BioInvasions Records (2021) Volume 10, Issue 3: 644–653

Rapid Communication

Reappearance of *Rhithropanopeus harrisii* (Gould, 1841) (Crustacea, Decapoda, Brachyura) in U.K. waters: a new record from the River Thames, London

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Citation: Jarvis S, Clark PF (2021) Reappearance of *Rhithropanopeus harrisii* (Gould, 1841) (Crustacea, Decapoda, Brachyura) in U.K. waters: a new record from the River Thames, London. *BioInvasions Records* 10(3): 644–653, https://doi.org/10.3391/bir.2021.10.3.15

Received: 8 February 2021
Accepted: 12 May 2021
Published: 12 July 2021

Handling editor: Yuriy Kvach
Thematic editor: Karolina Bącela-Spychalska

Abstract

The invasive American Harris mud crab is reported for the first time from the Thames catchment in proximity to East India Dock basin and the confluence with the River Lea (Bow Creek), East London. *Rhithropanopeus harrisii* (Gould, 1841) has only once previously been recorded in British waters from Roath Docks, Cardiff, South Wales. Although the current status of *R. harrisii* in Roath Dock and the Thames at Bow Creek requires clarification, the Harris mud crab has been established in North European estuaries since 1874 and has spread rapidly elsewhere.

Key words: invasive brachyuran crab, Harris mud crab, introduced species, shipping

Introduction

The Harris mud crab, *Rhithropanopeus harrisii* (Gould, 1841) is one of the world's most widespread brachyuran species. It was first described from the Charles River and Cambridge Marshes, Massachusetts and its native range is the eastern seaboard of North America from the Gulf of St. Lawrence in Canada to Veracruz in Mexico (Williams 1984). It was first recorded in Europe by Maitland (1874) from the saline Zuiderzee (now the freshwater Ijsselmeer, following construction of the Afsluitdijk in 1932). From there it appears to have spread eastwards along the North Sea coasts and into the Baltic, via Germany (Schubert 1936), Poland in 1952 (Grabowski et al. 2005), Estonia (Kotta and Ojaveer 2012) and then into the Finnish Archipelago of the southern Gulf of Bothnia (Gagnon and Borström 2016; Spiridonov and Zalota 2017). There have also been reports from Le Havre and Ouistreham (near Caen) in northern France (Marchand and Saudray 1972), the Loire (Marchand 1972) and Portugal (Gonçalves et al. 1995). Elsewhere, the Harris mud crab has been recorded from the Caspian and Black Sea region (reviewed by Spiridonov and Zalota 2017), the American Pacific coast (Jones 1940), the Panama Canal (Abele and Kim 1989; Roche and Torchin 2007; Roche et al. 2009), Japan (Iseda et al. 2007) and in freshwater reservoirs in Texas (Boyle et al. 2010). In all these areas it inhabits

