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The sponge-dwelling snapping shrimps (Crustacea, Decapoda, Alpheidae, *Synalpheus*) of Discovery Bay, Jamaica, with descriptions of four new species

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Abstract

Twenty-two species of sponge-dwelling shrimp in the genus *Synalpheus* were collected in the vicinity of Discovery Bay, Jamaica. Four of these species are new to science. *Synalpheus thele* **n. sp.**, *S. corallinus* **n. sp.**, and *S. plumosetosus* **n. sp.** belong to a group of morphologically similar species that also includes *S. brooksi, S. bousfieldi, S. carpenteri*, and *S. chacei*. *Synalpheus irie* **n. sp.** is a highly distinctive shrimp most similar to *S. mcclendoni*, but can be distinguished from the latter by the unique bowl-shaped fingers of the major chela and the two-pronged distal protuberance on the palm of the major chela. *Synalpheus belizensis* and *S. regalis* are reported for the first time from outside their type localities in Belize, while *S. bocas* and *S. duffyi* are reported for the first time outside their type localities in Caribbean Panama.

Key words: *Synalpheus, Zuzalpheus*, gambarelloides group, Alpheidae, Decapoda, symbiotic, coral reef, eusociality, sponges

Introduction

Snapping shrimps of the genus *Synalpheus* Bate, 1888 are a diverse component of the cryptic fauna of shallow tropical marine ecosystems worldwide (Felder and Chaney 1979; Reed et al. 1982). The genus includes more than 150 species (Chace 1988; Ríos and Duffy 2007) that inhabit the interstices of coral rubble, the internal spaces of sponges, and (in the Indo-Pacific) hard and soft corals, ascidians and crinoids (Beebe 1928, Pearse 1932; Banner and Banner 1975; Bruce 1976; Duffy 1992).

In the Caribbean, the diversity of the genus *Synalpheus* is dominated by a group of obligate sponge-dwelling species, designated the "*S. laevimanus* group" by Coutière (1908, 1909), and subsequently changed to the "*S. gambarelloides* group" (Holthuis and Gottlieb 1958), which currently contains at least 38 species. This group is monophyletic in the western Atlantic (Morrison et al. 2004) and, based on molecular results and several morphological synapomorphies, was raised to a generic level, as *Zuzalpheus* Ríos and Duffy. Subsequently, Anker and De Grave (2008) argued that the *S. gambarelloides* group was not distinctive enough to warrant recognition as a genus, although it may well represent a subgenus and that such an action should wait for a more comprehensive analysis of *Synalpheus*; they thus concluded that *Zuzalpheus* should be recognized as a junior synonym of *Synalpheus*. In the interest of minimizing taxonomic confusion, we follow the latter suggestion pending such a revision, and henceforth refer to the group as the *Synalpheus gambarelloides* species group.

Investigations of the sponge-dwelling *Synalpheus* in new localities have allowed new insights into the ecology of these shrimps, as well as yielding many new species (see Macdonald and Duffy 2006; Ríos and Duffy 2007; Anker and Tóth 2008). For example, >14 years of collecting on the Belize Barrier Reef substantially changed our understanding of host association and specificity patterns of *Synalpheus* shrimps in sponges (Duffy 1996b; Macdonald et al. 2006), and doubled the number of described species in the group. Yet few comparable surveys have been conducted elsewhere.

Here we report results of a survey of the sponge-inhabiting *Synalpheus* of the Discovery Bay region on the north coast of Jamaica, West Indies. Despite pioneering research conducted at Discovery Bay on coral reef ecology (Goreau 1959; Edmunds and Bruno 1996; Lehnert and van Soest 1998a,b; Hughes and Tanner 2000; Wulff 2006) and evolutionary ecology of snapping shrimps in the genus *Alpheus* Fabricius (Knowlton 1980), the sponge-dwelling *Synalpheus* of the region have not been systematically sampled. The goals of this study were to characterize the sponge-dwelling *Synalpheus* shrimp fauna of the Discovery Bay region area and to assess how comprehensively the diversity of a region can be estimated with a single, intensive sampling survey.

Materials and methods

We sampled sponge-associated snapping shrimps from five sites in the vicinity of Discovery Bay, Jamaica between 22 January and 1 February 2008. Sponges were collected by hand while using SCUBA; we focused on sponges previously known to host *Synalpheus* species (Macdonald et al. 2006; Ríos and Duffy 2007), but also examined as many other sponge species as possible. We extensively searched rubble and live reef framework for cryptic sponges (e.g., *Hymeniacidon caerulea* Pulitzer-Finali, *Lissodendoryx* spp.), excavated larger semi-cryptic sponges from the reef matrix (*Hyattella intestinalis* Lamarck, *Xestospongia proxima* Duchassaing & Michelotti, *X. subtriangularis* Duchassaing), and removed whole specimens of more exposed sponges (*Agelas* cf. *clathrodes* Schmidt, *Agelas* cf. *dispar* Duchassaing and Michelotti, *Aiolochroia (Pseudoceratina) crassa* Hyatt). Sponge samples were then transported to the field station at the Discovery Bay Marine Lab in mesh bags, and retained in flowing seawater until processed. Sponges were subsequently dissected carefully, and all macrofauna was removed. Alpheid shrimps were sorted by species, usually counted and sexed, photographed alive, and then preserved in 95% EtOH. Type specimens and voucher material are deposited in the National Museum of Natural History, Smithsonian Institution, Washington, DC (USNM); other material is housed temporarily at the Virginia Institute of Marine Science, Gloucester Point, VA (VIMS) as research is ongoing. VIMS numbers refer to specimen numbers assigned in the field; eventually all specimens will be deposited in appropriate permanent repositories. For all collected individuals, carapace length (CL) in mm was measured from the posterior margin of the carapace on the dorsal midline to the base of the rostrum. Carapace length is listed for all types and figured individuals, and max CL for both females and males is listed for all species. Specimens were figured from digital photos taken by a Diagnostic Instruments Spot RT photo system using an Olympus BX50 light microscope and a Nikon SMZ-U dissecting microscope. Because sexes in *Synalpheus* are difficult to distinguish based on external morphology (Tóth and Bauer 2007), we list specimens only as ovigerous (i.e. carrying eggs or embryos beneath the abdomen) vs. non-ovigerous (i.e. not carrying embryos).

To determine how well we sampled the sponge-dwelling *Synalpheus* fauna of Discovery Bay, we tallied the accumulation of both *Synalpheus* species and of shrimp/sponge associations (any unique pairing between a shrimp species and host sponge species) as a function of number of samples collected, looking for evidence of an asymptote. We subsequently calculated mean estimates of the true diversity of shrimp species, sponge species, and shrimp/sponge associations using the Michaelis–Menten (Michaelis and Menten 1913) logistic curve-fitting function in the program EstimateS (Colwell 2005). Three additional measures were used to estimate true species richness: Chao's (1987) Chao2 measure, the Burnham and Overton (1978) second-order jackknife, and the Smith and van Belle (1984) bootstrap.

Collecting sites. Columbus Park (18° 27.955′ N, 77° 24.843′ W) is located inside Discovery Bay and contains many freshwater fissures ~7-10 m below the surface, surrounded by a loose reef framework of rubble from colonies of the corals *Madracis auretenra* Locke, Weil and Coates (formerly *M. mirabilis*, see Dardeau 1984; Macdonald et al. 2006; Rios and Duffy 2007; Locke, Weil and Coates 2007), *Porites* sp., and *Acropora* spp., often covered by a thick layer of silt, and extending down to a depth of ~20 m. We collected at depths ranging from 5–18 m. The M1 fore-reef site (18° 28.344′ N, 77° 24.606′ W; 14–18 m depth) lies just offshore of Discovery Bay and consists primarily of a consolidated pavement of mounding and boulder corals (*Montastraea* sp.), dead coral, and algae, with little live coral cover. Dairy Bull (18° 28.083′ N, 77° 23.289′ W) and Pear Tree Bottom (18° 27.780′ N, 77° 21.643′ W) are ~ 2 and 5 km, respectively, east of Discovery Bay. Both reefs consist of spur-and-groove and patch reefs covered with rubble and live colonies of branching species (*Porites* sp., *Madracis auretenra*) and some massive and encrusting corals; collecting depths ranged from 8 to 15 m. The last site is situated ~ 4 km west of Discovery Bay, on the west side of Rio Bueno Harbor (18° 27.778′ N, 77° 27.617′ W); this site grades from an algae-dominated spur-and-groove reef at ~8 m depth down to a steep coral-dominated drop-off, which we explored to a depth of 24 m. In addition to these sites, we surveyed shallow seagrass beds, patch reefs, and sand flats in the Discovery Bay back-reef area (1–3 m depth), but found few appropriate sponges.

TABLE 1. Sponge-dwelling *Synalpheus* species found in the present study, with host associations. Numbers indicate the number of different individual sponges in which the given shrimp species was found. Sponge species in brackets "[ ]" indicate possible synonyms recorded in Lehnert and van Soest (1998a, 1998b). Entries for *Pseudoceratina crassa* include the soft, filmy grey-brown sponge that often lines the canals of *P. crassa.*

	Agelas cf. *clathrodes*	*Agelas* cf. *dispar*	*Hyattella intestinalis* [*cavernosa*]	*Hymeniacidon caerulea*	*Lissodendoryx* sp.
Total number of individual sponges sampled	10	16	30	5	3
Columbus park	3	0	20	2	3
Discovery Bay Fore Reef	1	4	2	1	0
Pear Tree Bottom	3	4	2	0	0
Dairy Bull Reef	1	4	3	2	0
Rio Bueno	2	4	3	0	0
***S. gambarelloides* group**					
agelas	4	4			
androsi			2		
belizensis					
bocas					
bousfieldi	1		1		
brevifrons					
brooksi			2		
carpenteri	9	15			
corallinus **n. sp.**			1		
duffyi					
elizabethae			7		
mcclendoni	2	1			
irie **n. sp.**					
pandionis					2
pectiniger					
plumosetosus **n. sp.**					
regalis			19		
sanctithomae			3		
thele **n. sp.**	4				
ul			1	3	1
williamsi				2	
yano				1	
non-*S. gambarelloides* group					
'brevicarpus green embryos'					
'brevicarpus orange'					
dominicensis			1		
townsendi	4		1		

continued next page

TABLE 1. (continued)

	Aiolochroia [*Pseudoceratina*] *crassa*	*Spheciospongia vesparium*	*Xestospongia proxima*	*Xestospongia subtriangularis*	Unid purple sponge	*Auletta* cf. *sycinularia*
Total number of individual sponges sampled	11	1	7	2	1	4
Columbus park	1	1	2	0	1	0
Discovery Bay Fore Reef	4	0	0	0	0	2
Pear Tree Bottom	0	0	2	1	0	0
Dairy Bull Reef	3	0	0	0	0	2
Rio Bueno	3	0	3	1	0	0
***S. gambarelloides* group**						
agelas						
androsi						
belizensis			6			
bocas			4	1		
bousfieldi					1	
brevifrons	1					
brooksi						
carpenteri						
corallinus **n. sp.**						
duffyi			5	1		
elizabethae						
mcclendoni		1				1
irie **n. sp.**						2
pandionis						
pectiniger		1				
plumosetosus **n. sp.**						1
regalis						
sanctithomae						1
thele **n. sp.**						
ul						
williamsi						
yano						
non-*S. gambarelloides* group						
'brevicarpus green embryos'	6					
'brevicarpus orange'	5					
dominicensis						
townsendi						

Results

Over the course of 11 days, we collected 90 samples that contained shrimps from a total of 11 sponge species. Twenty-two species of *Synalpheus* in the *S. gambarelloides* group were identified, of which four were new to science. These four new species, described below, have so far only been found in Jamaica. Seven additional

species were found for the first time outside their type localities. Eleven other species were previously not known from Jamaica, thus representing new records for the marine fauna of this island.

Accumulation curves for shrimp species richness, sponge species richness, and number of unique shrimp/sponge associations (Fig. 1) show evidence of a decelerating rise by the end of the collection period, but a definitive asymptote was not reached during the collection trip. All methods of estimating true species richness supported higher actual richness than that observed in Jamaica, but to different degrees (Table 2). The Michaelis–Menten function estimates a true (asymptotic) shrimp species richness of 30, while the jackknife, bootstrap, and Chao2 estimate 32, 27, and 27 species respectively. The four methods estimate shrimp-bearing sponge species richness at 12, 14, 12, and 12 respectively, and estimate the number of shrimp/sponge associations at 36, 38, 31, and 32 respectively. Thus, we estimate that we have collected 69-81% of the total *Synalpheus gambarelloides* group species, 79–92% of the shrimp-bearing sponge species, and uncovered 79–97% of the unique shrimp/sponge associations from the sites examined in Jamaica.

TABLE 2. Observed and estimated richness of *gambarelloides*-group shrimp species, shrimp-supporting sponge species, and unique shrimp/sponge associations in the vicinity of Discovery Bay, Jamaica. Values are based on the Michaelis–Menten (Michaelis & Menten, 1913) logistic curve-fitting function, Chao's (1987) Chao2 measure, the Burnham and Overton (1978) second-order jackknife, and the Smith and van Belle (1984) bootstrap, all estimated in the program EstimateS (Colwell, 2005).

	Shrimp Species	Sponge Species	Shrimp/Sponge Associations
Observed	22	11	30
Michaelis–Menten	30	12	36
Chao2	32	12	32
jackknife	27	14	38
bootstrap	27	12	31

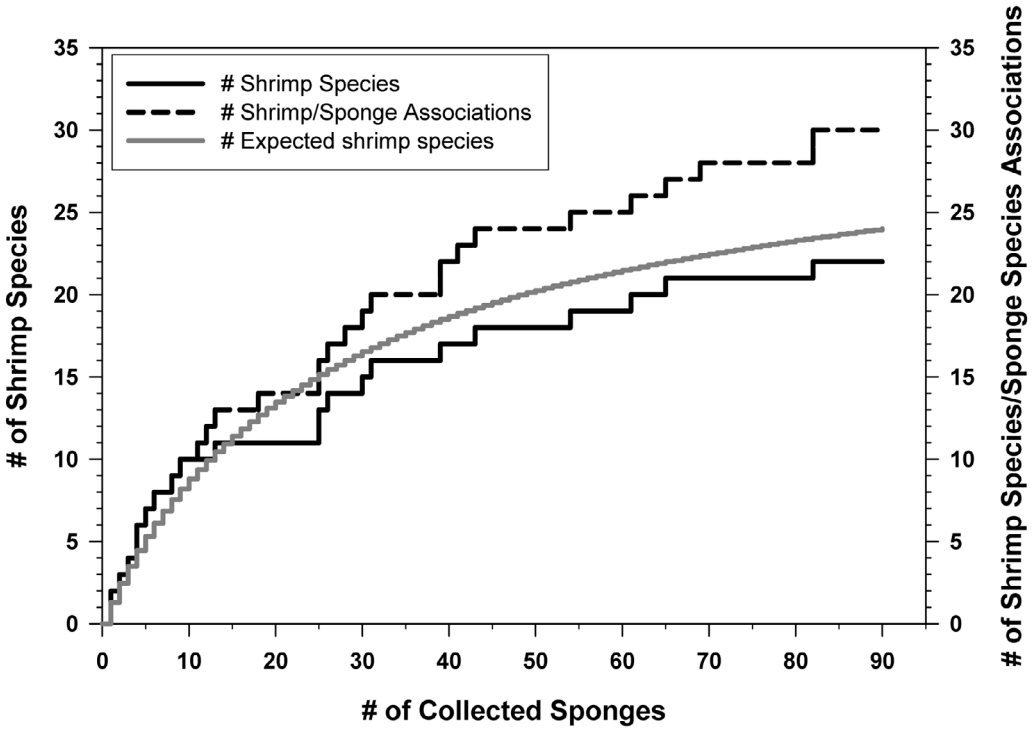


FIGURE 1. Accumulation of *Synalpheus* shrimp species (solid black line) and unique shrimp-sponge associations (dashed black line) as a function of collection effort (number of sponge specimens collected). Grey line is the expected species accumulation curve (Caldwell et al. 2004), as calculated using EstimateS (Caldwell 2005).

Taxonomy

Order Decapoda Latreille

Family Alpheidae Rafinesque

Genus *Synalpheus* Bate

Synalpheus agelas Pequegnat and Heard
Color plate 1A,B

Material examined. Jamaica. Ovigerous female (VIMS 08JAM0814), Pear Tree Bottom Reef, from canals of *Agelas* cf. *clathrodes*. 3 non-ovigerous individuals, 3 ovigerous females (VIMS 08JAM2001-05,27), Pear Tree Bottom Reef, from canals of *Agelas* cf. *dispar*. 3 non-ovigerous individuals, ovigerous female (VIMS 08JAM3001-03,06), Dairy Bull Reef (18° 28.083′ N, 77° 23.289′ W), from canals of *A.* cf. *dispar*. Ovigerous female (VIMS 08JAM4401), fore-reef (near M1 channel marker) Discovery Bay, from canals of *A.* cf. *dispar*. Non-ovigerous individual, ovigerous female (VIMS 08JAM5601,02), Columbus Park, Discovery Bay, from canals of *A.* cf. *clathrodes*. Non-ovigerous individual, ovigerous female (VIMS 08JAM6106,12), Columbus Park, Discovery Bay, from canals of *A.* cf. *clathrodes*. 3 non-ovigerous individuals, 2 ovigerous females (VIMS 08JAM8501,03,11), wall off Rio Bueno, from canals of *A.* cf. *dispar*. 6 non-ovigerous individuals, 2 ovigerous females (VIMS 08JAM8909,30,31), Columbus Park, Discovery Bay, from canals of *A.* cf. *clathrodes*. Maximum CL (MaxCL) ovigerous female: 4.55 mm. MaxCL Non-ovigerous individual: 3.78 mm.

Color. Orange, with distal palm and fingers of major chela brighter orange; ovaries and embryos usually brilliant orange, green in a few females (see Color plate 1A).

Hosts and ecology. As its name suggests, *S. agelas* has only been found inhabiting the canals of two members of the sponge genus *Agelas*: *A.* cf. *dispar*, and *A.* cf. *clathrodes*; in Jamaica it was usually found in heterosexual pairs, often sharing the sponge with *Synalpheus carpenteri* Macdonald and Duffy, 2006, and *Synalpheus thele* **n. sp.** (see below).

Distribution. Bahamas (Dardeau 1984), Gulf of Mexico (Pequegnat and Heard 1979; Dardeau 1984), Puerto Rico (Dardeau 1984), Cuba (Martínez Iglesias and García Raso 1999), Belize (Macdonald et al 2006; Ríos and Duffy 2007), Jamaica (this study).

Remarks. The specimens of *S. agelas* collected in Jamaica resemble those found in other locales, with the exception that some females carried green embryos (see Color plate 1A), unlike the orange embryos carried by females in other regions; these females, however, were morphologically alike in every other regard.

Synalpheus androsi Coutière
Figure 2, Color plate 1C

Material examined. Jamaica: Non-ovigerous individual, ovigerous female (VIMS 08JAM3301,02), fore-reef (near M1 channel marker), Discovery Bay, from canals of *Hyattella intestinalis*. 2 non-ovigerous individuals, ovigerous female (VIMS 08JAM6501-03), Columbus Park, Discovery Bay, from canals of *H. intestinalis*. MaxCL ovigerous female: 4.55 mm. MaxCL non-ovigerous individual: 4.62 mm. Belize: Non-ovigerous individual (VIMS 04CBC0402), Curlew Reef, Belize, from canals of *H. intestinalis*.

Color. Transparent, faintly blue-violet; distal portion of major chela brown-green; embryos brownish or dark green (see Color plate 1C).

Hosts and ecology. In Belize (Macdonald et al. 2006; Ríos and Duffy 2007), as well as in Jamaica (present study), *S. androsi* seems to be a pair-forming specialist inhabiting the canals of *H. intestinalis*.

Distribution. Bahamas (Coutière 1909); Belize (Macdonald et al. 2006; Ríos and Duffy 2007); Jamaica (this study).

Remarks. The unique diagnostic structure of *S. androsi*, matching concave flexor surfaces of the carpus and merus of the 3rd pereopod, (Coutière 1909) is not as evident in these individuals as in those from other regions (especially in regards to the carpus), but is still distinct enough to recognize this species (see Fig. 2 for a comparison of Jamaican and Belizean individuals).

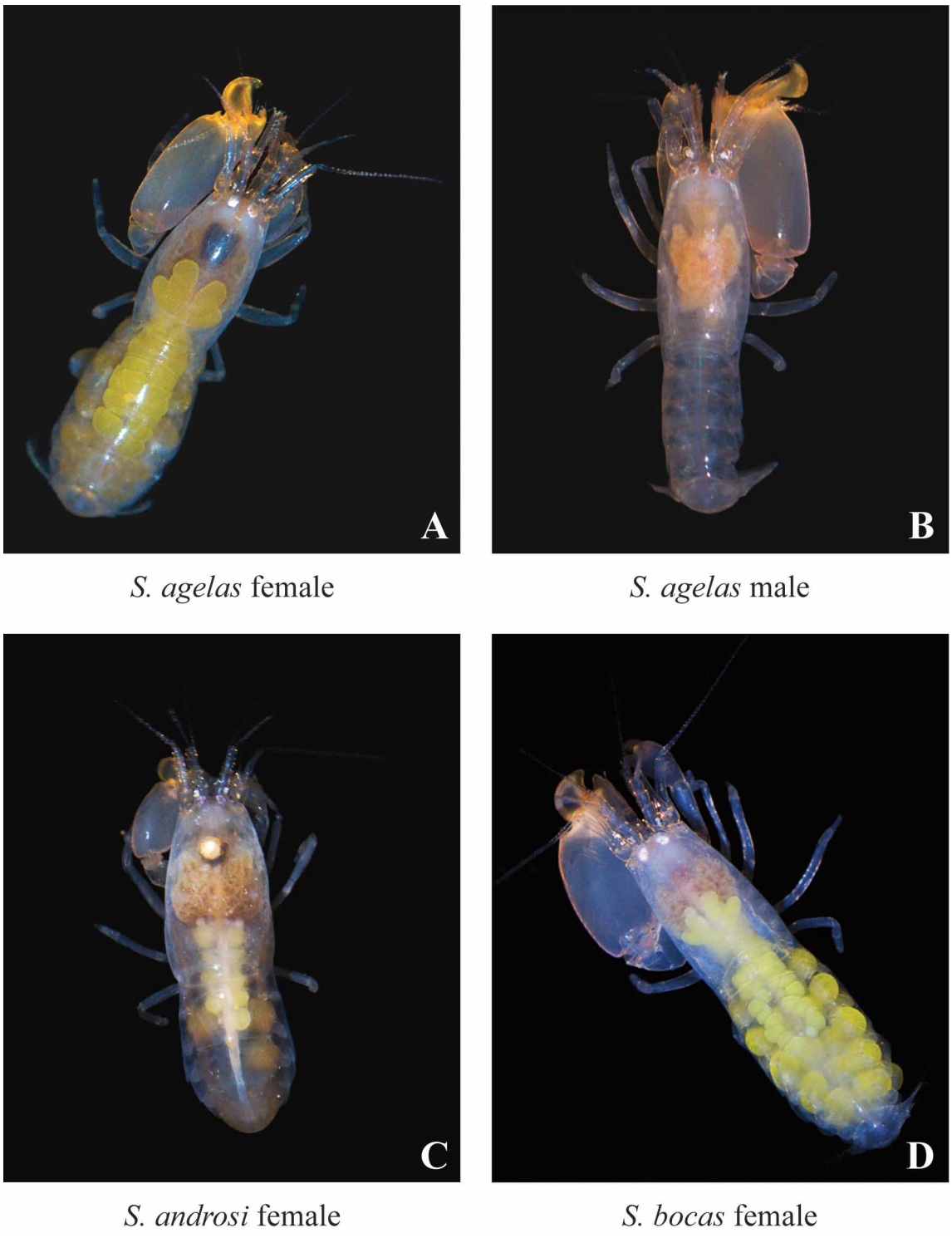


PLATE 1. A, *Synalpheus agelas* ovigerous female (08JAM8503) from *Agelas* cf. *dispar*, Rio Bueno Jamaica. B, *Synalpheus agelas* non-ovigerous individual (08JAM6112) from *Agelas* cf. *clathrodes*, Columbus Park, Discovery Bay, Jamaica. C, *Synalpheus androsi* ovigerous female (08JAM6502) from *Hyattella intestinalis*, Columbus Park, Discovery Bay, Jamaica. D, *Synalpheus bocas* (08JAM7402) from *Xestospongia proxima*, Rio Bueno, Jamaica.

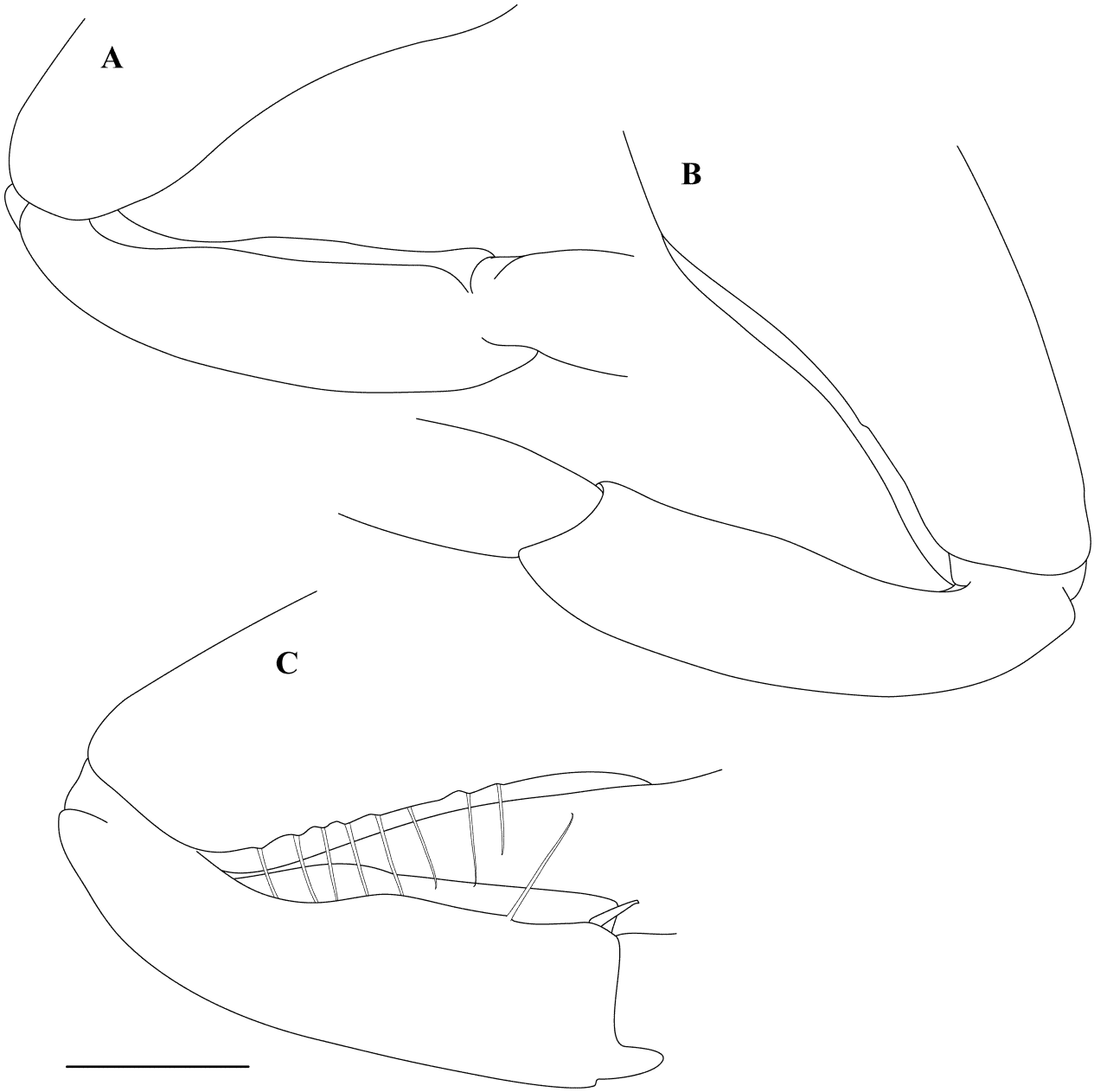


FIGURE 2. *Synalpheus androsi*. Non-ovigerous individual CL: 4.55 mm (08JAM6501). A, merus and carpus of 3rd pereopod, lateral view; B, merus and carpus of 3rd pereopod, alternate view. Non-ovigerous individual from Belize CL: 3.59 (04CBC0402). C, merus and carpus of 3rd pereopod, lateral view. Scale bar = 0.4 mm for A, B; 0.25 mm for C.

Synalpheus belizensis Anker and Tóth

Material examined. Jamaica: Non-ovigerous individual, ovigerous female (VIMS08JAM0501,02), Columbus Park, Discovery Bay, from canals of *Xestospongia proxima*. Non-ovigerous individual, ovigerous female (VIMS08JAM1101,02), Pear Tree Bottom Reef, from canals of *X. proxima*. 4 non-ovigerous individuals, ovigerous female (VIMS08JAM8401,05), wall off Rio Bueno, from canals of *X. proxima*. 3 non-ovigerous individuals, ovigerous female (VIMS08JAM8701-03), wall off Rio Bueno, Jamaica, from canals of *X. proxima*. MaxCL ovigerous female: 5.58 mm. MaxCL non-ovigerous individual: 4.67 mm.

Color. Pale milky in appearance, distal end of major chelae orange; embryos and ovaries bright yellow.

Hosts and ecology. In Jamaica, this species has only been found inhabiting sponges of the genus

Xestospongia. The types from the Belize Barrier Reef came from an unidentified cryptic sponge. In Jamaica, this species is often found cohabitating with other members of the *Synalpheus paraneptunus* Coutière complex, viz. *S. bocas* Anker and Tóth and *S. duffyi* Anker and Tóth.

Distribution. Belize (Anker and Tóth 2008); Jamaica (this study).

