a

Fig. 10. Empty shells of *Unio crassus* predated by *Ondatra zibethicus* collected at site 12. Photo: LUBOŠ BERAN

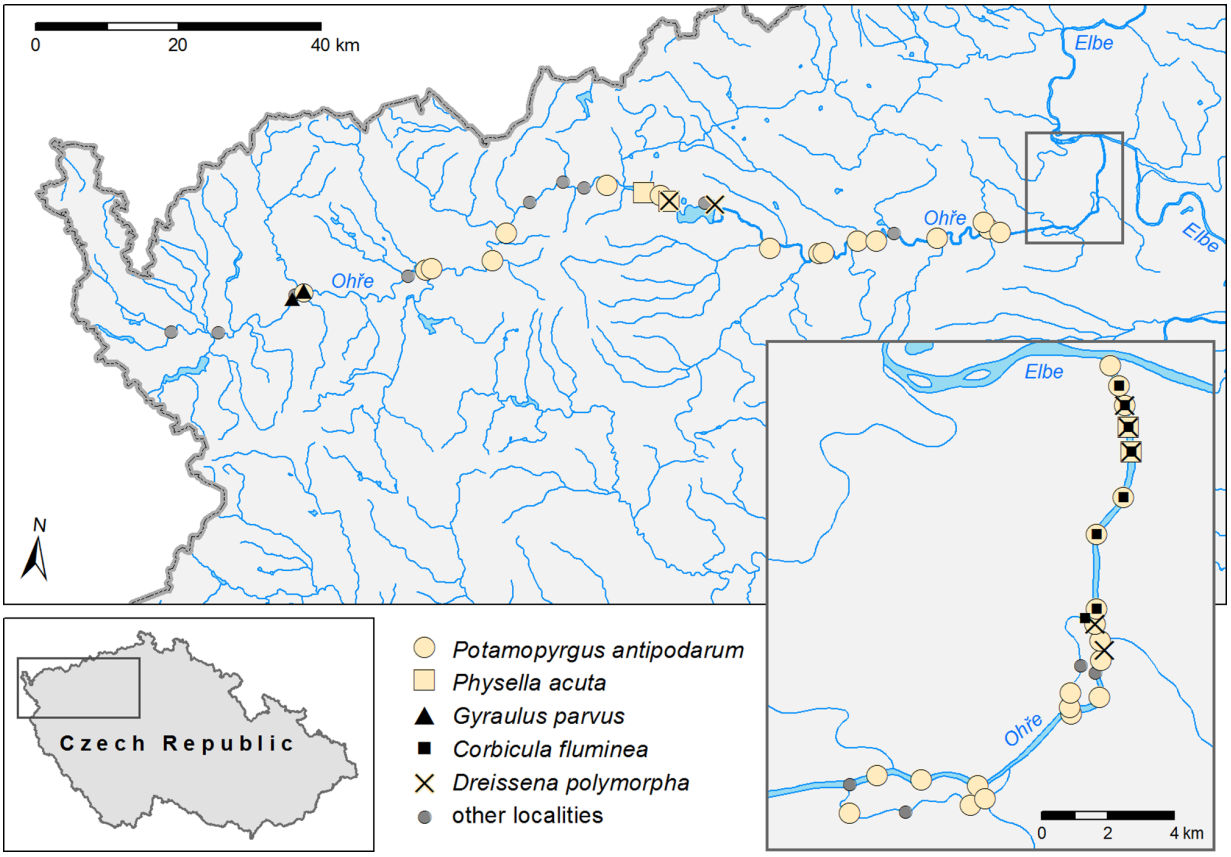

Fig. 11. Distribution of non-native molluscs. Drawing: HELENA KAŇKOVÁ

DISCUSSION

The Ohře River holds rich and diversified mollusc communities. Although only the main stream and two canals of the river were studied, 43 freshwater mollusc species were recorded. They constituted ca. 55% of the total freshwater malacofauna of the Czech Republic. The proportion was very similar to that observed in the Dyje River with its 41 species (BERAN 2013a) and higher than in the Labe (Elbe) River – the largest river in the Czech Republic (BERAN 2005b, 2009) which was canalised for most of its course.

The smallest number of species was recorded in the Nechranice dam reservoir. The reason was probably the inadequate character of the reservoir (near absence of littoral vegetation) and the manipulation with its water level. The site was studied at the normal water level and it is possible that a search during low water level would reveal a more diverse mollusc fauna (especially unionids). The reservoir also influences the watercourse and its mollusc communities (lower diversity, absence of unionids) downstream. A similar situation was observed in the Dyje River (BERAN 2013a).

