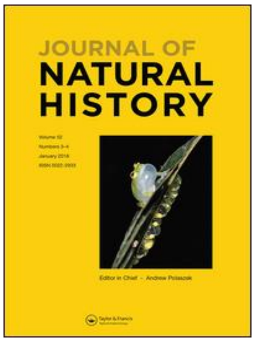

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A report on two large collections of the squat lobster *Munidopsis platirostris* (Decapoda, Anomura, Munidopsidae) from the Caribbean, with notes on their parasites, associates, and reproduction

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A report on two large collections of the squat lobster *Munidopsis platirostris* (Decapoda, Anomura, Munidopsidae) from the Caribbean, with notes on their parasites, associates, and reproduction

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ABSTRACT

The reproduction and parasite associates of the squat lobster *Munidopsis platirostris* (A. Milne Edwards and Bouvier, 1894) were investigated based on collections made in the Bahamas and Curaçao with grassmat and bundled fishing net traps used to collect sipunculan worms and other small invertebrates. Size of ovigerous *M. platirostris* was significantly correlated with clutch size for females from both localities but females from the Bahamas produced significantly more eggs (on average 10.1 eggs/clutch) than females from Curaçao (on average 6.6 eggs/clutch). Early embryos of *M. platirostris* from the Bahamas were 0.74–0.82 mm in diameter, similar to some other species of Munidopsidae as well as Chirostylidae. Two species of crustaceans, another squat lobster and a leptostracan, as well as a limpet mollusc, were collected with *M. platirostris* in the Bahamas, while a sipunculan was an associated species in a Curaçao collection. One specimen of *M. platirostris* had an unidentified cryptoniscoid epicaridean isopod, possibly representing a new genus and species. Two specimens of *M. platirostris* each had one rhizocephalan externa of a species belonging to *Lernaeodiscus* Müller, 1862 but their morphology does not match that of *L. schmitti* Reinhard, 1950, the only species in the genus known from squat lobsters in the western Atlantic. Additional materials and tools, such as DNA analysis, are needed to describe these potentially new parasites and we suggest that use of these traps may be an effective method to obtain additional samples.

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KEYWORDS
Epicaridea; Cryptoniscoidea; Munidopsidae; parasitism; Rhizocephala

Introduction

The squat lobster *Munidopsis platirostris* (A. Milne Edwards and Bouvier 1894) has previously been collected at ~95–860 m from the Florida Keys, Gulf of Mexico, and a few localities in the Caribbean Sea south to Colombia (e.g. Navas et al. 2003; Campos

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et al. 2005; Kilgour and Shirley 2014). In this region, the species appears to be most often associated with rocks, algae and coral substrates (Campos et al. 2005; Reyes et al. 2005). It is relatively uncommon in benthic samples, the species has never been reported as a host to any parasites, and essentially no data exist on its reproductive biology (Mayo 1974; Kilgour and Shirley 2014). In addition, although squat lobsters are known to host a wide range of parasites, with isopods (Epicaridea) and barnacles (Rhizocephala) being the most common parasitic taxa (Boyko and Williams 2011), no records exist of parasites associated with *M. platirostris*.

Collection of sipunculan worms and limpets in the Caribbean with novel trap designs (Rice et al. 2012; Young et al. 2013; see also Discussion) led to the capture of relatively large samples of small squat lobsters. Here we report on collections of *M. platirostris* from the Bahamas (95 specimens) and Curaçao (101 specimens), with a comparison of the size and fecundity of the squat lobsters from the two localities. We also provide a preliminary identification of their parasites, the first reported from this species, as well as crustacean and mollusc associates collected in the Bahamas and a sipunculan collected as an associate in Curaçao.

