

## ***Hemigrapsus takanoi* Asakura and Watanabe, 2005 (Crustacea: Decapoda: Brachyura: Grapsoidea): first records of the brush-clawed shore crab from Great Britain**

Christine A. Wood<sup>1\*</sup>, John D.D. Bishop<sup>1</sup>, Clare J. Davies<sup>2</sup>, Emma L. Delduca<sup>3</sup>, Josh C. Hatton<sup>3</sup>, Roger J.H. Herbert<sup>2</sup> and Paul F. Clark<sup>4</sup>

<sup>1</sup>The Marine Biological Association of the United Kingdom, The Laboratory, Citadel Hill, Plymouth, PL1 2PB, Devon, UK

<sup>2</sup>Centre for Conservation Ecology and Environmental Change, Department of Life and Environmental Sciences, Faculty of Science and Technology, Bournemouth University, Fern Barrow, Poole, Dorset, BH12 5BB, UK

<sup>3</sup>Marine Ecological Surveys Ltd., 3 Palace Yard Mews, Bath, BA1 2NH, UK

<sup>4</sup>Invertebrates Division, Department of Life Sciences, The Natural History Museum, Cromwell Road, London, SW7 5BD, UK

E-mail: [cwo@mba.ac.uk](mailto:cwo@mba.ac.uk) (CAW), [jbis@mba.ac.uk](mailto:jbis@mba.ac.uk) (JDDB), [cdavies@bournemouth.ac.uk](mailto:cdavies@bournemouth.ac.uk) (CJD), [emma.delduca@mesltd.co](mailto:emma.delduca@mesltd.co) (ELD), [josh.hatton@mesltd.co](mailto:josh.hatton@mesltd.co) (JCH), [RHerbert@bournemouth.ac.uk](mailto:RHerbert@bournemouth.ac.uk) (RJHH), [p.clark@nhm.ac.uk](mailto:p.clark@nhm.ac.uk) (PFC)

\*Corresponding author

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### **Abstract**

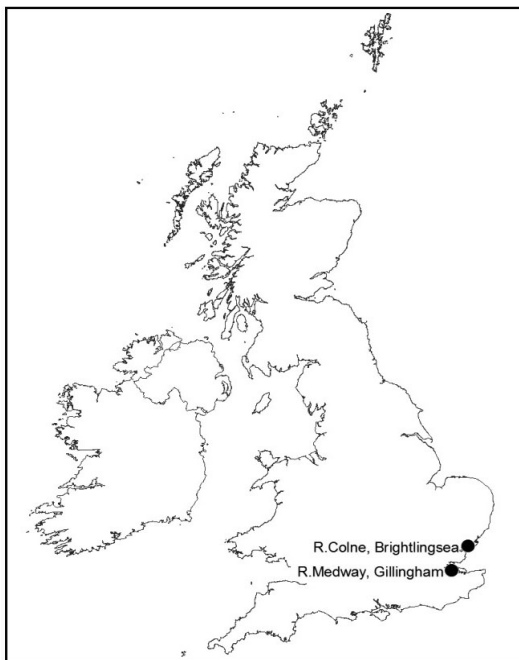
The brush-clawed shore crab is reported from the River Medway, Kent and the River Colne, Essex, England. These represent the first records of *Hemigrapsus takanoi* Asakura and Watanabe, 2005 from Great Britain. If *H. takanoi* becomes established in GB, it may pose a threat to populations of the native shore crab *Carcinus maenas*.

**Key words:** brush-clawed shore crab, invasive brachyuran species, River Medway, southern England, River Colne, Brightlingsea

