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The megalopa and early juvenile stages of *Calappa tortugae* Rathbun, 1933 (Crustacea, Brachyura) reared in the laboratory from South Carolina neuston samples

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Abstract.—Neuston samples collected from the Charleston Bump region off the coast of South Carolina, U.S.A., during the summers of 2002 and 2003 consistently included a decapod species of undetermined identity with a large brachyuran megalopa. Despite their resemblance to some calappids, it was impossible to make a definitive identification based solely on general morphology. Therefore, additional neuston tows were taken on the continental shelf near Charleston, during the summer of 2004 to obtain these living megalopae. These were raised successfully through five juvenile stages at the Southeastern Regional Taxonomic Center (SERTC) laboratory. The morphology of the juveniles provided evidence that they are megalopae of *Calappa tortugae* Rathbun, 1933. Comparisons with megalopae of *Hepatus epheliticus* (Linnaeus, 1763), *H. pudibundus* (Herbst, 1785), *Calappa flammea* (Herbst, 1794) and *Cryptosoma balguerii* (Desbonne, 1867) are presented here. This is the first complete description of the megalopa morphology of a member of the genus *Calappa* Weber, 1795 from the Western Atlantic, and it is helpful for taxonomic, systematic and ecological purposes.

The Calappidae de Haan, 1833, according to Williams (1984), Williams & Child (1989) and Nizinski (2003) is represented on the Atlantic coast and continental shelf waters of the United States by the following species: *Acanthocarpus alexandri* Stimpson, 1871; *Calappa flammea* (Herbst, 1794); *Calappa ocellata* Holthuis, 1958; *Calappa sulcata* Rathbun, 1898; *Cycloes bairdii* Stimpson, 1860 [now *Cryptosoma balguerii* (Desbonne, 1867) according to Galil & Clark (1996)]; *Cyclozodion angustum* (A. Milne-Edwards, 1880); and *Cyclozodion tuberatum* Williams & Child, 1989. The superfamily Calappoidea in this region also includes *Hepatus epheliticus* (Linnaeus, 1763); *Hepatus pudibundus* (Herbst, 1785); *Osachila semilevis* Rathbun, 1916; and *Osachila tuberosa* Stimpson, 1871.

The morphology of the larval stages of calappid crabs is not well known (Rice 1980, Števčić 1983). Most of the few published reports concerning the larval development of these crabs have only treated the zoeal or prezoeal stages (Lebour 1944, 1959; Raja Bai 1959, Motoh 1977, Terada 1987, Seridji 1993, González-Gordillo 1994, Taishaku & Konishi 1995, Guerao et al. 1999). The

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megalopa stage is known for *C. flammea* and *Cryptosoma balguerii* (cited as *Cycloes bairdii*), based on two incomplete descriptions by Lebour (1944) from plankton samples. Additionally, Guerao et al. (1998) described the complete morphology of the megalopa of *Calappa granulata* (Linnaeus, 1758) from the Balearic Islands, western Mediterranean, and also gave some information on the morphology of the first juvenile crab of this species.

In the Western Atlantic region, the morphology of larval stages of calappid species is poorly known. The species with the complete larval development described, belonging to the family Hepatidae, are *H. epheliticus* and *H. pudibundus*, studied respectively by Costlow & Bookhout (1962) and Rieger & Hebling (1993). Additionally, *Calappa flammea* and *Cryptosoma balgueri*, belonging to the family Calappidae, were studied by Lebour (1944) in their megalopae and first juvenile crab stages. However, only some parts of those stages were detailed in her descriptions.

Neuston samples collected from the Charleston Bump region off the coast of South Carolina, U.S.A., during the summers of 2002 and 2003, consistently included a decapod crustacean species of undetermined identity, with large sized brachyuran megalopae. Despite their resemblance to some calappid megalopae, it was impossible to make a definitive identification based solely on external general morphology. Therefore, additional neuston tows were taken on the shelf near Charleston during the summer of 2004, to obtain living megalopae. These larvae were then raised successfully through to five juvenile stages at the Southeastern Regional Taxonomic Center (SERTC) and identified as *Calappa tortugae* Rathbun, 1933.

In this report, we present a detailed description of the megalopa stage and first juvenile stage of *C. tortugae*. We also describe secondary sexual differentiation in the subsequent juvenile stages to facilitate identification of these planktonic and early benthic forms.

Materials and Methods

Collections were made in the Charleston Bump region during July and August 2004, using a neuston net (1 m × 1 m in mouth size, 4 m in length and 5 μm mesh diameter) towed for 10 min in early evening in darkness. After each tow, the contents of the net were washed with filtered seawater and all the plankton was transferred to plastic trays. The megalopae were attracted with a light focus and removed with a Pasteur pipette to individual containers with local seawater (35 ppt). They were transported to the laboratory in thermo boxes to maintain the temperature near that of the collecting site (25°C).

In the laboratory at SERTC, the megalopae were transferred to new, clean individual containers, each labeled with the number of the tow and the specimen. All the 26 larvae obtained from neuston samples were kept at 35 ppt salinity, 24 ±1°C temperature and a regimen of 14 hr light and 10 hr darkness. The larvae were fed daily with freshly hatched *Artemia* nauplii, after the seawater was changed and the presence of any exuviae was noted. The specimens remaining from raisings are deposited in the NEBECC larval collection, Departamento de Zoologia, Instituto de Biociências, UNESP, Botucatu (SP), Brasil under the numbers #000101.1; #000101.2; #000101.3 and #000101.4.

The raising procedures were similar to those utilized by Fransozo & Negreiros-Fransozo (1987), Fransozo et al. (1988), Pohle et al. (1999), and Guimarães & Negreiros-Fransozo (2005).

The dead larvae and the exuviae were preserved in 80% ethanol for dissection and drawings. Dissections were carried

Table 1.—Descriptive measures and duration of the megalopa and juvenile crabs of *C. tortugae* raised in laboratory conditions.

Stage	*n*	Carapace length (mm)	Carapace width (mm)	CL/CW	Duration (days) ($\bar{X} \pm SD$)
Megalopa	15	3.22 ± 0.96	2.32 ± 0.63	1.39	8.86 ± 2.27[1]
First juvenile	7	3.37 ± 0.05	3.23 ± 0.12	1.04	9.56 ± 2.26
Second juvenile	6	4.31 ± 0.29	4.50 ± 0.20	0.96	11.5 ± 1.64
Third juvenile	6	5.65 ± 0.41	5.96 ± 0.46	0.95	19.67 ± 4.59
Fourth juvenile	6	7.29 ± 0.62	7.76 ± 0.60	0.94	—

[1] Note: Megalopa duration only during laboratory raising. It was not counted since the last zoeal molt.

out under a stereoscopic microscope (Zeiss, SV6), after that drawings were made under an optical microscope (Zeiss, Axioskop 2) provided with camera lucida and Nomarski system. At least ten megalopa exuviae and/or the whole larvae and all juvenile specimens obtained were utilized for morphological descriptions.

The species were identified by comparing the morphology of the juveniles with that of adults, as provided by Williams & Child (1989).