Materials and methods

Carapace length (CL) of squat lobsters was measured to the nearest 0.1 mm from the anterior end of the rostrum to the posterior edge of the carapace using an ocular micrometer or micro-scale tool (Electron Microscopy Sciences; Hatfield, PA, USA). Clutch size of squat lobsters was determined by counting all embryos per brood using a stereo microscope; all ovigerous females (with broods from early to advanced embryos) were counted unless there was evidence of damage or brood loss. Early embryos (e.g. Baba et al. 2011, fig. 1(b–d)) and more advanced embryos (e.g. Baba et al. 2011, fig. 1(f,g)) of *M. platirostris* were traced with a drawing tube attachment and measurements made with Image J software (U. S. National Institutes of Health, Bethesda, Maryland, USA, https://imagej.nih.gov/ij/) after calibration with a slide micrometer. Volumes of early embryos were calculated with the formula $V = \frac{4}{3}\pi r^3$; more advanced embryo volumes were determined using the formula $V = \frac{\pi\left(d_1^2\right)*(d_2)}{6}$, where d_1 and d_2 are the short and long axis of the embryo, respectively. Sizes of parasites were recorded based on line drawings as indicated for embryos above. Light micrographs were created with a Macropod Pro kit (Macroscopic Solutions; Tolland, CT, USA) and resulting pictures were aligned and stacked with the focus stacking software Zerene Stacker (Zerene Systems; Richland, WA, USA) (10–65 images from bottom to top of specimens).

Descriptive statistics were reported as mean ± standard deviation, and independent sample *t*-tests were used to compare means. Linear regression was conducted to determine if number of eggs produced is positively correlated with female size. One-way ANCOVA was conducted to determine if there is a significant difference in slopes or intercepts for eggs produced and female size in *M. platirostris* from the Bahamas and Curaçao.

All specimens listed under Material examined are unparasitized unless noted differently. All specimens are deposited in the National Museum of Natural History, Smithsonian Institution, Washington, DC, USA (USNM).

Results

Systematics

Superfamily **GALATHEOIDEA** Samouelle, 1819
Family **MUNIDOPSIDAE** Ortmann, 1898
Munidopsis Whiteaves, 1874
Munidopsis platirostris (A Milne Edwards and Bouvier 1894)
(Figure 1)

Orophorynchus platirostris. A Milne Edwards and Bouvier, 1894: 286, 287 (key). – A Milne Edwards and Bouvier 1897: 114, pl. 9, figs. 12–15, pl. 10, fig. 3 (Barbados, 183 m, 1 male).

Munidopsis (Orophorhynchus) platirostris. Benedict 1901: 148 ('Fish Hawk' stn 6070, 403 m, unspecified number of specimens).

Munidopsis platirostris. Benedict 1902: 276 (key), 324 (list). – Doflein and Balss 1913: 175 (list), 178 (table). – Schmitt 1935: 178 (key), 180 (no record). – Chace 1942: 75 (key). – Pequegnat and Pequegnat 1970: 140 (key). – Pequegnat and Pequegnat 1971: 6 (key). – Mayo 1974: 9, 11 (mention), 27 (range), 30, 194 (mention), 216–224 (redescription), 364 (mention), 426, 432 (station data), fig. 31 (Straits of Florida, Yucatan Channel, off St. Vincent, off Dominica, north and south of Dominican Republic, range 92–842 m [but see below], 8 males, 6 females). – Ambler 1980: 21 (mention). – Wenner 1982: 373 (list). – Abele and Kim 1986: 31 (list), 143 (key). – Boschi 2000: 98 (list). – Navas et al. 2003: 209, figs. 21, 22 (Colombia, Caribbean Sea, 200–222 m). – Campos et al. 2005: 164, figs. 129, 130 (Colombia, Caribbean Sea, 129–860 m). – McLaughlin et al. 2005: 239 (list). – Reyes

