

First occurrence of *Callinectes sapidus* (Rathbun, 1896) within the Sacca di Goro (Italy) and surroundings

Chiara Manfrin^{1*}, Edoardo Turolla², J. Sook Chung³ and Piero G. Giulianini¹

¹ Department of Life Sciences, University of Trieste, via L. Giorgieri, 5, 34127, Trieste, Italy

² Istituto Delta Ecologia Applicata, Via B. Bartok, 29/B, 44124 Ferrara, Italy

³ Institute of Marine and Environmental Technology, University of Maryland Center for Environmental Science, 701 East Pratt Street Baltimore, MD 21202, USA

* Corresponding author. E-mail: cmanfrin@units.it

Abstract: The Sacca di Goro lagoon is an area located in the northern part of Italy. This locality has benefited in the past of an occasional and later the planned introduction of the Manila clam. Nowadays it produces more than 50% of the entire Italian clam production. Recently the crab *Callinectes sapidus* has been spotted and reported a few months ago on its female carrying eggs. This may signify the complete acclimation of this species in the Sacca di Goro lagoon and a potential ongoing spread to surrounding areas.

Key words: Blue Crab, *Callinectes sapidus*, Sacca di Goro lagoon, Manila Clam production, *Ruditapes philippinarum*

The Sacca di Goro lagoon that is an area located in the northern part of Italy nearby estuaries of the Po River (Figure 1) represents the southernmost lagoon of the Po estuary. It extends to about 26 km² and has a peculiar habitat composed of sandy bottom with an average depth of 60–70 cm and a maximum depth of 2 m. From the geographical point of view, the Sacca di Goro can be seen as an “D” overturned of 90 degrees with the arched part (continental margin) toward North and the straight part (*scanno*) to the South. The “Scanno di Piallazza” is a sandy cordon, which separates the lagoon from the open sea. The water exchanges between the sea and the lagoon are allowed by the presence of a natural mouth and by two interruptions made by anthropic endeavour in the *scanno*.

The Sacca di Goro, as being considered as a high trophic level ecosystem, is an ideal environment for mollusc farming.

In the past, this area was benefited by the first occasional, and then planned introduction of the *Ruditapes philippinarum* (Adams & Reeve, 1850). In fact, this species is an important economic resource since the

1970s, when it was introduced due to overfishing and irregular yields of the native European cross-cut carpet shell, *Ruditapes decussatus* (Linnaeus, 1758), led to import *R. philippinarum* into European waters. *Ruditapes philippinarum* is now the major species, contributing to most clam-landings in Europe. Due to its high trophic level, the Sacca di Goro Lagoon is one of the largest clam-farming grounds in Europe and about 1,400 fishermen, associated in cooperatives, exploit about 10 km² of the aquatic surface, with an annual production, mainly of *R. philippinarum*, that reaches around 15,000–16,000 tons. Moreover, nowadays the Sacca di Goro clam production occupies more than the 50% of the entire Italian production (Sessa 2012).

Recently, a new alien species has reached the Sacca di Goro area and triggered anglers’ curiosity, is the Blue Crab, *Callinectes sapidus* (Rathbun, 1896). This decapod species, belonging to the family Portunidae, inhabits the western Atlantic Ocean from Nova Scotia to Argentina (Williams 1974). It was accidentally or deliberately introduced into both Asia and Europe

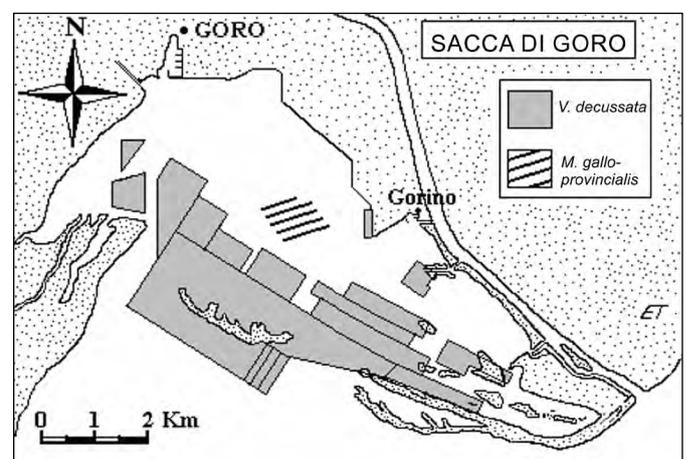


Figure 1. Geographical morphology of the Sacca di Goro lagoon.



