

Morphology of the megalopa and first crab instar of the Shamefaced Crab *Calappa granulata* (Crustacea, Brachyura, Calappidae)

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Morphology of the megalopa and first crab instar of the Shamefaced Crab Calappa granulata (Crustacea, Brachyura, Calappidae).— An unknown large megalopa was captured alive in a plankton sample taken south of Eivissa (Balearic Islands) in the western Mediterranean. The juvenile was obtained after moulting of the megalopa in the laboratory. The morphology of the first crab stage allowed the identification of the megalopa as belonging to the species *Calappa granulata*. Heterochely with right handedness is already evident in the megalopa stage. Its morphological characters are compared with those of the other known megalopae of related species.

Key words: Megalopa, *Calappa*, Calappidae, Heterochely.

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Introduction

Two species of the family Calappidae are known to inhabit the western Mediterranean waters (GARCÍA-RASO, 1993; SERIDJI, 1993; STEVCIC & GALIL, 1994): *Calappa granulata* (Linnaeus, 1758) and *Cryptosoma cristatum* Brullé, 1837 [cited as *Cycloes cristata*: GARCÍA-RASO (1993)].

Calappa granulata is a sublittoral species known from the Mediterranean Sea and eastern Atlantic waters from Portugal to Mauritania, including the Azores, Madeira, and the Cape Verde Islands (ZARIQUIEY-ÁLVAREZ, 1968; MANNING & HOLTHUIS, 1981). It lives on sandy mud and muddy detritus at depths of between 13 and 400-700 m (MANNING & HOLTHUIS, 1981).

The morphology of the larval stages of calappid crabs is insufficiently known (RICE, 1980; STEVCIC, 1983). There are only a few papers concerning the larval development of calappid crabs and most of them deal only with the zoeal or prezoal stages (LEBOUR, 1944, 1959; RAJA BAI, 1959; MOTOH, 1977; SERIDJI, 1993; GONZÁLEZ-GORDILLO, 1994; TAISHAKU & KONISHI, 1995). The megalopal stage is known only for *Calappa flammea* and *Cryptosoma bairdii* [cited as *Cycloes bairdii*: GALIL & CLARK (1996)], based on two incomplete descriptions made by LEBOUR (1944) of specimens collected from the plankton off Bermuda. Concerning *C. granulata*, only the prezoal stage is directly known from an ovigerous female (GONZÁLEZ-GORDILLO, 1994), whereas the first zoeal stage appears to be known from a plankton sample (SERIDJI, 1993).

The present paper describes the morphology of the megalopa and the first juvenile crab of *Calappa granulata*. It constitutes the first complete description of a megalopa of the family Calappidae.

Material and methods

An unknown large megalopa was collected alive in a plankton sample taken 50 km southeast of Formentera (38°12.6 N, 1°42.3 E; Balearic Islands; western Mediterranean) on 27 X 96 during the cruise "QUIMERA I". The megalopa was kept in a storage tank at 17°C, transported to the laboratory and kept

at a constant room temperature of 17±1°C in aquaria with filtered well-aerated sea water. The first crab stage was obtained by rearing this megalopa in the laboratory. The exuvia of the megalopa and the juvenile crab (which died after 11 days in the laboratory) were preserved in 70% ethanol. The first crab stage is deposited in the Biological Collections of Reference of the Institut de Ciències del Mar (CSIC) in Barcelona (Registration number: ICMD 299/1997).

An Olympus phase contrast microscope was used in the observation, after mounting the features of the appendages in polyvinyl lactophenol. Dissection and measurements were taken with a Wild binocular microscope equipped with an ocular micrometer. All drawings were made with the aid of a *camera lucida*. Carapace width was measured as the greatest distance across the carapace, and carapace length as the distance between the frontal margin and the posterior margin of the carapace. The megalopa is described using the basic malacostracan somite plan from anterior to posterior and appendage segments are described from proximal to distal, endopod then exopod. The morphological description of the first crab is restricted to the most definitive characters, and to the main differences from the adult form. The number of setae present in each segment of the appendages is that stated in the text; some setae present in the concealed face of the appendages are not figured in the drawings.

