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SHORT COMMUNICATION

Rapid establishment of the alien crab *Rhithropanopeus harrisii* (Gould) in the Gulf of Riga

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Abstract. The aim of this paper was to report the arrival and rapid colonization of the nektobenthic crustacean *Rhithropanopeus harrisii* in the shallow north-eastern Gulf of Riga. The crab was found for the first time from the Estonian coastal sea in Pärnu Bay in August 2011. In 2012, during targeted sampling efforts, different life-history stages of the species (larvae, juveniles, and adults) were observed all over Pärnu Bay with some sporadic findings at the open coast of the Gulf of Riga. These observations, together with a successful breeding, confirm that *R. harrisii* is established in the study area. Provided the high density of *R. harrisii* and the lack of such functional trait in the study area and in the north-eastern Baltic Sea range in general, this invasion is likely to cause significant repercussions on the structure and functioning of soft- and hard-bottom benthic macrophyte and invertebrate communities in the near future.

Key words: Baltic Sea, benthic invertebrate, range expansion, Harris mud crab, *Rhithropanopeus harrisii*.

INTRODUCTION

Owing to its low salinity and short evolutionary history, the Baltic Sea virtually lacks native top predatory crabs. This contrasts to true oceanic waters where crabs constitute an essential element of the nearshore benthic ecosystems (e.g. Lee, 1998). To date, the only 'iconic' species in the Baltic Sea range is the Chinese mitten crab *Eriocheir sinensis* (H. Milne-Edwards). Despite occasional findings of this invasive species all over the coastal Baltic Sea, the reproduction of the mitten crab in the central, northern, and eastern Baltic regions is considered unlikely due to the low salinity, and the individuals caught are assumed to have actively migrated into the region over 1500 km distance (Ojaveer et al., 2007).

However, the Baltic Sea also hosts the Harris mud crab *Rhithropanopeus harrisii* (Gould) (Fig. 1). This species has a native distribution from New Brunswick (Canada) to Veracruz (Mexico). In Europe the invasive species was first found in 1874 in the Netherlands, in the Baltic Sea area it was first observed in 1936 (Nikolaev, 1951). In contrast to *E. sinensis*, the mud crab is capable of reproducing

Fig. 1. Still photograph of the Harris mud crab in the study area.

in the diluted Baltic Sea and can form high-density populations (Maiju Lehtiniemi, pers. comm.); thus, it may exert strong pressure on the local benthic macrophyte and invertebrate communities. Despite its long invasion history, until very recently the distribution of *R. harrisii* was confined to Mecklenburg Bay, the Oder Estuary, the Gulf of Gdansk, and the Curonian Lagoon only (Jażdżewski & Konopacka, 1993; Bacevičius & Gasiūnaitė, 2008; Czerniejewski, 2009; Jażdżewski & Grabowski, 2011). Seemingly, *R. harrisii* has a large between population variability in Europe with more recent populations showing a tendency for increased genetic diversity (Projecto-Garcia et al., 2010). This suggests that *R. harrisii* is still in the process of expansion in Europe and its sudden northwards expansion seems to be a result of new introductions. In this study we report the sudden expansion of this alien invasive species over 500 km northwards and provide information on its distribution.

MATERIAL AND METHODS

Crabs are not systematically monitored in the Estonian coastal sea. Nevertheless, since 1995 the Estonian National Monitoring Programme surveys benthic macrophytes and the associated invertebrates around the whole Estonian coastal range. In addition, the programme also surveys pelagic communities. The phytobenthos and zooplankton sampling and sample analysis follow the guidelines developed for the HELCOM COMBINE programme (HELCOM, 2012). Although not specifically targeted towards large and mobile invertebrates, the national monitoring programme is potentially capable of sighting the mud crab both in benthic and pelagic ecosystems.

In addition, there is another local long-term activity that provides semi-quantitative data on crabs. Specifically, this is done through the provision of artificial spawning substrata for the commercially valuable fish pike-perch in Pärnu Bay. This activity was started already in the late 1980s and has been done every year since then. Most of these artificial spawning substrata consist of linen gillnets of small mesh size. Such substratum may also provide a suitable habitat for the Harris mud crab and, therefore, may provide occurrence information on the species. These artificial spawning substrata were checked for the mud crab occurrence in 2011–2012, also with SCUBA diving, which was also performed in several additional localities in Pärnu Bay to map the distribution of the species. Finally, owing to good long-term relations with local professional fishermen, several occurrence data on the crab were obtained from them.

RESULTS AND DISCUSSION

The Harris mud crab *R. harrisii* was first found in the Estonian waters in August 2011. Seven individuals were found in three deployed lines of pike-perch artificial spawning substrata at the northern coast of Pärnu Bay (NE Gulf of Riga) (Fig. 2). Within the similar activity in 2012, the species was already found at much higher abundances and at considerably wider spatial scale: among 14 deployed lines of artificial substrata only 3 contained no crabs. In addition to adult crabs, we also found juveniles of the year. Besides, in 2012 the species was also found from the pelagic mesozooplankton samples, including a sporadic finding at the open coast