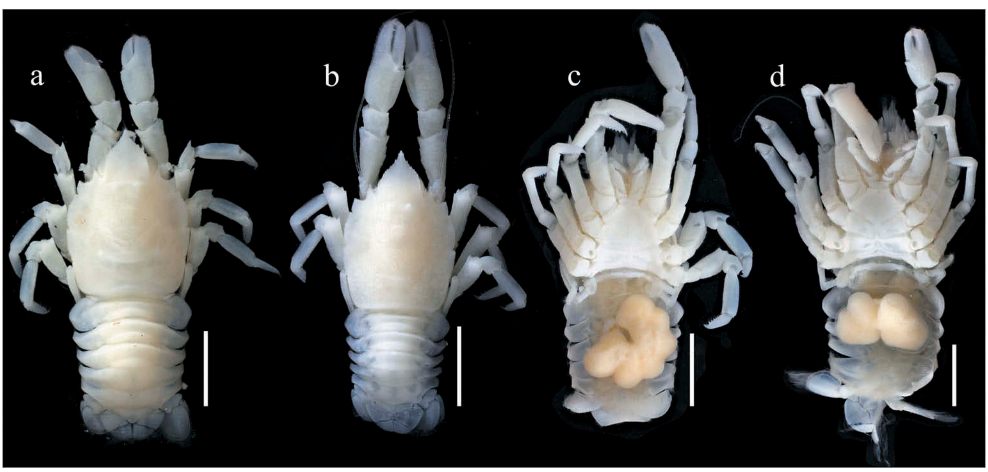

Figure 1. *Munidopsis platirostris* (A Milne Edwards and Bouvier 1894). (a) Female, dorsal view (USNM 1501683); (b) male, dorsal view (USNM 1501683); (c) female, ventral view showing cryptoniscoid isopod (gen. et sp. indet.) (USNM 1501685); (d) female, ventral view showing rhizocephalan externa (*Lernaeodiscus* sp.) (USNM 1501684). Scale bars: 2.5 mm.

et al. 2005: 325 (list). – Baba et al. 2008: 154 (list). – Fierro Rengifo et al. 2008: 8 (list), 10, (mention), 19 (list). – Perez-Gelabert 2008: 37 (list), 512 (index). – Navas Suárez et al. 2012: 371–372, 374, 376 (off Caribbean Colombia, 208–520 m). – Navas et al. 2013: 3503–3505, 3507 (list, mention). – Kilgour and Shirley 2014: 401 (list), 407 (Gulf of Mexico, 91–585 m, 3 males, 2 females). – Poupin and Corbari 2016: 47–48 (Guadeloupe, 204–399 m, unspecified number of individuals), fig; 11h (colour figure).

Material examined

Bahamas. 32 males (2.5–7.5 mm CL), 18 females (2.8–6.5 mm CL), 27 ovigerous females (4.6–7.3 mm CL; 3–26 eggs per brood, 1 female, 4.8 mm CL with 2 advanced stage embryos showing appendages), 10 juveniles (1.9–2.9 mm CL), 4 damaged specimens (2 males, 1 female, 1 ovigerous female; not measured) (USNM 1501683), 2 females (6.2–7.1 mm CL), each bearing one rhizocephalan externa on the ventral abdomen (1 mature externa with eggs = 3.9 mm max width on 7.1 mm host; 1 immature externa without eggs = 3.8 mm max width on 6.2 mm host) (USNM 1501684), 1 female (5.5 mm CL) bearing cryptoniscoid isopod (3.4 mm max width) on the ventral abdomen (USNM 1501685), from sipunculan grassmat trap, Southwest Reef, a steep, muddy slope and long-term study site just south of the eastern end of New Providence Island, Bahamas, 24°52.89′N, 77°32.23′W, 509.3 m depth, trap deployed on Johnson-Sea-Link (JSL) Dive 2821, morning of 26 February 1997; retrieved on JSL Dive 2981, morning of 11 October 1997.

