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REVIEWING THE INVASION HISTORY OF THE BLUE CRAB *CALLINECTES SAPIDUS* (PORTUNIDAE) IN SICILY (CENTRAL MEDITERRANEAN): AN UNDERESTIMATED ALIEN SPECIES

Luca CASTRIOTA & Manuela FALAUTANO

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ABSTRACT

The alien blue crab *Callinectes sapidus*, a species native to the western Atlantic coasts, has long invaded the Mediterranean, including the Italian seas. It is listed among the 100 worst invasive alien species in the Mediterranean and is presumed to exert an impact on biodiversity and fishing activities. To date, a small number of individuals of this species has been reported from Sicily. This note updates the status of the species in Sicilian seas by means of an analysis of records from various sources, and adds further records. The analysis shows that the distribution of the species in Sicily has so far been underestimated both in terms of abundance and frequency of occurrence.

Key words: citizen science, non-indigenous, Decapoda, Brachyura, waterways, lagoons

RILEGGERE LA STORIA DELL'INVASIONE DEL GRANCHIO BLU *CALLINECTES SAPIDUS* (PORTUNIDAE) IN SICILIA (MEDITERRANEO CENTRALE): UNA SPECIE ALIENA SOTTOSTIMATA

SINTESI

Il granchio blu alieno *Callinectes sapidus*, una specie originaria delle coste dell'Atlantico occidentale, ha invaso da tempo il Mediterraneo, compresi i mari italiani. È elencata tra le 100 peggiori specie esotiche invasive del Mediterraneo e si presume abbia un impatto sulla biodiversità e sulle attività di pesca. Ad oggi, solo di pochi individui è stata documentata la presenza in Sicilia. Questa nota aggiorna lo stato della specie nei mari siciliani mediante un'analisi delle segnalazioni provenienti da varie fonti e aggiunge ulteriori ritrovamenti. L'analisi mostra che la distribuzione delle specie in Sicilia è stata finora sottostimata sia in termini di abbondanza che di frequenza di ritrovamento.

Parole chiave: scienza dei cittadini, specie non indigene, decapodi, brachiuri, corsi d'acqua, lagune

INTRODUCTION

The blue crab *Callinectes sapidus* Rathbun, 1896 is a shelf-estuarine species native to the western Atlantic coasts, ranging from Nova Scotia in Canada down to northern Argentina, including Bermuda and the Antilles (Williams, 1974). This species started invading the European Atlantic coasts in 1900 (Nehring, 2011 and literature therein) and was probably introduced in the Mediterranean Sea through maritime traffic. Although mistaken in the past for the Lessepsian crab *Portunus segnis* (Forskål, 1775), its first occurrence in the Mediterranean can safely be dated to 1949, when a specimen, currently preserved in the zoological collection of the Museum of Natural History of Venice, was caught in the northern Adriatic Sea (Mizzan, 1993; Castriota et al., 2012). Currently, this species has spread to many areas of the Mediterranean Sea, probably owing to its tolerance to environmental changes, high fecundity, strong swimming ability, and pugnacious nature (Williams, 1974). Included among the 100 worst invasive alien species in the Mediterranean Sea (Streftaris & Zenetos, 2006), it is presumed to exert an impact on benthic communities at multiple trophic levels and to have considerable negative effects on fishing activities; on the other hand, this alien species is already a high-value resource in some fisheries of the eastern Mediterranean (Mancinelli et al., 2017). The first occurrence of *C. sapidus* in Sicilian waters dates back to 1970 when one specimen was collected in the Strait of Messina, followed by another specimen caught in 1972 in the same area (Cavaliere & Berdar, 1975). However, these occurrences have been questioned by some authors and rather attributed to misidentification of *P. segnis* (Lipej et al., 2017). Recently, Falsone et al. (2020) reported new records of *C. sapidus* in the Strait of Sicily and provided an updated distribution map of this species' records in the Mediterranean suggesting its successful settlement in the Strait of Sicily, despite the scarcity of valid supporting records. However, new reports originating from online sources (i.e., magazines) and those reported directly to the scientists, suggest that the distribution of this species in Sicilian seas as reported in the literature does not reflect the current situation but seems to be underestimated.

