

Polycheria josephensis, a new species of symbiotic amphipod (Crustacea, Amphipoda, Dexaminidae) from the Northern Gulf of Mexico, with notes on its ecology

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<http://zoobank.org/B1FF8521-2845-4EAE-A8D8-295ECB9C4881>

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Abstract

Received 1 August 2015
Accepted 26 November 2015
Published 29 January 2016

Academic editor:
Michael Ohl

Key Words

Amphipoda
commensal
ascidian
Florida
taxonomy
new species

Polycheria josephensis **sp. n.** (Dexaminidae), an ascidian symbiont, is described from St. Joseph Bay, Florida and other locations in the Gulf of Mexico and the nearshore Atlantic Ocean from South Carolina to northern Florida. Observations on its ecology, behavior, and distribution are provided. *Polycheria josephensis* **sp. n.** is morphologically most similar to *Polycheria osborni* Calman, 1898 from the Pacific coast of North America. *Polycheria josephensis* **sp. n.** differs from *P. osborni* in the number, spacing and size of the spines on the inner plate of the maxilliped and the shape of the distal margins of coxae 1-7.

Introduction

More than twenty nominal species or “forms” attributed to the dexaminid amphipod genus *Polycheria* Haswell, 1879 have been reported from coastal marine waters of Africa, Antarctica, East Asia, North America, South America, Australia, New Zealand, Indonesia, the Indian Ocean and the Southern Ocean near Antarctica (Barnard and Karaman 1991; Debroyer and Jazdzewski 1993; Bousfield and Kendall 1994; Myers and LeCroy 2009). The type species, *Polycheria tenuipes*, was described from Port Jackson, Australia by Haswell (1879). Although specimens conforming to the genus *Polycheria* have been reported from sites throughout the Gulf of Mexico, the Caribbean Sea, and along the Atlantic coast from Florida to South Carolina, these specimens do not appear to be attributable to any known species (LeCroy 2004).

Species of *Polycheria* are known to create and occupy cavities on the surfaces of compound ascidians and sponges (Skogsberg and Vansell 1928, Arndt 1933, Lambert 1979). However, the genus is not exclusive to the sponge and ascidian substrata as there are reports of *Polycheria* living among algae, stones, and gravel (Schellenberg 1931) and two reports of it occurring on a gorgonian (Dauby et al. 2001; LeCroy 2004).

During recent surveys of the crustacean fauna of St. Joseph Bay, located on the Florida Panhandle in the north-eastern Gulf of Mexico, specimens of an undescribed species of the genus *Polycheria* were found associated with several species of compound ascidians. Herein we describe this new species and provide observations on the ecology and range.

Abbreviations. Institutions and museums from which material was borrowed are abbreviated as follows: USNM

– Smithsonian Institution, Washington, D.C; GCRL – Gulf Coast Research Laboratory, University of Southern Mississippi; SERTC – Southeast Regional Taxonomic Center, South Carolina Department of Natural Resources, Charleston, South Carolina. Depth, when given, is in meters (m); ppt refers to salinity in parts per thousand. Additional abbreviations used in this study include: MX1 – maxilla 1; MX2 – maxilla 2; rMD – right mandible; lMD – left mandible; UL – upper lip; LL – lower lip; MP – maxilliped; GN1 – gnathopod 1; GN2 – gnathopod 2; P3-P7 – pereopods 3 through 7; URO – urosome; U1-U3 – uropods 1 through 3; T – telson.

Systematic account

Family Dexaminidae Leach

Genus *Polycheria* Haswell, 1879

Polycheria josephensis sp. n.

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Figs 1–4

Polycheria sp. A, LeCroy 2004: 480

Polycheria sp. Camp et al. 1998: 128

Type material. Holotype: male, 4.2 mm, USNM 1297736, host - *Eudistoma* sp., 11 June 2004, St. Joseph Bay, Florida, 200 m northwest of Blacks Island, 29°43.73'N 85°19.23'W, depth 1.0 m, 35 ppt, 32°C, coll. J.M. Foster and B.P. Thoma.

Paratypes: 5 vials. 4 males, 14 females, 6 females, 7 males, 26 unsexed; USNM 1297737-1297741, host *Didemnum* sp., St. Joseph Bay, Florida, 200 meters north of Blacks Island, 29°47.73'N 85°19.82'W, depth 1.0-2.0 m, 35 ppt, 32°C, coll. J Foster and B. Thoma.

