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NOTES ON *LIOCARCINUS PUSILLUS* (Leach) AND RELATED SPECIES

CARLO FROGLIA* and RAYMOND B. MANNING**

* Istituto di Ricerche sulla Pesca marittima (C.N.R.), Ancona, ITALY.

** Department of Invertebrate Zoology, National Museum of Natural History,
Smithsonian Institution, Washington, D.C. 20560, U.S.A.

ABSTRACT

Three species - *L. pusillus* (Leach), *L. maculatus* (Risso) and *L. zariquieyi* (Gordon) - are recognized within the "pusillus" group.

L. pusillus and *L. maculatus* are very similar morphologically, but the first is restricted to Eastern Atlantic and the second to the Mediterranean.

Abbreviated synonymy, differential diagnosis, remarks on habitat and a key to differentiate the three species are provided.

RIASSUNTO

Osservazioni sul *Liocarcinus pusillus* (Leach) e le specie affini: - Tre specie vengono distinte nel gruppo "pusillus": *L. pusillus* (Leach), *L. maculatus* (Risso) e *L. zariquieyi* (Gordon).

Le maggiori affinità si osservano tra *L. pusillus* e *L. maculatus*, il primo è distribuito nell'Atlantico orientale mentre il secondo è diffuso nel Mediterraneo.

Sono anche riportate la sinonimia fondamentale, le diagnosi, una chiave di indentificazione ed alcune osservazioni sull'habitat delle diverse specie.

Until recently, all species of the genus *Liocarcinus*, as restricted by INGLE (1980:92) (see also MANNING and HOLTHUIS, 1981: 83), of small size and with the front projecting beyond the orbits, have been identified with a species described by LEACH (1815) from England, *Portunus pusillus*.

RISSO (1827), followed hesitantly by ROUX (1828), described *Portunus maculatus* from the Mediterranean Sea. It has been synonymized with LEACH'S species by most subsequent authors. According to HOLTHUIS (1977: 66), in one of his manuscripts RISSO himself synonymized *P. maculatus* with *P. pusillus*.

In 1915 PARISI recognized the presence of two different small species with a projecting front in the Mediterranean Sea, and characterized one of these as a new species, *Portunus parvulus*. PALMER (1927), in a revision of the British species

then assigned to the genus *Portunus*, considered *P. parvulus* Parisi as a doubtful species. PARISI himself (see PALMER, 1927: 899, footnote added in proof), after comparison of his material of *P. maculatus* with British specimens of *P. pusillus*, wrote: "... it is possible that my species is only a "variety" or "form" of *P. pusillus*".

Subsequently, ZARIQUIEY ALVAREZ (1955) recognized that, as earlier discussed by PARISI, there are two species of *Liocarcinus* (at that time included in *Macropipus*) in the Mediterranean with the extended front, and he indicated a number of characters that could be used to differentiate the species. He, and later HOLTHUIS and GOTTLIEB (1958) and FOREST (1965), recognized the two species under the following epithets: *pusillus* to indicate the species with the fifth anterolateral tooth of the carapace rounded or blunt and smaller than the fourth, and *parvulus* to indicate the species with the fifth anterolateral tooth of the carapace pointed and more developed than the fourth.

GORDON (1968) recognized that the species reported from the Mediterranean by earlier authors as *Portunus pusillus* was distinct from the species described by LEACH in 1815 and proposed for it the name *Macropipus zariquieyi*. Further, she considered the two species named by RISSO and PARISI to be synonymous with that described by LEACH, so that, under the Law of Priority, *Portunus pusillus* Leach had precedence over both *P. maculatus* Risso and *P. parvulus* Parisi.

Recent examination of extensive collections from the Mediterranean Sea and comparison of it with material from England and the Atlantic coast of Europe lead us to conclude that three species should be recognized in the "pusillus" group of *Liocarcinus*: *L. pusillus* (Leach), *L. zariquieyi* (Gordon), and a third species which we indentify with *L. maculatus* (Risso).

