

A NEW ALIEN CRAB IN EUROPE: *HEMIGRAPSPUS SANGUINEUS*
(DECAPODA: BRACHYURA: GRAPSIDAE)

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A B S T R A C T

The Asian shore crab *Hemigrapsus sanguineus* is recorded for the first time in two European localities, Le Havre in France and the former estuary "Oosterschelde" in the Netherlands. While breeding populations occur in the former, only two male specimens were found in the latter. In both places, this alien species was mixed with the common shore crab *Carcinus maenas*.

Species of the genus *Hemigrapsus* had been confined to the Pacific Ocean until *Hemigrapsus sanguineus* (de Haan, 1835) was introduced to the eastern coast of North America (Williams and McDermott, 1990; McDermott, 1991). This invasive Asian shore crab was first discovered in New Jersey in September 1988 and by 1990 a breeding population was established. Recently *Hemigrapsus sanguineus* has also been found on European coasts, in Le Havre, France, and the former estuary "Oosterschelde" in the Netherlands.

Its congener *H. penicillatus* (de Haan, 1835), also an alien species to Europe, was discovered in La Rochelle, on the Atlantic coast of France, in March 1994 (No l *et al.*, 1997). By December 1996, it had spread southward to northeastern Spain and northward to Fromentine, covering a distribution range of some 800 km. It was recorded subsequently in Le Havre (Vincent and Breton, 1999) and recently in Nederland (Nijland and Beekman, 2000). Its ultimate distribution is likely to extend from western Norway to Morocco (No l *et al.*, 1997). The southwestern Delta area in the Netherlands would also provide suitable habitats (d'Udekem d'Acoz, 1998).

Alien species found in the docks of Le Havre Harbour include the algae *Sargassum muticum* (Yendo) Fensholt and *Undaria pinnatifida* (Harvey) Suringar in Okamura, the polychaete *Hydroides ezoensis* Okuda, 1934, the crab *Hemigrapsus penicillatus*, and the ascidians *Stryela clava* Herdman, 1882, and

Perophora japonica Oka, 1927 (Vincent, 1999; Vincent and Breton, 1999). They are new migrants to the French coast of the English Channel over the last four decades. All came from northwestern Pacific Ocean, and some of them transited via the eastern American or British coasts. For approximately sixteen alien species recorded in the area (the so-called cryptogenic species *sensu* Eno *et al.*, 1997, excluded), Le Havre Harbour is often the first or the only observation site (Breton and Vincent, 1999), with several ecological studies using SCUBA-diving (Breton, 1981; Breton *et al.*, 1995).

Alien species in the southwestern Delta area in the Netherlands, originating from the northwestern Pacific Ocean, include the algae *Sargassum muticum* and *Undaria pinnatifida*, the anthozoan *Haliplanella lineata* (Verrill, 1869), the crustaceans *Eriocheir sinensis* H. Milne Edwards, 1854, and *Caprella acanthogaster* Mayer, 1890 (= *C. macho* Platvoet, De Bruyne, and Gmelig Meyling, 1995), and the ascidian *Stryela clava*.

MATERIALS AND METHODS

Le Havre Harbour (Fig. 1) is located at 49°29'N, 0°07'E close to the estuary of the River Seine, on the Norman coast of the English Channel. Le Havre basins fall into two main categories: 1) the basins in direct communication with the sea, with 32-34 ppt salinity and same tidal range as in the open sea (= "bassins de mar e"); 2) the basins isolated from the sea by locks, with weak (1.5 m) to very weak (0.3 m) water-level range and with salinity decreasing irregularly eastwards (= "bassins   flot"). More details on the ecological characteristics of the basins are provided by Breton *et al.* (1995). Specimens were collected mainly at two sites of the Harbour named M le

Central and Roro 4, respectively by lifting boulders at the water edge during low tide, and by SCUBA diving.

Several apparently suitable localities for *Hemigrapsus* spp. in the Netherlands were visited during the present survey (April–October, 1999). The Delta area of the rivers Rhine, Meuse, and Scheldt is situated in the Netherlands, some 200 km northeast of the English Channel, along the southern Bight of the North Sea. In the Delta area suitable habitats for *Hemigrapsus* were expected to be found in the estuary "Westerschelde", and the former estuary "Oosterschelde" (Fig. 1). The sites Bath, Walsorden, Borssele, Vlissingen, and Zoutelande along the former and the sites Anna Frisopolder, Westbout, Burghsluis, Schelphoek, and Strijenham along the latter were visited. All sites were investigated by lifting boulders in the littoral zone during low tide. A few, i.e., Zoutelande and all sites in the Oosterschelde, were investigated during high tide as well, by SCUBA-diving whenever the underwater visibility permitted. Each site was investigated for at least one hour.