Other materials. 1 male, 2 females, 1 ovigerous female, USNM 1297742 host *Aplidium stellatum* Verrill, 20 July 2004, St. Joseph Bay, Florida, 400 m west of Blacks Island, 29°43.62'N 85°20.00'W, depth 1 m, 30 ppt, 30°C, coll. J.M. Foster and B.P. Thoma; 1 male, 1 female, 1 ovigerous female, USNM 1297743, host *Eudistoma hepaticum* (Van Name), 14 July 2004, St. Joseph Bay, Florida, 200 m northwest of Blacks Island, 29°43.73'N 85°19.23'W, depth 1 m, 33 ppt, 29°C, coll. J.M. Foster and B.P. Thoma; 6 ovigerous females, 23 juveniles, GCRL 06535, host *Didemnum* sp., 20 July 2004, St. Joseph Bay, Florida, 200 m northwest of Blacks Island, 29°43.73'N 85°19.23'W, depth 1 m, 33 ppt, 29°C, coll. J.M. Foster and B.P. Thoma; 6 males, 5 females, USNM 1297744, beach wash-up of *Didemnum* sp. and algae, 25 December 1997, St. Joseph Bay, Florida, Palm Point, 29°50.45'N 85°20.10'W, 27 ppt, 19°C, coll. J.M. Foster; 4 males, 1 female, 1 juvenile, USNM 1297745, host *Eudistoma* sp., on artificial substrate, 4 December 2004, St. Joseph Bay, Florida, 0.6 km southwest of Blacks Island, 29°43.21'N 85°20.40'W, depth less than

1.0 m, 29 ppt, 10°C, coll. J.M. Foster and B.P. Thoma. 6 females, USNM 205641, host *Distaplia bermudensis* (Van Name), Apalachee Bay, 8 km off Alligator Point, Florida, 4 February 1955, coll. E.L. Pierce; 1 male, host unknown, USNM 238408, Apalachee Bay, 8 km off Alligator Point, Florida, February, 1960, coll. C.E. King; 1 male, USNM 221129, Western Atlantic, off Georgia, 31°23'35"N 80°53'12"W, 20 January 1980, 19 m, suction sample; 1 male, NOAA w194MR31, Florida Bay, core sample; 2 males. 4 females, 1 juvenile, SERTC S 849, 32 km off St. Catherine's Island, Georgia, 31°03'47"N 80°03'36"W, 20 m, 20 September 1982; 5 males, 10 females, 1 juveniles, SERTC S 847, off Amelia Island, Florida, 30°06.3'N 81°01.7'W, 20 m, 4 August 1980, suction device; 2 males, SERTC S 848, off Sapelo Island, Georgia, 31°03.9'N 81°08.6'W, 19 m, 30 January 1980, suction device.

Diagnosis. Male (not terminal male) - Head with anteroventral margin rounded, eye one-third width of head. Pereopod 3 coxa with acute anteroventral process, length 2-3 times basal width. Pereopod 7 coxa with lobate posteroventral margin. Epimeral plates 2-3 without ventral spines; epimeral plate 1 with 2-3 short posterodistal spines; epimeral plate 2-3 with posteroventral setules; epimeral plate 3 rounded posteroventrally, ventral margins with plumed setae. Urosomite 1 with a short, elevated process projected posteriorly; urosomites 2-3 with dorsolateral carinae. Epimeron 3 ventral margin with slender plumed setae; uropod 1 peduncle with ventral a proximal fringe of slender plumed setae.

Description. Male (not terminal male) – Head with anteroventral margin rounded, slightly shorter than pereonites 1 and 2 combined; eye one-third width of head, ovate, red in life, brown in alcohol; rostrum absent.

Antennae subequal; antenna 1 with peduncle article 1 shorter than 2, flagellum of 10–20 articles. Antenna 2 with peduncular article 5 shorter than 4; flagellum of 14–15 articles. Mandible with 4 spines on left side, 3 on right side. Molars triturative and unequal in size, palp absent. Lower lip with outer lobe not projecting laterally. Upper lip with apical margin broadly rounded with fine lateral and facial setae. Maxilla 1 with inner plate having apex rounded, one terminal setule; outer plate truncate terminally with 6-8 spines; palp subequal to outer plate, sublinear, not tapering distally, 5–6 terminal and subterminal setae. Maxilla 2 inner plate expanded distally, half the length of outer plate with 3–4 stiff setae and a few terminal plumed setae. Maxilliped palp with 4 present articles, subequal in length to outer plate, article 4 with nail; outer plate with inner margin having 15 spines and facial setae proximally; inner plate greater than one-third length of outer plate, with distal setae.

Gnathopod 1 coxa with anteroventral margin produced into a strong tooth, basis sublinear, equal to distal segments combined, anteromedial margin with 4-5 elongate