Curaçao. 1 ovigerous female (8.6 mm CL; 12 eggs) (USNM 1406047), 1 male (7.8 mm CL) (USNM 1406048), 1 ovigerous female (8.6 mm CL; 4 eggs) (USNM 1406049), 1 male (7.5 mm CL) (USNM 1406050), 1 male (6.4 mm CL) (USNM 1406051), 1 male (4.9 mm CL) (USNM 1406052), from trap composed of bundled fishing nets in PVC (see Discussion), west of downline at Substation Curaçao, Curaçao, Sta. CURASUB14–16, 12°04′59.52″N, 68°53′56.76″W, 302 m depth, 22 September 2014, coll. CURASUB DSR/V (M. G. Harasewych, B. Brandt, M. A. McNeilus, C. Craig, and C. Baldwin) (Deep Reef Observation Project (DROP), September 2014).
1 male (8.8 mm CL) (USNM 1245421), 1 ovigerous female (7.5 mm CL; 14 eggs) (USNM 1245422), 1 ovigerous female (6.3 mm CL; 10 eggs) (USNM 1245423), 1 ovigerous female (5.8 mm CL; 10 eggs) (USNM 1245424), 1 ovigerous female (5.7 mm CL; 8 eggs) (USNM 1245425), 1 ovigerous female (6.2 mm CL; 5 eggs) (USNM 1245426), 1 female (6.4 mm CL; 8 eggs) (USNM 1245427), 1 male (4.6 mm CL) (USNM 1245428), 1 female with rhizocephalan scar on third abdominal somite (6.0 mm CL) (USNM 1245429), 1 ovigerous female (6.3 mm CL; 6 eggs) (USNM 1245430), 1 male (6.2 mm CL) (USNM 1245431), 25 males (3.1–6.4 mm CL), 6 females (3.5–4.6 mm CL), 15 ovigerous females (4.8–7.9 mm CL; 1–15 eggs per brood, 1 female, 5.0 mm CL with advanced stage larva under abdomen) (USNM 124532), 9 males (3.4–7.0 mm CL), 4 females (4.1–5.4 mm CL), 6 ovigerous females (4.7–6.5 mm CL; 3–11 eggs per brood) (USNM 1245433), 12 males (2.3–4.8 mm CL), 2 females (4.5 mm CL), 4 ovigerous females (4.5–6.4 mm CL; 2–15 eggs per brood) (USNM 1245434), Curaçao, 12°04′59.52″N, 68° 53′56.76″W, east of Substation Curaçao downline, 73–305 m depth, from grassmat collected at 304.8 m after 1+ year, 17 March 2014, coll. CURASUB DSR/V (C. Baldwin, R. Robertson, B. Brandt, H. Reichardt, and C. I. Castillo) (Deep Reef Observation Project (DROP), March 2014).

Type locality
Barbados, 183 m.

Distribution
Known in the western Atlantic from the Straits of Florida, Arrowsmith Bank in the north-west Caribbean, north and south of the Dominican Republic, and in the Lesser Antilles (south-eastern Caribbean) from Dominica to Barbados (Abele and Kim 1986). Mayo (1974) gave a calculated depth range for this species of 207–390 m but a possible range of 92–842 m, as some of her data ranges for stations were large (e.g. 201–842 m and 92–586 m). Navas et al. (2013) gave a depth range of 182–1290 m but it is unclear where they obtained this data from as they gave no published evidence to support this range. Poupin and Corbari (2016) gave the depth range for the species as 101–842 m; the material they examined was collected off Guadeloupe in 204–399 m. In summary, the depth range seems to be 91–860 m, based on published records, and this is very close to the possible (i.e. extrapolated) range prediction given by Mayo (1974) of 92–842 m.

Parasites
One female specimen of *M. platirostris* (prevalence = 1.05%) had a cryptoniscoid epicaridean isopod (gen. et sp. indet.) (Figure 1(c)). Although similar in morphology to species of the genus *Cabirops* Kossmann, 1884, this female differs in having an attachment stalk and occurring affixed to the ventral surface of the squat lobster host abdomen, whereas species of *Cabirops* have no attachment stalk and are found loose in the marsupia of their host isopods. We suspect that this specimen represents a new genus and species but in the absence of additional material, we refrain from making a formal description. Two female specimens of *M. platirostris* (prevalence = 2.1%) each had one rhizocephalan externa (*Lernaeodiscus* sp.); one mature with eggs (Figure 1(d)) and the other immature. The only species of *Lernaeodiscus* Müller, 1862 known parasitizing squat lobsters in the western Atlantic is *L. schmitti* Reinhard, 1950, but the shape of the lobes of the present specimens suggests that they are not conspecific with that species and more work is needed to determine their specific identity.

Associated fauna
Associated fauna from the Bahamas collection included the squat lobster *Munidopsis longimanus* (A Milne Edwards 1880) (1 male, 3.7 mm CL) (USNM 1501686; Figure 2(a)), the leptostracan *Nebalia* sp. (1 specimen, 3.9 mm CL; 2.9 mm without rostrum) (USNM 1501687; Figure 2(b)); and the limpet *Notocrater youngi* McLean and Harasewych, 1995 (USNM 1501688; 2 specimens: larger specimen 2.6 × 2.0 mm (Figure 2(c,d)), smaller specimen 2.2 × 1.5 mm). The March 2014 collection from Curaçao had the sipunculan *Phascolosoma turnerae* Rice, 1985 (USNM 1237692–1237694) as an associate; this species was also previously collected in the Bahamas using the grassmat method (Rice et al. 2012).