P. carinatus is the only freshwater gastropod species which is rare or endangered in the Czech Republic. It survives in the lowlands along larger rivers and, in the western part of Bohemia, also in several smaller rivers, oxbows and pools of the floodplains (BERAN 2002). Its occurrence in the upper section of the Ohře River is surprising and is probably restricted to sites with slow-flowing or stagnant water (oxbows). Such habitats are rare in this river section. Slow sections are more frequent downstream of the Nechranice dam reservoir, but the species was not found in that part or oxbows or pools during earlier studies (BERAN 1998, 2001, 2005a). *P. carinatus* was recorded in northwestern Bohemia also in oxbows of the Ohře River in Kynšperk nad Ohří (MÁCHA 1955, L. BERAN, unpublished records of 6.7.2000 and 9.3.2008) and in oxbows of the same river near Cheb (V. LOŽEK, unpublished record of 9.9.1973). No further records of this gastropod are known from northwestern Bohemia.

The most mysterious find is the single empty shell of the critically endangered *M. margaritifera* at site 26. The shell was not fresh but it was not subfossil (Fig. 12). There were no previous records of the species from the Ohře River or its tributaries. Site 26 is situated downstream of the Nechranice dam reservoir which was built in 1968, so it is not possible that

Fig. 12. Empty shell of *Margaritifera margaritifera* found at site 26 (length 87 mm, height 38 mm). Photo: LUBOŠ BERAN

the shell was transported by water during floods. Its occurrence in any of the small tributaries of the Ohře River is also unlikely.

In the past *U. crassus* was among the most common and widespread unionids; in the Czech Republic it was even used as feed for livestock (ULIČNÝ 1892–1895). In the 20th century it became endangered not only in the Czech Republic but also in many other European countries. At present, the species is included in the IUCN Red List as endangered (LOPES-LIMA et al. 2014) and is also listed in the EC Habitats Directive (92/43/ECC), Annexes II and IV. Only 20–25 watercourses in the Czech Republic are known to hold larger populations of *U. crassus* (BERAN 2002, DOUDA & BERAN 2009). An abundant population of the species was found in the Ohře River between its inflow into the Labe River (site 48) and Vojkovice (site 10). The recent occurrence of fresh empty shells is known also from the Ohře River in Karlovy Vary (V. MELICHAR, pers. comm.) and it is possible that a population lives upstream. The population of *U. crassus* in the Ohře River is divided into two parts by the Nechranice dam reservoir. This situation is similar as in the case of the Dyje River where the population of this mussel is divided into 2–3 subpopulations by dam reservoirs (BERAN 2013a). The abundance of *U. crassus*, usually not exceeding 1 ind./m^2 (the highest recorded density less than 2 ind./m^2), is smaller compared to the highest known densities recorded in the Czech Republic, especially in smaller watercourses, for example Hovězí (a small canal of the Bečva River): 20 ind./m^2 (BERAN 2007a), or Šárovcova Lhota (Lukavecký potok Brook): 8.3 ind./m^2 (BERAN 2012). The highest density was observed in the small canal of the Bečva River in Vsetín – 87 ind./m^2 (L. BERAN, unpublished record, 22.9.2012). The highest density recorded during the study of the Dyje River and its tributaries was 7.8 ind./m^2 (BERAN 2013a), but usually the densities of the thick-shelled river mussel in larger rivers in the Czech Republic do not exceed 1 ind./m^2 and are rather less than 1 ind./1 m of the watercourse, similarly as in the Ohře River. The maximum density of 14–100 ind./m^2 was recorded during the study of four populations in the rivers of Mecklenburg-Vorpommern (northeastern Germany) (ZETTLER & JUEG 1997), and 100–180 ind./"brook metre" in the case of the river Löcknitz (ZETTLER & JUEG 2007). The density of *U. crassus* ranged from 2–3 to 4–20 ind./m^2 in the Wkra River (Poland) (LEWIN 2014) and from 5 to 50 ind./m^2 in the Cedron River

(Poland) (Zając & Zając 2011). Nevertheless, the population in the Ohře River is the largest one (only one?) in northwestern Bohemia and, due to the total length of the river section inhabited by *U. crassus,* it also belongs to the most abundant populations in the Czech Republic. The total size of the population is estimated from 25,000 to 40,000 in the upper and from 30,000 to 100,000 individuals in the lower river section.

An SCI (Site of Community Importance) for *U. crassus* was established in the lower river section downstream of the Nechranice dam reservoir. The population in the upper river section was not known at the time when protected areas for this species were established, so the upper section was not included in the SCIs for this bivalve.