Results

Megalopa

Dimensions

Carapace length: 4.6 mm; carapace width: 3.7 mm.

Carapace (figs. 1A-C)

Longer than broad and without spines; dorsal surface smooth; frontal region and rostrum gradually deflected ventrally.

Antennule (fig. 2A)

Peduncle three-segmented, with 13,4,4 setae, basal segment bulbous; endopod

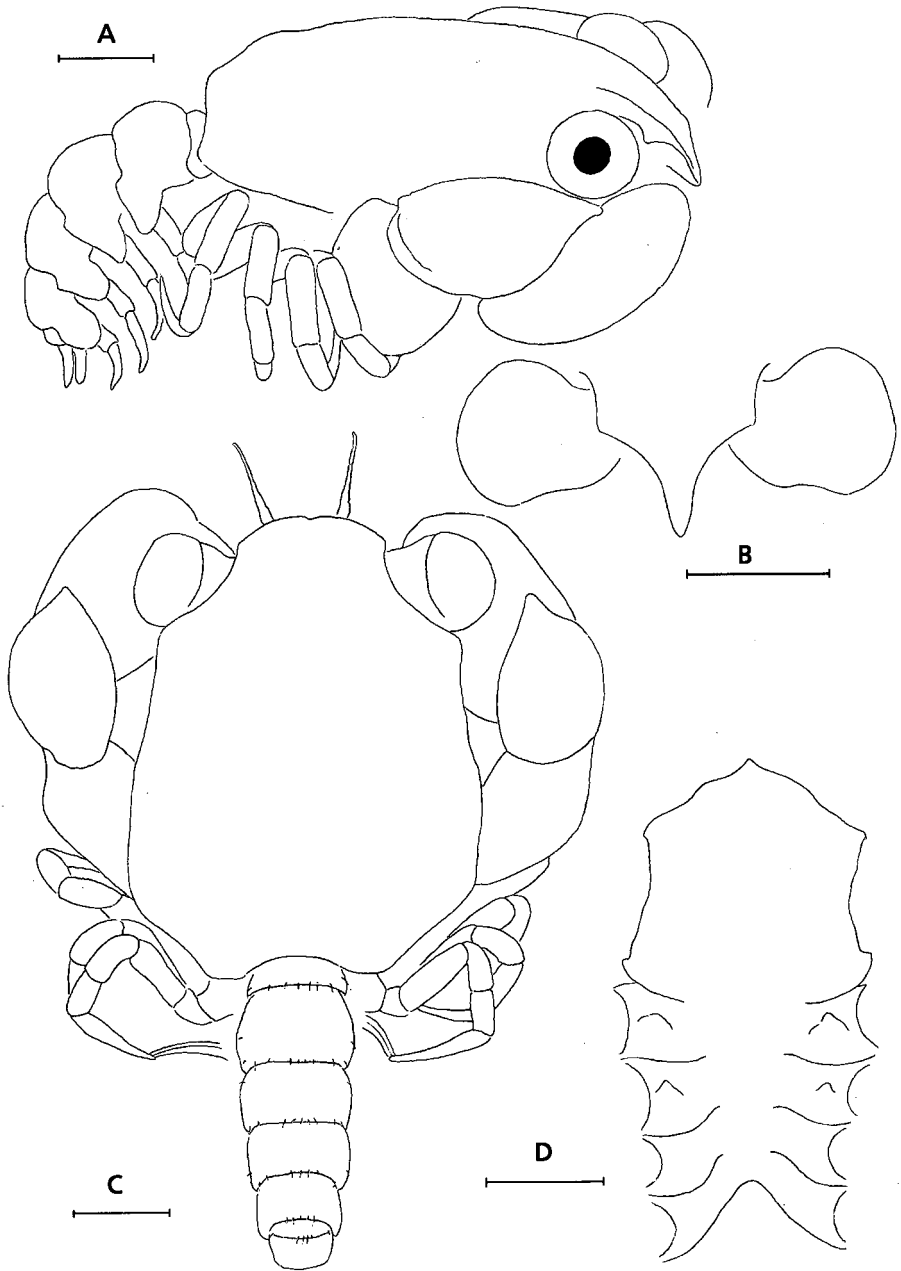


Fig. 1. *Calappa granulata*, megalopa: A. Lateral view; B. Rostrum, frontal view; C. Dorsal view; D. Sternum. (Scale bars: A-C, 1 mm; D, 0.7 mm.)