Description is made from the proximal to distal parts of the larval body or appendage segment. In general, the terms for larval morphology (mainly ornamentation) are adopted from those used by Pohle & Telford (1981) and Pohle et al. (1999). In antennule drawings, the aesthetascs were sometimes figured truncated in order to facilitate the counting. The abbreviations P_2, P_3, P_4, P_5 in the text and figures refer to pereopod 2, pereopod 3, etc.; and PL_1, PL_2, PL_3, PL_4, PL_5 and U to pleopods 1–5 and uropod, respectively.

Results

From the 26 megalopae obtained, only 15 molted to the first juvenile crab in 8.86 ± 2.27 d after collection, under experimental conditions.

Some descriptive measures and duration for the megalopa and first juvenile crabs of *C. tortugae* are presented in Table 1. The CL/CW ratio decreases from the megalopa to the fourth crab stage, becoming increasingly similar to that of the adult crab.

Some special setae present in *C. tortugae* larvae are shown in Fig. 1a–e. Figure 1a is a denticulate setae found on the third maxilliped endopod; Figure 1b is a serrate setae found on the pereopod dactyls; Figure 1c is another denticulate, but small, setae found on the coxal or basial endites of the maxillule; Figure 1d is the stiff setae found on the dactyl of the fifth pereopod; and Figure 1e is a cincinnulli found on the pleopodal endopod.

Megalopa description (Figs. 1f–3h).—Dimensions: CL = 3.22 ± 0.96 mm; CW = 2.32 ± 0.63 mm.

Carapace (Fig. 1f): longer than broad, without spines; dorsal surface smooth. Frontal region and rostrum slightly deflected downward. Chelipeds (Fig. 1g): chelipeds strong, large, dorsoventrally compressed; dactyl directed ventrally. Right cheliped is slightly larger than left. Both chelipeds bear sparse, simple setae, without ischial or coxal spines. Fixed and mobile fingers both provided with teeth and some simple setae; dactyl with row of small granules. Pereopods P_2, P_3, P_4, and P_5 (Fig. 1h–k) small compared with the entire body of megalopa. P_2, P_3, and P_4 bear 6 serrate setae on inner margin of dactyls. P5 with 3 or 4 serrate setae and 3 stiff setae.

Antennule (Fig. 2a): Peduncle 3-segmented, with 9 plumose and 1 simple setae on proximal segment; 2 terminal, 1 basal and several terminal simple setae on middle segment, and 1 terminal simple

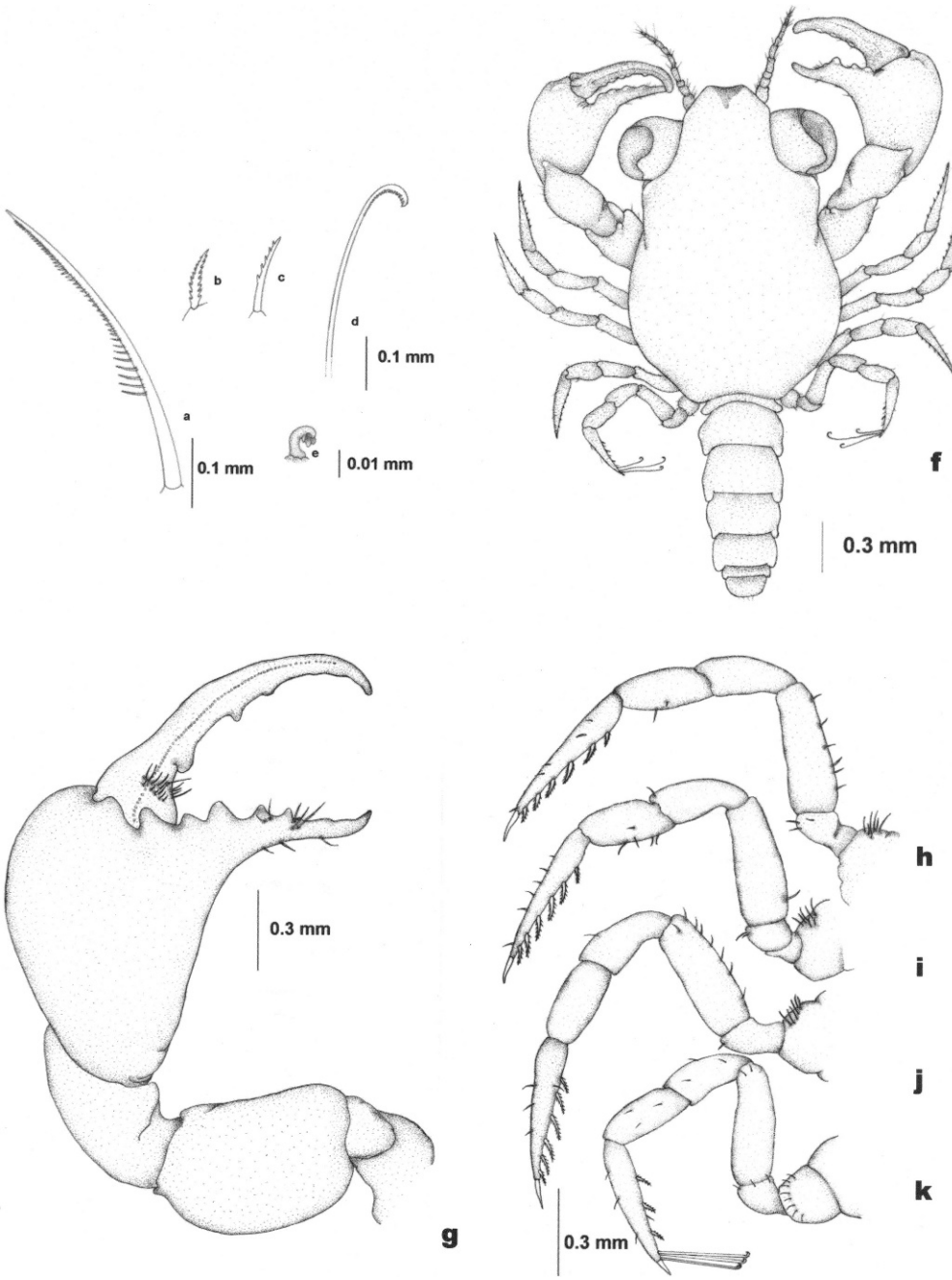

Fig. 1. *Calappa tortugae* Rathbun, 1933. Some special setae in the megalopa stage. a, denticulate; b, serrate; c, denticulate but small setae; d, stiff; e, cincinnulli; f, dorsal view of the megalopa stage; g, frontal view of the right cheliped; h–k, megalopa pereopods: P_2, P_3, P_4, P_5, respectively.

