Distribution and significance of alien amphipods and decapods in the Neva river basin (North-western Russia)

Répartition et effets des espèces exotiques amphipodes et décapodes dans le bassin du Neva

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RÉSUMÉ

Le fleuve Neva, en reliant le bassin Ponto-Caspien au sud et la mer Baltique et les écosystemes aquatiques du nord de la Russie, fait partie du corridor nord des invasions biologiques. Ce papier est centré sur l'histoire récente des invasions par les crustacés malacostracés (Amphipodes et Décapodes) dans le bassin du Neva (le plus grand fleuve du nord-est de la Russie). Ce papier analyse nos données et celles de la littérature concernant la distribution géographique des invasifs dans le bassin du Neva (essentiellement six espèces *Chelicorophium curvispinum, Pontogammarus robustoides, Gmelinoides fasciatus, Gammarus tigrinus, Eriocheir sinensis* et *Astacus leptodactylus).* Nous discutons également de l'histoire des invasions par ces espèces exotiques, les vecteurs possibles de leur extension à partir de leur aire d'origine mais aussi l'effet potentiel des interactions trophiques entre les amphipodes et les décapodes exotiques et les espèces natives. Les principales voies d'invasions dans la mer Baltique à partir des différents bassins sont liées aux activités humaines (principalement liées à la création de continuum rivières-canaux/corridors d'invasions et introduction volontaire/commerce). La prédation sélective par les Amphipodes et les Décapodes invasifs est le principale mécanisme expliquant le remplacement des crustacés cohabitant et les changements de densité des macroinvertébrés autochtones.

ABSTRACT

The Neva River is a part of Northern invasion corridor, linking southern areas (Ponto-Caspian region) with the Baltic Sea and aquatic systems of northern Russia. This paper focuses on invasion history of recent malacostracan crustaceans (Amphipoda and Decapoda) in the basin of the Neva River (largest river in North-western part of Russia). This paper analyzes literature and own data about current distribution of recent invaders to the Neva River basin (mainly, six species *Chelicorophium curvispinum, Pontogammarus robustoides, Gmelinoides fasciatus, Gammarus tigrinus, Eriocheir sinensis* and *Astacus leptodactylus.* Invasion history of the alien species and possible vector of their expansion from original area to study area and also, significance and possible trophic interactions between the alien amphipods and decapods and native biota are discussed. The main pathways of species invasions in Baltic Sea basin from different basins were associated with human activities (mainly due to creation of continual river-canal systems/ invasion corridors and intentional introduction/ stocking). The selective predation by some invasive amphipods and decapods is the main mechanism explaining the replacement of co-existing malacostracan crustaceans and shifts in density of native macroinvertebrates.

KEYWORDS

Alien Malacostraca, ecological significance, impact on benthic communities, invasion history, Ponto-caspian origin, Russia, species interactions, vectors of invasions.

1. INTRODUCTION

Extension of the range by malacostracan crustaceans from the Ponto-Caspian region to northern latitudes has been greatly facilitated by human activity (Jazdzewski, 1980; Bij de Vaate et al., 2002; Berezina, 2007). Among the most important factors, facilitating success of the species, are: the destruction of natural barriers between different basins of Europe due to construction of artificial canals, reservoirs, drainage systems and the formation of continual water routes from southern to northern latitudes; occasional and intentional introductions with the increase in international trade (shipping traffic) and climatic changes and also destruction of habitats that accompanies globalization. Neva River is largest river in north-western region of Russia and is included in different waterways connecting the inland waters of Finland, Estonia and Russia with southern basins (Black, Azov and Caspian seas) particularly via Northern invasion corridor (Bij de Vaate et al., 2002). The alien crustaceans are the most diverse and abundant taxa among invaders in the Neva River basin but their role in aquatic ecosystems remain still unclear. This paper aims to review current distribution of alien species of amphipods and decapods in the Neva River and its basin and to evaluate possible impact of the newcomers on native communities.

2. STUDY REGION

Basin of the Neva River is 281 thousand km^2 of territory in north-western part of Russia with around 50 thousands lakes (as well as large Lake Ladoga and Onega), above 60 thousands of rivers and connects with the eastern part of the Baltic Sea.

3. RESULT AND DISSCUSSION

3.1 Distribution of invasive species

The Ponto-Azov-Caspian elements among the alien crustaceans play an important role in the fauna of the Neva River basin. Totally, 10 species of malacostracan crustaceans were recorded in fresh waters of this region. Four species of order Amphipoda: *Chelicorophium curvispinum* (Sars 1895)*, Pontogammarus robustoides* (Sars 1894)*, Gmelinoides fasciatus* (Stebbing 1899) and *Gammarus tigrinus* Sexton 1939*,* and also two species from order Decapoda: *Eriocheir sinensis* H. Milne-Edwards 1853 and *Astacus leptodactylus* (Eschcholtz 1823) are widely spread among them and continie to expand actively in different direction.

