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New records of *Albunea carabus* (Linnaeus, 1758) (Decapoda: Anomura: Hippoidea) in the Tyrrhenian Sea, with notes on its ecology and distribution in the Italian seas

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Abstract

Twenty-four individuals of *Albunea carabus* (Linnaeus, 1758), a species rarely reported in the Mediterranean Sea, have recently been collected in the Tyrrhenian Sea (Italy) in hydraulic dredge surveys carried out to assess local razor clam stocks. They were found in sandy bottoms at depths of 1–6 m in association with the commercial bivalves *Ensis minor* and *Chamelea gallina* and the decapods *Diogenes pugilator*, *Portunus latipes* and *Liocarcinus vernalis*. The distribution of the species in the Italian seas is described based on a careful search of the available records. Notes on its reproductive biology and autoecology are also included.

Keywords: *Albuneidae*, *Albunea carabus*, *Mediterranean Sea*, *new records*, *autoecology*

Introduction

Albunea carabus (Linnaeus, 1758) is the sole species of the family Albuneidae recorded in the Mediterranean Sea, even though fossil records of the genus *Albunea* in Italy date back to the Eocene (Beschin & de Angeli 1984). The species has albeit seldom been recorded in the Mediterranean Sea from the Alboran Sea (western Mediterranean) (Zariquiey Álvarez 1961) to the Levant Sea (eastern Mediterranean) (Aharoni 1937; Corsini-Foka & Kalogirou 2013) and in the eastern Atlantic from the Algarve (Portugal) (Pereira et al. 2008) to the Gulf of Guinea (Boyko 2002).

In August 2016, a specimen was collected in the Gulf of Salerno (Tyrrhenian Sea) during a hydraulic dredge survey, conducted by our research group to estimate the status of razor clam, *Ensis minor* (Chenu, 1843) stocks. Given the rarity of the find, photographs of the specimen were circulated to professional clam fishers to ask whether they had already encountered the species. We learned that *A. carabus* is locally called “fortunato” (lucky in Italian), because of the

fishers’ belief that kissing and returning to the sea live specimens found in the catch will secure a good clam catch in the near future. Publication of the finding was postponed in hopes that scheduled surveys, soon to be conducted along the Tyrrhenian coast, would provide additional specimens. In the meantime, an accurate search was conducted for published records of the species in the Italian seas and for specimens held in the Decapod collections of some Italian museums.

We report all these new records of *A. carabus*, review the published records in the Italian seas, some of which had been overlooked in previous reviews, and provide some notes on its biology and ecology.

Materials and methods

Scientific surveys, conducted to assess razor clam stocks in the southern Tyrrhenian Sea, were carried out in 2016 and 2018 using professional vessels equipped with a hydraulic dredge (Lucchetti et al. 2016; Vasapollo et al. 2020). Hydraulic dredges like those used in our

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surveys consist of a metal cage, 3 m in width, whose walls are made of metal rods spaced 7 mm apart; the dredge is mounted on two lateral sledge runner skids to control digging into sediment (7–15 cm for razor clam). A hose connected to the vessel supplies pressurized water to a series of nozzles. The lower front of the cage is fitted with a scraper blade with nozzles oriented forward; water ejected through the nozzles fluidizes the sand and dislodges the marine organisms living in sediment, facilitating their collection. Another series of nozzles, placed under the roof of the dredge and oriented downward and backward, have the function of washing out sand and smaller organisms, facilitating towing of the gear. At the end of the tow, the dredge is hauled on board, its content is dropped into a collecting box and clams are hand-picked (Lucchetti & Sala 2012). In our surveys, a sampler consisting of a rectangular steel frame (40 cm long, 18 cm high) with an attached net bag (stretched mesh size, 14 mm), was fitted to the front of the dredge to collect undersize razor clams and the associated fauna, which are seldom retained by the dredge.