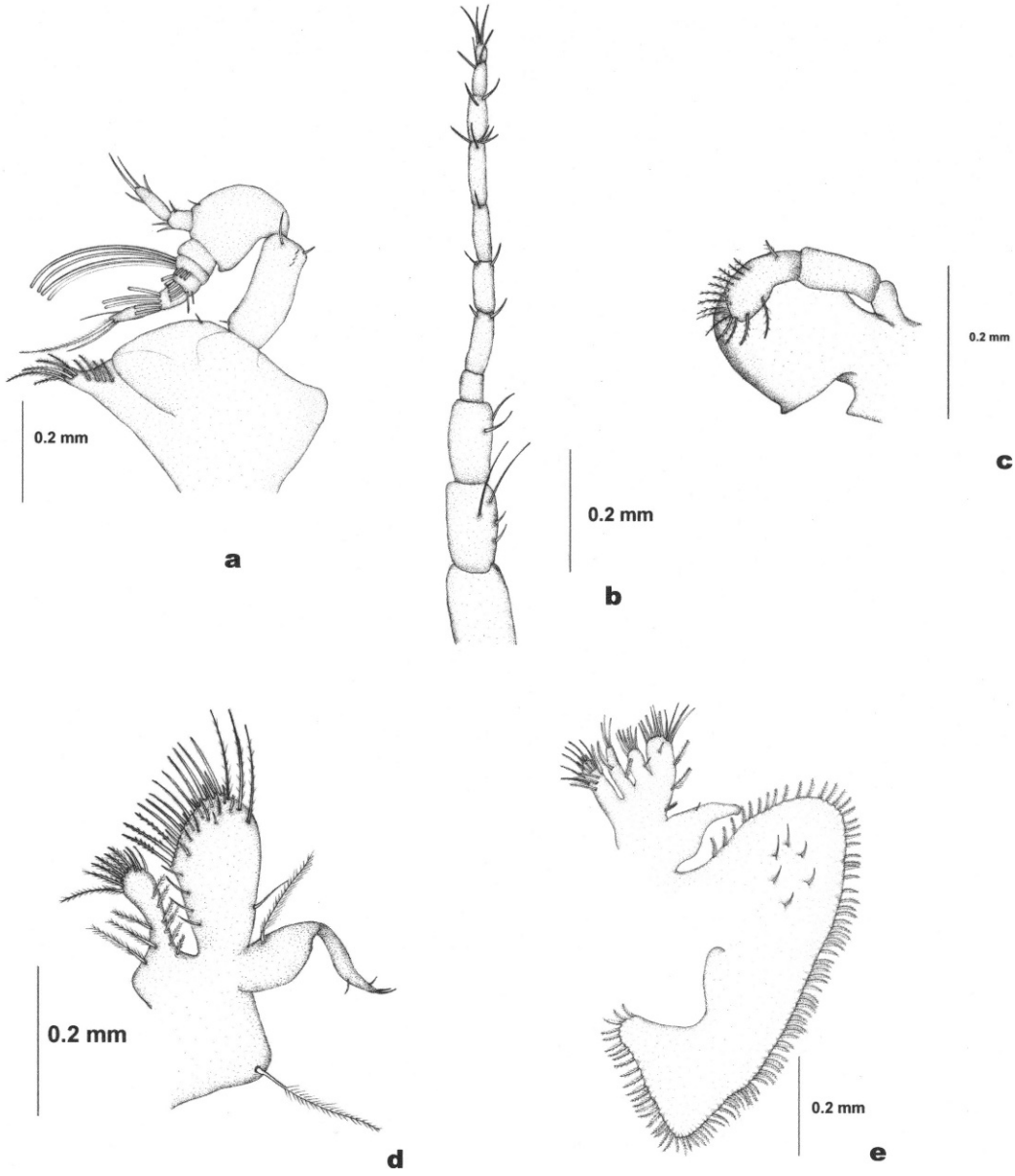

Fig. 2. *Calappa tortugae* Rathbun, 1933. Megalopa stage. a, antennule; b, antenna; c, mandible; d, maxillule; e, maxilla.

seta on distal segment. Inner flagellum (endopod) 2-segmented, with 3 simple setae on proximal segment and 4 simple setae on distal segment. Outer flagellum (exopod) 5-segmented, with 0, 7, 6, 5, and 0 aesthetascs and 0, 0, 2, 0, and 2 simple setae and 1 long plumose seta.

Antenna (Fig. 2b): Protopod 3-segmented, with 0, 4 and 2 simple setae; flagellum (endopod) 8-segmented, with 0, 2, 2, 1, 5, 2, 3, and 3 simple setae.

Mandible (Fig. 2c): with smooth, well-chitinized cutting blade. Palp 3-segmented, with 15 or 16 plumose setae,

provided with a few setules, on distal segment.

Maxillule (Fig. 2d): Protopod with 1 long plumose seta. Coxal endite with 3 and 6 plumose setae, respectively, on outer and inner margin, and 6 plumose setae and 3 simple setae distally. Basial endite with 4 simple setae on outer margin and 1 on inner margin, and with 3 plumose setae, 3 denticulate setae and 18–20 simple setae distally. Endopod 2-segmented, with 1 plumose seta in proximal region and 4 simple setae in distal.

Maxilla (Fig. 2e): Coxal endite strongly bilobed, with 3 bands of setae, terminal band with 6 denticulate setae, middle band with 3 denticulate setae, and proximal band with 4 plumose setae on proximal lobe, and distal lobe with 3 terminal simple setae and 2 subterminal plumose setae. Basial endite bilobed with 6 distal setae (3 simple setae and 3 denticulate) and 1 simple seta on proximal lobe, and distal lobe with 10 distal setae (7 simple and 3 denticulate), 3 plumose setae, and 3 simple setae. Endopod unsegmented, with 1 simple seta. Scaphognathite (exopod) with 96 marginal plumose setae and 6 sparse simple setae on blade surface.

First maxilliped (Fig. 3a): Coxal endite with 16 plumodenticulate setae and 1 simple seta on distal lobe, 10 plumodenticulate setae on dorsal part of proximal lobe, and several simple setae sparsely distributed, and 2 plumose setae. Basial endite with 14 or 15 plumose spines and 20 simple setae. Endopod unsegmented, with 6 simple setae on proximal and 5 setae on distal portion. Exopod 2-segmented, with 1 simple seta on proximal segment and 4 terminal plumose setae on distal segment. Epipod elongated with 22–26 slender simple setae.

Second maxilliped (Fig. 3b): Protopod with 1 long plumose seta. Endopod 4-segmented, with 2 simple, 8 simple, 3 simple + 2 plumose, and 2 simple + 8 plumose setae. Exopod 3-segmented, with 5 or 6 plumose setae on distal segment and 6–8 simple setae on proximal. Epipod with 2–4 slender simple setae. A gill bud can be seen in this appendage.

Third maxilliped (Fig. 3c): Protopod with 21–26 plumose setae with few setules. Endopod 5-segmented, covered by several simple setae. Additional setae as follows: 0, 5 (plumose), 10 (plumose), 12 (denticulate) and 7 or 8 (denticulate). Exopod 3-segmented, with 18 plumose setae on outer lateral margin of proximal segment, and 6 plumose setae and 2 simple setae on distal one. Epipod with 11 plumose setae on its basis and 10–12 slender simple setae on terminal part.

