

PONTONIINE SHRIMPS  
(DECAPODA: CARIDEA: PALAEMONIDAE) OF THE  
NORTHWEST ATLANTIC.  
IV. *PERICLIMENES ANTIPATHOPHILUS* NEW SPECIES,  
A BLACK CORAL ASSOCIATE FROM THE TURKS AND  
CAICOS ISLANDS AND EASTERN HONDURAS

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ABSTRACT

A series of *Periclimenes antipathophilus* new species, a small pontoniine shrimp, was collected from black coral colonies (*Antipathes gracilis*) in the Turks and Caicos Islands, British West Indies. Additional specimens from *Antipathes* spp. were collected at Roatan, Honduras. The new species is similar morphologically to *P. iridescens* but differs in (1) the presence of a triangular tooth on the moveable finger of major pereopod 2; (2) length of the carpus compared with the propodus of the major chela of pereopod 2 (carpus more than ½ length of propodus); (3) the presence of 4 or 5 spine-setae on the propodal flexor margins of pereopods 3-5; (4) the absence of an apical process between the mesial spine-setae on the posterior margin of the telson; and (5) the ventral branch of the lateral antennular flagellum, which is attenuated, of comparable length with the peduncle, and extends 4-6 articles beyond the tip of the antennal scale before bearing esthetascs. The two species also differ in color pattern and possibly habitat.

Pontoniine shrimps of the genus *Periclimenes* Costa, 1844 are distributed widely throughout the low-latitude marine waters of the world. Some species are free living, but many are associated with other invertebrates. Known associates in the western North Atlantic are sponges (Chace, 1972), gorgonians (Patton, 1963; Criales, 1980; Heard, 1986; Heard and Spotte, 1991), actinians (review of Spotte et al., 1991), corallimorpharians (Williams and Williams, 1982; Spotte et al., 1991), rhizostome scyphozoans (Chace, 1969; Mahnken, 1972; Criales and Corredor, 1977; Criales, 1984), hydroids (Criales, 1984), antipatharians (Criales, 1980, 1984), bivalves (Chace, 1972; Criales, 1984), ophiuroids (Chace, 1972; Criales, 1984), and crinoids (Chace, 1969, 1972; Criales, 1984).

We collected specimens of an undescribed species of *Periclimenes* from black coral (i.e., antipatharian) colonies at Pine Cay, Turks and Caicos Islands, British West Indies, and at Roatan, eastern Honduras. In this report we offer an anatomical description of the new species, along with comments on its ecology and affinity with a closely allied member of the genus *Periclimenes*.

METHODS AND MATERIALS

Collections were made during SCUBA dives at 17-45 m by placing a numbered plastic bag over an antipatharian, cinching the mouth of the bag at the base of the colony, and shaking vigorously to dislodge any shrimps. The bag was then pulled away while still cinched tightly, and its mouth was tied off with a rubber band. A piece of the antipatharian ordinarily was taken for identification. Associations were occasionally documented in situ by photographing individual shrimps on antipatharians prior to capturing them (Figs. 1, 2). Shrimps were recovered by pouring the contents of the bags through a 355-µm sieve. The shrimps and antipatharian cuttings were fixed briefly in 10% formalin-seawater and preserved in 70% ethanol.

