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Rapid Communication

The blue swimming crab *Portunus segnis* (Forskål, 1775) reaches the Adriatic Sea: a distant and disjointed occurrence

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Abstract

A single Blue swimming crab *Portunus segnis* was captured on November 5th 2022 close to the harbor of Ancona, off the central Adriatic coast (Italy) by artisanal fishers. Taxonomic comparisons were performed with collection materials, which also included two unreported specimens of the species from the Ionian coast of Calabria, Italy. The large distance between the Adriatic record of *P. segnis* and its invasion front, reinforces the hypothesis that human-mediated translocations contribute to the secondary dispersal or introduction of this invasive species in Mediterranean waters.

Key words: biological invasions, Portunidae, dispersal, ship transport

Introduction

The blue swimming crab *Portunus segnis* (Forskål, 1775), native to the western Indian Ocean, including Red Sea and Persian Gulf (Lai et al. 2010), is a large omnivorous predator which can live in a wide range of infralittoral ecosystems, from bare coastal sands to bottoms with algal or seagrass cover, from the shallowest lagoon waters down to depths of 65 meters (Naderloo 2017).

This tropical species, which is one of the earliest introductions through the Suez Canal, is responsible for one of the most spectacular invasions of the Mediterranean Sea (Streftaris and Zenetos 2006). After its first Mediterranean detection in Egypt in 1898 (Fox 1924), the species underwent a long lag time (*sensu* Azzurro et al. 2016) before establishing a permanent population in the Levant Sea (Gruvel 1931) and starting its westward geographical expansion (Castriota et al. 2022). Today *P. segnis* has successfully colonized extensive areas in the eastern and central parts of the basin (Katsanevakis et al. 2020), with recent occurrences documented in the Strait of Sicily (reviewed by Shaiek et al. 2021; Castriota et al. 2022).

Besides its negative ecological and socio-economic impacts, the blue swimming crab represents today a new valuable fishery resource contributing

to food provision and local economies in a number of Mediterranean countries (Tsirintanis et al. 2022) and especially in southern Tunisia, where it is currently exploited as a novel fishery resource (Ennouri et al. 2021). Only in 2019, 3500 tons of *P. segnis* were exported from Tunisia, in more than 20 world countries, for a total income exceeding 12 million euros (Rjiba Bahri et al. 2022). New observations of the blue swimming crab are particularly useful to monitor its geographical spread and possible new introductions.

Materials and methods

A large swimming crab, with a coloration markedly different from that of the morphologically similar *Callinectes sapidus* Rathbun, nowadays common in the central Adriatic Sea (Cerri et al. 2020), was accidentally by-caught by a professional small-scale fisher targeting turbots—*Scophthalmus maximus* (L.). The fisher used a 80-mm meshed trammel net on a sandy bottom at 5.0 m of depth about 3 miles West of Ancona harbor. He brought the crab alive at the CNR-IRBIM Institute of Ancona, where it was identified as *Portunus segnis*, following the revision of the *P. pelagicus* species complex by Lai et al. (2010), photographed, measured and finally preserved in 80% ethanol. The specimen was subsequently compared with the material of *P. segnis* present in the C.F. decapods collection, which also includes two unreported specimens collected by another fisher in 2018 off the Ionian coast of Calabria, Italy. Measures of Carapace Length (C.L.) and Width (C.W.), Cheliped Propodus and Merus Length were taken with a quadrant caliper (precision 0.1 mm). The study of this material is herein reported, together with some remarks on the literature record of *P. pelagicus* larvae in the Ligurian Sea

Results

Systematics

Portunidae Rafinesque, 1815
Portunus Weber, 1795

***Portunus segnis* (Forskål, 1775) (Figure 1 inset, 2)**

Cancer segnis Forskål, 1775: 18, 91.
Portunus segnis – Lai, Ng and Davie 2010: 215, figs 6B, 7B, 11–14, 20B, 21B, 22B, 23B, 23F, 24B.