Forty-four stations were sampled in the Gulf of Salerno in 2016. The whole sampler catch was frozen and subsequently sorted in the laboratory, where the first specimen of *A. carabus* was picked and identified according to the key and descriptions in Boyko (2002). The further dredge surveys, conducted in 2018 from the mouth of the Tiber River to the southern part of the Gulf of Salerno to investigate the density of razor clams, involved sampling of 57 stations at a depth of 1 to 5 m. The whole catch of the dredge was examined for *A. carabus* specimens while hand-picking the commercial size razor clams. There were 24 *A. carabus* specimens, which were refrigerated and taken to the laboratory. Here they were sex-sorted according to gonopore position and pleopod morphology and measured for carapace length (cl), i.e., the distance from the tip of the rostrum to the midpoint of the posterior concavity of the carapace. Unless otherwise stated, all specimens, stored in 80% ethanol, have been deposited in the collection of the Museo civico di Storia naturale in Verona under catalog numbers of the first author's collection that includes another specimen collected in the past with the same fishing gear.

The search of the catalogs at the Museo regionale di Scienze naturali in Torino and the Museo civico di Storia naturale in Milano failed to locate any specimen, whereas two specimens are present in the collections of the Museo di Storia naturale dell'Università in Firenze, MZUF (G. Innocenti, pers. comm.), and another one is kept in the private exhibit of the Museo della Vita nelle Acque in Russi (RA) (R. Gattelli, pers. comm.).

Results

Systematics

Order DECAPODA Latreille, 1817
 Family ALBUNEIDAE Stimpson, 1858
 Genus *Albunea* Weber, 1795
 Species *Albunea carabus* (Linnaeus, 1758)
 (Figures 1–4)

Material examined

Tyrrhenian Sea: Gulf of Salerno (40°24.60'N – 14°51.22'E), 6 m, Aug. 4, 2016, 1 F cl. 19.0 mm (D2110); Gulf of Salerno (40°36.84'N – 14°50.90'E), 3 m, Aug. 30, 2018, night sampling, 5 M cl. 14.4–18.0 mm, 4 F cl. 20.5–24.5 mm (D2113); Gulf of Salerno (2 tows merged) (40°26'N – 14°58'E), 2–3 m, Aug. 30, 2018, 5 M cl. 14.0–17.5 mm, 5 F cl. 19.1–20.8 mm (D2114); off Baia Domizia (41°09.74'N – 13°49.93'E), 2 m, May 9, 2018, 1 F cl. 19.0 mm (D2111); Gulf of Gaeta (41°15.96'N – 13°09.22'E), 2 m, May 6, 2018, 1 F cl. 19.6 mm (D2115); Gulf of Gaeta (41°13.36'N – 13°31.24'E), 1 m, May 6, 2018, 1 F cl. 18.6 mm (D2116); off Torvaianica, 3 m, May 1993, coll. G. Iocca, razor clam hydraulic dredge, 1 F cl. 21.4 mm (D1624); off Torvaianica (41°33.77'N – 12°31.27'E), 3 m, Jun. 26, 2018, 1 F cl. 18.4 mm (CNR-IRBIM Ancona, reference collection).

Ionian Sea: Roccella Jonica, near the mouth of the Barrauca River (38°18.4'N – 16°22.1'E), 5 m, Nov. 21, 2004, coll. A. Martino, in trammel net, 1 M cl. 19.0 mm, preserved dry in the exhibition of the “Museo della Vita nelle Acque” Russi; Gulf of Catania, Feb. 2017, coll. D. Scuderi, stranded ashore, 2 F cl. 17.9–19.6 mm, dried specimens subsequently stored in ethanol (D2112).

Since our specimens (Figure 1) match the detailed descriptions and illustrations provided by Zariquiey Álvarez (1961) and Boyko (2002), no further details are given here.

Albunea carabus was collected at depths of 1.5 to 3 m at 7 (12%) of the 57 stations sampled in 2018, which are characterized by medium-fine sands; coarser fraction was significant only in some station close to the shore. The benthic community associated with *A. carabus* included the commercial bivalves *E. minor* (Chenu, 1843), *Chamelea gallina* (Linnaeus, 1758) and *Donax trunculus* (Linnaeus, 1758), the gastropod *Tritia mutabilis* (Linnaeus, 1758), the echinoderm *Echinocardium cordatum* (Pennant, 1777), the decapods *Diogenes pugilator* (Roux, 1829), *Liocarcinus vernalis* (Risso, 1827) and *Portunus latipes* (Pennant, 1777), and the



Figure 1. *Alburnea carabus*. Specimens caught in a single night tow with hydraulic dredge in the Gulf of Salerno in 2018.

sipunculid worm *Sipunculus nudus* (Linnaeus, 1766). It can be ascribed to the biocoenosis of infralittoral “well-sorted fine sands” as defined by Pérès and Picard (1964).