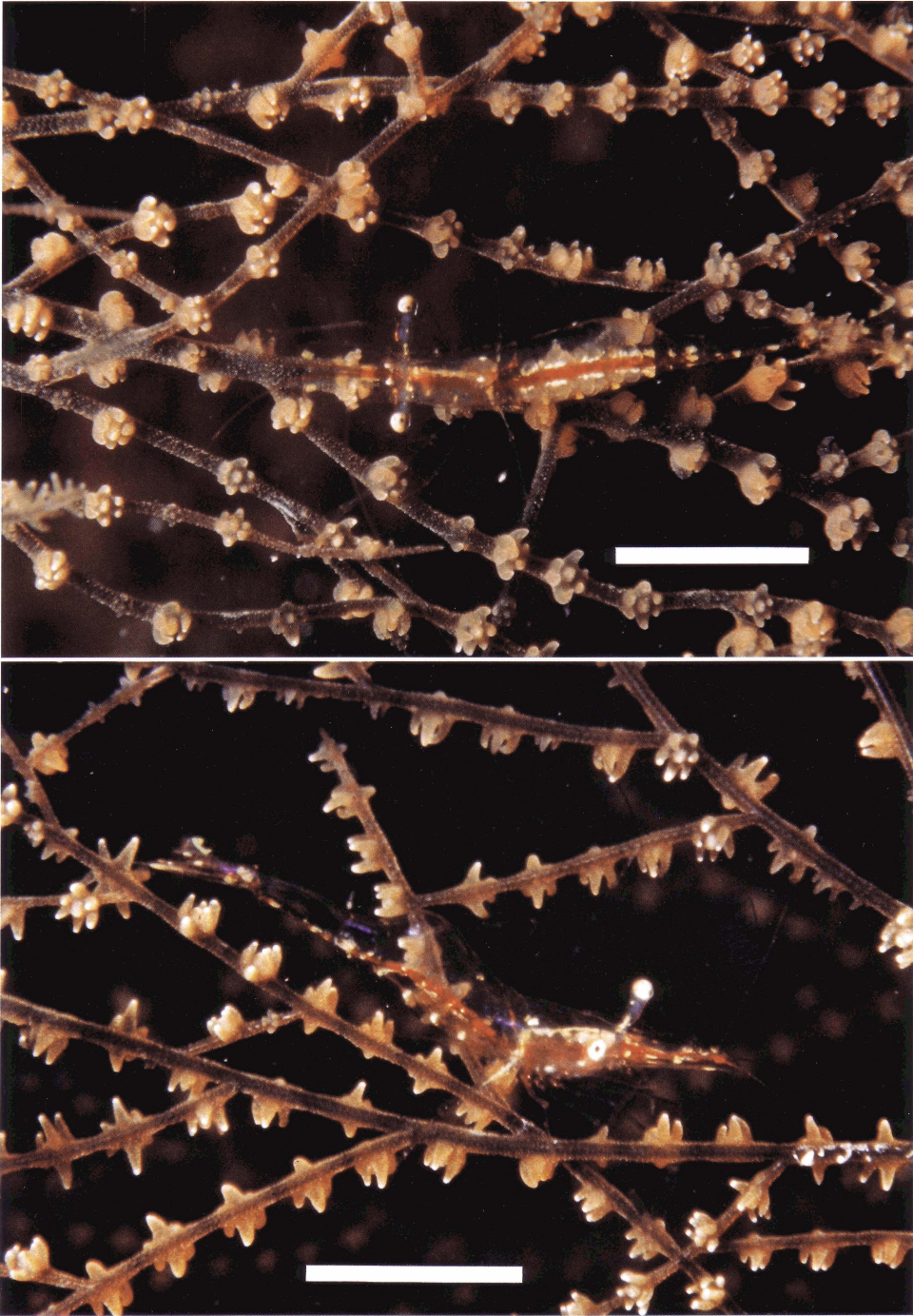


Figure 1. (top) *Periclimenes antipathophilus* (ovigerous) photographed 10 July 1990 at 38 m on the antipatharian *Antipathes gracilis*. Pine Cay, Turks and Caicos Islands. Scale = 5 mm.

Figure 2. (bottom) *Periclimenes antipathophilus* photographed 12 December 1990 at 26 m on the antipatharian *Antipathes gracilis*. Roatan, Honduras. Scale = 5 mm.

***Periclimenes antipathophilus* new species**  
 Figures 3–6

*Synonyms.*—*Periclimenes* sp.: Heard et al. (1993).

*Material Examined.*—Holotype, U.S. National Museum of Natural History (USNM 243593); Ovigerous female (Field No. 51, CL = 3.6 mm), Pine Cay, Turks and Caicos Islands (near N21°53', W72°05'), from the antipatharian *Antipathes gracilis* Gray, 1860, depth 37–40 m, S. Spotte and P. M. Bubucis (coll.), 10 July 1990. Paratypes (6 shrimp), U.S. National Museum of Natural History (243594): Field No. 38, CL = 2.4 mm, male, 4 July; Field No. 46, CL = 3.3 mm, male, 4 July; Field No. 55, CL = 2.8 mm, male, 10 July; Field No. 13, CL = 3.9 mm, female (ovigerous), 4 July; Field No. 22, CL = 3.4 mm, female (ovigerous), 4 July; Field No. 49, CL = 4.9 mm, female (ovigerous), 4 July; all from *A. gracilis*, 37–40 m, at holotype collection site, S. Spotte and P. M. Bubucis (coll.). Paratypes (2 shrimp), Gulf Coast Research Laboratory Museum (GCRL I-1152): Field No. 41, CL = 3.4 mm, male, 4 July; Field No. 48, CL = 3.9 mm, female (nonovigerous), 4 July; both from *A. gracilis*, 37–40 m, at holotype collection site, S. Spotte and P. M. Bubucis (coll.). Additional Material (Spotte collection): Pine Cay, from *A. gracilis* at holotype collection site, S. Spotte and P. M. Bubucis (coll.), 1990—11 May (6 shrimp, 40 m), 12 May (3 shrimp, 40 m), 4 July (43 shrimp, 37–40 m), 10 July (11 shrimp, 37 m). Roatan, Honduras (near N16°20', W86°20'), S. Spotte (coll.), 1990—11 December (2 shrimp, 33.5 m from *Antipathes gracilis*), 11 December (1 shrimp, 17 m from *Antipathes* sp.), 12 December (1 shrimp, 26 m from *A. gracilis*), 14 December (1 shrimp, 45 m from *A. pennacea* Pallas, 1766).

*Habitat.*—Associated with antipatharians of the genus *Antipathes* at depths of 17–45 m.

*Distribution.*—Turks and Caicos Islands (northeastern West Indies) and eastern Honduras (western Caribbean).

*Etymology.*—Derived from the Greek for black coral loving: *Antipathes*, genus of black corals with which *P. antipathophilus* associates, and *philos*—(loving); Latin ending *-us* is masculine.

*Diagnosis.*—Small pontonine shrimp, adults attaining 5.5 mm CL. (Carapace length, CL, distance between tip of rostrum and posterodorsal margin of carapace.) Rostral blade with 3–7 dorsal teeth; ventral teeth rare, represented by single vestigial tooth. Antennal and hepatic spines well developed, no other carapace spines. Ventral branch (fused and unfused parts) of lateral antennular flagellum attenuated, comparable in length with the peduncle, extending 4–6 articles beyond tip of antennal scale before bearing esthetascs. Length of antennal scale nearly 4 times width. Second maxilla with bilobed endite. Pereopods 2 dissimilar (one much more massive), slightly dissimilar, or nearly equal; when dissimilar, moveable finger (dactyl) of major chela with single triangular tooth on cutting edge, fixed finger with blunt protuberance on cutting edge, and carpus more than ½ length of propodus. Dactyls of pereopods 3–5 bifid, 4 or 5 spine-setae on propodal flexor margin; propodus of pereopod 5 with 3 clusters or rows of comb-setae on and near distal end. Telson lacking acute terminal process on posterior margin between mesial pair of plumose spine-setae.