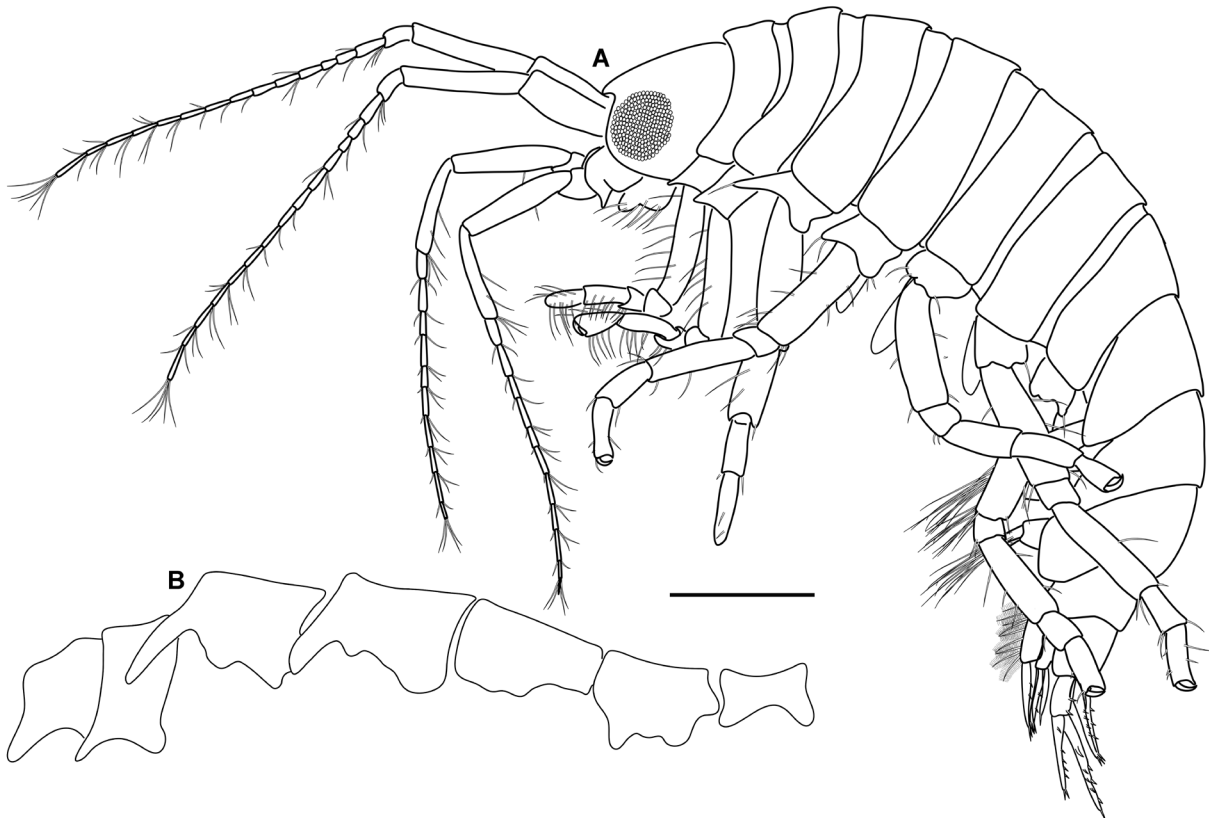


Figure 1. *Polycheria josephensis* sp. n. (St. Joseph Bay, Florida) **A** whole animal **B** coxae 1-7: female, 5.0 mm, Paratype, USNM 1297737, 200 meters north of Blacks Island, St. Joseph Bay, Florida. Scale = 1.0 mm (A), 0.5 mm (B).

