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Research Article

Gonioinfradens paucidentatus (A. Milne Edwards, 1861) (Crustacea, Decapoda, Portunidae): a new alien crab in the Mediterranean Sea

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Abstract

The first record for the Mediterranean Sea of the Red Sea/Indo-Pacific portunid *Gonioinfradens paucidentatus* (red swimming crab) is documented. A detailed description of the specimens collected at Rodos Island (southeastern Aegean Sea) is given, while possible introduction vectors of the species in the area are discussed

Keywords: Mediterranean Sea; SE Aegean Sea; Brachyura; Portunidae; Introduction; Alien.

Introduction

Southeastern Aegean coasts are considered a crucial region for the arrival, establishment and spread of alien species, in particular warm-water species of Indo-Pacific origin (CORSINI-FOKA, 2010; cfr ELNAIS 2010). The Dodecanese Islands belong to the biogeographic region of the Mediterranean named by POR (1990) the 'Lessepsian Province' and they are considered to be a hot-spot area for the spread of alien species to the European Mediterranean coasts. A huge increase in alien species' introductions has been observed during the last three decades. The lowering of the salinity in the Suez Canal seems to play an important role in this ongoing process in the whole Eastern Mediterranean area (POR, 2010). Moreover, the remarkable increase in alien species in the Southeastern Aegean Sea has also paralleled the observed warming of the area, which is creating more favourable conditions for the establishment of exotic species (PANCUCCI-PAPADOPOULOU *et al.,* 2009; PANCUCCI-PAPADOPOULOU & CORSINI-FOKA, 2010).

Gonioinfradens paucidentatus (A. Milne Edwards, 1861) is a portunid crab

with a wide Indo-Pacific distribution: the Red Sea (SPIRIDONOV & NEUMANN, 2008), the Persian Gulf (Arabian and Iranian coasts, Gulf of Oman), the East African coast, Madagascar, Western Indian Ocean islands, Australia, New Caledonia, French Polynesia, Japan, Hawaii (POUPIN, 1994, 2007, 2008; APEL & SPIRIDONOV, 1998; DAVIE, 1998; APEL, 2001; NADERLOO & SARI, 2007). It occurs mainly on hard substrate from shallow subdital waters to 100 m of depth and reaches a carapace length of 52.5 mm (POUPIN, 1994).

The aim of the present work is to report the presence of *Gonioinfradens paucidentatus* from Rodos Island (Dodecanese, Southeastern Aegean Sea) as the first record of the species for the whole Mediterranean Sea and to discuss its possible introduction vectors in the study area.

Material examined

Three males of *Gonioinfradens paucidentatus* were caught along the eastern coasts of Rodos Island (Fig. 1); the first two specimens were observed during snorkel-

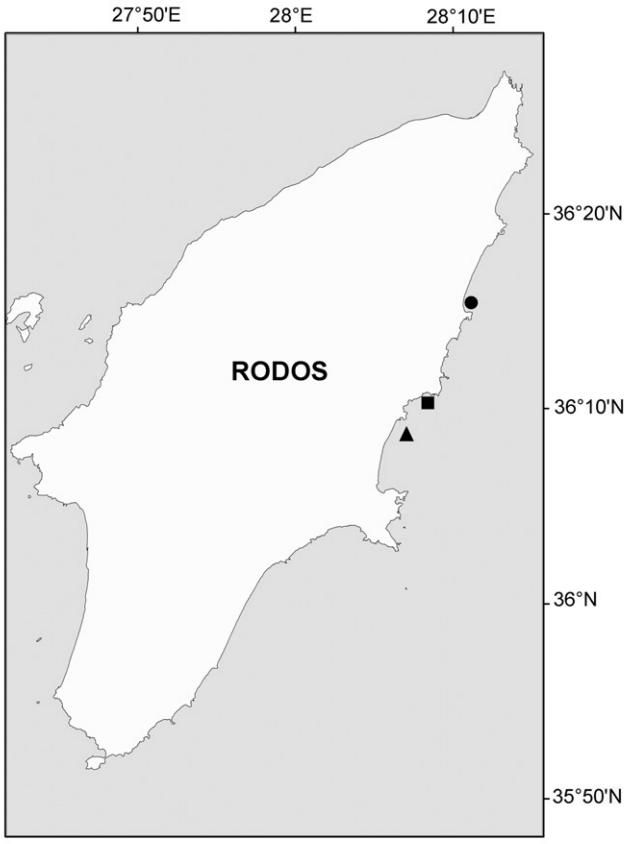

Fig. 1: Sampling locations of *Gonioinfradens paucidentatus* at Rodos Island, Southeastern Aegean Sea (●: Kolimbia; ■ Agathi; ▲ Haraki).