Abdomen (Fig. 1f) with somites broader than long, slightly shorter than carapace, with sparse, simple setae. Telson broader than long; posterior margin bearing 3 simple setae.

Pleopods (Fig. 3d–g) present from second to fifth abdominal somites, on their ventral surface. PL_2, PL_3, PL_4, and PL_5, have 26, 25, 25, and 21, long plumose setae, respectively, on the exopod, and 3 cincinnuli on inner margin of the endopod.

Uropod (Fig. 3h) present on sixth abdominal somite. Protopod with 1 long plumose seta, and exopod with 18 long marginal plumose setae.

First Juvenile crab (Figs. 4a–7f).—Dimensions: CL = 3.37 ± 0.05 mm; CW = 3.23 ± 0.12 mm.

Carapace (Fig. 4a) as long as broad, strongly convex and rough; rostrum slightly bilobed and prominent; anterolateral margins rounded; middle posterior margin not straight, because of abdominal insertion. Mid-dorsal area with protuberances evidencing stomach and cardiac regions.

Cheliped (Fig. 4b): well developed; slightly asymmetrical in size and shape; very high, strongly widening anteriorly, as long as high. Both chelipeds with dorsal dented keel. Right cheliped with large tubercle on propodus and another tuber-

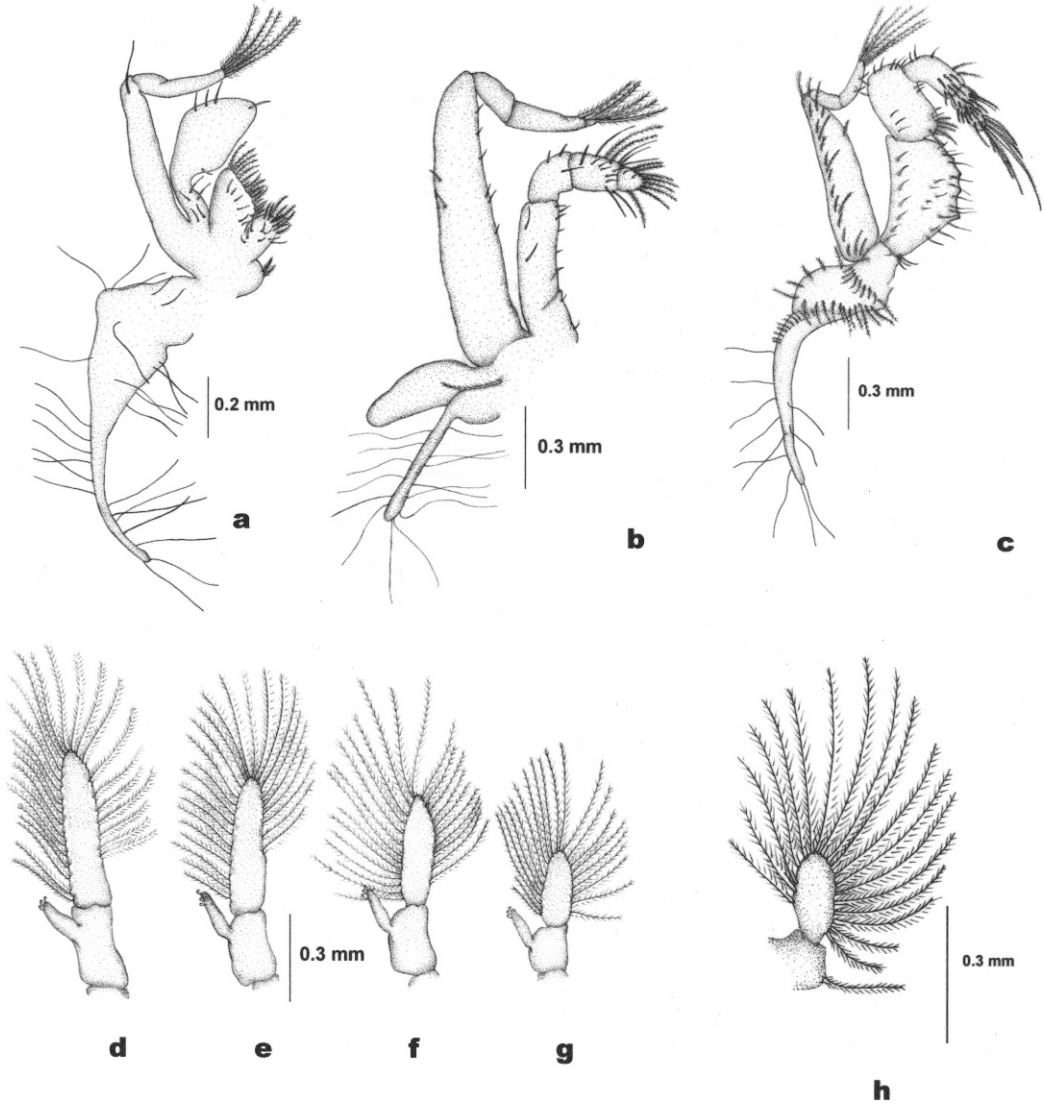

Fig. 3. *Calappa tortugae* Rathbun, 1933. Megalopa stage. a, first maxilliped; b, second maxilliped; c, third maxilliped; d–g, pleopods, Pl_2, Pl_3, Pl_4, Pl_5, respectively; h, uropod.

cle on dactyl. Left cheliped is thinner than right and unarmed with tubercles.

Pereopods thin, without spines or tubercles, dactyli slightly longer than other articles.

Antennule (Fig. 5a): Peduncle 3-segmented. Basial segment bulbous, bearing 36 plumose setae, arranged in 3 rows, 8, 4, and 24 from proximal to distal portion. The dorsodistal margin of the proximal segment has several nodules. Median segment with 2 plumose and 6 simple setae, 2 simple setae inserted on proximal inner margin. Distal segment with 2 simple setae distally. Endopod 2-segmented, bearing 2 simple setae on proximal segment and 8 simple setae on distal segment. Exopod 8-segmented, with 0, 7, 6, 5, 3, 0, 0, and 0 aesthetascs; penultimate segment with 4 simple setae distally and last segment with 1 simple and 2 plumose setae distally.