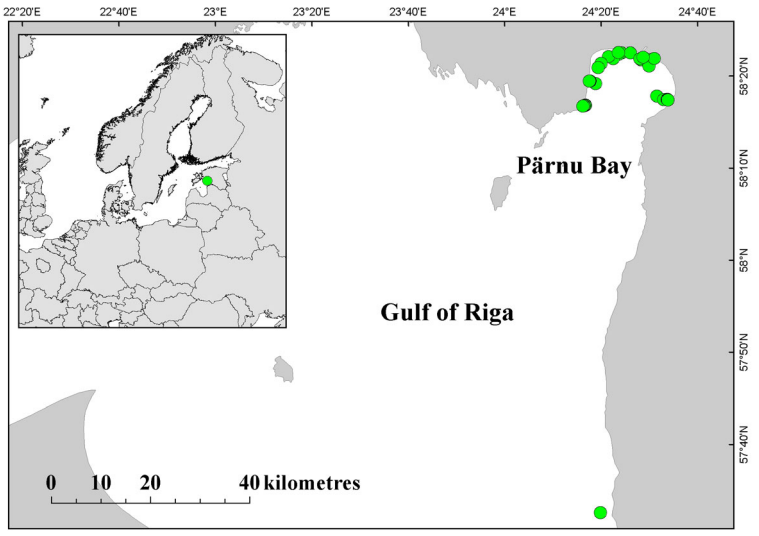

Fig. 2. Locations (filled circles) where *Rhithropanopeus harrisii* was found in the Estonian coastal sea in the Gulf of Riga.

of the Gulf of Riga (Mart Simm, unpublished data) (Fig. 2). Thus, our findings confirm that the mud crab successfully reproduces in the study area and should be therefore considered as established. However, to date we have not yet found *R. harrisii* in the benthic quantitative samples collected in the framework of Estonian national coastal monitoring. Thus, it is possible that the mud crab avoids densely vegetated areas.

Although the species may have been present in Pärnu Bay prior to 2011, we consider its occurrence in high abundances very unlikely because artificial spawning substrata have been provided to pike-perch in the same area annually since the end of the 1980s and high-frequency (i.e. fortnightly) pelagic samples have been collected since the late 1950s. Pärnu Bay should provide *R. harrisii* a suitable habitat, a rich feeding ground as well as a small number of natural enemies. All this promotes a rapid dispersal of the mud crab after its initial invasion. Specifically, owing to elevated eutrophication the mud crab finds plentiful food sources in Pärnu Bay either in the form of a high filamentous macroalgal cover or dense bivalve and amphipod populations. Benthic habitats are characterized by a mixture of silty sand sediment covered by pebbles and cobbles (Kotta et al., 2008). Due to the high fishing pressure, commercially valuable predatory fishes are nowadays depressed in the study area (e.g. Saat & Ojaveer, 2005). Therefore, the predation risk for the crab is currently low and the top-down food-web control should be considered as weak. Potentially, water birds may consume some mud crabs; however, due to the high turbidity and low number of birds this control is not important in the study area compared to e.g. the Puck Bay area (Tomczak et al., 2009).

Despite some evidence on new introductions of the Harris mud crab in Europe, the timing of the arrival of the species is enigmatic and possibly not just another stochastic invasion event. During the last two years we have witnessed introductions of a number of new alien species in Pärnu Bay (e.g. Kotta & Kuprijanov, 2012) with one new abundant polychaete species of the genera *Potamilla*/*Pseudopotamilla* still to be identified. This all suggests that recent human activities have opened, modified, or intensified the vector(s) responsible for the transfer of the large mobile invertebrates into the north-eastern Baltic Sea, potentially accompanied by recent abrupt changes in environmental conditions (Arula, 2012; ICES, 2012a).

The fast expansion of its distribution area within just a year and a successful breeding suggest that *R. harrisii* is established in the study area. Provided the potentially high density of *R. harrisii* and the lack of such functional trait in the Gulf of Riga and in the north-eastern Baltic Sea range in general, this invasion is likely to cause significant repercussions on the structure and functioning of soft- and hard-bottom benthic macrophyte and invertebrate communities in the near future. This invasion is part of the wide-range expansion of the Harris mud crab in the Baltic Sea basin (Bacevičius & Gasiūnaitė 2008; Czerniejewski, 2009; Jażdżewski & Grabowski, 2011). In recent years increasing densities and new sites for *R. harrisii* have been reported in Denmark (ICES, 2010). In addition, the species was recently found in Finland, where it largely increased in abundance and distributional range (ICES, 2012b).

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Mudakrabi *Rhithropanopeus harrisii* kiire naturaliseerumine Liivi lahes

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On antud ülevaade nektobentilise mudakrabi *Rhithropanopeus harrisii* levikust Liivi lahe kirdeosa rannikumeres. Mudakrabi leiti Eesti rannikumerest esmakordselt 2011. aastal Pärnu lahest. 2012. aastal leiti kogu Pärnu lahe akvatooriumist arvukalt krabi noorjärke ja täiskasvanud indiviide. Krabi leiti vähearvukalt ka Liivi lahe avaosas. Need andmed näitavad, et mudakrabi on uurimisalal naturaliseerunud. Kuna tegemist on täiesti uue funktsiooniga Läänemere idaosa rannikumeres ja liigi suurest arvukusest ning sigimispotentsiaalist tingituna põhjustab see invasioon lähiaastatel rannikumere kooslustes suuri muutusi.