

The invasive crab *Percnon gibbesi* (Crustacea: Decapoda: Plagusiidae) is spreading in the Aegean and Ionian Seas

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Percnon gibbesi is an opportunistic feeder, feeding primarily on algae, of the shallow infra-littoral rocky shores. It was first observed in 1999 in the Mediterranean Sea and has rapidly spread since then. The range expansion of the species in the Aegean and Ionian Seas was recorded and evidence of its further establishment in Greek waters was provided. Established populations were observed in areas where it had not been previously reported: the Saronikos Gulf (central Aegean Sea), Chios Island (central Aegean Sea), Milos Island (central Aegean Sea), Zakynthos Island (central Ionian Sea) and Syvota (north-eastern coast of the Ionian Sea). The species was also observed in new sites in the Messiniakos Gulf, Crete and Rhodes Island, where it had been previously reported. The species keeps spreading in the Mediterranean Sea with a high rate of expansion.

Keywords: alien, decapoda, *Percnon gibbesi*, Greece, Mediterranean Sea

Submitted 29 October 2009; accepted 6 January 2010

INTRODUCTION

The Mediterranean Sea is one of the regions most severely affected by alien marine invasions, fostered by the opening of the Suez Canal, intense shipping (resulting in the transportation of species by fouling and ballast waters), aquaculture, and aquarium trade (Streftaris *et al.*, 2005; Galil, 2009). At least 947 alien taxa have been reported in the Mediterranean Sea until October 2009, of which 521 are considered to be established and spreading (Zenetos *et al.*, 2009a). Many of the marine alien species exhibit aggressive invasive behaviour, leading to alterations in ecosystem functioning, biodiversity loss, and negative impact to human activities such as fisheries, tourism and aquaculture (Streftaris & Zenetos, 2006).

In the Aegean and Ionian Seas, there is an uncontested increase of alien marine species during the last decades (Çinar *et al.*, 2006; Pancucci-Papadopoulou *et al.*, 2006). For most of them the geographical range keeps expanding: this phenomenon could be attributed both to the presence of empty ecological niches and to global warming (tropicalization scenario: Bianchi, 2007; Occhipinti-Ambrogi, 2007). Twenty-two alien marine crustaceans have been reported in the Greek waters of the Aegean and Ionian Seas, of which seventeen are

decapods; among them 9 species (53%) can be considered as established in the Greek Seas (Zenetos *et al.*, 2009b). Most of the alien decapods in Greece have been encountered only in the south-eastern part of the Aegean Sea, their occurrence decreasing substantially northwards and westwards (Pancucci-Papadopoulou *et al.*, 2005; ELNAIS, 2009).

Percnon gibbesi (H. Milne-Edwards, 1853) is a primarily algivorous crab of the shallow infra-littoral rocky shores. It is a widely distributed species, its range extending from California to Chile, Florida to Brazil, and Madeira to the Gulf of Guinea (Manning & Holthuis, 1981). It was first observed in the Mediterranean Sea in 1999 in Linosa Island, Sicily Strait (Relini *et al.*, 2000). Since then its population in the Mediterranean Sea has expanded rapidly and is now considered as the most invasive decapod species introduced into the Mediterranean basin (Thessalou-Legaki *et al.*, 2006; Yokes & Galil, 2006). It has the ability to get established in large numbers in both anthropogenically impacted areas, e.g. close to ports, and in natural habitats (Cannicci *et al.*, 2006; Thessalou-Legaki *et al.*, 2006).

In Greece, it was first observed (in March 2004) on the north-eastern coast of Messiniakos Gulf (south Ionian Sea) (Thessalou-Legaki *et al.*, 2006) and was subsequently (in 2005) found in Crete, Antikythira and Rhodes Island (Cannicci *et al.*, 2006; Thessalou-Legaki *et al.*, 2006). The present study records the subsequent range expansion of this species in the Aegean and Ionian Seas and provides evidence of its further establishment in Greek waters.