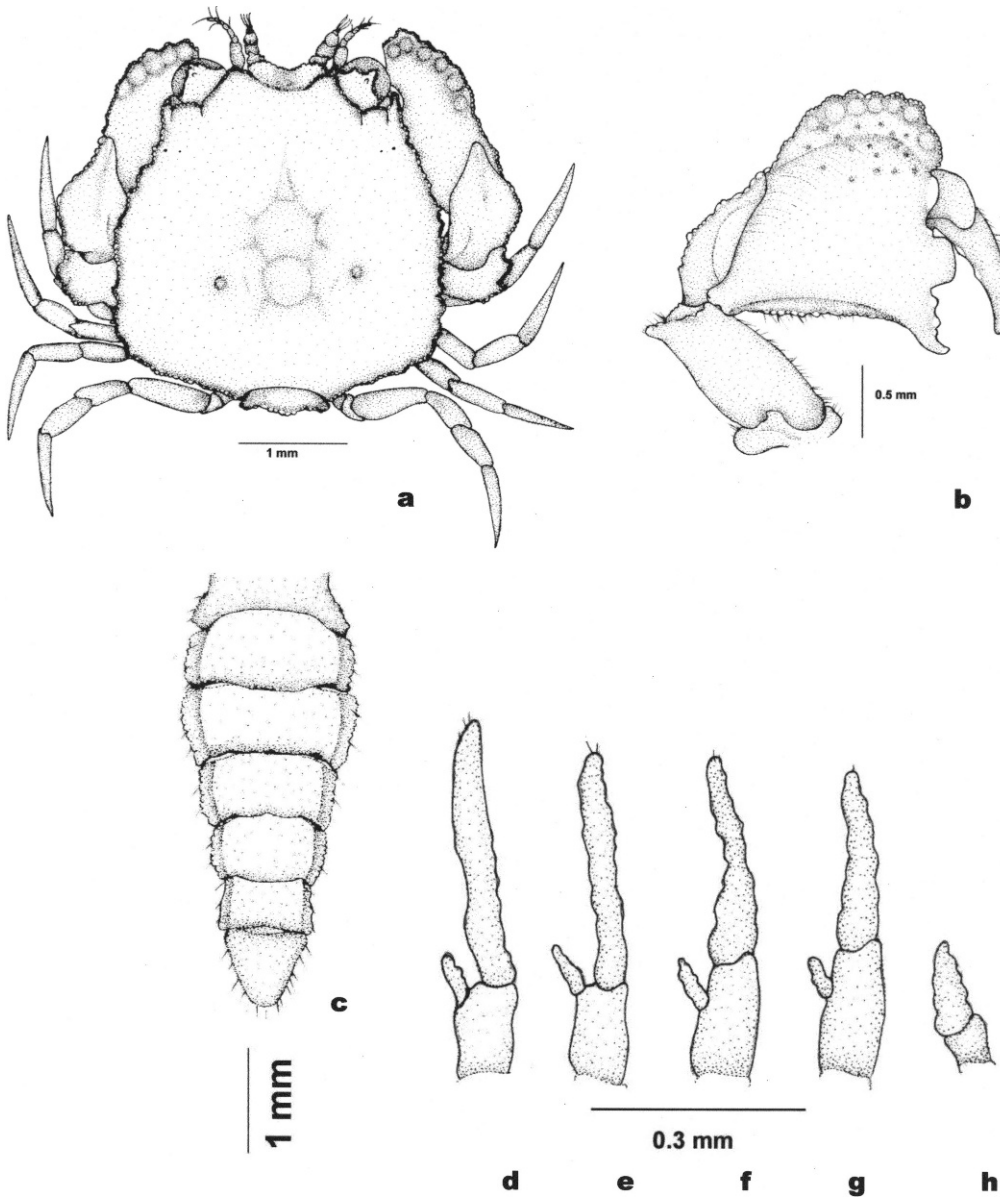

Fig. 4. *Calappa tortugae* Rathbun, 1933. First juvenile crab. a, dorsal view; b, right cheliped in frontal view; c, dorsal view of abdomen; d–g, pleopods, Pl_2, Pl_3, Pl_4, Pl_5, respectively; h, uropod.

Antenna (Fig. 5b): Protopod 3-segmented, the proximal segment provided with 15, 2 and 6 simple setae and some lateral and dorsal nodules. Flagellum 12-segmented with 1, 2, 0, 1, 0, 4, 0, 0, 2, 1, 1, and 3 simple setae.

Mandible (Fig. 5c): Molar and incisor processes provided with a cutting blade. Dorsally there is a 2-segmented palp with no setae on the proximal segment and 30 short plumose setae along almost its entire margin.

Maxillule (Fig. 5d): Protopod provided with 4 plumose setae on outer margin and 5 simple setae on inner margin. Coxal endite reduced but covered with setae;

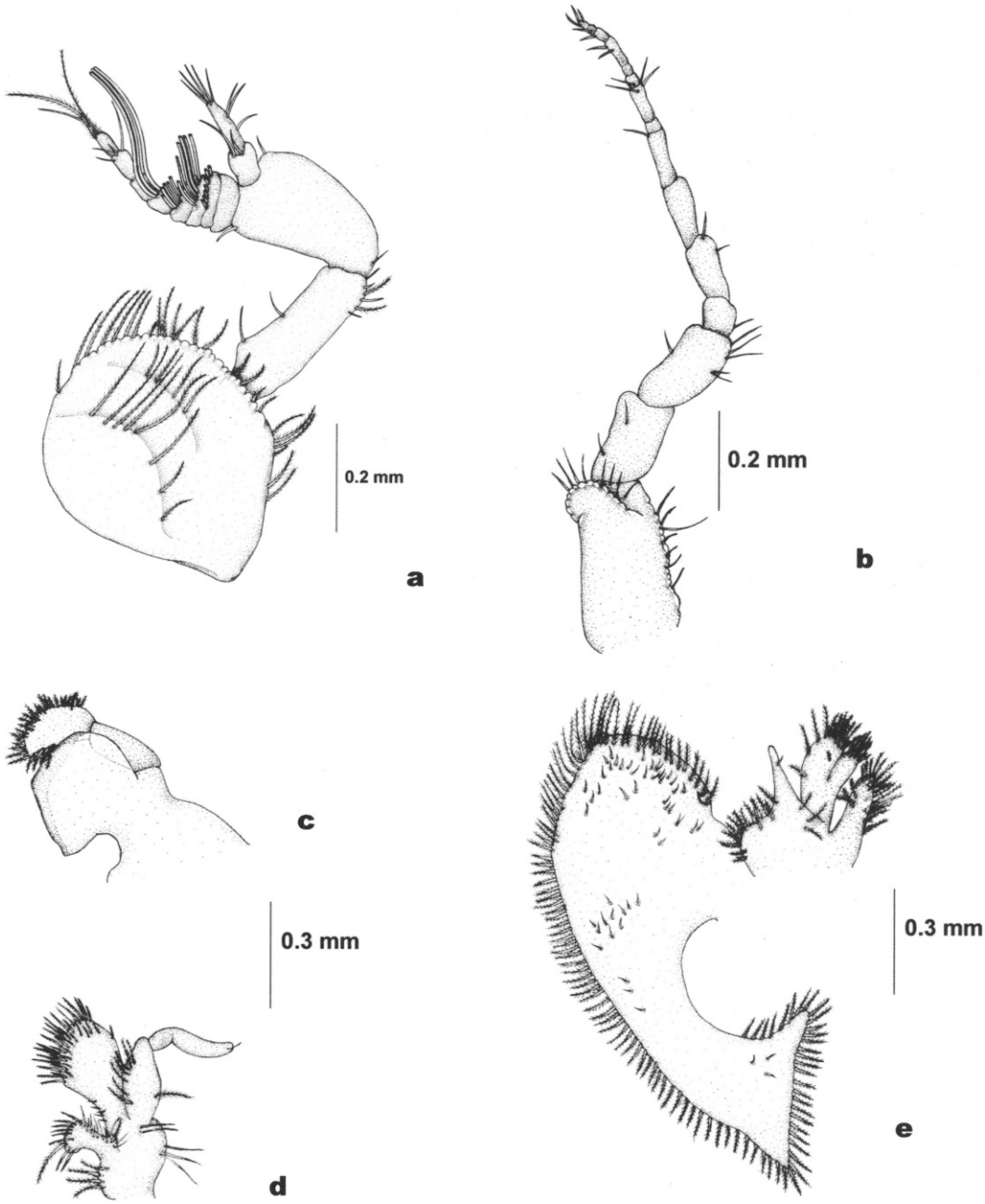

Fig. 5. *Calappa tortugae* Rathbun, 1933. First juvenile crab. a, antennule; b, antenna; c, mandible; d, maxillule; e, maxilla.