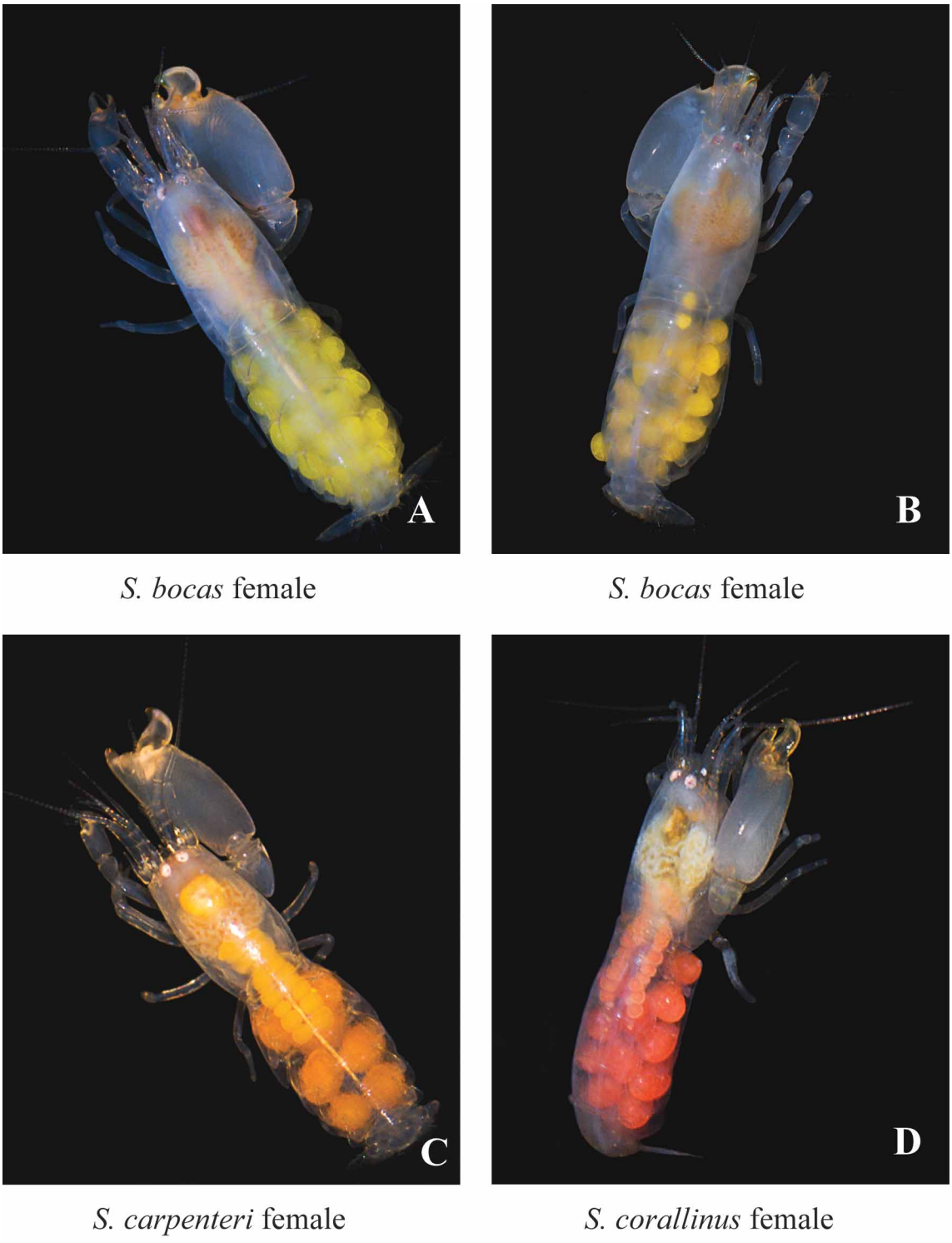


PLATE 2. A, *Synalpheus bocas* ovigerous female (08JAM7404) from *Xestospongia proxima*, Rio Bueno, Jamaica. B, *Synalpheus bocas* ovigerous female (08JAM7504) from *Xestospongia proxima*, Rio Bueno, Jamaica. C, *Synalpheus carpenteri* ovigerous female (08JAM6113) from *Agelas* cf. *clathrodes*, Columbus Park, Discovery Bay, Jamaica. D, *Synalpheus corallinus* ovigerous female (08JAM7001) from *Hyattella intestinalis*, Dairy Bull Reef, Jamaica.

Remarks. *Synalpheus belizensis* belongs to a complex of morphologically similar species that includes *S. paraneptunus, S. bocas, S. duffyi, S. brevidactylus* Anker and Tóth, and *S. riosi* Anker and Tóth. Although *S. belizensis* females always have bright yellow embryos or mature ovaries, the color of these parts in the morphologically similar *S. bocas* ranged from bright green to yellow, therefore, making these two species difficult to distinguish by color pattern alone, i.e., without careful morphological examination. *Synalpheus belizensis* may be most reliably distinguished from *S. bocas* by the presence of a scaphocerite blade in the former species, although the blade was often vestigial (or missing on one side) in larger individuals of *S. belizensis.* Although the diagnosis of *S. belizensis* in Anker and Tóth (2008) states that the scaphocerite does not have a blade, this is presumably an error, for the figure of the holotype plainly shows a blade, and the authors mention the scaphocerite blade in other parts of the manuscript (including the key). *Synalpheus belizensis* can be distinguished from the remaining members of the *S. paraneptunus* group by the uropodal exopod bearing a single fixed tooth anterior to the movable spine on the lateral margin (vs. two or more in other species); and the third maxilliped armed with a crown of eight to nine spines (vs. six or fewer in other species).

***Synalpheus bocas* Anker and Tóth**
Color Plates 1D, 2A,B

Material examined. Jamaica: Ovigerous female (VIMS08JAM0503), Columbus Park, Discovery Bay, from canals of *Xestospongia* sp. Non-ovigerous individual, 2 ovigerous females (VIMS08JAM7402,04,08), wall off Rio Bueno, from canals of *Xestospongia proxima*. 2 ovigerous females (VIMS08JAM7503,05), wall off Rio Bueno, from canals of *Xestospongia subtriangularis*. 2 non-ovigerous individuals, 3 ovigerous females (VIMS08JAM8403-05), wall off Rio Bueno, from canals of *X. proxima.* MaxCL ovigerous female: 4.42 mm. MaxCL non-ovigerous individual: 4.17 mm.

Color. Pale, milky appearance, distal portion of major chela orange-brown; embryos and mature ovaries either bright green or yellow (see Color plates 1D, 2A,B).

Hosts and ecology. In Jamaica, this species has only been found in sponges of the genus *Xestospongia*. It is found as one to several pairs, and is often cohabitating with other members of the *S. paraneptunus* group (*S. belizensis, S. duffyi*).

Distribution. Bocas del Toro, Panama (Anker and Tóth 2008); Jamaica (this study).

Remarks. *Synalpheus bocas* is another member of the *S. paraneptunus* complex, which also includes *S. belizensis* and *S. duffyi* in Jamaica. *Synalpheus bocas* is morphologically most similar to *S. belizensis* (Anker and Tóth 2008), from which it can be distinguished by the absence of a scaphocerite blade (vs. presence of a small blade in *S. belizensis*); stouter telson dorsal spines, and bright green embryos and ovaries (vs. yellow), although the embryos of one specimen from Panama were described as “greenish yellow” (Anker and Tóth 2008). Similarly, in Jamaica, we have observed individual females of *S. bocas* carrying embryos ranging from green to yellow (see Color plate 1D, 2A,B). Therefore, differentiation between these two species requires a careful examination of the scaphocerite and often a direct comparison of the dorsal spines on the telson. *Synalpheus bocas* may be distinguished from the remaining members of the *S. paraneptunus* complex by the same characters as *S. belizensis* (see above).

***Synalpheus bousfieldi* Chace**
Figure 3

Material examined. Jamaica: Ovigerous female (VIMS08JAM0601), Columbus Park, Discovery Bay, from canals of unidentified purple sponge. MaxCL ovigerous female: 3.01 mm.

Color. Translucent, gold-brown tinge toward distal portion of major chela; ovaries and embryos olive green to chestnut-brown.

Hosts and ecology. *Synalpheus bousfieldi* is typically found in pairs, most commonly in *Hyattella intestinalis*. In Jamaica, we found one individual in an unknown purple, mucus-producing sponge.

Distribution. Bahamas (Dardeau 1984); Cuba (Martínez Iglesias and García Raso 1999); Gulf of Mexico (Dardeau 1984); Yucatan, Mexico (Chace 1972); Belize (Macdonald et al. 2006; Ríos and Duffy 2007); Jamaica (this study).

Remarks. *Synalpheus bousfieldi* is a member of a complex of closely related, morphologically similar *Synalpheus* species that includes *S. brooksi* Coutière, *S. carpenteri* Macdonald & Duffy, *S. chacei* Duffy, and the below-described S. *corallinus* **n. sp.**, *S. plumosetosus* **n. sp.**, and *S. thele* **n. sp.** (see Table 3). *Synalpheus bousfieldi* is distinguishable from *S. brooksi*, *S. chacei*, and *S. thele* by the distal protuberance on the palm of the major chela, which tapers distally and curves slightly downward, toward the dactyl; from *S. chacei*, *S. corallinus* and *S. thele* by the presence of a thick brush of setae on the dactyl of the minor chela (instead of two longitudinal rows); from *S. plumosetosus* by the absence of plumose setae on the gambarelloides brush of the minor chela.

The single female, tentatively identified here as *S. bousfieldi*, shares all diagnostic characters with the typical *S. bousfieldi* (see Chace 1972, Macdonald and Duffy 2007), except for the fingers of the major chela, which are narrow, with straight flexor margins and unusual tips (Fig 3), unlike any other *Synalpheus* species. With only one specimen in hand, found in a sponge from which we had never collected shrimp before, it is difficult to determine if this individual belongs to a new species, or is *S. bousfieldi* with an aberrant major chela.

TABLE 3. Morphological characters useful in distinguishing members of the *Synalpheus brooksi* species complex.

	S. carpenteri	*S. chacei*	*S. corallinus*	*S. bousfieldi*
frontal margin	normal	shallow	shallow	normal
scaphocerite blade	absent	absent	absent	absent
minor chela dactyl setae	thick brush	two longitudinal rows	two longitudinal rows	thick brush
setae of minor chela brush	simple	simple	simple	simple
embryo color	bright orange	cream to pale yellow	coral pink	olive green to chestnut brown
major chela protuberance	distally produced, curved towards palm	small tubercle	distally produced, curved towards palm	distally produced, curved towards palm
ovigerous females: others	~1:1	<<1:1	~1:1	~1:1

	S. brooksi	*S. plumosetosus*	*S. ruetzleri*	*S. thele*
frontal margin	normal	normal	normal	shallow
scaphocerite blade	absent	absent	present	absent
minor chela dactyl setae	varies (thick brush/two longitudinal rows)	thick brush	thick brush	thick brush
setae of minor chela brush	simple	plumose	simple	simple
embryo color	highly variable (pale green to gray to pink	drab green	olive green to chestnut brown	grass green
major chela protuberance	conical, pointed away from palm	distally produced, curved towards palm	distally produced, curved towards palm	large, blunt
ovigerous females: others	1:1 - 1:10	~1:1	~1:1	~1:1

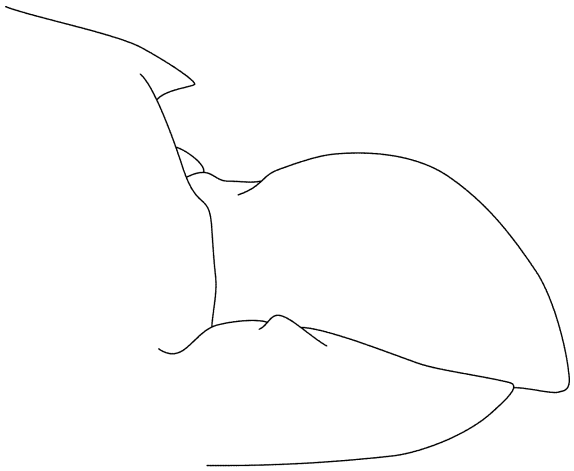


FIGURE 3. *Synalpheus bousfieldi*. Non-ovigerous individual CL: 3.01 mm (08JAM0601) chela of major first pereopod, anterior region, ventral view. Scale bar = 0.5 mm.

***Synalpheus brevifrons* Chace**
Figure 4

Material examined. Jamaica: Non-ovigerous individual (VIMS08JAM0706), fore-reef (near M1 channel marker), Discovery Bay, from canals of *Aiolochroia* (*Pseudoceratina*) *crassa*. Non-ovigerous individual, ovigerous female (VIMS08JAM4501,02), fore-reef (near M1 channel marker), Discovery Bay, host unknown. MaxCL ovigerous female: 3.05 mm. MaxCL non-ovigerous individual: 2.51 mm.

Color. Translucent, distal portion of major chela gold; embryos and ovaries bright green.

Hosts and ecology. *Synalpheus brevifrons* in Belize has typically been found inhabiting the canals of a soft, filmy, grey-brown sponge that lines the cavities of rocks and the canals of the sponge *Aiolochroia (Pseudoceratina) crassa* (see Color plate 7A). It is possible that the Jamaican specimens had also been associated with this cryptic sponge species.

Distribution. Dominica (Chace 1972); Belize (Macdonald et al. 2006; Ríos & Duffy 2007); Jamaica (this study).

Remarks. While specimens of *S. brevifrons* from Jamaica do not differ morphologically from those found in Belize, they do consistently differ from the female holotype figured by Chace (1972): the female specimens from Belize and Jamaica have hooks on the ventral margin of the third through fifth pleura and deeper adrostral sinuses on the frontal margin (Fig. 4).

***Synalpheus brooksi* Coutière**

Material examined. Jamaica: non-ovigerous individual (VIMS 08JAM0103), Columbus Park, Discovery Bay, from canals of *Hyattella intestinalis*. Non-ovigerous individual and ovigerous female (VIMS 08JAM0703,06), Columbus Park, Discovery Bay, from canals of *H. intestinalis*. MaxCL non-ovigerous individual: 3.05 mm.

Color. Translucent overall, distal portion of major chela usually orange; ovaries and embryos vary in color, but are typically pale.

Hosts and ecology. In Jamaica *S. brooksi* were collected as infrequent inhabitants of *H. intestinalis*. In other regions, *S. brooksi* can also be found, often in large numbers, in the common loggerhead sponge

Spheciospongia vesparium Lamarck and in *Lissodendoryx colombiensis* Zea & van Soest. However, in Jamaica we found no *L. colombiensis*, and only a single *S. vesparium*, which harbored no *S. brooksi*.

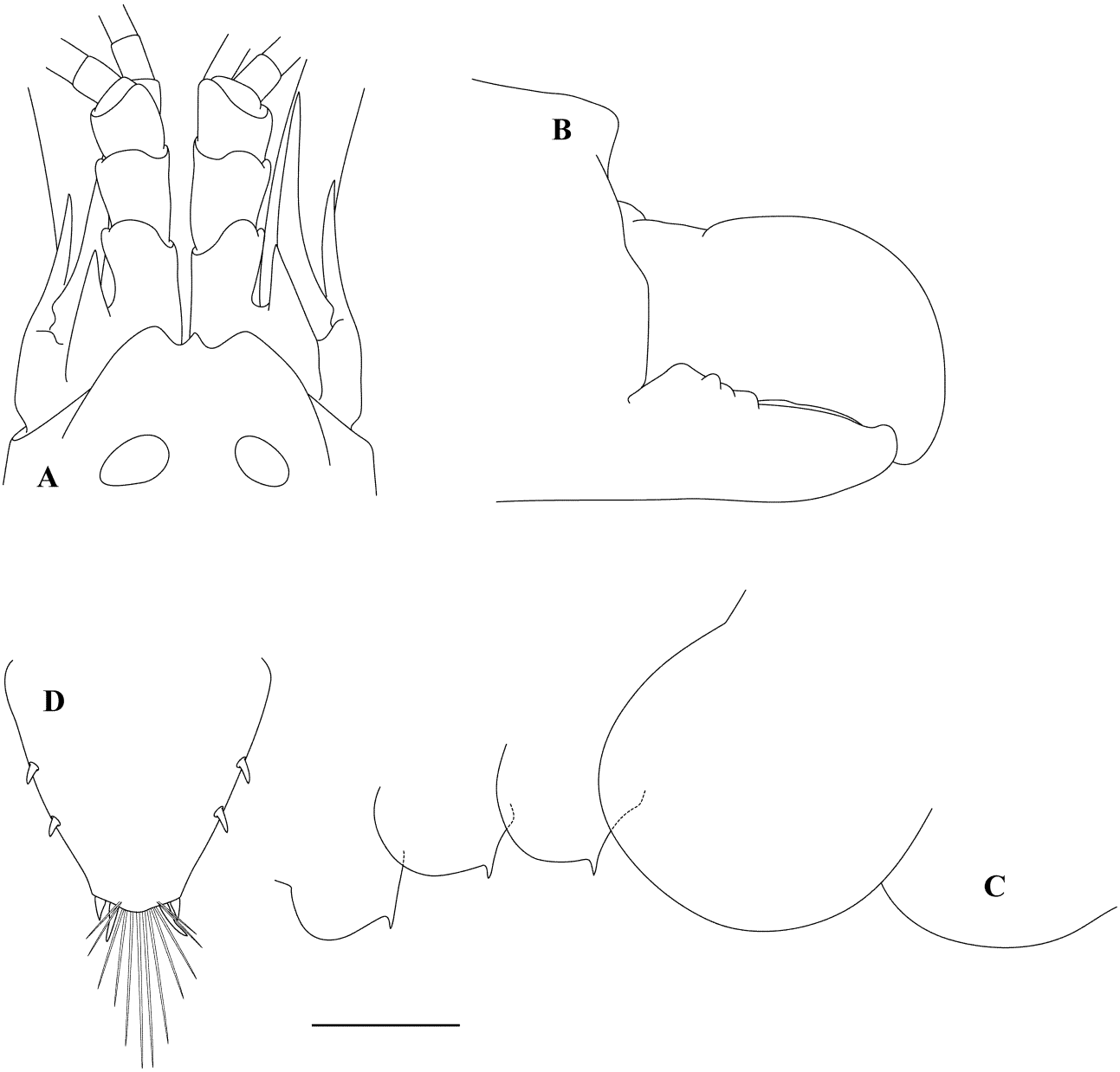


FIGURE 4. *Synalpheus brevifrons*. Non-ovigerous individual CL: 2.32 mm (08JAM4502). A, carapace, anterior region, and cephalic appendages, dorsal view. Ovigerous female 3.05 mm (08JAM4501). B, chela of major first pereopod, anterior region, ventral view; C, abdomen, lateral view; D, telson, dorsal view. Scale bar = 0.4 mm for A; 0.5 mm for B, C, D.

Distribution. Bahamas (Coutière 1909; Pearse 1950; Lemaitre 1984; Macdonald & Duffy 2007); Florida Keys, USA (Coutière 1909, 1910; McClendon 1911; Pearse 1932; Heard & Perlmutter 1977; Duffy 1993); Gulf of Mexico (Coutière 1909; Lyons et al. 1971; Dardeau 1984; Erdmann & Blake 1987); Yucatan, Mexico (Coutière 1909; Chace 1972); Cuba (Martínez Iglesias & García Raso 1999); Puerto Rico (Rathbun 1901; Coutière 1909); US Virgin Islands (Coutière 1909); Leeward Islands, Windward Islands, Tobago (Chace 1972); Netherlands Antilles (Westinga & Hoetjes 1981); Caribbean Panama (Duffy 1992, 1993, 1996b); Surinam (Holthuis 1959); Belize (Duffy 1993; Macdonald et al. 2006; Macdonald & Duffy 2007; Ríos & Duffy 2007); Brazil (Coutière 1909; Coelho & Ramos 1972); Discovery Bay, Jamaica (this study).

Remarks. *Synalpheus brooksi* is the nominal species of the complex of morphologically similar and

presumably closely related *Synalpheus* species that includes *S. bousfieldi, S. carpenteri, S. chacei, S. corallinus* **n. sp.**, *S. plumosetosus* **n. sp.**, and *S. thele* **n. sp.** (see Table 3). *Synalpheus brooksi* is distinguishable from all of these species by the distal protuberance on the palm of the major chela, which is bluntly conical and directed upward and slightly away from the dactyl. Unlike *S. brooksi* collected from other localities, Jamaican specimens have two parallel rows of setae on their minor chela dactyl, as described for *S. chacei*, (Duffy 1998) and for *S. corallinus* and *S. thele* (this paper), rather than a thick brush. Due to this distinctive difference, the identification of the three individuals from Jamaica as *S. brooksi* must be provisional pending further study.

***Synalpheus carpenteri* Macdonald and Duffy**
Color plate 2C

Material examined. Jamaica: 2 non-ovigerous individuals, ovigerous female (VIMS 08JAM1001,02), Pear Tree Bottom Reef, from canals of *Agelas* cf. *clathrodes*. 2 non-ovigerous individuals, 2 ovigerous females (VIMS 08JAM1301-03), Pear Tree Bottom Reef, from canals of *Agelas* cf. *dispar.* Non-ovigerous individual (VIMS 08JAM1401), Pear Tree Bottom Reef, from canals of *A.* cf. *clathrodes*. Non-ovigerous individual, ovigerous female (VIMS 08JAM1501,02), Pear Tree Bottom Reef, from canals of *A.* cf. *dispar*. 9 non-ovigerous individuals, 8 ovigerous females (VIMS 08JAM1701,02), Pear Tree Bottom Reef, from canals of *A.* cf. *dispar.* 68 non-ovigerous individuals, 21 ovigerous females (VIMS 08JAM2006-26,28,29), Pear Tree Bottom Reef, from canals of *A.* cf. *dispar.* Non-ovigerous individual (VIMS 08JAM2101), Pear Tree Bottom Reef, from canals of *A.* cf. *clathrodes*. Non-ovigerous individual (VIMS 08JAM2301), Dairy Bull Reef, from canals of *A.* cf. *clathrodes*. Non-ovigerous individual (VIMS 08JAM2401), Dairy Bull Reef, from canals of *A.* cf. *dispar.* 10 non-ovigerous individuals, 3 ovigerous females (VIMS 08JAM2601-04), Dairy Bull Reef, from canals of *A.* cf. *dispar.* 4 non-ovigerous individuals, 2 ovigerous females (VIMS 08JAM3004,07,08), Dairy Bull Reef, from canals of *A.* cf. *dispar.* 4 non-ovigerous individuals, 2 ovigerous females (VIMS 08JAM3501-04), fore-reef (near M1 channel marker), Discovery Bay, from canals of *A.* cf. *dispar*. 11 non-ovigerous individuals, 7 ovigerous females (VIMS 08JAM3801-04), fore-reef (near M1 channel marker), Discovery Bay, from canals of *A.* cf. *dispar.* 8 non-ovigerous individuals, 7 ovigerous females (VIMS 08JAM3901-08), fore-reef (near M1 channel marker), Discovery Bay, from canals of *A.* cf. *dispar.* 2 non-ovigerous individuals (VIMS 08JAM4106,07), fore-reef (near M1 channel marker), Discovery Bay, from canals of *A. clathrodes.* 21 non-ovigerous individuals, 6 ovigerous females (VIMS 08JAM4402-09), fore-reef (near M1 channel marker), Discovery Bay, from canals of *A.* cf. *dispar.* 4 non-ovigerous individuals, 3 ovigerous females (VIMS 08JAM6102,09,13,14,23), Columbus Park, Discovery Bay, from canals of *A.* cf. *clathrodes*. Non-ovigerous individual, ovigerous female (VIMS 08JAM6801,02), Dairy Bull Reef, from canals of *A.* cf. *dispar.* 4 non-ovigerous individuals, 3 ovigerous females (VIMS 08JAM8001-05), wall off Rio Bueno, from canals of *A.* cf. *dispar.* Non-ovigerous individual, ovigerous female (VIMS 08JAM8101,02), wall off Rio Bueno, Jamaica, from canals of *A.* cf. *dispar.* Ovigerous female (VIMS 08JAM8301), wall off Rio Bueno, from canals of *A.* cf. *clathrodes*. 11 non-ovigerous individuals, 7 ovigerous females (VIMS 08JAM8502,04-10), wall off Rio Bueno, from canals of *A.* cf. *dispar*. 11 non-ovigerous individuals, 11 ovigerous females (VIMS 08JAM8904,07,11,15-19), Columbus Park, Discovery Bay, from canals of *A.* cf. *clathrodes*. MaxCL ovigerous female: 3.78 mm. MaxCL non-ovigerous individual: 3.17 mm.

Color. Bright orange overall, distal portion of major chela typically even brighter orange; embryos and ovaries are also an intense bright orange.

Hosts and ecology. *Synalpheus carpenteri* appears to be a specialist inhabiting sponges of the genus *Agelas*. In Jamaica, *S. carpenteri* was found in large numbers, typically in relatively equal sex ratios, and was the most commonly found shrimp in both *A.* cf. *clathrodes* and *A.* cf. *dispar.* This contrasts with the situation in Belize (Macdonald et al. 2006; Rios and Duffy 2007) and Caribbean Panama (Macdonald and Duffy 2007), where *S. carpenteri* is less common and typically occurs as one or a few pairs per sponge.

Distribution. Bahamas (as *S. bousfieldi* in part, Dardeau 1984; Macdonald and Duffy 2007); Caribbean Panama (Macdonald and Duffy 2006); Belize (Macdonald et al. 2006; Macdonald and Duffy 2006; Ríos and Duffy 2007); Jamaica (this study).

Remarks. *Synalpheus carpenteri* is another member of a complex of closely related, morphologically similar species that includes *S. brooksi, S. bousfieldi, S. chacei, S. corallinus* **n. sp.**, *S. plumosetosus* **n. sp.**, and *S. thele* **n. sp.** (see Table 3). In life it is easily distinguishable from all other members of the complex by the intense orange color, especially the brilliant orange of the ovaries and developing embryos (see Color Plate 2C). In preserved specimens, it can be recognized by the short, wide telson and usually by the extremely short distolateral spines of the basicerite and scaphocerite. However, two of the new species described here (*S. corallinus* and *S. plumosetosus*) also have basicerite and scaphocerite distolateral spines that rarely reach beyond the distal margin of the second segment of the antennular peduncle. *Synalpheus carpenteri* can be differentiated from *S. corallinus* by the width of the telson (telson length/proximal margin width ratio averages 0.75 in *S. carpenteri* and 1.19 in *S. corallinus*) and by the presence of a thick brush of setae on the dactyl of the minor chela (vs. two closely set, longitudinal rows of setae in *S. corallinus*), and from *S. plumosetosus* by the stouter telson (ratio of length/proximal margin width ~0.75 in *S. carpenteri* vs. ~1.04 in *S. plumosetosus*) and by the lack of plumose setae in the minor chela setal brush.

***Synalpheus corallinus* n. sp.**
Figures 5–9, Color plates 2D, 3A

Material examined. Jamaica: Holotype: non-ovigerous individual, CL: 3.40, (USNM 112363, original VIMS 08JAM7002), Dairy Bull Reef, (18° 28.083′ N, 77° 23.289′ W), from canals of *Hyattella intestinalis*. Allotype: ovigerous female, CL: 3.93 mm, (USNM 112364, original VIMS 08JAM7001), Dairy Bull Reef, from canals of same individual *H. intestinalis* as holotype.

Description. Body form subcylindrical; carapace smooth, sparsely setose, posterior margin with cardiac notch distinct. Frontal margin very shallow, rostrum slightly longer than ocular hoods (Fig. 5). Orbitorostral process absent. Ocular hoods dorsally convex; in dorsal view, blunt, separated from rostrum by shallow adrostral sinus. Stylocerite acute, with blunt tip; mesial margin concave; reaching midpoint of first segment of antennular peduncle. First antennular segment without ventromesial tooth, and with two basal ventral processes. Basicerite without sharp tooth on dorsomesial corner, with longer ventrolateral spine, not reaching third segment of antennular peduncle. Scaphocerite blade absent, acute lateral spine robust, with lateral margin slightly concave, slightly longer than basicerite spine, barely reaching third segment of antennular peduncle. Third maxilliped (Fig. 6) with distal circlet of approximately six spines on distal segment, without ventrodistal spine on antepenultimate segment.

Major first pereopod (Fig. 5) massive, fingers clearly shorter than half-length of palm; fixed finger slightly shorter than dactyl. Palm of chela with distal superior margin protuberance tapering distally and slightly curved downward, toward dactyl. Minor first pereopod (Fig. 7) with palm less than two times longer than high; fingers clearly shorter than palm; dactyl with flexor margin concave, blade-like, with two distinct distal teeth, subequal in length; extensor surface of dactyl with two closely set longitudinal rows of curved setae; fixed finger with flexor margin slightly concave, blade-like, and two distinct distal teeth subequal in length.

Second pereopod (Fig. 8) with carpus 5-segmented, subequal in length to merus. Both fingers terminating in a narrow, curved tooth.