ing and collected by hand, while the third was captured in fishing pot. The first sample (specimen 1) was found on 1 May 2010 in a crevice between sand and rock at 15 m of depth (seawater temperature 19° C), at Kolimbia; the second (specimen 2) was collected on 28 May 2010 from sandy-rocky bottom at 15 m of depth (seawater temperature 20° C), at Agathi; the third (specimen 3) was caught on 27 June 2010 on biogenic detritus at 200 m of depth, off Haraki (Fig. 1). Specimen 1 was damaged (it lacked the right cheliped, the first and second right walking legs and the left swimming leg) and it is now preserved in alcohol (Catalogue number HSR53). Specimens 2 and 3 were delivered alive (specimen 2 lacked the first left walking leg) and they are now deep-frozen at -22° C (respective Catalogue numbers HSR54 and HSR58).

Identification of specimens was performed following APEL & SPIRIDONOV (1998). LEENE (1938), CROSNIER (1962), POUPIN (1994, 1996, 2007) and SAKAI (2004) were also consulted.

Description

Carapace hexagonal, length 1.27-1.37 times in carapace width, front 2.68-2.75 in carapace width and 2.01-2.12 in carapace length (Table 1). Front with six teeth, the median and submedian ones truncate, the lateral ones triangular with rounded tips and separated from the previous by a deeper groove. Four large acute anterolateral teeth, the first more rounded, the last spiniform; there are also two accessory denticles, positioned respectively at the base of the external border of the first and

Table 1
Measurements (mm) of *Gonioinfradens paucidentatus* male specimens caught at Rodos Island in May and June 2010.

Measurements	Specimen 1	Specimen 2	Specimen 3
Carapace length	29.2	30.1	31.9
Carapace width	37.0	39.2	43.8
Frontal margin (=Front)	13.8	14.4	15.9
Fronto-orbital width*	28.5	30.0	31.5
Orbital cavity diameter	5.9	6.2	6.8
Posterior margin of carapace	12.2	12.5	13.2
Left chela length	26.9	28.1	30.0
Left chela height	10.7	11.5	11.8
Right chela length	-	27.1	31.0
Right chela height	-	10.0	14.4
Left cheliped length**	53.8	54.4	60.3
Right cheliped length**	-	52.8	60.2

* distance between external orbital angles

** maximum opening

second teeth, the second denticle very small, better distinguishable in specimens 3, more reduced in specimens 1 and 2 (Fig. 2A); furthermore, an inconspicuous tubercule between the third and fourth antero-lateral teeth in specimen 3. Carapace smooth, granular lines on frontal, protogastric and mesogastric regions, epibranchial line interrupted at the cervical groove and across midline. Postero-lateral junctions rounded. Antennal flagellum excluded from orbit. Basal antennal article with a strong spine. Chelipeds: merus with 3 strong spines on the anterior border, carpus with a strong interior spine and three smaller spines on the outer face; chela bearing two large spines on the superior surface and two other marginal and smooth spines near the movable finger (Fig. 2A), a single spine at carpus articulation, lower surface smooth. Swimming leg: merus with a subdistal posterior spine, propodus with a row of 7 spinules on posterior border followed by 1-2 small tubercule-like protuberances in specimens 1 and 2, a single row of 8 spinules in specimen 3. Distal part of first male pleopod tubular, with short bristles proximally, on the lateral external surface.

Colour in life (specimen 2): Carapace reddish-brown dorsally with sparse darker

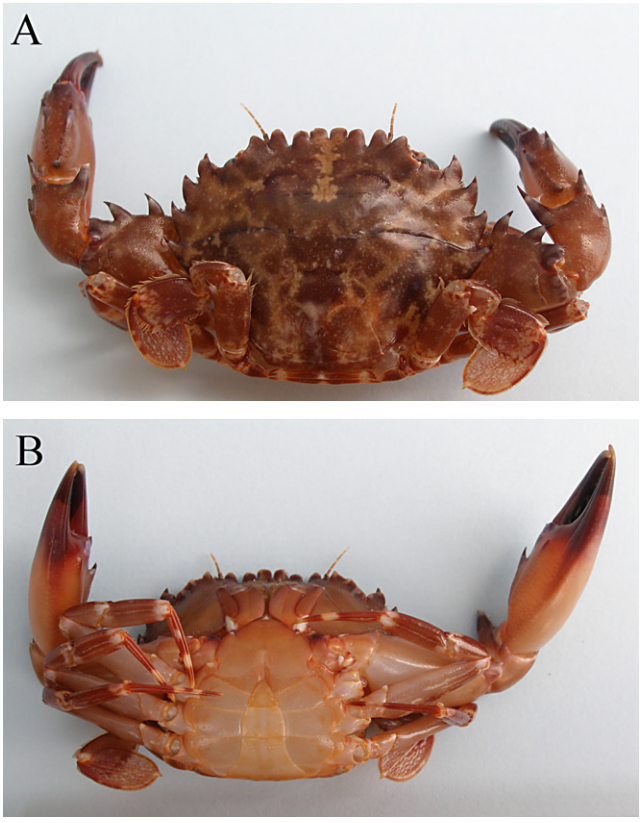

Fig. 2: *Gonioinfradens paucidentatus* (specimen 2, male, color in life, carapace length 30.1 mm) collected at Haraki, Rodos (**A:** dorsal view, **B:** ventral view).