This note aims to update the distribution of *C. sapidus* in Sicilian waters through the addition of several new records in new locations, since tracing the spread of invasive species may be useful for controlling and preventing the potential adverse effects on local ecosystems.

MATERIAL AND METHODS

An analysis of both scientific and grey literature as well as that of other sources (i.e., online magazines, observations reported directly to scientists) was carried

out in order to revise the invasion history of *Callinectes sapidus* in Sicilian waters and to update the knowledge on its current distribution in Sicily. Records were reported in chronological order on a map (Fig. 1). Published records that did not provide detailed photos or descriptions of specimens were considered unconfirmed. Citizen reports were collected by ISPRA (Italian Institute for Environmental Protection and Research) researchers through both personal contacts and the dedicated institutional email alien@isprambiente.it. This email address was launched in 2013 with the aim of collecting records of marine alien species in the national territory from citizens. These records were considered valid only when the reports contained details on the capture/sighting of blue crabs along with photos of the



Fig. 1: Map of Sicily indicating the distribution of *Callinectes sapidus* by chronological order of occurrence, with enlargement of the south-eastern area. 1, 2: Lipej et al., 2017; 3: Guadagnino, 2016; 4–6: Katsanevakis et al., 2020; 7–8: Falsone et al., 2020; 9: Giacobbe et al., 2019; 10–12: Katsanevakis et al., 2020; 13: Pipitone et al., 2020; 14: Falsone et al., 2020; 15: Pipitone et al., 2020; 16: www.oggimilazzo.it 2020; 17: present paper; 18: www.tp24.it 2020; 19: Sercia & Innocenti, 2020; 20–24: present paper. Blue points are records from literature; red points are records from other sources.

SI. 1: Razširjenost modre rakovice (*Callinectes sapidus*) na podlagi zapisov v časovnem zaporedju na zemljevidu Sicilije, z razširjenim jugovzhodnim predelom. 1, 2: Lipej et al., 2017; 3: Guadagnino, 2016; 4–6: Katsanevakis et al., 2020; 7–8: Falsone et al., 2020; 9: Giacobbe et al., 2019; 10–12: Katsanevakis et al., 2020; 13: Pipitone et al., 2020; 14: Falsone et al., 2020; 15: Pipitone et al., 2020; 16: www.oggimilazzo.it 2020; 17: to delo; 18: www.tp24.it 2020; 19: Sercia & Innocenti, 2020; 20–24: to delo. Modre točke so podatki iz literature, rdeči pa podatki iz drugih virov.

Tab. 1: Records of *Callinectes sapidus* collected from online sources and citizen reports.**Tab. 1: Podatki o vrsti *Callinectes sapidus*, zbrani iz spletnih virov in virov, povezanih z ljubiteljsko znanostjo.**

Record number (Fig. 1)	Observation date	Location	Coordinates (DD)	Substratum	Depth	Sex	Number of specimens
16	24/02/2020	Milazzo	38.2384°N 15.2397°E	sand-gravel bottom	0-10 m	male	1
17	31/03/2020	Porto Empedocle	37.231006°N 13.622655°E	rocky bottom with sand	4 m	immature female	1
18	01/06/2020	Stagnone di Marsala	37.8572°N 12.4595°E	sand with seagrass	0-2 m	-	many
20	22/08/2020	Sampieri	36.720000°N 14.737306°E	sand with rocks	10-15 cm	-	1
21	20/09/2020	Oasi del Simeto	37.387223°N 15.082757°E	-	-	-	5
22	18/10/2020	Sampieri quagmire	36.719778°N 14.750889°E	-	0-10 cm	-	1
23	19/10/2020	Marina di Modica quagmire	36.709833°N 14.782472°E	-	-	-	3
24	17/12/2020	Sciacca	37.517078°N 12.986948°E	sandy bottom	7-8 m	-	1

specimens that allowed the identification of the species. Records from online magazines were validated through analyses of the photo/video documentation referring to the reports and directly provided by the Authors/Editors. The specimens recorded were identified to species level on the base of the presence of two large and obtuse teeth on the frontal margin, which distinguish *C. sapidus* from *P. segnis*, another exotic crab reported in the Mediterranean (Williams, 1974; Mizzan, 1993; Lai et al., 2010), which also occurs in Sicily either reported as *P. pelagicus* or misidentified as *C. sapidus* (Ariani & Serra, 1969). *P. segnis* also bears a prominent spine on the internal margin of the cheliped carpus (Lai et al., 2010), which is missing in *C. sapidus*. In addition, *P. segnis* exhibits many pale white spots on the carapace surface, particularly posteriorly and anterolaterally (Lai et al., 2010), which are absent in *C. sapidus*.