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MATERIALS AND METHODS

Presence/absence surveys were conducted at a large number of coastal sites in the Saronikos Gulf (central Aegean; 54 sites), National Marine Park of Zakynthos Island (central Ionian; 40 sites), and Chios Island (central Aegean; 14 sites) (Figure 1). The sampling sites were randomly distributed in each sub-area after excluding sandy coasts. In the Saronikos Gulf and Zakynthos Island, transects of 200 m length were defined along the coastline with the use of a diving reel and were surveyed with snorkelling during standardized 20-minute dives. In Chios Island, standardized one-hour transects (of various lengths) along the coastline were surveyed. The surveys were conducted during July–August 2009 in the Saronikos Gulf, in August 2009 in Chios Island, and during September–October 2009 in Zakynthos Island. During these surveys, the presence/absence of *Percnon gibbesi* was recorded.

Further to these surveys, other observations not published in the scientific literature (personal observations by the authors, personal communications, and information available in grey literature or websites and documented by photographs or specimens) of *P. gibbesi* in other sites of Greece were compiled. The personal observations by the authors were made by chance during surveys for other purposes in the last two years.

RESULTS

Percnon gibbesi was found in four sites in the Saronikos Gulf (7.4% of the surveyed sites), in two sites in Chios Island (14% of the surveyed sites) and in 27 sites in Zakynthos Island (67.5% of the surveyed sites). The species seemed to be very well established in the National Marine Park of Zakynthos Island as it was highly abundant, widely spread throughout the study area, and represented by a noticeable number of ovigerous females and juveniles. *Percnon gibbesi* was also observed by the authors in three sites in Rhodes (March 2009), two sites in Crete (June–July 2008), and one site on the north-eastern coast of the Ionian Sea (Syvota) (October 2008). Furthermore, its presence was documented in Milos Island (central Aegean) (Th. Balaskas, personal communication) and from additional sites in the Messiniakos Gulf and adjacent areas (G. Psaltis, personal communication) in respect to those previously reported in Thessalou-Legaki *et al.* (2006).

Percnon gibbesi was observed in many different types of rocky substrate, varying from straight cliffs on the sea side to gentle sloped pebble coasts. The highest densities were generally observed in areas with boulders, either natural or artificial near marinas. For example, its abundance was extremely high in some of the sites of south Zakynthos Island, at