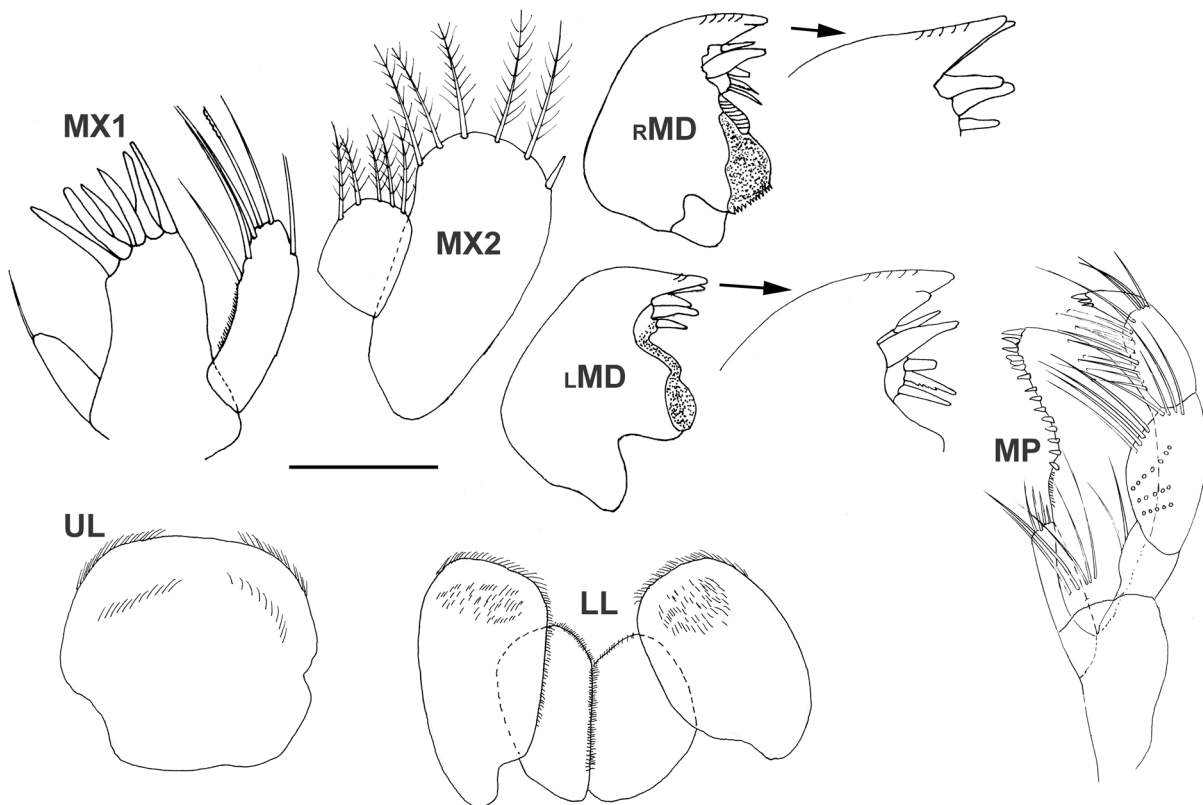


Figure 2. *Polycheria josephensis* sp. n. ♂, 5.0 mm, Paratype, USNM 1297738, 200 meters north of Blacks Island, St. Joseph Bay, Florida. Scale = 0.10 mm; MP = 0.25 mm.

setae and several shorter setae; merus shorter than carpus, carpus slightly longer than propodus, anterior and posterior margins with long simple and plumed setae; palm much shorter than dactyl and finely pectinate; dactyl broadly curved.

Gnathopod 2 coxa with anteroventral margin with a small triangular tooth, produced ventrally; basis as in gnathopod 1; merus shorter than carpus, posterior margin with elongate setae; carpus longer than propodus, ventral margin with a row of elongate simple setae; propodus expanded distally, ventral margin with pectinate setae, dorsal margin with distal elongate simple setae; palm short and broadly convex, dactyl falcate and finely pectinate, less than half the length of palm.

Pereopod 3 with anteroventral margin of coxa produced into a strong ventrally directed tooth, length twice its basal width; posteroventral margin of coxa rounded; basis with posterodistal setae, merus shorter than basis, subequal to carpus and propodus combined, with one short posterodistal spine and 2-3 posterior marginal setae; carpus slightly shorter than propodus, posterodistal and anterodistal angles with short spines; propodus with posterodistal margin produced with 2-3 spines, anterior margin with 2-3 distal spines; palm with one short distomedial spine.

Pereopod 4 with anteroventral margin of coxa produced into a blunt tooth, posteroventral margin broadly lobate, produced; basis with slender anteromarginal and posteromarginal setae; merus linear, longer than carpus and propodus combined, with 3 short anteromarginal spines.

Pereopod 5 with anteroventral and posteroventral margins of coxa rounded, not produced; basis with long anteromarginal and posteromarginal simple setae; merus longer than carpus, with anteromarginal and posteromarginal simple setae; carpus longer than propodus with posteromarginal setae; propodus with short spines and long setae on anterior and posterior margins.

Pereopod 6 coxa with ventral angles rounded, not produced; basis subequal to merus, with a small proximal expansion on the posterior and anterior margins, with 2-3 posterodistal spines; carpus subequal to propodus with one long anterodistal spine; merus with 3-4 anteromarginal setae and 4-5 short, stiff anteromarginal spines; propodus with a cluster of 2-3 anteromarginal spines, palm with one short distomedial spine, posterior margins produced into a short tooth at dactyl closure.

Pereopod 7 with posteroventral margin of coxa strongly produced into a narrow lobe, with length equal to basal width; basis linear with anteromarginal and posteromarginal setae; merus shorter than basis with a cluster of anterodistal spines; carpus short, less than half the length of merus, with anterodistal and posterodistal spines; posterior margin of propodus produced distally, with 2-3 spines, anterior margin with 1 short spine and a cluster of simple setae, distomedial margin with one strong spine; dactyl falcate, closing on posterodistal spine cluster.

Epimeron 1 with posteroventrally acuminate, ventral margin with 2-3 short, curved spines; Epimeron 2 with

anteroventral margin with simple setae; Epimeron 3 with posteroventral margin quadrate; ventral margin with elongate plumed setae. Urosomite 1 with posteroventral margin with several long plumed setae; dorsal marginal keel bearing an acute posterior process. Urosomites 2-3 fused to a mid-dorsal saddle-shaped indentation; with 0-3 dorsal spines and with dorsolateral margins forming keels, running out to form acute lobes. Uropod 1 shorter than uropod 3; peduncle fringed with ventral plumed setae; rami subequal; subequal to inner ramus; rami with marginal spines and long apical spines on both rami. Uropod 2 shorter than uropod 1; peduncle less than half the length of inner ramus; inner ramus shorter than outer ramus; rami with long apical spines. Uropod 3 with peduncle shorter than rami, 2 spines distally; rami wide proximally, tapering to apices; both rami strongly spinose marginally; inner ramus longer than outer ramus; longer than uropod 1 and telson. Telson broadly lanceolate, acute distally; length more than twice its width; cleft at least 90 percent to base; with 4-6 lateral spines; apical spines present, equal to marginal spines.

Females are indistinguishable from non-copulatory males, except for the presence of penes in the male or brood plates in the female.