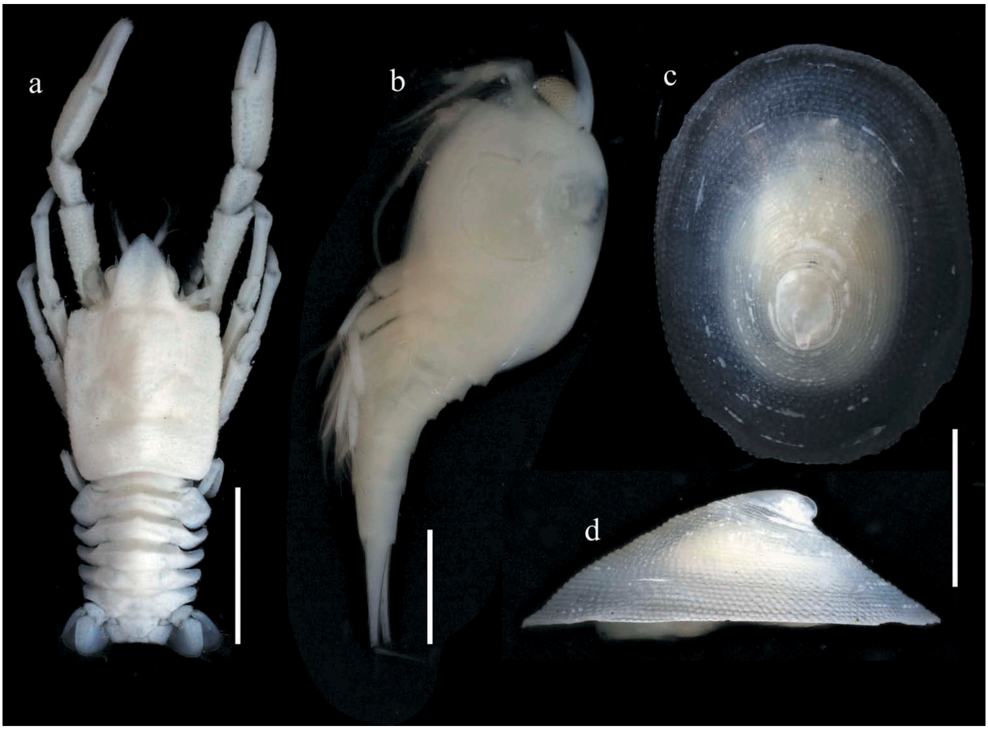

Figure 2. Fauna associated with *Munidopsis platirostris* (A Milne Edwards and Bouvier 1894). (a) *Munidopsis longimanus* (A Milne Edwards 1880) (USNM 1501686); (b) *Nebalia* sp. (USNM 1501687); (c, d) *Notocrater youngi* McLean and Harasewych, 1995 , dorsal and lateral views, respectively (USNM 1501688). Scale bars: a = 2.5 mm, b–d = 1 mm.

Reproduction

Juveniles of *M. platirostris* from the Bahamas ranged from 1.9 to 2.9 mm (2.34 ± 0.3 mm, n = 10); in general, sex of specimens greater than 2.5 mm could be identified. The average total body length of adult males from the Bahamas (4.3 ± 1.3 mm, n = 32) was significantly shorter than that of males from Curaçao (5.1 ± 1.2 mm, n = 53) ($T_{83} = -2.9$, $p < 0.005$; Figure 3(a,b)). The average total body length of adult females (both non-ovigerous and ovigerous) from the Bahamas (5.1 ± 1.2 mm, n = 49) was not significantly different than that of females from Curaçao (5.5 ± 1.2 mm, n = 48) ($T_{95} = -1.58$, $p = 0.12$; Figure 3(a,b)).