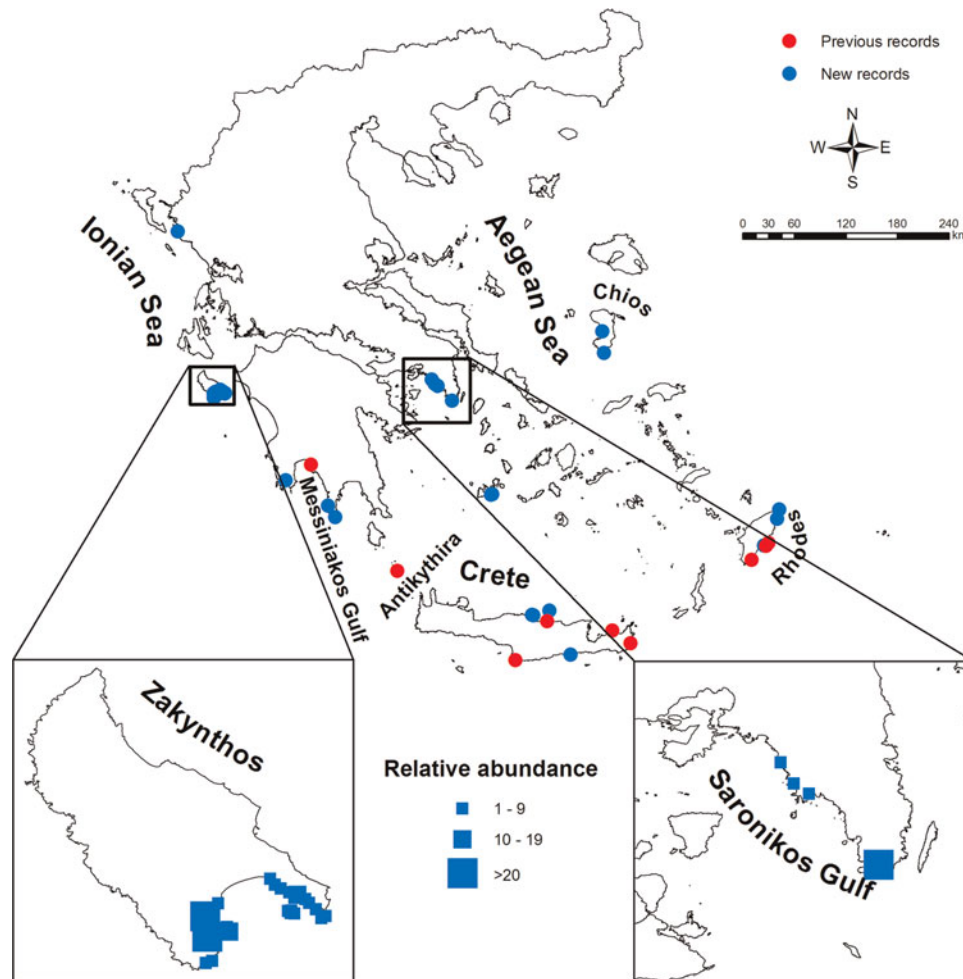


Fig. 1. Records of *Percnon gibbesi* presence in the Greek waters of the Aegean and Ionian Seas. In the cases of the Saronikos Gulf and the south Zakynthos Island, the size of the bullet indicates relative abundance, i.e. recorded individuals during standardized 200-m transects.

shallow rocky coasts with gentle slopes paved with boulders and medium size stones. Vegetation coverage of occupied habitats was generally poor. However, it included both early successional filamentous green and brown algae such as *Cladophora* and *Sphacelaria*, as well as late successional species such as *Corallina*, *Lithophyllum* and *Palmophyllum crassum* (Naccari) Rabenhorst. Most individuals were found at depths between 0.5 and 2 m, although a maximum depth of occurrence of 8.5 m was observed in Zakynthos Island.

The species presented a highly cryptic behaviour hiding under cracks and crevices, in either artificial or natural hard substrates. In the presence of the observers the crabs quickly retreated into their crevice. Only occasionally, specimens were observed feeding close to the indigenous grapsid crab *Pachygrapsus marmoratus* (Fabricius, 1787).

In general, *Percnon gibbesi* tended to exhibit a very patchy distribution and aggregated in groups of more than two individuals. In most of the surveyed locations, groups of individuals were observed close together, grazing tufted and crustose algae that grow on the rocks. However, in Chios Island only one individual was found in each of two sites. The scarcity of the species in Chios Island probably indicates a quite recent arrival of the species in the island, which is the northernmost site of presence of the species in the Aegean Sea as recently suggested also by Crocetta & Colamonaco (2008) for the northern Gulf of Taranto.

DISCUSSION

After its first record in Linosa Island (Sicily) in 1999 (Relini *et al.*, 2000), *Percnon gibbesi* was observed in several central and western Mediterranean sites, rapidly reaching part of the eastern Mediterranean too (Garcia & Reviriego, 2000; Müller, 2001; Pipitone *et al.*, 2001; Bellantoni & Corazza, 2002; Borg & Attard-Montalto, 2002; Galil *et al.*, 2002; Mori & Vacchi, 2002; Cannicci *et al.*, 2004; Catalano, 2004; Deudero *et al.*, 2005; Russo & Villani, 2005; Cannicci *et al.*, 2006; Thessalou-Legaki *et al.*, 2006; Yokes & Galil, 2006; Faccia & Bianchi, 2007; Sciberras & Schembri, 2007; Crocetta & Colamonaco, 2008; Elkrwe *et al.*, 2008; present study). Thus, the present occurrence in the Mediterranean seems to extend in a geographical zone of middle latitudes leaving out the Adriatic Sea (Kirinčić & Stevčić, 2008;

C. Froglija, personal communication), the Ligurian Sea, the Corsica Island, the Alboran Sea, and most of the African coasts (with the exception of its finding in Al Haniyah, Lybia (Elkrwe *et al.*, 2008) and in Zembra and Zembretta Islands in Tunisia (MedMPA, 2004)), and the far eastern Mediterranean shores (Figure 2). Nevertheless, its absence from these areas cannot be definitive, as it is suggested that many other invaded locations still remain unreported, and with such an expansion rate, the species outruns the reports.