*Description of Adult Female.*—The following description is qualitative; ratios and other comparisons are therefore approximate. *Carapace* (Fig. 3A–C): Rostrum (Fig. 3A, B) deep, upturned, extending to end of first segment of antennular peduncle; ventral surface with setae, rarely with single vestigial tooth; seven or fewer prominent dorsal teeth, first tooth nearly even with hepatic spine, second nearly even with posterior margin of ocular orbit. Carapace length to 5.5 mm; carapace with well developed antennal and hepatic spines, other spines or ornamentation lacking (Fig. 3C). Abdomen and telson (Figs. 3C, 4E): Abdominal pleura rounded; sixth abdominal somite 2 to 2½ times longer than fifth, ⅓ length of telson as measured along middorsal surface (Fig. 3C). First pair of dorsolateral spines of telson (Fig. 4E) located ⅓ length of telson from anterior margin, second pair equidistant between anterior pair and posterior margin of telson; 3 pairs of apical spine-setae, lateral pair shortest, intermediate pair longest (3 times length

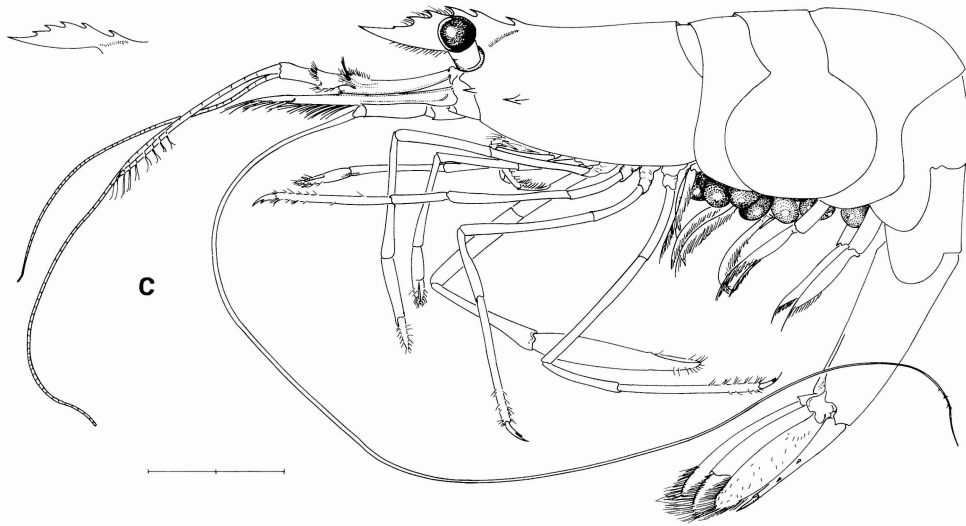
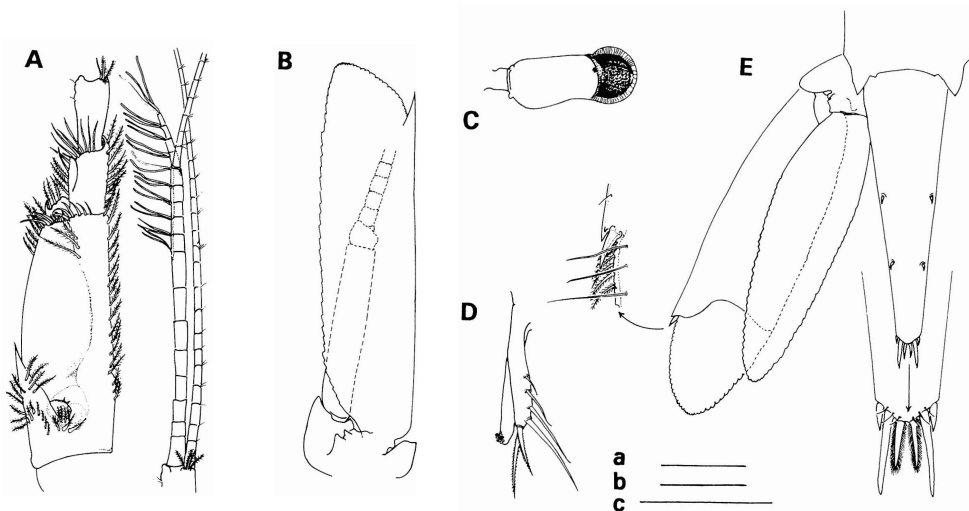


Figure 3. *Periclimenes antipathophilus* n. sp. A, rostrum of adult male paratype (CL = 3.3 mm); B, rostrum of adult female paratype (CL = 4.9 mm); C, female holotype, lateral view. Scale = 2 mm.