In the next section we give an abbreviated synonymy, a list of material examined, a differential diagnosis, sketches of the diagnostic features of each of the three species, and a key to differentiate them. Morphological differences among these three species and some aspects of their biology also are discussed. We hope that this will be of help to others in recognizing these species so that more precise information on their distribution and biology can be obtained.

We thank Prof. C. Conci and Dr. G. Grippa (MSNM) for the loan of typematerial of *P. parvulus* Parisi and Dr. G. Pretzmann, who, during a visit of one of us (C.F.) to the Naturhistorisches Museum, Vienna, made possible the profitable examination of the collection under his care. The illustrations were prepared by Lily King Manning and Maria Emilia Gramitto.

In the lists of material given below, the following acronyms are used to identify different repositories:

ITP: Istituto Tecnologia della Pesca ⁽¹⁾-Ancona; - MSNM: Museo Civico di Storia Naturale - Milano; - WNHM: Naturhistorisches Museum - Vienna; - USNM: National Museum of Natural History - Washington.

The abbreviations cl. and cb. are used for carapace length and carapace width, respectively.

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***Liocarcinus zariquieyi* (Gordon, 1968) (Fig. 1a-d)**

Portunus pusillus - Parisi, 1915: 259 (Italy) (not *Portunus pusillus* Leach, 1815).

Macropipus pusillus - Zariquiey Alvarez, 1955: 91, pl. 1, fig. b, d, e, g, pl. 2, fig. b, e, f, h, (Mediterranean coast of Spain). - Holthuis & Gottlieb, 1958: 86 (Haifa Bay, 18 m). - Forest, 1965: 376 (Isla de Mallorca, 46-48 m.).

Macropipus zariquieyi Gordon, 1968: 320 (Sorrento, Naples). - Zariquiey Alvarez, 1968: 374, figs. 120b, 127c, (Costas Catalanas, 5-30 m.). - Turkey, 1971: 115 (Marseille). - Lewinsohn, 1976: 246 (Rhodes, 15 m.).

Liocarcinus zariquieyi. - Ingle, 1980: 95, fig. 37, pl. 9b, c (England, Mediterranean) - Manning & Holthuis, 1981: 74.