The terminal male is characterized by the following: (1) dense pubescence on antenna 2, article 3; (2) long marginal setae on rami of uropod 3; (3) strong row of dorsolateral spines on the peduncle of uropod 1; (4) a row of short spines on the ventral margin of epimera 1-2-3; (5) coxal plates reduced, especially coxa 3 which has no strong anteroventral process, with the exception of coxa 1 which has well developed anteroventral process; (6) uropod 2 with marginal spines at least twice width of the rami.

Habitat. Symbiotic with compound ascidians (*Eudistoma hepaticum*, *Eudistoma* sp., *Didemnum* sp., *Distaplia bermudensis*, *Aplidium stellatum*) in sand and seagrass (*Thalassia testudinum*) communities.

Depth range. 1-20 meters.

Distribution. Gulf of Mexico-Florida: St. Joseph Bay, Alligator Harbor, Seahorse Key, Florida Bay. Western Atlantic: Amelia Island, Florida; Sapelo Island, Georgia; Gray's Reef off Charleston, South Carolina.

Etymology. This species is named for its type locality, St. Joseph Bay, Florida (Gulf County, Florida).

Discussion. Specimens of *Polycheria josephensis* sp. n. from St. Joseph Bay, Florida conform morphologically to *Polycheria* sp. A of LeCroy (2004) from the same locality. Males are similar to females except in the terminal form. Material examined from the Atlantic coast off Georgia (Gray's Reef; Sapelo Island) and from the Gulf of Mexico (Amelia Island, Florida Bay, and Alligator Harbor) appear to be assignable to *Polycheria josephensis* sp. n. (LeCroy 2004); however, these individuals may

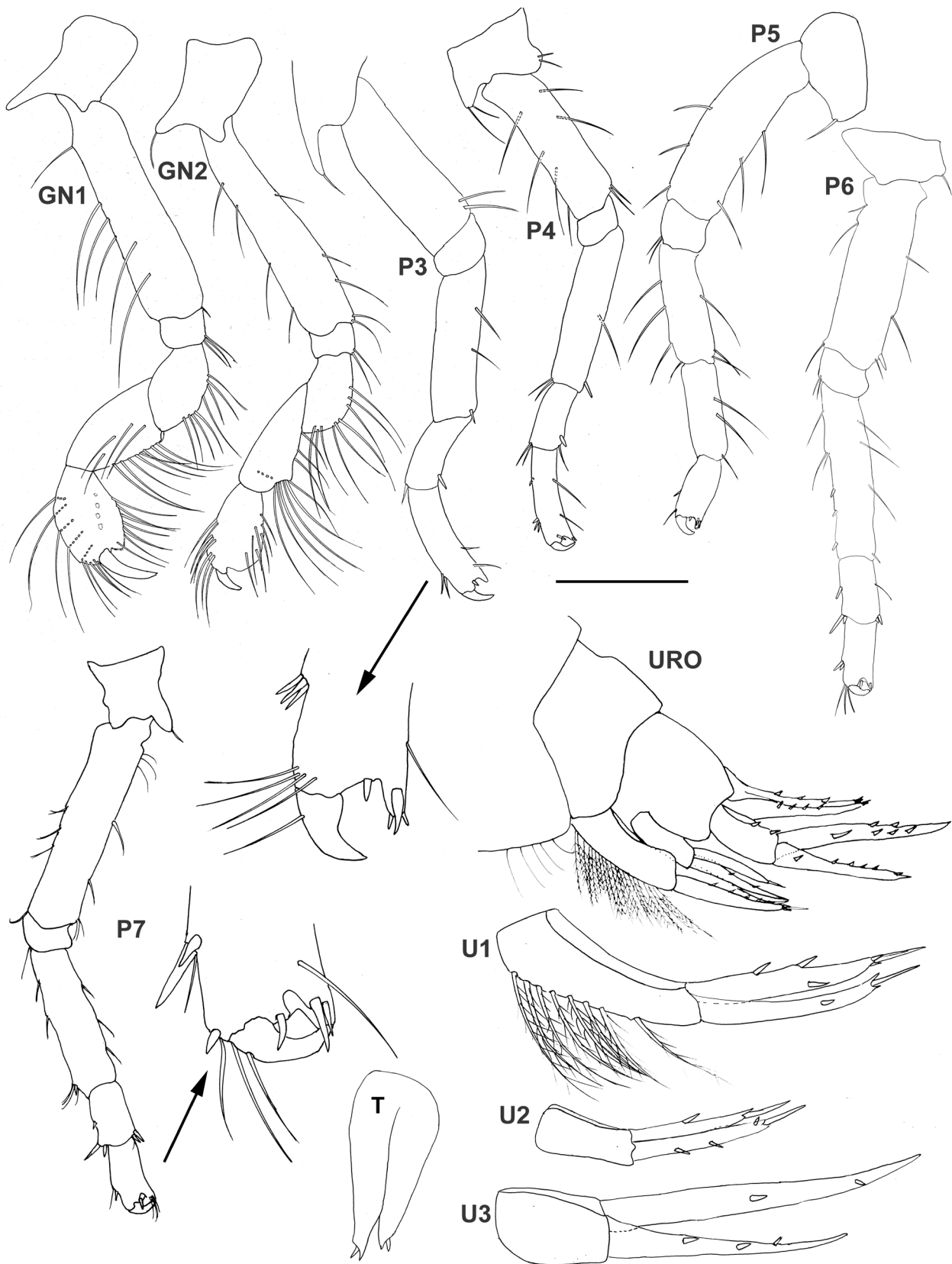


Figure 3. *Polycheria josephensis* sp. n. ♂, 5.0 mm, Paratype, USNM 1297738, 200 meters north of Blacks Island, St. Joseph Bay, Florida. Scale = 0.5 mm GN1 – P7; 1.0 mm URO; 0.3 mm U1-T.

represent cryptic species and warrant further investigation using molecular techniques.