In some cases, it was also possible to determine the sex and maturity stage through an analysis of abdomen morphology according to Williams (1974). The approximate size of the individuals was also recorded, estimated by the person who reported them.

RESULTS

Literature analysis yielded 16 valid records of at least 50 individuals of *Callinectes sapidus* from 12 Sicilian localities (Lipej et al., 2017; Giacobbe et al., 2019;

Falsone et al., 2020; Katsanevakis et al., 2020; Pipitone et al., 2020; Sercia & Innocenti, 2020), plus 3 unconfirmed records from 2 localities (Cavaliere & Berdar, 1975; Franceschini et al., 1993). Additionally, eighth records in as many locations were extracted from other sources (Tab. 1). Three of these records were retrieved through online magazines and consist of: i) one specimen spotted in November 2016 in the southwestern Sicilian coast (Guadagnino, 2016), subsequently also reported in the literature (Katsanevakis et al., 2020), ii) one specimen recorded in February 2020 in the northeastern coast (www.oggilimazzo.it, 2020), and iii) dozens of individuals reported in June 2020 in the Stagnone di Marsala Lagoon (west coast) (www.tp24.it, 2020).

Two records were personally reported to ISPRA researchers by two professional fishermen. The first fisherman reported the capture of one specimen (Fig. 2) caught on 31 March 2020, by trammel net targeting cuttlefish *Sepia officinalis*, on a mixed rocky-sandy bottom at 4 m depth, 300 m far from the mouth of the Naro River in the southwestern coast of Sicily (Porto Empedocle). Upon photographing the specimen, the fisherman released it alive back into the sea. It was an immature female, as shown by the triangular poorly expanded abdomen (Williams, 1974), and measured about 12 cm in carapace width. At the moment of capture it exhibited the following colours: brownish green dorsally with whitish scattered dots anteriorly, white ventrally, cheli-

peds orange with blue anterior sides, merus of chelipeds bearing three white spines with dark brown extremities, legs light blue. The fisherman reported damages to the net the meshes of which were cut by the crab's claws.

The second fisherman reported the capture of one specimen of about 20 cm in carapace width, caught on 17 December 2020, by trammel net on a sandy bottom at 7-8 m depth in the locality of Sciacca (southwestern coast of Sicily). This record was validated based on an analysis of a video made by the fisherman.

Additional four records were reported to ISPRA researchers by email: on 22 August 2020, an adult specimen measuring about 20 cm in width was caught by hand net on the seashore, on a sandy bottom with rocks, in the south-eastern coast of Sicily (Sampieri), and photographed; in September 2020, six specimens (Fig. 3) were poached in inland waters within the Oriented Nature Reserve Simeto Oasis in eastern Sicily, subsequently seized and photographed by the staff of the Reserve; on 18 October 2020, an individual of about 13 cm in carapace width was photographed at the depth of 10-15 cm on the bank of the Sampieri quagmire, south-eastern Sicily; on 19 October 2020, three individuals of different sizes, the largest of which measured about 20 cm in carapace width, were spotted in the marsh of Marina di Modica, south-eastern Sicily, and photographed.