Third pereopod (Fig. 8) slender; dactyl biunguiculate, with flexor unguis clearly thicker than extensor, mesial margin of flexor unguis strongly convex; propodus with row of five movable spines on flexor margin and one pair of distal movable spines flanking base of dactyl; carpus with distal movable spine on flexor margin; merus almost four times longer than wide, without movable spines on flexor margin. Fourth pereopod

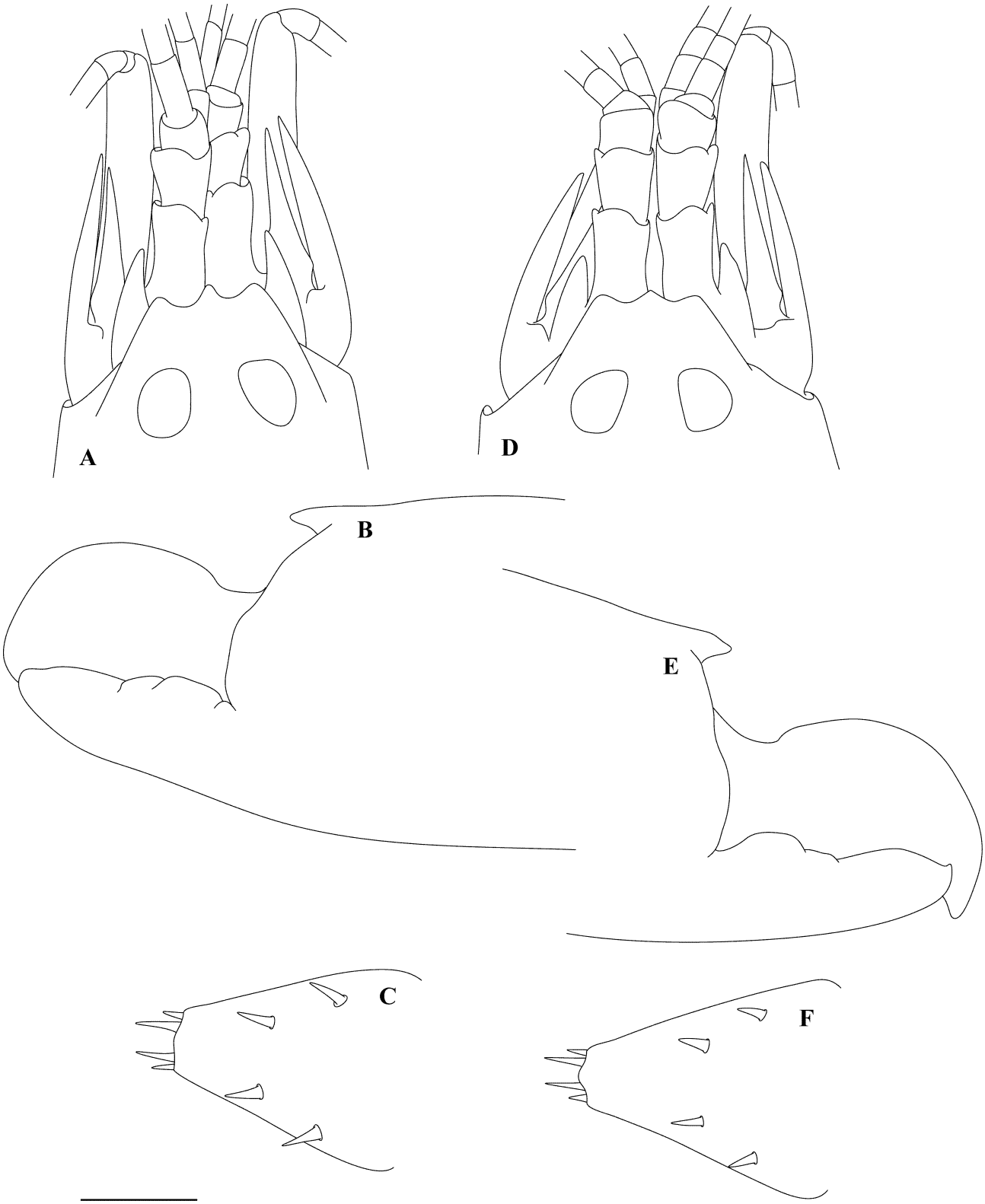


FIGURE 5. *Synalpheus corallinus* **n. sp.** Holotype non-ovigerous individual CL: 3.40 mm (USNM 112363, original VIMS 08JAM7002) from *Hyattella intestinalis*, Dairy Bull Reef, Jamaica: A, carapace, anterior region, and cephalic appendages, dorsal view; B, chela of major first pereopod, anterior region, ventral view; C, telson, dorsal view. Allotype ♀ CL: 3.93 mm (USNM 112364, original VIMS 08JAM7001) from *H. intestinalis*, Dairy Bull Reef, Jamaica: D, carapace, anterior region, and cephalic appendages, dorsal view; E, chela of major first pereopod, anterior region, ventral view; F, telson, dorsal view. Scale bar = 0.5 mm

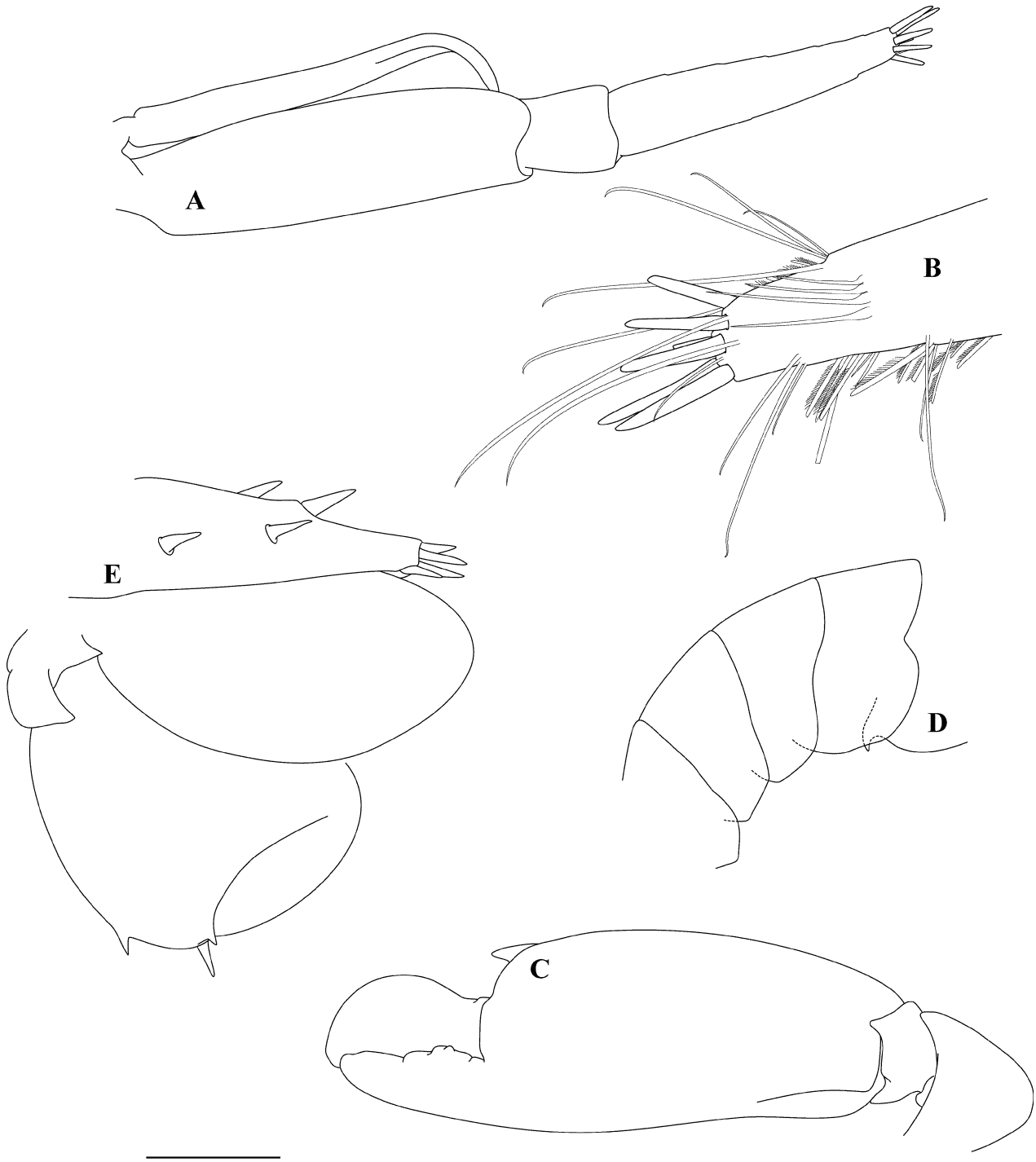


FIGURE 6. *Synalpheus corallinus* **n. sp.** Holotype non-ovigerous individual CL: 3.40 mm (USNM 112363, original VIMS 08JAM7002) from *Hyattella intestinalis*, Dairy Bull Reef, Jamaica: A, third maxilliped; B, same, detail of distal region; C, chela of major first pereopod, ventral view; D, abdomen, lateral view; E, left uropod and telson, lateral view. Scale bar = 0.4 mm for A, E; 0.15 mm for B; 0.1 mm for C, D.

(Fig. 8) similar to third, slightly weaker; three spines on flexor margin of propodus. Fifth pereopod (Fig. 8) weaker than fourth; propodus with only two spines on flexor margin, and four transverse combs of stout setae on ventral face; carpus without distal spine.

First pleura (Fig. 6) of male with posterior corner distinctly produced ventrally into strong hook; second pleura of male broadly rounded with slightly concave ventral margin; third to fifth pleura of male with rounded anterior corner, slightly obtuse posterior corner.

First pleopod (Fig. 9) of male with single terminal seta on endopod; second pleopod of male with marginal setae on exopod originating in distal half; appendix interna present on second to fifth male pleopods. Second pleopod (Fig. 7) of female with marginal setae on exopod originating in distal half; appendix interna present on second to fifth female pleopods.

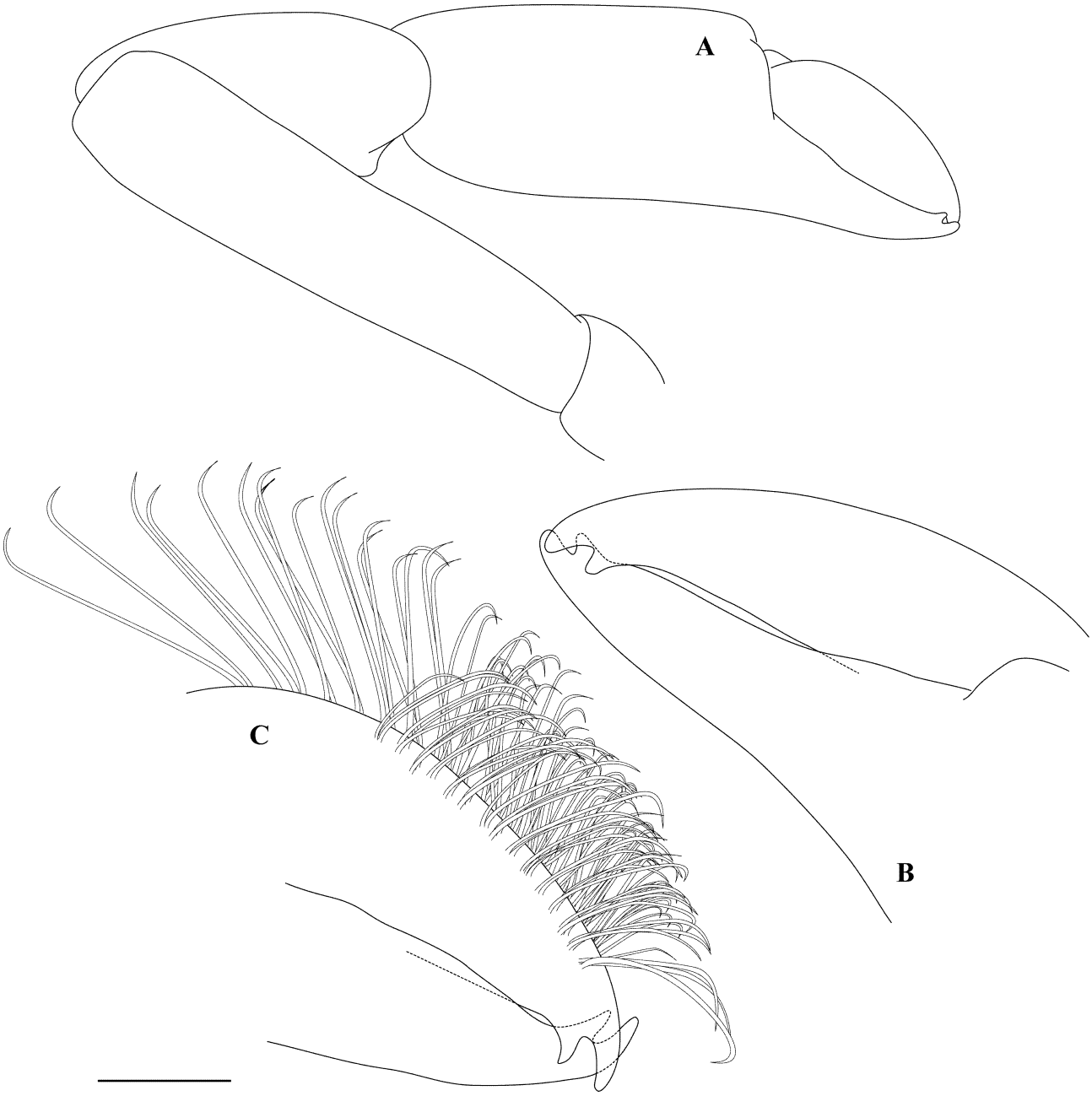


FIGURE 7. *Synalpheus corallinus* **n. sp.** Holotype non-ovigerous individual CL: 3.40 mm (USNM 112363, original VIMS 08JAM7002) from *Hyattella intestinalis*, Dairy Bull Reef, Jamaica: A, minor first pereopod, setae removed, mesial view; B, same, detail of anterior region, setae removed, lateral view. Allotype ovigerous female CL: 3.93 mm (USNM 112364, original VIMS 08JAM7001) from *H. intestinalis*, Dairy Bull Reef, Jamaica: C, chela of minor first pereopod, anterior portion, lateral view. Scale bar = 0.33 mm for A, 0.15 mm for B, C.

Telson (Figs. 5, 6) with convex marginal lobe on distal margin; posterior corners adjacent to spines obtuse. Dorsal spines large, clearly removed from lateral margins. Posterior margin with six setae between two sets of spines, lateral spines half-length of mesial. Distance between distal spines 30% width of distal margin. Telson 30% as wide at distal margin as at base. Uropods (Fig. 6) with a single fixed tooth on lateral

margin of exopod distinctly removed anteriorly from movable spine, latter much longer than adjacent posterior fixed tooth.

Color in life. Nondescript, translucent with dull gold tinge to thickened parts of cuticle; distal palm and fingers of major chela brownish; ovaries and embryos orange-tinged pink (Plate 2D).

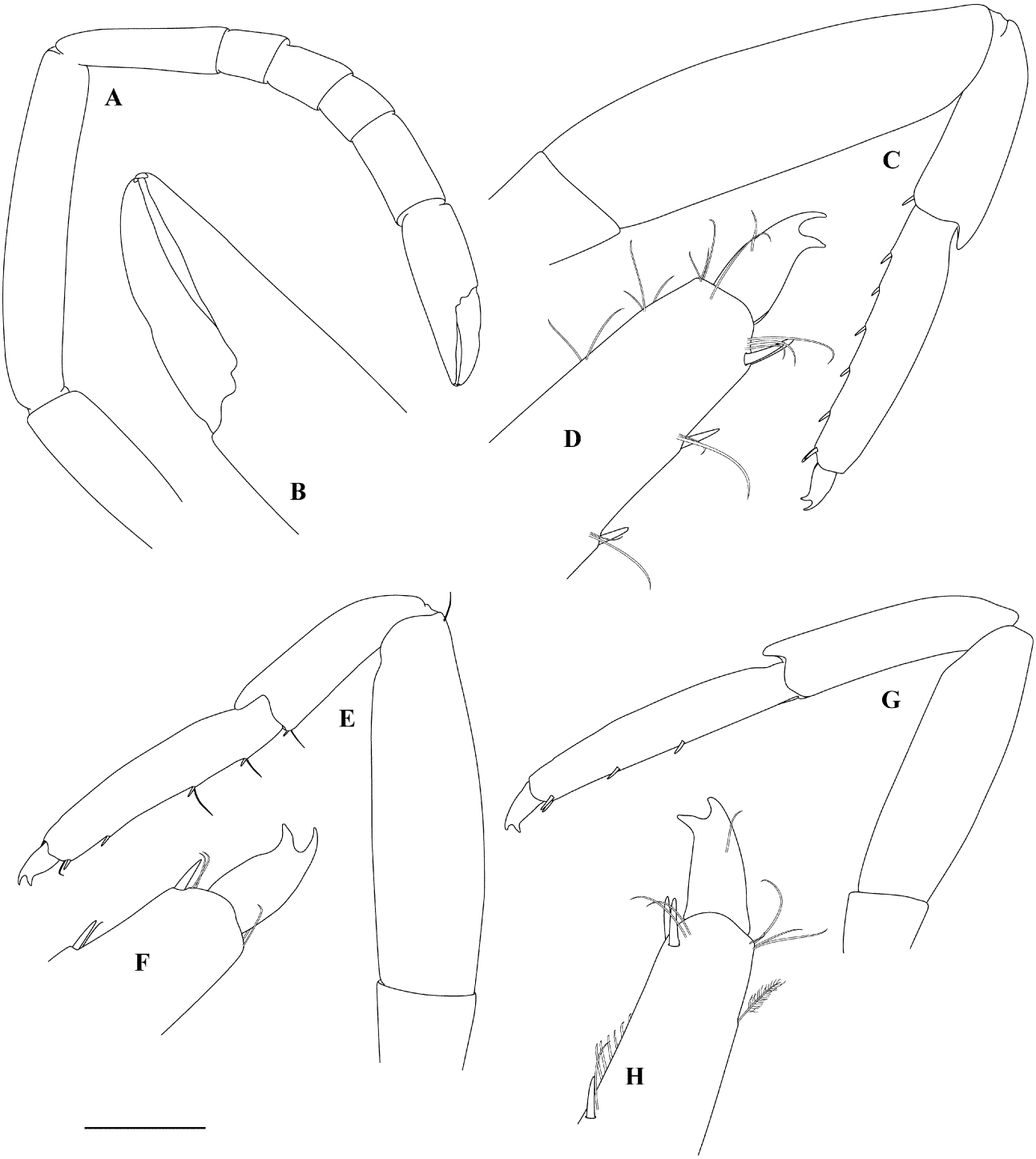


FIGURE 8. *Synalpheus corallinus* **n. sp.** Holotype non-ovigerous individual CL: 3.40 mm (USNM 112363, original VIMS 08JAM7002) from *Hyattella intestinalis*, Dairy Bull Reef, Jamaica: A, second pereopod; B, same, detail of distal region; C, third pereopod; D, same, detail of distal region; E, fourth pereopod; F, same, detail of distal region; G, fifth pereopod; H, same, detail of distal region. Scale bar = 0.4 mm for A, C, E, G; 0.15 mm for B, D, F, H.

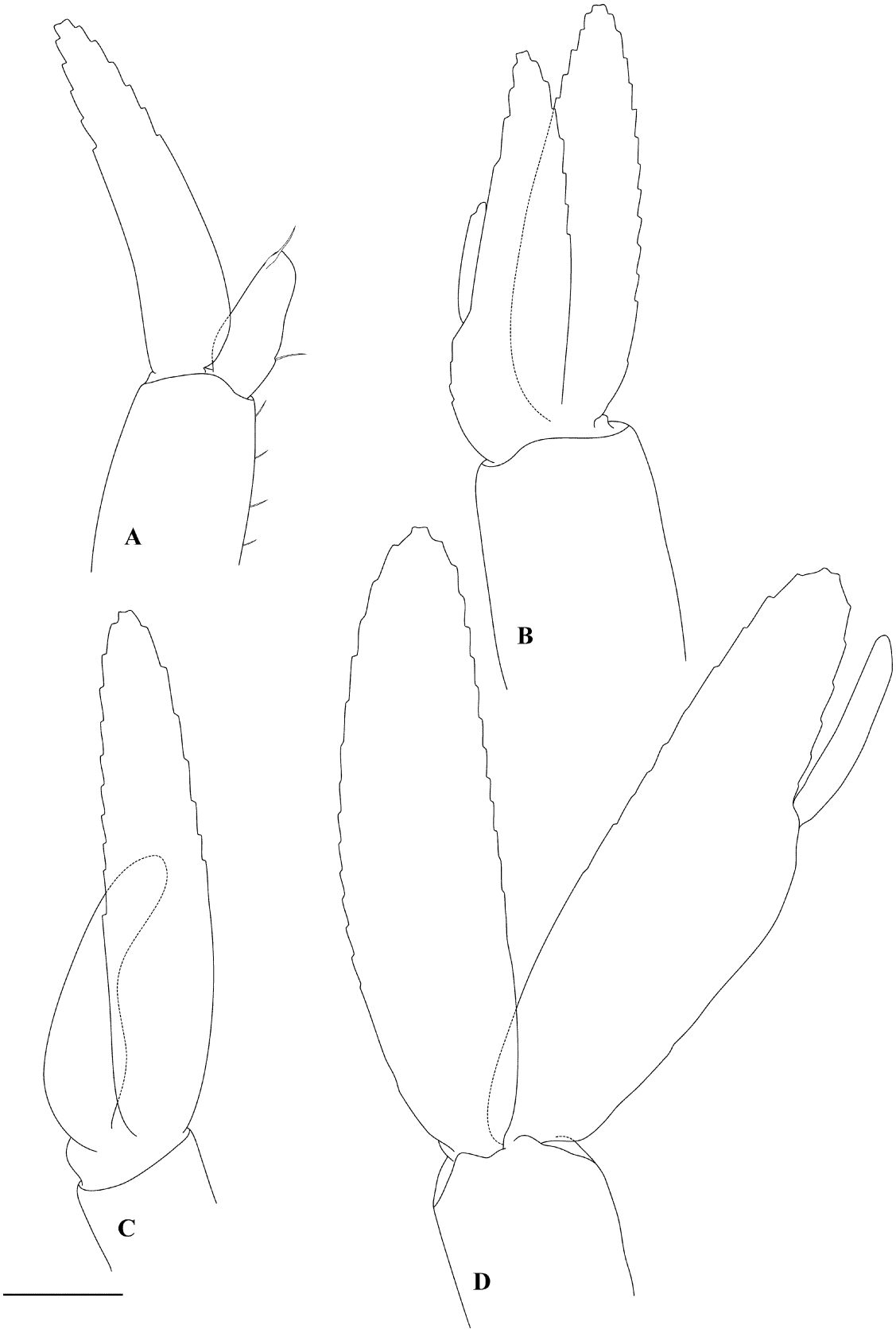


FIGURE 9. *Synalpheus corallinus* **n. sp.** Holotype non-ovigerous individual CL: 3.40 mm (USNM 112363, original VIMS 08JAM7002) from *Hyattella intestinalis*, Dairy Bull Reef, Jamaica: A, first pleopod; B, second pleopod. Allotype ovigerous female CL: 3.93 mm (USNM 112364, original VIMS 08JAM7001) from *H. intestinalis*, Dairy Bull Reef, Jamaica: C, first pleopod; D, second pleopod. Scale bar = 0.2 mm.

Etymology. We have named this species after the highly distinctive embryo color, which most closely matches "coral pink" from the ISCC-NBS Dictionary of Color Names (Kelly & Judd 1976).

Variation. There is little variation between the two specimens of *Synalpheus corallinus* we examined. The dactyl of the female's major chela (Fig. 5) is distally acute, rather than rounded as in the male. Additionally, the frontal margin (Fig. 5) of the female is shallower than that of the male, and the relative lengths of the lateral spines of the basicerite and scaphocerite differ between these individuals.

Hosts and ecology. The single pair of *Synalpheus corallinus*, **n. sp.** was collected from the canals of the common Caribbean sponge *Hyattella intestinalis*.

Distribution. Presently known only from Discovery Bay, Jamaica.

Remarks. *Synalpheus corallinus* **n. sp.** appears to be another member of the complex of closely related, morphologically similar species that includes *S. brooksi, S. bousfieldi, S. chacei, S. thele* **n. sp.** and *S. plumosetosus* **n. sp.** (see Table 3). *Synalpheus corallinus* is distinguished by the combination of very shallow frontal margin, two parallel longitudinal rows of setae on the dactyl of the minor chela, protuberance on the major chela palm tapered and curved downward distally, and distinctive coral-colored embryos and ovaries (Color Plate 2D). While most of these individual characters are shared with one or more members of the *S. brooksi* complex, such as shallow frontal margin and minor chelae setal brush (*S. chacei, S. thele*), and the shape of the major chela protuberance (*S. bousfieldi, S. plumosetosus*), *Synalpheus corallinus* exhibits a unique combination of these characters.

***Synalpheus duffyi* Anker and Tóth**
Color plate 3B

Material examined. Jamaica: 13 non-ovigerous individuals, 1 ovigerous female, (VIMS 08JAM0901,02), Pear Tree Bottom Reef, from canals of *Xestospongia proxima*. 61 non-ovigerous individuals, 2 ovigerous females, (VIMS 08JAM1201-04), Pear Tree Bottom Reef, from canals of *X. proxima*. 60 non-ovigerous individuals, 1 ovigerous female, (VIMS 08JAM5001-03), Columbus Park, Discovery Bay, from canals of *X. proxima*. 47 non-ovigerous individuals, 1 ovigerous female, (VIMS 08JAM7401,03,05-07), wall off Rio Bueno, from canals of *X. proxima*. 47 non-ovigerous individuals, 1 ovigerous female, (VIMS 08JAM7501,07,08), wall off Rio Bueno, from canals of *Xestospongia subtriangularis*. 58 non-ovigerous individuals, (VIMS 08JAM8406,07), wall off Rio Bueno, from canals of *X. proxima*. MaxCL ovigerous female: 4.00 mm. MaxCL non-ovigerous individual: 4.83 mm.

Color. Pale milky in appearance, distal end of major chela pale gold/orange. Embryos and ovaries light green.

Hosts and ecology. In Jamaica, this species has only been collected from sponges of the genus *Xestospongia*, often found cohabitating with other members of the *Synalpheus paraneptunus* group (*S. belizensis, S. bocas*). *Synalpheus duffyi* in Jamaica exhibits a eusocial colony structure, being found in colonies consisting of one or two reproducing females and up to 61 non-ovigerous individuals.

Distribution. Caribbean Panama (Anker and Tóth 2008); Jamaica (this study).

Remarks. *Synalpheus duffyi* is a member of the complex of morphologically similar species that includes *S. paraneptunus, S. belizensis* and *S. bocas*. *Synalpheus duffyi* can be distinguished from its two coexisting Jamaican relatives by the presence of a well-developed blade on the scaphocerite, and two teeth anterior to the moveable spine on the margin of the uropodal exopod. As mentioned by Anker and Tóth (2008), many individuals of this species had pieces of sponge in the mouthparts, evidence that they may actively feed upon the sponge. Finally, *S. duffyi* seemed to be the only heavily parasitized species collected in Jamaica: at least 10% of non-ovigerous individuals harbored large, abdominal bopyrid isopods, which were rarely, if ever, found in individuals of other species.

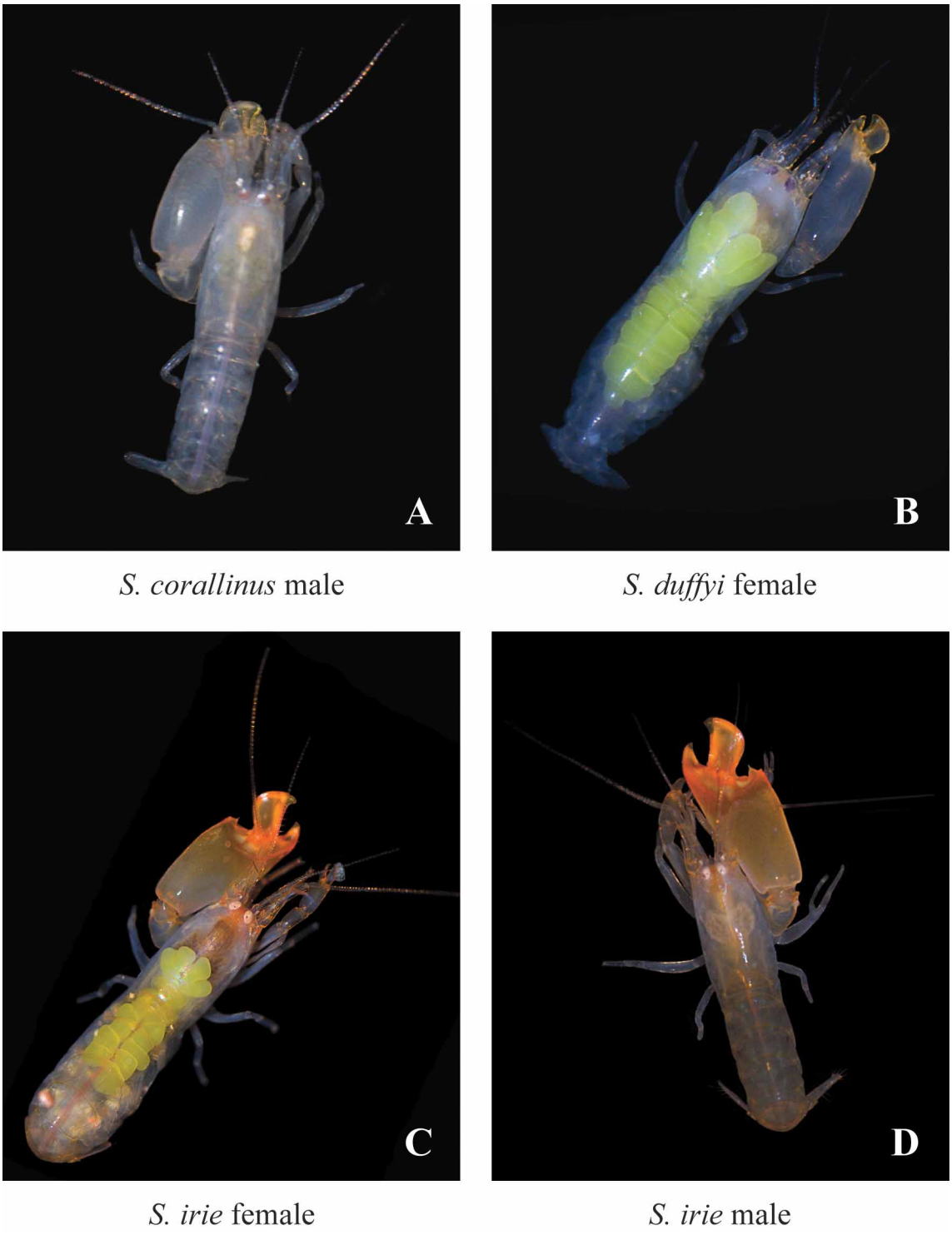


PLATE 3. A, *Synalpheus corallinus* non-ovigerous individual (08JAM7002) from *Hyattella intestinalis*, Dairy Bull Reef, Jamaica. B, *Synalpheus duffyi* ovigerous female (08JAM7403) from *Xestospongia proxima*, Rio Bueno, Jamaica. C, *Synalpheus irie* ovigerous female (08JAM3601) from *Auletta* cf. *sycinularia*, Dairy Bull Reef, Jamaica. D, *Synalpheus irie* non-ovigerous individual (08JAM3602) from *Auletta* cf. *sycinularia*, Dairy Bull Reef, Jamaica.