there are 2 plumose setae, 8 denticulate setae, and 10 simple setae. Basial endite with 5 small simple setae on inner margin, and 35–40 small denticulate setae. Endopod 2-segmented, with 8 plumose setae on proximal segment.

Maxilla (Fig. 5e): Coxal endite unlobed, with 12 plumose setae, 5 denticulate setae, and 4–6 simple setae. Basial endite bilobed, with only 10 denticulate setae on proximal lobe, and 12–14 denticulate and 5 or 6 plumose setae

on distal lobe. Scaphognathite (exopod) with 112–117 plumose setae and several simple setae on blade surface, distributed in three differentiated areas, 35 on proximal, 14 on medial, and 3 on distal area. Endopod unsegmented, with 14 plumose setae on its outer lateral margin, 3 plumose setae on its inner margin, and 1 simple seta more distally.

First maxilliped (Fig. 6a): Coxal endite with 13 plumodenticulate setae and several simple setae (as figured). Basial endite with 20–22 denticulate setae. Endopod unsegmented, with 9 plumose setae on proximal portion and several simple setae on inner margin. Exopod 2-segmented, bearing 9 plumose setae on proximal portion and 14 on distal portion of proximal segment, and 6 terminal plumose setae on distal segment. Epipod with slender simple setae as figured.

Second maxilliped (Fig. 6b): Protopod with 1 plumose seta and 1 simple seta. Endopod 4-segmented, with 9 and 4 simple setae on first and second segments, respectively; 10 and 10 denticulate setae on third and fourth segments, respectively. Exopod 2-segmented, with 8 plumose setae on its basis, 14 plumose setae on outer margin, and 5 simple setae on inner margin of the proximal segment; distal segment with 6 plumose setae. Epipod with slender simple setae as figured; gill bud present.

Third maxilliped (Fig. 6c): Protopod without setae. Endopod 5-segmented, with several setae as follows: 22 (simple), 16 (plumose), 15 (plumose), 4 (simple), and 2 (denticulate), and 4 (denticulate) setae. Exopod 2-segmented, with 7 simple setae on outer lateral margin of proximal segment, and 14 to 16 plumose setae from inner margin to distal margin; terminal segment with 10 small plumose setae. Epipod with 34–36 plumose setae in the proximal part, and 22–24 slender simple setae along its terminal part.

Abdomen (Fig. 4c) narrow with somites free, well-calcified; each somite with slight depression on lateral margins.

Pleopods (Fig. 4d–g) present from second to fifth somites. Biramous, but reduced and almost without setae.

Uropods (Fig. 4h) uniramous, without setae.

Morphological changes from second to fourth juvenile stages (Figs. 6d–f, 7a–r).—The general shape of the carapace, pereopods and abdomen (Fig. 6d–f) does not change remarkably from the second to the fourth juvenile stages. Nevertheless, the number and shape of the pleopods can vary according to sex. The secondary sexual characters can be noted beginning in the second juvenile stage. If the juvenile crab is a male, it has a pair of uniramous pleopods (Fig. 7a) on the ventral surface of the first abdominal somite and a pair of biramous pleopods (Fig. 7b) on the second abdominal somite. In the third and fourth juvenile crabs, both pleopods are uniramous (Fig.7c–f). If the juvenile crab is a female, it has 4 pairs of biramous pleopods from the second to the fifth abdominal somites (Fig.7g–r). As juvenile development continues, the segmentation and setation of these pleopods become more complex.

Discussion

The complete larval development of calappoid crabs is poorly known. Bellwood (1996) reviewed the taxonomy and phylogenetic position of the Calappoidea, showing only the families Calappidae and Hepatidae now constitute this group. Additionally, Martin & Davis (2001) also adopted changes for the Calappoidea, including placing Matutidae in Leucosioidea and Orithyiidae in Dorippoidea. Therefore, the complete larval development within the family Calappidae (sensu stricto) is not known for any species, as the fully described *H. epheliticus* and *H. pudibundus* belong to the Hepatidae.

An interesting feature presented by the megalopa of *C. tortugae* and, to our knowledge only previously reported for