Calappa granulata, megalopa: A. Vista lateral; B. Rostro, vista frontal; C. Vista dorsal; D. Sternum. (Escala: A-C, 1 mm; D, 0,7 mm.)

unsegmented with five setae; exopod four-segmented with 0,15,11,7 aesthetascs and 0,0,2,2 setae, respectively.

Antenna (figs. 2B, 2C)

Protopod three-segmented, with 6,4,1 setae; flagellum eight-segmented, with 0,0,4,2,4,2,3,4 setae.

Maxillule (fig. 2D)

Coxal endite with 21 setae; basal endite with 27 setae, and four setae on its inner lateral margin; endopod unsegmented with three setae.

Maxilla (figs. 2E, 2F)

Coxal endite deeply bilobed with 17+7 setae; basal endite bilobed with 9+13 setae; endopod unsegmented with seven setae in its outer lateral margin; exopod (scaphognathite) with 126 marginal setae and 12 medial setae.

First maxilliped (fig. 3A)

Epipod with 29 long setae; coxal endite with 37 setae; basal endite with 42 setae; endopod unsegmented with six setae; exopod three-segmented, proximal segment with two setae placed distally, distal segment with five long terminal setae.

Second maxilliped (fig. 3B)

Epipod with 16 setae; protopod with nine setae, coxa and basis not differentiated; endopod four-segmented with 8,5,17,10 setae; exopod three-segmented with three short and thick setae on the proximal segment, and five terminal setae on the distal segment.

Third maxilliped (fig. 3C)

Epipod with 20 setae; protopod with 34 setae, coxa and basis not differentiated; endopod five-segmented with 34,25,15,19,9 setae; exopod two-segmented, with 30 setae on the proximal segment and six terminal setae on the distal segment.

Pereiopods (figs. 4A-F)

All segments well differentiated and sparsely armed with setae and without ischial or coxal spines. First pereiopod (chelipeds) large, dorsoventrally compressed; dactyl directed ventrally. Heterochely with right-handedness already evident: right dactyl with a well-

developed tubercle, placed near the base, and directed posteriorly; teeth of the right propodus more developed than those in the left. Dactyli of second to fifth pereiopods long, with 8,8,7,3 small spines on the inner margin; dactyl of fifth pereiopod with three long subterminal setae.

Sternum (fig. 1D)

Sternite of second and third pereiopods with a pair of rounded tubercles.

Abdomen (figs. 1A, 1C)

With six somites, broader than longer, with well-developed tergites, plus telson; postero-lateral margins of second to fifth segments rounded; setal arrangement as figured.

Pleopods (fig. 4G-I)

Biramous; present on second to sixth abdominal segments; endopod of second to fifth pleopods unsegmented with 6,5,4,5 sub-terminal coupling hooks on the internal margin; exopod of second to fifth pleopods unsegmented with 30,32,31,27 long marginal natatory setae; uropods with two long setae on the basal segment, endopod absent and exopod with 20-21 long marginal natatory setae.

Telson (fig. 4I)

Broader than long; posterior margin with six setae; dorsal surface with four setae.

First crab

Dimensions

Carapace length: 5.4 mm; carapace width: 5.1 mm.

Carapace (fig. 5A)

Slightly longer than broad, strongly convex; frontal region wider than in the adult; rostrum bilobed and slightly protruding; antero-lateral margins rounded; four postero-lateral and four posterior teeth, as in adult; middle posterior margin straight.

Abdomen (fig. 5B)

Narrow; segments free.