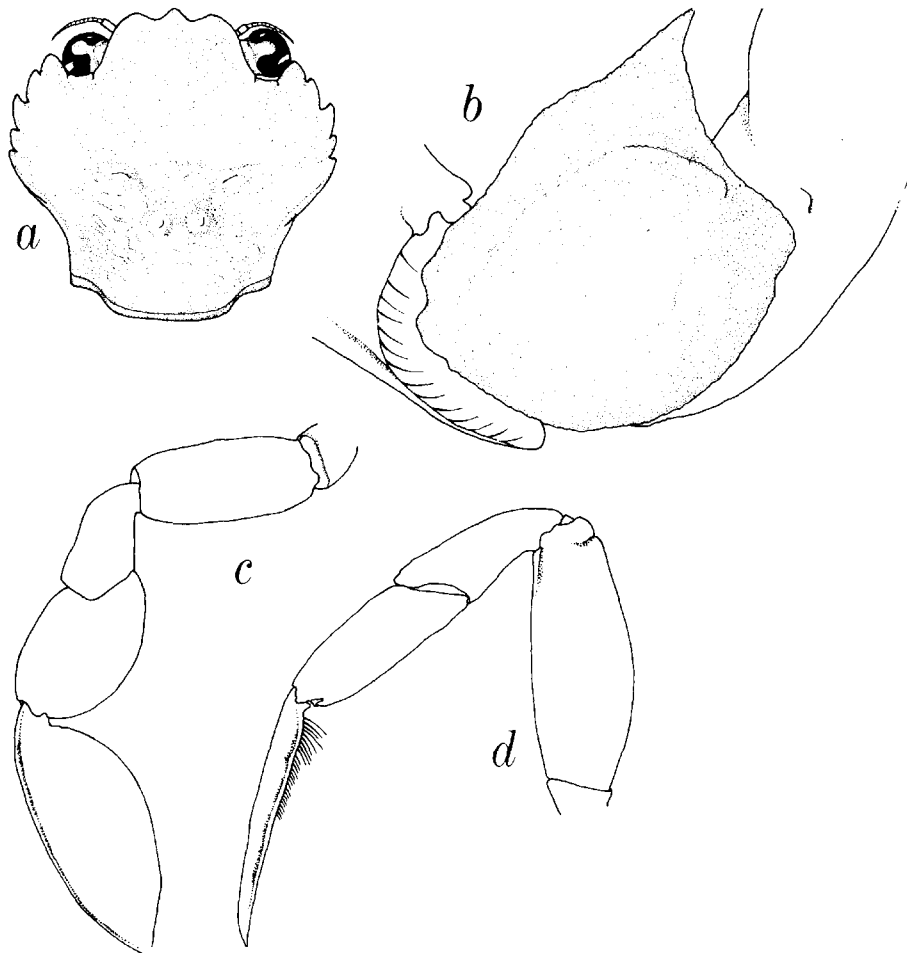


Fig. 1. *Liocarcinus zariquieyi* (Gordon), male, cl. 10.5 mm., Adriatic Sea, Tremiti Archipelago: a) carapace; b) carpus of cheliped; c) 5th pereiopod; d) 4th pereiopod.

Holotype: - British Museum (Nat. Hist.), a male specimen with *Sacculina* (Reg. no. 1959.5.26:122). Type-locality: Sorrento-Vivisce, Naples, Italy, 60 m. deep.

Material Examined: - Adriatic Sea: Tremiti Archipelago, 42°06.7'N, 15°29.7'E, coarse sand and gravel, depth 25 m., 11 July 1974, C. Froglià leg.: 2 ♂, cl. 11.5-12.7 mm. (ITP); 1 ♂, cl. 10.4 mm. (USNM).

Tyrrhenian Sea: Naples, no other data: 1 ♂, cl. 7.4 mm., 1 ♀, cl. 10.5 mm. (WNHM).

Sardinia: near Scoglio La Ghinghetta, 39°12'N, 8°21'E, coarse sand and gravel, depth 22 m., 4 April 1972, G. Orel leg.: 1 ♂, cl. 12.5 mm. (ITP).

Western Sicily: SE of Scoglio Porcelli, 38°01.8'N, 12°25.7'E, depth 30 m, 17 June 1974, C. Froglià & R.B. Manning leg.: 1 ♂, cl. 10.6 mm. (ITP).

Diagnosis: - Carapace slightly wider than long (ratio cb./cl. 1.02-1.25). Front advanced beyond orbits, with three teeth or lobes, the median slightly longer than laterals, latter markedly more obtuse. No prominences visible between internal margin of orbit and external margin of front. Carapace surface smooth, with regions well marked. Anterior margin of cardiac region rising gently. Anterolateral margin of carapace with teeth decreasing in size from third to fifth, all with apices rounded. Antennal flagellum short, less than one-fourth carapace length. Dorsal ridge of chela not prolonged into distal tubercle. Carpus of cheliped with spine only at antero-internal border; external margin, like proximal margin, uniformly rounded, lacking teeth or tubercles. Third and fourth pereopods with carpus longer than or subequal to propodus.

Size: - Carapace lengths of males 7.4 - 12.7 mm., of the only female examined 10.5 mm. Maximum size reported for this species is cl. 13.4 mm. (ZARIQUIEY ALVAREZ, 1968); he also reported ovigerous females with cl. 10.2 mm.

Distribution: - *Liocarcinus zariquieyi* is known from the Mediterranean Sea, the Canary Islands (ZARIQUIEY ALVAREZ, 1968), and from one specimen from England in A.M. NORMAN'S collection at the British Museum (Natural History). That specimen is labelled "Shetland-Clyde-Durham coast-Guernsey" (INGLE, 1980: 95). The species has otherwise not been collected outside of the Mediterranean.