Synalpheus elizabethae **(Ríos and Duffy)**
Figure 10

Material examined. Jamaica: 50 non-ovigerous individuals, 1 ovigerous female, (VIMS 08JAM0201-03),

Columbus Park, Discovery Bay, from canals of *Hyattella intestinalis*. 50 non-ovigerous individuals, (VIMS 08JAM0701,02), Columbus Park, Discovery Bay, from canals of *H. intestinalis*. 42 non-ovigerous individuals, 1 ovigerous female, (VIMS 08JAM0801,02), Columbus Park, Discovery Bay, from canals of *H. intestinalis*. 51 non-ovigerous individuals, 1 ovigerous female, (VIMS 08JAM1601-03), Pear Tree Bottom Reef, from canals of *H. intestinalis*. 13 non-ovigerous individuals, (VIMS 08JAM2501,02), Dairy Bull Reef, from canals of *H. intestinalis*. 53 non-ovigerous individuals, (VIMS 08JAM5501,02), Columbus Park, Discovery Bay, from canals of *H. intestinalis*. 51 non-ovigerous individuals, 1 ovigerous female, (VIMS 08JAM5701-03), Columbus Park, Discovery Bay, from canals of *H. intestinalis*. MaxCL ovigerous female: 3.29 mm. MaxCL non-ovigerous individual: 2.92 mm.

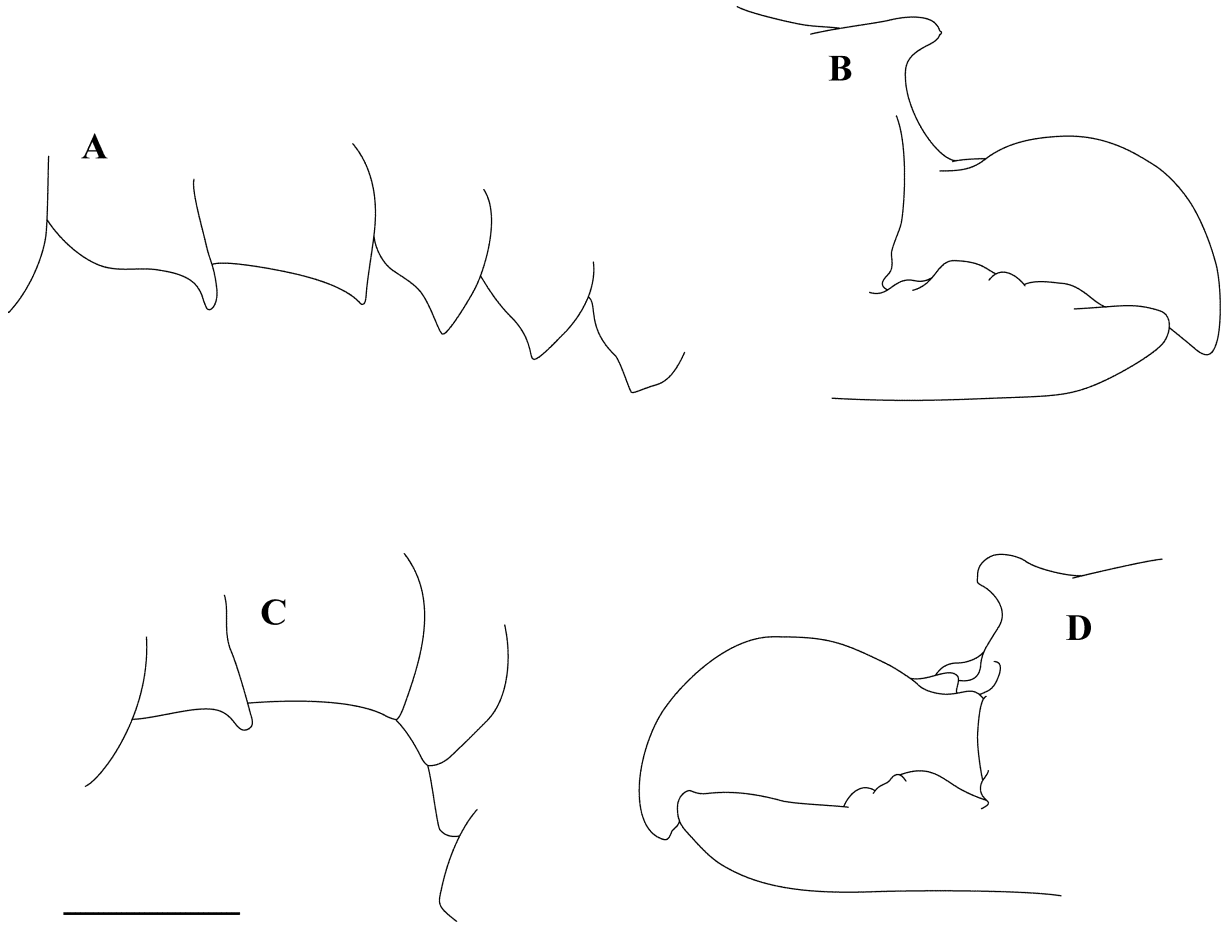


FIGURE 10. *Synalpheus elizabethae*. Non-ovigerous individual CL: 2.29 mm (08JAM070102) from canals of *H. intestinalis*, Columbus Park, Discovery Bay, Jamaica: A, ventral region of abdomen, lateral view; B, chela of major first pereopod, anterior region, ventral view. *S. regalis*. Non-ovigerous individual CL: 2.09 mm (08JAM620202) from canals of *H. intestinalis*, Columbus Park, Discovery Bay, Jamaica: C, ventral region of abdomen, lateral view; D, chela of major first pereopod, anterior region, ventral view. Scale bar = 0.4 mm for A, B; 0.5 mm for C, D.

Color. Pale orange; distal portion of major chela brighter; embryo and ovaries pale.

Hosts and ecology. In Jamaica, *S. elizabethae* has only been found in the canals of *Hyattella intestinalis* at a depth less than 6 m. In both Belize and Panama it was not found in *H. intestinalis*, and instead was found in members of the genus *Lissodendoryx*, and rarely *Hymeniacidon caerulea*. Like other members of the *Synalpheus rathbunae* group, it is eusocial, with colonies in Jamaica consisting of a single reproductive female and up to 51 non-ovigerous individuals.

Distribution. Caribbean Panama (as *S. "rathbunae* A", Duffy 1996c); Belize (Macdonald et al. 2006; Ríos and Duffy 2007); Jamaica (this study).

Remarks. *Synalpheus elizabethae* is one of a complex of morphologically similar, eusocial species that

includes *S. rathbunae* Coutière, *S. regalis* Duffy, and *S. filidigitus* Armstrong. The individuals found in Jamaica differ from *S. elizabethae* found elsewhere in lacking a secondary point emanating from the protuberance on the palm of the major chela (Fig. 10). Additionally, *S. elizabethae* from Jamaica are pale orange in color, rather than the bright orange characteristic of shrimp from other regions. In addition to the differences in color (less useful in Jamaican species), *S. elizabethae* can be distinguished from *S. regalis* by the acute ventral projection of the male abdominal pleura (Fig. 10).

***Synalpheus irie* n. sp.**
Figures 11–16, Color plate 3C,D

Material examined. Holotype: non-ovigerous individual, CL: 4.88 mm, (USNM 1126365, original VIMS 08JAM3602), fore-reef (near M1 channel marker), (18° 28.083′ N, 77° 23.289′ W), from canals of *Auletta* cf. *sycinularia* Schmidt. Allotype: ovigerous female, CL: 5.33 mm, (USNM 1126366, original VIMS 08JAM3601), fore-reef (near M1 channel marker), from canals same of same individual *Auletta* cf. *sycinularia* as holotype. Paratypes: non-ovigerous individual, CL: 4.88 mm, ovigerous female, CL: 5.10 mm, (USNM 1126367, 1126368, original VIMS 08JAM2801-02), Dairy Bull Reef, Discovery Bay, (18° 28' 20.6 N, 77° 24' 36.4 W), from canals of *Auletta* cf. *sycinularia*. MaxCL ovigerous female: 5.33 mm. MaxCL non-ovigerous individual: 4.88 mm.

Description. Body form subcylindrical; carapace smooth, sparsely setose, posterior margin with cardiac notch distinct. Rostrum shorter and narrower than ocular hoods (Fig. 11). Ocular hoods dorsally convex; in dorsal view, blunt, separated from rostrum by adrostral sinus. Stylocerite acute, with sharp tip; mesial and lateral margins concave; reaching almost to distal margin of first segment of antennular peduncle. First antennular segment without ventromesial tooth, and with two basal ventral processes. Basicerite with acute angle on dorsomesial corner, with longer ventrolateral spine; reaching midpoint of second segment of antennular peduncle, ~60% length of scaphocerite. Scaphocerite blade narrow, slightly shorter than basicerite, acute lateral spine robust, with lateral margin concave; reaching beyond third segment of antennular peduncle. Third maxilliped (Fig. 13) with distal circlet of approximately six spines on distal segment, without ventrodistal spine on antepenultimate segment.

Major first pereopod (Fig. 11, 12) massive, fingers clearly shorter than half length of palm; fixed finger ~75% length of dactyl. Fingers strongly curved dorsally. Palm of chela almost twice as wide distally as at base. Superior margin of palm with distinct distal two-pronged protuberance consisting of an elongated sharp spine closer to fingers and a rounded prominence on outside (i.e. lateral to spine in life position of chela). Minor first pereopod (Fig. 13) with palm clearly less than two times longer than high; fingers clearly shorter than palm; dactyl with flexor margin concave, blade-like, with large, distinct second tooth basal and subequal in length to tip; extensor surface of dactyl with thick brush of curved setae; fixed finger with flexor margin straight, blade-like, with small but distinct tooth proximal to tip.

Second pereopod (Fig. 14) with carpus 5-segmented, subequal in length to merus. Both fingers terminating in a narrow, curved tooth.

Third pereopod (Fig. 14) slender; dactyl biunguiculate, with flexor and extensor unguis subequal in thickness, mesial margin of flexor unguis strongly convex; propodus with row of six movable spines on flexor margin and one pair of distal movable spines flanking base of dactyl; carpus without distal movable spine on flexor margin; merus almost four times longer than wide, without movable spines on flexor margin. Fourth pereopod (Fig. 14) similar to third, carpus with distal movable spine on flexor margin. Fifth pereopod (Fig. 14) weaker than fourth; propodus with three spines on flexor margin, and six transverse combs of stout setae on ventral face; carpus without distal spine.

First pleura (Fig. 13) of male with posterior corner distinctly produced ventrally into short, broad, anteriorly directed hook; second through fourth pleura of male slightly concave ventral margin, anterior corners rounded, posterior corners subacute.

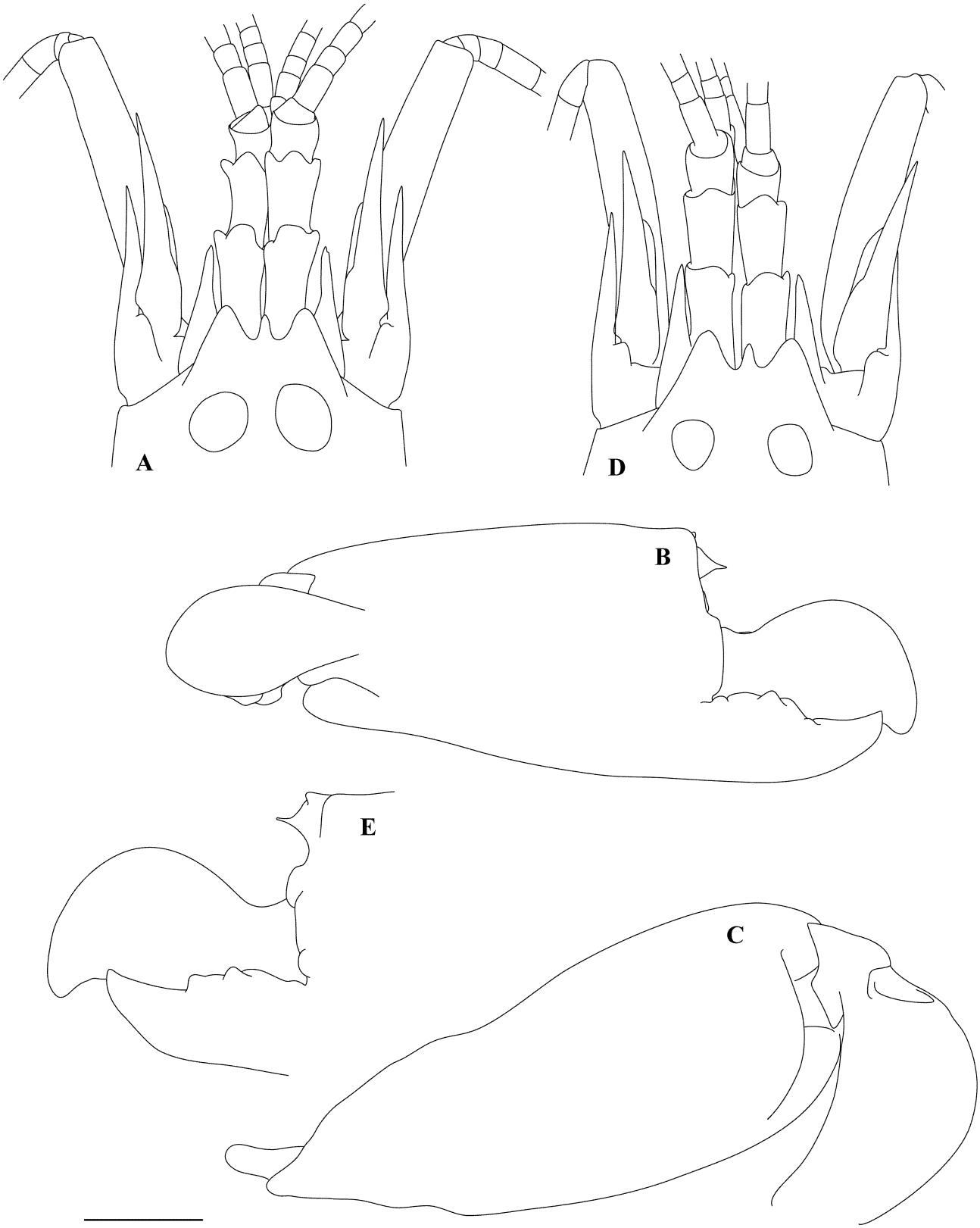


FIGURE 11. *Synalpheus irie* **n. sp.** Holotype non-ovigerous individual CL: 4.88 mm (USNM 1126365, original VIMS 08JAM3602) from *Auletta* cf. *sycinularia*, Dairy Bull Reef, Jamaica: A, carapace, anterior region, and cephalic appendages, dorsal view; B, chela of major first pereopod, ventral view; C, same, mesial view. Allotype ovigerous female CL: 5.32 mm (USNM 1126366, original VIMS 08JAM3601) from *Auletta* cf. *sycinularia*, Dairy Bull Reef, Jamaica: D, carapace, anterior region, and cephalic appendages, dorsal view; E, chela of major first pereopod, anterior region, ventral view. Scale bar = 0.75 mm for A, D; 1 mm for E; 1.25 mm for B, C.

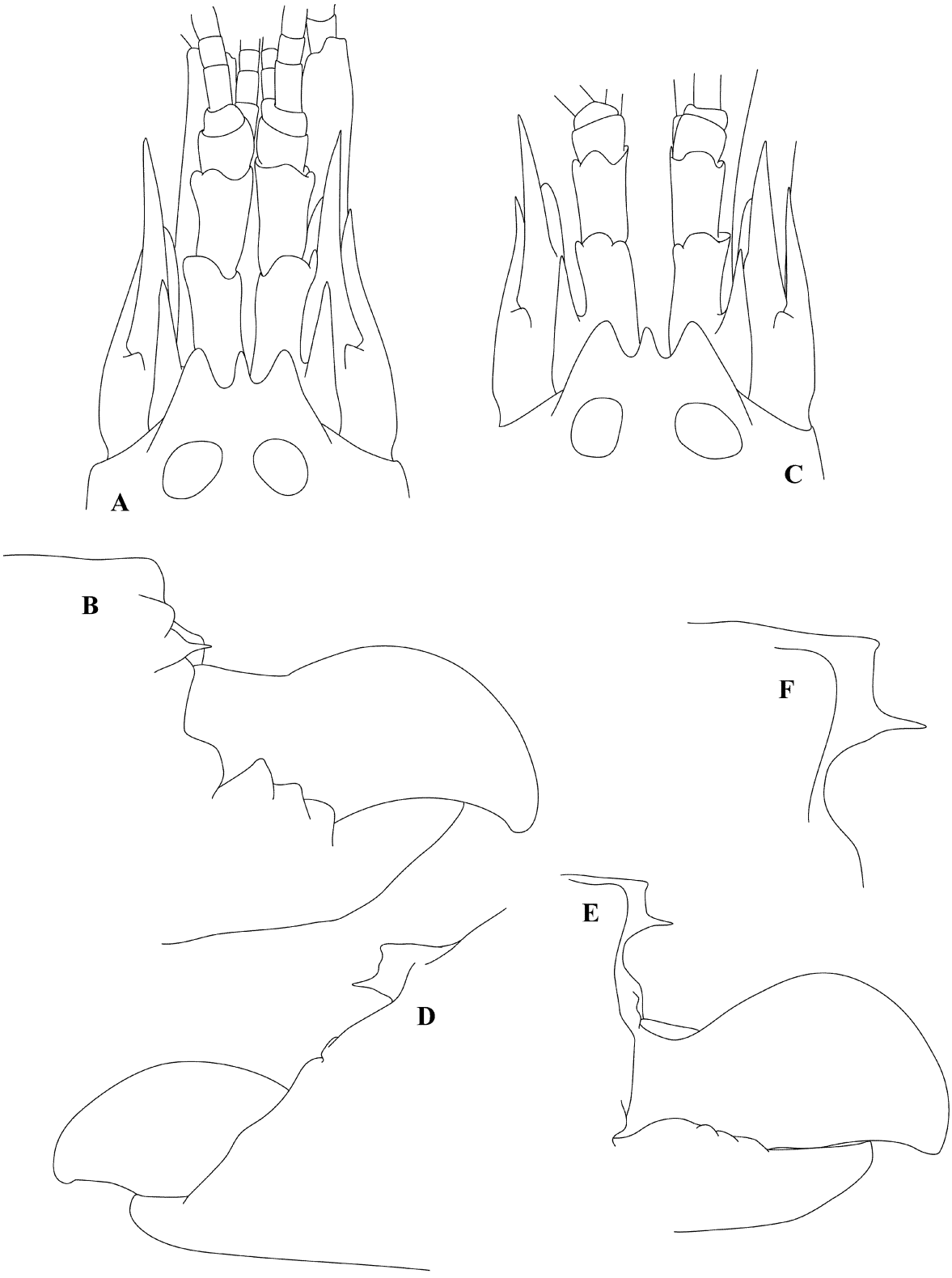


FIGURE 12. *Synalpheus irie* **n. sp.** Paratype non-ovigerous individual CL: 4.88 mm (USNM 1126367, original VIMS 08JAM2801) from *Auletta* cf. *sycinularia*, fore-reef, Discovery Bay, Jamaica: A, carapace, anterior region, and cephalic appendages, dorsal view; B, chela of major first pereopod, anterior region, lateroventral view. Paratype ovigerous female CL: 5.10 mm (USNM 1126368, original VIMS 08JAM2802) from *Auletta* cf. *sycinularia*, fore-reef, Discovery Bay, Jamaica: C, carapace, anterior region, and cephalic appendages, dorsal view; D, chela of major first pereopod, anterior region, mesial view; E, same, ventral view; F, same, detail of distal superior margin protuberance. Scale bar = 0.75 mm for A, B, C, D, E; 0.4 for F.

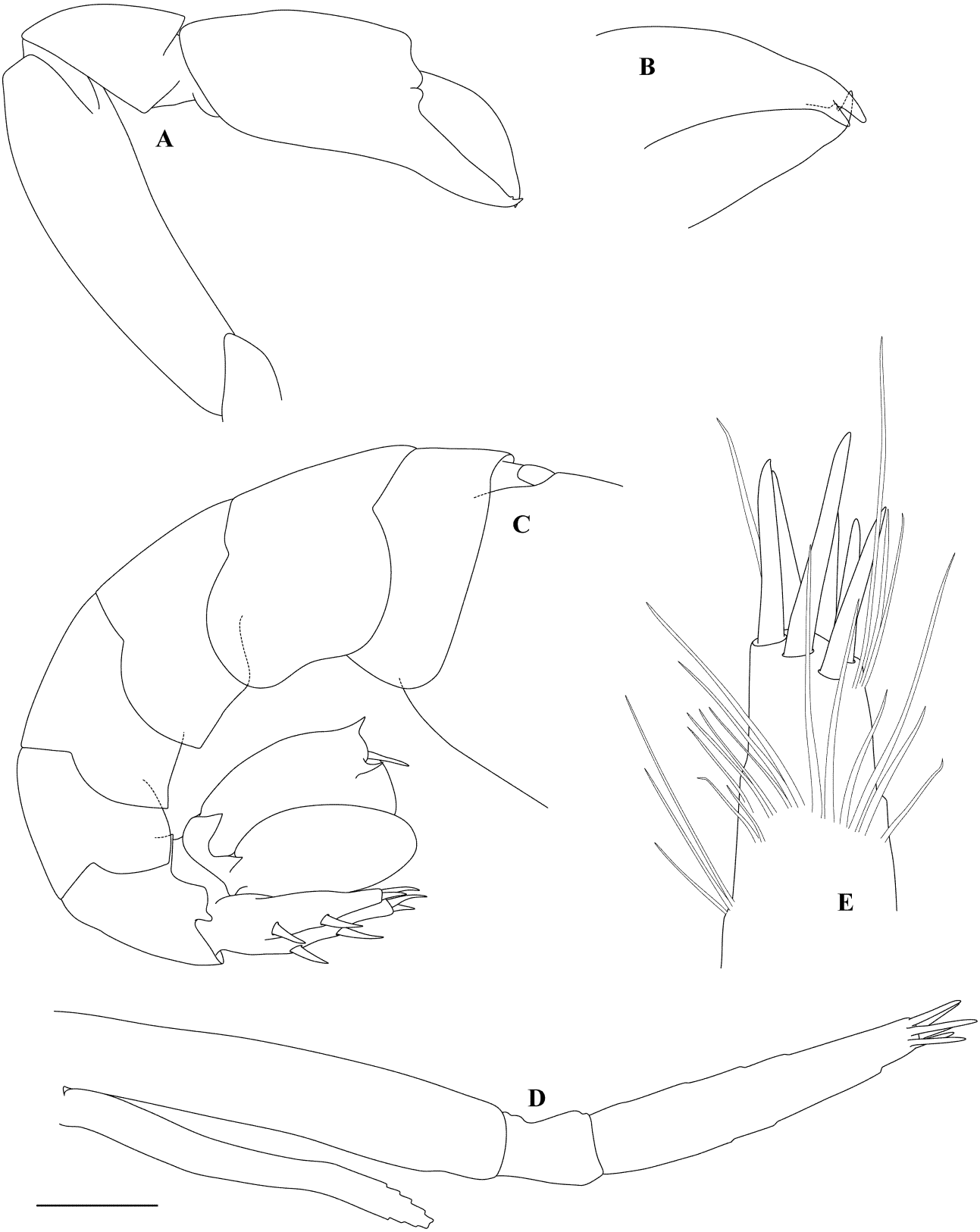


FIGURE 13. *Synalpheus irie* **n. sp.** Holotype non-ovigerous individual CL: 4.88 mm (USNM 1126365, original VIMS 08JAM3602) from *Auletta* cf. *sycinularia*, Dairy Bull Reef, Jamaica: A, chela of minor first pereopod, setae removed, lateral view; B, same, detail of distal region, mesial view; C, abdomen, right uropod, and telson, lateral view; D, third maxilliped; E, same, detail of distal region. Scale bar = 0.75 mm for A; 0.33 mm for B, 1 mm for C; 0.5 mm for D; 0.15 mm for E.

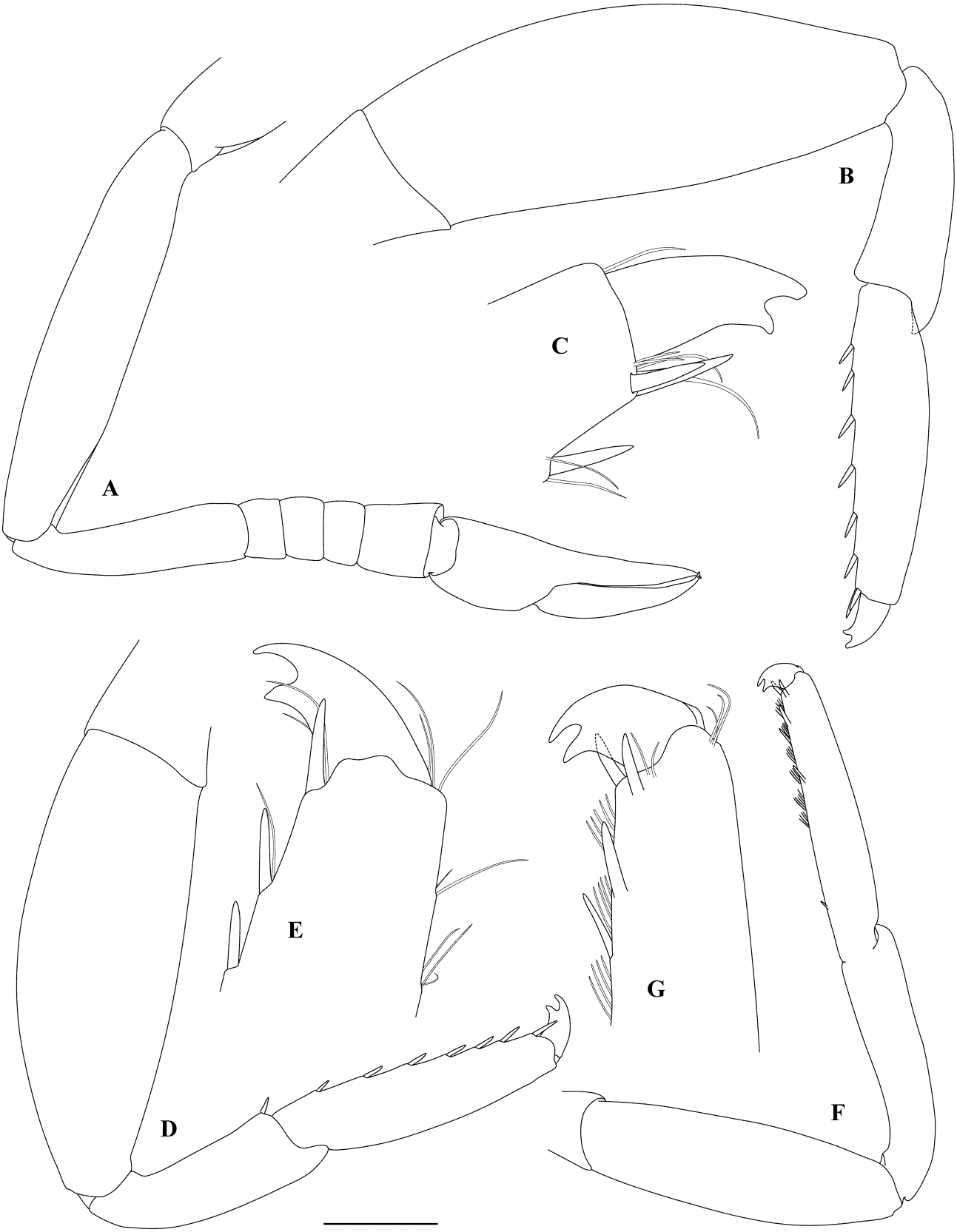


FIGURE 14. *Synalpheus irie* **n. sp.** Holotype non-ovigerous individual CL: 4.88 mm (USNM 1126365, original VIMS 08JAM3602) from *Auletta* cf. *sycinularia*, Dairy Bull Reef, Jamaica: A, second pereopod; B, third pereopod; C, same, detail of distal region; D, fourth pereopod; E, same, detail of distal region; F, fifth pereopod; G, same, detail of distal region. Scale bar = 0.5 mm for A, B, D, F; 0.15 for C, E, G.

