



## Short Communication

# Mass mortality event of *Callinectes sapidus* Rathbun 1896 in a coastal pond of the protect area of Vendicari in summer 2020 (S-E Sicily)

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## ABSTRACT

In the 2020 summer the territory of Sicily was affected by a strong drought which caused a strong lowering of the level of the water bodies of the whole Region; the protected area of Vendicari (S-E Sicily) was not spared by these events. Furthermore, a strong storm affected the coasts of southeastern Sicily. These meteorological events, drought and storm, acted synergistically causing the silting up of the mouth of the coastal pond Pantano Sichilli which represents for the latter the only way of communication with the sea. Therefore, the water level of the Marsh has drastically dropped causing, directly or indirectly, the death of several tens of thousands of aquatic organisms that populate them such as fish, crabs, molluscs, etc. Among these, our attention was drawn to the remains of thousands of specimens of the voracious Atlantic blue crab of the *Callinectes sapidus* species. Following these events, linked to the climate, it was possible to detect, for the first time, the presence of *C. sapidus* in the Vendicari ponds and to formulate hypotheses on the great abundance of individuals of this species which could represent a strong threat to the biodiversity of these environments.

## 1. Introduction

American blue crab *Callinectes sapidus* Rathbun 1896 is a coastal and estuarine species (Williams, 1974); native to the Western Atlantic coasts, today, also widely spread in the Mediterranean and in the Black Sea (see Falsone et al., 2020 and Shaiek et al., 2021 for the more updated data on *C. sapidus* distribution in Mediterranean basin). This species for the Mediterranean basin was correctly registered for the first time thanks to a sample, preserved in the collections of the Natural History Museum of Venice, captured on 4 October 1949 near Marina di Grado (Italy) and uncorrectly labeled as *Neptunus pelagicus* (L., 1758) (Castriota et al., 2012; Mizzan, 1993).

Atlantic blue crab, due to its high reproductive capacity and its voracity and aggressiveness, was included in the list of the “worst invasive” species in the Mediterranean and have a high impacts on both biodiversity and socioeconomics (Strefitaris and Zenetos, 2006).

The protected area of Vendicari, located in south-eastern Sicily, consists of a regional reserve that includes dune environments, coastal ponds, a long coastline that alternates rocky stretches and long beaches and a small island not far from the coast. This area represents a small treasure trove of terrestrial and marine biodiversity as well as an

important resting area along the routes that migratory birds travel between the northern European regions and North Africa.

The coastal ponds of Vendicari have no natural tributaries but are fed thanks to rainwater and groundwater. The severe drought that affected the Sicilian territory, in the three-year period between 2018 and 2020, led to a drastic reduction of the natural water supply to the coastal ponds of the protected area of Vendicari. To this it should be added that, in the month of May 2020, two violent storm surges affected the stretch of coast on which the mouth of the Pantano Sichilli opens, and this determined the silting up of the mouth itself with the consequent interruption of the natural water exchange between the sea and the Pantano Sichilli.

It should be emphasized that the mouth of the Pantano Sichilli is not permanently communicating with the open sea. In fact, as explained above, the communication between the pond and the sea is established when the appropriate atmospheric and marine weather conditions allow it. The last time that there was a silting up of the mouth of this pond dates back to autumn winter 2016–2017 when strong winter storms hit the Vendicari coast, accumulating large quantities of sand and debris on the sandy shore, forming a high ephemeral dune cord over 1.5 m.

The silting up of the mouth of the Pantano Sichilli has had the

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Fig. 1. Map of the Oriented Natural Reserve "Faunistic Oasis of Vendicari" created by the managing body of the reserve.



**Fig. 2.** Sampling area: “a” general view of the Pantano Sicchilli and “b” its mouth with the sampling site highlighted (red area). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

consequence that many aquatic species, especially those that migrate between the lagoon and the open sea during their biological cycle, have remained confined within the pond, facing death due to various factors. Which acted in synergy with each other: a) lack of water; b) increase in water temperature, incompatible with the life of these organisms; c) strong decrease of dissolved oxygen in the water body; d) increase in the salinity of the water; e) lack of food (to satisfy the needs of the most voracious species such as *C. sapidus*).

In this context, a mass die-off event of blue crabs *C. sapidus* was observed; during the surveys most of the dead crabs were observed in their original position, partially buried in the seabed on which they

lived.

The observation of this event was useful to ascertain that the Vendicari ponds were colonized by the Atlantic blue crab *C. sapidus* whose presence was not yet known and could represent a strong threat to the diversity of these lagoon environments.