It has been recorded from sublittoral habitats in depths between 10 and 60 m.; it seems to prefer substrates of coarse sand and gravel.

Liocarcinus maculatus (Risso, 1827) (Fig. 2a-d)

Portunus maculatus Risso, 1827: 5, pl. 1 fig. 1 (Nice). - Roux, 1828: pl. 31 (Sicily).

Portunus parvulus Parisi, 1915: 260 (Gulf of Naples, 30-45 m.).

Macropipus parvulus. - Zariquiey Alvarez, 1955: 93, pl. 1, fig. a, c, h, pl. 2, fig. a, c, g, i, j (Cadaques and Rosas, Spain, 7-49 m.). - Holthuis & Gottlieb, 1958: 86 (Israel, 30-59 m.). - Forest, 1965: 376 (Ibiza, Spain 40-50 m.). - Forest, 1967: 8 (Porto Cesareo, Gulf of Taranto, Italy).

Portunus pusillus. - Monod, 1956: 176 (partim), figs. 203, 204 (Sicily).

Macropipus pusillus. - Zariquiey Alvarez, 1968: 372 (Cadaques, Spain; Melilla, Morocco). - Turkey, 1971: 115 (Naples). - Kocatas, 1971: 25, pl. 3, fig. 5 (Izmir Bay, Turkey).

Liocarcinus maculatus. - Manning & Holthuis, 1981: 74.

Type: - Probably lost. Type-locality: Nice, Mediterranean coast of France.

Material examined: - Eastern Adriatic: Gulf of Trieste, Zaule: 1 ♂, cl. 11.2 mm. (WNHM). - Piran: 2 ♂, cl. 11.0-11.6 mm., 2 ♀, cl. 8.9-9.6 mm. (WNHM). - Piran, 1887: 3 ♂, cl. 8.2-9.5 mm., 3 ♀, cl. 9.7-11.2 mm. (WNHM). - Rovigno, depth 30 m.: 1 ♀, cl. 8.3 mm. (WNHM). - Rovigno, near Due sorelle, depth 10 m., sand: 1 ♂, cl. 8.0 mm. (WNHM). - Rovigno, 1912, depth 5-10 m.: 2 ♀, cl. 7.5-8.4 mm. (smaller ovigerous), 1 juv., cl. 4.2 mm. (WNHM). - Brioni, depth 4-10 m.,