In the Bahamas, 29.5% of females were ovigerous (October collection; Figure 3(a)) versus 32.7% in Curaçao (March and September collections; Figure 3(b)). A significant positive correlation was found between female size of *M. platirostris* and number of eggs produced for both Bahamas and Curaçao collections ($T_{25} = 3.38$, $p = 0.0024$; $T_{29} = 7.59$, $p < 0.0001$, respectively) and there was no significant difference in the slopes of the regression lines ($F_{1,\ 54} = 0.16$, $p = 0.69$; Figure 3(c)). The minimal size of ovigerous females was 4.6 and 4.5 mm for Bahamas and Curaçao, respectively. Although average size of ovigerous females from the two sites were not significantly different ($T_{58} = -0.8$, $p = 0.43$), females from the Bahamas produced significantly more eggs than females from Curaçao ($F_{1,\ 54} = 12.61$, $p < 0.001$; Figure 3(c)). The average number of eggs

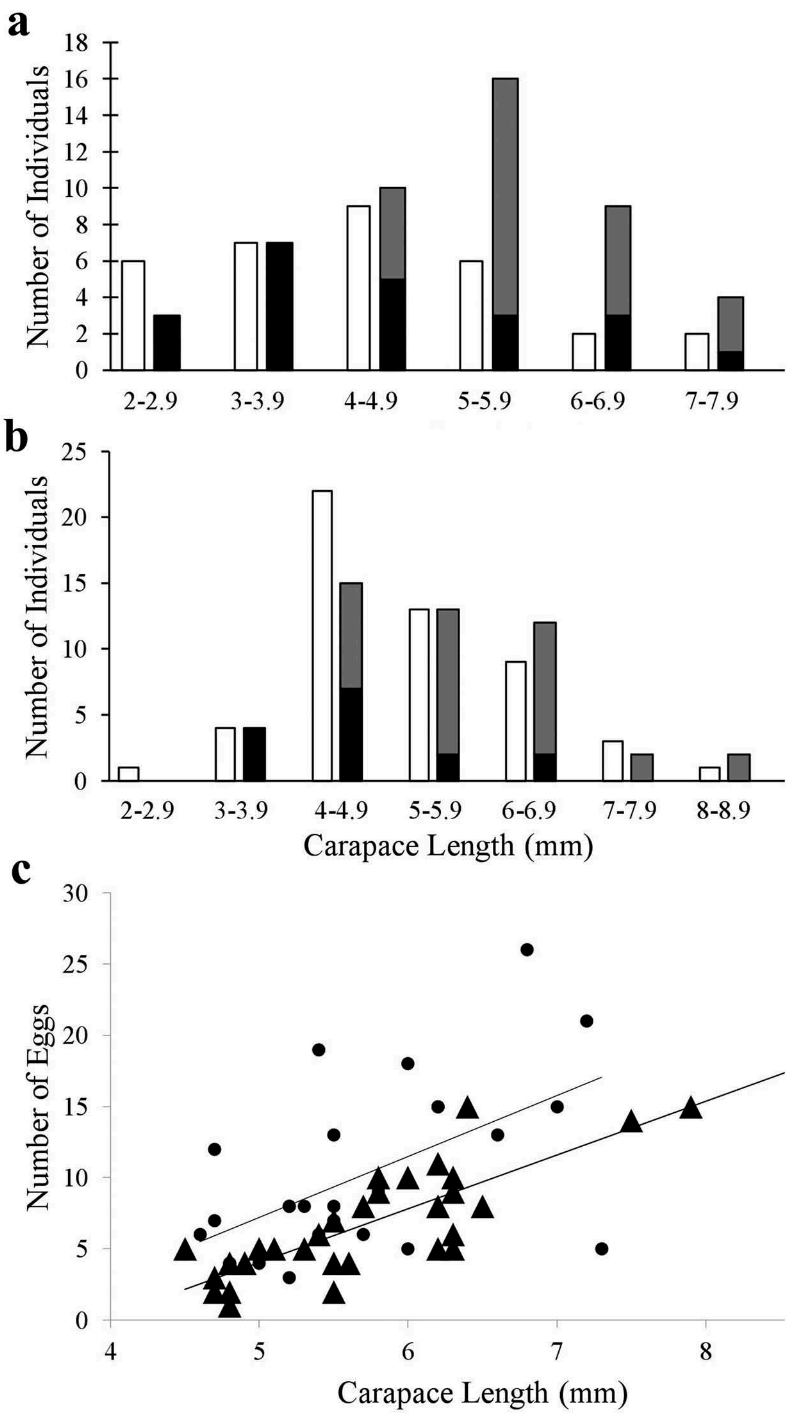

Figure 3. Size frequency distribution of *Munidopsis platirostris* (A Milne Edwards and Bouvier 1894) (males = white bars, non-ovigerous females = grey bars, and ovigerous females = black bars). (a) Specimens collected from the Bahamas; (b) specimens collected from Curaçao; (c) relationship between female brood size (number of eggs) and carapace length of *M. platirostris* [regression equation for Bahamas specimens (circles): $y = 4.28x - 14.17$, $R^2 = 0.31$, $n = 27$; regression equation for Curaçao specimens (triangles): $y = 3.77x - 14.81$, $R^2 = 0.67$, $n = 31$].

produced were 10.1 ± 5.9 mm (n = 27) and 6.6 ± 3.8 mm (n = 31) for Bahamas and Curaçao, respectively.

Early embryos of *M. platirostris* from the Bahamas were approximately spherical and 0.82 ± 0.03 mm (n = 30) in diameter versus more advanced embryos that were 1.0 ± 0.05 mm (n = 28) along the long axis and significantly larger ($t_{56} = -15.81$, $p < 0.0001$). Volumes of early embryos were 0.29 ± 0.04 mm (n = 30); more advanced embryo volumes were approximately 117% greater (0.34 ± 0.06 mm; n = 28).

Discussion

The specimens of *M. platirostris* examined closely match those described by Mayo (1974) (Figure 1(a,b)). The brood size of *M. platirostris* is similar to other smaller species in the genus (e.g. *M. curvirostra* Whiteaves, 1874, *M. polymorpha* Koelbel, 1892, and *M. similis*; Smith, 1885) and some chirostylids which produce ~1–52 eggs per brood (Baba et al. 2011). The only other data on the reproduction of *M. platirostris* is from Mayo (1974) who reported that