Figure 2. Specimen of *Callinectes sapidus* harvested in the Sacca di Goro lagoon.

initially, but has now reached the Northern Adriatic Sea coasts. Previous notes of the presence of *C. sapidus* in Italy go back in 2006 in South Italy (Gennaio 2006), the Gargano National Park (Florio 2008), the Abruzzi region (Castriota 2012), the Acquatina lagoon, and Torre Colimena basin (SE Italy) (Mancinelli 2013) as well as in neighbouring countries such as Turkey (Tuncer 2008), Albania (Beqiraj 2010), Croatia (Dulcic 2010, 2011), and along the Mediterranean coast of the Iberian Peninsula (Castejón 2013). This indicates that *C. sapidus* is under an active spread within the Mediterranean basin.

During spring of 2014 (5 April 2014), we noticed an adult specimen of Blue Crab in the catch of the day from an angler who fished in the Sacca di Goro's harbour (44°51'06.48" N, 012°17'45.24" E). We immediately collected a photograph documentation (Figure 2) and asked to the angler if he had already fished the Blue Crab. Following his affirmative answer and after this spotting that we were able to document it, we collected all the information related to the presence of such species within this area.

One of the authors has done the species identification immediately in the site of collection, but confirmation was done also by the other authors after receiving picture documentation. Online resources and crustacean taxonomic books confirmed the identity of the individual as *Callinectes sapidus*.

The first record of *C. sapidus* in the Sacca di Goro dates

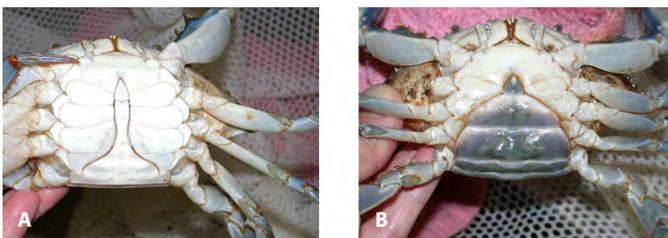


Figure 3. Sexual dimorphism of *Callinectes sapidus*. **A**, male morphology. **B**, female anatomy.

back July 2007 (Turolla, personal observation), which reports on single adult specimen. Further and more consistent spotting has occurred since 2010. However, it is hard to quantify the presence of such species, because nobody is actually monitoring or studying its population dynamics. What is significant about the Blue Crabs in the Sacca di Goro is that the great numbers have led local anglers to embark a business associated with these animals.

Other than in the Sacca di Goro, *C. sapidus* is present also in other lagoons of the Delta del Po and along the entire coast of the Emilia-Romagna Region. In 2011, an adult specimen was been found in San Benedetto (Forlì-Cesena) (Turolla, personal observation). What is the relevant fact is that only adult blue crabs are found and despite this species is not mistaken with other autochthonous species, no juveniles have been observed as of now. A possible explanation for the occurring of this situation could derive from the fact that *C. sapidus* larvae require high salinity for their growth and survival (> 25 ppt). The salinity of this area varies between 5 and 35 ppt along the year (Angonese 2010) and when salinity is below than 20–25 ppt both larvae and subsequently juveniles are not recorded. Recently, during the month of June 2014, in the trait in front of Goro, a female with eggs has been harvested by anglers. This signs that probably such species is starting to reproduce itself *in loco*.

C. sapidus is an omnivorous species characterized by an intense blue colour of the carapace, this is the reason why is it is named as Blue Crab. Males and females of *C. sapidus* can be distinguished by the sexual dimorphism in the shape of the abdomen: males possess a structure shaped as a long, narrow, inverted "T" named apron (Figure 3A), whereas in females, it is a wider and rounded, half-moon shape (Williams 1974) (Figure 3B).

This species as a strong osmoregulator can tolerate a wide range of salinity and is an opportunistic bottom-dwelling predator. Some information on spawning, morphology and behaviour may be available at the Department of Natural resources of Maryland (2015) website.

The feeding habits of such species are known to be preferentially fed on small bivalves. In fact, a study published by Micheli (1995) reports that *C. sapidus* preferences are related to small-size individuals of the Hard Clam, *Mercenaria mercenaria*. Another research published the same year (Ebersole 1995) described a specific preference among three different bivalve species, the Soft Clam, *Mya arenaria*, the Atlantic Rangia clam, *Rangia cuneata*, and the Hooked Mussel, *Ischadium recurvum*. The Blue Crab's preference was addressed to *M. arenaria* inhabiting shallow sand and prey consumption was greater when prey density was higher. Many other studies underscored the feeding behaviour of *C. sapidus* on different bivalve species, but none of them was specifically related to *R. philippinarum* (Gómez Luna

2009). The feeding rate of *C. sapidus* is also important, in fact, faster the stomach is emptied and quicker is the necessity of the crab to search for another food resource. From a laboratory experiment, it has been seen that after 1–2 h the food reached the midgut, at 6 h it has entered the hindgut, and material was still present in the stomach at that time. The stomach was emptied between 8 and 10 h after feeding, and the entire digestive system was cleared of material after 18 h (McGaw 2000). This is important information to estimate the interval time requested to the animal for foraging for food.