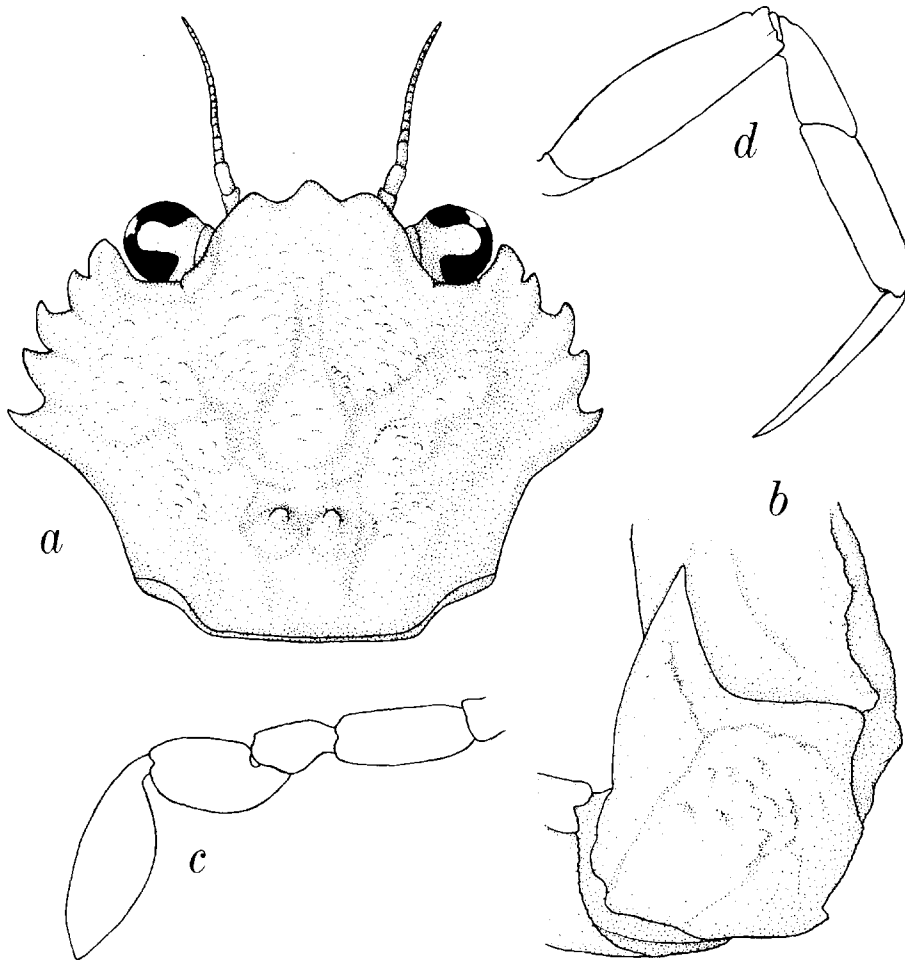


Fig. 2. *Liocarcinus maculatus* (Risso), male cl. 9.5 mm., western Central Adriatic: a) carapace; b) carpus of cheliped; c) 5th pereopod; d) 4th pereopod.

sand, 1913: 1 ♂, cl. 7.8 mm. (WNHM). - Spalato, depth 10-15 m., mud with eel grass, depth 10-15 m.: 1 ♀ ovigerous, cl. 7.0 mm. (WNHM).

Western Central Adriatic: 1978, C. Froglija leg.: 3 ♂, cl. 8.5-9.0 mm., 2 ♀, cl. 7.2-7.5 mm. (ITP).

Western Adriatic: Off Ravenna, 44°29'N, 12°31.5'E, depth 26 m., 27 July 1972, Picard dredge, C. Froglija leg.: 1 ♀ ovigerous, cl. 10.0 mm. (ITP). - Off Fano, 43°47'N, 13°12'E, depth 13 m., sandy mud, 26 July 1973, bottom trawl, C. Froglija leg.: 1 ♂, cl. 12.1 mm. (ITP). - About 10 miles NE of Fano, 43°56'N, 13°15'E, depth 34 m., coastal mud, 11 August 1975, bottom trawl, C. Froglija leg.: 1 ♂, cl. 12.5 mm. (ITP). - Off Senigallia, 43°41'N, 13°23'E, depth 13 m., muddy sand, 14 June 1973, beam trawl, C. Froglija leg.: 2 ♂, cl. 10.3-10.6 mm. (ITP). - Same locality, 29 July 1976, trawl, C. Froglija leg.: 2 ♀, cl. 10.1-10.9 mm. (ITP). - Off Ancona, 43°42'N, 13°30'E, depth 21 m., sandy mud, 2 April 1973, bottom trawl, C. Froglija leg.: 4 ♀, cl. 9.0-9.9 mm. (2 ovigerous, cl. 9.0-9.6 mm.) (ITP); 1 ♂, cl. 10.6 mm., 4 ♀ ovigerous, cl. 7.4-10.6 mm. (USNM). - 22 miles NE of Ancona, 43°56'N, 13°51'E, depth 73 m., mud, 11 October 1973, bottom trawl, C. Froglija leg.: 4 ♂, cl. 9.6-10.5 mm. (ITP). - Isole Tremiti, 42°07'03"N, 15°30'06"E, depth 35 m., 11 July 1972, dredge, C. Froglija leg.: 1 ♂, cl. 9.9 mm., 2 ♀, cl. 7.4-7.5 mm. (ITP).