Polycheria josephensis sp. n. is most similar to *Polycheria osborni* Calman, 1898 in both male and female forms but can easily be separated by the number of spines on the inner plate of the maxilliped and the shape of coxae 1 and 7. The inner plate of the maxilliped of *P. josephensis* sp. n. bears 14–15 short, stout spines on the inner margin, while *P. osborni* has 8 larger, wider spaced marginal spines. Additionally, the anteroventral margin of coxa 1 is projected anteriorly, but blunt in shape in *P. osborni*, while in *P. josephensis* sp. n. coxa 1 it is acute and strongly projected. Coxa 7 differs in shape between the two species with the anteroventral margin being unproduced and rounded in *P. josephensis* sp. n. versus produced and acute in *P. osborni*.

When examining materials of *P. osborni* from the Gulf of California, Bousfield and Kendall (1994) described and illustrated the terminal, or copulatory, male and the female, but did not differentiate the copulatory male from the sub-terminal males. In both of these species, the sub-terminal males are quite similar to females, but can be differentiated by the presence of a larger number of spines on the uropods, epimeral plates, and pereopods. Additionally, the male antennae are much more setose.

Representatives of the genus *Polycheria* are typified by conservative sexual dimorphism. With the exception of the terminal males, non-ovigerous females and sub-terminal males of *P. josephensis* sp. n. are superficially identical. Sex of specimens was determined by the presence of oostegites or of penes on the mesial surface of the basis of pereopod 7. Additionally, the sexes differ in antenna length (females have subequal antennae and males have shorter first antennae) and eye size, with males having slightly larger eyes. The latter character has limited value when differentiating large non-ovigerous females from smaller males.

In the collections from St. Joseph Bay, Florida during a four-year study (2004–2008), males tended to occur in collections less frequently than females. The terminal male form was quite rare, with only two specimens observed from more than 500 specimens examined during 2004. The typical sex ratio throughout the collection, performed on individual tunicates, was: Terminal males: 2; males (with penes): 286; females (with and without eggs): 288. This ratio suggests that terminal supermales are capable of supporting a large population of *P. josephensis* sp. n. in St. Joseph Bay, Florida, which raises the question of the function of the supermale form, if not required exclusively for copulation and fertilization. Further studies of population ratios and laboratory observations of mating behaviour will clarify this issue.

Undescribed *Polycheria* material from several areas of the Caribbean Sea bear distinct similarities to *P. josephensis*. Material from Curacao conforms to *P. josephensis* sp. n. in the presence of a strong tooth on the anteroventral margin of coxae 1 and 3, the rounded anteroventral margin of the head, the presence of plumed

setae on the ventral margins of epimera 3 and the peduncle of uropod 1. This undescribed material differs from *P. josephensis* sp. n. by its strongly produced posteroventral lobe on coxa 7 and its fewer marginal spines on the telson. *Polycheria josephensis* sp. n. is the only material of *Polycheria* examined from the Gulf of Mexico, Caribbean Sea, and the U.S. Atlantic coast with a rounded posteroventral margin on coxa 7. The significance of this character will be assessed as more material is examined from the region. Undescribed material from Puerto Rico varies considerably from *P. josephensis* in the length of the anteroventral projection of coxa 1 having a projection at least three times the length of *P. josephensis*. The material consists of only a single specimen, so the significance of this character will become evident upon the examination of more materials from Puerto Rico.

Ecological notes. *Polycheria josephensis* sp. n. is a common member of the marine invertebrate community of St. Joseph Bay, Florida where it occupies excavations, or burrows, on the tough, semi-transparent tunicin layer of several species of compound ascidians including *Eudistoma hepaticum*, *E. obscuratum*, *Aplidium stellatum*, and *Didemnum* sp. These records are in addition to the previous records of occurrence with *Aplidium* sp., reported by LeCroy (2004) from the same body of water and the other records from Apalachee Bay. The exact nature of these relationships, such as the structural adaptations between the hosts and the amphipod, is not well known.

In June, 2004, the examination of more than 20 specimens of *Eudistoma hepaticum*, a massive tunicate reaching lengths greater than 20 cm, indicated that *Polycheria josephensis* sp. n. constructs cavities on the exposed surfaces of the tunicate host rather than in folds of the tunic or on the undersides (Figure 4A–C). *Didemnum* sp., colonies are usually found attached to seagrass blades rather than in unattached, discrete colonies like *Eudistoma* spp. Members of this genus are also found as fouling on dead and living pen shells (*Atrina* spp.) or other available hard substrates. Observations of *Polycheria josephensis* sp. n. burrowed in *Didemnum* spp. indicate behavior similar to those individuals found on *Eudistoma*, where the amphipods form excavations on the test (Figure 4D–E).