Material examined

Adriatic Sea: 1 ♂ C.L. 64.5 mm, off Palombina (Ancona), 43°37′43″N; 13°25′27″E, depth 5 m, fine sands, trammel net, collegit: C. Bernardini, [D2875].

Ionian Sea: 1 ♂ C.L. 61.6 mm, 1 ♀ C.L. 61.5 mm, off Roccella Ionica, depth 10 m, summer 2018, trammel net, collegit: A. Martino, [D2152]. – 1 ♂ C.L. 55.5 mm, 4 ♀ C.L. 39.5–59.2 mm, Bay of Siracusa, 22 June 1974, purchase from local fisher, collegit: C. Froglia and R.B. Manning, [D226].

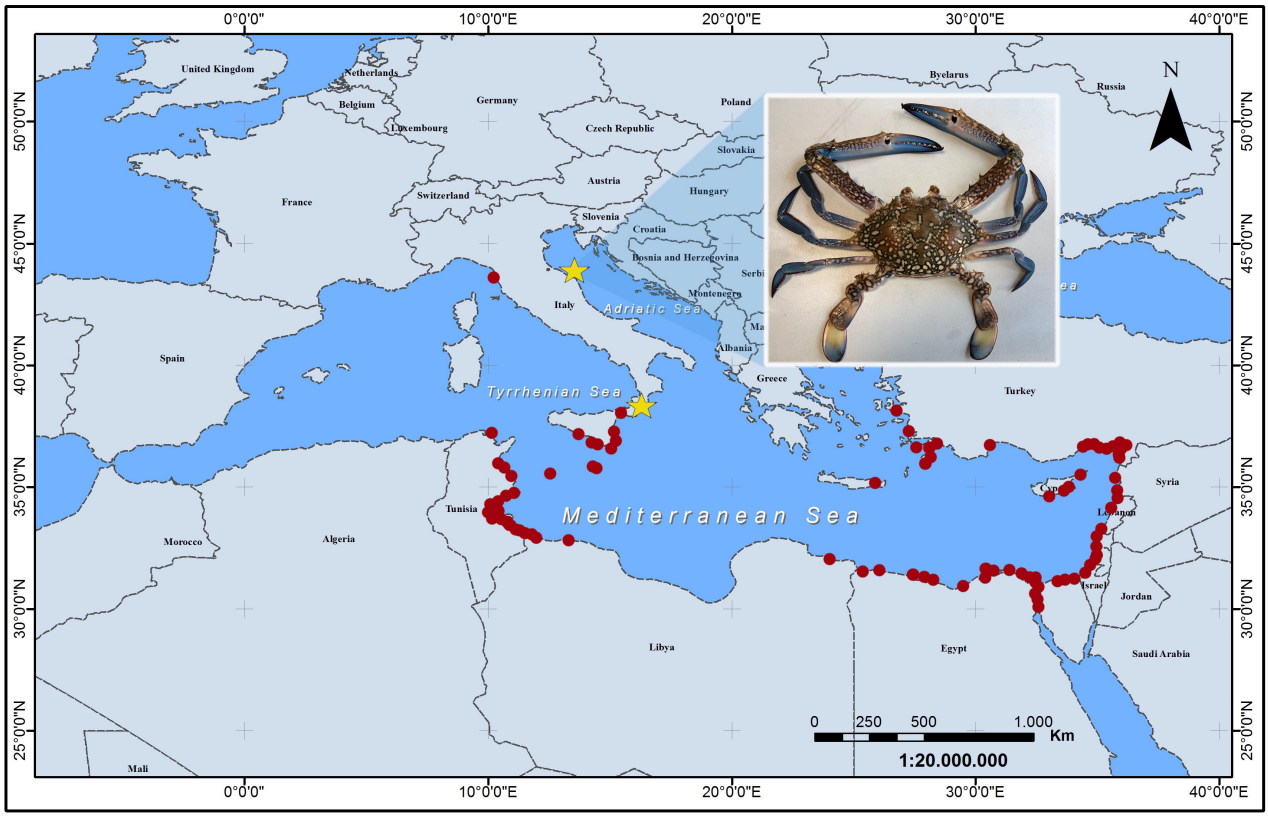

Figure 1. Capture locations (yellow stars) and picture of *Portunus segnis* caught out off Palombina, (Ancona, Italy, central Adriatic Sea) on November 5th 2022. Red dots show the former Mediterranean records of the species, modified with respect to the previous revision of Castriota et al. (2022).