Tyrrhenian Sea: Naples, depth 35-45 m., marl, 23 June 1914, 6 ♂, cl. 7.7-11.0, 2 ♀, cl. 10.6-11.0 mm. (syntypes of *Portunus parvulus* Parisi, 1915; MSNM cat. no. 8889). - Same locality and date: 1 ♂, cl. 4.3 mm., 2 ♀, cl. 4.4-7.7 mm. (larger ovigerous) (MSNM).

Diagnosis: - Carapace slightly wider than long (ratio cb./cl. 1.08-1.26). Front advanced beyond orbit, with three teeth or lobes, median slightly longer and more acute than laterals. Frontorbital angle poorly marked. Carapace surface granulate, regions well marked, anterior margin of cardiac region rising steeply. On anterolateral margin of carapace, fifth, fourth, and usually also third tooth sharply pointed, first two with apex more or less rounded; fourth tooth smaller than fifth. Antennal flagellum about one-third carapace length, longer than in other species of group. Carpus of cheliped with strong spine on antero-internal border, and with pointed tubercle and slight prominence on external margin. Third and fourth pereopods with carpus shorter than propodus.

Size: - Carapace lengths of males 4.2 - 12.5 mm., of females 4.4 - 11.2 mm. The smallest ovigerous female we examined had a carapace length of 7.0 mm, but HOLTHUIS & GOTTLIEB (1958) reported an ovigerous female with cl. 6 mm. and ZARIQUIEY ALVAREZ (1968) examined one with cl. 5.2 mm.

Distribution: - *Liocarcinus maculatus* appears to be restricted to the Mediterranean Sea. It has been recorded from sublittoral habitats in depths between 5 and 73 m., but in the Adriatic Sea it seems to prefer coastal muddy sand in depths between 10 and 25 m.

Liocarcinus pusillus (Leach, 1815) (Fig. 3a-c).

Portunus pusillus Leach, 1815: 318 (south coast of Devon and Firth of Forth, England). - Monod, 1956: 176 (partim), figs. 205-206 (Spain).

Macropipus pusillus. - Gordon, 1968: 320 (England). - Christiansen, 1969: 58, fig. 22, map 16 (west coast of Norway).

Liocarcinus pusillus. - Ingle, 1980: 95, fig. 38, pl. 10a (England). - Manning & Holthuis, 1981:74.

Lectotype: British Museum (Nat. Hist.), female specimen (reg. no. 228h), selected by GORDON (1968: 320) from the syntypes of LEACH. Type-locality: south coast of Devon and Firth of Forth, England.

Material: - Sweden: No other data: 1 ♂, cl. 10.7 mm., 2 ♀ ovigerous, cl. 10.2-10.3 mm. (WNHM). - Kristineborg (? Sweden), 1920: 1 ♂, cl. 10.5 mm. (WNHM).