## 2. Material and methods

### 2.1. Study site

The site where the observations were conducted is located within the



Fig. 3. Study area with  $5 \times 5$  m squares in which the reliefs of the specimens of *C. sapidus* were carried out.

protected area called “Oasi Faunistica di Vendicari” Nature Reserve, established in 1984 (act of the Sicilian Region - Ass. Terr. Amb. N. 81 of 14/03/1984) (Fig. 1). In the precinct of the protected area there are 4 coastal ponds called Pantani di Vendicari (Pantano Sichilli, Pantano Roveto, Pantano Piccolo and Pantano Grande). The coastal ponds are separated from the sea by a dune barrier, about 3 km long, interrupted by a single natural channel, called “Foce Sichilli” which seasonally communicates with the sea.

Not far from the coast is the island of Vendicari which is also part of the protected area.

The protected area, in its entirety, is part of the European Network “Natura 2000” and, at the same time, is Special Protection Area (SPA) and Site of Community Importance (SIC) called IT090002 “Vendicari”; furthermore, the marine area facing it, up to the 40 m bathymetric depth, is a marine SIC called ITA090027 “Fondali di Vendicari”.

In the same protected area there is another pond, called Pantano Grande, that have an artificial channel, kept always open, to allow the continuous exchange of water with the sea. In this pond, even today, there are the vestiges of the ancient salt pans of Vendicari. Between the two coastal ponds, Pantano Grande and Pantano Sichilli, there is no communication between them; therefore the two ponds can be considered as two separate bodies of water that do not allow the direct interchange of organisms.

The mouth of Pantano Sichilli during the last three winter seasons (2017–2018, 2018–2019 and 2019–2020) was open and freely communicating with the open sea (Giorgio Cavarra, manager of the protected area, pers. com.).

In late 2020 spring, at the beginning of the hot season, the severe drought that hit Sicily also led to a sharp drop in the water regime of the Pantano Sichilli. In addition to this, two strong storms in May 2020 caused the total closure of the mouth, interrupting the natural exchange of water between the coastal pond and the sea.

## 2.2. Sampling of *Callinectes sapidus*

The observations on the dead specimens of *C. sapidus*, following the evaporation of the water of the Pantano Sichilli, were carried out in August 2020, inside the channel that connects the pond to the sea. The canal has a total area of over  $17,000 \text{ m}^2$  while the emerged area in which the observations were made measures approximately  $3000 \text{ m}^2$  (Fig. 2).

The observation area was measured by means of a metric roller and

wooden stakes were fixed inside it, at a distance of 5 m from each other, and red/white tape to be used as a reference to count the number of dead crabs inside of it (Fig. 3). Subsequently, the average number of crabs per square meter was estimated, taking into consideration only the crabs that, without any doubt, were still in their original position (such as those still buried in the sediment) as showed in Fig. 4.

In order to obtain a plausible figure relating to the number of crabs per square meter, we have chosen not to count the crabs that appeared upside down, with a broken carapace, with damaged and/or amputated appendages or with the body visibly altered. This is because the area is populated by numerous active predatory or opportunistic species that may have taken advantage of the large number of easy prey to eat them, displacing them from their original position.

To all this we must also add the disturbance caused by the numerous visitors who, intrigued by the large number of dead crabs, may have taken some as a souvenir (sic!!!) or may have used some specimens as a subject for souvenir photos by moving them from their original position.

In the course of our surveys we observed only adult, male and female specimens. This does not mean that juvenile individuals were not present in the pond but it is a further confirmation of the fact that during their biological cycle the adult females approach the mouths of the ponds to reach the open sea and thus be able to lay their own eggs outside the lagoons to ensure maximum dispersion to the larvae, once the eggs have hatched.

In the area under study we counted a total number of 2760 specimens on a total area of 3000 square meters. This allowed us to calculate the average density per square meter which was equal to 0.92 specimens per square meter. Simultaneously with the count of the total number of dead specimens we have detected the sex to have the male / female ratio as showed in Table 1.

In order to obtain comparable data with what is already present in the literature we have also calculated the average size on 100 specimens of each sex, chosen randomly, considering only intact individuals, measuring the width (=Wc) and the length (=Lc) of the carapaces. Measurements of *C. sapidus* samples gave the following results: females ( $n = 100$ ) Wc:  $158.63 \pm 11.05$  mm, Lc:  $75.13 \pm 5.21$  mm and males ( $n = 100$ ), Wc:  $169.62 \pm 10.54$  mm, Lc:  $63.59 \pm 7.22$  mm (Table 1).