The comparison of size structure in selected sites and periods in both sections of the river shows that the population in the upper section (samples from sites 12 and 13) includes a higher proportion of smaller (younger) individuals, compared to the population of the lower section studied in 2012 (sites 44, 45), while the size structure of the sample from the same part in 2003 (site 46a) more closely resembles such structure of the population from the upper section (Fig. 9). It is not possible to exclude negative changes in the lower river section which were reflected in the size (age) structure of the population of *U. crassus*.

The predation of unionids may also represent a negative impact on their populations. In the Ohře River the impact is too local to be the main reason for the decline. The impact may be much more significant in smaller watercourses. For example, a significant predation of *U. crassus* by the muskrat (*Ondatra zibethicus*) was observed in 2008 in the Lukavecký potok. This small brook in eastern Bohemia is about 1 m wide. In 2008, more than 180 empty fresh shells were found along a section of ca. 50 m (Beran 2012). In such cases, the predation may be a major cause of decline or extinction of local populations. It is supposed that in the Ohře River the only predator is the muskrat (*O. zibethicus*). At least at two most exploited sites typical signs of predation by this alien species were observed – piles under the water near burrows, and empty open complete shells. Typical traces of activity of other predators – holes in the shells made by the otter (*Lutra lutra*) or shells partly damaged by the raccoon (*Procyon lotor*) were not recorded. The muskrat (*O. zibethicus*) is also regarded as the most serious predator of unionids in the Czech Republic, while predation by another alien animal, the raccoon, was described in the Czech Republic only from Central Moravia (Beran 2007b), and predation by the otter is probably rare (V. Hlaváč, pers. comm.). Predation by the mink (*Neovison vison*) has not been observed in the Czech Republic.

Another endangered unionid, *P. complanata,* occurs only in the lowest river section downstream of the weir in Terezín; it is a very rare species in the Ohře River. This bivalve is rare or endangered in many European countries and it is also listed in the IUCN Red List as vulnerable (Van Damme 2011). It seems to be common in the Czech Republic, but its occurrence is scattered and its densities small (Beran 2002). Its presence in the lowest river section is probably connected with the population in the Labe River where this species also occurs (Beran 2005b).

P. amnicum is an endangered pea mussel which inhabits unregulated and unpolluted rivers, brooks and canals with sandy or sandy-muddy bottom. In the Czech Republic it is known to occur especially in brooks or small rivers (Beran 2002, 2006a) and also in canals of larger rivers (Beran 2003, 2007b). This corresponds with the results of this study where very scattered occurrence was observed in the Ohře River, but a much more abundant population was found in one (Malá Ohře canal) of its two investigated canals. A similar situation was observed also in the case of *P. moitessierianum* inhabiting slow-flowing waters with sandy-muddy sediments and often co-occurring with the preceding species.

Altogether five alien species (four originating from other continents) were recorded in the Ohře River. A gradual invasion of *C. fluminea* was observed during this study. It is especially visible when results of surveys at several sites (site 42, 43, 46) in different periods are compared (see Appendix 2: Table 4). The first records of this species in the Ohře River date from 2012. The occurrence was observed in five sites in that year while there were no records during the previous 15 years. *C. fluminea* was found at site 46 also in 2012 while the previous visits (2003, 2008) failed to reveal its occurrence. The same was true of sites 42 and 43 where *C. fluminea* was not found in 2008. The first record of the species in the Czech Republic dates from 1999 when it was found in the Labe (Elbe) River (Beran 2000). As a result of its gradual invasion in the Czech Republic (Beran 2006b, 2013b, Horáčková et al. 2014) it is now present in a ca. 200 km section of the Labe River, the lowest section of the Vltava River, several small tributaries of the Labe and also in the Ohře River (Beran 2013b). Its invasion, not only in the Ohře River, is likely to continue. A very abundant occurrence was observed in site 56: the species was dominant, and its density exceeded 700 ind./m^2. Piles of its empty shells were also observed on the canal banks at sites 41 and 56. The animal that consumed *C. fluminea* was not identified. Large clams (Unionidae) are often consumed by the muskrat. Typical traces of muskrat predation were observed (piles below water level near the burrow, empty open complete shells, Fig. 13), indicating that it was the predator.