of lateral pair), mesial pair plumose ( $\frac{3}{5}$  length of intermediate pair). Uropods and telson (Fig. 4E) typical of genus; exopod distinctly broader and longer than endopod,  $\frac{1}{2}$  longer than telson, distolateral tooth and associated moveable spine-setae well developed, transverse suture distinct. Eye (Fig. 4C): Cornea slightly broader than stalk,  $\frac{1}{2}$  as long, and barely constricted where joining stalk; accessory pigment spot and associated ommatidia present. Antennular peduncle (Fig. 4A): Sharp, slender stylocerite extending to midlength of basal article; distolateral margin of basal article with single spine; second and third articles with combined length  $\frac{1}{2}$  that of basal article, third article not extending to tip of antennal scale. Antennular flagellum (Fig. 4A): Lateral flagellum of antennule branches fused for 13 articles, last 4 articles of ventral branch separated; each of last 10 articles of ventral branch with esthetascs (2 on proximal articles, 3 on distal article); ventral branch (fused and unfused parts) attenuated, comparable in length with the peduncle. Antennal scale (Fig. 4B): Length of antennal scale nearly 4 times width, lateral margin nearly straight, distolateral spine not extending to tip of blade. Antennal peduncle not extending past midlength of blade. Mouthparts (Fig. 5A–F): Mandible (Fig. 5A) lacking palp; incisor process ending in 4 distinct teeth, distal tooth largest; molar process dentate with numerous small spine-setae. Maxilla 1 (Fig. 5B) with upper endite (lacinia) possessing 5 or 6 stout apical spine-setae interspersed with, or distal to, 10 or more smaller subapical setae; endite with 4 or more marginal subapical setae on each side. Maxilla 2 (Fig. 5C) with bilobed endite. Maxilliped 1 (Fig. 5D) with well developed exopodal flagellum (lash) possessing 3 or 4 terminal plumose spine-setae; epipod weakly bilobed; palp slender and lacking terminal spine-setae. Maxilliped 2 (Fig. 5E) possessing well developed exopod with terminal plumose setae. Maxilliped 3 (Fig. 5F) with ischiomerus fused to basis; exopod well developed and possessing 4 terminal plumose spine-setae; exopod exclusive of terminal spine-setae extending just past



**Figure 4.** *Periclimeses antipathophilus* n. sp. Female paratype (CL = 4.9 mm). A, left antennule (peduncle on left, flagella on right); B, right antennal scale showing relative length of antennal peduncle (dorsal view); C, left eye; D, appendix interna and appendix masculina of adult male (CL = 3.3 mm); E, telson showing enlargement of posterior end; left uropod showing enlargement of lateral spine-seta. Scales: a = 0.25 mm (D); b = 0.5 mm (C); c = 1.0 mm (A, B, E).

midlength of antepenultimate article of endopod. Pereopods (Fig. 6A–F): Slender, delicate, and spidery. Pereopods 1 (Fig. 6C) not extending beyond antennal scale; fingers of chelae  $\frac{1}{5}$  length of palm, cutting edges lacking teeth; chelae  $\frac{2}{3}$  length of carpus, merus subequal to carpus in length, ischium  $\frac{2}{3}$  length of merus. Pereopods 2 (Fig. 6A, B) dissimilar (one much more massive), slightly dissimilar, or nearly equal, both extending well past antennal scale by length of propodus; when dissimilar, moveable finger (dactyl) of large major chela with single triangular tooth on cutting edge, fixed finger with blunt protuberance on cutting edge, fingers slightly less than  $\frac{1}{2}$  length of palm; chela  $1\frac{1}{2}$  times length of carpus and  $1\frac{1}{2}$  times length of merus. Minor chela or chelae in specimens with equal pereopods 2 possessing fingers slightly less than  $\frac{2}{3}$  length of palm, cutting edges lacking teeth; chela slightly more than  $\frac{3}{4}$  length of carpus, merus  $\frac{3}{4}$  length of carpus, ischium slightly longer than merus. Pereopods 3–5 (Fig. 6D–F) similar, extending to, or slightly past, distal end of antennal scale, dactyls bifid, propodi with 4 or 5 spine-setae along distal  $\frac{1}{2}$  of flexor margin. Pereopods 3 and 4 (Fig. 6D, E) most similar, propodi of both 4 times length of dactyl, carpus  $\frac{1}{2}$  length of propodus, merus twice length of carpus, ischium  $\frac{1}{2}$  length of merus. Pereopod 5 (Fig. 6F) with propodus  $4\frac{1}{2}$  times length of dactyl, carpus  $\frac{1}{2}$  length of propodus, merus  $1\frac{1}{2}$  times length of carpus, ischium  $\frac{1}{2}$  length of merus; propodus with clusters or rows of 4–7 comb-setae associated with 3 distal spine-setae or pair of spine-setae on flexor margin. Pleopods (Fig. 3C): Typical of genus.

*Description of Adult Male.*—Compared with adult female, maximum length attained is less (CL to 3.9 mm), body less robust, pleopods and antennae generally longer, rostrum smaller and less deep (Fig. 3A). Similar to adult female in other respects. Appendix masculina (Fig. 4D): Ordinarily possessing 1–2 (typically 2) apical, weakly serrate spine-setae; 0–5 simple spine-setae along inner (lateral) margin increasing in size distally, the most distal usually subapical.