Chelipeds (figs. 5C, 5D)

Well developed, right-handed (crusher chela

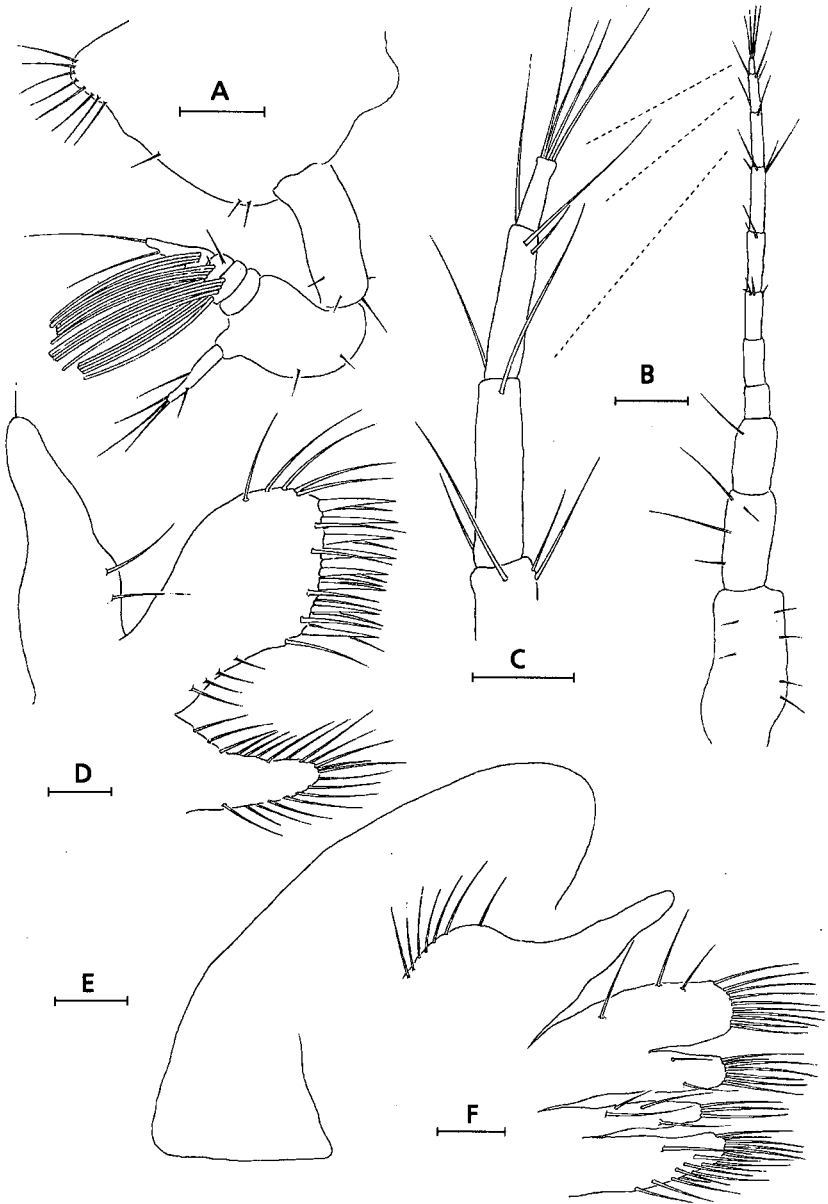


Fig. 2. *Calappa granulata*, megalopa: A. Antennule; B. Antenna; C. Antenna, segments 5-8; D. Maxillule; E. Maxilla, scaphognathite; F. Maxilla, endopod, basis and coxa. (Scale bars: A, B, E, 0.2 mm; C, D, F, 0.1 mm.)

Calappa granulata, megalopa: A. Anténula; B. Antena; C. Antena, segmentos 5-8; D. Maxílula; E. Maxila, escafognatito; F. Maxila, endopodio, basis y coxa. (Escala: A, B, E, 0,2 mm; C, D, F, 0,1 mm.)

