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Spreading expansion of *Corbicula fluminea* (Mollusca: Bivalvia) in the Czech Republic.

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With 1 map and 2 figures.

Abstract.

The Asian clam *Corbicula fluminea* has been observed from 14 different sites on the River Elbe from the Czech-German border near Hřensko to Hněvice village, lying 83 km upstream from this border since 1999 when this non-indigenous mollusc was discovered in the Czech Republic for the first time (BERAN 2000). The Asian clam has not been found yet in any of three studied tributaries of the Elbe and neither in any site of the Elbe situated upstream Hněvice. The passive upstream movement is a probable type of movement in the case of the Elbe because the invasion of the Asian clam seems to be fluent, but other types of movement (ships, birds, fish) are also possible. According to my observation the Asian clam moved upstream at least 2.4 km/year. The density of Asian clam in the Elbe did not reach 100 clams/m^2 and greater densities of living clams were usually observed in shallow places with fine sandy/muddy sediments near river banks. The biggest clam (empty shell) found in the Elbe measured 36 mm (respectively 36x33x23 mm).

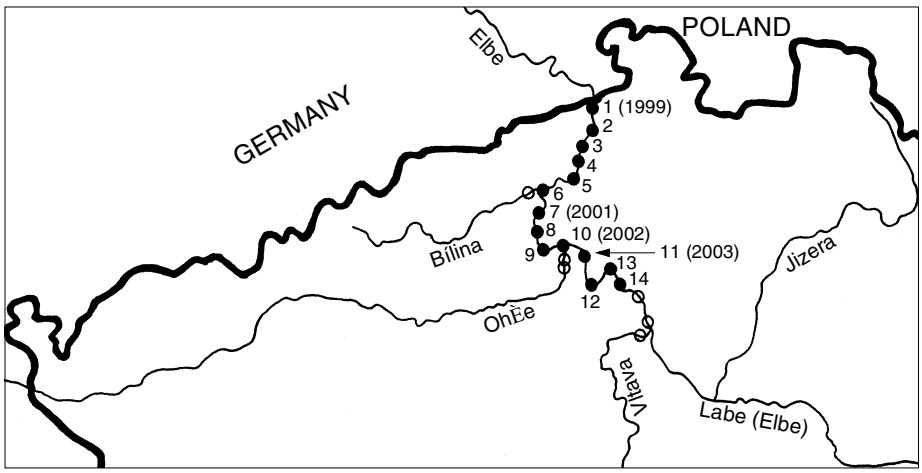
Introduction.

The Asian (Asiatic) clam *Corbicula fluminea* (O. F. MÜLLER, 1774) of the family Corbiculidae is native to south-eastern part of Asia which includes south-east China, Korea and south-east Russia (ŽADIN 1952, LACHNER & al. 1970). This clam was introduced to North America where it was first collected in British Columbia in 1924. In 1938 the Asian clam was discovered in the United States (CLENCH 1970) where it has been recently known in 35 states (COUNTS 1991) and it is also known in Cuba (DIEGUEZ & al. 1997) and Mexico (CARLTON 1992). Recently the Asian clam has been known also in Africa, Australia and South America inclusive Patagonia (CAZZANIGA & PEREZ 1999) so this species is one of the most invasive molluscs which spreads and inhabits new sites very quickly. Especially in the United States the Asian clam became a serious pest due to bio-fouling of complex power plant and industrial water systems (ISOM & al. 1986) and it also causes problems in irrigation canals and pipes (PROKOPOVICH & HEBERT 1965). Given the high growth and production rates of this mollusc, concerns have been raised over the capacity Asian clams have to alter trophic and nutrient dynamics of aquatic systems and to displace native bivalves (GOTTFRIED & OSBORNE 1982, STITES & al. 1995, HAKENKAMP & al. 2001). This invasive non-indigenous mollusc was introduced to Europe from North America after 1980 (DE VAATE 1991, KINZELBACH 1991, GLÖER & MEIER-BROOK 2003). In bordering countries the Asian clam has recently been known in the Elbe basin from Germany (GRABOW & MARTENS 1995) and in the Danube basin from Hungary (CSÁNYI 1999), Germany (TITTIZER & TAXACHER 1997), Austria (FISCHER & SCHULTZ 1999) and newly also from Slovakia (VRABEC & al. 2003). In the Czech Republic this mollusc was discovered in 1999 (BERAN 2000).

Results and discussion.

Spreading expansion, distribution.