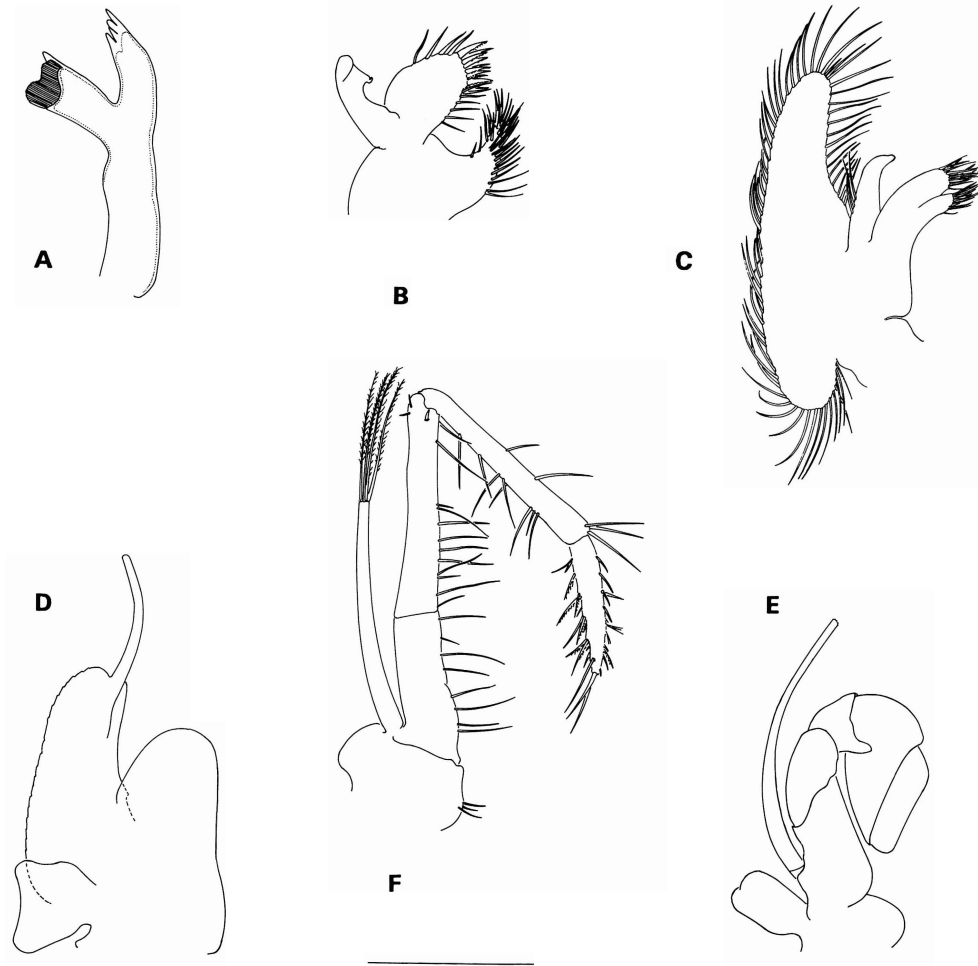


Figure 5. *Periclimenes antipathophilus* n. sp. A, right mandible; B, maxilla 1; C, maxilla 2; D, maxilliped 1 (setae omitted); E, maxilliped 2 (setae omitted); F, maxilliped 3. Scale = 0.5 mm.

*Color Pattern in Life.*—Transparent, or clear, not notably iridescent, with a bright red ventrum that appears gray in the natural habitat. Microscopic examination (only the Turks and Caicos specimens were examined microscopically in life) reveals a subtle, varied pattern of transparency, red, even orange, yellow, and green. Rostrum and carapace clear. Abdominal somites clear except fourth and fifth, which have a single, pale yellow dorsal spot. Ventrum red to posterior margin of somite 6. Lateral antennular flagella clear, mesial antennular flagella red to midlength, then clear. Ventral surfaces of eyestalks red, dorsal surfaces pale yellow. Lens gray tinged with iridescent yellow, the center a small black spot. Antennular peduncle red on mesial surface and edged with yellow where articulating with antennal scale but otherwise clear. Coxa, basis, part of ischium red on large specimens, pale yellow on small ones (pereopods 4 and 5 with yellow but sometimes only pereopods 4); remainder of segments clear in shrimp of all sizes. Pleopodal prodopodites of large specimens sometimes yellow at base with red spots on lateral surface, those of small specimens clear. Pleopodal endopods and

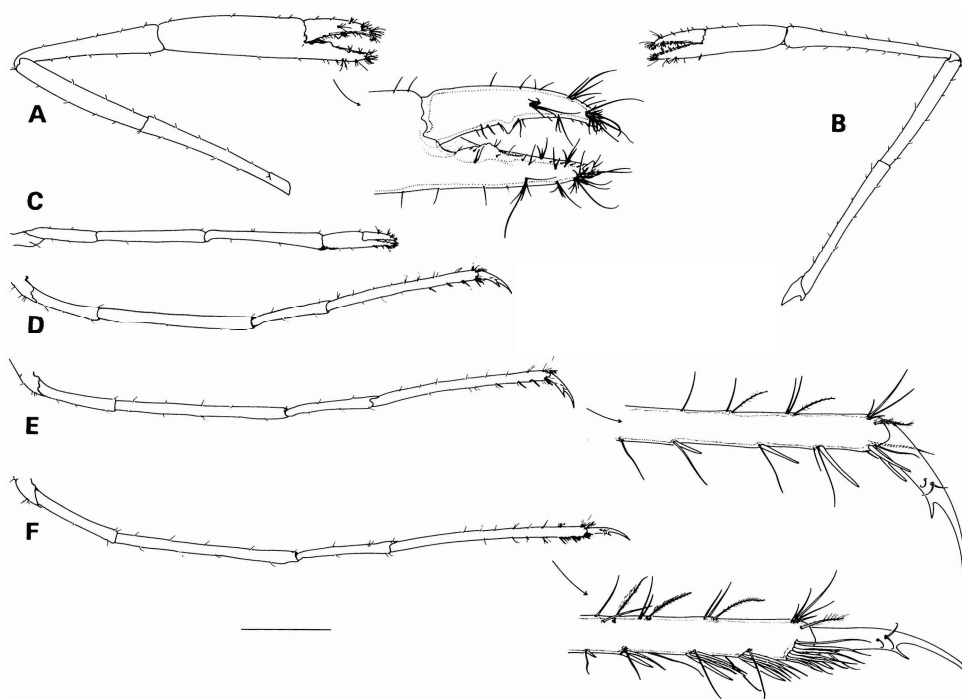


Figure 6. *Periclimenes antipathophilus* n. sp. A, B, major and minor pereopods 2 of holotype; C, pereopod 1; D-F, pereopods 3-5. Scale = 1 mm.

exopods clear. Ova pale yellow tinged with green. Telson clear tipped with yellow. Uropods clear with pale orange spots on distolateral surface, mesial margins pale yellow. Third maxilliped clear with tiny red bands, other maxillipeds clear.