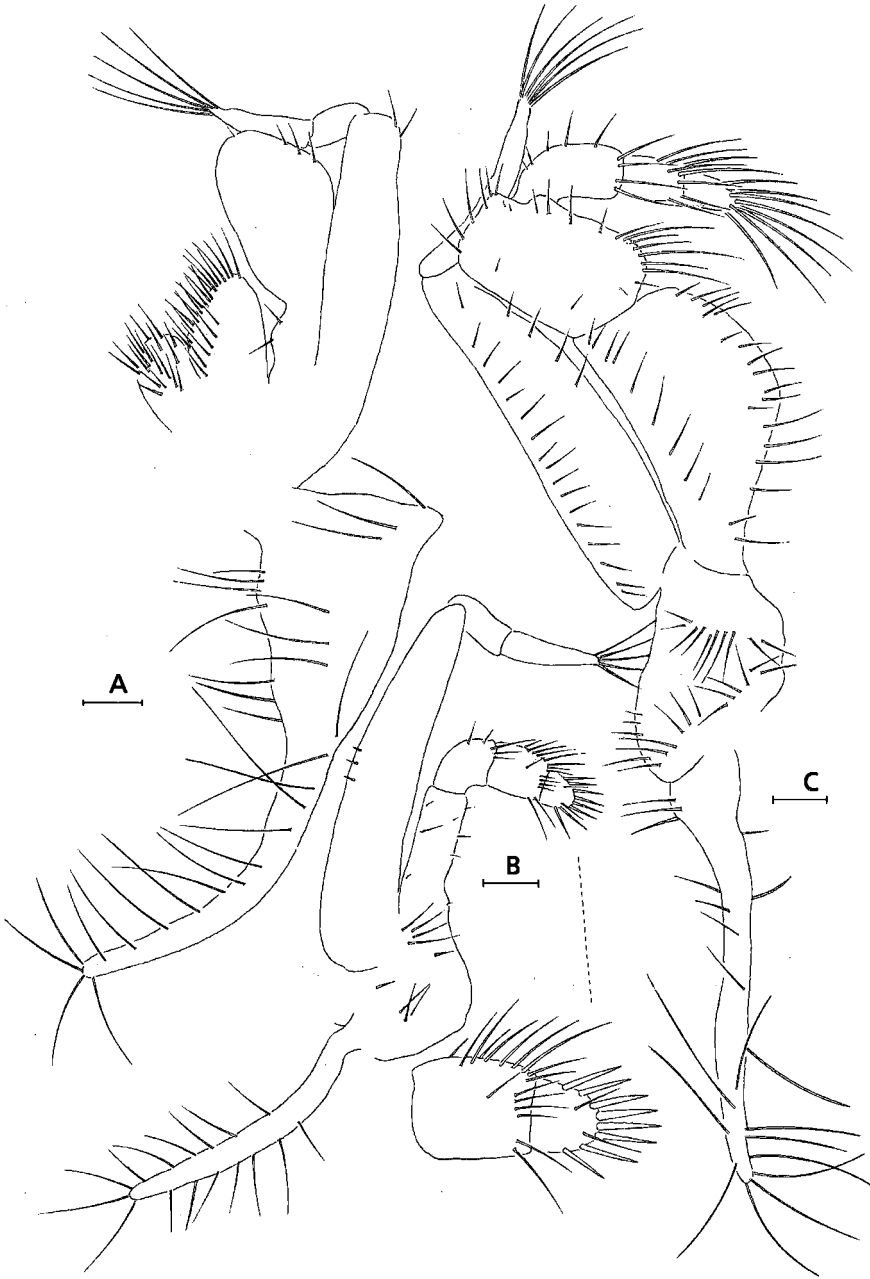


Fig. 3. *Calappa granulata*, megalopa: A. First maxilliped; B. Second maxilliped; C. Third maxilliped. (Scale bars: 0.2 mm.)

Calappa granulata, megalopa: A. Primer maxilípido; B. Segundo maxilípido; C. Tercer maxilípido. (Escala: 0,2 mm.)

