Occurrence of *Penaeus aztecus* Ives , 1891 (Crustacea, Decapoda), in the Scheldt estuary (Belgium): isolated record or forerunner of a penaeid invasion?

Jan Soors[1*], Jan Breine[1], Cédric d'Udekem Acoz[2], Ericia Van den Bergh[1], Frank Van de Meutter[1] Thomas Terrie[1]

[1] Research Institute for Nature and Forest (INBO), Herman Teirlinck Havenlaan 88 bus 73, 1000 Brussels, Belgium

[2] Royal Belgian Institute of Natural Sciences, Vautierstraat, 29. 1000 Brussel

*Corresponding author.

E-mail address jan.soors@inbo.be

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Abstract

A single specimen of the penaeid prawn *Penaeus aztecus* (Ives, 1891) was recorded in 2018 in the Scheldt estuary near Antwerp (Belgium), in the brackish zone. The presence of this species, native to the West Atlantic, might result either from ships' ballast water coming from transatlantic boat shipping, from illegal import or from a considerable expansion leap northwards from the Mediterranean Sea, where this species has established and thriving invasive populations.

Introduction

Invasions of marine and estuarine habitats by non-indigenous species are a worldwide phenomenon, which is steadily increasing as a consequence of human activities (Boudouresque 2008; Galil *et al*. 2011; Ojaveer *et al.* 2018). The Scheldt estuary (The Netherlands - Belgium), with a high number of marine alien species recorded is no exception (e.g. Faasse & van Moorsel 2003, Wolff 2005, Kerckhof *et al.* 2007, Soors 2010, De Blauwe 2017) The brackish zone harbours established populations of over 50 non-indigenous species including many small crustaceans (anonymus 2010). The port of Antwerp (Belgium) renders this part of the river very vulnerable to introductions of non-indigenous species (Ysebaert *et al*. 1997). The main port activities of this large international harbour, receiving ships from over 800 locations worldwide, are situated in the brackish zone between the Dutch-Belgian border and the city of Antwerp.

The present paper reports the first record of a penaeid shrimp that is very likely to be a northern brown shrimp *Penaeus aztecus* in the Scheldt Estuary. This species is native to the Western Atlantic (Pérez Farfante 1969; Williams 1984), has colonized the largest part of the Mediterranean Sea (Özcan *et al.* 2019), has recently reached the Black Sea (Gönülal & Türetken, 2019) and is now very probably recorded for the first time in Northwest Europe.

Material and methods

The river Scheldt is 435 km long, originating on the plateau of Saint-Quentin in France. The Scheldt estuary is approximately 160 km long and has a complete salinity gradient from polyhaline to a tidal freshwater zone, including extensive freshwater, brackish and saline tidal mudflats and marshes to its ecosystem. It is a well-mixed estuary characterized by strong currents, high turbidity and large tidal amplitude up to 6 m (Van den Bergh *et al*. 2005). Yearly, in the framework of the Research Institute for Nature and Forest fish monitoring program , fish assemblages are surveyed in spring, summer and fall with a mid-water beam trawl from an anchored boat. Each trawl consists of a net fixed between two eight meter long steel beams. The lower beam is lowered to the bottom of the river while the upper beam is held at the surface. Both ends of the beams are attached to the anchor which keeps the boat at a fixed position. At the sampling site the nets are placed for two hours during flood as well as ebb-tide. Landed fish is measured and weighed and by-catch is counted and weighed. In Antwerp (Figure 1) one single specimen of a penaeid shrimp was recorded during the 2018 fall survey. Its (tentative) identification is presented and the implications of the record are discussed.