Fig. 13. One of many piles of empty shells of *Corbicula fluminea* at site 56. Photo: LUBOŠ BERAN

G. parvus was found at only one site with slow-flowing water at the inlet of the canal of the Ohře River into Lake Medard, an artificial lake created by flooding of a coal mine. This species inhabits especially newly created sites with stagnant water (sand pits, quarries, new ponds). The occurrence in the Ohře River is probably related to its occurrence in Lake Medard (L. BERAN, unpublished records). *P. antipodarum* is the most common and widespread non-native gastropod in the Ohře River. The probable reason for its occurrence is suitable habitats (sandy and gravel bottom) in this watercourse. The species was recorded also during the earlier study (BERAN 1998). Another two non-native species are known to occur in the Labe River basin and in northwestern Bohemia. *Menetus dilatatus* occurs especially in the Labe River and its oxbows (BERAN 2001), and *Ferrissia fragilis* was recorded in oxbows of the lower section of the Ohře River (BERAN 2001, 2005a). Its occurrence in slow-flowing parts of the river is possible. *Sinanodonta woodiana*, a non-native invasive unionid, was recorded neither in the study area nor in the lower part of the Labe River near the mouth of the Ohře River. The species occurrs in south Moravia (BERAN 2013a) and south Bohemia (HORÁČKOVÁ et al. 2014).

CONCLUSIONS

The survey confirmed the existence of rich mollusc communities. The malacofauna of the Ohře River was negatively altered by the construction of two dam reservoirs which divided the river into several sections, changed the watercourses below the dams and, in the case of the Nechranice dam reservoir, also divided the population of the endangered *U. crassus*. Other negative impacts are pollution and watercourse alteration including building of many weirs. Unionids are locally affected also by predation by the muskrat. Despite these negative anthropogenic effects, populations of endangered or rare species are present at several sites and a large population of *U. crassus* occurs in two sections of the Ohře.

ACKNOWLEDGEMENTS

I thank HELENA KAŇKOVÁ for preparing the maps.

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Received: April 24th, 2015
Revised: June 1st, 2015
Accepted: June 6th, 2015
Published on-line: September 18th, 2015

Appendix 1

List of investigated sites (see Fig. 1); data in the list are as follows: site number, geographical co-ordinates (http://www.mapy.cz/), code of the mapping grid for faunistic mapping (according to PRUNER & MÍKA 1996), name of the nearest settlement, description of the site, date of investigation.

Ohře (Ohře I – 1–17, Ohře II – 18–19, Ohře III – 20–48)

1 – 50°06'25"N, 12°23'48"E, 5840, Jindřichov, Ohře River downstream of the road Jindřichov-Tršnice, 18.11.2013;
2 – 50°06'56"N, 12°29'24"E, 5840, Mostov, Ohře River in Mostov, 6.7.2000;
3 – 50°10'37"N, 12°37'15"E, 5841, Sokolov, inlet of the canal of Ohře River into artificial Lake Medard, 30.3.2014;
4 – 50°10'37"N, 12°37'17"E, 5841, Sokolov, Ohře River by the inlet of the canal into artificial Lake Medard, 3.9.2011;
5 – 50°10'58"N, 12°38'24"E, 5841, Sokolov, Ohře River at the inflow of Svatava River in Sokolov, **a)** 3.9.2011, **b)** 14.9.2014;
6 – 50°13'28"N, 12°50'29"E, 5743, Karlovy Vary, Ohře River up- and downstream of the weir in Karlovy Vary-Tuhnice, 6.7.2000;
7 – 50°14'04"N, 12°52'12"E, 5743, Karlovy Vary, Ohře River downstream of the inflow of Teplá River, 9.10.2011;
8 – 50°14'07"N, 12°52'34"E, 5743, Karlovy Vary, Ohře River ca 1 km downstream of the inflow of Teplá River, 9.10.2011;
9 – 50°15'42"N, 13°00'00"E, 5744, Kyselka, Ohře River in Kyselka by the bridge, 28.8.2010;
10 – 50°17'55"N, 13°01'01"E, 5744, Vojkovice, Ohře River in Vojkovice, 28.8.2010;
11 – 50°20'20"N, 13°03'13"E, 5644, Stráž nad Ohří, Ohře River upstream of the bridge in Stráž nad Ohří, 27.8.2010;
12 – 50°22'11"N, 13°06'29"E, 5644, Okounov, Ohře River 400 m upstream of the bridge in Okounov, 15.11.2014;
13 – 50°22'02"N, 13°09'13"E, 5644, Kotvina, Ohře River 100 m upstream of the railway station Kotvina, 15.11.2014;
14 – 50°22'37"N, 13°11'44"E, 5645, Klášterec nad Ohří, Ohře River ca 1.2 km downstream of the bridge in Klášterec nad Ohří, 4.9.2011;
15 – 50°22'26"N, 13°16'10"E, 5645, Kadaň, Ohře River between two weirs, 27.8.2010;
16 – 50°22'29"N, 13°18'15"E, 5645, Kadaň, Ohře River east of Kadaň, 7.7.2000;
17 – 50°22'08"N, 13°19'13"E, 5646, Tušimice, Ohře River at inflow of the Nechranice dam reservoir, 23.1.2010;
18 – 50°22'34"N, 13°23'31"E, 5646, Tušimice, northern bank of the Nechranice dam reservoir, 23.1.2010;
19 – 50°22'30"N, 13°25'04"E, 5646, Nechranice, southeastern bank of the Nechranice dam reservoir, 25.10.2009;
20 – 50°19'52"N, 13°31'58"E, 5647, Žatec, Ohře River downstream of the weir in Žatec, 5.10.2014;
21 – 50°19'56"N, 13°38'02"E, 5647, Hradiště, Ohře River upstream of the bridge in Hradiště, 6.8.2006;
22 – 50°20'03"N, 13°38'12"E, 5647, Hradiště, Ohře River at the bridge in Hradiště, **a)** 30.8.2001, (BERAN 2001), **b)** 26.8.2010;
23 – 50°21'20"N, 13°42'11"E, 5648, Postoloprty, Ohře River at the bridge south of Postoloprty, 30.8.2001 (BERAN 2001);
24 – 50°21'26"N, 13°44'14"E, 5648, Březno, Ohře River downstream of the weir, 12.5.2006;
25 – 50°22'19"N, 13°46'15"E, 5648, Lenešice, Ohře River upstream of Lenešice, 6.8.2006;
26 – 50°22'27"N, 13°51'22"E, 5649, Obora, Ohře River between Obora and Černčice, 6.8.2006;
27 – 50°23'42"N, 13°56'52"E, 5649, Želevice, Ohře River at the bridge in Želevice, 6.8.2006;
28 – 50°24'02"N, 13°56'38"E, 5549, Koštice, Ohře River downstream of the weir in Koštice, **a)** 30.8.2001 (BERAN 2001), **b)** 7.6.2003;

