ORCONECTES LIMOSUS COLONISES NEW AREAS FAST ALONG THE DANUBE IN HUNGARY

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ABSTRACT

Introduced species are one of the most important anthropogenic impacts on freshwater ecosystems with many direct and indirect effects on native taxa. Among other invasive groups, such as plants, mussels and fish, several alien Decapoda species have also spread successfully in Europe in the last 110 years. In Hungary three native (*Astacus astacus, Astacus leptodactylus, Austropotamobius torrentium*) and three alien Decapoda species, namely *Orconectes limosus*, *Pacifastacus leniusculus* and *Eriocheir sinensis* are known to be present. *O. limosus*, which had been tried for use in crayfish farming in the 1950s, was the first to occur in the country's natural waters. Initially it was found in the Danube at river km 1,653 at Budapest in 1985. Since then, it has been spreading fast and populations have reached high abundances. By 1998, it was already in the Gemenc section of the river colonising five 50 km × 50 km UTM squares. In the early 2000s it was also found at Mohács (and further downstream in Croatia), in canals in the Great Hungarian Plain and in the River Ipoly, which added three new 50 km × 50 km UTM squares to its previously known distribution area in the Carpathian Basin. On the basis of the available records from the past 20 years, the downstream colonisation speed of this decapod was calculated to be more than 13 km yr^{-1}, but if its presence at Kopácsi rét/Kopacki rit in Croatia is also taken into consideration, it is over 16 km yr^{-1}. It is unknown, however, how much this process was helped by deliberate introductions, if at all. Besides the main watercourse of Hungary, *O. limosus* is also common in its lowland tributaries and spreading towards Lake Balaton along the Sió canal. However, it has not been recorded entering mountain streams in the Danube Bend, where *A. torrentium* lives, which is important for the conservation of that native species. If *O. limosus* spreads with the same speed and distribution pattern in the Carpathian Basin, it may colonise large rivers such as the River Tisza, their lowland tributaries and canals in the near future. Based on the present situation, *O. limosus* is likely to threaten *A. astacus* populations especially in the southern part of Transdanubia, perhaps leading to the elimination of some populations, but less likely to affect *A. torrentium* living in the mountains of the Danube Bend.

Key-words: crayfish, *Orconectes limosus*, alien species, Hungary, distribution, conservation.

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ORCONECTES LIMOSUS COLONISE DE NOUVELLES ZONES LE LONG DU DANUBE EN HONGRIE

RÉSUMÉ

Les espèces introduites représentent un des impacts anthropiques les plus importants au niveau des écosystèmes d'eau douce avec beaucoup d'effets directs ou indirects sur les espèces natives. Parmi d'autres groupes invasifs, tels que les plantes, les moules et les poissons, plusieurs espèces étrangères de décapodes se sont aussi répandues avec succès en Europe pendant les 110 dernières années écoulées. En Hongrie, trois espèces natives (*Astacus astacus, Astacus leptodactylus, Austropotamobius torrentium*) et trois espèces étrangères (*Orconectes limosus*, *Pacifastacus leniusculus* et *Eriocheir sinensis)* de décapodes sont connues. *O. limosus*, qui a fait l'objet d'une tentative d'élevage dans les années 50, fut la première à atteindre les eaux naturelles. A l'origine, elle fut trouvée dans le Danube au km 1,653 à Budapest en 1985. Depuis elle s'est répandue rapidement et les populations sont très abondantes. En 1998, elle était présente dans la section de Gemenc de la rivière en colonisant cinq carrés UTM de 50 km × 50 km. Dès les années 2000, elle a été trouvée également à Mohács (puis en aval en Croatie), en atteignant ainsi son aire de distribution au niveau du Bassin des Carpates. Sur la base des données disponibles ces 20 dernières années, la colonisation rapide de ce décapode a été évaluée à plus de 13 km par an, mais si on tient compte également de sa présence à Kopácsi rét/Kopacki rit en Croatie, elle est alors estimée à plus de 16 km par an. Par contre, il n'est pas connu si cette progression a été favorisée par des introductions délibérées. A part dans les cours d'eau principaux de Hongrie, *O. limosus* est aussi commune dans les petits cours d'eau et s'est aussi répandue vers le lac Balaton le long du canal Sió. Cependant elle n'a pas été signalée dans les cours d'eau de montagne dans le Danube Bend, où *A. torrentium* vit, ce qui est important pour la sauvegarde de cette espèce indigène. Si *O. limosus* se répandait avec la même vitesse et mode de distribution dans le bassin des Carpates, à moyen terme, elle coloniserait de grands cours d'eau tels que la rivière Tisza, ses petits affluents et les canaux. Au vu de la situation actuelle, *O. limosus* pourrait donc plutôt menacer les populations d'*A. astacus*, en particulier dans la partie sud du Transdanube, que celles d'*A. torrentium* qui vivent dans les zones montagneuses du Danube.

