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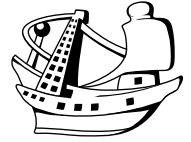
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First record of the marbled crab *Pachygrapsus marmoratus* (Fabricius, 1787) on the coast of Calvados (Bay of Seine, English Channel)

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Abstract: A unique specimen of the decapod *Pachygrapsus marmoratus*, the marbled crab, was reported for the first time in August 2014 from the intertidal zone on the Calvados coast (western part of the Bay of Seine, Eastern English Channel). However, information is still insufficient to ascertain the origin and mode of introduction of this species into the Eastern English Channel. Among the different hypotheses, the presence of the marbled crab could be related to shipping traffic, while the occurrence of mild winters in the Bay of Seine over several years could provide favorable conditions for the permanent establishment of this Mediterranean species. Supplementary records will be necessary to confirm that this species is becoming established in the Bay of Seine, such as already observed along the western coast of the Cotentin peninsula (western English Channel).

Résumé : Premier signalement du crabe marbré *Pachygrapsus marmoratus* (Fabricius, 1787) sur la côte du Calvados (Baie de Seine, Manche). Un unique spécimen du crabe décapode *Pachygrapsus marmoratus*, le crabe marbré, a été signalé pour la première fois en août 2014, de la zone intertidale du Calvados (partie ouest de la baie de Seine, Manche orientale). Toutefois, l'information n'est pas encore suffisante pour déterminer exactement l'origine et le mode d'introduction de l'espèce en Manche orientale. Parmi elles, l'hypothèse pourrait être liée au trafic maritime, cependant la présence d'hivers doux depuis quelques années en Baie de Seine pourrait assurer des conditions favorables pour l'implantation durable de cette espèce d'origine méditerranéenne. Des récoltes supplémentaires seront nécessaires pour vérifier l'implantation de l'espèce dans ce secteur, comme le long de la côte ouest du Cotentin (Manche occidentale).

Keywords: *Pachygrapsus marmoratus* • Marbled crab • Mussel beds • Bay of Seine • English Channel

Introduction

The marbled crab *Pachygrapsus marmoratus* (Fabricius, 1787) is a common decapod living on European intertidal rocky shores. It originates from the Mediterranean Sea and has been reported as ranging from the Black Sea to the South of England (d'Udekem d'Acoz, 1999; Ingle & Clark, 2008; Brockerhoff & McLay, 2011; Crocetta et al., 2011; Dauvin, 2009 & 2012).

Pachygrapsus marmoratus is a highly prolific species, and females produce multiple broods from late spring to late summer along the Portuguese coast (Flores et al., 2002). In laboratory, the incubation of eggs takes about 25 days and the time of development from hatching to the sixth and terminal zoeal stage took 31 days at $25 \pm 1^\circ\text{C}$ (Cuesta & Rodriguez, 2000). Larval dispersal occurs during a four week planktonic stage in the southern part of its geographical distribution, and is influenced by tidal and wind-driven currents (Cannicci et al., 1999).

Over several years (from 2008 up to present) a *Pachygrapsus marmoratus* population has become established on the middle part of the western coast of the Cotentin (Fig. 1) (Dauvin, 2008 & 2012). This northern population could act as a potential source of larvae to colonize other English Channel sites. During annual survey of the *Hemigrapsus* spp. colonization, which was started in 2008 around the Cotentin and then extended in 2011 to the Calvados coast (Dauvin & Duffossé, 2011; Gothland et al., 2013), the sightings of *P. marmoratus* remained restricted to a small sector of the western Cotentin (Fig. 1). In August 2014, a single specimen of *P. marmoratus* was found at Saint-Honorine-des-Pertes in the western part of the Calvados coast in the Bay of Seine. This observation represents the easternmost record of the species in the English Channel. We discuss here the geographical expansion of *P. marmoratus* at its north-eastern limit and give additional data for this species along the western coast of Cotentin.

Materials and Methods

Located in the Normano-Breton Gulf, the wide intertidal zone of the west coast of the Cotentin is composed of a mixture of sandy, rocky and sandy-rocky areas in a megatidal environment (tidal range > 12 m during equinoctial spring tides) (Levoy et al., 1997). The Calvados coast is made up of a rocky limestone shore with a gentle slope and open to the sea. The tidal range in this area varies from 8 m during spring tides to 3 m during neap tides (<http://www.shom.fr/>).

Since 2008, spring sampling of *Hemigrapsus sanguineus* (De Haan, 1853) and *H. takanoi* Asakura &

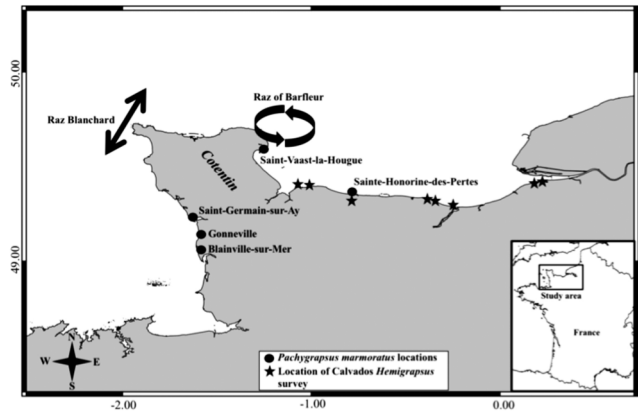


Figure 1. *Pachygrapsus marmoratus*. Locations of the sightings on the Normandy coast since 1908, and the 8 sites prospected along the Calvados coast for the study of non-native *Hemigrapsus* crabs.

Watanabe, 2005 were carried on 8 sites of the Cotentin coast. For the Calvados coast, the *Hemigrapsus* sampling times to 2011 with a summer sampling in mussel beds in 2013 and 2014.