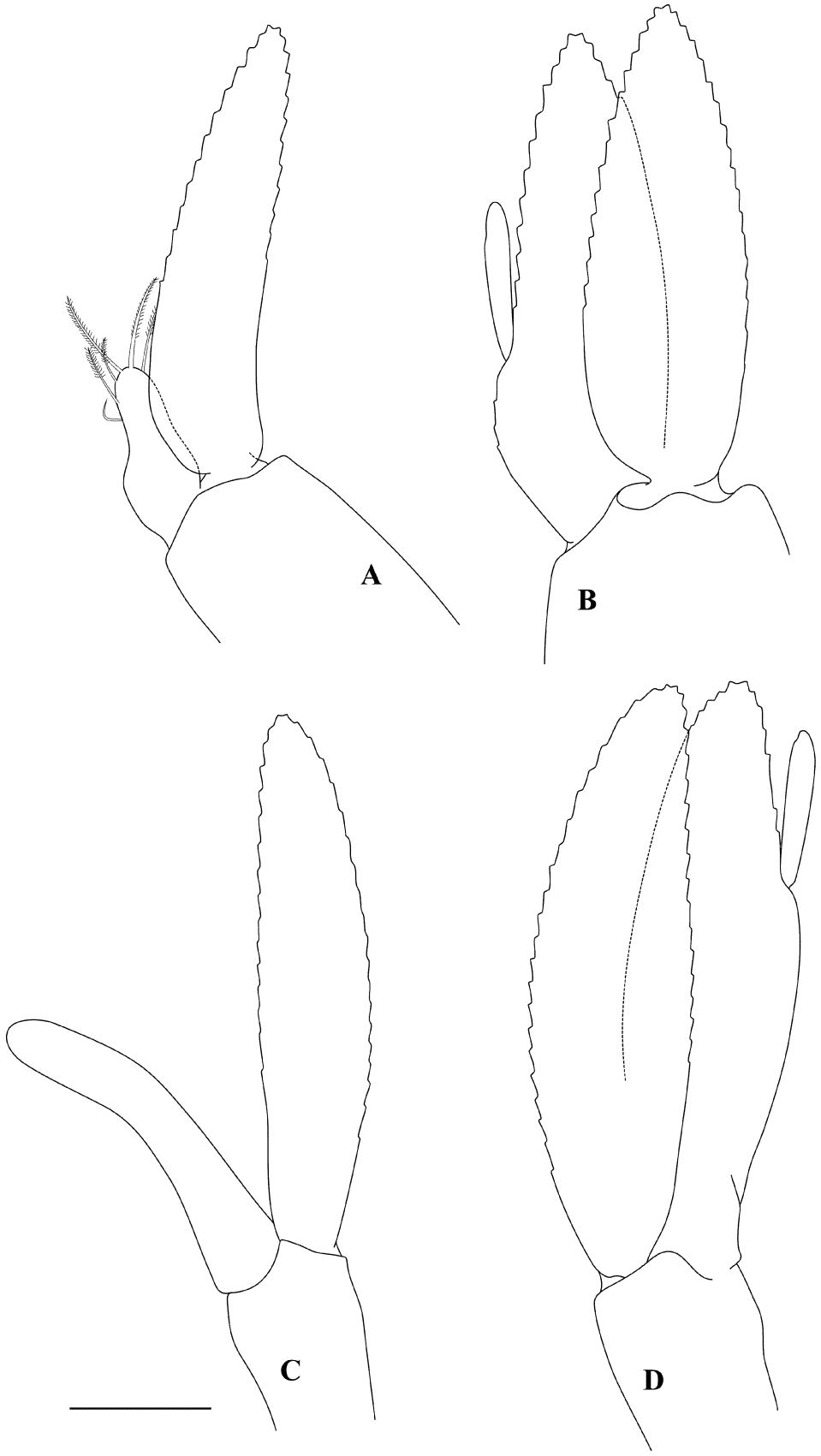


FIGURE 15. *Synalpheus irie* **n. sp.** Holotype non-ovigerous individual CL: 4.88 mm (USNM 1126365, original VIMS 08JAM3602) from *Auletta* cf. *sycinularia*, Dairy Bull Reef, Jamaica: A, first pleopod; B, second pleopod. Allotype ovigerous female CL: 5.32 mm (USNM 1126366, original VIMS 08JAM3601) from *Auletta* cf. *sycinularia*, Dairy Bull Reef, Jamaica: C, first pleopod; D, second pleopod. Scale bar = 0.33 mm.

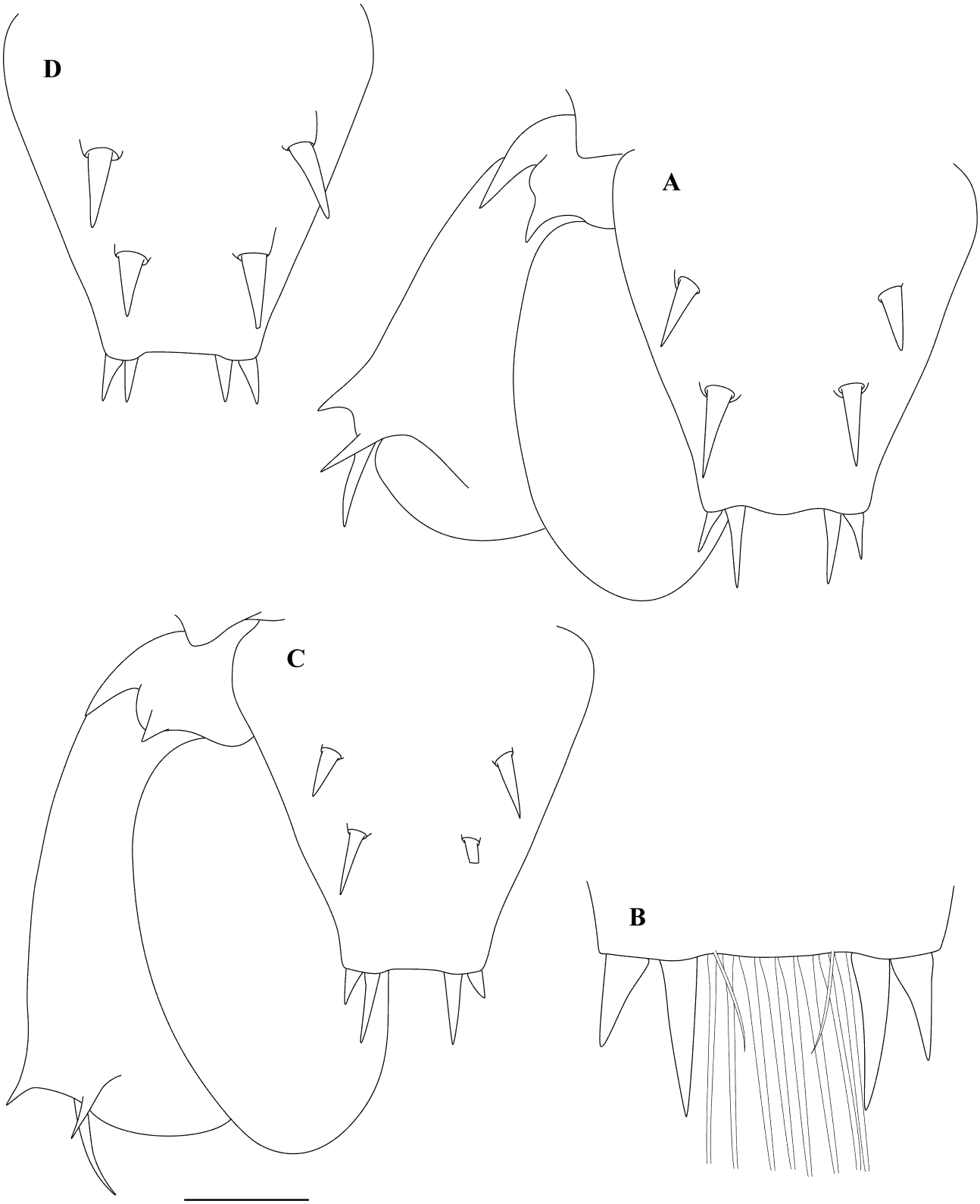


FIGURE 16. *Synalpheus irie* **n. sp.** Holotype non-ovigerous individual CL: 4.88 mm (USNM 1126365, original VIMS 08JAM3602) from *Auletta* cf. *sycinularia*, Dairy Bull Reef, Jamaica: A, left uropod and telson, dorsal view; B, telson, dorsal view, detail of distal margin. Allotype non-ovigerous individual CL: 5.32 mm (USNM 1126366, original VIMS 08JAM3601) from *Auletta* cf. *sycinularia*, Dairy Bull Reef, Jamaica: C, left uropod and telson, dorsal view. Paratype ovigerous female 5.10 mm (USNM 1126368, original VIMS 08JAM2802) from *Auletta* cf. *sycinularia*, fore-reef, Discovery Bay, Jamaica: D, telson, dorsal view. Scale bar = 0.5 mm for A, C, D; 0.25 for B.

First pleopod (Fig. 15) of male with 2 terminal setae on endopod; second pleopod of male with marginal setae on exopod originating in distal third; appendix interna present on second to fifth male pleopods. Second pleopod (Fig. 12) of female with marginal setae on exopod originating in distal third; appendix interna present on second to fifth female pleopods.

Telson (Fig. 13, 16) with convex marginal lobe present; posterior corners adjacent to spines obtuse. Space between distal spines 50% of distal margin, lateral spines ~60% length of mesial. Distal margin with fan of 8 plumose setae between spines. Distal margin ~40% width of proximal margin. Dorsal spines strong, emanating from prominent longitudinal ridges (Fig. 13). Uropods (fig 13, 16) with a single fixed tooth on lateral margin of exopod distinctly removed anteriorly from the movable one, the latter extremely long, slender, and curved.

Color. Nondescript, translucent with orange tinge to thickened parts of cuticle; distal 1/4 of palm and fingers of major chela bright orange with split white crescent spanning palm near fingers; ovaries and embryos green.

Etymology. We have named this species in honor of the nation in which it was found. The word "irie" is a Rastafari term referring to that which is good and peaceful.

Variation. Length of lateral distal spine of telson ranges from 25% length of mesial spine to 75% of mesial spine.

Hosts and ecology. Both pairs of *Synalpheus irie*, **n. sp.** were collected from the canals of *Auletta* cf. *sycinularia.*

Distribution. Jamaica (this study).

Remarks. *Synalpheus irie*, **n. sp.** is easily distinguishable from all other west Atlantic *Synalpheus* species by its distinctive major chela. The short fingers that curve dorsally almost into a bowl-shape, and the two-pronged distal superior marginal protuberance are both unique within the genus in this region. The distinctive curved movable spine on the outer uropod is similar to that found in other *Synalpheus* species, but appears to be unique among members of the *S. gambarelloides* group. However, the presence of a thick brush of setae on the minor chela dactyl, as well as the triangular shape of the telson, firmly places *S. irie* within the *S. gambarelloides* group. With its curved major chela fingers, fan of setae on the distal margin of the telson, and antennal characters, this new species most closely resembles *Synalpheus mcclendoni*, but it is easily distinguished by the characters listed previously.

***Synalpheus mcclendoni* Coutière**
Color plate 4A, B

Material examined. Jamaica: non-ovigerous individual, ovigerous female, (VIMS 08JAM2702,03), Dairy Bull Reef, from canals of unidentified white tube sponge. Non-ovigerous individual, (VIMS 08JAM4101), Columbus Park, Discovery Bay, from canals of *Agelas* cf. *clathrodes*. 5 non-ovigerous individual, 3 ovigerous females, (VIMS 08JAM6101,07,22,24,28), Columbus Park, Discovery Bay, from canals of *A.* cf. *clathrodes*. Non-ovigerous individual, (VIMS 08JAM8201), wall off Rio Bueno, from canals of *A.* cf. *clathrodes*. 6 non-ovigerous individuals, ovigerous female, (VIMS 08JAM8802,03), Columbus Park, Discovery Bay, from canals of *Spheciospongia vesparium* Lamarck. MaxCL ovigerous female: 3.09 mm. MaxCL non-ovigerous individual: 3.91 mm.

Color. The specimens of *S. mcclendoni* found in Jamaica differed greatly in color, with three main variations: 1) translucent body, distal portion of major chela brownish, with pale brown ovaries and embryos; 2) translucent body, distal portion of major chela orange, with olive embryos and ovaries; and 3), translucent body, distal portion of major chela bright orange/red, with white crescent following extensor margin of dactyl and another white crescent across palm near base of fingers, embryos and ovaries green/yellow (see Color plate 4A, which shows the last of these morphs).

Hosts and ecology. *Synalpheus mcclendoni* was found inhabiting several species of sponges in Jamaica:

Agelas cf. *clathrodes*, *Auletta* cf. *sycinularia*, and *Spheciospongia vesparium*. It is typically found as heterosexual pairs, or in small groups with equal sex ratios.

Distribution. Florida, USA (Coutière 1910); Bahamas (Dardeau 1984); Cuba (Martínez Iglesias and García Raso 1999); St. Lucia, Tobago Cays, Yucatan Mexico (Chace 1972); Caribbean Panama (Duffy 1992); Belize (as "*S. rathbunae* A", Macdonald et al. 2006; Ríos and Duffy 2007); Jamaica (this study).

Remarks. The individuals examined here are morphologically very similar, yet they may represent more than one species based on body color and pattern, and embryo/ovary color. While individuals from *A.* cf. *sycinularia* had a brownish major chela and pale embryos, color does not otherwise seem to correlate with host, with some shrimp from *A.* cf. *clathrodes* having orange chela and olive ovaries and embryos, while other individuals from the same host species displayed the bright orange major chela with white crescent and green/yellow embryos. However, individual sponges never contained mixed populations; all *S. mcclendoni* in a particular sponge shared the same color pattern. The bright orange/white crescent color pattern on the major chela was found in individuals from both *S. vesparium* and *A.* cf. *clathrodes*.

***Synalpheus pandionis* Coutière**
Color plates 4C, D, 5A

Material examined. Jamaica: 9 non-ovigerous individuals, 7 ovigerous females, (VIMS 08JAM5901-15), Columbus Park, Discovery Bay, from canals of *Lissodendoryx* sp. Non-ovigerous individual, ovigerous female, (VIMS 08JAM9001,02), Columbus Park, Discovery Bay, from canals of *Lissodendoryx* sp. MaxCL ovigerous female: 6.75 mm. MaxCL non-ovigerous individual: 6.08 mm.

Color. Faint orange, often with a pale reddish tinge; distal portion of major chela brilliant orange; embryos and ovaries either green or bright orange.

Hosts and ecology. *Synalpheus pandionis* was only found in two specimens of a free-standing, very soft-bodied sponge within the genus *Lissodendoryx*. In Belize, it was found most frequently in *Lissodendoryx* cf. *strongylata* van Soest, and was typically found as a single pair of shrimp.

Distribution. Bahamas (Lemaitre 1984); Cuba (Martínez Iglesias and García Raso 1999); Virgin Islands (Coutière 1909; Chace 1972); Gulf of Mexico (Dardeau, 1984); Belize (Macdonald et al. 2006; Ríos and Duffy 2007); Discovery Bay, Jamaica (this study).

Remarks. *Synalpheus pandionis* is one of a complex of morphologically similar species that includes *Synalpheus ul* Ríos and Duffy, *Synalpheus dardeaui* Ríos and Duffy and *Synalpheus yano* Ríos and Duffy. Specimens of *S. pandionis* from Jamaica superficially resemble *S. dardeaui*, another large orange species that commonly occurs in *Lissodendoryx colombiensis* in Belize. However, all individuals collected in Jamaica possessed square ocular hoods, unequal sized distal fingers on the minor first chela, and uropod characteristics typical of *S. pandionis* (see Ríos and Duffy 2007 for more details). While embryo and ovary color varied among females, this variation did not seem to consistently coincide with other morphological differences.

***Synalpheus pectiniger* Coutière**

Specimens examined. Jamaica: non-ovigerous individual, (VIMS 08JAM8801), Columbus Park, Discovery Bay, from canals of *Spheciospongia vesparium*. MaxCL non-ovigerous individual: 4.17 mm.

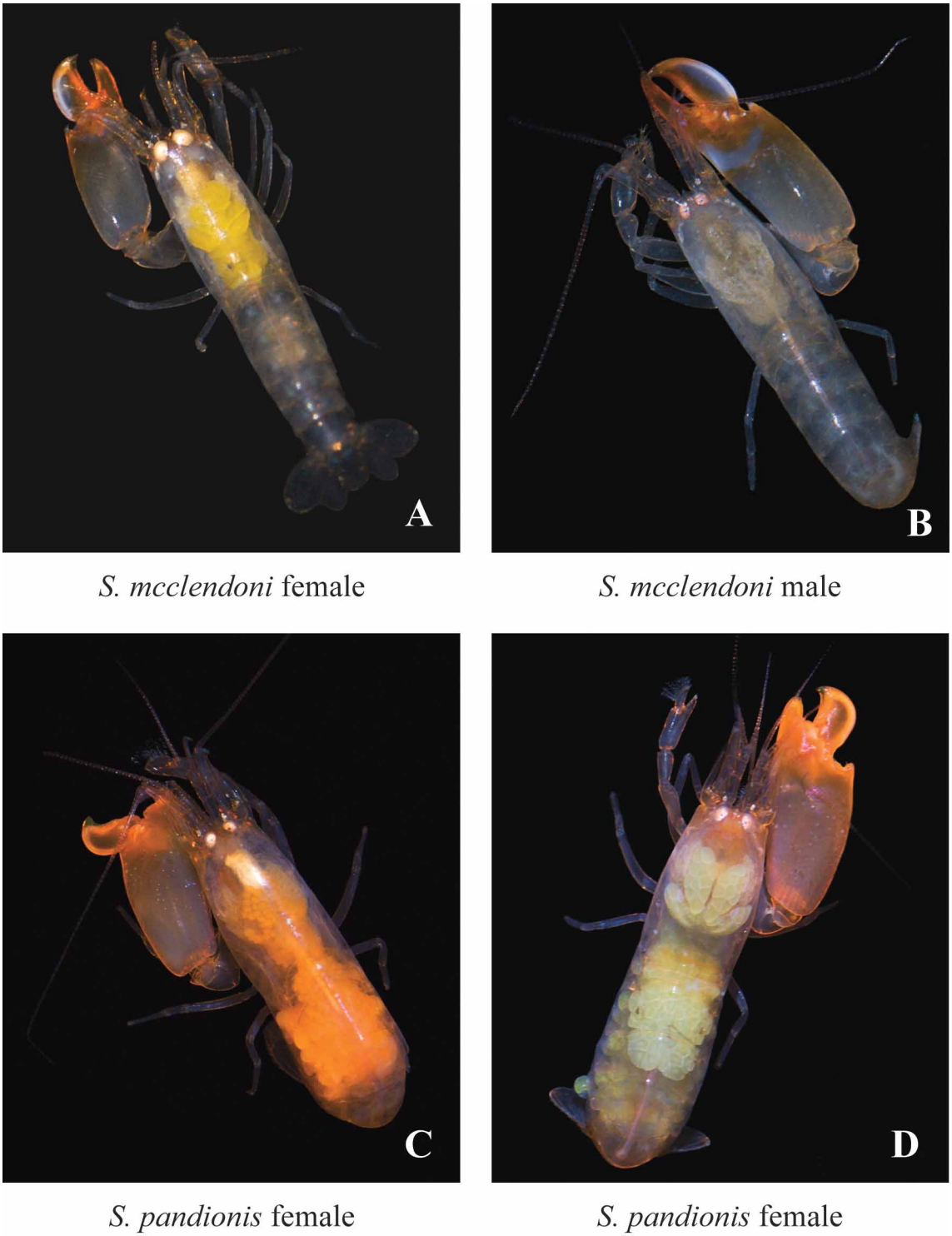
Color. Translucent; distal portion of major chela brownish.

Hosts and ecology. This single specimen of *Synalpheus pectiniger* was found in *S. vesparium*, in which it seems to be a strict host specialist throughout its range.

Distribution. Florida, USA (Coutière 1909; Duffy 1993); Bahamas (Coutière 1909; Lemaitre 1984); Cuba (Martínez Iglesias and García Raso 1999); Virgin Islands (Coutière 1909; Chace 1972); Gulf of Mexico (Coutière 1909; Wass 1955; Tabb and Manning 1961; Rouse 1970; Lyons et al. 1971; Menzel 1971; Dardeau

1984; Erdmann and Blake 1987); Yucatan Mexico (Chace 1972); Belize (Macdonald et al. 2006; Ríos and Duffy 2007); Caribbean Panama (Duffy 1992); Windward Island (Chace 1972); Netherlands Antilles (Coutíere1909; Westinga and Hoetjes 1981); Discovery Bay, Jamaica (this study).

Remarks. This species is readily identifiable due to its distinctive tridentate minor chela dactyl and extremely short major chela fixed finger.



S. mcclendoni female | *S. mcclendoni* male

S. pandionis female | *S. pandionis* female

PLATE 4. A, *Synalpheus mcclendoni* ovigerous female (08JAM6101) from *Agelas* cf. *clathrodes*, Columbus Park, Discovery Bay, Jamaica. B, *Synalpheus mcclendoni* non-ovigerous individual (08JAM8201) from *Agelas* cf. *clathrodes*, Rio Bueno, Jamaica. C, *Synalpheus pandionis* ovigerous female (08JAM6901) from *Lissodendoryx* sp., Columbus Park, Discovery Bay, Jamaica. D, *Synalpheus pandionis* ovigerous female (08JAM6903) from *Lissodendoryx* sp., Columbus Park, Discovery Bay, Jamaica.

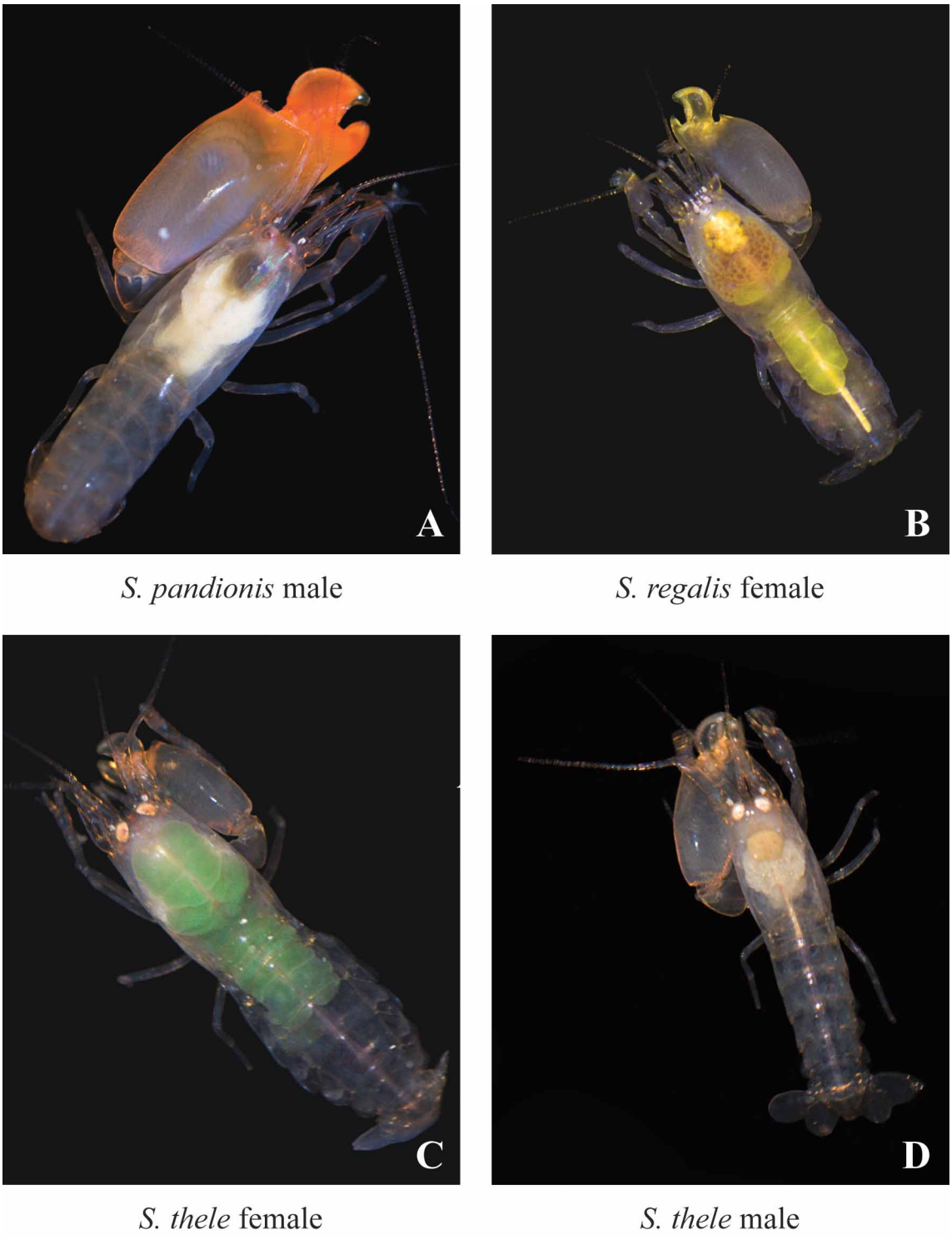


PLATE 5. A, *Synalpheus pandionis* non-ovigerous individual (08JAM6908) from *Lissodendoryx* sp., Columbus Park, Discovery Bay, Jamaica. B, *Synalpheus regalis* ovigerous female (08JAM3303) from *Hyattella intestinalis*, fore-reef (near M1 channel marker), Discovery Bay, Jamaica. C, *Synalpheus thele* ovigerous female (08JAM6108) from *Agelas* cf. *clathrodes*, Columbus Park, Discovery Bay, Jamaica. D, *Synalpheus thele* non-ovigerous individual (08JAM6121) from *Agelas* cf. *clathrodes*, Columbus Park, Discovery Bay, Jamaica.

***Synalpheus plumosetosus*, n. sp.**
Figures 17–21

Material examined. Jamaica: Holotype: non-ovigerous individual, CL: 2.55 mm, (USNM 1126369, original VIMS 08JAM2706), Dairy Bull Reef, (18° 28.083′ N, 77° 23.289′ W), from canals of *Auletta* cf. *sycinularia*. Allotype: ovigerous female, CL: 2.62 mm, (USNM 1126370, original VIMS 08JAM2704), Dairy Bull Reef, from canals same of same individual *Auletta* cf. *sycinularia* as holotype. Paratypes: non-ovigerous individual, CL: 2.59 mm, ovigerous female, CL: 2.47 mm, (USNM 1126371,1126372, original VIMS 08JAM2705,07), Dairy Bull Reef, from canals same of same individual *Auletta* cf. *sycinularia* as holotype. MaxCL ovigerous female: 2.62 mm. MaxCL non-ovigerous individual: 2.55 mm.

Description. Body form subcylindrical; carapace smooth, sparsely setose, posterior margin with cardiac notch distinct. Rostrum longer than ocular hood (Fig. 17, 18), distinctly narrower, distally upturned; margins in dorsal view, slightly concave. Ocular hoods dorsally convex; in dorsal view, blunt, separated from rostrum by deep adrostral sinus. Stylocerite acute, with blunt tip; mesial margin concave; reaching beyond midpoint of first segment of antennular peduncle. First antennular segment without ventromesial tooth, and with two basal ventral processes. Basicerite without tooth on dorsomesial corner, with longer ventrolateral spine, reaching distal end of third segment of antennular peduncle. Scaphocerite without blade, acute lateral spine robust, with lateral margin slightly concave, slightly shorter than basicerite spine, reaching almost to distal end of third segment of antennular peduncle. Third maxilliped with distal circlet of approximately six spines on distal segment, without ventrodistal spine on antepenultimate segment.

Major first pereopod (Fig. 17, 18) massive, fingers clearly shorter than half length of palm; fixed finger slightly shorter than dactyl. Palm of chela with tapering acute distal protuberance on superior margin, directed slightly downward, towards dactyl. Minor first pereopod (Fig. 19) with palm clearly less than two times longer than high; fingers clearly shorter than palm; dactyl with flexor margin concave, blade-like, with small but distinct second tooth basal to strongly curved tip; extensor surface of dactyl with thick brush of curved, plumose setae; fixed finger with flexor margin straight, blade-like, and small but distinct second tooth basal to strongly curved tip.

Second pereopod (Fig. 20) with carpus 5-segmented, subequal in length to merus. Both fingers terminating in a narrow, curved tooth.

Third pereopod (Fig. 20) slender; dactyl biunguiculate, with flexor unguis subequal in thickness to extensor, mesial margin of flexor unguis strongly convex; propodus with row of six movable spines on flexor margin and one pair of distal movable spines flanking base of dactyl; carpus with distal movable spine on flexor margin; merus 3 ½ times longer than wide, without movable spines on flexor margin. Fourth pereopod (Fig. 20) similar to third, weaker, propodus with five spines on flexor margin. Fifth pereopod (Fig. 20) weaker than fourth; propodus with only four spines on flexor margin, and four transverse combs of stout setae on ventral face; carpus without distal spine.

First pleura (Fig. 17) of male with posterior corner distinctly produced ventrally into short, blunt, downward directed point; second pleura of male broadly rounded**.** Third to fifth pleura of male with straight ventral margin, rounded anterior corner and subacute posterior corner.

First pleopod (Fig. 21) of male with 2 terminal setae on endopod; second pleopod of male with marginal setae on exopod originating in distal one-half; appendix interna present on second to fifth male pleopods. Second pleopod (Fig. 21) of female with marginal setae on exopod originating in distal one-half; appendix interna present on second to fifth female pleopods.

Telson (Fig. 17, 18) with convex lobe on distal margin; posterior corners adjacent to spines obtuse. Space between distal spines 25% of distal margin, lateral spines ~70% length of mesial. Distal margin ~30% width of proximal margin. Uropods (Fig. 17) with a single fixed tooth on lateral margin of exopod distinctly removed anteriorly from the movable spine, the latter longer and thicker than adjacent posterior fixed tooth.

Colot in life. Nondescript, translucent with dull gold tinge to thickened parts of cuticle; distal palm and fingers of major chela orange; ovaries and embryos drab green.