Laboratory observations indicate that domicile cavities are similar in shape and size to that of the amphipod. When in the excavation, *Polycheria* lies on its back with antennae, uropods, and pereopods (except pereopod 5) facing the opening of the shallow cavity it occupies. The fifth pereopod usually projects downward toward the host and splayed slightly from each side of the body. A possible explanation for this behavior is to provide stability or attachment in the burrow. The amphipod is capable of creating feeding currents with its appendages and filtering food materials from the water. The pleopods beat continuously, providing a current of water toward the antennae. According to Skogsberg and Vansell (1928) and personal observations, the first and second antennae are held vertically and still during this feeding process. At a

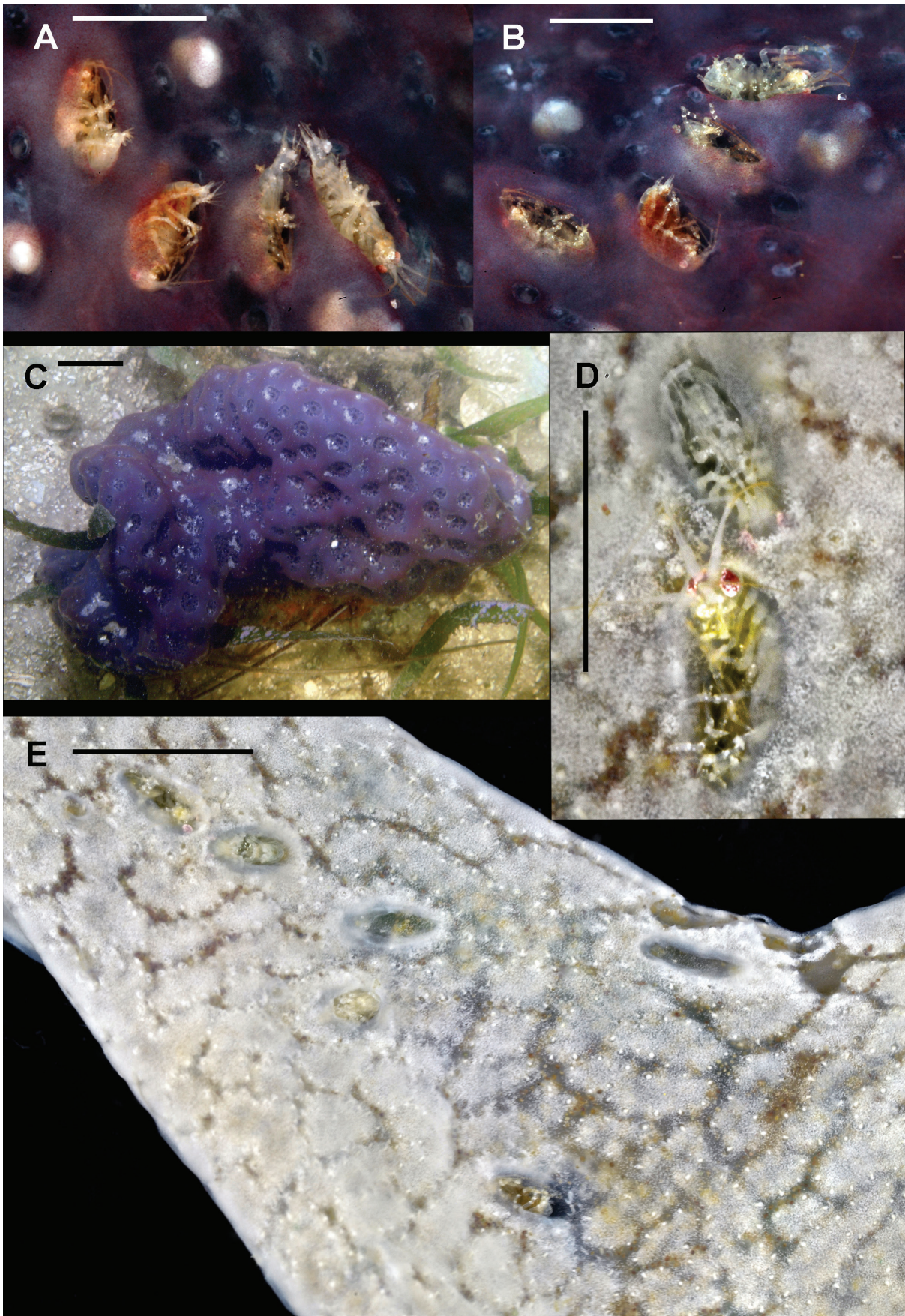


Figure 4. A–B closeup of *Polycheria josephensis* sp. n. *in situ* in tunicin of *Eudistoma hepaticum* C *in situ* photo of *E. hepaticum* D close-up of *Polycheria josephensis* sp. n. *in situ* in tunicin of *Didemnum* sp. E *Polycheria josephensis* sp. n. *in situ* in tunicin of *Didemnum* sp. Scale = 5 mm (A, B, D); 25 mm (C); 10 mm (E).