During spring, crabs were sampled in the mid-littoral zone under 30 boulders with 3 replicates, making a total of 90 boulders at each site (3×30) and 3 densities of 1m^2 are made (Dauvin et al., 2009, Dauvin, 2009a & b; Dauvin & Dufossé 2011; Gothland et al., 2013).

During summer, three locations, namely: Sainte-Honorine-des-Pertes, Luc-sur-Mer and Villers-sur-Mer are sampled to estimate the abundances of new recruits and juveniles crabs. At each site, the sampling was based on six replicates of $1/16\text{m}^2$, with each quadrat of 0.0625m^2 being placed at random. Mussel beds were sampled by scraping all the mussels off the rocks with a spatula, and the scraped surface was brushed to avoid missing any organisms (Pezy & Dauvin, 2015). Live crabs were removed from the samples immediately after arriving at the laboratory (Marine Station of Luc-sur-Mer), and then fixed in alcohol before being measured.

Results and Discussion

Along the coast of Cotentin, *Pachygrapsus marmoratus* are present since 2008 (Dauvin 2008 & 2012). In 2012-2014 sampling, 22 individuals of *P. marmoratus* are discovered with a new presence at Saint-Germain-sur-Ay, this new location representing the northernmost record of this species along the western coast of the Cotentin (Fig. 1 & Table 1). The regular observation of specimen at Blainville-sur-Mer and Gonneville confirms the persistence of an established population in this sector of the Cotentin coast, the presence of ovigerous females shows a reproduction

Table 1. *Pachygrapsus marmoratus*. Date and number recorded at Blainville-sur-Mer (49°04'N–1°35'W) and Gonneville (49°05'N–1°36'W), Saint-Germain-sur-Ay (49°13'N–1°39'W) and Saint-Honorine-des-Pertes (49°35'N–0°80'W) from June 2012 to August 2014; size, carapace width in mm, Ovg: Ovigerous.

Location	Date	Size (mm)	Sex
Blainville-sur-Mer	23 June 2012	48.5	Male
		36.0	Male
		39.0	Male
		30.0	Female
		30.0	Female Ovg
		30.0	Female Ovg
		30.0	Female Ovg
	28 July 2012	24.9	Male
		21.4	Male
		18.0	Male
		21.3	Male
		19.5	Female
		18.4	Female
		21.0	Female
	2 May 2014	17.0	Male
		18.0	Male
		13.0	Male
19.0		Female	
19.0		Female	
Gonneville	26 July 2012	31.5	Male
	20 August 2013	39.0	Female
	18 February 2014	40.0	Male
Saint-Germain-sur-Ay	26 July 2012	31.5	Male
Sainte-Honorine-des-Pertes	27 August 2014	11.7	Female

capacity. The elevation of the sea surface temperature in the Normano-breton Gulf (+ 1.7°C in 30 years at St Peter Port Harbour, Guernsey) and the retention of larvae trapped by numerous gyres around the Channel Islands (long planktonic phase about one month; Cannicci et al., 1999) could ensure the northward progression and persistence of this established population.

On 27 August 2014, one non-ovigerous female to 11.7 mm in size was discovered at Sainte-Honorine-des-Pertes

from a sample collected in the mussel beds. This represents the only specimen recorded along the Calvados coast, in spite of extensive spring-summer sampling campaigns during over the period 2011–2014.

The map on Figure 1 shows the different locations of the sightings of *Pachygrapsus marmoratus* along the Normandy coast of the English Channel, showing the great distance between the western Cotentin coast population and the new record at Saint-Honorine-des-Pertes. The residual currents and gyres present off the North Cotentin in the west at the 'Raz Blanchard' and in the east at the 'Raz de Barfleur' (Fig. 1) do not account for the transport of *P. marmoratus* larvae along the Calvados coast (Salomon & Breton, 1991 & 1993). Hence, the presence of the single specimen of *P. marmoratus* along the Normandy coast in a mussel bed suggests an introduction by shipping traffic, as in the case of the specimens from the English coast (Ingle & Clark, 2008). Mussel beds appear to be a very good habitat for the colonization of non-native crustaceans such as the mitten crab *Eriocheir sinensis* H. Milne Edwards, 1853 and the Asian shore crab *Hemigrapsus sanguineus* (Pezy & Dauvin, 2015). Moreover, the

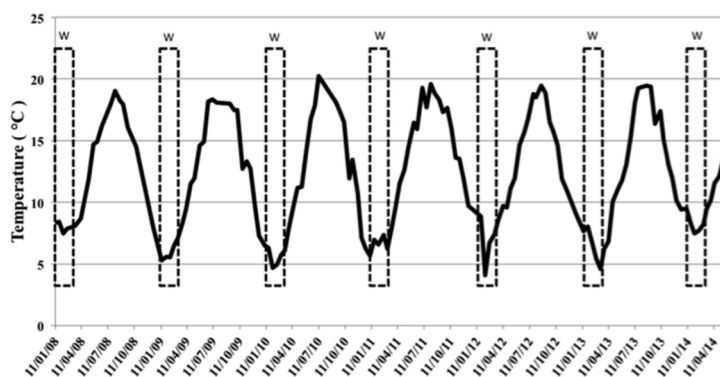


Figure 2. Winter temperature along the Calvados coast from 2008 to 2014 (W: Winter).

presence of a mild winter in 2014 (minimum sea surface temperature of 7.5°C in February 2014 against < 5°C for the previous winter (Fig. 2), station SOMLIT, Luc-sur-Mer, (somlit.epoc.u-bordeaux1.fr/fr/) could be favourable for the establishment of a new population of these Mediterranean species.

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