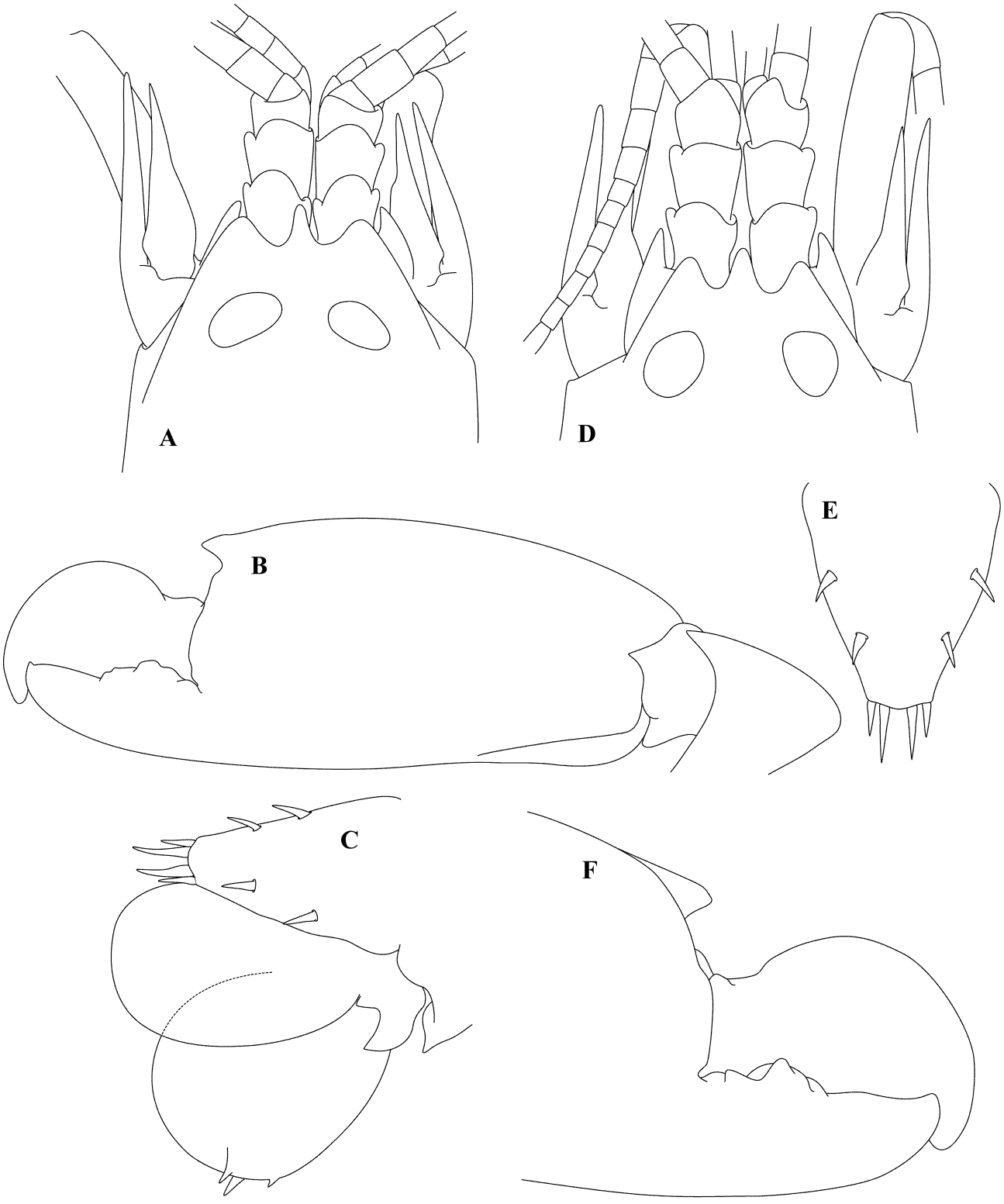


FIGURE 17. *Synalpheus plumosetosus* **n. sp.** Holotype non-ovigerous individual CL: 2.55 mm (USNM 1126369, original VIMS 08JAM2706), from *Auletta* cf. *sycinularia*, Dairy Bull Reef, Jamaica: A, carapace, anterior region, and cephalic appendages, dorsal view; B, chela of major first pereopod, ventral view; C, telson and left uropods, dorso-lateral view. Allotype ovigerous female CL: 2.62 mm (USNM 1126370, original VIMS 08JAM2704) from *Auletta* cf. *sycinularia*, Dairy Bull Reef, Jamaica: D, carapace, anterior region, and cephalic appendages, dorsal view; E, chela of major first pereopod, anterior region, ventral view; F, telson, dorsal view. Scale bar = 0.4 mm for A, C, D, E, F; 0.75 for B.

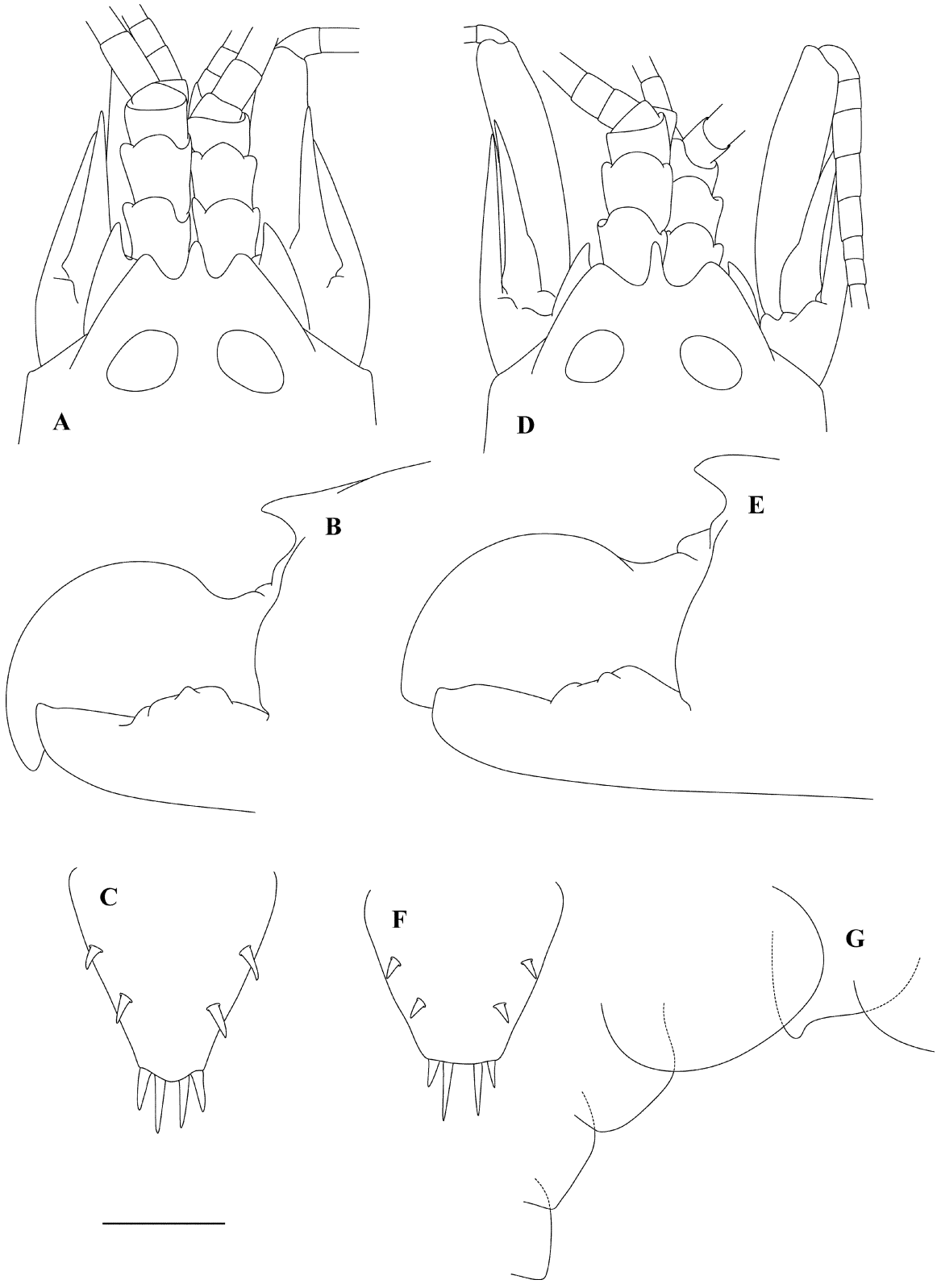


FIGURE 18. *Synalpheus plumosetosus* **n. sp.** Paratype ovigerous female CL: 2.59 mm (USNM 1126371, original VIMS 08JAM2705), from *Auletta* cf. *sycinularia*, Dairy Bull Reef, Jamaica: A, carapace, anterior region, and cephalic appendages, dorsal view; B, chela of major first pereopod, anterior region, ventral view; C, telson, dorsal view. Paratype non-ovigerous individual CL: 2.47 mm (USNM 1126372, original VIMS 08JAM2707), from *Auletta* cf. *sycinularia*, Dairy Bull Reef, Jamaica: D, carapace, anterior region, and cephalic appendages, dorsal view; E, chela of major first pereopod, anterior region, ventral view; F, telson, dorsal view; G, abdomen, lateral view. Scale bar = 0.4 mm for A, B, C, D, E, F; 0.5 for G.

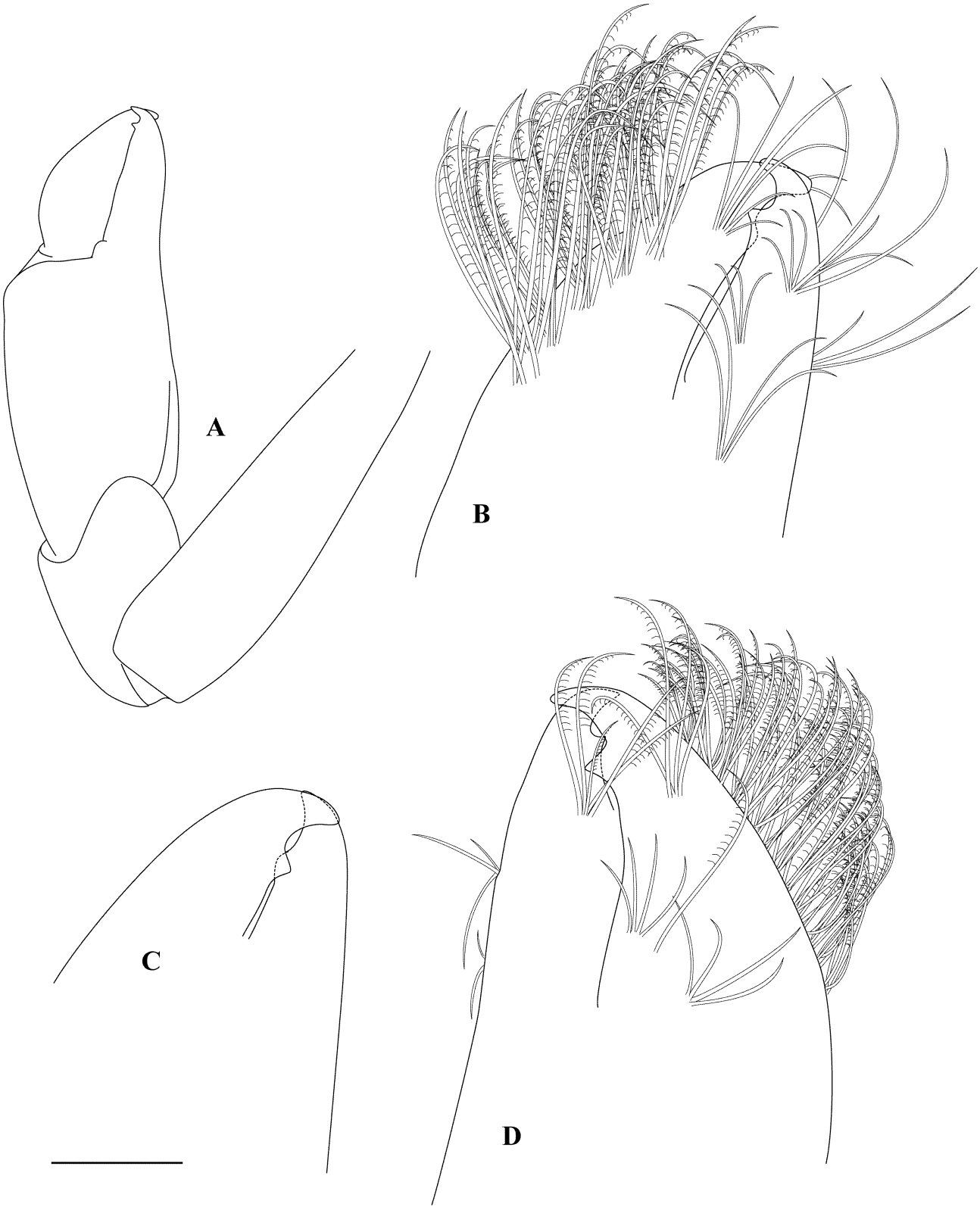


FIGURE 19. *Synalpheus plumosetosus* **n. sp.** Holotype non-ovigerous individual 2.55 mm (USNM 1126369, original VIMS 08JAM2706), from *Auletta* cf. *sycinularia*, Dairy Bull Reef, Jamaica: A, minor first pereopod, setae removed, mesial view; B, same, distal region. Allotype ovigerous female CL: 2.62 mm (USNM 1126370, original VIMS 08JAM2704) from *Auletta* cf. *sycinularia*, Dairy Bull Reef, Jamaica: C, chela of minor first pereopod, distal region, setae removed, lateral view. Paratype non-ovigerous individual CL: 2.47 mm (USNM 1126372, original VIMS 08JAM2707), from *Auletta* cf. *sycinularia*, Dairy Bull Reef, Jamaica: D, chela of minor first pereopod, distal region, lateral view. Scale bar = 0.33 mm for A; 0.2 mm for B, C, D.

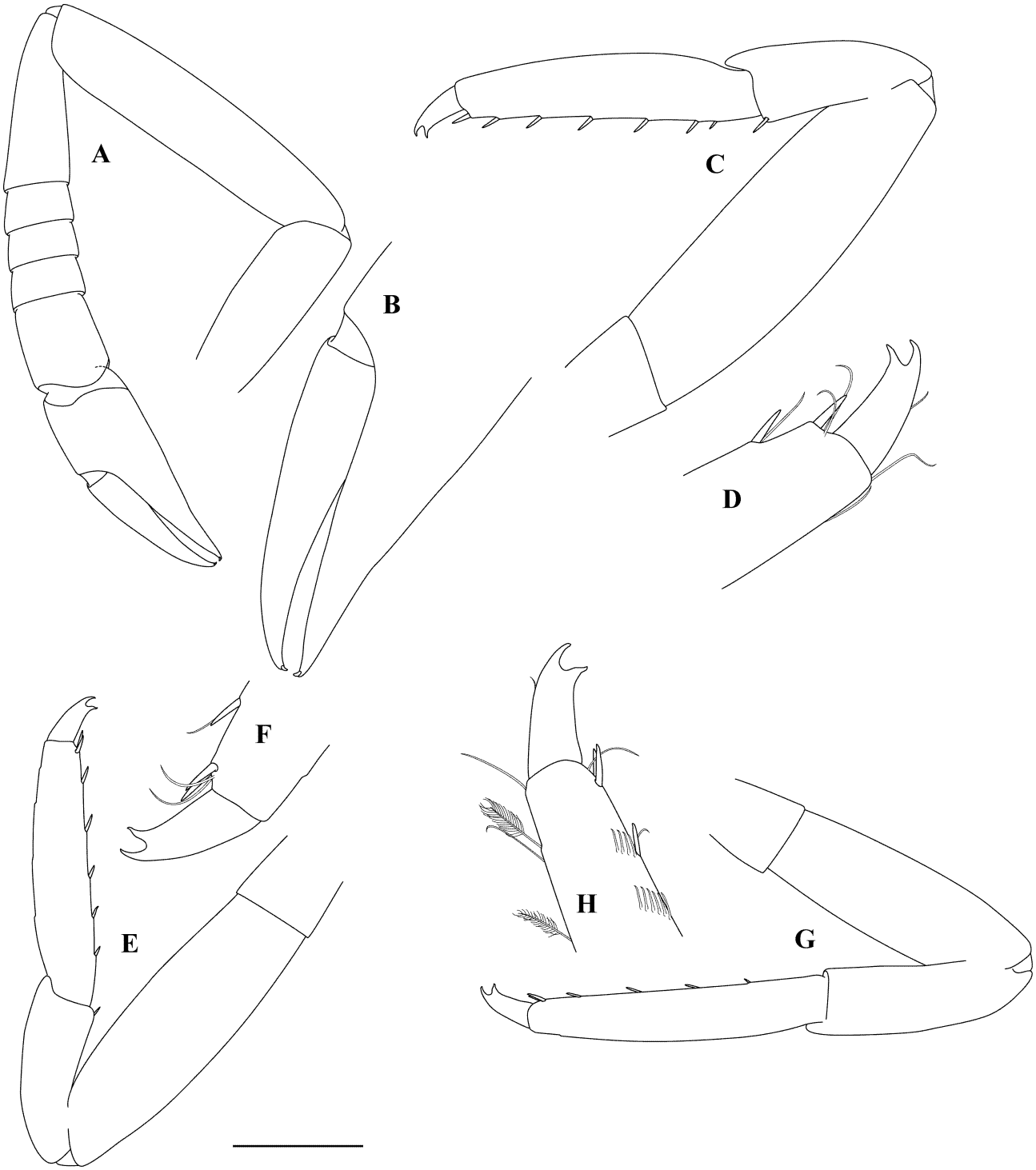


FIGURE 20. *Synalpheus plumosetosus* **n. sp.** Holotype non-ovigerous individual CL: 2.55 mm (USNM 1126369, original VIMS 08JAM2706), from *Auletta* cf. *sycinularia*, Dairy Bull Reef, Jamaica: A, second pereopod; B, same, detail of distal region; C, third pereopod; D, same, detail of distal region; E, fourth pereopod; F, same, detail of distal region; G, fifth pereopod; H, same, detail of distal region. Scale bar = 0.33 mm for A, C, E, G; 0.15 for B, D, F, H.

Etymology. We have named this species for its distinguishing characteristic: the plumose setae making up the setal brush on the minor chela.

Variation. There is variation in the relative lengths of the scaphocerite and basicerite among the four specimens examined. In the holotype and allotype (USNM 1126369,70), the scaphocerite is longer than the basicerite, while in the two paratypes (USNM 1126371,72), the scaphocerite is shorter.

Hosts and ecology. All four individuals were collected from the canals of *Auletta* cf. *sycinularia* (Plate 7B). This sponge appears to be the same species from which all samples of *Synalpheus irie*, **n. sp.** were also collected.

Distribution. Jamaica (this study).

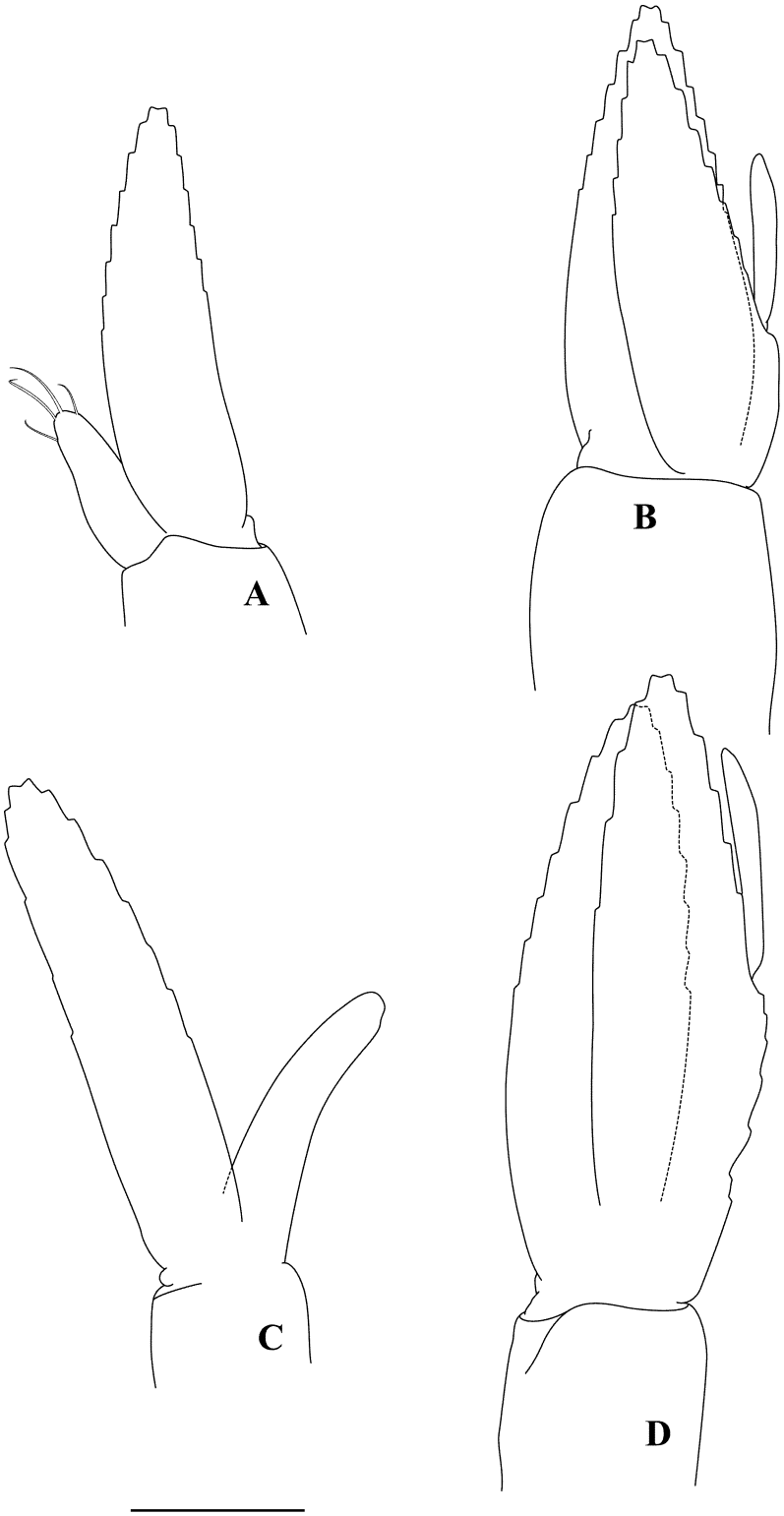


FIGURE 21. *Synalpheus plumosetosus* **n. sp.** Holotype non-ovigerous individual CL: 2.55 mm (USNM 1126369, original VIMS 08JAM2706), from *Auletta* cf. *sycinularia*, Dairy Bull Reef, Jamaica: A, first pleopod; B, second pleopod. Allotype ovigerous female CL: 2.62 mm (USNM 1126370, original VIMS 08JAM2704) from *Auletta* cf. *sycinularia*, Dairy Bull Reef, Jamaica: C, first pleopod; D, second pleopod. Scale bar = 0.2 mm.

Remarks. *Synalpheus plumosetosus* **n. sp.** appears to be another member of the complex of morphologically similar species that includes *S. brooksi, S. bousfieldi, S. chacei, S. corallinus* **n. sp.** and *S. thele* **n. sp.** (see Table 3). *Synalpheus plumosetosus* can be easily distinguished from all of these by the setal brush on the dactyl of its minor chela, which consists of plumose setae rather than the simple setae found in all other examined *Synalpheus* species. In most other characters, *S. plumosetosus* resembles *S. bousfieldi*.

***Synalpheus regalis* Duffy**
Figure 10, Color plate 5B

Material examined. Jamaica: 96 non-ovigerous individuals, 1 ovigerous female (VIMS 08JAM3303-05), fore-reef (near M1 channel marker), Discovery Bay, from canals of *Hyattella intestinalis*. 56 non-ovigerous individuals, 1 ovigerous female (VIMS 08JAM4201-03), fore-reef (near M1 channel marker), Discovery Bay, from canals of *H. intestinalis*. 59 non-ovigerous individuals, 1 ovigerous female (VIMS 08JAM4901-03), Columbus Park, Discovery Bay, from canals of *H. intestinalis*. 82 non-ovigerous individuals, 1 ovigerous female (VIMS 08JAM5101-03), Columbus Park, Discovery Bay, from canals of *H. intestinalis*. 7 non-ovigerous individuals (VIMS 08JAM5201), Columbus Park, Discovery Bay, from canals of *H. intestinalis*. 24 non-ovigerous individuals, 1 ovigerous female (VIMS 08JAM5401,02,04), Columbus Park, Discovery Bay, from canals of *H. intestinalis*. 59 non-ovigerous individuals, 1 ovigerous female (VIMS 08JAM6001-03), Columbus Park, Discovery Bay, from canals of *H. intestinalis*. 66 non-ovigerous individuals, 1 ovigerous female (VIMS 08JAM6201-03), Columbus Park, Discovery Bay, from canals of *H. intestinalis*. 265 non-ovigerous individuals, 1 ovigerous female (VIMS 08JAM6301-03), Columbus Park, Discovery Bay, from canals of *H. intestinalis*. 202 non-ovigerous individuals, 1 ovigerous female (VIMS 08JAM6401-03), Columbus Park, Discovery Bay, from canals of *H. intestinalis*. 6 non-ovigerous individuals (VIMS 08JAM7601), wall off Rio Bueno, from canals of *H. intestinalis*. 23 non-ovigerous individuals (VIMS 08JAM7901), wall off Rio Bueno, from canals of *H. intestinalis*. 25 non-ovigerous individuals, 1 ovigerous female (VIMS 08JAM8601-03), wall off Rio Bueno, from canals of *H. intestinalis*. 265 non-ovigerous individuals, 1 ovigerous female (VIMS 08JAM9101-03), Columbus Park, Discovery Bay, from canals of *H. intestinalis*. 29 non-ovigerous individuals (VIMS 08JAM9201,02), Columbus Park, Discovery Bay, from canals of *H. intestinalis*. 88 non-ovigerous individuals (VIMS 08JAM9301,02), Columbus Park, Discovery Bay, from canals of *H. intestinalis*. 31 non-ovigerous individuals, 1 ovigerous female (VIMS 08JAM9401,02), Columbus Park, Discovery Bay, from canals of *H. intestinalis*. 10 non-ovigerous individuals (VIMS 08JAM9501), Columbus Park, Discovery Bay, from canals of *H. intestinalis*. 18 non-ovigerous individuals (VIMS 08JAM9601,02), Columbus Park, Discovery Bay, from canals of *H. intestinalis*. MaxCL ovigerous female: 4.14 mm. MaxCL non-ovigerous individual: 3.17 mm.

Color. Translucent orange; distal portion of major chela brighter orange; embryos and ovaries pale green.

Hosts and ecology. In Jamaica, we have found *S. regalis* exclusively in *Hyattella intestinalis*, typically at depths exceeding 6 m. In Belize, the only other known locality of *S. regalis*, they are commonly found in *Xestospongia* spp. in addition to *H. intestinalis*.

Distribution. Belize (Duffy 1996a,d, Macdonald et al. 2006; Ríos and Duffy 2007); Jamaica (this study).

Remarks. *Synalpheus regalis* is distinguishable from its close relative, *S. elizabethae*, by the possession in non-ovigerous colony members of abdominal pleura (pleura 3–5) that are rounded ventrally versus the ventrally pointed pleura possessed by *S. elizabethae* (Fig. 10). Similarly to the *S. elizabethae* found here, *S. regalis* individuals in Jamaica lack a secondary spine on the major chela protuberance (Fig. 10).

***Synalpheus sanctithomae* Coutière**

Material examined. Jamaica: non-ovigerous individual, ovigerous female (VIMS 08JAM0101,02),

Columbus Park, Discovery Bay, from canals of *Hyattella intestinalis*. Non-ovigerous individual, ovigerous female (VIMS 08JAM0704,05), Columbus Park, Discovery Bay, from canals of *H. intestinalis*. Non-ovigerous individual (VIMS 08JAM1901), Pear Tree Bottom Reef, from canals of *H. intestinalis*. Non-ovigerous individual (VIMS 08JAM4301), fore-reef (near M1 channel marker), Discovery Bay, from canals of unidentified white tube sponge. MaxCL ovigerous female: 3.93 mm. MaxCL non-ovigerous individual: 3.24 mm.

Color. Faint to bright orange; distal portion of major chela more intensely orange; ovaries and embryos green.

Hosts and ecology. In Jamaica, we found pairs of *S. sanctithomae* most commonly inhabiting *Hyattella intestinalis*, but one individual was also discovered in an unidentified, white tube sponge. In other regions, *S. sanctithomae* is commonly found in *Hymeniacidon caerulea*, *H. intestinalis* and *Agelas* cf. *clathrodes*.

Distribution. Florida, USA (Gore 1981); Virgin Islands (Coutière 1909); Belize (Macdonald et al. 2006; Ríos and Duffy 2007); Brazil (Christoffersen 1979); Jamaica (this study).

REMARKS : *Synalpheus sanctithomae* is easily distinguishable from its morphologically closest relative (*Synalpheus mcclendoni*) by the uncurved, short fingers of the major chela, and by the lack of the fan of 10 or more setae emanating from the distal margin of the telson in the latter species. It is distinguishable from *S. irie* **n. sp.** by the lack of the distal setal fan on the telson, and the different shape of both the fingers and the protuberance of the major chela.

***Synalpheus thele* n. sp.**
Figures 22–27, Color plate 5C, D

Material examined. Jamaica: Holotype: non-ovigerous individual, CL: 2.93 mm, (USNM 1126373, original VIMS 08JAM891402), Columbus Park, Discovery Bay, (18° 27.955' N, 77° 24.843' W), from canals of *Agelas* cf. *clathrodes* Schmidt, 1870. Allotype: ovigerous female, CL: 3.32 mm, (USNM 1126374, original VIMS 08JAM891401), Columbus Park, Discovery Bay, from canals of same individual *A.* cf. *clathrodes* as holotype. Paratypes: 17 non-ovigerous individuals, CL: 2.07-3.13 mm, 16 ovigerous females, CL: 3.01-3.61, (USNM 1126375, 1126376, 1126377, 1126378, 1126379, 1126380, 1126381, 1126382, 1126383, original VIMS 08JAM89-0101,-0601,-20,-21,-1004,-1005,-1006,-1007,-1008; VIMS 08JAM89-06,-08,-1002,-1003,-13,-14,-22,-23,-24), Columbus Park, Discovery Bay, from canals of same individual *A.* cf. *clathrodes* as holotype.

Non-types: non-ovigerous individual, ovigerous female (VIMS 08JAM4104,05), fore-reef (near M1 channel marker), Discovery Bay, from canals of *A.* cf. *clathrodes*. 12 non-ovigerous individuals, 8 ovigerous females (original VIMS 08JAM6103,08,11,15–21,26,27,30), Columbus Park, Discovery Bay, from canals of *A.* cf. *clathrodes*. 5 non-ovigerous individuals, 6 ovigerous females (VIMS 08JAM7801-08), wall off Rio Bueno, from canals of *A.* cf. *clathrodes*. MaxCL ovigerous female: 3.61 mm. MaxCL non-ovigerous individual: 3.13 mm.

Description. Body form subcylindrical; carapace smooth, posterior margin with cardiac notch distinct. Frontal margin shallow, rostrum slightly longer than ocular hood (Fig. 22, 23), distinctly narrower, distally upturned; margins in dorsal view, straight. Ocular hoods dorsally convex; in dorsal view, blunt, separated from rostrum by adrostral sinus. Stylocerite acute, with blunt tip; mesial margin straight; reaching midpoint of first segment of antennular peduncle. Basicerite without tooth on dorsomesial corner, with longer ventrolateral spine, reaching just beyond second segment of antennular peduncle, length ~85% of scaphocerite. Scaphocerite blade absent, acute lateral spine robust, with lateral and mesial margins slightly concave, reaching to midpoint of third segment of antennular peduncle. Third maxilliped (Fig. 24) with distal circlet of approximately six spines on distal segment, without ventrodistal spine on antepenultimate segment.