29 – 50°23'35"N, 13°58'40"E, 5649, Křesín, Ohře River downstream of the weir in Křesín, **a)** 16.10.2000 (Beran 2001), **b)** 12.8.2006;
30 – 50°24'16"N, 14°03'44"E, 5550, Libochovice, Ohře River downstream of the weir east of Libochovice, **a)** 27.9.2006, **b)** 20.5.2007;
31 – 50°24'25"N, 14°04'11"E, 5550, Radovesice, Ohře River at the bridge in Radovesice, **a)** 7.6.2003, **b)** 18.7.2005, **c)** 24.8.2008;
32 – 50°24'32"N, 14°05'30"E, 5550, Žabovřesky nad Ohří, Ohře River in Žabovřesky, 1.5.2004;
33 – 50°24'34"N, 14°06'58"E, 5550, Budyně nad Ohří, Ohře River downstream of the bridge of the road Budyně - Žabovřesky, 22.7.2000 (Beran 2001);
34 – 50°25'57"N, 14°09'04"E, 5550, Hostěnice, Ohře River upstream and downstream of the weir, 5.5.2013;
35 – 50°26'16"N, 14°09'50"E, 5550, Doksany, Ohře River south of the highway, 11.7.2004;
36 – 50°26'38"N, 14°09'27"E, 5550, Brozany nad Ohří, Ohře River (left bank) next to the highway, 24.7.2004;
37 – 50°26'52"N, 14°09'46"E, 5550, Doksany, Ohře River upstream of the weir, 24.7.2004;
38 – 50°27'04"N, 14°09'43"E, 5550, Doksany, Ohře River downstream of the weir, **a)** 30.8.2008, **b)** 26.5.2011;
39 – 50°27'07"N, 14°09'25"E, 5550, Doksany, Ohře River ca. 500 m downstream of the weir, 30.8.2008;
40 – 50°27'30"N, 14°09'29"E, 5550, Doksany, Ohře River downstream of the bridge, **a)** 27.8.2000, (Beran 2001), **b)** 30.8.2008, **c)** 26.8.2010;
41 – 50°27'42"N, 14°09'20"E, 5550, Doksany, Ohře River downstream of the inflow of Brozanský náhon canal, 26.4.2014;
42 – 50°28'57"N, 14°09'01"E, 5550, Brňany, Ohře River in Brňany, **a)** 12.10.2008, **b)** 30.9.2012;
43 – 50°29'38"N, 14°09'29"E, 5550, Bohušovice nad Ohří, Ohře River downstream of the bridge, **a)** 11.10.2008, **b)** 8.3.2013;
44 – 50°30'35"N, 14°09'25"E, 5450, Terezín, Ohře River upstream of the weir in Terezín, 23.5.2012, 22.6.2012, 16.9.2012, 27.9.2012;
45 – 50°30'56"N, 14°09'12"E, 5450, Terezín, Ohře River downstream of the weir in Terezín, 11.5.2012, 25.7.2012, 9.8.2012;
46 – 50°31'01"N, 14°09'12"E, 5450, Terezín, Ohře River ca 500 m downstream of the weir in Terezín, **a)** 13.7.2003, **b)** 25.9.2008, **c)** 19.10.2008, **d)** 1.5.2012;
47 – 50°31'15"N, 14°09'03"E, 5450, Terezín, Ohře River ca 1.5 km upstream of the inflow to Labe River, 30.9.2012;
48 – 50°31'40"N, 14°08'34"E, 5450, Litoměřice, Ohře River ca 300–500 m upstream of the inflow to Labe River, 27.7.2003;