RESULTS

Identification

On the sea-shore, crabs of the genus *Hemigrapsus* can be distinguished from the abundant shore crabs, *Carcinus maenas* (Linnaeus, 1758) by the shape of the carapace and the pigment pattern. Careful examination revealed that the morphological characteristics of the specimens collected agree quite well with the description and color illustrations of *Hemigrapsus sanguineus* (de Haan, 1835; Sakai, 1965, 1976; McDermott, 1998a, b): the carapace is square, with three teeth on each side and mottled color, greenish to red-brown or dark-purple. Purple-red spots are present on the dorsal part of chelipeds; other pereopods display a distinctive pattern of alternating light and dark transverse stripes. Males have a fleshy vesicle at the base of the cheliped dactylus which is absent in females; a hair patch is present at the same place in *H. penicillatus* (Fig. 2). The infraorbital ridge is also different in *H. sanguineus* and *H. penicillatus* (Fig. 3). Two *H. sanguineus* from Le Havre (one small male ~23-mm CW and one larger male ~29-mm CW) deposited in the collections of the Muséum National d'Histoire Naturelle (coll. n° MNHN-B 27366) were compared with reference specimens of *Hemigrapsus sanguineus* (de Haan, 1835) kept in MNHN [male 29 mm CW, from Japan, 58-1897; coll. n° MNHN-B 12841, E.-L. Bouvier det.] and found conspecific.

Populations of *Hemigrapsus sanguineus* in Le Havre

Hemigrapsus sanguineus, new to the English Channel fauna, was first found by Mr.

Anthony Brière, on 29th August 1999, in a tidal basin, at the Môle Central. Several specimens were then collected under stones, during low tide, at the water edge. The Môle Central is located at about 700 m downstream of a power station release, which is more or less canalized. The substrate is a muddy shelly sand. At the power station release point, according to the season and the power station activity, the temperature increase is 2–11°C compared to the sea. At the Môle Central, it is far less, but still appreciable, especially at low tide. By lifting boulders at the water edge for approximately one hour at low tide, Anthony Brière on 31.08.1999 and one of us (GB) on 01.09.1999 observed several dozens of adult crabs. In addition to the two specimens now housed in the Muséum National d'Histoire Naturelle, Paris, fifteen specimens were collected in this survey and are in the collections of the Muséum d'Histoire Naturelle du Havre. [MH D/068.001.009: 6 males, 21–31.5-mm CW, and 3 nonovigerous females, 20–24-mm CW, 31.08.99.—MH D/068.010.015: 6 males, 23–30-mm CW, 01.09.99].

The ovigerous females were left or released *in situ*, one of them had a 19-mm CW. Most females found in the beginning of September 1999 were ovigerous. The crabs were abundant (one per 4–5 stones, i.e., an approximate maximum density at low tide of 0.2–0.5 individual per m²), but shallow subtidal zones were not explored.

At the Môle Central, the following species of decapod crustaceans were found with *Hemigrapsus sanguineus*: *Palaemon serratus* (Pennant, 1777)[common], *Athanas nitescens* (Leach, 1814)[one], *Carcinus maenas* [abundant, some specimens mating], *Polybius (Necora) puber* (Linnaeus, 1767)[one juvenile], *Hemigrapsus penicillatus* [abundant], *Porcellana platycheles* (Pennant, 1777)[abundant], *Pilumnus hirtellus* (Linnaeus, 1761)[a few specimens], *Inachus phalangium* (Fabricius, 1775)[one]. Males of *H. sanguineus* were more abundant than females. This may not indicate an abnormal sex-ratio, but may be due to a collecting bias.