## 3. Results and conclusion

During our survey we were able to observe only adult individuals,



Fig. 4. Photos of dead crabs: “a” general and “b” “c” “d” and “e” particular views of the crabs in their original position.

**Table 1**

Male/female ratio on the total of 2760 specimens detected and average size on 100 specimens, randomly collected (males and females).

Total specimens	Male	Female
2760	929	1831
percentage	33.65%	66.35%
Wc ( $\pm$ SD) in mm on 100 specimens	169.62 ( $\pm$ 11.65)	158.63 ( $\pm$ 11.65)
Lc ( $\pm$ SD) in mm on 100 specimens	63.59 ( $\pm$ 7.22)	75.13 ( $\pm$ 5.21)

with a fair prevalence of females over males (Table 1), while there were no juvenile individuals. Since we do not have a series of temporal data relating to the presence of *C. sapidus* in the Vendicari lagoons, we can only hypothesize that the lack of juveniles could be interpreted with what was observed by Guijarro-García et al. (2019) in the lagoons of southeastern Spain and the Atlantic Ocean. In those sites, in fact, at the beginning of spring the females of *C. sapidus* migrate from the lagoons towards the open sea to lay their eggs (Turner et al., 2003).

Also to explain the presence of such a large number of dead crabs

incorporated in the sediment, we referred to what was observed and described by Guijarro-García et al. (2019); these authors report, in fact, that during the autumn season the blue crabs that populate the southeastern lagoons of Spain tend to bury themselves in the sand of the seabed until the following spring season when they resume their reproductive activity.

In the Pantano Sichilli, as we have already said, the channel that allows direct communication between the open sea and the lagoon depends on various seasonal meteorological factors, such as the strong storm surges and the floods of small streams and aquifers that allow the waters of the marsh and the waters of the sea to exert the necessary and sufficient thrust to force the dune belt that separates it from the sea. For this reason, the mouth of the Pantano Sichilli can remain closed even for several subsequent years; all this obviously has a negative impact on the aquatic fauna that needs to make seasonal migrations, between the lagoon and the open sea, in order to complete its life cycle.

*Callinectes sapidus*, having codified in its genetic patrimony the behavior that induces it to bury itself in the mud of the ponds during the adverse season, is one of those species that suffers negative influences

due to the lack of opening of the mouth of the quagmire; this is demonstrated by the large number of individuals who died as a result of the evaporation of the waters of the quagmire when atmospheric temperatures began to rise.

The biological cycle of *C. sapidus* requires environments with different salinity in the various stages of the crab's life. Juveniles and adults can indifferently populate both brackish and salty environments and/or fresh water environments; ovigerous females need waters with a salinity greater than 20‰ to lay their eggs, in fact the larval stages need a minimum salinity of 20‰ in order to complete their development correctly (Millikin and Williams, 1984; Hines, 2007; Mancinelli et al., 2013).

*C. sapidus* is also considered a eurythemic species, with high fecundity, good swimming skills and strong aggressiveness. All these characteristics have certainly helped to ensure that the Atlantic blue crab spread over vast areas of the Mediterranean (Galil et al., 2002).

We are well aware that the expeditious nature of our observations did not allow us to carry out a detailed analysis of the spatial distribution of the crabs within the Pantano Sicilli in relation, also, to the environmental factors that could contribute to influencing the distribution of *C. sapidus* within the lagoon. In any case, thanks to what we observed in August 2020, we can affirm that this species is present in great abundance in the Pantano Sicilli and this could compromise the biological diversity of this precious protected environment.

In this regard, we agree with Guijarro-García et al. (2019) when they state that it is urgent to have more complete data to better understand how the *C. sapidus* species is expanding in the Mediterranean basin and, above all, in coastal ponds and lagoons (Shaiek et al., 2021). We agree, once again, with these authors when they state that it would be appropriate to be able to classify the Atlantic blue crab as a commercial species as well as an invasive species. In fact, the current classification of *C. sapidus* as an invasive species means that, according to EU regulations, industrial fishing and consequent commercialization are prohibited with the result that this species has now invaded a huge number of coastal locations and transitional environments in the Mediterranean, heavily interfering with coastal fishing as it causes serious damage to fishing gear (nets, pots, etc.).

#### Declaration of Competing Interest

The Authors of the manuscript entitled " Mass mortality event of *Callinectes sapidus* Rathbun 1896 in a coastal ponds of the protect area of Vendicari in summer 2020 (S-E Sicily)" declare that they have no conflict of interest in relation to the research activities mentioned in the text of the manuscript.

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