Malá Ohře

49 – 50°23'46"N, 14°03'41"E, 5650, Poplze, canal Malá Ohře ca. 1.5 km east of Poplze, 22.7.2000 (Beran 2001);
50 – 50°23'52"N, 14°05'17"E, 5650, Kostelec nad Ohří, canal Malá Ohře ca. 200 m west of Kostelec nad Ohří, 8.5.2008;
51 – 50°24'09"N, 14°07'08"E, 5550, Budyně nad Ohří, canal Malá Ohře ca. 1.5 km south-west of Budyně nad Ohří, 22.7.2000 (Beran 2001);
52 – 50°24'23"N, 14°07'10"E, 5550, Budyně nad Ohří, canal Malá Ohře north-west of Budyně nad Ohří, 22.7.2000 (Beran 2001);

Brozanský náhon

53 – 50°26'03"N, 14°09'01"E, 5550, Hostěnice, Brozanský náhon (canal of Ohře River) at its beginning in Hostěnice, 8.5.2013;
54 – 50°26'07"N, 14°09'00"E, 5550, Hostěnice, Brozanský náhon (canal of Ohře River) next to the bridge in Hostěnice, 8.5.2008;
55 – 50°26'44"N, 14°09'10"E, 5550, Brozany nad Ohří, Brozanský náhon (canal of Ohře River) 1 km S of Brozany, 27.8.2000 (Beran 2001);
56 – 50°27'32"N, 14°09'22"E, 5550, Doksany, Brozanský náhon (canal of Ohře River) ca. 250 m upstream of its inflow into Ohře River, 26.4.2014.

Appendix 2

Table 2. List of freshwater molluscs recorded at Ohře I and II study sites. Number of specimens recorded at the sites is given (only estimation in the case of more abundant species). x – only old shells found

Species	Section/Site No.																				
	Ohře I																			Ohře II	
	1	2	3	4	5a	5b	6	7	8	9	10	11	12	13	14	15	16	17		18	19
Viviparus viviparus (Linnaeus, 1758)																40		35		300	4
Potamopyrgus antipodarum (Gray, 1843)						19		8	4	2	8				3		30				
Bithynia tentaculata (Linnaeus, 1758)																2000		50		6	
Valvata cristata O. F. Müller, 1774	13																				
Valvata piscinalis (O. F. Müller, 1774)															23	80	1			3	2
Acroloxus lacustris (Linnaeus, 1758)			7																		
Galba truncatula (O. F. Müller, 1774)									2		2										
Radix ampla (Hartmann, 1821)	2	1	8	24	45	12	25	12	10	2	3	3	8	3		7					
Radix auricularia (Linnaeus, 1758)	3		4	13	20	10									4	12	3	3			4
Radix balthica (Linnaeus, 1758)			2																		
Lymnaea stagnalis (Linnaeus, 1758)	3		14	3	4	6										6					
Physa fontinalis (Linnaeus, 1758)			36		12																
Physella acuta (Draparnaud, 1805)																10		12			
Planorbis carinatus O. F. Müller, 1774					25	15										70	25				
Bathyomphalus contortus (Linnaeus, 1758)																	8				
Gyraulus albus (O. F. Müller, 1774)	8		18	8	18	15	25								28	3	200			2	1
Gyraulus parvus (Say, 1817)			12			6															
Hippeutis complanatus (Linnaeus, 1758)																	3				
Ancylus fluviatilis (O. F. Müller, 1774)	15	10	10	400	250	35	50	40	60	12	25	30	300	80	300	15				16	
Unio crassus Philipsson, 1788											1	10	28	35	20						
Unio pictorum (Linnaeus, 1758)	5	1																			
Anodonta anatina (Linnaeus, 1758)	2	4					1				13			8	6			14			
Anodonta cygnea (Linnaeus, 1758)																		9			
Sphaerium corneum (Linnaeus, 1758)	70	15		16	30	12	4	3	2	7	8	16	2	10	25	1000		30			
Musculium lacustre (O. F. Müller, 1774)					3																
Pisidium casertanum Poli, 1791		10		2	5		3				1	2									
Pisidium henslowanum (Sheppard, 1823)			4	1	3	3									2						
Pisidium nitidum Jenyns, 1832	11		2	6	14	12		2							6	2					
Pisidium subtruncatum Malm, 1855			5	4	10	8		1	3	2	3	2		3							
Pisidium supinum A. Schmidt, 1851													4	5							
Dreissena polymorpha (Pallas, 1771)																		80			3000
Number of species	10	6	12	10	13	12	6	6	6	5	9	6	5	7	10	12	7	8		5	5