Hemigrapsus sanguineus was also found on 24 October 1999 in a basin 6 km from the Môle Central, with a very weak tidal range and a salinity of 30 ppt at the so-called Roro 4, on the south bank of the Canal Central Maritime. Young males and adult females

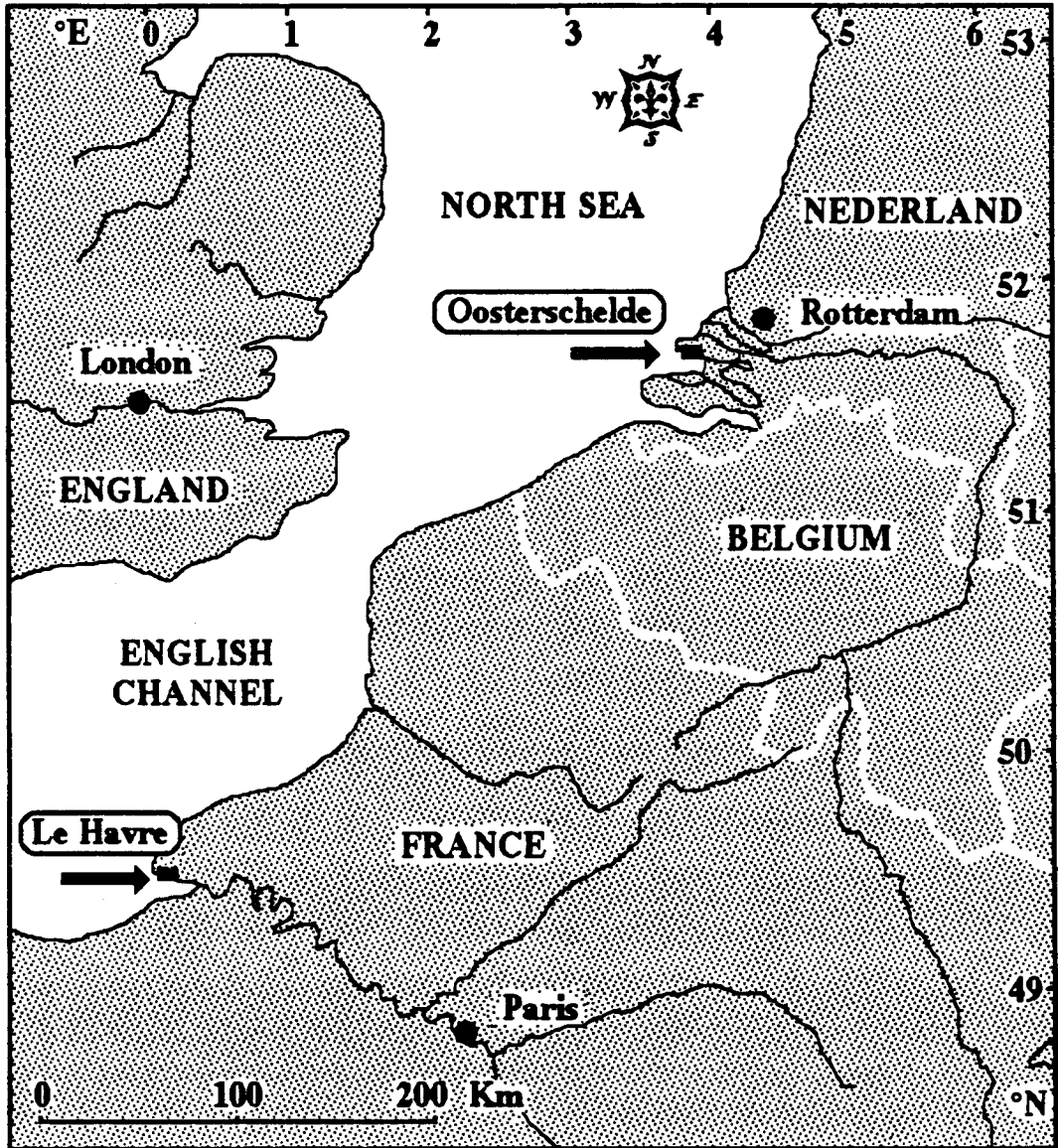


Fig. 1. Location of first sites of *Hemigrapsus sanguineus* in Europe.

(20–25-mm CW) were found but were much less abundant than *H. penicillatus* (ratio 1:10 to 1:20) and *Carcinus maenas*. The crabs inhabited the cavities of a mussel colony of *Mytilus edulis* Linnaeus, 1758, at 1- to 4-m depth. For the moment, this species is only known at these two sites in Le Havre harbour.