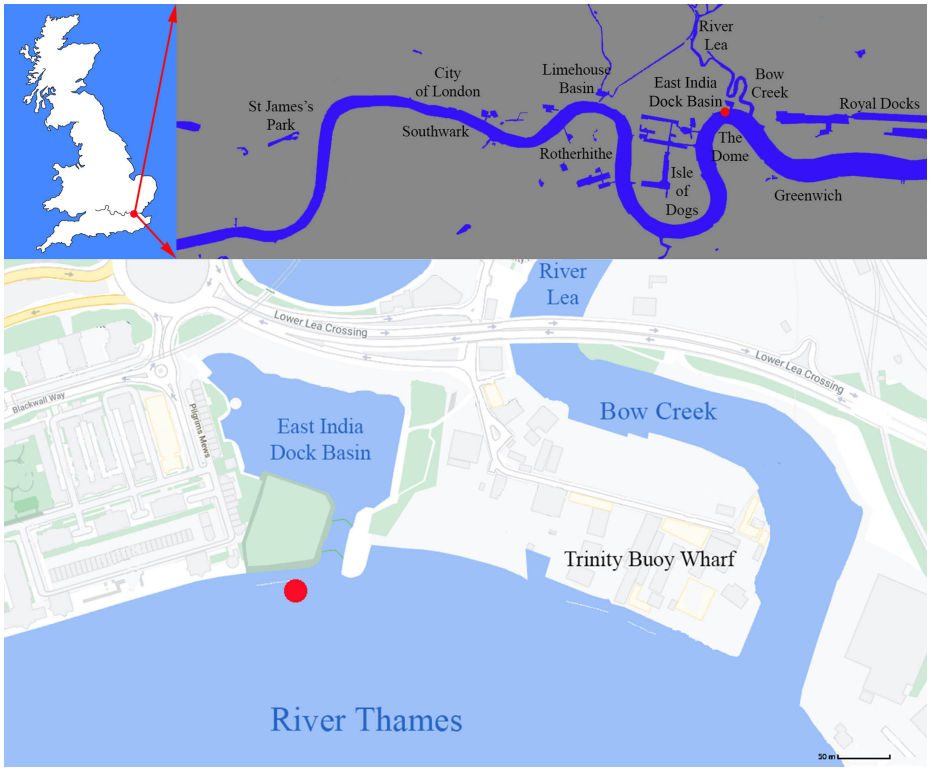

Figure 1. Sample position of *Rhithropanopeus harrisii* in the River Thames showing proximity to East India Dock basin and confluence with River Lea (Bow Creek).

estuarine to freshwater shallow habitats. For a comprehensive review of distribution and biology see Brockerhoff and Mclay (2011) and Roche (2020).

In view of the apparent invasiveness of this species it is surprising that *R. harrisii* has not been reported from English Channel ports or estuaries. This is all the more remarkable given the frequency of shipping between England and the Continent and the short distances involved. The only previous U.K. record was in Roath Dock, Cardiff, Wales in 1996 (Eno et al. 1997) but it appears that these specimens were not deposited in a museum and no further occurrences have been recorded.

Materials and methods

Study area

The specimens were taken from the north side of the tidal River Thames, Central London near to the confluence with the River Lea (Bow Creek) and the entrance to the East India Dock basin (Figure 1). The sub-tidal riverbed here consists of fine mud and sand overlying gravel with cobbles, pebbles and some building rubble.

Sampling and analysis

As part of a base-line environmental survey conducted in support of a residential and commercial ("mixed use") riverside development, nine sub-tidal Day grab samples were taken at high tide on 24 October 2019 when water depth was approximately 12 m. The samples were sieved (0.5 mm)

on-board the survey vessel and fixed immediately in buffered formalin. In the laboratory all invertebrates were identified and transferred to 70% ethanol (UN1170).

Results

Sample analysis

Specimens of *R. harrisii* were restricted to one grab sample which contained a large, smooth, channelled cobble (max length/width 13 cm, max depth 7 cm), a tile fragment and an iron nail segment together with numerous smaller examples of anthropogenic material (glass fragments, thread/filament) which were extracted under the microscope.

The associated low diversity fauna in this sample was dominated numerically by the non-native spionid polychaete *Boccardiella ligerica* (Ferronnière, 1898) (692 specimens), and the corophiid amphipod *Apocorophium lacustre* (Vanhöffen, 1911) (198 specimens). Also present in this sample were the non-native hydroid *Cordylophora caspia* (Pallas, 1771), and barnacle *Amphibalanus improvisus* (Darwin, 1854), *Leptocheirus pilosus* Zaddach, 1844 (another corophiid), the isopod *Cyathura carinata* (Krøyer, 1847) and the bryozoan *Einhornia crustulenta* (Pallas, 1766). The non-native tubeworm *Ficopomatus enigmaticus* (Fauvel, 1923), and the bryozoan *Victorella pavida* Saville-Kent, 1870 were found elsewhere in the survey.

Systematics

Superfamily Xanthoidea MacLeay, 1838
Family Panopeidae Ortmann, 1893
Genus *Rhithropanopeus* Rathbun, 1898

***Rhithropanopeus harrisii* (Gould, 1841)**

Material examined. Sample STF5, Orchard Wharf, River Thames, Leamouth Peninsula, Poplar, London, OSGB-36 539070 180652, coll. 24 October 2019, depth 12 m, Gear: Day grab, det. Stephen Jarvis, 1 ♂ 13.79 mm carapace width 2 ♀ 6.45 mm, 6.45 mm carapace width Natural History Museum, London reg. NHM 2020.45-47 1♂ 7.35 mm carapace width in first author's collection.