1

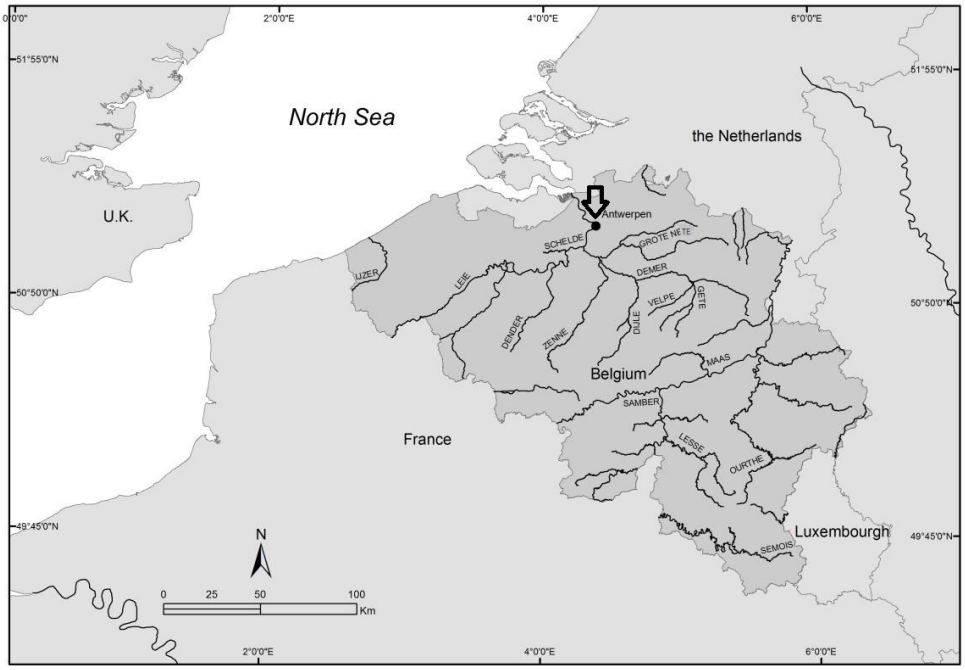

Figure 1. Location of Belgian record of *Penaeus aztecus* (see arrow)