Specimens in Former Oosterschelde Estuary

Two specimens of *H. sanguineus* were discovered at one site in the Delta area. The site, called "Schelphoek" [$\sim 51^{\circ}41'N$, $03^{\circ}49'E$], is situated near the entrance of the former es-

tuary "Oosterschelde." One male (RMNH D48570), 21 mm in CW, was found on 21.08.99 during high tide and another male (RMNH D48273), 20 mm in CW, on 23.08.99 during low tide. Both specimens lived approximately at 1 m below high water level, between boulders lying on the slope of a man-made basalt seadyke. The crabs seemed to be more active during high tide. The littoral habitat was rather barren, the only other crustaceans noted being barnacles *Elminius modestus* Darwin, 1854 [abundant], and common shore crabs *Carcinus maenas* [abundant].

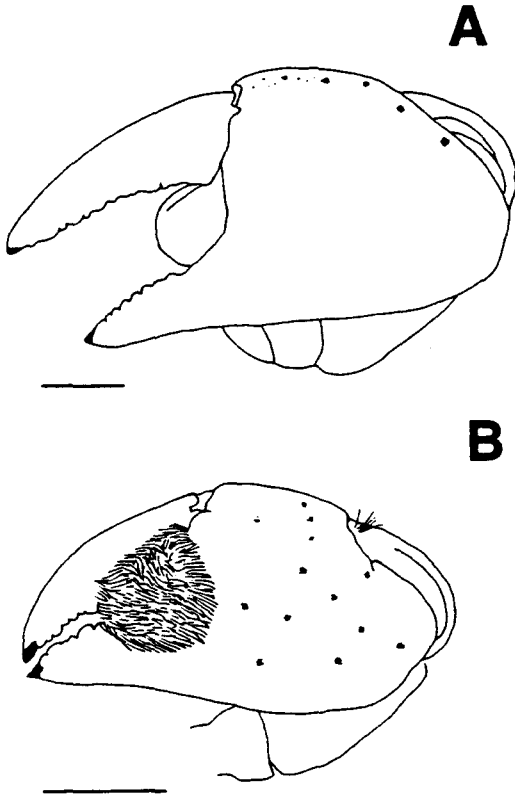


Fig. 2. External view of male left cheliped showing between the fingers (A) the *pulvinus* (= fleshy vesicle or membranous swelling) in *Hemigrapsus sanguineus* and (B) the tuft of hair in *Hemigrapsus penicillatus* [*H. sanguineus* specimen n° = MNHN B.27429; *H. penicillatus* = an 18-mm CW male, collected in St. Georges de Didonne, France, 9.05.1996]. Scale bar = 5 mm.

Subsequent thorough investigations on the site did not yield any more specimens of *H. sanguineus*.

DISCUSSION

Hemigrapsus sanguineus was likely to have settled in Le Havre Harbour in or before 1998, because the 1999 population is adult and breeding (including ovigerous females), but the settlement went unnoticed until August 1999. This species, native to the northwestern Pacific Ocean, was first reported outside its original area near Cape May, New Jersey, U.S.A., in 1988 and colonized subsequently the northeast coast of the U.S.A. (McDermott, 1998a). It covered more than 650 kilometres of coasts between 1988 and 1995, ranging from Cape Cod, Massachusetts, in the north to Oregon Inlet, North Carolina, in the south; it feeds there primarily on algae, blue mus-

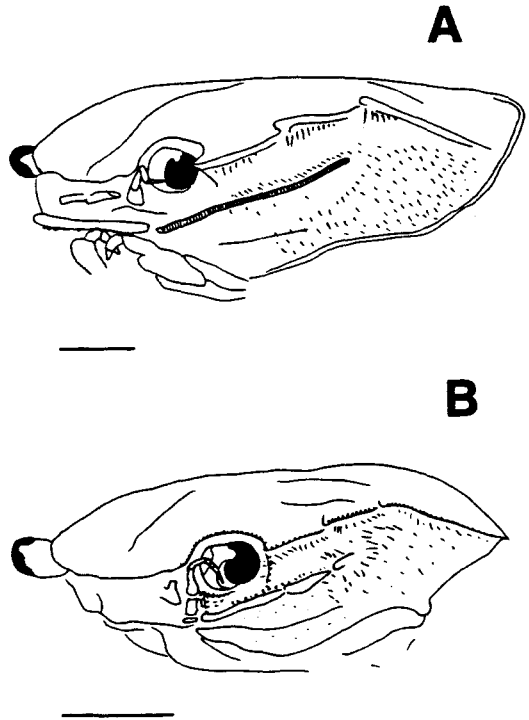


Fig. 3. Semidiagrammatic representation of cephalothorax in frontolateral view showing the suborbital stridulating organ (A) a finely striated crest in *Hemigrapsus sanguineus* and (B) a more or less smooth crest divided into three parts of unequal length in *Hemigrapsus penicillatus* [same specimens as in Fig. 2]. Scale bar = 5 mm.