### **Introduction**

The varunine crab *Hemigrapsus takanoi* Asakura and Watanabe, 2005 is native to Northwest Pacific coastlines, occurring intertidally. *Hemigrapsus takanoi* was named and formally distinguished from the Northwest Pacific species *H. penicillatus* (de Haan, 1835) only in 2005 and, in Europe, it was initially identified as *H. penicillatus* (Gollasch 1996, 1999; Noël et al. 1997; d'Udekem d'Acoz 1998, 1999). Around this time, Masatsugu Takano recognised two sympatric forms of *H. penicillatus* in Japan, with statistically different-sized setal patches on the male chelae: form I possessed smaller setal patches than form II (Takano et al. 1997, 1999). Seeking clarification of the identity of European populations, Cédric d'Udekem d'Acoz (d'Udekem d'Acoz and Faasse 2002) sent Bay of Biscay *Hemigrapsus* material to Masatsugu Takano, who identified these as form II (Takano

et al. 1997). Further examination by Cédric d'Udekem d'Acoz (2004 pers. comm. to Asakura and Watanabe 2005: 287) of abundant material collected from France and the Netherlands revealed that all specimens lacked dark spots on the abdominal somites, further confirming European *H. penicillatus* as form II (Takano et al. 1997, 1999). Asakura and Watanabe (2005) named form II as a new species, *Hemigrapsus takanoi*, and distinguished it from *H. penicillatus* by the relatively larger setal patches on the male chelae of *H. takanoi* (Asakura and Watanabe 2005: Figure 3A-D cf. Figure 9A-D). Furthermore, the coloured spots on *H. takanoi* are comparatively small where present (Asakura and Watanabe 2005: Figures 2A; 3A, C, D; 7A, B cf. Figures 8; 9A, E; 10) and, unlike *H. penicillatus*, are absent from the abdomen (Asakura and Watanabe 2005: Figures 2C; 7B cf. Figures 8; 10B), and the first male pleopods differ between the species (Asakura and Watanabe 2005: Figure 6A, B cf. Figure 6C, D).



**Figure 1.** Showing locations of first Great Britain records of *Hemigrapsus takanoi*.

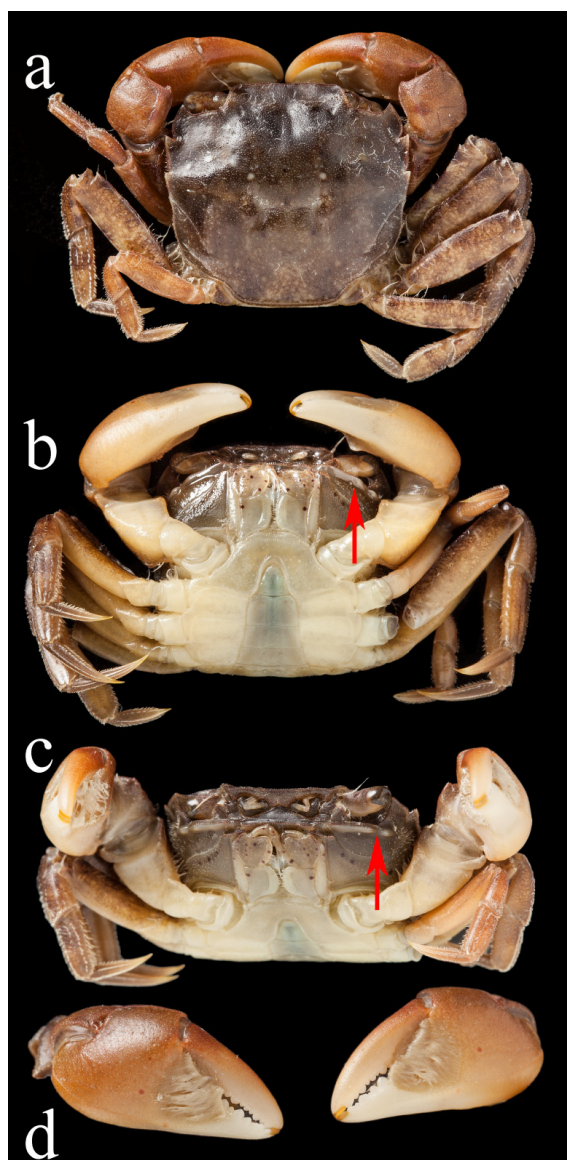
While visiting the Natural History Museum, London, Asakura examined and redetermined a male and female collected in 1996 by P.Y. Noël from the French coast as *H. takanoi*. Yamasaki et al. (2011) were able to distinguish between *H. penicillatus* and *H. takanoi* based on sequence differences within the 16S rRNA region of mitochondrial DNA; their analysis of the sequence from one specimen collected in France as *H. penicillatus* (GenBank accession number AJ278835) re-identified it as *H. takanoi*. Also Markert et al. (2014) have recently confirmed, by molecular analysis, that the Asian brush-clawed crabs in the Wadden Sea are *H. takanoi*.