Results

***Penaeus aztecus* Ives, 1891**

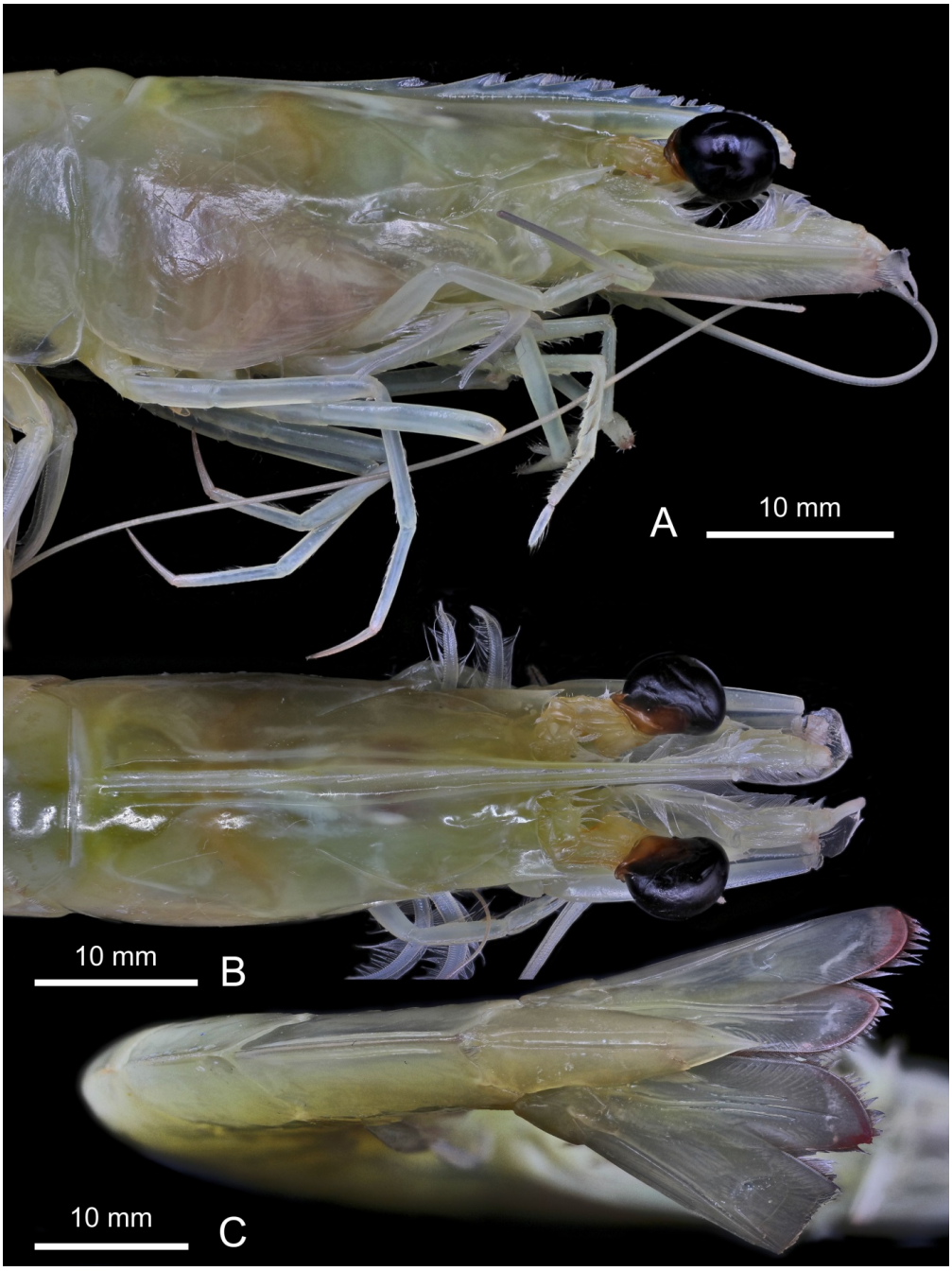

Figure 2: A. Lateral habitus of the Belgian *Penaeus aztecus*. B. Anterior dorsal view. C. Posterior dorsal view.

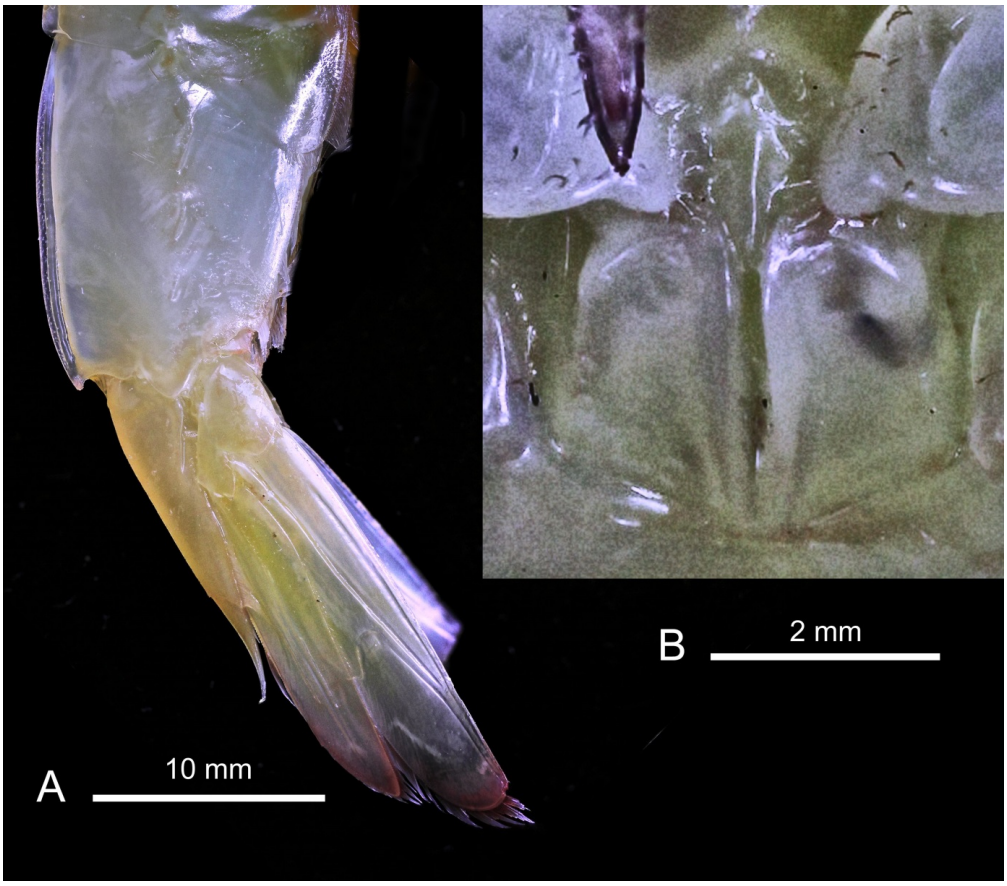

Figure 3: A. Lateral view telson. B. Developing thelycum.