Mots-clés : écrevisses, *Orconectes limosus*, espèces introduites, Hongrie, distribution, conservation.

INTRODUCTION

Introduced species are one of the most important anthropogenic impacts on freshwater ecosystems with many direct and indirect effects on native taxa. They can cause degradation of natural habitats, alter species assemblages and trophic structure, displace or decimate native species (ALDRIDGE *et al.*, 2004; GRATTON and DENNO, 2005) depending on the number of simultaneous negative interactions such as competition and predation (MILLS *et al*., 2004). Among other invasive groups, such as plants, mussels and fish, crayfish have particularly important ecological impacts on aquatic ecosystems. However, they were often introduced outside their native ranges, either by deliberate stocking or even by bait bucket releases (HOBBS *et al.,* 1989).

In the last 110 years several alien decapod species have spread successfully in Europe. In Hungary three native and three alien Decapoda species, namely *Orconectes limosus*, *Pacifastacus leniusculus* and *Eriocheir sinensis* are known to be present (PUKY *et al.*, 2005). The spread of all these species accelerated at the turn of the century, *Eriocheir sinensis*, for example, which had first been found in the Hungarian Danube stretch in 2003 at Budapest, was also detected in February, 2004 from the same river but nearly 200 km downstream, at river km 1,437 at Kölked. This new locality corresponds

well to the estimation of CZERNIEJEWSKI and FILIPIAK (2001), who found the average migration speed of young crabs to vary between 1 and 3 km day^{-1} depending on the conditions, as well as with the fact that this species has recently been found in the River Danube both upstream and downstream of Hungary (PAUNOVIC *et al*., 2004; RABITCH and SCHIEMER, 2003).

O. limosus is a North American crayfish species native to the eastern part of the continent. Following its introduction to Europe at the end of the 19th century to compensate for the strong decline of *Astacus astacus* caused by crayfish plague, it colonised areas from the Pyrenees and Italy north to England and Belorussia (HOLDICH, 2002). This species may strongly influence other aquatic organisms (see e.g. CALLAGHAN and KARLSON, 2002) and evidence has also accumulated that it also affects native European crayfish by spreading the crayfish plague, which is a significant threat to European native species causing disappearance and decline till today (for a description of recent crayfish plague outbreaks and the role of *O. limosus* within the process see for example KOZUBIKOVÁ *et al.*, 2005). Adversely, in North America, its New England populations are threatened by another closely related invasive crayfish species, *Orconectes rusticus* (KLOCKER and STRAYER, 2004).

This article describes the spread of *O. limosus* in Hungary together with its possible consequences.

MATERIAL AND METHODS

The distribution of *O. limosus* was investigated in several sections of the Danube. Active diurnal searches by turning stones and checking holes and trapping were used to prove the presence of the species. The occasional findings of dead crayfish on the banks were also taken into consideration (PUKY, 2000, 2004). Besides crayfish-oriented surveys, valuable observations or collections were also made during the study trips of the Hungarian Danube Research Station staff along the River Danube or its backwaters. Several crayfish specialists were also interviewed and other experts (e.g. ichthyologists) were also contacted to incorporate their observations into the database together with the available literature. In those investigations crayfish were caught by hand, netting, diving and dredging and also by electro fishing during ichthyological surveys (CSÁNYI *et al.*, 2002; KOVÁCS et al., 2005; NESEMANN *et al.*, 1995).

To provide reliable data, doubtful records were not included in the compiled database, similarly to other European countries such as Poland (ŚMIETANA, 2004). However, these sites should be checked in the future, as it is possible they might provide valuable additional information.