Table 3. List of freshwater molluscs recorded at Ohře III (first part) study sites. For explanations see Table 2

Species	Section/Site No.																						
	Ohře III																						
	20	21	22a	22b	23	24	25	26	27	28a	28b	29a	29b	30a	30b	31a	31b	31c	32	33	34	35	36
Viviparus viviparus (Linnaeus, 1758)									2	6	4		2	2	2	3			1	2	30	10	7
Potamopyrgus antipodarum (Gray, 1843)	10	3	5	25	6	3		8	30	40	7	35	1				8	28	2	7	25	7	
Bithynia tentaculata (Linnaeus, 1758)						2		4	3	25	8	15		6	3	4	20	3	12	5	10		25
Valvata piscinalis (O. F. Müller, 1774)				16					1	15	1										7		
Acroloxus lacustris (Linnaeus, 1758)										3												40	3
Galba truncatula (O. F. Müller, 1774)		10	12					6	5	20	2	20	3					75	10				
Radix ampla (Hartmann, 1821)	13	15	250	30	4	20	3	5	3			10											
Radix auricularia (Linnaeus, 1758)									1	5	4	5	2									7	8
Lymnaea stagnalis (Linnaeus, 1758)										6												6	2
Physa fontinalis (Linnaeus, 1758)						1																2	
Planorbis planorbis (Linnaeus, 1758)																						12	
Bathyomphalus contortus (Linnaeus, 1758)																						10	
Gyraulus albus (O. F. Müller, 1774)										40	6	50	8			2	5	6			3	15	30
Hippeutis complanatus (Linnaeus, 1758)								1			1											6	3
Ancylus fluviatilis (O. F. Müller, 1774)	15	30	6	65	12	30	10		10	15	14	15	7	25	8		25	100	14	5	14	3	
Margaritifera margaritifera (Linnaeus, 1758)								x1															
Unio crassus Philipsson, 1788					1	1	1	x1	2	4	3		4	9	3	9	3	4	14	3	1		1
Unio pictorum (Linnaeus, 1758)									1	6	12		4	3	1	4	1	3	7	12	4		3
Anodonta anatina (Linnaeus, 1758)				6			1	5	1	15	10		5	2	2	3	2	2	5	10	6	3	4
Anodonta cygnea (Linnaeus, 1758)																					1		2
Sphaerium corneum (Linnaeus, 1758)	20	3	3	40	70	20	5	3	3	2	10		4	3	4			1	3	5	13		2
Sphaerium rivicola (Lamarck, 1818)																					6		
Musculium lacustre (O. F. Müller, 1774)									2													4	3
Pisidium amnicum (O. F. Müller, 1774)																					2		
Pisidium casertanum Poli, 1791		3		5		2											4						5
Pisidium henslowanum (Sheppard, 1823)				3		2				4								10					3
Pisidium hibernicum Westerlund, 1894				1																			
Pisidium milium Held, 1836		6		3																			
Pisidium moitessierianum (Paladilhe, 1866)																				1			4
Pisidium nitidum Jenyns, 1832	18	7	2	8	6	7	3	5	8		1	4	4			2	3	12		1	4	2	3
Pisidium subtruncatum Malm, 1855	10	3	5	14	7	3	2			6	4				10	3	2	6			7		12
Pisidium supinum A. Schmidt, 1851									10	17	12		8		12	6	8	14		8	10		
Number of species	6	9	7	12	7	8	7	10	15	17	16	8	12	7	9	9	11	13	9	11	16	14	17

Table 4. List of freshwater molluscs recorded at Ohře III (second part) study sites. For explanations see Table 2