The baikalian G. fasciatus is most adaptive species and spread in different inland waters of studied region, forming a very abundant populations (up to 100 gm^{-2}) in coastal areas of many lakes and rivers. Three other amphipod species concentrate mainly in the Neva River, Neva Estuary, Lake Ladoga and some small rivers connecting with Baltic Sea. The chinese mitten crab *E. sinensis* was found in Neva River basin in 1982 and then in 2000s its records were often i the Neva River, its estuary and connected lakes and rivers (Lake Onega, Lake Ladoga, Vuoksa River, and Severnay Dvina River). During last decades narrow clawed crayfish *A. leptodactylus* expanded widely in the nortern areas of Russia. Origin area of this species was limited by south-western Asia and eastern Europe, including Ponto-Caspian region. This marketable crayfish species was most intensively introduced among alien malacostracan species from the begining of 20 century, it was introduced in at least 14 European countries. Due to high tolerance and rapid range expansion, *A.leptodactylus* became common species in aquatic ecosystems of 27 European countries by 2000s. In Russia, this species was introduced in Neva River basin in 1920-40s, and by present it inhabits ponds and small lakes of different rivers basins (Neva, Shuya, Padas, Suna and Lizhma).

3.2 Dynamics of alien crustaceans and impact in recipient communities

Invasive amphipods caused dramatic alterations in invertebrate communities in the sites where they abundant species (comprising above 40 % to the total benthic biomass). In the most areas they successfully outnumbered or even completely replaced some native species and/or earlier established invaders. Besides the influence of this eutrophication, the intraguild predation and competition for food may result in changes of population structure and decreasing density of some gammarid species (including alien *Pontogammarus robustoides, Gammarus tigrinus, Gmelinoides fasciatus* and native *Gammarus lacusris, Gammarus pulex, Palasea quadrispinosa*) and also isopod *Asellus aquaticus* and

aquatic insects in the case of simpatric populations. Also, nobile crayfish *Astacus astacus* was replaced by introduced *A. leptodactylus* in cases of coexistance in the same habitats during period 10-20 years.

At the same time, abrupt seasonal declines of alien amphipod abundances during summer was recorded in the estuary of the Neva River a result of increase eutrophication and decline in oxygen concentration. This period is characterized by a maximum phosphorus in water; this increase in eutrophic conditions was due to high concentrations of decaying filamentous algae *Cladophora* in littoral zone. The decomposition process creates a high bacterial oxygen demand and the subsequent temporary decrease of dissolved oxygen content in the littoral zone can be an actual reason of high mortality of gammarids. It is known that all species of amphipods are limited by oxygen concentration in water less 2 mgl^{-1}. Predation impact on invertebrates also decrease significantly in the case of unfavorable enviromental conditions and low abundance of alien amphipods.

Besides, predation impact on benthic communities changes during season depending on change in size structure of predaceous alien species. The minimal predation pressure on benthic invertebrates in the Neva River mouth was evaluated in the midle of summer when young generation dominating group in population of alien amphipods. That is result of ontogenetic changes in the diet of amphipods. As for *Pontogammarus robustoides*, microscopic analisys of gut content in its specimens collected from the Neva River estuary confirmed the prevalence of detritus (80%) in the diet of 5–7 mm specimens; the filamentous algae, macrophytes and small invertebrates in the diet of 8–12 mm specimens and mainly animal food (oligochaetes, isopods, planktonic crustaceans, aquatic insects) in the diet of larder 13 mm specimens.

The selective predation by predaceous alien crustaceans is explaining reason of the replacement of co-existing native species and shifts in density of native macroinvertebrates. However, enviromental conditions and life cycle traits of invaders can determinate abundance, population structure of the predator and as a result the strength and character of invasive impact on native community.

LIST OF REFERENCES

Berezina, N.A. (2007). *Invasions of alien amphipods (Crustacea: Amphipoda) in aquatic ecosystems of North-Western Russia: pathways and consequences*. Hydrobiologia 590, 15-29.

Bij de Vaate, A., Jazdzewski, K., Ketelaars, H.A.M., Gollasch, S. and van der Velde, G. (2002). *Geographical patterns in range extension of Ponto-Caspian macroinvertebrate species in Europe*. Can. J. Fish. Aq. Sci. 59, 1159-1174.

Jażdżewski, K. (1980). *Range extension of some gammaridean species in European inland waters caused by human activity.* Crustaceana 6, 84-107.