The literature search found the first mention of *A. carabus* in the Italian seas as *Hippa symnista* (Petagna 1792, pp. 413–414). Petagna followed the systematic arrangement of taxa proposed in “*Mantissa insectorum*” (Fabricius, 1787). Petagna noted that all the species of the genus *Hippa* were exotic except *H. symnista*, which he described with the following diagnosis: “*Thorax semicylindricus, lateribus inaequalibus, auctis spina antrorsum spectante. Margo anticus obtusus, serratus, ciliatus. Antennae, utrinque pilis ciliatae. Cauda articulis sex. Brachia inermia. Manus cordatae, pilose. Pollex subulatus, arcuatus. Pedes octo. Plantae bifidae, ciliatae*”. The description allows Petagna’s *H. symnista* to be identified with the species currently known as *A. carabus*, not with *Corystes cassivelaunus* (Pennant, 1777, Pl. 7), which original figure is quoted in the synonymy of *H. symnista* in the “*Mantissa insectorum*”. Fabricius (1793) subsequently realized to have mixed up two species under the name *symnista* and in the new “*Entomologia Systematica emendata*” he omitted the reference to Pennant in the description of *Hippa symnista* and named Pennant’s species *Hyppa dentata*.

The second mention of *A. carabus* was by Rafinesque-Schmaltz (1814), who reported it as *Alburnea symnista* from Sicily, without precise

locality. Zava et al. (2019) have suggested that it may have been found near Messina.

Only two specimens had been collected near Catania (Philippi 1857, p. 129; Magri 1911, p. 40) until February 2017 when thousands of specimens were found stranded on the beach south of the town (Scuderi et al. 2017, 2019). Additional records from the seas around Sicily have been published by Giacobbe and Spanò (1996), Spanò et al. (1999), Pipitone and Arculeo (2003) and Zava et al. (2019). The species has also been collected in the Gulf of Cagliari (Sardinia) (Mura & Corda 2011). In the eastern Tyrrhenian Sea, where hydraulic dredgers harvest razor clams since the late 1960s, the capture off Formia of four specimens by a dredger was reported by Moncharmont (1969); another specimen, reported in the present study, was caught with the same gear off Torvaianica in 1993.

All the records of *A. carabus* in the Italian seas, including those from our surveys and those in the literature, are summarized in Table I and Figure 2. Possible records based only on photographs, posted online, have not been considered.

Discussion

The range of *A. carabus* includes the eastern Atlantic Ocean, from southern Portugal (Pereira et al. 2008) to the Gulf of Guinea and Macaronesia (Boyko 2002), and the Mediterranean Sea. Rubió and Holthuis (1976), while reporting some new

Table I. Summary of previous publications, in chronological order, and present records of *Albunea carabus* in the Italian seas (estimated geographic coordinates in *italics*).