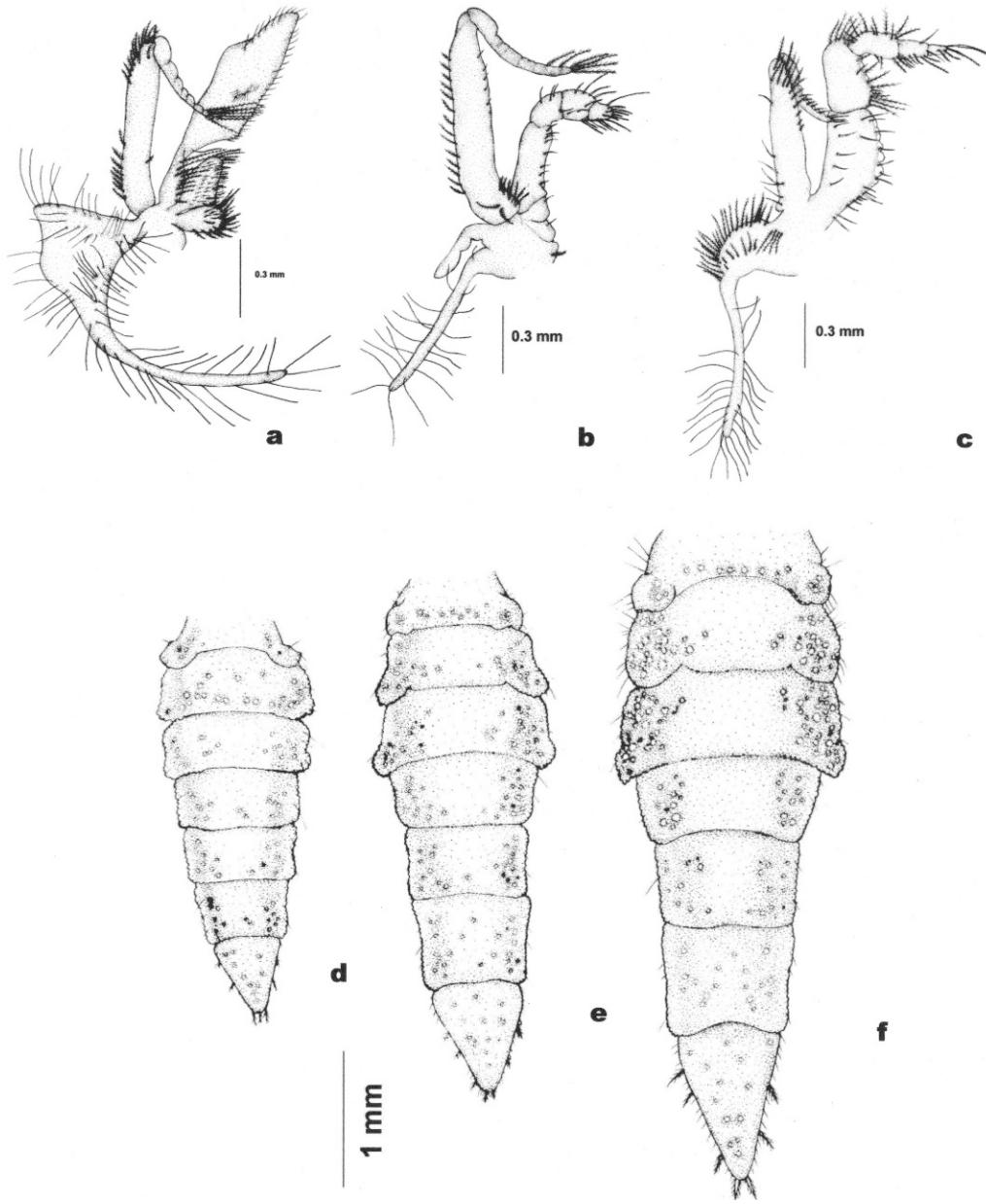

Fig. 6. *Calappa tortugae* Rathbun, 1933. First juvenile crab. a, first maxilliped; b, second maxilliped; c, third maxilliped; d–f, dorsal view of the abdomens of second, third and fourth juvenile crabs.

C. granulata megalopa by Guerao et al. (1998), is that right-handed heterochely is already present at the megalopal stage.

The megalopa of *Calappa* species can now be distinguished from other crab megalopae known from United States western Atlantic waters by its large size, large and characteristic chelipeds, and the large number of setae on the scaphognathite, as usually the megalopal general features are shared by species within the genus.

The morphology of the first crab observed in this study agrees with that

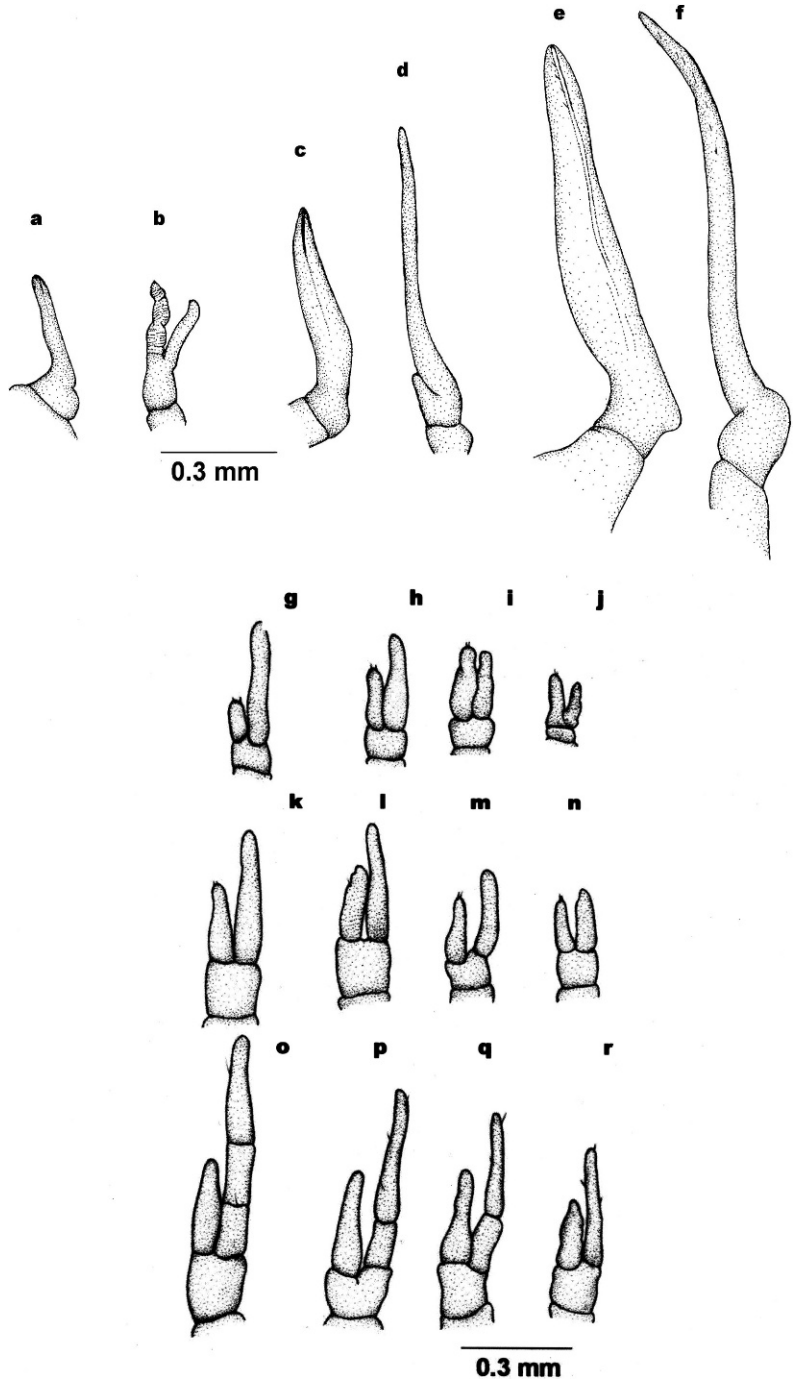

Fig 7. *Calappa tortugae* Rathbun, 1933. First juvenile crab. Male pleopods Pl_1 (a, c, e) and Pl_2 (b, d, f) of the second, third, and fourth juvenile stages, respectively; d–f, female pleopods Pl_2 (g, k, o), Pl_3 (h, l, p), Pl_4 (i, m, q), Pl_5 (j, n, r) of the second, third, and fourth juvenile stages, respectively.

of the adult of *C. tortugae*, especially in the diagnostic characteristics of the species (overall shape of the carapace, placement of granules in carapace and chelipeds, etc.) as described by Williams & Child (1989). The morphology of the juvenile crabs examined here does not suggest that it could be assigned to any of the other species known to occur in the western Atlantic off the coast of the U.S.A.