**Morphometric Observations.**—Morphometric characters and other data from the 72 Pine Cay specimens, which represent the largest statistical population of the collections, were analyzed for the following: number of dorsal (RTD) and ventral (RTV) rostral teeth, carapace length (CL), postorbital carapace length (PCL, distance between posterior edge of orbit and posterior dorsal margin of carapace), rostral length (RL, distance between PCL and CL), unextended total length of each pereopod, unextended length of each pereopod article as a fraction of total length (pereopod article ratios), lengths of abdominal somites 5 and 6, ratio of abdominal somite 6 to somite 5, length of telson, number of apical (AMA) and lateral (AML) appendix masculina spines of males, and reproductive status of females assessed dichotomously as ovigerous or nonovigerous. Seven small shrimp of uncertain gender were excluded from analyses in which gender was a variable.

Distributions of variables were tested for normality. Numbers of dorsal rostral teeth and total lengths of pereopods 2 (left) and 5 (left and right) and somite 5 were not distributed normally, nor were lengths of some of the pereopod articles. We nonetheless chose parametric tests because power of the analyses was more important than robustness. The loss of robustness when parametric tests are applied to data that deviate moderately from a normal distribution is more than compensated by the increased retention of information and enhanced capacity to distinguish variation in the results. In such situations, application of methods

Table 1. Linear least-squares regression summary of analyses of morphologic characters in which CL is the independent variable. For all analyses,  $N = 72$ ,  $df(1,70)$ ,  $P < 0.001$ . RTD = dorsal rostral teeth, RL = rostral length, PCL = postorbital carapace length.

Dependent variables	Range, mm	$R^2$	$F$	$a$	$b$
RTD	3–7*	0.48	64.031	2.7578	0.7534
RL	0.4–2.1	0.97	2,447.7	-0.0357	0.3905
PCL	0.6–3.4	0.99	5,962.0	0.0357	0.6095
Telson	0.8–2.4	0.71	168.35	0.3383	0.3278
Somite 5	0.3–1.7	0.77	235.36	0.0351	0.2505
Somite 6	1.2–3.5	0.95	1,424.6	0.4166	0.5744
Somite 6 to 5 ratio	1.5–4.1	0.23	20.592	3.4544	-0.2117

\* Range is in tooth counts.

outside the boundaries of rigid statistical convention is often appropriate (Green, 1979).

Morphometric characters (data for males, females, and juveniles combined) were assessed using linear least-squares regression with CL (range 1.0–5.5 mm) as the independent variable. Multiple  $R$  values were significant in all analyses (Table 1). Only the relationship between CL and the somite 6/somite 5 ratio was negative. We identified outliers (points falling outside the mean  $\pm 3$  times the standard deviation) from casewise plots of the raw residuals and repeated the analyses with outliers removed. Bias in the original results was not detected.

Gender did not affect CL significantly ( $t$ -test of independent sample means,  $df = 63$ ,  $t = -1.93$ ,  $N = 29$  for males and 36 for females,  $P > 0.05$ ). Its effects on the lengths of somites 5 and 6 were significant, as determined by ANCOVA with gender as independent variable and CL as covariate to eliminate size effects (Table 2). Tests of homogeneity of variances indicated significant deviation for CL in both analyses (Bartlett's  $\chi^2$ ,  $P < 0.05$ ). However, the consequences of even major violations of this type are seldom critical (Lindman, 1974, p. 33).

We used ANCOVA with CL as covariate to isolate between-gender effects on RTD, RL, PCL, telson length, somite 6/somite 5 ratio, and total pereopod length. Significance was not detected:  $F(1, 62) = 0.00265$ – $2.9850$ ,  $P > 0.05$ .

Biologic characters (data for males and females analyzed separately) were assessed using linear least-squares regression with either CL or RTD as the independent variable. Multiple  $R$  values were significant in all analyses (Table 3). Casewise plots of the raw residuals revealed no outliers (observations falling outside the mean  $\pm 3$  times the standard deviation). Females ranged from 1.8–5.5 mm CL and possessed 3–7 RTD ( $N = 36$ ). Maximum CL and maximum number of RTD of nonovigerous females ( $N = 24$ ) were 3.9 mm and 6 RTD; minimum size of ovigerous specimens ( $N = 12$ ) was 3.7 mm CL and minimum RTD was 5. The presence of ova correlated positively with CL and RTD. Males ranged from 1.8–3.9 mm CL with 3–7 RTD ( $N = 29$ ). Numbers of apical and lateral

Table 2. ANCOVA summary of between-gender effects on the lengths of abdominal somites 5 and 6 with carapace length as covariate

Dependent variables	df effect	MS effect	Main effect: males vs. females		$F$	$P$
			df error	MS error		
Somite 5	1	0.1008	62	0.0167	6.0322	0.0169
Somite 6	1	0.3035	62	0.0010	31.4223	0.0000



Table 3. Linear least-squares regression summary of analyses of biologic characters. CL = carapace length, RTD = dorsal rostral teeth, AMA = apical appendix masculina spines, AML = lateral appendix masculina spines

Independent variables	Dependent variables	$R^2$	df	$F$	$P$	$a$	$b$
CL	Ova	0.62	1,36	59.655	0.0000	-0.8689	0.3714
RTD	Ova	0.19	1,36	8.436	0.0062	-0.8247	0.2178
CL	AMA	0.56	1,27	34.093	0.0000	0.2460	0.5263
CL	AML	0.85	1,27	148.46	0.0000	-3.8388	2.2594
RTD	AMA	0.22	1,27	7.832	0.0094	0.5127	0.2509
RTD	AML	0.23	1,27	7.910	0.0090	-1.7055	0.8782

appendix masculina spines correlated positively with both CL and RTD, although the relationship with RTD was weak.