It is difficult to reach definite conclusions on the means of initial arrival of *Percnon gibbesi* in the Mediterranean Sea since different authors speculate different vectors. It could be either through shipping (Galil *et al.*, 2002) or by larval drift by currents (Pipitone *et al.*, 2001; Abelló *et al.*, 2003). However, its further spreading in the Mediterranean basin seems to be primarily via larval transport by currents, although fishing and recreational vessels may also contribute to its dispersal (Cannicci *et al.*, 2006; Thessalou-Legaki *et al.*, 2006; Crocetta & Colamonaco, 2008). Ovigerous females have been observed in most sites of the species occurrence in the Mediterranean Sea (e.g. Balearic Islands: Deudero *et al.*, 2005; Sicily: Deudero *et al.*, 2005; Rhodes: Thessalou-Legaki *et al.*, 2006; southern Turkey: Yokes & Galil, 2006; Malta: Sciberras & Schembri, 2007; Libyan coast: Elkrwe *et al.*, 2008; Zakynthos: present study). The wide distribution of breeding populations in the Mediterranean Sea suggests that the prevailing environmental conditions favour its reproduction, settlement and establishment, and that the species is currently expanding its range in the Mediterranean Sea by natural dispersal.

Percnon gibbesi appears to be an opportunistic feeder, feeding primarily on algae, including a wide variety of algal meals, such as filamentous algae, calcareous algae, corticated macrophytes, and foliose algae (Puccio *et al.*, 2006), but also on animal food such as pagurids, polychaetes, gastropods, crustaceans and jellyfish (Cannicci *et al.*, 2004; Deudero *et al.*, 2005; Sciberras & Schembri, 2008). The vast availability of food in the upper infralittoral zone and the flexibility of *P. gibbesi* in feeding, the high fecundity of the species, the large duration of the larval phase (Paula & Hartnoll, 1989), and the exceptionally large megalopa from which a robust first crab stage is produced (Hartnoll, 1992) are some of the reasons explaining the rapid spreading of the species in the Mediterranean Sea.

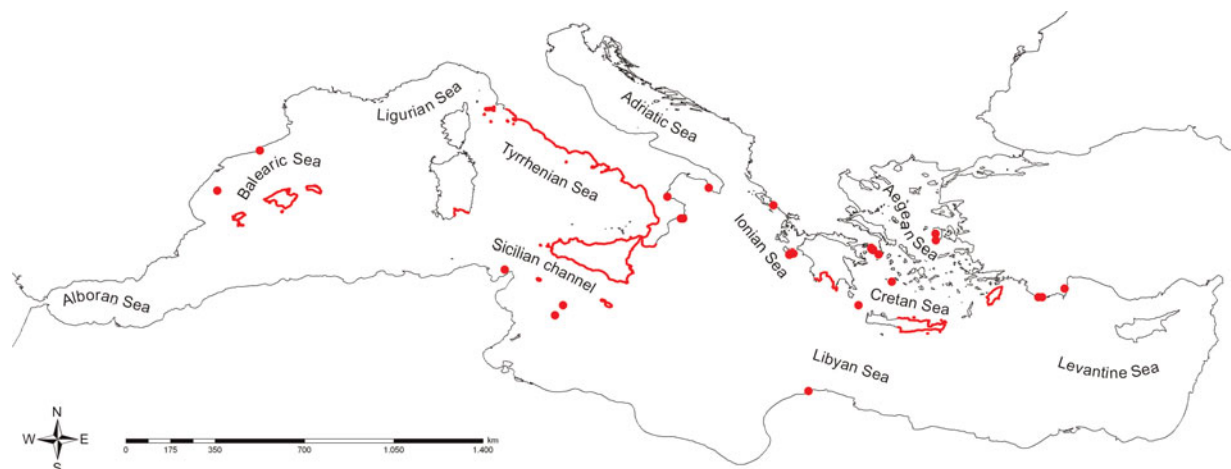


Fig. 2. The distribution of *Percnon gibbesi* in the Mediterranean Sea based on published records until October 2009.

According to the present study, the species has already reached the central parts of the Aegean Sea and the entire Ionian Sea. The species is expected to keep spreading in the Mediterranean Sea, and if the current rate of expansion continues, it will soon be abundant throughout this area.

ACKNOWLEDGEMENTS

Data from Zakynthos were collected during the project 'Survey of the Marine Benthic Fauna in the National Marine Park of Zakynthos', funded by the EU and national sources (coordinator: M.T.-L.). An anonymous referee made useful comments that helped to improve the quality of this manuscript.

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