Material examined

1 immature female (carapace length: 25 mm; total length 115 mm), Scheldt estuary, 65 km upstream, near the town of Antwerp, 51°12'19.84"N, 4°22'15.38"E (Fig. 1), mid-water beam trawl handled from an anchored boat, 27 Sep. 2018, deposited in the collections of the Royal Belgian Institute of Natural Sciences, registration number INV. 34094.

Characters and identification

The specimen was tentatively identified as *P. aztecus* based on Pérez Farfante (1969, 1970, 1988), Williams (1984), Tavares (2002), Tavares & Gusmão (2016), Deval *et al.* (2010). It exhibited the following characters. Carapace smooth, rostrum armed with 10 dorsal teeth (epigastric spine included) and 2 ventral teeth; adrostral sulcus reaching almost to posterior margin of carapace; adrostal carina beginning slightly ahead of the first dorsal tooth on the rostrum and ends at 2 mm before of the hind edge of the carapace. Broad dorso-lateral sulcus on 6th abdominal somite. Telson without spines but with a deep dorsal sulcus (Figure 2).The captured female measured 25 mm CL and 115 mm TL. Because this female was still juvenile —adult females *P. aztecus* measure up to 236 mm (TL)—, the identification of this one and only specimen is partly tentative and deductive. It definitely belongs to the species group previously referred as the genus *Farfantepenaeus*., and the developing

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Comment [SJ2]: Cédric, vous pensez que c'est nécessaire ? (Remarque VDMF1

thelycum has some features in common with adult female *P. aztecus*: the posterior process is exposed and is armed with a median crest that bifurcates anteriorly to form an Y-shape (Pérez Farfante, 1969)(Fig. 3B) Additionally, the rostrum characters match with Pérez Farfante, 1988: median sulcus is long and deep along the entire length and the dorsolateral sulcus is broad (Fig. 2A & B) The colour of the freshly caught shrimp was not documented but the preserved specimen was uniformly pale coloured (Fig. 2), which suggests that it was a rather dull-colored shrimp, as reported for *P. aztecus* (Pérez Farfante, 1969). Additionally, considering the estuarine and temperate environment, *P. aztecus* is the only species of the *Farfantepenaeus* group occurring in cold-temperate waters (Williams 1984)), the relative proximity of a population in the Mediterranean sea and the invasive character of the species, the only likely species candidate is *Penaeus aztecus*. Despite all this, considering its immature status, an examination of its phenotype cannot confirm its identification with 100% certainty. The other highly unlikely candidates are species closely related to *P. aztecus* (other species of the former genus *Farfantepenaeus*), namely the northern pink shrimp *Penaeus duorarum* Burkenroad, 1939, *Penaeus isabelae* Tavares & Gusmão, 2016) [no vernacular name], the southern pink shrimp *Penaeus notialis* Pérez Farfante, 1967, the southern brown shrimp *Penaeus subtilis* Pérez Farfante, 1967 and the Sao Paulo shrimp *Penaeus paulensis* Pérez Farfante, 1967. These species were never found in Europe and have never been found far from their area of origin.

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Biology

Unlike most Penaeidae, *Penaeus aztecus* is not restricted to tropical and warm-temperate climatic conditions. In the West Atlantic, this species is present from the subtropical waters of Yucatan, Mexico and Belize up to cold temperate waters at Martha's Vineyard, Massachusetts, being the northern limit of this species (41°24'0"NB) (Williams 1984). Recently, it was recorded even more north: from the Atlantic coasts of Canada and has been introduced in New Caledonia and French Polynesia for aquacultural purposes (Scanella *et al*. 2017).