Maximums of males possessing 1 AMA were 2.4 mm CL and 5 RTD ( $N = 7$ ); minimums of those with 2 AMA were 2.4 mm CL and 4 RTD ( $N = 22$ ). Maximums with zero AML were 2.1 mm CL and 5 RTD ( $N = 4$ ); shrimp possessing 1 AML ranged from 2.1–2.5 mm CL and had 4 or 5 RTD ( $N = 4$ ). Both specimens with 2 AML measured 2.4 mm CL and had 4 and 5 RTD. Shrimp with 3 AML ranged from 2.4–3.5 mm CL with 5–7 RTD ( $N = 8$ ); when 4 AML were present the range was 3.2–3.9 mm CL and 4–7 RTD ( $N = 10$ ). One individual of 3.7 mm CL and possessing 5 RTD had 5 AML.

Total pereopod length was calculated by summing the lengths of all articles except the coxa, which could not always be measured. The few measurements obtained showed the coxa to represent 2–6% of total pereopod length. Absent and broken articles were treated statistically as missing data. We used ANCOVA with CL as covariate to isolate between-gender effects on total length of each pair of pereopods. Significance in the main effects analysis was not detected ( $P > 0.05$ ).

We separated data for males and females and analyzed corresponding left and right pereopods (total length and article ratios) for within-gender similarity by Wilcoxon's matched pairs test. Significance in males was detected at  $P < 0.05$  ( $N = 21$ –26) for pereopods 2 (total length, propodus) and 4 (ischium). In females, differences were significant at  $P < 0.05$  ( $N = 33$ –34) for pereopods 1 (total length) and 4 (total length, carpus, dactyl). Gender exerted a significant effect on some pereopod article ratios, analyzed by ANCOVA with gender as independent

Table 4. ANCOVA summary of between-gender effects on pereopod article ratios (only articles demonstrating significance are listed) with CL as covariate. Dependent variable codes are: LP, RP = left and right pereopods followed by pereopod number; i = ischium; c = carpus; p = propodus; d = dactyl.

Dependent variables	df effect	MS effect	Main effect: males vs. females		$F$	$P$
			df error	MS error		
LP2i	1	0.0040	60	0.0007	5.6172	0.0210
LP2c	1	0.0016	60	0.0003	6.1746	0.0158
LP2p	1	0.0053	60	0.0007	7.4557	0.0083
LP2d	1	0.0014	60	0.0002	7.1578	0.0096
LP4i	1	0.0017	58	0.0002	7.4049	0.0086
RP1c	1	0.0021	61	0.0004	4.9757	0.0294
RP2d	1	0.0008	54	0.0002	4.7320	0.0340
RP5p	1	0.0008	54	0.0002	4.6263	0.0360
RP5d	1	0.0004	54	0.0001	4.5777	0.0369

variable and CL as covariate (Table 4). Tests of homogeneity of variances (Bartlett's  $\chi^2$ ) were significant for LP2i ( $P < 0.01$ ) and LP2p ( $P < 0.05$ ).

Obvious characters of some specimens were unequal chelae (one broader and longer) of pereopods 2. We tested for sexual dimorphism in chelae by examining differences between right and left for total pereopod length, in addition to propodal length and width, of pereopods 1 and 2. Analyses were performed using ANCOVA with gender as independent variable and CL as covariate. Gender exerted a significant effect on the differences between the total lengths of left and right pereopods 2:  $N = 21$  for males and 34 for females,  $F(1, 52) = 4.4270$ ,  $P = 0.0379$ . Significance was also detected in differences in the lengths of pereopods 2 propodi:  $N = 21$  for males and 35 for females,  $F(1, 53) = 10.6677$ ,  $P = 0.0023$ . In both analyses differences in mean lengths were greater in females. Wilcoxon's test failed to detect dimorphism because the larger chela was not consistently on the left or right side.

#### DISCUSSION

*Morphology.*—Male and female *P. antipathophilus* at Pine Cay are not notably dimorphic. As measures of incremental growth, CL and PCL are equally strong and statistically indistinguishable. In adults and juveniles of all sizes, RL, PCL, and the lengths of somites 5 and 6 are strong predictors of incremental growth when paired with CL; RTD is a weak predictor. Compared with CL, RTD is also a weak predictor of other morphometric and biologic characters. For example, CL predicts a female's probability of possessing ova more reliably than does RTD. Similarly, CL is a more reliable predictor than RTD of the numbers of appendix masculina spines (both AMA and AML) of males. Somite 6 is proportionately longer in small shrimp, and the somite 6/somite 5 ratio shifts in the direction of unity with increasing CL. The largest value (4.1) was recorded for the smallest shrimp in the sample population (1.0 mm CL).

Female *P. antipathophilus* at Pine Cay in spring and summer do not become ovigerous until almost 3.7 mm CL, and larger females are more likely than smaller ones to possess ova. Females probably grow larger than males. However, CL is a poor predictor of gender, as is RTD. Abdominal somites 5 and 6 of females are slightly longer than those of males, and gender differences are statistically significant.

In males, the numbers of apical and lateral appendix masculina spines increase with CL, although the correlation for AML is the stronger. Perhaps this is because only 2 apical spines are ever acquired, but up to 5 lateral spines can be added incrementally over time. Males have 2 apical spines at  $\sim 2.4$  mm CL and acquire 2–5 lateral spines at this size and larger.