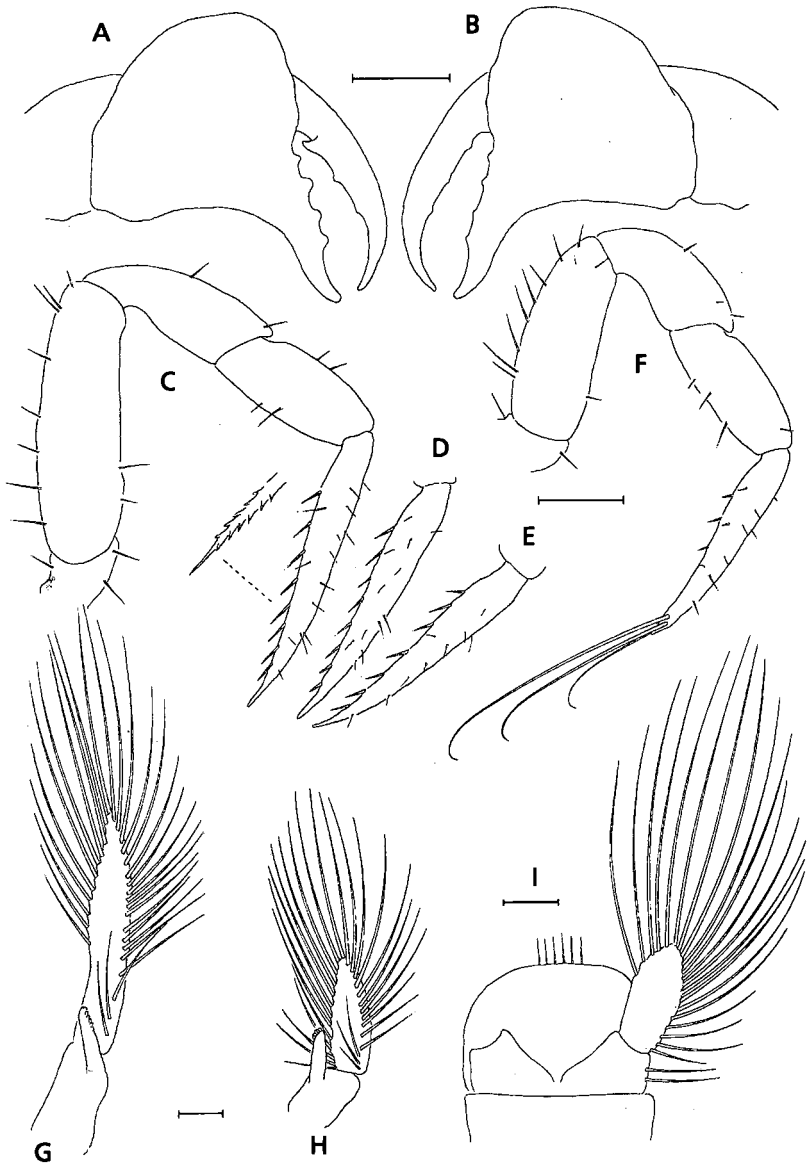


Fig. 4. *Calappa granulata*, megalopa: A. Right cheliped; B. Left cheliped; C. Second pereiopod; D. Third pereiopod, dactyl; E. Fourth pereiopod, dactyl; F. Fifth pereiopod; G. First pleopod; H. Fourth pleopod; I. Telson and right uropod, ventral view (setules of the setae omitted). (Scale bars: A, B, 1 mm; C-F, 0.4 mm; G-I, 0.2 mm.)

Calappa granulata, megalopa: A. Quelípedo derecho; B. Quelípedo izquierdo; C. Segundo pereiópodo; D. Tercer pereiópodo, dáctilo; E. Cuarto pereiópodo, dáctilo; F. Quinto pereiópodo; G. Primer pleópodo; H. Cuarto pleópodo; I. Telson y urópodo derecho, vista ventral (sétulas de las sedas, omitidas). (Escala: A, B, 1 mm; C-F, 0,4 mm; G-I, 0,2 mm.)

on the right); propod very high, strongly widening anteriorly, almost as long as high, with a dorsal dented keel; right propod with a large blunt tubercle; dactyl directed ventrally; dactyl of the right chela wider than the left and with a large blunt tubercle near its base; dactyl of the left chela much thinner and without a developed tubercle.

Pereiopods

Thin, without spines or tubercles, similar to the adult; dactyl long.