Major first pereopod (Fig. 22, 23) massive, fingers clearly shorter than half length of palm; fixed finger slightly shorter than dactyl. Palm of chela with distinct blunt distal superior margin protuberance.

Protuberance with hint of secondary tubercle emerging distally (Fig. 23). Minor first pereopod (Fig. 25) with palm clearly less than two times longer than high; fingers shorter than palm; dactyl with flexor margin

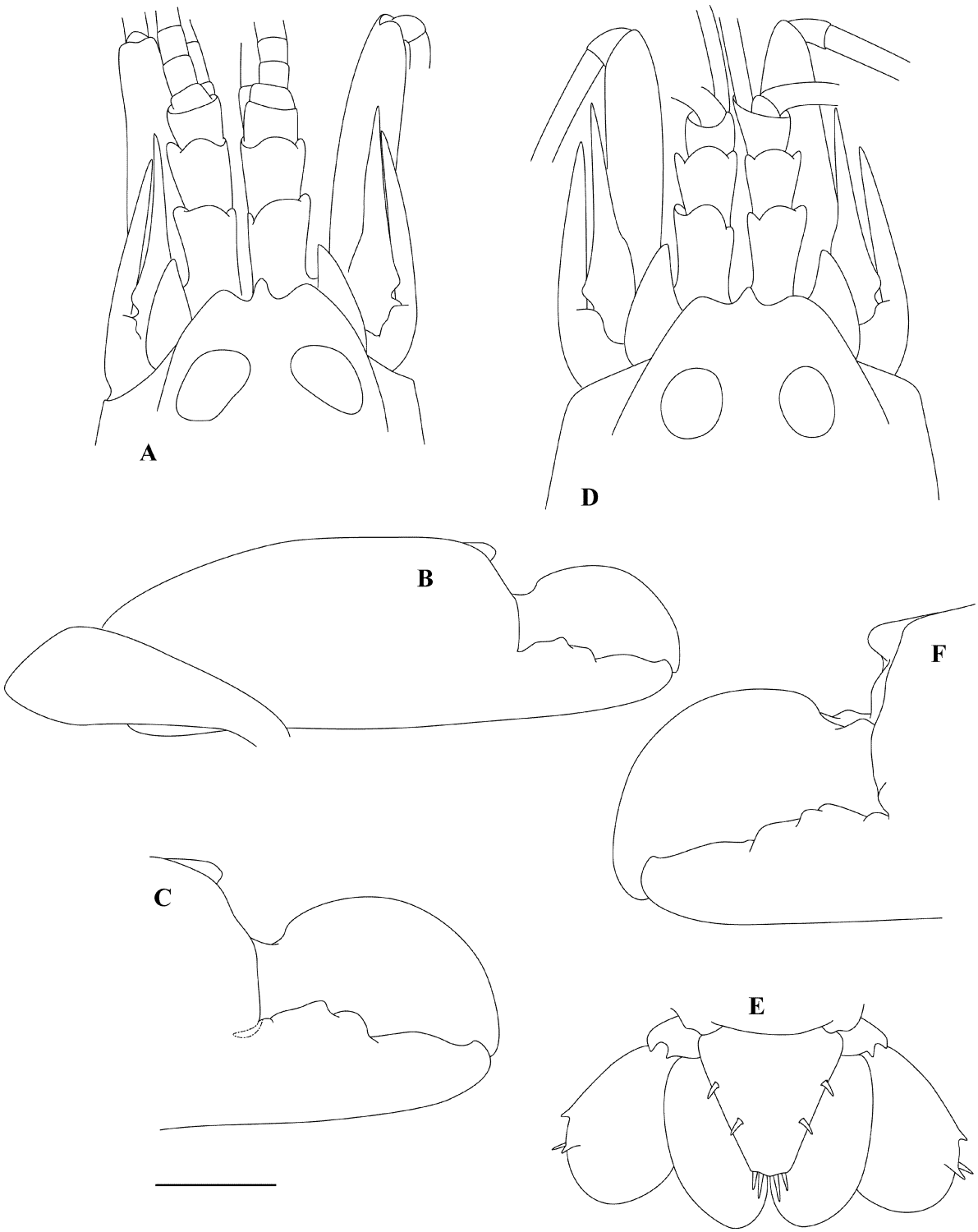


FIGURE 22. *Synalpheus thele* **n. sp.** Holotype non-ovigerous individual CL: 2.93 mm (USNM 1126373, original VIMS 08JAM891402) from *Agelas* cf. *clathrodes*, Columbus Park, Discovery Bay, Jamaica: A, carapace, anterior region, and cephalic appendages, dorsal view; B, chela of major first pereopod, ventral view; C, same, anterior region. Allotype ovigerous female CL: 3.32 mm (USNM 1126374, original VIMS 08JAM891401) from *A.* cf. *clathrodes*, Columbus Park, Discovery Bay, Jamaica: D, carapace, anterior region, and cephalic appendages, dorsal view; E, telson and uropods, dorsal view; F, chela of major first pereopod, anterior region, ventral view. Scale bar = 0.5 mm for A, C, D, F; 0.75 mm for B, E.

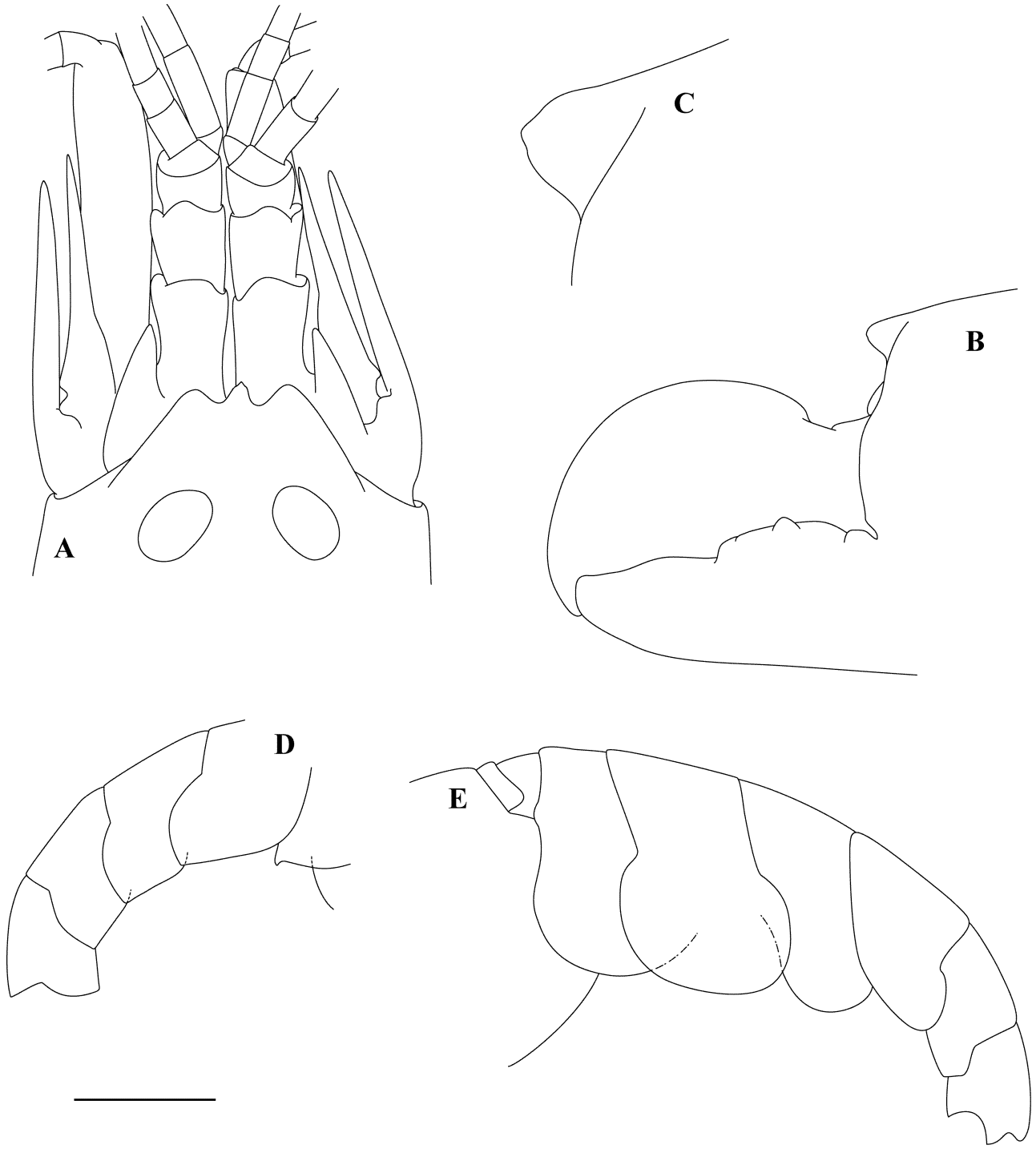


FIGURE 23. *Synalpheus thele* **n. sp.** Non-ovigerous individual CL: 2.97 mm (VIMS 08JAM891002) from *Agelas* cf. *clathrodes*, Columbus Park, Discovery Bay, Jamaica: A, carapace, anterior region, and cephalic appendages, dorsal view; B, chela of major first pereopod, anterior region, ventral view; C, same, detail of distal superior margin protuberance; D, abdomen, lateral view. Allotype ovigerous female CL: 3.32 mm (USNM 1126374, original VIMS 08JAM891401) from *Agelas* cf. *clathrodes*, Columbus Park, Discovery Bay, Jamaica: E, abdomen, lateral view. Scale bar = 0.5 mm for A, B; 0.15 mm for C; 1 mm for D, E.

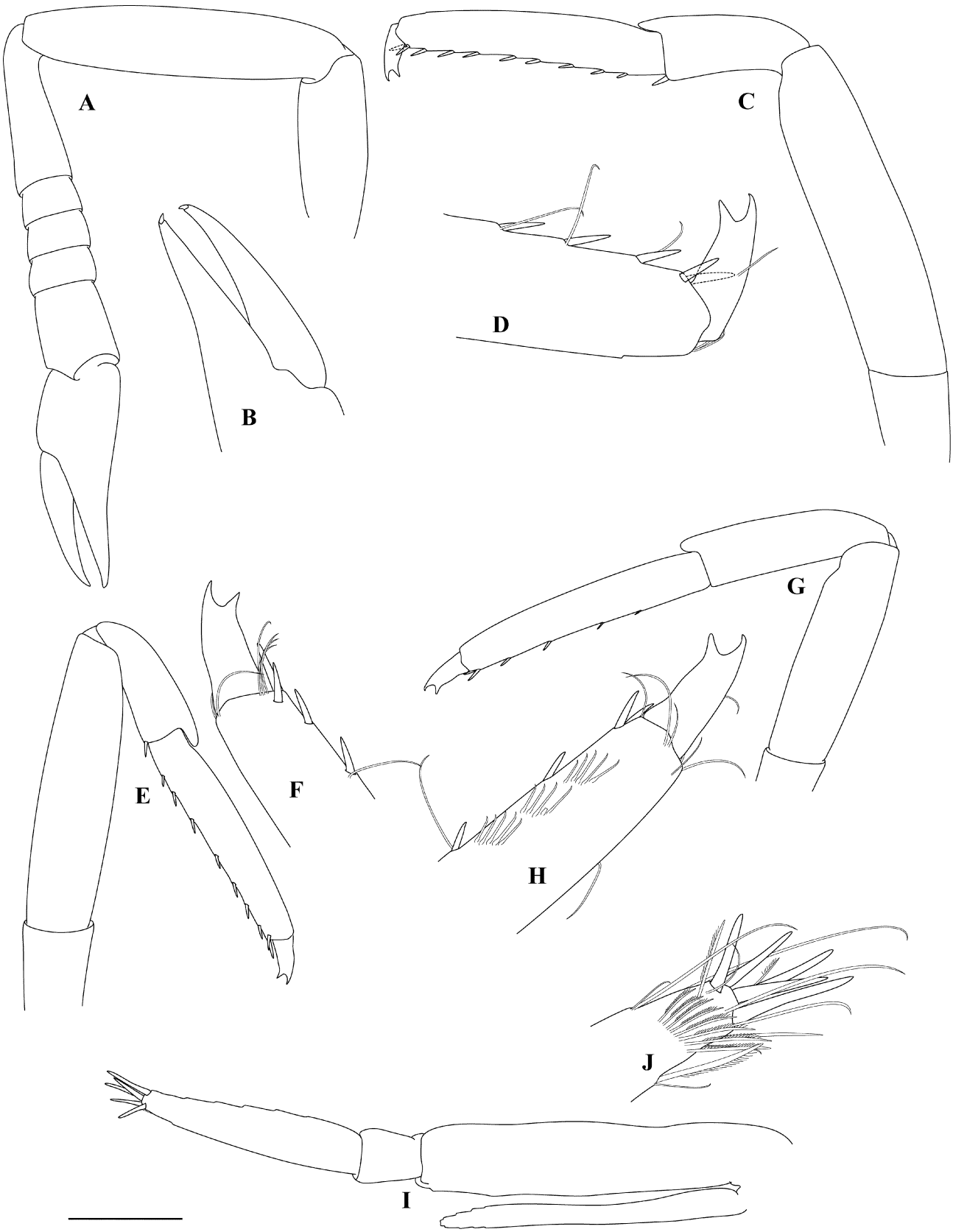


FIGURE 24. *Synalpheus thele* **n. sp.** Allotype ovigerous female CL: 3.32 mm (USNM 1126374, original VIMS 08JAM891401) from *Agelas* cf. *clathrodes*, Columbus Park, Discovery Bay, Jamaica: A, second pereopod; B, same, detail of distal region; C, third pereopod; D, same, detail of distal region; E, fourth pereopod; F, same, detail of distal region; G, fifth pereopod; H, same, detail of distal region; I, third maxilliped; J, same, detail of distal region. Scale bar = 0.4 mm for A, C, E, G, I; 0.25 for B; 0.15 for D, F, H, J.

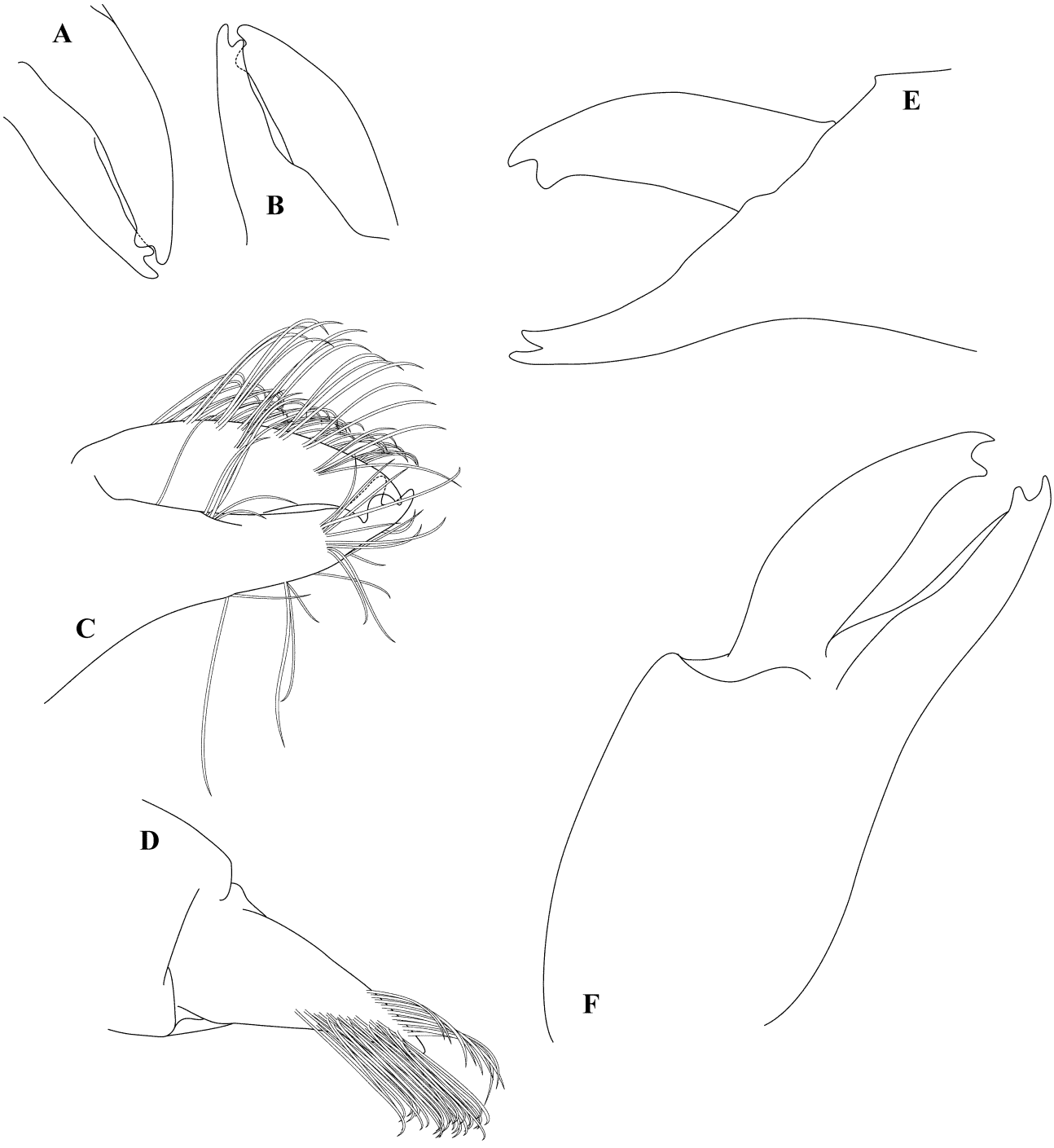


FIGURE 25. *Synalpheus thele* **n. sp.** Holotype non-ovigerous individual CL: 2.93 mm (USNM 1126373, original VIMS 08JAM891402) from *Agelas* cf. *clathrodes*, Columbus Park, Discovery Bay, Jamaica: A, chela of minor first pereopod, setae removed, anterior region, in mesial view; B, same, lateral view. Allotype ovigerous female CL: 3.32 mm (USNM 1126374, original VIMS 08JAM891401) from *A.* cf. *clathrodes*, Columbus Park, Discovery Bay, Jamaica: C, chela of minor first pereopod, anterior region, mesial view. Non-ovigerous individual CL: 2.97 mm (VIMS 08JAM891002) from *A.* cf. *clathrodes*, Columbus Park, Discovery Bay, Jamaica: D, chela of minor first pereopod, anterior region, dorsal view. Non-ovigerous individual CL: 3.13 mm (VIMS 08JAM891003) from *A.* cf. *clathrodes*, Columbus Park, Discovery Bay, Jamaica: E, chela of minor first pereopod, setae removed, anterior region, lateral view. Ovigerous female CL: 3.32 mm (VIMS 08JAM6117) from *A.* cf. *clathrodes*, Columbus Park, Discovery Bay, Jamaica: F, chela of minor first pereopod, setae removed, mesial view. Scale bar = 0.15 mm for A, B; 0.25 for C, D, E, F.

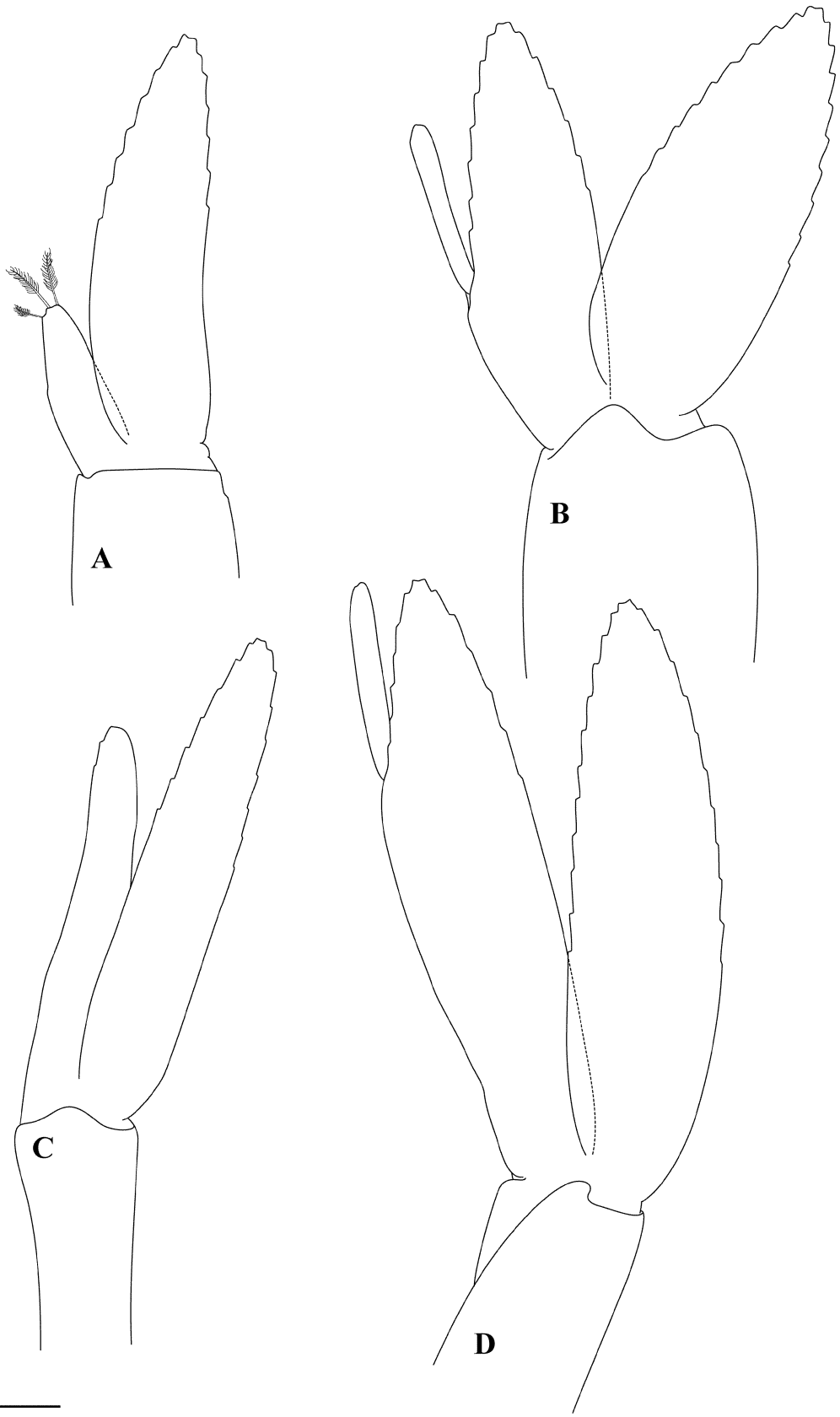


FIGURE 26. *Synalpheus thele* **n. sp.** Holotype non-ovigerous individual CL: 2.93 mm (USNM 1126373, original VIMS 08JAM891402) from *Agelas* cf. *clathrodes*, Columbus Park, Discovery Bay, Jamaica: A, first pleopod; B, second pleopod. Allotype ovigerous female CL: 3.32 mm (USNM 1126374, original VIMS 08JAM891401) from *A.* cf. *clathrodes*, Columbus Park, Discovery Bay, Jamaica: C, first pleopod; D, second pleopod. Scale bar = 0.2 mm

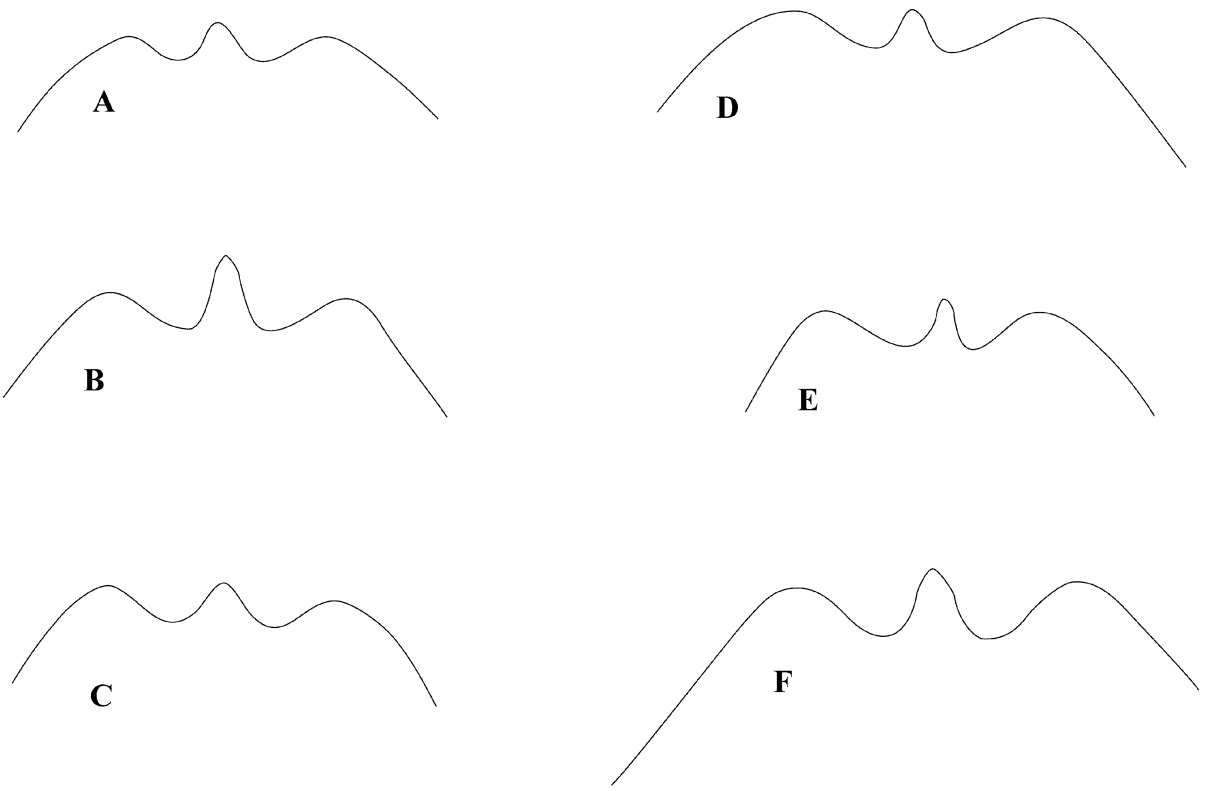


FIGURE 27. *Synalpheus thele* **n. sp.** Ovigerous female CL: 3.66 mm (VIMS 08JAM7804) from *Agelas* cf. *clathrodes*, Wall off Rio Bueno, Jamaica: A, carapace, frontal margin, dorsal view. Non-ovigerous individual CL: 2.97 mm (VIMS 08JAM6115) from *A.* cf. *clathrodes*, Columbus Park, Discovery Bay, Jamaica: B, carapace, frontal margin, dorsal view. Non-ovigerous individual CL: 2.97 mm (VIMS 08JAM612606) from *A. clathrodes*, Columbus Park, Discovery Bay, Jamaica: C, carapace, frontal margin, dorsal view. Ovigerous female CL: 3.42 mm (VIMS 08JAM6127) from *A.* cf. *clathrodes*, Columbus Park, Discovery Bay, Jamaica: D, carapace, frontal margin, dorsal view. Ovigerous female CL: 2.74 mm (original VIMS 08JAM7804) from *A.* cf. *clathrodes*, fore-reef, Discovery Bay, Jamaica: E, carapace, frontal margin, dorsal view. Non-ovigerous individual CL: 2.93 mm (VIMS 08JAM7804) from *A.* cf. *clathrodes*, fore-reef, Discovery Bay, Jamaica: F, carapace, frontal margin, dorsal view. Scale bar = 0.25 mm

concave, blade-like, with 2 distinct distal teeth, subequal in length; extensor surface of dactyl with two closely set longitudinal rows of curved setae (Fig. 25); fixed finger with flexor margin concave, blade-like, and 2 distinct distal teeth subequal in length, both longer than dactyl distal teeth.

Second pereopod (Fig. 24) with carpus 5-segmented, subequal in length to merus. Both fingers terminating in a narrow, curved tooth.

Third pereopod (Fig. 24) slender; dactyl biunguiculate, with both ungues subequal in thickness, mesial margin of flexor unguis straight; propodus with row of eight movable spines on flexor margin and one pair of distal movable spines flanking base of dactyl; carpus with distal movable spine on flexor margin; merus four times longer than wide, without movable spines on flexor margin. Fourth pereopod (Fig. 24) similar to third, slightly weaker; propodus with seven flexor margin spines. Fifth pereopod (Fig. 24) weaker than fourth; propodus with four spines on flexor margin, and six transverse combs of stout setae on ventral face; carpus without distal spine.

First pleura (Fig. 23) of male with posterior corner distinctly produced ventrally into small hook; second to fifth pleura of male ventral margin straight, anterior corner rounded, posterior corner subacute.

First pleopod (Fig. 25) of male with three terminal setae on endopod ; second pleopod of male with marginal setae on exopod originating in distal half; appendix interna present on second to fifth male pleopods. Second pleopod (Fig. 25) of female with marginal setae on exopod originating in distal third; appendix interna present on second to fifth female pleopods.

Telson (Fig. 21) with convex lobe present on distal margin; posterior corners adjacent to terminal spines obtuse. Dorsal spines, anterior pair close to lateral margin, posterior pair further removed. Posterior margin with six setae between two sets of spines, lateral spines 70% length of inner spines. Space between distal spines <30% of distal margin; distal margin ~25% width of proximal margin. Uropods with a single fixed tooth on lateral margin of exopod distinctly removed anteriorly from movable spine, the latter slightly longer and more slender than adjacent posterior fixed tooth.

Color in life. Nondescript, translucent with dull gold tinge to thickened parts of cuticle; distal palm and fingers of major chela gold/orange; ovaries and embryos grass green.