It lives in coastal marine waters from the intertidal zone to approximately 110 m deep, is rarely found at depths exceeding 165m, and reaches its highest densities between 27 and 55 m, mainly on muddy, sandy-mud or loose peat bottoms (Pérez Farfante 1969; Cook & Lindner 1971; Williams 1984). The species spawns offshore and the planktonic larvae and postlarvae are carried into estuaries by currents. They utilize estuarine marshes as nursery grounds. The juvenile shrimps grow within the estuary until they reach >70 mm total length and then migrate offshore to mature and spawn (Knudsen *et al*. 1985; Matthews *et al*. 1991; Arreguin-Sanchez & Castro-Melendez 2000). Larvae and juveniles are known to withstand a wide range of salinities and temperatures (Re et al. 2005).

Discussion

Since the publication of Soors et al. (2010) on crustacean invaders only two Non-Native Crustacean Species were added for the Belgian part of the Scheldt estuary: the American mysid shrimp *Neomysis americana* (S.I. Smith, 1873) and *Grandidierella japonica* Stephensen, 1938 (unpublished records, INBO). Until now *Palaemon macrodactylus* was the only invasive decapod shrimp or prawn that has been found there.

Penaeus aztecus is the first penaeid prawn that has been found in Belgium. During the mid-water beam trawl of 27 September 2018, it was found among ten thousands of shrimps, mainly *Palaemon longirostris* (>50.000 ind.) and *Crangon crangon* (>20.000 ind.). The pescofauna that day (20 species) was dominated by marine fish such as the European sprat *Sprattus sprattus*, Atlantic herring *Clupea harengus*, European smelt *Osmerus eparlanus*, Sand goby *Pomatoschistus minutus* and Common goby *P. microps*. Striking was the catch of a Scaldfish *Arnoglossus laterna* (rare that far inland) and to a lesser extent the Atlantic horse mackerel *Trachurus trachurus* and Sand smelt *Atherina boyeri* (Breine et al. 2019).

The northern brown shrimp is a commercially important Atlantic shrimp (Tavares, 2002). Globally 40.000 t was landed in 2010 (NOAA 2013). It has been introduced in the Mediterranean Sea, where it

has spread amazingly fast. From the Gulf of Antalya, where it first appeared it reached , within eight years to the southeastern Levant, to the Gulf of Lion at its northeastern corner and to the Black sea (Galil et al., 2016, Gönülal & Türetken, 2019). It is suspected to outcompete the native mediterranean penaeid prawn *Penaeus kerathurus* (Forskål, 1775) (Kevrekidis 2014). Both species reproduce in coastal waters, and post-larvae enter estuaries and coastal lagoons, where juveniles grow and later return to the marine environment (Scanella et al., 2017).
Eight of the fourteen non-indigenous penaeids in the Mediterranean were introduced through the Suez Canal (Galil et al. 2015) and they have become a new and increasingly important resource for Mediterranean coastal fisheries (Scanella et al., 2017), owing to their high commercial value. *P.aztecus* is frequently farmed in aquaculture facilities. Escape from shrimp farms or intentional release are probable introduction pathways. Other proposed vectors are ship's ballast water, illegal introduction and naturalexpansion by transportation of shrimp eggs and larvae along the main paths of surface water circulation and active swimming (Gönülal & Türetken, 2019). However, in the neighbouring countries, France (Le Havre) and the UK, the Kuruma prawn *Penaeus japonicus* (Bate, 1888) is the only *Penaeus* species that has been found with certainty on more than one occasion (Pezy et al, 2017). Another penaeid shrimp, *Penaeus semisulcatus* (De Haan, 1844) was found only once, in august 2016 in Le Havre, English Channel (Pezy et al., 2017). These two species do not belong to the Farfantepenaeus group and are thus not to be confused with *P. aztecus*.
In the 2019 surveys no specimen of *P. aztecus* was caught. As the Scheldt estuary and surrounding water bodies are well monitored, it can be expected that the accidental or invasive nature of the presence of *P. aztecus* in the region will soon be established.

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CAPTIONS

Fig. 1. Location of Belgian record of Penaeus aztecus (see arrow)
Fig. 2. A. Lateral habitus of the Belgian Penaeus aztecus. B. Anterior dorsal view. C. Posterior dorsal view.
Fig. 3. A. Lateral view telson. B. Developing thelycum.