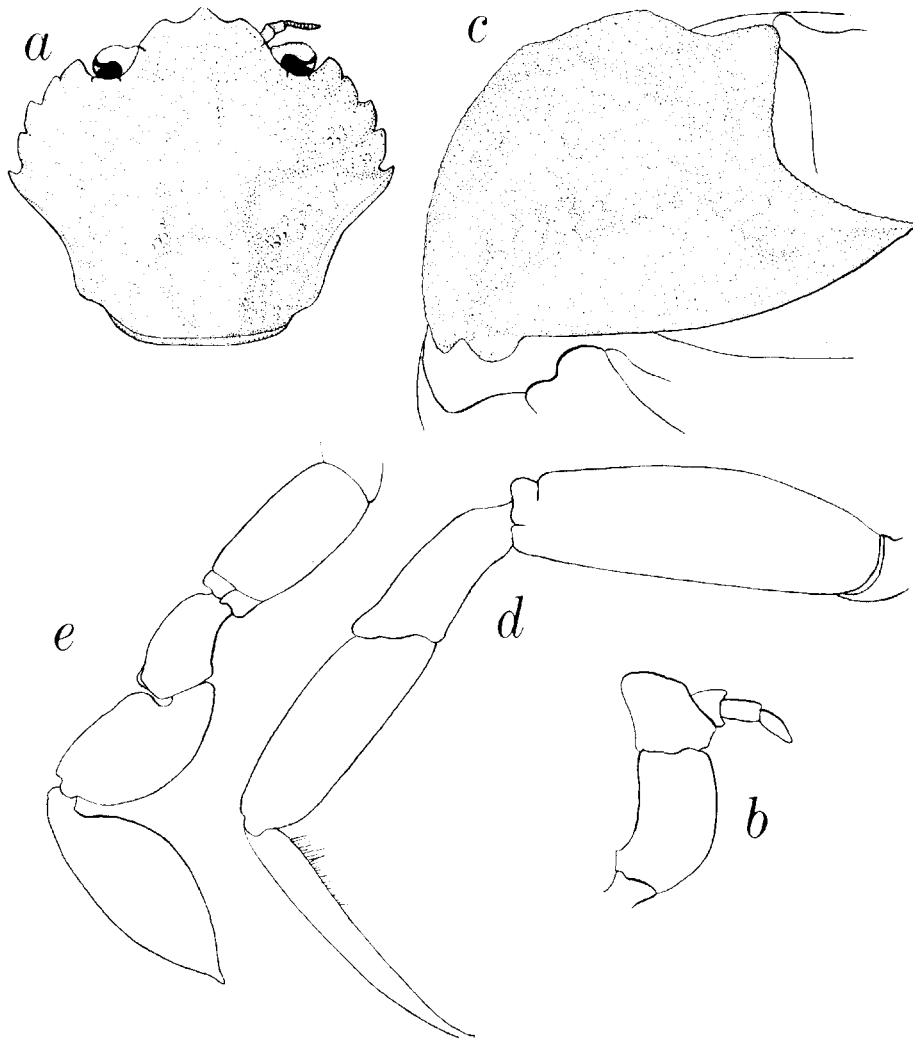


Fig. 3. *Liocarcinus pusillus* (Leach), male cl. 12.4 mm., England: a) carapace; b) carpus of cheliped; c) 5th pereopod; d) 4th pereopod.

England: No locality given, E. Lovett leg.: 1 ♀, cl. 12.4 mm. (USNM).

Ireland: Birterbay Bay, A. M. Norman, 1874: 5 ♀, cl. 6.9-9.2 mm. (USNM).

France: Roscoff, 1911: 1 ♀, cl. 6.8 mm. (WNHM).

Northwest Spain: Ria de Arosa, 42°28.2'N, 08°58.5'E, depth 50-60 m., 13 August 1964, L. B. Holthuis leg.: 2 ♂, cl. 11.5-12.5 mm., 1 ♀, cl. 9.2 mm. (ITP). - Mouth of Ria de Arosa, 2.7 km. SE of Pta. del Castillo, Isla Salvora, 42°26.5'N, 08°57.3'W, 45-55 m., L.B. Holthuis leg.: 3 ♂, cl. 8.0-15.0 mm. (USNM). - Ria de Arosa, 0.3 km. SSE of Lobeira de Cambados buoy, 25 m., dredge, 12 August 1964, L. B. Holthuis leg.: 1 ♂, cl. 14.5 mm. (USNM). - Ria de Arosa, halfway between Lobeira de Cambados and Goldfeina, 19 m., 30 July 1964, L.B. Holthuis leg.: 3 ♂, cl. 10.0-14.7 mm., 1 ♀, cl. 10.1 mm. (USNM).

Diagnosis: - Carapace slightly wider than long (ratio cb./cl. 1.1 - 1.3). Front advanced beyond orbits, produced into three lobes, median slightly more prominent than the laterals. Front-orbital corner distinguishable. Carapace surface more or less granulate. Anterior margin of cardiac region rising gently. On anterolateral margin of carapace, fourth tooth smaller than fifth, second very small; usually only fifth tooth with pointed tip. Length of antennal flagellum less than or equal to one - fourth carapace length. Carpus of chelipeds with anteroexternal border rounded or sinuate, with two slight prominences. Third and fourth pereopods with carpus shorter than propodus.