Comparative material examined. Pier slip at Chesapeake Biological Laboratory, Solomons, Maryland, USA, coll. A.C. Edwards and F.T. Schwartz, August 1963, det. A.C. Edwards, NHM reg. 1964.9.7.152-220.

Rhithropanopeus harrisii is described and figured by Christiansen (1969: 81), Ingle (1980: 113), Williams (1984: 401) and Adema (1991: 180).

Identification

Rhithropanopeus harrisii is most likely to share habitat with the common shore crab *Carcinus maenas* (Linnaeus, 1758) and can be distinguished from

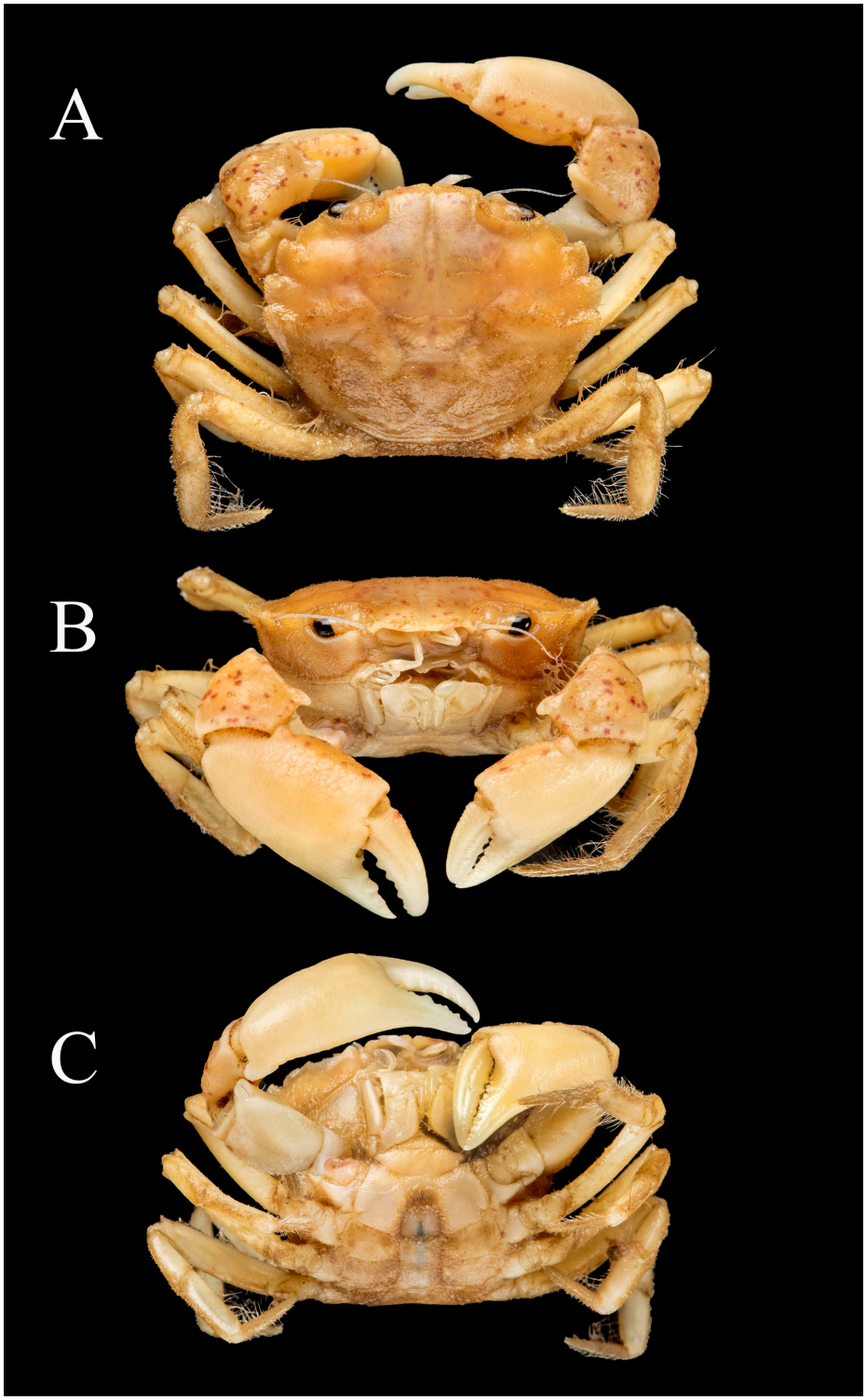

Figure 2. *Rhithropanopeus harrisii*, Orchard Wharf, River Thames, ♂ carapace width 13.79 mm, NHM reg. 2020.45-47. A) dorsal view, B) frontal view, C) ventral view. Photos by Kevin Webb, NHM Photo Unit.

this species by having 3 teeth on the anterolateral margin of the carapace and an almost straight, two-lobed front, the lobes separated by a shallow notch (Figure 2A). *Carcinus maenas* has 5 teeth on the anterolateral margin of the carapace and three frontal teeth or lobes, more or less developed, depending on crab size.