Discussion

Knowledge of the larval development and morphology of calappoid crabs is limited. The taxonomic position of the family Calappidae was recently reviewed by BELLWOOD (1996) who showed that this family is not monophyletic and that the crab species of this group may now be arranged as belonging to three different families: Calappidae and Hepatidae within the superfamily Calappoidea, and Matutidae, which together with Leucosiidae would form the superfamily Leucosioidea. SERIDJI (1993) studied the affinities between the genera of Calappidae at the larval level and already envisaged the conclusions reported by BELLWOOD (1996) based on adult crabs. SERIDJI (1993) reported that the zoeae of *Hepatus* are closely related to those of *Calappa*, while those of *Matuta* are clearly distinct. Therefore, the complete larval development within the family Calappidae (*sensu stricto*) is unknown for any species, since that of *Hepatus epheliticus* described by COSTLOW & BOOKHOUT (1962), and *H. pudibundus* described by RIEGER & HEBLING (1993) would correspond to the family Hepatidae.

Within the family Calappidae, the megalopal stage is known only for *Calappa flammea* and *Cryptosoma bairdii* from incomplete descriptions given by LEBOUR (1944). No information on setation is provided and their morphological characteristics are not given in detail. No appendages are described and the only drawings presented show the overall dorsal morphology of the whole animal. Concerning the megalopa of *C. flammea*, the overall carapace shape and

the chelipeds are very similar to those of *C. granulata* described herein. The size of the carapace is also large and similar (4.2 mm in *C. flammea* vs. 4.6 mm in *C. granulata*). The only setation counts given by LEBOUR (1944) on *C. flammea* are those of the uropods (20 setae), almost coinciding with the 20-21 given in the present description for *C. granulata*.

The megalopa of *Hepatus epheliticus* and *H. pudibundus* (COSTLOW & BOOKHOUT, 1962; RIEGER & HEBLING, 1993) differs widely from that of *Calappa granulata* in many aspects: the *C. granulata* is much larger (4.6 mm vs approx. 1.3 mm in *H. epheliticus* and *H. pudibundus*); the shape of the rostrum and frontal region are very different; the shape and relative size of the chelae are elongated and flattened dorso-ventrally, as in the adult crab, in *C. granulata*, while the chelae of *H. epheliticus* and *H. pudibundus* are not so calappid-like; the setation of the appendages is more developed in *C. granulata*.

An interesting feature presented by the megalopa of *Calappa granulata* and, to our knowledge, not previously reported for any other brachyuran megalopa, is that right-handed heterochely is already present at this stage.

The megalopa of *Calappa granulata* can be easily distinguished from other crab megalopae known from Mediterranean and north-eastern Atlantic waters by its large size, large and characteristic chelipeds, and the high number of setae on the scaphognathite.

The morphology of the first crab obtained in the present study agrees with that of the adult *Calappa granulata*, especially in the characteristic and diagnostic features of the species (overall shape, placement of spines, etc.) (ZARIQUIEY-ÁLVAREZ, 1968), and differs from that figured by MANNING & HOLTHUIS (1981) for other eastern Atlantic *Calappa* juveniles. The ratios of the interocular length versus carapace width, as well as the ratio of carapace length versus carapace width, are larger than in adult crabs, showing the occurrence of a strong negative allometry in the growth of these measurements throughout ontogeny. PASTORE (1995) recently described two new species of the genus *Calappa* in the Ionian Sea