Etymology. We have named this new species using the Greek word for teat or nipple, after the shape of the protuberance of the major chela, the most distinguishing feature of *S. thele* (see Fig 23C).

Variation. While a vast majority (28 of 31 examined here) of females examined had green embryos and ovaries (Color plate 5C), three individuals had embryos of a different color. One (08JAM8913) had embryos the color of burnt sienna, the second individual (08JAM8912) had olive embryos, and the third female (08JAM4105) carried pale, whitish embryos. The shape of the frontal margin is also variable: not only does the depth of the adrostral sinuses vary among individuals, the length of the rostrum also varies, from subequal to the ocular hoods to almost 2x the length of the ocular hoods (fig 27).

Hosts and ecology. *Synalpheus thele*, **n. sp.** has been found only in the canals of the common Caribbean sponge *Agelas* cf. *clathrodes*. It was found in approximately equal sex ratios, with individual sponges containing from a single pair up to 33 shrimp. Most *S. thele* found were coexisting in the host sponge with *Synalpheus agelas*, *Synalpheus carpenteri*, and sometimes *Synalpheus mcclendoni* Coutière, 1910.

Distribution. Jamaica (this study).

Remarks. *Synalpheus thele* **n. sp.** appears to be a member of the complex of closely related, morphologically similar species that includes *S. brooksi, S. bousfieldi, S. chacei, S. corallinus* **n. sp.**, and *S. plumosetosus* **n. sp.** (see Table 3). *Synalpheus thele* most closely resembles *S. chacei*, sharing a shallow frontal margin, minor chela setal brush consisting of two parallel rows of setae, and a blunt protuberance on the major chela. *Synalpheus thele* is distinct from *S. chacei* in the grass-green embryo color, larger size, and in its habit of living in equal sex ratios as opposed to eusocial colonies as in *S. chacei* (Duffy 1998), and from all other members of the group in the shape of the large blunt major chela protuberance.

Synalpheus ul (Ríos and Duffy)

Material examined. Jamaica: non-ovigerous individual (VIMS 08JAM0301), Columbus Park, Discovery Bay, from canals of *Hymeniacidon caerulea*. Non-ovigerous individual (VIMS 08JAM0803), Columbus Park, Discovery Bay, from canals of *Hyattella intestinalis*. Non-ovigerous individual (VIMS 08JAM3401), fore-reef (near M1 channel marker), Discovery Bay, from canals of *H. caerulea*. Non-ovigerous individual (VIMS 08JAM4801), Columbus Park, Discovery Bay, from canals of *Lissodendoryx* sp. Ovigerous female (VIMS 08JAM6602), Dairy Bull Reef, from canals of *H. caerulea*. MaxCL ovigerous female: 2.44 mm. MaxCL non-ovigerous individual: 3.00 mm.

Color. Translucent; distal portion of major chela bright orange; embryos and ovaries bright orange.

Hosts and ecology. In Jamaica, *S. ul* was collected from a variety of sponge species, including *Hymeniacidon caerulea*, *Hyattella intestinalis*, and *Lissodendoryx* sp. This pattern of generalized host associations contrasts with that found in Belize, where it seems to be a specialist on *H. caerulea*.

Distribution. Belize (Macdonald et al. 2006; Ríos and Duffy 2007); Jamaica (this study).

Remarks. *Synalpheus ul* is another member of the morphologically similar complex of species that includes *S. pandionis, S. dardeaui*, and *S. yano*. Individuals of *S. ul* superficially resemble the related *S. yano*, but can be distinguished by the presence in *S. ul* of a scaphocerite blade (reduced but present in some individuals) and distal telson spines that are unequal in length.

***Synalpheus williamsi* Ríos and Duffy**

Material examined. Jamaica: non-ovigerous individual (VIMS 08JAM6601), Dairy Bull Reef, from canals of *Hymeniacidon caerulea*. Non-ovigerous individual, ovigerous female (VIMS 08JAM6701,02), Dairy Bull Reef, from canals of *Hymeniacidon caerulea*. MaxCL non-ovigerous individual: 2.95 mm.

Color. Golden-brown; distal portion of major chela bright orange-red; ovaries and embryos green.

Hosts and ecology. *Synalpheus williamsi* was only found in the midnight-blue sponge *Hymeniacidon caerulea* in Jamaica.

Distribution. Belize (Macdonald et al. 2006; Ríos and Duffy 2007); Jamaica (this study).

Remarks. As has been mentioned in accounts of *S. williamsi* from other regions (Ríos and Duffy 1999), individuals often have traces of dark blue in their gut, presumably from the pigment of their host sponge *H. caerulea.*

PLATE 6. A, *Synalpheus yano* ovigerous female (08JAM4601) from *Hymeniacidon caerulea*, Columbus Park, Discovery Bay, Jamaica. B, *Synalpheus yano* non-ovigerous individual (08JAM4602) from *Hymeniacidon caerulea*, Columbus Park, Discovery Bay, Jamaica.

***Synalpheus yano* (Ríos and Duffy)**
Color plate 6A, B

Material examined. Jamaica: non-ovigerous individual, ovigerous female (VIMS 08JAM4801,02), Columbus Park, Discovery Bay, from canals of *Hymeniacidon caerulea*. MaxCL ovigerous female: 3.32 mm. MaxCL non-ovigerous individual: 3.75 mm.

Color. Dull gold; darker in the distal portion of the major chela; embryos and ovaries brick red.

Hosts and ecology. This pair was found in the midnight-blue sponge *Hymeniacidon caerulea*. In Belize, *S. yano* is most commonly found in *Lissodendoryx colombiensis*, but is also found in *H. caerulea* and *Calyx podatypa* de Laubenfels.

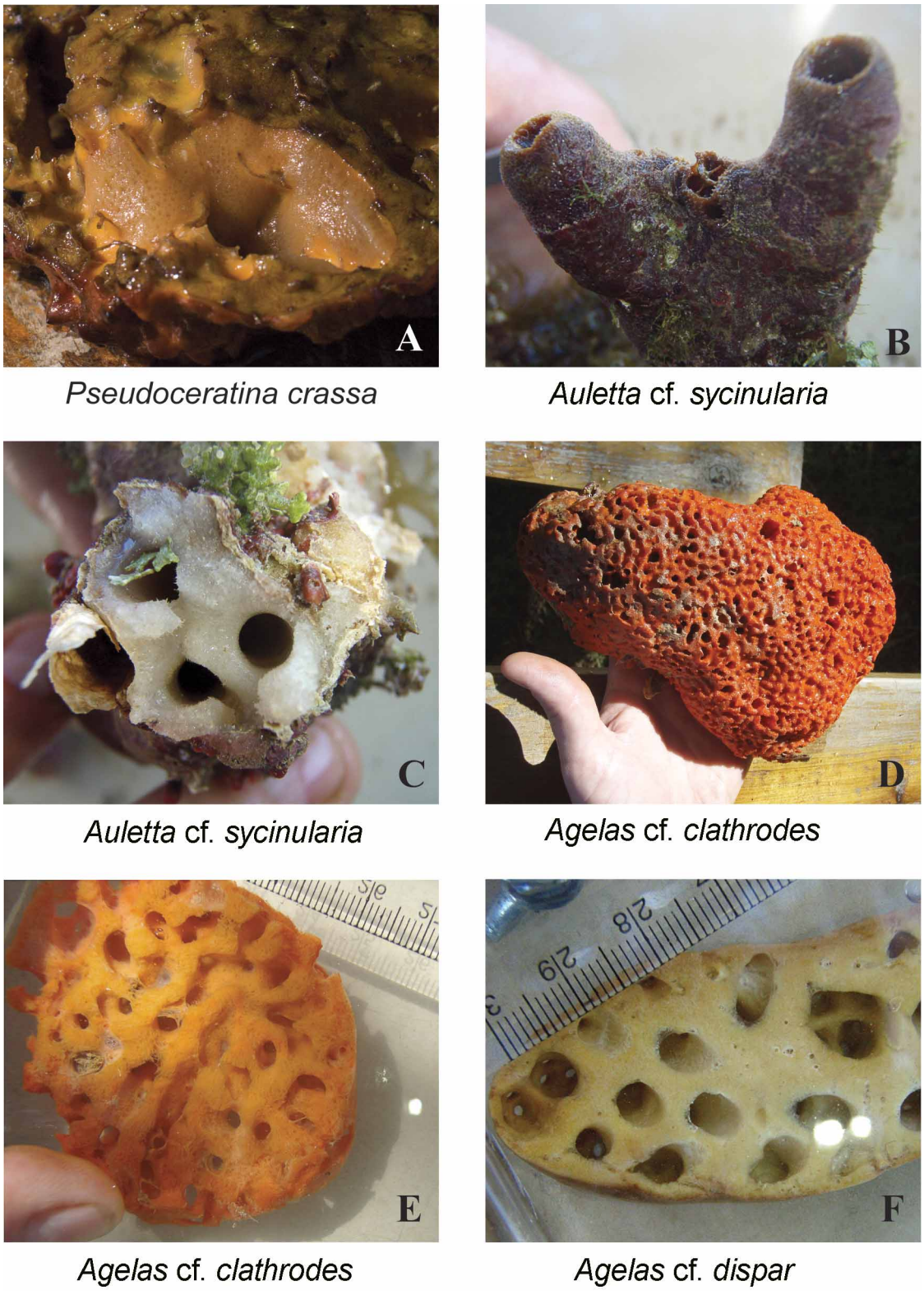


PLATE 7. A, *Pseudoceratina* (*Aiolochroia*) *crassa* (08JAM32), including an unidentified soft, filmy grey-brown sponge lining the canals, fore-reef (near M1 channel marker), Discovery Bay, Jamaica. B, *Auletta* cf. *sycinularia* (08JAM27), external view, Dairy Bull Reef, Jamaica. C, Same, interior view. D, *Agelas* cf. *clathrodes* (08JAM61), external view, Columbus Park, Discovery Bay, Jamaica. E, Same, interior view. F, *Agelas* cf. *dispar* (08JAM82), interior view, Rio Buenos, Jamaica.

Distribution. Belize (Macdonald et al. 2006; Ríos and Duffy 2007); Jamaica (this study).

Remarks. *Synalpheus yano* is another member of the morphologically similar complex of species that includes *S. pandionis*, *S. dardeaui*, and *S. ul*. It can be distinguished by its complete lack of a blade on the scaphocerite, and by the equally sized spines of the distal margin of the telson.

Discussion

We found 22 species of sponge-dwelling snapping shrimp and 30 unique shrimp/sponge species associations during two weeks of sampling in Jamaica, a total falling somewhat short of the diversity found in 14 years of collecting in the Belizean barrier reef (27 shrimp species, 56 associations, Macdonald et al. 2006). We used several methods to estimate true species richness, and all suggest that additional shrimp species remain to be uncovered in Discovery Bay, Jamaica. The estimated number of shrimp species remaining undiscovered varies between methods, ranging from five to ten. This variance among methods in itself suggests that additional sampling is needed; in contrast, in Belize, where we had many more samples, all four methods (Michaelis–Menten, Chao2, second-order jackknife, and bootstrap) resulted in similar estimates of true species richness (27, equal to the observed species richness). We also found many fewer unique shrimp/sponge associations in Jamaica than in Belize, and unlike the shrimp species richness estimates, the estimated numbers of these associations in Jamaica are substantially lower than even the observed number of associations in Belize.

The lower number of species and especially of shrimp/sponge associations found in Jamaica is likely due in part to the smaller number of sponge species sampled (11 vs. 16 in Belize), during the short duration of the survey. This is supported by the species accumulation curve, which reached a plateau after 70 collected sponges, until a new sponge species (*Spheciospongia vesparium*) was collected as the 82nd sponge, adding one new shrimp species and two new associations to the curve. This suggests that sheer numbers of collected sponges are not as important as sponge diversity in achieving a comprehensive survey of the local *Synalpheus*. However, better sampling of individual sponge species would also likely yield more shrimp species; for example, in the only sponge species of which we collected more than 20 individuals, *Hyattella intestinalis*, we found a new shrimp species inhabiting the 22nd sponge. This agrees with the species accumulation curves from Belize, in which shrimp richness from some sponge species reached an asymptote in as few as ten individual sponges, while others did not plateau until at least 50 sponges were collected (Macdonald et al. 2006, fig 4). Thus, comprehensively characterizing the sponge-dwelling shrimp fauna of a site requires thorough sampling of the sponge diversity, but also large numbers of individual sponges within each species. It may also be important to sample a range of sponge sizes within each species, since the shrimp fauna in large sponges can differ from that in very small individuals of the same sponge species (pers. obs.). This seems particularly true in sponge species that harbor social species of shrimp.

Despite the short duration of our survey, we believe we have sampled most of the sponges that support shrimp in the vicinity of Discovery Bay, Jamaica; estimates of remaining undiscovered sponge diversity range from one to three species. Of the sponges found to support shrimp in this study, five have been previously reported from Jamaica in comprehensive surveys of the area (*Agelas* cf. *clathrodes, Agelas* cf. *dispar, Xestospongia subtriangularis, Hyattella cavernosa* (likely our *H. intestinalis*), and *Spheciospongia vesparium*, Lehnert and van Soest 1998a, 1998b). We additionally found several species of shrimp-inhabiting sponges not recorded in previous surveys, such as the *Lissodendoryx* sp., the cryptic blue sponge *Hymeniacidon caerulea*, and *Auletta* cf. *sycinularia*. We collected most of these species several times, suggesting that we collected the great majority of the sponge species hosting shrimp in the Discovery Bay area. One difficulty arose in identifying our two *Agelas* spp. We collected two morphologically different members of the genus *Agelas*, one orange and one brown, and preliminarily identified them as *A.* cf. *clathrodes* and *A.* cf. *dispar*, respectively. However, the morph we have called *A.* cf. *clathrodes* does not exactly resemble the species in other regions, and it has been suggested that both forms are simply different

color morphs of *A. dispar*. While this may be true, the two morphs differ in sponge shape, canal morphology, and associated fauna, and we have thus decided to retain our original classifications for now.

We can also compare sampling efficiency between our short survey in Jamaica and the results of long-term research in Belize (Macdonald et al. 2006). In Jamaica, where we focused explicitly on maximizing diversity of habitats and sponges sampled, we collected 90 sponges in total, representing 11 sponge species, with 22 shrimp species, and 30 shrimp/sponge associations. In contrast, after 96 collected sponges in Belize, where we often focused our collecting efforts on accumulating many colonies of a few species of shrimp, we had collected 20 shrimp species, and the same number of associations, from 13 sponge species. While the overall numbers are similar, the accumulation curves look very different. Accumulation curves for sponge species, shrimp species, and unique shrimp-sponge associations in Jamaica started to level off well before the 96th sponge had been collected (Fig. 1), whereas the Belizean curves (Macdonald et al. 2006, Fig. 4) were still rising steeply at that number. This may be due in part to a lower overall diversity of shrimp and/or sponges in Jamaica, although all estimates of true species richness equaled or exceeded similar estimates for Belize. In part, the more rapid leveling of accumulation curves in the Jamaican data probably reflects our explicit focus on a rapid assessment of diversity in Jamaica, whereas collections in Belize had other aims, as mentioned above.

In contrast to our previous shrimp collections from Belize (Macdonald et al. 2006; Ríos and Duffy 2007), in Jamaica we found no social species from the *Synalpheus brooksi* species group (i.e. neither *S. chacei*, nor social forms of *S. brooksi*, although a single pair of the latter was collected). This may be due in part to the sponge fauna collected: of the six sponge species most commonly hosting *S. brooksi* and *S chacei* in Belize (*Lissodendoryx colombiensis* and *Spheciospongia vesparium* for *S. brooksi*, *Lissodendoryx strongylata*, *Hyattella intestinalis*, *Agelas* cf. *clathrodes* and *Agelas* cf. *dispar* for *S. chacei*), we only found *H. intestinalis* and the two *Agelas* spp. in any quantity in Jamaica; of the other three sponge species hosting social shrimp in Belize, only a single small *S. vesparium* was found. However, despite being collected in relatively high numbers, neither of the *Agelas* spp. nor *Hyattella intestinalis* in Jamaica contained *S. chacei*. Both *Agelas* spp. in Jamaica commonly held *S. agelas* and *S. carpenteri*, as in the other regions, while *A.* cf. *clathrodes* also commonly contained the new species *Synalpheus thele*. *Hyattella intestinalis* in Jamaica only contained colonies of either *Synalpheus elizabethae* in shallow water (< 6 m, N=7 sponges collected) or *Synalpheus regalis* in deeper water (> 6 m, N=19 sponges), both eusocial species and members of the *Synalpheus rathbunae* group. In Belize, *H. intestinalis* is typically inhabited by colonies of either *S. chacei* or *S. regalis*, while *S. elizabethae* is a shallow water shrimp most commonly found in an unidentified *Lissodendoryx* species. *Synalpheus duffyi*, a eusocial species described from Caribbean Panama and not found in Belize, is a member of the *Synalpheus paraneptunus* group (Anker and Tóth 2008) and was common on the Rio Bueno Reef in Jamaica, where it was found in sponges of the genus *Xestospongia*. In Belize, *Xestospongia* spp. are dominated by *S. regalis*, or occasionally *Synalpheus filidigitus*, both eusocial species in the *S. rathbunae* group.

As found also by Ríos and Duffy (2007) for Belize, our collections in Jamaica produced closely related species of shrimp inhabiting the same host species, and sometimes the same individual sponge. For example, *Hyattella intestinalis* contained either *S. elizabethae* or *S. regalis*, closely related members of the *S. rathbunae* group. Additionally, we found two or even all three members of the *S. paraneptunus* group in Jamaica (*Synalpheus belizensis*, *S. bocas*, and *S. duffyi*) co-inhabiting the same individual sponge. This suggests that host associations are generally conservative phylogenetically and lends further support to the hypothesis raised by Ríos and Duffy (2007) that speciation in this group proceeds initially from allopatric divergence, followed by secondary contact, rather than by host-mediated divergence as suggested earlier (Duffy 1996c).

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Literature cited

Anker, A. and De Graves, S. (2008) *Zuzalpheus* Ríos and Duffy, 2007: a junior synonym of *Synalpheus* Bate, 1888 (Decapoda: Alpheidae). Journal of Crustacean Biology, 28, 735–740.

Anker, A. and Tóth, E., (2008) A preliminary revision of the *Synalpheus paraneptunus* Coutière, 1909 species complex (Crustacea: Decapoda: Alpheidae). *Zootaxa*, 1915, 1–28.

Banner, D.M. and Banner, A.H. (1975) The alpheid shrimp of Australia. Part II: The genus *Synalpheus*. *Records of the Australian Museum*, 29, 267–389.

Bate, C.S. (1888) Report on the Crustacea Macrura collected by H. M. S. Challenger during the years 1873–76. *In*: *Report on the scientific results of the Voyage of H. M. S. Challenger during the years 1873–76, Zoology* 24, xc+942. Eyre and Spottiswoode, London.

Beebe, W. (1928) *Beneath tropic seas. A record of diving among the coral reefs of Haiti*. Blue Ribbon Books. New York. 234 pp.

Bruce, A.J. (1976) Shrimps and prawns of coral reefs, with special reference to commensalism. Pages 37–94 *In*: Jones, O. A. and R. Endean (Editors) *Biology and geology of coral reefs. Vol. III, Biology 2*, Academic Press, New York.

Burnham, K.P. & W.S. Overton. (1978) Estimation of the size of a closed population when capture probabilities vary among animals. *Biometrika*, 65, 623–633.

Chace, F.A. (1972) The shrimps of the Smithsonian-Bredin Caribbean expeditions with a summary of the West Indian shallow-water species (Crustacea: Decapoda: Natantia). *Smithsonian Contributions to Zoology*, 98, 1–179.

Chace, F.A. (1988) The caridean shrimps (Crustacea: Decapoda) of the Albatross Philippine Expedition, 1907–1910, Part 5: Family Alpheidae. *Smithsonian Contributions to Zoology*, 466, 1–99.

Chao, A. (1987) Estimating the population size for capture-recapture data with unequal catchability. *Biometrics*, 43, 783–791.

Christoffersen, M. L. (1979) Campagne de la Calypso au large des côtes Atlantiques de l'Amerique du sud (1961–1962), I. 36. Decapod Crustacea: Alpheoida. Résultats Scientifiques des Campagnes de la Calypso, 11. *Annales de L'Institute Océanographique*, 55 (Supplement 2), 297–377.

Coelho, P.A. and Ramos, D.A. (1972) A constituição e a distribuição da fauna dé decápodos do litoral leste da América do sul entre as latitudes de 5° N e 39° S. *Trabalhos do Institute Oceanografico, Universidade Federal de Pernambuco Recife*, 13, 133–236.

Colwell, R. K., C. X. Mao, & J. Chang. (2004) Interpolating, extrapolating, and comparing incidence-based species accumulation curves. *Ecology*, 85, 2717–2727.

Colwell, R. K. (2005) EstimateS: Statistical estimation of species richness and shared species from samples. Version 7.5. User's Guide and application published at: http://purl.oclc.org/estimates.

Coutière, H. (1907) Sur la présence de males en excès chez deux espèces de Synalphées. *Compte rendu des Séances de la Societé de Biologie*, 62, 610–612.

Coutière, H. (1908) Sur les Synalphées americaines. *Comptes rendus hebdomadaires des séances de l'Académie de Sciences*, 146, 710–712.

Coutière, H. (1909) The American species of snapping shrimps of the genus *Synalpheus*. *Proceedings of the United States National Museum*, 36, (1659), 1–93.

Coutière, H. (1910) The snapping shrimp (Alpheidae) of the Dry Tortugas, Florida. *Proceedings of the United States National Museum*, 37, 485–487.

Dardeau, M.R. (1984) *Synalpheus* shrimps (Crustacea: Decapoda: Alpheidae). I. The Gambarelloides group, with a description of a new species. *Memoirs of the Hourglass Cruises*, 7 (2), 1–125.

Duffy, J.E. (1992) Host use patterns and demography in a guild of tropical sponge-dwelling shrimp. *Marine Ecology Progress Series*, 90, 127–138.

Duffy, J.E. (1993) Genetic population structure in two tropical sponge-dwelling shrimps that differ in dispersal potential. *Marine Biology*, 90, 127–138.

Duffy, J.E. (1996a) Eusociality in a coral-reef shrimp. *Nature*, 381, 512–514.

Duffy, J.E. (1996b) Resource-associated population subdivision in a symbiotic coral-reef shrimp. *Evolution*, 50, (1), 360–373.

Duffy, J.E. (1996c) Species boundaries, specialization, and the radiation of sponge-dwelling alpheid shrimp. *Biological*

Journal of the Linnean Society, 58, 307–324.
Duffy, J.E. (1996d) *Synalpheus regalis*, new species, a sponge-dwelling shrimp from the Belize Barrier Reef, with comments on host specificity in *Synalpheus*. *Journal of Crustacean Biology*, 16, (3), 564–573.
Edmunds, P.J. and Bruno, J.F. (1996) The importance of sampling scale in ecology: kilometer-wide variation in coral reef communities. *Marine Ecology Progress Series*, 143, 165–171.
Erdman, R.B. and Blake, N.J. (1987) Population dynamics of the sponge-dwelling alpheid *Synalpheus longicarpus*, with observations on *S. brooksi* and *S. pectiniger*, in shallow-water assemblages of the eastern Gulf of Mexico. *Journal of Crustacean Biology*, 7, 328–337.
Gore, R.H. (1981) Three new shrimps, and some interesting new records of decapod Crustacea from a deep-water coral reef in the Florida Keys. *Proceedings of the Biological Society of Washington*, 94, 135–162.
Goreau, T.F. (1959) The ecology of Jamaican coral reefs I. Species composition and zonation. *Ecology*, 40, (1), 67–90.
Felder, D.L., and Chaney, A.H. (1979) Decapod crustacean fauna of Seven and One-Half Fathom Reef, Texas: species composition, abundance, and species diversity. *Contributions in Marine Science*, 22, 1–29.
Heard, R.W. and Perlmutter, D.G. (1977) Description of *Colomastix janiceae* **n. sp.**, a commensal amphipod (Gammaridea: Colomastigidae) from the Florida Keys, USA. *Proceedings of the Biological Society of Washington*, 90, 30–42.
Holthuis, L. B. & Gottlieb, E. (1958) An annotated list of the decapod Crustacea of the Mediterranean coast of Israel, with an appendix listing the Decapoda of the eastern Mediterranean. *The Bulletin of the Research Council of Israel. Section B: Zoology, 7B*, 1–126.
Holthuis, L.B. (1959) The Crustacea Decapoda of Suriname (Dutch Guiana). *Zoologische Verhandelingen*, 44, 1–296.
Hughes, T.P. and Tanner, J.E. (2000) Recruitment failure, life histories, and long-term decline of Caribbean corals. *Ecology*, 81, (8), 2250–2263.
Kelly, K.L. and Judd, D.B. (1976) *Color: Universal Language and Dictionary of Names.* National Bureau of Standards, Special Publication 440, 189 pp.
Knowlton, N., (1980) Sexual Selection And Dimorphism In 2 Demes Of A Symbiotic, Pair-Bonding Snapping Shrimp. *Evolution*, 34, 161–173.
Lehnert, H. and van Soest, R.V.N. (1998a) More North Jamaica deep fore-reef sponges. *Beaufortia*, 49, 141–169.
Lehnert, H. and van Soest, R.V.N., (1998b). Shallow water sponges of Jamaica. *Beaufortia*, 48, 71–103.
Lemaitre, R. (1984) Decapod crustaceans from Cay Sal Bank, Bahamas, with notes on their zoogeographic affinities. *Journal of Crustacean Biology*, 4, 425–447.
Locke, J.M., Weil, E. and Coates, K.A. (2007) A newly documented species of *Madracis* (Scleractinia: Pocilloporidae) from the Caribbean. *Proceedings of the Biological Society of Washington*, 120, (2), 214–226.
Lyons, W.G., Cobb, S.P., Camp, D.K., Mountain, J.A., Savage, T., Lyons, L., and Joyce, E.A. Jr. (1971) Preliminary inventory of marine invertebrates collected near the electrical generating plant, Crystal River, Florida, in 1969. *Florida. Department of Natural Resources Marine Research Laboratory, Professional Paper Ser*ies, 14, 1–45.
Macdonald, K.S., Ríos, R. and Duffy, J.E. (2006) Biodiversity, host specificity, and dominance by eusocial species among sponge-dwelling alpheid shrimp on the Belize Barrier Reef. *Diversity and Distributions*, 12, 165–178.
Macdonald, K.S. and Duffy, J.E. (2006) Two new species of sponge-dwelling snapping shrimp from the Belizean barrier reef, with a synopsis of the *Synalpheus brooksi* species complex. *American Museum Novitates*, 3543, 1–22.
Martínez Iglesias, J.C. and García Raso, J.E. (1999) The crustacean decapod communities of three coral reefs from the southwestern Caribbean Sea of Cuba: species composition, abundance and structure of the communities. *Bulletin of Marine Science*, 65, (2), 539–557.
Menzel, R.W., editor (1971) Checklist of the marine fauna and flora of the Apalachee Bay and the St. George's Sound area. Third edition. *Florida State University Oceanography Institute* 126 pp.
McClendon, J.F. (1911) On adaptations in structure and habits of some marine animals of the Tortugas, Florida. *Papers of the Tortugas Laboratory, Carnegie Institute of Washington*, 3, 57–62.
Morrison, C.L., Rios, R. and Duffy, J.E. (2004) Phylogenetic evidence for an ancient rapid radiation of Caribbean sponge-dwelling snapping shrimps (Synalpheus). *Molecular Phylogenetics and Evolution*, 30, 563–581.
Pearse, A.S. (1932) Inhabitants of certain sponges at Dry Tortugas. (Papers from Tortugas Laboratory 28), *Carnegie Institution of Washington Publication*, 435, 119–122.
Pearse, A.S. (1950) Notes on the inhabitants of certain sponges at Bimini. *Ecology*, 31, 149–151.
Pequegnat, L.H. and Heard, R.W. (1979) *Synalpheus agelas*, new species of snapping shrimp from the Gulf of Mexico and Bahama islands (Decapoda: Caridea: Alpheidae). *Bulletin of Marine Science*, 29, (1), 110–116.
Rathbun, M.J. (1901) The Brachyura and Macrura of Porto Rico. *Bulletin of the United States Fisheries Commission*, 20, 1–127.
Reed, J.K., Gore, R.H., Scotto, L.E., and Wilson, K.A. (1982) Community composition, structure, areal and trophic relationships of decapods associated with shallow- and deep-water *Occulina varicosa* coral reefs. Studies on decapod Crustacea from the Indian River Region of Florida, XXIV. *Bulletin of Marine Science*, 32, 761–786.
Ríos, R. and Duffy, J.E. (2007) A review of the sponge-dwelling snapping shrimp from Carrie Bow Cay, Belize, with

description of *Zuzalpheus*, new genus, and six new species (Crustacea: Decapoda: Alpheidae). *Zootaxa*, 1602, 1–89.
Rouse, W.L. (1970) Littoral Crustacea from southwest Florida. *Quarterly Journal of the Florida Academy of Sciences*, 32, 127–152.
Rützler, K. (1976) Ecology of Tunisian commercial sponges. *Tethys*, 7, 249–264.
Smith, E.P. & van Belle, G. (1984) Nonparametric estimation of species richness. *Biometrics*, 43, 119–129.
Tabb, D.C. and Manning, R.B. (1961) A checklist of the flora and fauna of northern Florida Bay and adjacent brackish waters of the Florida mainland collected during the period July, 1957 through September, 1960. *Bulletin of Marine Science of the Gulf and Caribbean*, 11, 552–649.
Tóth, E. and Bauer, R.T. (2007) Gonopore sexing technique allows determination of sex ratios and helper composition in eusocial shrimps. *Marine Biology*, 151, 1875–1886.
Westinga, E. and Hoetjes, P.C. (1981) The intrasponge fauna of *Spheciospongia vesparia* (Porifera, Demospongia) at Curaçao and Bonaire. Marine Biology, 62, 139–150.
Wulff, J.L. (2006) Resistance vs. recovery: morphological strategies of coral reef sponges. *Functional Ecology*, 20, 699–708.