DISCUSSION

The history of the invasion by *Callinectes sapidus* in Sicily begins with the record of a female of this species collected in the Strait of Messina in 1970,

followed by the capture of another female in 1972 in the same area (Cavaliere & Berdar, 1975). These two specimens were later attributed to *Portunus segnis* (Lipej et al., 2017), but they are to be re-examined at the University of Messina, where they are currently preserved and waiting to be inventoried (Giacobbe et al., 2019). We have classified these individuals as unconfirmed until proven otherwise, as we did with the record from eastern Sicily, no longer verifiable, reported by Franceschini et al. (1993) in a species checklist from trawl surveys. If we exclude these unconfirmed records, the first validated record of *C. sapidus* in Sicily is the specimen caught in October 2016 outside the harbour of Licata (southern coast) on sandy-muddy bottom, followed by a further capture of two individuals in the same locality ten days later (Lipej et al., 2017) (Fig. 1, nos. 1, 2). About a month later, another individual was reported on a sandy bottom of the Sicilian southwestern coast (Selinunte), at about 110 km west from the first record site (Guadagnino, 2016) (Fig. 1, n. 3). No additional records were reported until May 2018 when this species reappeared in a few localities of the southeastern Sicilian coast (Fig. 1, nos. 4, 5), on both muddy bottoms and sandy bottoms with sparse seagrass *Posidonia oceanica*; an exceptional capture of 20 individuals was reported on muddy bottoms near a river mouth on the eastern coast (Fig. 1, no. 6) (Katsanevakis et al., 2020). Subsequently, the species reappeared in some locations where it had already been recorded (Falsone et al., 2020; Katsanevakis et al., 2020) (Fig. 1, nos. 7, 8, 10, 11) and appeared for the first time in

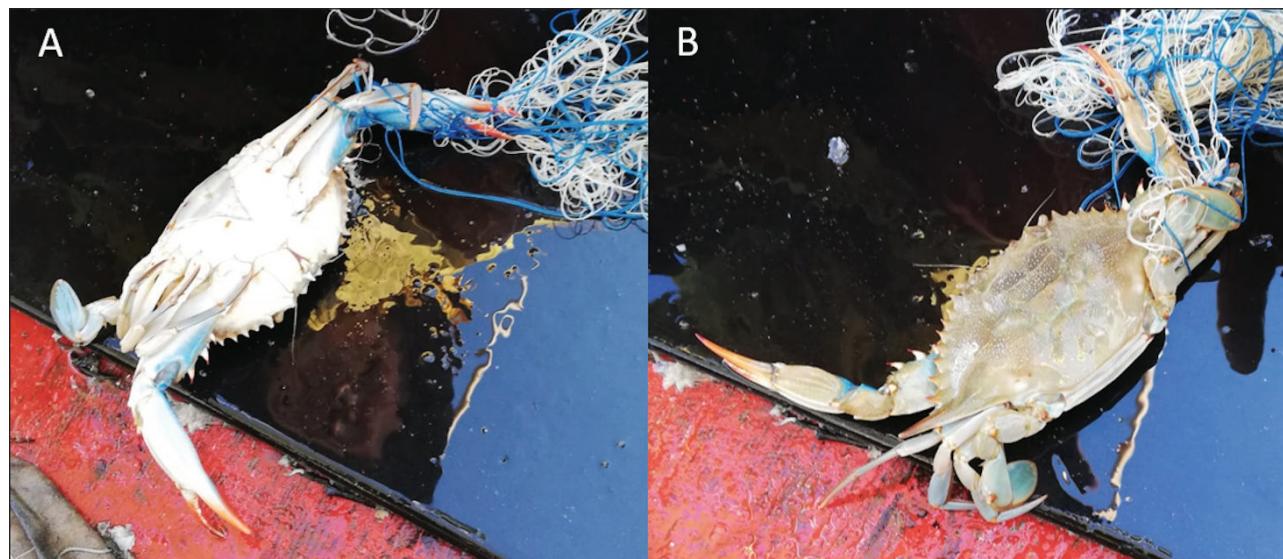


Fig. 2: Specimen of *Callinectes sapidus* caught at Porto Empedocle (Sicily) on 31 March 2020 (A: ventral view, B: dorsal view).

Sl. 2: Primerek modre rakovice (*Callinectes sapidus*), ujet pri Portu Empedocle (Sicilija) 31. marca 2020 (A: trebušna stran; B: hrbtna stran).



Fig. 3: Specimens of *Callinectes sapidus* poached within the Oriented Nature Reserve Simeto Oasis in September 2020.