During a 4-year period (1992–1995), the ballast water, tank sediments, and hull fouling of 131 ships recently berthed at German ports were sampled and examined as part of a study on German shipping (Gollasch 1996; 1999). On 14 August 1993, six specimens (2 male, 4 female) of *H. takanoi* (as *H. penicillatus*) were collected in hull samples from the car-carrier *SPICA* berthed in Bremerhaven. After the journey from Japan into European waters, this vessel had docked for a routine inspection and coating with antifouling paint (Gollasch 1996: 117; 1999). As Gollasch (1999) stated at the time, this was the first direct observation of long-range transmission and survival of '*H. penicillatus*' on a ship hull of

a fast ocean-going vessel (*SPICA* was capable of an average cruising speed of 17 knots). These specimens were subsequently re-identified as *H. takanoi* (S. Gollasch, pers. comm. 2014).

Noël et al. (1997) record collecting a single specimen of *H. takanoi* (as *H. penicillatus*) from the estuary of Charente Maritime near La Rochelle on the Atlantic coast of France in March 1994. They reason that the crab could have been included with Asian oysters introduced near La Rochelle or in the Bay of Arcachon, or by shipping lines operating from Bordeaux and La Rochelle. Moreover, Noël et al. (1997) could estimate the date of this introduction, stating that the intertidal fauna of La Rochelle had been systematically surveyed for years and this species had not been sighted before 1994. Noël (1997) thus believed that the introduction of the species may have taken place in 1993. Gollasch (1999) later postulated that in 1993 the car-carrier *SPICA* passed the French coast on its passage to Bremerhaven, unintentionally transporting perhaps "several hundreds of specimens of *H. penicillatus*" and assumed these crabs either dropped off or were displaced from the hull in sufficient numbers to generate a new population. Whether this was the case is uncertain, but Noël et al. (1997) reported that *H. takanoi* (as *H. penicillatus*) had spread rapidly and by December 1996 was present from Laredo, Spain (43°25'N, 003°23'W) north to Fromentine, France (46°53'N, 002°09'W), a distance of ca. 700 km, in sheltered areas of the mid-littoral zone (Noël et al. 1997, Figure 2). *Hemigrapsus takanoi* continued to spread along the NW coast of Europe with Dauvin et al. (2009, Figure 5) mapping its distribution with data up until July 2008 as far as the eastern Wadden Sea, Germany. Most recently however, Landschoff et al. (2013, Figure 1) record the brush-clawed shore crab as far north as Rømø Island, Denmark, but without details. Confirmation was obtained by email (dated 9 September 2014 to PFC from Jonas Geburzi, Zoologisches Museum, Universität zu Kiel), stating that on 15 March 2012, Karsten Reise (AWI Wadden Sea Station in List on Sylt) found numerous specimens in Havneby harbour, Rømø Island but that the species was not recorded at this locality in 2011. In 18 years, *H. takanoi* has therefore dispersed around the NW coastline of continental Europe a distance of ca. 2200km.

The purpose of this current paper was to note the first GB records of *H. takanoi* from the River Medway, Kent, England, and from the River Colne, Essex, England, see Figure 1.



**Figure 2.** *Hemigrapsus takanoi* Asakura and Watanabe, 2005, collected from River Medway, 15<sup>th</sup> August 2014, male, a. dorsal view; b. ventral view; c. anterior view; d. frontal view of chelae showing setal patches. Arrows indicate position of suborbital stridulation ridge. Photographs taken by Phil Hurst, NHM Photo Unit.