Year collection	Locality	Latitude	Longitude	Depth	Number	Reference
–	Kingdom of Naples	–	–	–	–	Petagna (1792)
–	Sicily	–	–	–	–	Rafinesque-Schmaltz (1814)
–	Catania, beach	–	–	Stranded	1	Philippi (1857)
–	Bay of Catania	–	–	–	1	Magri (1911)
1969	Off Formia	41°15'N	13°36'E	3–4 m	3 M, 1 F	Moncharmont (1969)
1992	Mortelle (W Capo Peloro)	38°16.7'N	15°36.3'E	5 m	3 M, 1 Fov	Giacobbe and Spanò (1996)
1992	Off Gioia Tauro	38°26.1'N	15°52.8'E	20 m	1 M	Giacobbe and Spanò (1996)
1996	Marinella	37°34.83'N	12°49.73'E	2 m	1 M	Spanò et al. (1999)
1996	Near Porto Scoglitti	36°50.26'N	14°27.13'E	5 m	1 F	Spanò et al. (1999)
1999	Near Castiglione (south of Livorno)	43°25'N	10°24'E	5 m	1 M, 1 F	Silvestri et al. (2001)
–	Gulf of Castellammare	–	–	>10 m	–	Pipitone and Arculeo (2003)
1999–2000	Poetto beach (Gulf of Cagliari)	39°13'N	9°12'E	3 m	Frequent	Mura and Corda (2011)
2017	Bay of Catania	37°28'N	15°05'E	Stranded	Several	Scuderi et al. (2017, 2019)
2000, 2017	Irminio River mouth	36°46.38'N	14°35.07'E	6–8 m	1 M, 1 F	Zava et al. (2019)
2017	Marina di Ragusa	36°46.70'N	14°33.70'E	8 m	1 F	Zava et al. (2019)
1993	Off Torvaianica	–	–	2 m	1 F	Present study
1994	Rio Martino mouth	41°23'N	12°54'E	–	1 M	Present study (MZUF 5070)
1997	Gulf of Cagliari	–	–	–	1 F	Present study (MZUF 4082)
2004	Roccella Jonica	38°18.4'N	16°22.1'E	5 m	1 M	Present study
2016	Gulf of Salerno	40°24.6'N	14°51.22'E	6 m	1 F	Present study
2018	Gulf of Salerno, South	40°26'N	14°58'E	2–3 m	5 M, 5 F	Present study
2018	Gulf of Salerno, North	40°36.84'N	14°50.90'E	3 m	5 M, 4 F	Present study
2018	Baia Domizia	41°09.74'N	13°49.94'E	2 m	1 F	Present study
2018	Gulf of Gaeta	41°15.96'N	13°09.22'E	2 m	1 F	Present study
2018	Gulf of Gaeta	41°13.36'N	13°31.24'E	1 m	1 M	Present study
2018	Off Torvaianica	41°33.77'N	12°31.27'E	3 m	1 F	Present study

collections from the Catalan coast, provided a list of previous Mediterranean records known to them. The list was partially updated by Pereira et al. (2008) and Zava et al. (2019), who reported new captures from the Algarve (Portugal) and southern Sicily, respectively. Most records are based on one or a small number of specimens. Before our Tyrrhenian records, most *A. carabus* specimens in the western Italian seas had been collected at sites around Sicily. The two specimens caught with trammel net in the southern Ligurian Sea (Silvestri et al. 2001) represent the northernmost record in the Mediterranean, since Boyko (2001) provided evidence that *Hippa caerulea* (Risso 1816), described in Nice (France), was based on a gnathid isopod and was not a synonym of *A. carabus*, as suggested by Holthuis (1977). The specimen herein reported from Roccella Jonica (Ionian coast of Calabria) is, to the best of our knowledge, the easternmost record in Italy.

A. carabus does not seem to live in the Adriatic Sea, since no specimen has been collected in over 40 years of extensive sampling of its coastal sandy bottoms with hydraulic dredges targeting razor clam

(Frogliola 1975; Del Piero et al. 1984) and venus clam (Frogliola 2000). One specimen has been reported, without comment, in a study of the stomach contents of poor cod, *Trisopterus capelanus* (Lacepède, 1800) sampled with a bottom trawl net in the eastern Adriatic Sea at a depth of 50–175 m (Dulčić & Dulčić 2004). The small size of the fish (total length <14 cm), the fishing depth, and the difficulty in identifying material at various stages of digestion in stomach contents let us suppose that a misidentification occurred. Indeed, all our samples and most of the literature records are from shallow sandy bottoms (depth <10 m). The deepest record in the literature (50 m) regards a specimen caught in a professional shrimp trap off Rhodes, Aegean Sea (Corsini-Foka & Kalogirou 2013), whereas the specimens on which Lucas (1853) described *Albunea guerini*, a junior synonym of *A. carabus*, were collected at 30–40 m in the Bay of Algiers (southern Mediterranean).