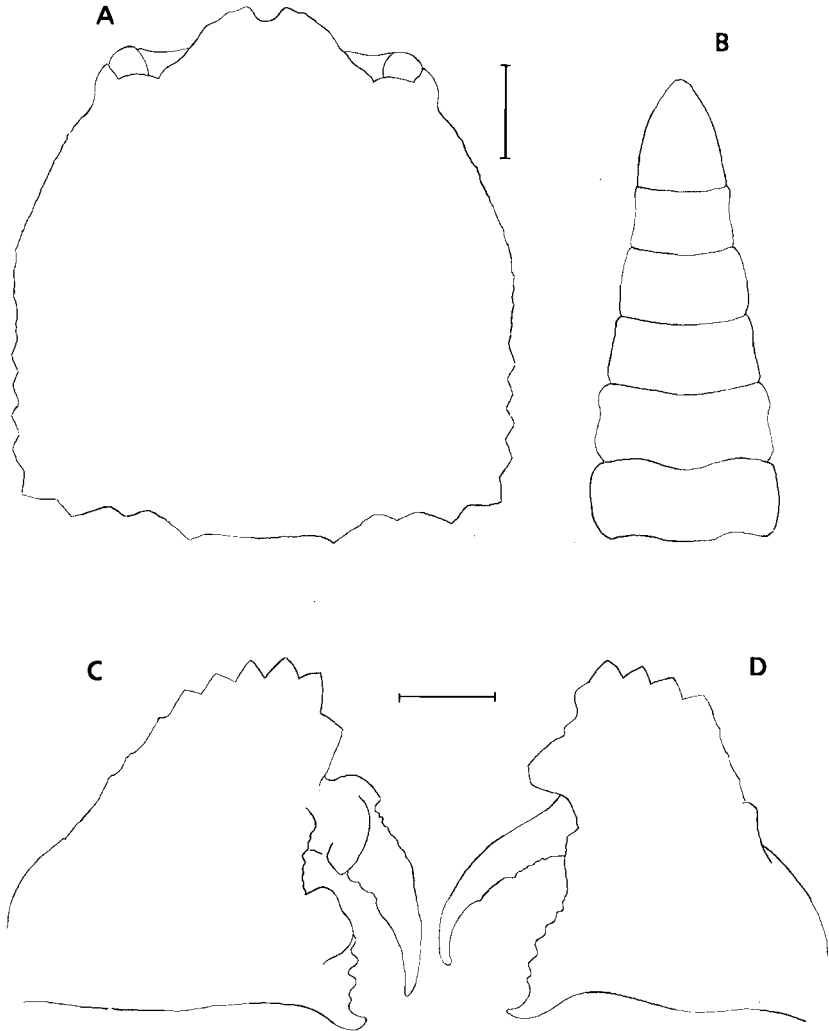


Fig. 5. *Calappa granulata*, first crab: A. Caparace, dorsal view; B. Abdomen, dorsal view; C. Right cheliped; D. Left cheliped. (Scale bars: A-D, 1 mm.)

Calappa granulata, juvenil: A. Caparazón, vista dorsal; B. Abdomen, vista dorsal; C. Quelípedo derecho; D. Quelípedo izquierdo. (Escala: A-D, 1 mm.)

(eastern Mediterranean basin), mainly based on colour differences and widely overlapping meristic characteristics. The morphology of the juvenile crab examined does not suggest that it could be assigned to either of these species.

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Resumen

Morfología de la megalopa y del primer estadio juvenil del cangrejo real Calappa granulata (Crustacea, Brachyura, Calappidae)

Una megalopa de gran tamaño, de morfología no descrita, fue capturada viva en una muestra de plancton tomada al sur de Eivissa (islas Baleares) en el Mediterráneo occidental. Un juvenil se obtuvo por muda de la megalopa en el laboratorio. La megalopa es de gran tamaño (4,6 mm de longitud de cefalotórax), más larga que ancha y sin espinas; el rostro se inclina gradualmente en dirección ventral (fig. 1). Se describe el número y posición de las sedas de los distintos apéndices (figs. 2-4). El número de sedas del escafognatito es alto. Los quelípedos son grandes y comprimidos, con el dácilo dirigido ventralmente. Heteroquelia diestra (pinza derecha con morfología robusta) es evidente en el estadio megalopa (fig. 4).

Los caracteres morfológicos de la megalopa se comparan con los de otras megalopas conocidas de especies cercanas (superfamilia Calappoidea). La morfología del primer estadio de cangrejo permitió identificar la megalopa como perteneciente a la especie *Calappa granulata*. El cefalotórax (fig. 5) es ligeramente más largo que ancho, fuertemente convexo; la región frontal es más ancha que en el adulto; el rostro es bilobado y protrude ligeramente; los márgenes anterolaterales son redondeados, presenta cuatro dientes postero-laterales y cuatro dientes posteriores, como el adulto; el margen medio posterior es recto. Este estudio constituye la primera descripción completa de una megalopa de la familia Calappidae.

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