Flores et al. (1998) emphasized that the crab species having large-sized megalopae are typical of difficult, stressed habitats, such as rocky shores (with strong waves) or even estuarine areas (with wide variations in salinity). Such species are assumed to have a long larval development and short juvenile phases [e.g., *Pachygrapsus transversus* (Gibbes, 1850)]. However, *C. tortugae* inhabits a relatively calm environment. It has been observed to be more abundant in offshore than inshore waters in depths of 13–238 m (Williams & Child 1989). This species has a large megalopa (3.22 ± 0.96 mm CL) stage and short juvenile development (secondary sexual characters present in the second juvenile stage), which is contrary to previous explanations about the relation between the size of the megalopae and a stressed environment.

Within the family Calappidae, the megalopa stage is known only for *C. flammea*, *Cryptosoma balgueri* (from incomplete descriptions given by Lebour (1944), and for *C. granulata* (complete description provided by Guerao et al. 1998). Concerning the megalopa of *C. flammea*, the overall carapace shape and the chelipeds are very similar to those of *C. granulata* and *C. tortugae*. The carapace length is similar for *C. flammea* and *C. granulata* (4.2 mm in the former and 4.6 mm in the latter), with *C. tortugae* (3.22 ± 0.96 mm) being the smallest among them. This is still large when compared with *H. epheliticus* (CL = 1.1 mm) and *H. pudibundus* (CL = 1.24 mm).

A detailed comparison of the morphologic features among *H. epheliticus, H. pudibundus* and *C. tortugae* are presented in Table 2. Note that the description provided by Lebour (1944) was not included in this table as it is very superficial; she presented two figures of a dorsal view of *Cryptosoma balgueri* (as *Cyclöes. bairdii*), the cheliped, the dactyl of the fifth pereopod (3 stiff setae + 1 simple setae) and the uropod (showing 17 setae).

This analysis shows that there is a general similarity among the species concerning the overall shape of the carapace, which have a slightly deflected rostrum and an enlargement of their anterolateral margins. The entire bodies are covered by minute simple setae. The dactyls of the fifth pereopod have 3 stiff setae in all the analyzed species. With respect to the antennule the species of the genus *Hepatus* have an unsegmented inner flagellum while *C. tortugae* has it 2-segmented. The outer flagellum of the antennule differed between the species of the genus *Hepatus*, but both *H. pudibundus* and *C. tortugae* have 5 segments. The mandibular palp is 2-segmented in the megalopae of *Hepatus* species, but *C. tortugae* has it 3-segmented with a higher number of setae (15 or 16). The maxillule has distinct setation for the three species, but the easier feature to distinguish them is the setation of the protopod (*H. epheliticus* = 3 plumose setae; *H. pudibundus* = 2 plumose setae; *C. tortugae* = 1 plumose setae).The scaphognathite of the maxilla is very different among the species: 55, 49–55, and 96 plumose setae for *H. epheliticus*, *H. pudibundus*, and *C. tortugae*, respectively. The epipod of the first maxilliped present a higher number of setae in *C. tortugae* (22–26 simple setae). Both second and third maxillipeds present variations of setae number and type in the three compared species, and it is difficult to separate them by this feature. The original description of *H.*

Table 2.—Comparison of Calappoid megalopae characters among previously known species[1] from the U.S. western Atlantic and *C. tortugae*.

Characters	*Hepatus epheliticus* (L.) Costlow & Bookhout (1962)	*Hepatus pudibundus* (Herbst, 1785) Rieger & Hebling (1993)	*Calappa tortugae* Rathbun, 1933 present study
Size	CL = 1.1 mm[2]	CL = 1.24 mm[2]	CL = 3.22 ± 0.96 mm
	CW = 0.86 mm[2]	CW = 1.12 mm[2]	CW = 2.32 ± 0.63 mm
Carapace	with numerous short hairs	with some simple setae	dorsal surface smooth
	anterolateral margins terminates as a slightly thickened knob	anterolateral margins with a rounded protuberance	
	rostrum short with a median knob deflected downward	rostrum small and deflected downward	rostrum slightly deflected downward
Chelipeds	Simple setae	Symmetrical with simple setae	Asymmetrical, strong, large
Pereopods	Dactyls of P5 with 3 stiff setae[a]	Dactyls of P5 with 3 stiff setae	P2, P3, P4 with 6 serrate setae; Dactyls of P5 with 3–4 serrate setae + 3 stiff setae
Telson	naked	naked	3 simple setae on distal margin
Antennule			
inner flagellum	unsegmented with 5 simple setae	unsegmented with 6 simple setae	2-segmented with 3, 4 simple setae
outer flagellum	4-segmented with 8, 8, 6, 3 aesthetascs	5-segmented with 0, 8, 8, 6, 3 aesthetascs	5-segmentend with 0, 7, 6, 5, 0 aesthetascs
Antenna	9-segmented	8-segmented	8-segmented
Mandibular palp	with 13 simple setae	with 13 plumose setae	with 15 or 16 plumose setae
Maxillule			
protopod	3 plumose setae	2 plumose setae	1 long plumose setae
endopod	2-segmented with 2, 2 simple setae		2-segmented with 1 plumose setae, 4 simple setae
Maxilla			
endopod	8 plumose setae	6 plumose setae	1 simple setae
exopod	55 plumose setae	49–55 plumose setae	96 plumose setae + 6 simple setae
First maxilliped			
endopod	11 plumose setae	6 simple setae	11 simple setae
exopod	2, 6 plumose setae	3 plumose setae, 1 simple setae	4 plumose setae, 1 simple setae
epipod	16 simple setae	2 plumose setae, 12 simple setae	22–26 simple setae
Second maxilliped			
protopod	4 plumose setae	3 plumose setae	1 long plumose setae
endopod	2, 0, 6, 8 plumose setae	2, 1, 4, 7 plumose setae	2 simple, 8 simple, 13 simple + 12 plumose, 2 simple + 8 plumose
exopod	4 plumose setae	4 plumose setae	5 or 6 plumose setae, 0, 6–8 simple setae

Table 2.—Continued.

Characters	*Hepatus epheliticus* (L.) Costlow & Bookhout (1962)	*Hepatus pudibundus* (Herbst, 1785) Rieger & Hebling (1993)	*Calappa tortugae* Rathbun, 1933 present study
Third maxilliped			
endopod	26, 9, 5, 8, 7 plumose setae	21–23, 14 or 15, 9, 9, 7 plumose setae	0, 5 plumose, 10 plumose, 12 plumodenticulate, 7 or 8 plumodenticulate
exopod	6, 2 plumose setae	6, 1 plumose setae	18 plumose, 6 plumose, 2 simple
epipod	6 plumose setae, 11 simple setae	4 plumose setae, 9 or 10 simple setae	11 plumose setae, 10–12 simple setae
Pleopods			
exopod		14 or 15, 14–16, 14 or 15, 12–14 plumose setae	24, 25, 25, 21 plumose setae
Uropod			
protopod		1 plumose setae[2]	1 plumose setae
exopod		9 plumose setae[2]	18 plumose setae

[1] Lebour's (1944) paper is not detailed enough to be listed in this table.
[2] Obtained from original drawings.

epheliticus larvae does not show the ornamentation of the pleopods and uropods, but *H. pudibundus* and *C. tortugae* differ in the setal numbers, the last being more setose than the former.

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