The long antennulae of *A. carabus*, which are almost three times the length of the carapace, bear two rows of plumose setae (Figure 3); when paired, they act as a snorkel, facilitating the flow of water



Figure 2. Records of *Alburnea carabus* in the Italian seas: circles, literature records; stars, present material.

into the branchial chamber while the animal lies buried in sediment (Garstang 1897). This feature allows *A. carabus* to bury quite deep in the sand. This behaviour makes it less vulnerable to the sampling gears used in scientific studies, and probably led to its presumed rarity. The increased number of records in recent years are related to accidental captures by professional fishers who, as in past

centuries, continue to add to our knowledge of marine biota. At least four of the Italian records are based on specimens caught by trammel nets and gill nets, which are commonly set in the evening and retrieved early in the morning. It has been suggested (Zava et al. 2019) that *A. carabus* may be active on the sediment surface during the night and get entangled in the nets. This habit would explain

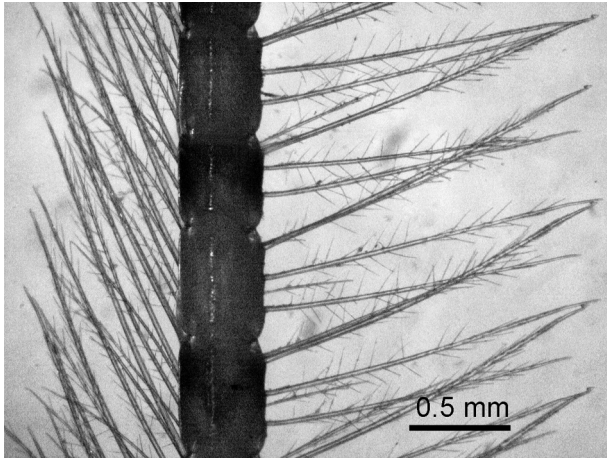


Figure 3. *Albunea carabus*, detail of articles of antennular flagellum with rows of plumose setae.

our catch of nine specimens (density $1/33 \text{ m}^{-2}$) in a single late-night tow, but the capture of the species in only 12% of the sampled stations may also point out a patchy distribution.

Two massive stranding episodes, recorded in March 1954 and February 2017, respectively, in the Bay of Algiers (Piguet 1955) and on a beach in Catania (Scuderi et al. 2017, 2019), indicate that *A. carabus* is actually far from rare in Mediterranean coastal sandy habitats. The two episodes followed heavy rain with flooding of local rivers; on both occasions, stormy seas washed ashore thousands of dead or moribund *A. carabus* specimens, which were probably forced out of the sediment by a local reduction in salinity due to the exceptional river runoff.

Almost no information is available on *A. carabus* reproduction. Ovigerous females seem to be highly elusive. In his monograph, Boyko (2002) mentions a single ovigerous female among the 22 females of *A. carabus* examined in museum collections. The review of all Mediterranean records disclosed only two ovigerous females, collected, respectively, near the strait of Messina in October 1992 (Giacobbe & Spanò 1996) and off the Balearic Islands in June 1987 (Garcia Socias & Gracia 1988). The “ovigerous” female collected near Marina di Ragusa in May 2017, reported by Zava et al. (2019, Figure 2(c)), actually does not carry eggs on the pleopods, but an orange spermatophore mass attached to the sternal region.

In our samples collected in the Gulf of Salerno in August 2018, one female (cl. 20.6 mm) still had some egg envelopes attached to the setae of pleopods, whereas four other females (cl. 19.1–21.1 mm) had a yellowish striated sperm mass attached to the coxae



Figure 4. *Albunea carabus* female (cl. 19.0 mm). Ventral view. Arrow points to the spermatophore mass.

of the 3rd and 4th pairs of pereopods, like the female collected in May 2018 off Baia Domizia (Figure 4). A similar spermatophore-containing structure was described by Subramoniam (1984) in *A. symnista* and has been observed in several other *Albunea* species (Boyko 2002). Albuneid larvae identified as *A. carabus*, the only member of the family found in the Mediterranean, have been collected off the Algerian coast mainly in summer (Seridji 1988). These scattered observations suggest that the reproductive season of *A. carabus* extends from late spring to early autumn.

At present, several other aspects of the life history and ecology of this beautiful and elusive species still remain unknown.

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