Data are presented here in a graphical format, which shows the distribution area of the species in 50 km $\times$ 50 km UTM square units. To show the spreading of *O. limosus* over time, data were summarised by decades starting from the 1950s, when the species was introduced to Hungary for farming (THURÁNSZKY, 1960).

RESULTS AND DISCUSSION

The distribution of *O. limosus* in Hungary between 1950 and 2004 can be seen in Figure 1. This species was introduced to Hungary from Germany in the late 1950s for farming, when approximately 12,000 individuals were imported (THURÁNSZKY, 1960). That venture was not successful and no records existed for Hungary for the 1960s and 1970s. In natural waters the first individuals were recorded in 1985 in a large secondary branch of the River Danube at Budapest at river km 1,653 (THURÁNSZKY and FORRÓ, 1987). In 1991, *O. limosus* was detected at Dunaföldvár, approximately 90 km downstream

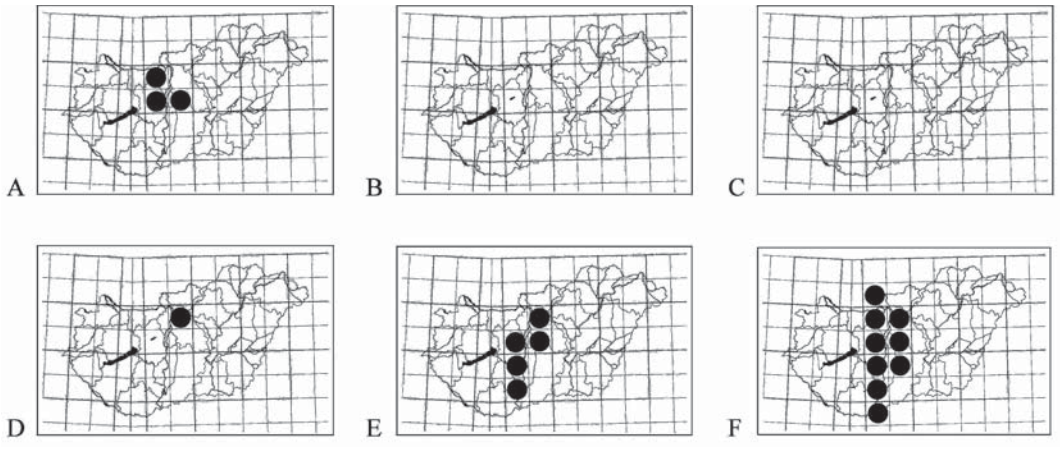

Figure 1

50 km × 50 km UTM distribution of *Orconectes limosus* in Hungary between 1950 and 2005 (the edge of the squares represent 50 km). Empty square: no data; solid circle: data available. A: 1950s, B: 1960s, C: 1970s, D: 1980s, E: 1990s, F: 2000s (Note that unlike what is plotted in map A-E, map F represents only half a decade.).

Figure 1

Distribution 50 km × 50 km UTM d'*Orconectes limosus* en Hongrie entre les années 1950 et le années 2000 (la taille des carrés représentent 50 km). Carrés vides : aucune donnée ; Cercles pleins : données disponibles. A : années 1950, B : années 1960, C : années 1970, D : années 1980, E : années 1990, F : années 2000 (noter que contrairement aux cartes A-E, cette période représente moins de la moitié d'une décennie.).

(NESEMANN *et al.*, 1995). By 1998, it had reached the Gemenc section of the river (river km 1,481), 172 km downstream of the first observations (PUKY, 2000), by 2001 it was also recorded from Mohács (Gábor CSÖRGITS, Tamás DEME, pers. comm.). During its colonisation of the Carpathian Basin *O. limosus* also got into Croatia from Hungary. It was found there at Kopácsi rét/Kopacki rit (MAGUIRE and KLOBUCAR, 2003), a floodplain area approximately 25 km upstream from the mouth of the River Dráva, which reaches the River Danube at river km 1,382, and is expected to spread westwards to other rivers and lakes (LAJTNER *et al.*, 2005).