### Systematics

Superfamily Grapsoidea MacLeay, 1838  
Family Varunidae H. Milne Edwards, 1853  
Subfamily Varuninae H. Milne Edwards, 1853  
*Hemigrapsus takanoi* Asakura and Watanabe, 2005

### Material examined:

Specimen A – Figure 2a-d, 1♂, carapace width 15.7mm, Gillingham Marina, 51°23.84'N 000°33.62'E, River Medway, Kent, England, collected by Christine Wood, John Bishop and Anna Yunnice on 5 August 2014, NHMUK reg. 2015.2779, during surveys of south and south east coast marinas for non-native species. The crab was found on a rope hanging from a floating pontoon within the semi-enclosed marina basin. Adjacent to the basin is an area of tidal mudflats. The salinity was 28.0 and the water temperature 21.6°C at the surface at the time of collection. No other crabs were recorded. The specimen was confirmed as *H. takanoi* by Paul Clark on 16 August 2014.

Specimens B and C – 1♂, carapace width 6.53mm; 1♀, carapace width 15.27mm, not egg-bearing, Colne estuary, Brightlingsea, Essex, England, 51°48.35'N, 001°01.17'E, collected by Clare Davies, 7 May 2013, NHMUK reg. 2015.2780-27781. These crabs were found in preserved samples taken from a wild Pacific oyster reef (*Crassostrea gigas*) growing on tidal mudflats in a lower estuarine environment, see Figure 3. The specimens were confirmed as *H. takanoi* by Paul Clark on 27 November 2014. Of the 15 samples analysed one contained the two *H. takanoi* and a single *Carcinus maenas*. In total, 11 samples contained *C. maenas* with abundances between 1 and 8.

*Hemigrapsus takanoi* can be distinguished from *H. sanguineus* (de Haan, 1835), the other NW Pacific *Hemigrapsus* species established in NW Europe, by possessing a suborbital stridulation ridge (Figure 2b, c) divided into three unequal parts (vs. a continuous finely striated ridge in *H. sanguineus*) and setal patches (Figure 2d) at the base of the joint between the propodus and dactylus on the male cheliped (vs. a fleshy vesicle at that site).

### Discussion

Recently Seeley et al. (2015) reported two GB sightings of *H. sanguineus* from Glamorgan, south Wales, 2 May 2014 and Kent, southern England, 14 May 2014. Now *H. takanoi* has been reported from a Medway marina in North Kent, 5 August 2014, and from an estuary in Essex, 7 May 2013. Minchin et al. (2013) list 90 alien species in British brackish and marine waters; 35 originated from the North Pacific (particularly the North-West Pacific) of which 82% have become established in British waters. The two *Hemigrapsus* crab



**Figure 3.** *Crassostrea gigas* reef, Brightlingsea, Essex. Photograph taken by M. Gray.

species discovered in 2014 add to the NW Pacific component of the alien marine fauna in GB. Roy et al. (2014) considered which invasive alien species were most likely to impact on native biodiversity but were not yet established in the wild in Great Britain. *Hemigrapsus sanguineus* and *H. takanoi* were both included in the top ten species as posing a ‘high risk’ (Roy et al. 2014, Table 2) to arrive in the next ten years.

Considering its current NW European distribution, these UK records of *H. takanoi* are not a great surprise. However, it is only possible to speculate as to the introduction vector(s) of these new arrivals. The nearest established populations of *H. takanoi* are along the continental coast of the English Channel and North Sea from Boulogne-sur-mer, France to Knokke Heist, Belgium (Dauvin et al. 2009) on the coastline opposite to where the GB specimens were found in Kent and Essex. However according to Dauvin and Delhay (2010, Figure 1) larval dispersal is an unlikely vector as surface currents would tend to carry the larvae north-westwards towards the Netherlands. Transport by shipping, either as hull fouling or in ballast water is a distinct possibility, as is transfer with commercial oysters. Genetic profiling will be needed and hydrographic movements investigated to infer the source(s) of any GB populations.