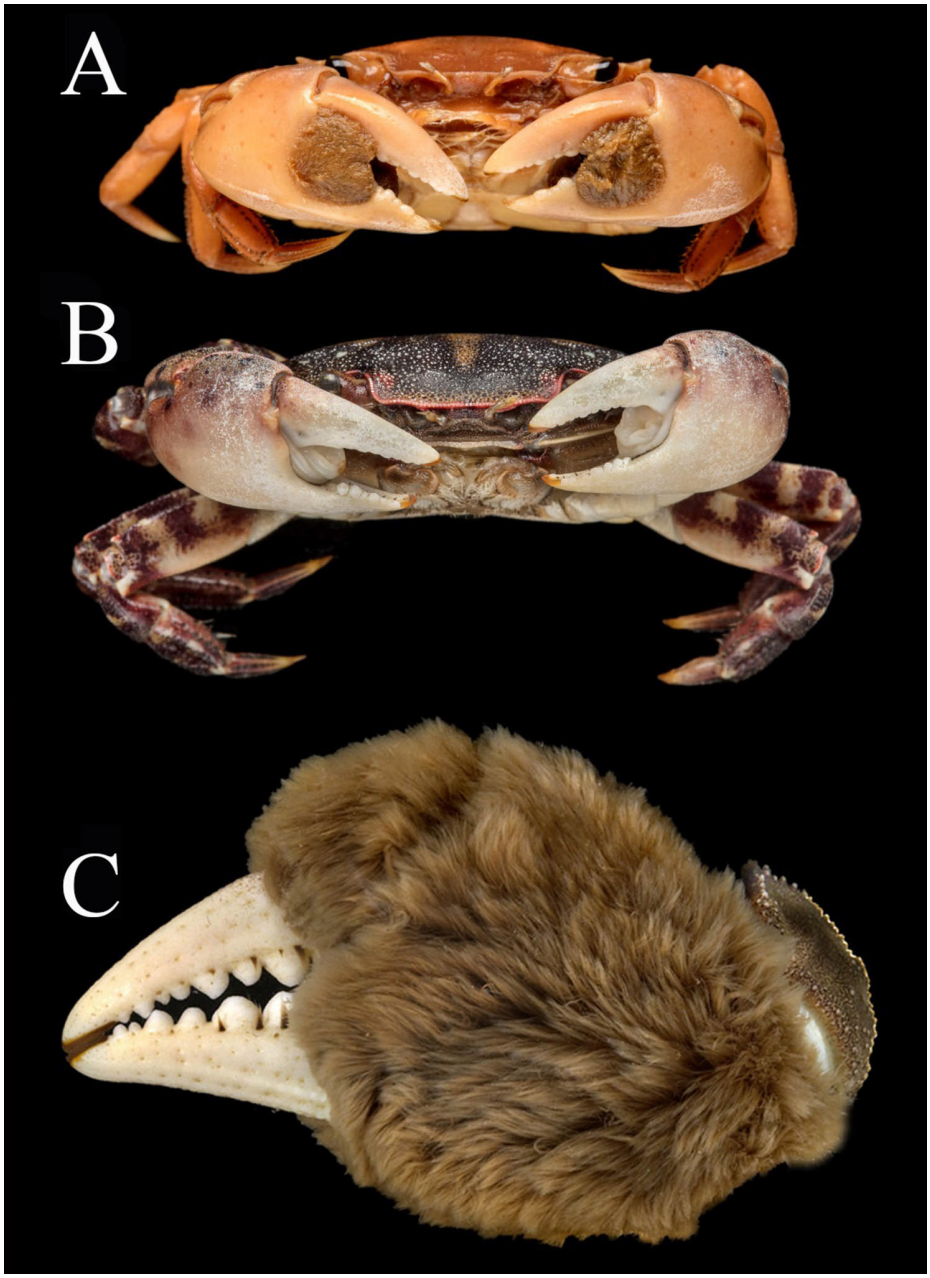

Figure 3. U.K. Invasives, SE Asian Varunidae cheliped morphology; A) *Hemigrapsus takanoi* B) *H. sanguineus*; C) *Eriocheir sinensis*. Photos A, B taken by Kevin Webb; C taken by Harry Taylor, both NHM Photo Unit.

Three invasive grapsoids assigned to the Varunidae are reported from the coast of SE England including two *Hemigrapsus* species. See Wood et al. (2015) and Ashelby et al. (2017) for *H. takanoi* Asakura and Watanabe, 2005 and Seeley et al. (2015) for *H. sanguineus* (De Haan, 1835) for U.K. records. Although superficially similar to *R. harrisii* in possessing three anterolateral teeth on the carapace margin, the cheliped morphology of these *Hemigrapsus* species is distinct. The chela of *R. harrisii* from the frontal view is smooth as seen in Figure 2B. This compares with a discrete setal mat in the vicinity of the junction of the propodus and dactylus in *H. takanoi* (Figure 3A) and a vesicle at the propodal and dactyl junction in *H. sanguineus* (Figure 3B). To date, only *H. takanoi* is known to be established in SE

England with a viable breeding population in the Orwell Estuary (Ashelby et al. 2017).

The third varunid invasive is the Chinese mitten crab, *Eriocheir sinensis* H. Milne Edwards, 1853, which is present in the River Lea (Clark et al. 1998) and well established in the Thames catchment (Clark 2011). For U.K. distribution of *E. sinensis* see Mitten Crab Watch (2021). *Rhithropanopeus harrisii* differs from *E. sinensis* in possessing 3 teeth on the anterolateral margin of the carapace (as opposed to 4 in *E. sinensis*), an almost straight, two-lobed front, (Figure 2A) vs four frontal teeth, and the chela of *R. harrisii* in frontal view is smooth (Figure 2B) whereas the propodus of the chela in *E. sinensis* is distinctively setosed (Figure 3C).

Discussion