sels, barnacles, and small crustaceans (McDermott, 1999). D'Udekem d'Acoz (1999; p. 253) thought that, from the U.S.A., it might reach the European coasts by way of ship ballast waters.

Can we now predict the colonization of the eastern Atlantic by *Hemigrapsus sanguineus* in the future? On the European coasts, the species meets ecological conditions similar to those of the northern Pacific Ocean (Lohrer *et al.*, 2000) and of the east coast of North America (Lohrer and Whitlach, 1997; McDermott, 1995, 1998a); it is therefore probably able to invade many places. Because laboratory observations showed that adults of *H. sanguineus* survived salinity reductions down to 10 ppt (McDermott, 1995, 1998a), the species may invade the Baltic Sea or similar places with low salinity as well. In fact, the majority of successful invasive species of north-west European coastal waters are more or less euryhaline. Wolff (1999) suggested the availability of many empty niches in north-

west European brackish waters plays a prime role in the success of invasive species.

In Le Havre Harbour, *H. sanguineus* lives in the same environment as two other crabs, *Carcinus maenas*, which is of a larger size, and *Hemigrapsus penicillatus*, another alien species, which is smaller. Will there be any competition between this last immigrant and the other species? We have the experience of some places in Le Havre Harbour where *Hemigrapsus penicillatus* have competed since their settlement in 1997 with juveniles of *Carcinus maenas* of approximately the same size; after a couple of years, the development of both populations is well-balanced.

At the fall 1999, *H. sanguineus* seemed rare in The Netherlands, and no ovigerous females have been reported. Its rarity may be only temporary, the colonization having just begun. The origin of the colonizing individuals is unknown. The "Oosterschelde" is an important center of shellfish culture. Several alien species are believed to have been introduced to the Netherlands and neighbouring countries with imported shellfish (Vaas, 1975). In times of shortage, importation of living shellfish from other countries occurs, among them the U.S.A., but this does not happen regularly. There is no international harbour in the "Oosterschelde", all local harbours are for yachting or small-scale fisheries and shellfish culture. Introduction of adults in fouling or larvae with ballast water cannot be ruled out, however, the distance from the international seaports of Antwerp and Rotterdam being only some 100 km. It is well known that grapsid crabs, among which the Pacific species *Hemigrapsus penicillatus*, occur in fouling communities on ship hulls; in Europe one case was reported in the harbour of Bremerhaven, Germany (Gollasch, 1999). Another possibility is a settlement of larvae originating from France, where a breeding population lives, or elsewhere along the Channel coast. Residual currents are in the right direction. Similar colonization of the coast of The Netherlands by other immigrant species with pelagic larvae has been suggested by Vaas (1975).

With the data available at present, it is impossible to make predictions about the future development of Dutch and French populations of *H. sanguineus*. However, the spectacular spread of its congener *H. penicillatus* in France and Spain should make us cautious

and points out the importance of continuing investigations.

ACKNOWLEDGEMENTS

We are indebted to the following persons/colleagues. Anthony Brière (Le Havre) made the first observations of the species in the harbour of Le Havre. Th. Hollem (Rotterdam) provided assistance during the SCUBA-dive near Schelphoek. F. Kerckhof (Oostende, Belgium) drew attention to the article of Gollasch. C. d'Udekem d'Acoz (Braine-l'Alleud, Belgium) identified the Dutch specimens of *H. sanguineus*. D. Guinot made available reference specimens from the Muséum National d'Histoire Naturelle for confirmation of the identification of specimens from Le Havre and helped in literature search. Finally, we also thank referees for their valuable criticisms and suggestions in improving the manuscript.

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Note: Order for authors is alphabetical. Contribution of G.B. and T.V. is mainly for Le Havre data, that of M.F. is mainly for Nederland data, and P.N. for coordination.

RECEIVED: 10 May 2000.

ACCEPTED: 20 June 2001.