point when food is detected and captured from the passing water current by the posterior setae of the antennae, the flagellum bends at the last peduncular segment and drawn toward the body. The gnathopods and maxilliped seize the antennae and comb the setae for food, which is then transferred to the mouthparts. Microscopic gut analyses show *Polycheria josephensis* sp. n. feeds mainly on diatoms, which it filters from in the current as described several workers (Skogsberg and Vansell 1928; Ricketts et al. 1968; Bousfield and Kendall 1994; and Dauby et al. 2001) for other related species.

The amphipod controls exposure of the burrow to the outside environment by opening and closing the edges of tunic with the prehensile dactyls of the pereopods 3–7. Observations made in St. Joseph Bay, Florida of *Polycheria josephensis* sp. n. opening and closing the excavation conform to those reported from California for the species *P. osborni*. *Polycheria josephensis* sp. n. does not appear to be a motile feeder and seldom leaves its burrow except in response to stress created by reduced oxygen or physical disturbance.

In St. Joseph Bay, Florida, dense populations of *Polycheria josephensis* sp. n. are often found as clusters of adult and juvenile burrows on the tunicate's test (Figure 4A–B, D–E). The clustering condition may result from the behavior of juveniles clinging to the tunicate upon leaving the mother's oostegites until they can make burrows of their own or find refuge in abandoned cavities. As juveniles likely have limited ability to burrow, individuals that cannot locate existing, unoccupied burrows may be washed away by currents thus providing a potential mechanism for dispersal (Skogsberg and Vansell 1928; Ricketts et al. 1968; Barnard 1975). However, this pattern of juveniles clustered near adults, along with a lack of morphological adaptations potentially linked with increased motility (ie., dense setation on, or flattening of, the pereopods) suggests that this mechanism is likely of limited capacity. As a result of this limited dispersal potential, individual host specimens may act as islands of suitable habitat and thus may result in decreased rates of gene flow between groups of *Polycheria* from different host specimens. Future studies investigating the population genomics and connectivity of this species, particularly on small geographic scales, are warranted as they may reveal increased rates of molecular diversification and endemism than what is expected based solely on morphological diversity.

The density of burrowed amphipods on several *Eudistoma* specimens (averaging 10 cm by 5 cm) from St. Joseph Bay, Florida was about 6–12 occupied burrows per square centimeter of total surface area. This level was the highest among all the density observations in the present study. It corresponds to the reported 10–12 amphipods per sq. cm. on several species of the sponge *Ircinia* in Tunisia (Rutzler 1976). No other reports of tunicate density of *Polycheria* have been located in the literature. Although species of *Polycheria* are a common commensal of sponges in the Southern Ocean (Dauby et al. 2001), representatives of the genus have not been observed in sponges in the current study. Furthermore, field notes on

museum specimens and literature searches have revealed no records of *Polycheria* associated with sponges from the Gulf of Mexico and Caribbean Sea. This may suggest that greater phylogenetic diversity than is evidenced by present systematic schemes.

Available information about the host selection and feeding behavior of *Polycheria*, drawn from the literature, field observations, and notes from museum collections indicate that members of the genus primarily live symbiotically with sponges and ascidians. There is no firm consensus, supported by data, regarding the nature of those relationships, particularly as to whether the interactions are commensal, as defined in classical terms (Dauby et al. 2001; McClintock et al. 2009; Schmidt et al. 1995), or ectoparasitic, including the consumption the host's biomass (Skogsberg and Vansell 1928; Kunzmann 1996).

In a study of sponge dwelling Crustacea from the Weddell Sea, Kunzmann (1996) characterized *Polycheria* as an ectoparasite due to the presence of sponge spicules in the gut. However, Dauby et al. (2001) reported *Polycheria antarctica* to be a commensal organism since only diatoms and organic debris were found in the gut contents of specimens collected in their study. Presumably, an ectoparasite, feeding on the host sponge would have spicule fragments in its gut, but feeding on host tissues does not constitute the only reliable evidence of parasitism (R.W. Overstreet, pers. comm.) The nature of the symbiosis between sponges and tunicates and amphipods of the genus *Polycheria* remains open to future research as investigations thus far have resulted in conflicting results.

Acknowledgements

The authors thank R. W. Heard, R.W. Overstreet, and S. E. LeCroy (University of Southern Mississippi, Gulf Coast Research Laboratory), J.D. Thomas (Nova Southeastern University), and Katrin Linse (British Antarctic Survey) for their helpful comments and encouragement.

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Zeitschrift/Journal: [Zoosystematics and Evolution](#)

Jahr/Year: 2016

Band/Volume: [92](#)

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Artikel/Article: [Polycheria josephensis, a new species of symbiotic amphipod \(Crustacea, Amphipoda, Dexaminidae\) from the Northern Gulf of Mexico, with notes on its ecology 23-31](#)