shades, apart from a longitudinal whitish shade from the front to the mesogastric region, yellow-orange ventrally (Fig. 2A, B); chelipeds reddish externally, yellow-orange internally, fingers dark brown; walking legs reddish with yellow bands. Tips of anterolateral teeth, spines of chelipeds and merus of 5th pereiopod dark brown, preceded by a whitish band.

Discussion

APEL & SPIRIDONOV (1998) recognized full generic status in *Gonioinfradens* Leene, 1938, and separated it from *Charybdis* De Haan, 1833, followed in this by all subsequent authors (NG *et al.,* 2008). *Gonioinfradens* includes only one species, *G. paucidentatus.* The presence of only four large anterolateral teeth allows *Gonioinfradens* to be easily distinguished from all the other subgenera retained in *Charybdis* (CROSNIER, 1962; APEL & SPIRIDONOV, 1998), namely *Charybdis, Goniohellenus, Gonioneptunus* and *Goniosupradens.*

The present first report of the species in the Mediterranean comes with a series of question marks. The origin of the Rodos specimens has to be clarified. Indeed, POUPIN (1994) asserts: «*Les spécimens polynésiens se distinguent du matériel de la côte d'Arabie par la quasi disparition de la troisième plus petite épine antérolatérale, qui n'est repérable, dans le meilleur des cas, que par un tubercule, et par la hauteur plus faible de la paume*». In the specimens from Rodos, the third small denticle between third and fourth anterolateral teeth is absent or reduced to a tubercule. Consequently, the origin of the Rodos specimens (Red Sea and/or Indo-Pacific area) should be ascertained through further comparisons with samples from different areas of the native range of the species, including genetic analyses.

The second point to be mentioned is its depth distribution. Erythrean alien invertebrates establish successfully in the littoral and infralittoral zones of the eastern Mediterranean to a depth of approximately 50 m, and are hardly ever found in deeper waters, according to GALIL & ZENETOS (2002); to date, this was true also for the majority of the brachyurans of Indo-Pacific origin recorded in the marine region of Rodos, although a few species, like *Charybdis (Goniohellenus) longicollis* Leene, 1938, could occur in deeper waters up to 80 m (KEVREKIDIS & GALIL, 2003; ELNAIS 2010). In our case, the third specimen of *G. paucidentatus* was found at 200 m. The species is considered to inhabit coastal waters, even though it has been reported from Polynesia at up to 100 m (POUPIN, 1994). Its being found at a depth even higher than that known in its native range (100 m), could open new horizons concerning our knowledge about the ability of certain alien species to colonize the Mediterranean coasts, also widening their possible distribution range to deep waters.

Considering the present record, alien brachyurans in the Mediterranean today account for 46 species, as at least three more species must be added to the CIESM Atlas list (GALIL *et al.,* 2002 updated on 2008), namely *Sirpus monodi* Gordon, 1953 (PANCUCCI-PAPADOPOULOU & NALETAKI, 2007), *Charybdis lucifera* (Fabricius, 1798) (MIZZAN & VIANELLO, (2008) 2009) and *Eurycarcinus integrifrons* (ÖZCAN *et al.,* 2010).

Among the alien brachyurans, represented in the Mediterranean Sea by 21 families, 11 are of Atlantic origin (24%) and 35 of Indo-Pacific origin (76%). The

most successful families in colonization of the Mediterranean coasts are Portunidae (12 species), Pilumnidae and Epialtidae (5 and 4 species respectively), Leucosiidae and Calappidae (3 species each one), in agreement with BROCKERHOFF & MCLAY (2008).