Sl. 3: Primerki modre rakovice (*Callinectes sapidus*), ulovljeni v Naravnem rezervatu Simeto Oasis v septembru 2020.

new Sicilian areas such as the northeastern (Giacobbe et al., 2019) (Fig. 1, n. 9) and northwestern coasts (Katsanevakis et al., 2020; Pipitone et al., 2020) (Fig. 1, nos. 12, 13). Additional records were reported in 2020, some of them in already mentioned sites (Falsone et al., 2020; Pipitone et al., 2020; present paper) (Fig. 1, n. 14, 15, 20-23), others from new Sicilian areas (Sercia & Innocenti, 2020; present paper) (Fig. 1, nos. 16–19). The occurrence of *C. sapidus* in some of these localities was also confirmed by the results of an online questionnaire administered to recreational fishers (Cerri et al. 2020). From our revision, this species spread to almost the entire coast of Sicily over a period of four years (2016–2020), first colonising the southern coasts and then extending its distribution in other areas, without showing a well-traced path. Such a rapid spread could be related to the presence in Sicily of several lagoons and waterways connected to the sea where *C. sapidus* spends some phases of its life cycle. As known, *C. sapidus* specimens migrate from seawater to rivers, and vice versa, at different stages of their life cycle. In particular, after mating in estuarine brackish waters females migrate to higher salinity coastal waters to lay eggs and then tend to remain there, or rather move to close-by sea waters while males prefer to remain in low salinity areas (Van Engel, 1958; Williams, 1965). Larval stages complete their development in coastal waters and re-enter brackish habitats at the stage of post-larva up to reach

the juvenile stage; both juvenile and adult stages can be found in freshwater areas as well as highly saline habitats (Hines et al., 2008; Mancinelli et al., 2013; Cilenti et al., 2015). According to collected data, this species in Sicilian waters predominates on soft bottoms, mainly in proximity of river mouths or inland channels, but also in coastal lagoons and near ports, in different periods of the year, and in shallow waters. The occurrence of several *C. sapidus* records in the vicinity of Sicilian brackish water bodies suggests these places to be potential areas of establishment, as observed in other Mediterranean estuaries and lagoons where established populations occurred with numerous specimens at different life stages (Beqiraj & Kashta, 2010; Dulčić et al., 2011; Mancinelli et al., 2013). For this reason, it is important to monitor estuarine and lagoon areas and consider them for management purposes in order to contain the invasion by this species and to mitigate possible impacts on biodiversity and fishing activity. *C. sapidus* would in fact interfere with fishing activities, on the one hand, by damaging the nets with its claws (Beqiraj & Kashta, 2010), on the other, by representing a valuable commercial resource for its highly appreciated meat, although in Sicily the species has not yet been introduced in local markets. The fishermen from our study confirmed the damage to the nets caused by the crab and pointed out the need to receive guidelines of good practices for the management of this species. The several records reported by fishermen stress the importance of their cooperation as sentinels for the detection of invasive species. In this process, the voluntary help offered by citizens in informing scientists about the presence of alien species should not be underestimated. The wide response on social pages dedicated to the knowledge of marine life is proof of this and could constitute in the next future a valid tool to support the monitoring of alien species.

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REVIZIJA ZGODOVINE INVAZIJE MODRE RAKOVICE *CALLINECTES SAPIDUS* (PORTUNIDAE) NA SICILIJI (OSREDNJE SREDOZEMSKO MORJE):
PODCENJENA TUJERODNA VRSTA

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POVZETEK

Tujerodna modra rakovica (Callinectes sapidus), ki izvira iz vzhodne atlantske obale, že dlje časa naseljuje Sredozemsko morje, vključno z italijanskimi morji. Je na seznamu stoterice najbolj nevarnih invazivnih vrst v Sredozemskem morju in domnevajo, da povzroča posledice na biodiverziteti in ribištvu. Do danes je bilo le manjše število primerkov te vrste potrjenih za Sicilijo. V tem zapisu avtorja poročata o statusu modre rakovice v morju okoli Sicilije na podlagi analize potrjenih zapisov iz raznih virov in dodajata nove primere pojavljanja. Analiza kaže, da so bili doslej podatki o razširjenosti te vrste podcenjeni tako glede abundance kot tudi frekvence pojavljanja.

Ključne besede: ljubiteljska znanost, tujerodne vrste, Decapoda, Brachyura, vodne poti, lagune

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