On the basis of the available records from the past 20 years in Hungary, the colonisation speed of *O. limosus* was calculated to be more than 13 km yr^{-1} (varying between 11.7 and 15 km yr^{-1} over shorter sections), but if its presence at Kopácsi rét/ Kopacki rit in Croatia is also taken into consideration, it is over 16 km yr^{-1}. This pace can be considered very fast as in the River Rhine a three times slower, five km yr^{-1} colonisation speed was reported in the 1960s (SCHWENG, 1968). It is unknown, however, if the rapid spread of *O. limosus* along the Hungarian Danube stretch was helped by deliberate introductions. Several authors suggested earlier that unknown translocation by boat traffic on the River Danube can be how an isolated population was formed in the Ölhafen, in the southeastern part of Vienna (NESEMANN *et al.*, 1995; PÖCKL, 1999a, 1999b) and this factor could certainly influence the colonisation of the Hungarian Danube stretch. However, at present no such evidence exists for Hungary. If *O. limosus* spreads with the same speed among other waters, the colonisation of Lake Balaton and upstream sections of the River Dráva belonging to Hungary is to be expected within 2-5 and 5-10 years, respectively.

The colonisation pattern of *O. limosus* varies between different European countries. Besides the main arm and side arms of the River Danube, abundant and spreading populations have been found in other connected waters such as the Szõdrákos-stream and the Sió canal (PUKY, 2000, 2004) as well as the River Ipoly and lowland canals in the Great Hungarian Plain (KOVÁCS *et al*., 2005) in Hungary. It is similar to the situation in several other European lowland countries and areas, such as the Netherlands (ADEMA, 1989), northeastern Germany and northwestern Poland (SCHULZ and ŚMIETANA, 2001), where *O. limosus* has become predominant. What is more, in many regions of Poland it is also the only crayfish species present and as such it has even become the commonest prey of fish such as *Silurus glanis* or other piscivorous fish in certain life stages (CZARNECKI *et al*., 2003). It is partly due to the fact, that, unlike e.g. *A. astacus*, *O. limosus* is not sensitive to land use changes and human activities (SCHULZ *et al.*, 2002). In other, more mountainous or hilly regions, such as Austria, Switzerland or the western part of the Czech Republic it is mainly restricted to large running waters such as the River Danube, Elbe or Morava (PETRUSEK *et al.*, 2006; HEFTI, 2006; PÖCKL and PEKNY, 2002). In large rivers, where the habitat diversity, discharge and current velocity is high and crayfish density is low, native species can coexist with *O. limosus* (PÖCKL and PEKNY, 2002) but even in the Czech Republic, however, this species is the main potential vector of *Aphanomyces astaci*, which was also proved by recent (1998-99 and 2004) outbreaks of crayfish plague in smaller brooks and rivers, and a subsequent investigation also proved a high ratio of infected individuals in different populations (KOZUBIKOVÁ *et al.*, 2005). As such, it also means a potential threat to native crayfish species in Hungary, too. Fortunately, however, even if *O. limosus* was spreading fast along the Hungarian Danube stretch, there is a hope that it will not enter into certain habitats. In the detailed investigation of the floodplain of the River March/Morava in Austria it was never found in backwaters, old meanders and oxbow lakes (PÖCKL and PEKNY, 2002). Similarly, PETRUSEK *et al.* (2006) detected in the Czech Republic that in smaller streams it usually stayed in lower reaches and did not penetrate far upstream. This is in accordance with our findings that even if *O. limosus* is present in the neighbouring Danube stretch for nearly 15 years, it has not been recorded entering mountain streams in the Danube Bend. As those are the main habitats of *A. torrentium* in Hungary, this finding has important applications for the conservation of that native species, i.e. most of those efforts should be focussed on habitat improvement and possible (re)introductions. However, the regular (3-5 year) checking of those habitats for the presence of *O. limosus* is also advisable. If *O. limosus* will spread with the same speed and distribution pattern in the Carpathian Basin, mid-term it should colonise large rivers such as the River Tisza, their lowland tributaries and canals. Especially in smaller water flows it will probably be a significant threat to *A. astacus* populations e.g. in the southern part of Transdanubia, where this phenomenon is likely to occur soon, and their elimination is a real possibility. As a consequence, the current distribution of decapod species in that geographical region and the regular monitoring of future changes are urgent conservation tasks, which has not not only national but also regional importance.

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