The native habitat of *H. takanoi* ranges from cold-temperate to warm-temperate (Gollasch 1999). Its native habitats include muddy and rocky

shores and it can be found in sheltered estuaries and port areas. The juvenile and adult stages are tolerant of salinities as low as 9 (Gittenberger et al. 2010; Soors et al. 2010), although the larvae require higher salinity conditions (Mingkid et al. 2006). The habitats where the crabs were found in GB match these conditions. Both are estuarine environments with soft sediments. At Gillingham shelter is provided by the marina basin, whereas at Brightlingsea the oyster reef serves this function. The escape of the Pacific oyster *C. gigas* from commercial oyster beds is leading to the establishment of wild reefs along parts of the southern GB coast (Herbert et al. 2012). This ecosystem engineering has created areas of hard substrate and more heterogeneous habitats, which can provide spatial refuges against predators for small crabs such as *H. takanoi* (van den Brink et al. 2012). There appear to be no environmental conditions preventing *H. takanoi* from becoming established around the UK and Irish coastlines in the future.

If *H. takanoi* becomes established in GB, it may pose a threat to populations of the native shore crab *Carcinus maenas*. According to Dauvin et al. (2009), d’Udekem d’Acoz reported a drastic reduction in the number of juvenile *C. maenas* on some Dutch shores with high densities of *H. takanoi*. Dauvin et al. (2009) also observed that *H. takanoi* dominated *C. maenas* in Dunkirk harbour.