In many respects the absence of *R. harrisii* from estuarine waters of southern England is more surprising than its appearance in the survey reported here (see Minchin et al. 2013). Since at least 1874 it has been found in many places on the north European coast, only a short distance along busy shipping routes between France, The Netherlands, Belgium and ports such as London and Felixstowe. Furthermore, recently it appears to have spread rapidly north eastwards to the Baltic (Fowler et al. 2013; Gagnon and Borström 2016). In contrast, two *Hemigrapsus* species have been discovered in England shortly after their first occurrence on North European shores (Seeley et al. 2015; Wood et al. 2015; Ashelby et al. 2017).

Invasive characteristics and habitat requirements

The spread of *R. harrisii* is facilitated by some interesting aspects of its biology. The species has a wide salinity and temperature tolerance (Williams 1984), high fecundity and rapid development (Morgan et al. 1983). Under laboratory favourable conditions females are capable of spawning up to four times without copulation, using stored sperm. This is unusual for brachyurans which normally mate immediately following ecdysis of the female (Morgan et al. 1983). In Europe it appears to be capable of reproduction when water temperature exceeds 14 °C (Turoboyski 1973) and these conditions do occur in the Thames during the Summer. Development time can be rapid but is temperature dependent (Morgan et al. 1983).

In addition to these reproductive traits, *R. harrisii* is a trophic generalist (Forsström et al. 2015) with some evidence of an ontogenetic diet shift from plant tissue in smaller crabs to invertebrates in larger individuals (Aarnio et al. 2015). It is known to eat plant and algal tissue as well as invertebrates such as the annelids and peracarids found to be abundant in this survey and throughout the Thames estuary (Attrill 1998).