Concerning Hellenic waters and including the present record, exotic brachyurans account today for 15 species: 11 of Indo-Pacific origin and 4 of Atlantic origin (ZENETOS *et al.,* 2009; PANCUCCI-PAPADOPOULOU *et al.,* 2010; CORSINI-FOKA & PANCUCCI-PAPADOPOULOU, 2010). Most of them occur off Rodos (two of Atlantic origin and all the 11 species of Indo-Pacific origin) where 77% of them were first recorded, mainly during the last decade. Portunids predominate with 7 species (6 Indo-Pacific, 1 Atlantic), followed by leucosiids (3 species), and finally by plagusiids, xanthids and macrophthalmids, each with one species. All these alien crabs are actually established along the coast of the island, including the latest one recorded, *Atergatis roseus* (Rüppell, 1830) (CORSINI-FOKA & PANCUCCI-PAPADOPOULOU, 2010), as two more adult males (carapace length 58-61 mm) were caught in May 2010 (Authors pers. comm.).

The 10 crab species of Indo-Pacific origin previously recorded from Rodos were introduced via the Suez Canal, according to GALIL *et al.* (2002 updated on 2008) and ZENETOS *et al.* (2009), while the vector of introduction of *G. paucidentatus* is an unclear point.

For the time being, we do not know if collected specimens represent only a local population or if the species is present along other coasts of the Levantine basin, but not yet detected. Due to the significant distance of the sampling location (Rodos Island) from the Suez Canal, it is hard to hypothesize that the introduction into the Mediterranean of this new alien is the result of Lessepsian migration. Moreover, although it is a widespread species in its native range, no bibliographic reference could be found for its occurrence in the Suez Canal. Nevertheless, even though not yet detected in other sites, the counter-clockwise circulation in the Levantine basin could have favoured the propagation of the planktonic stages of the species (BEN RAIS LASRAM *et al.,* 2008) up to Rodos, as already discussed for *Tylerius spinosissimus* (Regan, 1908), an Indo-Pacific tetraodontid, unknown in the Red Sea, which to date occurs only in the specific study area (GOLANI *et al.,* 2006 online; CORSINI-FOKA *et al.,* 2010).

Shipping is considered to be one of the most important introduction vectors of exotic species in the Mediterranean, and the second most important in Greek waters (ZENETOS *et al.,* 2009; PANCUCCI-PAPADOPOULOU & CORSINI-FOKA, 2010). According to ABELLÓ & HISPANO (2006) the most probable vector of the introduction into the Western Mediterranean of another Indo-Pacific portunid, *Charybdis feriata* (Linnaeus, 1758), is shipping, probably due to 'an accidental escape from holding tanks of live specimens'. It has however to be noted that *Charybdis feriata* is a species of high commercial value and the unique specimen observed in the wild was found in the vicinity of Barcelona, one of the most important international ports in the Mediterranean. Transport in ballast is supposed the most likely vector of introduction into the eastern Mediterranean of the alien *Eurycarcinus integrifrons* De Man, 1879, a pilumnid native to the Red Sea-Indian Ocean and recently first recorded

in an area subjected to intense industrial shipping traffic, Iskenderun Bay, Turkey (ÖZCAN *et al.,* 2010). Rodos, on the other hand, is a tourist area, and international maritime traffic in its relatively small harbour is mainly represented by cruise ships. However, large commercial ships (tankers and cargos) travel along trade routes in the open sea, offshore of the island. Ballast waters could offer suitable conditions for the survival of the eggs and/or larvae of the red swimming crab, while young individuals could survive in ballast sediments. This has been ascertained for other aliens, including some crabs, introduced into various marine ecosystems all over the world (GALIL *et al.,* 2008; MINCHIN *et al.,* 2009), as it has been assumed for the above-mentioned recent introduction of *E. integrifrons* into the Eastern Mediterranean. Also the sea-chests of ships could be taken into consideration as a possible means of introduction of the species, as thoroughly discussed in SCHEMBRI *et al.* (2010) in relation to the finding of the exotic fish *Oplegnathus fasciatus* (Temminck & Schlegel, 1844) in Malta.

Concerning aquaculture, only native fish are currently cultured in cages, while a land-based farm operated up to 2008 in the south of Rodos, both activities being carried out under the supervision and control of the Ministry of Agriculture and strictly following the rigid EU and national procedures and legislations. Therefore, accidental introduction of *Gonioinfradens paucidentatus,* a medium sized species without commercial value, or of its eggs and/or larvae, through transport by ship for aquaculture purposes seems very improbable.

Data on local pet-shops and home aquaria are not available, but import of exotic organisms is also subjected to rigorous international law, and the red swimming crab is not listed among the species traded for tropical aquaria purposes.

Even if all the above vectors appear somewhat biased to explain the first occurrence of *G. paucidentatus* in Rodos, the collecting of three adult specimens in a very short time and from different sites and depths suggests the already establishment of this new alien crab. Its presence in the area could have been overlooked, both because underwater identification at 15 m depth on hard substrate is difficult and also because, being not commercially exploited, it is probably discarded in fishery. Consequently, it is difficult to evaluate the exact time of its introduction into the water off Rodos and the Mediterranean as a whole.

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