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## References

- Asakura A, Watanabe S (2005) *Hemigrapsus takanoi*, new species, a sibling species of the common Japanese intertidal crab *H. penicillatus* (Decapoda: Brachyura: Grapsoidae). *Journal of Crustacean Biology* 25: 279–292, <http://dx.doi.org/10.1651/C-2514>
- van den Brink AM, Wijnhoven S, McLay CL (2012) Competition and niche segregation following the arrival of *Hemigrapsus takanoi* in the formerly *Carcinus maenas* dominated Dutch delta. *Journal of Sea Research* 73: 126–136, <http://dx.doi.org/10.1016/j.seares.2012.07.006>
- Dauvin JC, Tous Rius A, Ruellet T (2009) Recent expansion of two invasive crabs species *Hemigrapsus sanguineus* (de Haan, 1835) and *H. takanoi* Asakura and Watanabe, 2005 along the Opal Coast, France. *Aquatic Invasions* 4: 451–465, <http://dx.doi.org/10.3391/ai.2009.4.3.3>
- Dauvin JC, Delhay JB (2010) First record of *Hemigrapsus takanoi* Asakura and Watanabe 2005 (Crustacea: Decapoda: Grapsidae) on the western coast of northern Cotentin, Normandy, western English Channel. *Marine Biodiversity Records* 3: e101, <http://dx.doi.org/10.1017/S1755267210000928>
- Gittenberger A, Rensing M, Stegenga H, Hoeksema B (2010) Native and non-native species of hard substrata in the Dutch Wadden Sea. *Nederlandse Faunistische Mededelingen* 33: 21–76
- Gollasch S (1996) Untersuchungen des Arteintrages durch den internationalen Schiffsverkehr unter besonderer Berücksichtigung nichtheimischer Arten. PhD Thesis, Universität Hamburg, Germany, 314 pp
- Gollasch S (1999) The Asian decapod *Hemigrapsus penicillatus* (de Haan, 1835) (Grapsidae, Decapoda) introduced in European waters: status quo and future perspective. *Helgoländer Meeresuntersuchungen* 52: 359–366, <http://dx.doi.org/10.1007/BF02908909>
- Herbert RJH, Roberts C, Humphreys J, Fletcher S (2012) The Pacific Oyster (*Crassostrea gigas*) in the UK: Economic, legal and environmental issues associated with its cultivation, wild establishment and exploitation. Report for the Shellfish Association of Great Britain, 166 pp
- Landschoff J, Lackschewitz D, Kesy K, Reise K (2013) Globalization pressure and habitat change: Pacific rocky shore crabs invade armored shorelines in the Atlantic Wadden Sea. *Aquatic Invasions* 8: 77–87, <http://dx.doi.org/10.3391/ai.2013.8.1.09>
- Markert A, Raupach MJ, Segelken-Voight A, Wehrmann A (2014) Molecular identification and morphological characteristics of Asian brush-clawed crabs from native Japanese and invasive German sites: *Hemigrapsus penicillatus* (de Haan, 1835) versus *Hemigrapsus takanoi* Asakura and Watanabe 2005 (Crustacea: Brachyura). *Organisms, Diversity and Evolution* 14: 369–382, <http://dx.doi.org/10.1007/s13127-014-0176-4>
- Minchin D, Cook EJ, Clark PF (2013) Alien species in British brackish and marine waters. *Aquatic Invasions* 8: 3–19, <http://dx.doi.org/10.3391/ai.2013.8.1.02>
- Mingkid WM, Yokota M, Watanabe S (2006) Salinity tolerance of larvae in the penicillate crab *Hemigrapsus takanoi* (Decapoda, Brachyura, Grapsidae). *La Mer* 44: 17–21
- Noël PY (1997) Presentation on the introduction of the Asian shore crab *Hemigrapsus penicillatus*. In: ICES WGITMO. 1997. Report of the Working Group of Introductions and transfers of Marine Organisms. La Tremblade, France, April 22–25, 1997. ICES CM 1997/Env:6, pp ii +96
- Noël PY, Tardy E, d'Udekem d'Acoz C (1997) Will the crab *Hemigrapsus penicillatus* invade the coasts of Europe? *Comptes Rendus de l'Académie des Sciences. Série 3, Sciences de la vie* 320: 741–745
- Roy HE, Peyton J, Aldridge DC, Bantock T, Blackburn TM, Britton R, Clark P, Cook E, Dehnen-Schmutz K, Dines T, Dobson M, Edwards F, Harrower C, Harvey MC, Minchin D, Noble DG, Parrott D, Pocock MJO, Preston CD, Roy S, Salisbury A, Schönrogge K, Sewell J, Shaw RH, Stebbing P, Stewart AJA, Walker KJ (2014) Horizon scanning for invasive alien species with the potential to threaten biodiversity in Great Britain. *Global Change Biology* 20: 3859–3871, <http://dx.doi.org/10.1111/gcb.12603>
- Seeley B, Sewell J, Clark PF (2015) First GB records of the invasive Asian shore crab, *Hemigrapsus sanguineus* from Glamorgan, Wales and Kent, England. *Marine Biodiversity Records* (in press)
- Soors J, Faasse MA, Stevens M, Verbessem I, de Regge N, Van den Bergh E (2010) New crustacean invaders in the Schelde estuary (Belgium). *Belgian Journal of Zoology* 140: 3–10
- Takano M, Ikeda M, Kijima A (1997) Biochemical and morphological evidence of two sympatric forms, interpreted as sibling species, in the estuarine grapsid crab *Hemigrapsus penicillatus* (de Haan). *Benthos Research* 52: 111–117
- Takano M, Ikeda M, Fujio Y (1999) Geographical distribution patterns of two forms of *Hemigrapsus penicillatus* (de Haan). Meeting of the Japanese Society of Fisheries Science, April 1–5, 1999: 119
- d'Udekem d'Acoz C (1998) Kolonisatie van de Europees-Atlantische kusten door de borstelkrab *Hemigrapsus penicillatus* (de Haan, 1835). *De Strandvlo* 18: 45–48
- d'Udekem d'Acoz C (1999) Inventaire et distribution des crustacés décapodes de l'Atlantique nord-oriental, de la Méditerranée et des eaux continentales adjacentes au nord de 25°N. Muséum National d'Histoire Naturelle, Paris (Collection Patrimoines Naturels, 40), 383 pp
- d'Udekem d'Acoz C, Faasse M (2002) De huidige status van *Hemigrapsus sanguineus* (de Haan, 1835) en *H. penicillatus* (de Haan, 1835) in de noordelijke Atlantische Oceaan, in het bijzonder in Nederland, met opmerkingen over hun biologie (Crustacea, Decapoda, Brachyura). *Het Zeepaard* 62: 101–115
- Yamasaki I, Doi W, Mingkid WM, Yokota M, Strüßmann CS, Watanabe S (2011) Molecular-based method to distinguish the sibling species *Hemigrapsus penicillatus* and *Hemigrapsus takanoi* (Decapoda: Brachyura: Varunidae) *Journal of Crustacean Biology* 31: 577–581, <http://dx.doi.org/10.1651/10-3366.1>