In the Czech Republic the first specimens of the Asian clam were found in the Elbe on the Czech-German border near Hřensko in 1999 (BERAN 2000). During the follow-up research its presence was discovered in several locations up to the weir of Střekov in Ústí nad Labem (BERAN 2000) which is situated about 30 km from the Czech-German border. Spreading expansion of *C. fluminea* was watched till the end of 2003. In 2001 presence of Asian clam was ascertained further upstream in Elbe, up to the Lovosice town (BERAN 2001), lying about 48 km from the Czech-German border. In 2002 *Corbicula fluminea* was found in the Elbe in Litoměřice town (55 km from the Czech-German border). Many new locations upstream of the Elbe were documented in 2003 and the Elbe in Hněvice was the most distant site where the Asian clam was found in 2003. This place lies 83 km from the Czech-German border. Other parts of the Elbe situated upstream were also observed in 2003, but without any finding of the Asian clam. These locations were the Elbe in Křivenice village (about 6 km upstream from Hněvice) and the Elbe near Mělník town (about 15 km upstream from Hněvice). In this case we can suppose that migration of Asian clam will continue and it will be found in new sites lying upstream very soon. Different situations can be in the case of tributaries of the Elbe. Altogether three tributaries of the Elbe were visited in 2003. These tributaries are the following: the River Bílina (84 km long tributary, one of the most polluted rivers in the Czech Republic), the River Ohře (300 km long tributary, one of the last larger rivers with relatively a natural character in the Czech Republic) and the canal of the River Vltava (430 km long tributary, inflow of this canal is upstream of known locations of Asian clam). The Asian clam has not been found in any of these tributaries yet. This fact is most surprising in the case of the Ohře, because this river is inhabited by similar molluscan community as the Elbe. On the other hand this river is very important from the malacological point of view owing to an occurrence of large population of endangered and protected bivalve *Unio crassus* PHILIPSSON, 1788 and other rare or endangered molluscs (BERAN 1998, 2002). An invasion of *C. fluminea* to this river could evoke the negative changes in molluscan community of this river especially in the case of its high densities.



Map 1. The map with the known distribution of *Corbicula fluminea* in the Czech Republic. Full circle=site with occurrence of *C. fluminea*; empty circle=observed site without finding of *C. fluminea*. [Orig. L. BERAN].

Survey of locations with records of *Corbicula fluminea*.

Data in the survey are as follows: number of the locality, code of the mapping field for faunistic mapping (BUCHAR 1982, PRUNER A MÍKA 1996), name of the nearest village or town, description of the locality, date of investigation, leg., det., coll.

1: 5151, Hřensko, the Elbe in Hřensko, 3. IX. 1999, E. STUCHLÍK leg., L. BERAN det. & coll.; 7. XI. 1999, L. Beran leg., det. & coll. (BERAN 2000); 12. X. 2002, E. STUCHLÍK leg., L. BERAN det.; 12. VII. 2003 (opposite river bank), L. BERAN leg. & det.; — **2**: 5151, Děčín-Dolní Žleb, the Elbe in Dolní Žleb near Děčín, 7. XI. 1999, L. BERAN leg. & det. (BERAN 2000); 12. VII. 2003, L. BERAN leg.,

det. & coll.; — **3**: 5251, Děčín, the Elbe in Děčín, 7. XI. 1999, L. BERAN leg. & det. (BERAN 2000); 24. V. 2002, L. BERAN leg. & det.; 12. X. 2002, E. STUCHLÍK leg., L. BERAN det.; — **4**: 5251, Nebočady, the Elbe in Nebočady, 22. I. 2001, B. FRANĚK leg., L. BERAN det.; — **5**: 5350, Povrly, the Elbe in Povrly, 7. XI. 1999, L. BERAN leg. & det. (BERAN 2000), 22. I. 2003 (opposite river bank in Malé Březno), L. BERAN leg. & det.; — **6:** 5350, Ústí nad Labem, the Elbe in Ústí nad Labem (downstream of the weir in Ústí nad Labem-Střekov), 7. XI. 1999, L. BERAN leg. & det. (BERAN 2000); 21. XII. 2002, L. BERAN leg. & det.; 17. XI. 2003, L. BERAN leg. & det.; — **7**: 5450, Sebuzín, the Elbe in Sebuzín, 16. VII. 2001 (the opposite river bank near Dolní Zálezly), L. BERAN leg. & det.; 18. II. 2003, L. BERAN leg. & det.; — **8**: 5450, Libochovany, the Elbe in Libochovany, 1. VI. 2002, L. Beran leg. & coll.; — **9**: 5450, Lovosice, the Elbe in Lovosice, 16. VII. 2001, L. BERAN leg., det. & coll. (BERAN 2001); — **10**: 5450, Litoměřice, the Elbe in Litoměřice, 1. VI. 2002, L. BERAN leg. & det.; — **11**: 5451, Nučničky, the Elbe in Nučničky, 18. II. 2003, L. BERAN leg., det. & coll.; — **12**: 5551, Roudnice nad Labem, the Elbe in Roudnice nad Labem (downstream of a weir), 7. VI. 2003, L. BERAN leg., det. & coll.; — **13**: 5552, Račice, the Elbe near weir between Račice and Záluži, 6. VII. 2003, L. BERAN leg., det. & coll.; — **14**: 5552, Hněvice, the Elbe in Hněvice, 24. VIII. 2003, L.BERAN leg. & coll.