The species prefers some form of cover and is usually found in habitats providing shelter such as rocks and fucoids (Riipinen et al. 2017) and in

this survey may well have been sheltering under a cobble when sampled (see above). This kind of habitat is common in the Thames. The presence and status of any predators in the study area has not been established. *R. harrisii*, may suffer competition from *E. sinensis* in the nearby River Lea but at this stage the situation in the Thames area is unknown. Bearing in mind the abovementioned traits and possible lack of competition, it would appear that this crab has the potential to become established in the Thames catchment.

Possible means of introduction

The most likely mode of translocation for marine and estuarine non-native species is often given as ballast water (for larvae or adults) and, indeed, a gravid female *R. harrisii* has been recovered from a ballast tank on the Atlantic coast of Canada, even after mid-ocean exchange of seawater (Briski et al. 2012). Larval stages are however, more likely to be taken up as ballast than the bottom dwelling adults and so are probably more easily transported. Adults may also be carried in sea chests (recesses in the hull for cooling water or ballast intake etc.) or in thick epifaunal fouling on the hull, as reported by Gollasch for *Hemigrapsus takanoi* (identified as *H. penicillatus*) (Gollasch 1999). Aquaculture has also been cited as a source of introduction for *R. harrisii* on the Pacific coast of America (Cohen and Carlton 1995) but this is not at all likely in this area.

It is, of course, impossible to know how these individuals came to be in the Thames. Populations may have existed for some time remaining undetected and suitable habitat is probably present in the River Lea (Bow Creek), the East India Dock Basin (now a local nature reserve) and the Thames itself. As far as the authors are aware there are no longer any direct shipping movements between the Continent and central London other than small pleasure craft. Large cargo vessels now use facilities such as at Tilbury (40 km downstream of central London) and Purfleet (about 30 km downstream) where there are regular sailings to and from the Continent. *Rhithropanopeus harrisii* may have been introduced into these ports and either migrated upstream (without being detected) or trans-shipped via the many intra-port barges that carry construction material, waste and other goods up and down the Thames. None of these scenarios however, has any supporting evidence. There is a scrap metal dockyard on the eastern side of the confluence of the River Lea (Bow Creek) and the Thames. It is not known if this facility has shipping traffic connected with the European mainland.

Potential effects of establishment

The question now remaining is whether there is an established population in the Thames and perhaps the River Lea. Habitat structure, food sources and lack of competition would appear to favour establishment. Both sexes

were present in this survey, but the sampling date was probably too late in the year to detect any ovigerous females, thus earlier spawning cannot be ruled out. The two females found in this survey however, would appear to be too small to reproduce in cooler European waters. In the Baltic the minimum carapace width for females in berry was 8.4 mm (Aarnio et al. 2015) compared to 5.8 mm in the Panama Canal (Roche and Torchin 2007).

The effects of *Rhithropanopeus* on resident invertebrate communities is poorly known but evidence of substantial changes in ecosystem functioning, species composition and abundance has now been reported (Forsström et al. 2015; Kotta et al. 2018). Added to this is the possibility of non-indigenous species importing parasites and pathogens into a novel environment. Gregarine parasites (Belofastova and Lozovsky 2008) and a herpes-like virus (Projecto-Garcia et al. 2009) injurious to other invertebrates have been detected in *R. harrisii*. In its native range it carries the parasitic barnacle (rhizocephalan) *Loxothylacus panopaei* (Gissler, 1884) and it is not known whether this parasite can switch hosts.

Rhithropanopeus harrisii were found in only one of the nine samples, which indicates low abundance in the small area surveyed. Further surveys, perhaps using artificial collectors as deployed by Fowler et al. (2013) and Kotta et al. (2018) or using eDNA are needed to determine the presence and status of the species at other potential locations.

Acknowledgements

The authors thank Kevin Webb and Harry Taylor, both NHM Photo Unit, for taking the images reproduced for this present study. Thanks are also due to Matt Crabb of Carcinus Ltd who carried out the survey and secured the samples. We wish to thank the two reviewers for their constructive comments on our manuscript.

Authors' contribution

SJ – original draft; PFC writing – review and editing.

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