Size: - Maximum carapace length 23 mm. (INGLE, 1980).

Distribution: - Atlantic coast of Europe from northern Norway to Portugal, possibly on NW African coast (CHRISTIANSEN, 1969; MANNING & HOLTHUIS, 1981). INGLE (1980) lists numerous British localities.

It has been recorded from depths between 6 - 13 m. down to 200 m., but, according to CHRISTIANSEN (1969: 60) is most common in depths of less than 50 m. INGLE (1980: 96) noted that off England it had been recorded from the intertidal to a depth of 100 m. on sandy to stony bottoms. PALMER (1927: 886) recorded it on shelly gravel at Plymouth, and CHRISTIANSEN (1969:60) noted that it is "Most common on rough bottom with gravel and small stones, and on hard bottom, but also found on sandy bottom, sometimes mixed with clay, and on shell-sand". Its habitat preference is similar to that of *L. zariquieyi*.

KEY TO SPECIES OF THE "pusillus" GROUP

1. All anterolateral teeth of carapace blunt, fifth smaller than fourth. Third and fourth pereopods with carpus longer than propodus. Cheliped with external margin of carpus simply rounded *L. zariquieyi*
 All least fifth anterolateral tooth of carapace clearly pointed, always larger than fourth. Third and fourth pereopods with carpus shorter than propodus. External margin of carpus of cheliped sinuate or with a well marked tubercle. 2
2. External margin of carpus of cheliped with pointed tubercle proximally and with slight prominence near midlength. Antennal flagellum at least one-third as long as carapace *L. maculatus*

External margin of carpus of cheliped sinuate, with two slight prominences, or simply rounded. Antennal flagellum about one-fourth as long as carapace
..... *L. pusillus*

REMARKS

Liocarcinus maculatus and *L. pusillus* are very similar morphologically and obviously are closely related. We consider them sufficiently distinct to recognize them as separate species. The easiest way to distinguish the two species is through the ornamentation of the carpus of the cheliped: In *L. maculatus* there is a marked tubercle as well as a small median prominence on the external margin; in *L. pusillus*, two slight prominences can be seen in some specimens, but, as PALMER (1927: 886) noted, the carpus is "without a tooth of any sort on its external margin". The relative length of the antennal flagellum also is different in the two species: in *L. maculatus* it is at least one third as long as the carapace, whereas in *L. pusillus* it is only about one-fourth of the carapace length. Unfortunately, in preserved specimens, the antennae are frequently broken.

Other small differences can be found in the fifth pereopods. *Liocarcinus pusillus*, especially English specimens, have the anterior margin of the carpus distally expanded into a small, flattened lobe; no such lobe could be recognized in either of the Mediterranean species.

Direct comparison of the three species suggests a gradient of smoothness of the carapace ranging from *L. maculatus*, in which the surface is granulate with the regions well marked, to *L. zariquieyi*, with the carapace surface nearly smooth; *L. pusillus*, the most variable of the three, falls between these extremes. The specimen from England identified with *L. zariquieyi* by INGLE (1980), has the blunt lateral teeth of that species, but the cardiac region rises sharply, as in our material of *L. maculatus*.

The color of all three species is extremely variable; a uniform coloration is never seen. Usually specimens show mottled or variegated patterns, with brown or gray as dominant colors in *L. maculatus*, whereas brownish yellow and dark red dominate in *L. zariquieyi*. INGLE (1980: 96) recorded the following color for *L. pusillus*: "Very variable, carapace dorsal surface yellowish orange with brown bandings on pereopods, to a variegated brown and yellow with a narrow to broad median band of white or yellow, pereopods often a uniform yellowish brown with white bands".

The banded pattern of the pereopods of *L. pusillus*, which often persists in preserved material, is not noticeable on preserved specimens of *L. maculatus*. It seems likely that the overall color pattern of these species is related to their habitat.

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