Species	Section/Site No.																			
	Ohře III																			
	37	38a	38b	39	40a	40b	40c	41	42a	42b	43a	43b	44	45	46a	46b	46c	46d	47	48
Viviparus viviparus (Linnaeus, 1758)	30			13		7	2		250	250		6	1300	60			2	6	600	
Potamopyrgus antipodarum (Gray, 1843)	5			7		10		4	35	150	40				7	4	15		8	13
Bithynia tentaculata (Linnaeus, 1758)	60	45	35	30	4	8	20	7	6	40	25	7	100	12	140	250	40	70	40	200
Valvata piscinalis (O. F. Müller, 1774)										16									2	
Acroloxus lacustris (Linnaeus, 1758)	2										20		2							
Galba truncatula (O. F. Müller, 1774)		13		13		30									30			16		
Stagnicola palustris (O. F. Müller, 1774)											1									
Radix ampla (Hartmann, 1821)															25	2				
Radix auricularia (Linnaeus, 1758)	25					2			26	25		3	27			3	3		4	
Lymnaea stagnalis (Linnaeus, 1758)	3										2		3	4						
Physella acuta (Draparnaud, 1805)													30	3						
Planorbis planorbis (Linnaeus, 1758)	7										1		1							
Bathyomphalus contortus (Linnaeus, 1758)											4									
Gyraulus albus (O. F. Müller, 1774)	40						3		14	18	60		6		1	10				3
Gyraulus crista (Linnaeus, 1758)	9																			
Hippeutis complanatus (Linnaeus, 1758)	4																			
Ancylus fluviatilis (O. F. Müller, 1774)		30	28		25	150	100	6		14					2	25	65	120		
Unio crassus Philipsson, 1788	3	2	1	1	2	4	2	2	3	1	3	10	31	30	25	2	2	6		1
Unio pictorum (Linnaeus, 1758)	4	1	2	1	2	1	3		4	6	2	4	119	6	14	3	7	2	9	3
Unio tumidus Philipsson, 1788																	1			
Anodonta anatina (Linnaeus, 1758)	9		1	2	1	3	15	4	7		3	23	284	62	12	5	15	9	4	5
Anodonta cygnea (Linnaeus, 1758)								1					1		1					
Pseudanodonta complanata (Rossmässler, 1835)														2	3		2	1	1	
Corbicula fluminea (O. F. Müller, 1774)								70		3		7	9	4				21	14	
Sphaerium corneum (Linnaeus, 1758)		35	11	35	4	10	25	7	5	7	6	3	20	2	6	10	8	55	6	12
Sphaerium rivicola (Lamarck, 1818)												4	4		2				5	2
Musculium lacustre (O. F. Müller, 1774)													35		2					
Pisidium amnicum (O. F. Müller, 1774)										6		2								
Pisidium casertanum Poli, 1791	2					3														
Pisidium henslowanum (Sheppard, 1823)	7	10		4		12		2	5	7		8	4	6						
Pisidium moitessierianum (Paladilhe, 1866)							12					2			3		2			
Pisidium nitidum Jenyns, 1832	3	4		6		8	3		4	2	3	1					2		2	
Pisidium subtruncatum Malm, 1855	6	6		3		14	2	6	6	4	8	2	3		10		7			4
Pisidium supinum A. Schmidt, 1851		6	4	8		20	20	2	3	18		3	14		12		8		9	3
Dreissena polymorpha (Pallas, 1771)			1			2				6			45	18		3				
Number of species	17	10	8	12	6	16	12	11	13	17	14	15	20	12	17	11	15	10	13	10

Table 5. List of freshwater molluscs recorded at Malá Ohře and Brozanský náhon. For explanations see Table 2

Species	Section/Site No.							
	Malá Ohře				Brozanský náhon			
	49	50	51	52	53	54	55	56
Viviparus viviparus (Linnaeus, 1758)					3	3		
Potamopyrgus antipodarum (Gray, 1843)	25		80	4	70	18		
Bithynia tentaculata (Linnaeus, 1758)					7	15	15	4
Valvata piscinalis (O. F. Müller, 1774)	15							
Galba truncatula (O. F. Müller, 1774)	50		6	6				
Radix auricularia (Linnaeus, 1758)					2			
Gyraulus albus (O. F. Müller, 1774)						3		
Ancylus fluviatilis (O. F. Müller, 1774)					7	6		16
Unio crassus Philipsson, 1788					1	4	3	
Unio pictorum (Linnaeus, 1758)	1					4	7	
Anodonta anatina (Linnaeus, 1758)	2			3	3	6	3	3
Corbicula fluminea (O. F. Müller, 1774)								45
Sphaerium corneum (Linnaeus, 1758)			2		10	6	2	7
Sphaerium rivicola (Lamarck, 1818)					13			
Musculium lacustre (O. F. Müller, 1774)	3							
Pisidium amnicum (O. F. Müller, 1774)	3	10	40	30			8	2
Pisidium casertanum Poli, 1791				2				
Pisidium moitessierianum (Paladilhe, 1866)	20	2	2	80				
Pisidium nitidum Jenyns, 1832	3		2	1		8		3
Pisidium subtruncatum Malm, 1855	10	12	6					7
Pisidium supinum A. Schmidt, 1851	4				24	20	8	16
Number of species	11	3	7	7	10	11	7	8