Levant Sea: 2 ♂ C.L. 52.2–54.8 mm, 4 ♀ C.L. 46.9–55.8 mm, St. George Bay (Lebanon), 10 July 1963, collegit C. George, [D319].

Red Sea: 1 ♀ C.L. 49 mm, Bay of Berenice (Egypt), depth 1 m, 2 May 1980, hand-net snorkeling, collegit C. Froglia, [D1840].

All the specimens examined (i.e. C.F. collection), stored in 80% ethanol, are on the way of transfer to the Museo civico di Storia Naturale, in Verona.

The species was reported and illustrated by earlier Mediterranean authors under the name *Portunus pelagicus* (see: Galil et al. 2002 and references therein) before Lai et al. (2010) separated *P. segnis* from the other species of the *P. pelagicus* complex on the basis of a molecular study and on minute morphological differences, among which those of the frontal region. The median teeth on the frontal margin have been described as "Minute and inconspicuous, almost obsolete; if present always small (Fig. 23B)". In the Adriatic specimen, and in the other comparative material examined, the front, except for inner supraorbital teeth has only two acute lateral teeth, and the median margin is slightly sinuous without trace of median teeth (as in the fig. 23B in Lai et al. 2010); the acute epistome tooth extends forward beyond frontal margin, so that front may seem tridentate (Figure 2). In *P. segnis*, as in other portunids, sexual dimorphism in chelipeds size is evident: the sum of propodus plus merus length exceeds maximum carapace width in the males, being less than that in females (Table 1).

Figure 2. *Portunus segnis*, off Palombina (Ancona), male C.L. 64.5 mm, 5 Nov. 2022, detail of frontal region. Photograph by Carlo Froglia.

Table 1. Biometrical measures (in mm) taken on examined specimens of *P. segnis*.

Locality	Sex	C.L.	C.W.	Front W.	Cheliped propodus L.	Cheliped merus L.
Adriatic Sea, off Palombina	Male	64.5	140.4	22.0	100.7	60.0
Ionian Sea, off Roccella Ionica	Male	61.6	140.7	19.7	95.3	52.0
	Female	61.5	140.0	19.0	73.8	52.0
Ionian Sea, Bay of Siracusa	Male	55.5	131.0	18.6	67.9	64.0
	Female	59.2	126.3	18.6	68.3	47.4
	Female	58.2	126.3	18.6	68.3	47.1
	Female	50.6	112.0	16.2	59.1	41.7
	Female	39.5	86.6	12.5	45.3	30.5
Levant Sea, Lebanon	Male	52.2	120.5	17.5	77.4	56.5
	Female	46.9	106.9	14.2	56.1	39.5
Red Sea, Egypt, Bay of Berenice	Female	49.0	107.7	15.2	57.8	37.2

Discussion

Here we provide the first documented evidence on the occurrence of the blue swimming crab in the Adriatic Sea. Suboptimal conditions, especially the low winter temperatures of the central and northern Adriatic (Russo et al. 2012), are expected to be a limit to its settlement in the area, even if in laboratory tests *P. segnis* could stand temperatures of 10 °C (Zainal and Noorani 2019). This also agrees with the current distribution of the species in its invaded range (Figure 1), being the established populations currently confined to the warmer sectors of the basin (Castriota et al. 2022).