ovigerous females were 4.5–5.5 mm CL (without indication of brood size); this size range matches our findings. Egg loss during collection (Van Dover and Williams 1991) was not evident in our samples but could have resulted in lower counts of brood size for some individuals. Early embryo sizes of *M. platirostris* are the smallest reported for a member of the genus *Munidopsis*, but similar in size to some other munidids and chirostylids (Tapella et al. 2002; Dellatorre and Baron 2008; Schnabel 2009; Baba et al. 2011). The increase in embryo volume during development is poorly known in the group but the present data are comparable to those collected for *Munida gregaria* (Fabricius, 1793) (Baba et al. 2011).

Mayo (1974) reported no parasites in the samples of *M. platirostris* taken by trawl from Florida and the Caribbean but did find *Munidopsis squamosa* (A Milne Edwards 1880), likewise unparasitized, co-occurring in a sample from the Dominican Republic. Our findings are the first to show both epicaridean isopod and rhizocephalan barnacle parasites on *M. platirostris*, but additional material is required to determine if, as we suspect, the rhizocephalan represents a new species of *Lernaeodiscus* and the cryptoniscoid represents a new genus and species. In the Bahamas, specimens were captured with a trap ('sipuncollector') used to collect sipunculan worms (Rice et al. 2012) and limpets (McLean and Harasewych 1995; Young et al. 2013). The trap (composed of a fibrous door mat surrounding a PVC pipe and then wrapped in plastic netting; see Rice et al. 2012 for full description) was clearly also effective at capturing these squat lobsters. In one of the Curaçao collections, a different type of trap design was used based on the *lumun-lumun* collection method (bundled nets to collect small gastropods in the Philippines (see Seronay et al. 2010)). The modified trap was composed of a 76.2 cm length of PVC pipe (20.3 cm diameter) with numerous 5 cm holes and filled with semi-compacted fishing nets and bait (fish and chicken bones) (Harasewych, pers. comm.). Such grassmat and bundled fishing net traps could enable effective sampling for further studies on the natural history and host/parasite relationships of *M. platirostris* and other squat lobsters from similar habitats.

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Disclosure statement

No potential conflict of interest was reported by the authors.

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