The presence of a high density of clam, particularly in shallow water that has been intentionally released in this area is the typical condition characterizing the Sacca di Goro lagoon, which may present as the *optimum* for *C. sapidus*. Moreover, being the Sacca di Goro lagoon, a relatively small area (26 km² surface), it could be easily affected by the introduced or invaded *C. sapidus* if the numerousness of this species would increase along the time. Negative impacts to the mollusc production of this area may be influenced also by the already present invasive species reported in Table 1 (Turolla 2006) updated at 2011 (Crocetta 2011). In addition, also neighbouring areas of Venice Lagoon, such as Scardovari and Chioggia, important at National level for clam production, may be affected by the presence and the spreading of the Blue Crab.

Stakeholders and researchers need to pay attention to this species and its feeding behaviour in these areas should be monitored in order to detect if it may severely damage clam production and the economy of these lagoons.

ACKNOWLEDGEMENTS

A special thanks to my father who that day planned for me and my guests an excursion to the Sacca di Goro lagoon and thanks to the fisherman who showed me *C. sapidus* specimens.

LITERATURE CITED

Angonese, G. 2010. Attività di monitoraggio ambientale della Sacca di Goro - Rapporto annuale 2008. Acque Costiere ed Economia Ittica. Ferrara, Italy: Provincia di Ferrara. Accessed at <http://www.provincia.fe.it/sito?doc=D129010EC8C5DDC9C125775E0032A7C9>, 15 September 2014.

- Beqiraj, S. and L. Kashta. 2010. The establishment of blue crab *Callinectes sapidus* Rathbun, 1896 in the Lagoon of Patok, Albania (south-east Adriatic Sea). *Aquatic Invasions* 5(2): 219–221. doi: [10.3391/ai.2010.5.2.16](https://doi.org/10.3391/ai.2010.5.2.16)
- Castejón, D. and G. Guerao. 2013. A new record of the American blue crab, *Callinectes sapidus* Rathbun, 1896 (Decapoda: Brachyura: Portunidae), from the Mediterranean coast of the Iberian Peninsula. *BioInvasions Records* 2(2): 141–143. doi: [10.3391/bir.2013.2.2.08](https://doi.org/10.3391/bir.2013.2.2.08)
- Castriota, L., Andaloro, F., Costantini, R. and A. De Ascentiis. 2012. First record of the Atlantic crab *Callinectes sapidus* Rathbun, 1896 (Crustacea: Brachyura: Portunidae) in Abruzzi waters, central Adriatic Sea. *Acta Adriatica* 53(3): 467–471. <http://hrcak.srce.hr/file/143161>
- Crocetta, F. and E. Turolla. 2011. *Mya arenaria* Linné, 1758 (Mollusca: Bivalvia) in the Mediterranean Sea: its distribution revisited. *Journal of Biological Research-Thessaloniki* 16: 188–193. <http://www.jbr.gr/papers20112/04-Crocetta%20et%20al.pdf>
- Department of Natural Resources of Maryland. [2015]. Maryland fish facts. Shellfish – Blue Crab. Accessed at <http://dnr2.maryland.gov/Fisheries/Pages/Fish-Facts.aspx?fishname=Shellfish%20-%20Blue%20Crab>, 18 April 2015.
- Dulcic, J., Dragicevic, B., and L. Lipej. 2010. New record of the Blue Crab, *Callinectes sapidus* Rathbun, 1896, (Decapoda: Brachyura) in the Adriatic Sea. *Annales Series Historia Naturalis* 20: 23–28.
- Dulcic, J., Tutman, P., Matic-Skoko, S. and B. Glamuzina. 2011. Six years from first record to population establishment: the case of the blue crab, *Callinectes sapidus* Rathbun, 1896 (Brachyura, Portunidae) in the Neretva River delta (South-eastern Adriatic Sea, Croatia). *Crustaceana* 84: 1211–1220. doi: [10.1163/156854011X587478](https://doi.org/10.1163/156854011X587478)
- Ebersole, E. and V.S. Kennedy. 1995. Prey preferences of blue crabs *Callinectes sapidus* feeding on three bivalve species. *Marine Ecology Progress Series* 118: 167–177. <http://www.int-res.com/articles/meps/118/m118p167.pdf>
- Florio, M., Breber, P., Scirocco, T., Specchiulli, A., Cilenti, L. and L. Lumare. 2008. Exotic species in Lesina and Varano lakes new guest in lesina and varao lakes: Gargano National Park (Italy). *Transitional Waters Bulletin* 2: 69–79. doi: [10.1285/i1825229Xv2n2p69](https://doi.org/10.1285/i1825229Xv2n2p69)
- Gennaio, R., Scordella, G. and M. Pastore. 2006. Occurrence of blue crab *Callinectes Sapidus* (Rathbun, 1986, Crustacea, Brachyura), in the Ugento ponds area (Lecce, Italy). *Thalassia Salentina* 29: 29–39. doi: [10.1285/i15910725v29p29](https://doi.org/10.1285/i15910725v29p29)
- Gómez Luna, L., Sosa Montano, A., Moreno Castillo, I. and A. Jover Capote. 2009. Biodiversity, morphometry and diet of *Callinectes crabs* (Decapoda: Portunidae) in Santiago de Cuba. *Revista de Biología Tropical* 57(3): 671–686. http://www.scielo.sa.cr/scielo.php?script=sci_arttext&pid=S0034-77442009000300017
- Mancinelli, G., Carrozzo, L., Costantini, M.L., Rossi, L., Marini, G. and M. Pinna. 2013. Occurrence of the Atlantic blue crab *Callinectes sapidus* Rathbun, 1896 in two Mediterranean coastal habitats:

Table 1. List of invasive species currently recorded in the Sacca di Goro.

Species	First record	Literature
<i>Crassostrea gigas</i> (Thunberg, 1793)	1964	Matta, 1968; 1969; Ghisotti, 1971
<i>Scapharca inaequivalvis</i> (Bruguère, 1789)	1969	Rinaldi, 1972; Ghisotti, 1973; Ghisotti and Rinaldi, 1976
<i>Rapana venosa</i> (Valenciennes, 1846)	1973	Ghisotti, 1974; Cesari & Pellizzato, 1985
<i>Musculista senhousia</i> (Benson in Cantor, 1842)	1993	Lazzari e Rinaldi, 1994; Turolla, 1999a
<i>Xenostrobus securis</i> (Lamarck, 1819)	1993	Lazzari e Rinaldi, 1994; Turolla, 1999a
<i>Anadara demiri</i> (Piani, 1981)	2000	Morello e Solustri, 2001
<i>Mercenaria mercenaria</i> (Linné, 1758)	2006	Turolla, 2006
<i>Mya arenaria</i> (Linné, 1758)	2008	Crocetta & Turolla, 2011
<i>Callinectes sapidus</i> (Rathbun, 1896)	2007	Current publication

- temporary visitor or permanent resident? Estuarine, Coastal and Shelf Science 135: 46–56. doi: [10.1016/j.ecss.2013.06.008](https://doi.org/10.1016/j.ecss.2013.06.008)
- McGaw, I.J. and C.L. Reiber. 2000. Integrated physiological responses to feeding in the blue crab *Callinectes sapidus*. The Journal of Experimental Biology 203: 359–368. <http://jeb.biologists.org/content/203/2/359>
- Micheli, F. 1995. Behavioural plasticity in prey-size selectivity of the blue crab *Callinectes sapidus* feeding on bivalve prey. Journal of Animal Ecology 64(1): 63–74.
- Sessa, C. 2012. Sustainable Water Ecosystems Management in Europe. London: IWA Publishing. 148 pp.
- Tuncer, S. and S. Bilgin. 2008. First record of *Callinectes sapidus* Rathbun, 1896 (Crustacea: Decapoda: Brachyura) in the Dardanelles, Canakkale, Turkey. Aquatic Invasions 3(4):469. doi: [10.3391/ai.2008.3.4.19](https://doi.org/10.3391/ai.2008.3.4.19)
- Turolla, E. 2006. Considerazioni sul ritrovamento di esemplari adulti di *Mercenaria mercenaria* (Linneo, 1758) in due lagune del Delta del Po. Bollettino Malacologia 42(1–4): 1–4. <http://www.societaitalianadimalacologia.it/Bollettino/Bollettino%202006/Boll.%20Mal.%202006%201-4.pdf>
- Williams, A.B. 1974. The swimming crabs of the genus *Callinectes* (Decapoda: Portunidae). Fisheries Bulletin 72: 685–798.
- Authors' contribution statement:** CM found the *C. sapidus* specimen and wrote the manuscript, ET collected the information about previous “not official” records of the Blue crab within the Sacca di Goro, JSC identified the *C. sapidus* species and PGG assisted in preparing the manuscript.
- All the authors declare not to have direct or indirect conflict of interest related to the work described in the manuscript.
- Received:** October 2014
Accepted: April 2015
Editorial responsibility: Sérgio Stampar