A significant observation, with respect to the last revisions (Castriota et al. 2022) is that the *Portunus* larvae collected in the Golfo del Tigullio (Ligurian Sea) by Pessani and Salton (1998) cannot be attributed to *P. segnis*. Indeed these authors identified the species as *Portunus pelagicus* before the taxonomic revision of Lai et al. (2010), who splitted the *P. pelagicus* complex into four species and reinstated the name of *P. segnis* (Forskål, 1775). According to the description provided by Pessani and Salton (1998, Tab. 3),

the telson of the Tigullio larvae had 2 fork spines and thus belongs to the *P. pelagicus* complex, but not to *P. segnis*. Al-Aidaroos et al. (2019) described the complete larval development of *P. segnis* from laboratory rearing, and listed among the distinctive characters of its zoeae, the presence of 3 spines on telson, versus 2 spines for the zoeae of the other species in the *P. pelagicus* complex.

The Blue Swimming Crab has recently expanded its distribution in many new sectors of the Mediterranean Sea. Many of the recent arrivals could be the result of natural dispersal mechanisms and for the purposes of EU Policies, their introduction should be considered as "unaided" (Zenetos et al. 2022). This is for instance the case of the *P. segnis* captured in Roccella Ionica, which could have arrived as larvae generated from the population in the eastern shores of Sicily, perhaps favored by the periodical reversal of the Ionian gyre (Menna et al. 2019).

On the other hand, the present finding in the Adriatic Sea, over 1000 km from the nearest established populations (East Sicily and Crete), has to be of different origin, also keeping in mind that along the West Adriatic shore the main current flows southward (Russo and Artegiani 1996). The proximity (only 5 km), of the Adriatic *P. segnis* capture location to the international harbor of Ancona and its oil refinery terminal, supports the idea of secondary introduction mediated by human transport, likely shipping. This hypothesis, which also applies to many analogous cases of distant and disjointed occurrences of Mediterranean Non Indigenous Species (NIS) (Azzurro et al. 2022), must be considered in light of the general discontinuity of *P. segnis* distribution in the Mediterranean region (Castriota et al. 2022). As already suggested by Ariani ad Serra (1969), larvae, juveniles, or even adults of *P. segnis* could be inadvertently translocated by ships from the abundant populations of the eastern and central Mediterranean sectors up to new areas. Nevertheless, new introductions from the native areas are also possible.

Even if direct observations are missing, the hypothesis of ship transport was also advanced to explain the capture of a single specimen in the Livorno harbor (Crocetta 2006). This also applies to the larvae of the *P. pelagicus* complex recorded in the Tigullio Gulf (Pessani and Salton 1998), not far from the Genova harbor, one of the largest commercial ports of the Mediterranean.

Shipping is the most likely pathway of introduction for more than half of the species introduced in European Seas and 40% in the Mediterranean, and 127 NIS were supposed to be introduced by shipping into the Adriatic Sea (Slišković et al. 2021).

Ship transport can significantly contribute to the connectivity between coastal regions (Costello et al. 2022) and it typically allows the primary or secondary dispersal of many aquatic invaders worldwide (Sieracki et al. 2014). Efforts to control this vector in the global Ocean, are governed by the "International Convention on the Control and Management of Ships' Ballast Water and Sediment" (hereafter the BWM Convention), adopted by

the International Maritime Organization in 2004 (see IMO 2022). The BWM Convention entered into force on 8 September 2017, with 67 ratifying states (Outinen et al. 2021). Despite this global effort, recent predictions integrated with global climate change projections and shipping-mediated invasion models, forecast an increase of 3- to 20-fold in global invasion risk by 2050, mostly due to global growth of maritime traffic (Sardain et al. 2019).

Current strategies to reduce the risk of harmful invasions in marine systems require a thorough understanding of the factors which may facilitate their spread and further studies, especially molecular analyses, are certainly needed to clarify the origin of these disjointed records and the patterns of secondary dispersal for the blue swimming crab in the Mediterranean Sea. We should also consider the possibility of multiple and independent introductions of this species, which could contribute to the success of this invasion through both genetic and demographic mechanisms (Roman and Darling 2007), as illustrated in many aquatic invaders worldwide.

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Authors' contribution

FG was contacted by the fisher, collected the *P. segnis* specimen and preserved it frozen; CF performed the morphological and taxonomic analyses on the *P. segnis* specimen, EA drafted a first version of the MS, All the authors equally contributed in writing the paper.

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