Fig. 1. The Elbe in Hnevice (loc. No. 14) is the most distant location with known occurrence of *Corbicula fluminea*. This site is situated 83 km upstream from the Czech-German border. Photo L. BERAN, Melník.

Dispersal, upstream movement.

During four years the Asian clam has been observed altogether from 14 different sites situated at a 83 km long part of the Elbe, but we do not know the real time of its coming to the Czech Republic so the upstream movement was probably much lower. Some sites of the Elbe were visited before an invasion of the Asian clam and could be used for study of a rate of its expansion. First site is location No. 11 (respectively opposite river bank of the Elbe) which was visited in November 1999 and second is loc. No. 12 (August 1998). The most distant location (No. 14) which was visited in August 2003 is 19 km and 12 km far from loc. No. 11 and respectively loc. No. 12. If we suppose that the expansion had got on upstream fluently, these results would mean that the Asian clam moved 5 km respectively 2.4 km/year. Because it is not possible to exclude a mistake in the first situation (two different river banks were visited) we can suppose that Asian clam moved upstream at least 2.4 km/year. This movement is twice as fast as follows from results mentioned by VOELZ & al. (1998). These authors supposed fish were partially responsible for dispersing *C. fluminea* (at least for longer distances) and they suggested unassisted upstream movement might also be an important dispersal mechanism for this species. According to COUNTS (1986) and ISOM (1986) the Asian clam was thought to enter the United States as a food item used by Chinese immigrants and dispersal with man shown to be primary agent of dispersal. Current methods of introduction include bait bucket introductions (COUNTS 1986). Passive movement is thought to be another significant dispersal agent (ISOM 1986). The passive upstream movement is a probable

kind of movement in the case of the Elbe (weirs can be overcome through shipping canals) because the invasion of the Asian clam seems to be fluent but other types of movement (ships, birds, fish) are also possible.

Fig. 2. The confluence of rivers Elbe and Vltava in Melník. The occurrence of *Corbicula fluminea* have not been confirmed yet. Photo L. BERAN, Melník.

Density, shell length.

The invasion of Asian clam is a serious problem in many areas especially due to its high density. The greatest known density, 131000 clams/m^2, was documented in California but usually is much less about 10-3000 clams/m^2 (BRITTON & MORTON 1982). In Europe high density, 2500 clams/m^2, is mentioned from the River Chet in Britain (ALDRIDGE & MÜLLER 2001). In the Czech Republic the density of Asian clam in the Elbe did not reach 100 clams/m^2. An amount of empty shells on the river banks corresponded to a density mentioned above. Greater densities of living clams were usually observed in shallow places with fine sandy/muddy sediments near river banks. This observation is in agreement with results of GOTTFRIED & OSBORNE (1982) from the United States. In the Elbe the Asian clam inhabits these sites together with bivalves *Unio pictorum* (LINNAEUS, 1758), *Anodonta anatina* (LINNAEUS, 1758), *Sphaerium rivicola* (LAMARCK, 1818), *Pisidium supinum* A. SCHMIDT, 1851 and rarely also with *U. tumidus* PHILIPSSON, 1788, *Pseudanodonta complanata* (ROSSMÄSSLER, 1835) and *Sphaerium corneum* (LINNAEUS, 1758) s. lat. Any visible negative impact to original molluscan communities has not been observed yet probably due to such a low density. Its density is much lower than densities of other non-indigenous molluscs e. g. *Potamopyrgus antipodarum* (GRAY 1843), *Dreissena polymorpha* (PALLAS 1771) living also in the Elbe.

The biggest clam (empty shell) found in the Elbe measured 36 mm (respectively 36 x 33 x 23 mm) but according to my observation this length was unusual. In the United States the Asian clam may grow to between 50 and 65 mm in shell length (HALL 1984), but individuals above 25 mm are uncommon (GOTTFRIED & OSBORNE 1982). A length between 20 and 36 mm is also mentioned in GLÖER & MEIER-BROOK (2003) for populations in Germany and maximum length 37 mm is mentioned in ŽADIN (1952).

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