When size effects (i.e., the effect of CL) are removed, total pereopod lengths are unaffected by gender when analyzed pairwise. However, differences in total length between left and right pereopods 2 revealed significant gender effects. This seeming discrepancy in results arises because either the right or the left pereopod 2 can be larger.

Gender affects certain pereopod article ratios significantly. Females have significantly longer left pereopod 2 propodi than males, although differences in propodal width are not significant. Within-gender effects are apparent in some pereopod article ratios, including the propodus of pereopods 2. However, as stated previously, the incidence of dissimilarity between the left and right sides is inconsistent. In both males and females the left propodus can be wider and longer,

or narrower and shorter, than the right; alternatively, the propodi can be nearly equal.

*Taxonomy.*—*Periclimenes antipathophilus* is similar to *P. iridescens* in terms of its morphology. *Periclimenes iridescens* was described from a single adult female collected at Bermuda (Lebour, 1949). *Periclimenes antipathophilus* is distinguished from the *P. iridescens* holotype by (1) the presence of a triangular tooth on the moveable finger of pereopod 2 major chela; (2) carpus of major pereopod 2 more than  $\frac{1}{2}$  length of propodus; (3) the presence of 4 or 5 spine-setae on the propodal flexor margins of pereopods 3–5; (4) the absence of an apical process between the mesial spine-setae on the posterior margin of the telson; and (5) the ventral branch of the lateral antennular flagellum, which is attenuated, of comparable length with the peduncle, and extends 4–6 articles beyond the tip of the antennal scale before bearing esthetascs.

Lebour's description and our observations of the holotype (Heard and Spotte, 1991) show *P. iridescens* to have (1) a blunt, rounded tooth on the major chela of pereopod 2; (2) carpus of major pereopod 2 only  $\frac{1}{4}$  to  $\frac{1}{2}$  length of propodus; (3) only 3 spine-setae on the propodal flexor margin of pereopods 3–5; (4) a distinct apical process between the mesial spine-setae on the posterior margin of the telson; and (5) the ventral branch of the lateral antennular flagellum distinctly shorter than the peduncle and bearing esthetascs more proximal to the tip of the antennal scale.

Since Lebour's description, *P. iridescens* has been reported from Venezuela (Holthuis, 1951; see below), Tobago (Chace, 1972), Curaçao and Bonaire in the Netherlands Antilles (Criales, 1980), Colombia (Criales, 1984), the Florida Gulf coast (Hopkins et al, 1977; Herbst et al., 1979; Williams, 1984), and Cape Hatteras, North Carolina (Herbst et al, 1979; Williams, 1984). Whether any of these shrimps is actually *P. iridescens* remains equivocal. The "iridescens" complex probably contains several undescribed species (Herbst et al, 1979; Criales, 1980, 1984; Heard and Spotte, 1991). Holthuis (1951, pp. 41–46), for example, noticed that some of the Venezuelan specimens he examined from the Allan Hancock Foundation collection had simple dactyls on pereopods 3–5; in others the dactyls were transitional between simple and strongly bifid. The Venezuelan specimens, like the *P. iridescens* holotype, had dissimilar pereopods 2 (see fig. 5, p. 46, of Heard and Spotte, 1991). However, the fingers of the major chelae, unlike those of the holotype, possessed 2 or 3 teeth on the cutting edges.

We examined 10 of the Venezuelan shrimp identified as *P. iridescens* by Holthuis (1951) and confirmed his observations of distinct variation from the *P. iridescens* holotype. The specimens had been collected 14 April 1939 "in 2–5 fathoms on sand and algae" off Cubagua Island. They also differ from *P. antipathophilus* in several respects, most strikingly in the ventral branch of the lateral flagellum of the antennule. In *P. iridescens* (sensu Holthuis, 1951) this structure is distinctly shorter than the antennular peduncle, and the last 9 or more articles are unfused.

Our limited information suggests that the color patterns of *P. antipathophilus* and *P. iridescens* are different. Lebour (1949, p. 1112) described the living *P. iridescens* holotype as "blue, pink, orange and yellow, and the whole animal was brilliantly iridescent." Bruce (1980) considered color pattern to be conservative and therefore a reliable character for separating shallow-water shrimps of closely related species. He cited as examples the rigid patterns of two species that are distributed widely: *Coralliocaris superba* (east Africa and the Red Sea to Tahiti) and *Gnathophyllum americanum* (almost circumtropical; also see Bruce, 1989).

The color pattern of *Gnathophylloides mineri* is similar in specimens from Australia, the Indian Ocean, Hawaii, and the Caribbean (Bruce, 1974a; 1988). Knowlton and Keller (1985) argued for color pattern as a diagnostic character in separating closely related alpheidids from the West Indies.

Color pattern appears adequate to distinguish *P. antipathophilus* from the holotype of *P. iridescens*. However, it seems inadequate for separating *P. antipathophilus* from sympatric genera and species of comparable size that are also transparent with bright red ventrums. As a diagnostic character, color pattern might prove even less reliable if the variation seen in *P. antipathophilus* under magnification also exists in these other species. The holotype of *Neopericlimenes thornei* was collected at Pine Cay (Heard et al., 1993) within 25 m of the *P. antipathophilus* holotype collection site. Both species are transparent with bright red ventrums. Differences in color pattern are not apparent except under magnification. Only the holotype of *N. thornei* has so far been found, and the stability of its color pattern is unknown.

At Pine Cay we also collected specimens of an undescribed species of *Periclimenes* from hand-net sweepings of gorgonians and the substratum at 5 to 30 m. Although easily distinguished from *P. antipathophilus* or *N. thornei* by its robustness, it too is transparent with a bright red ventrum. The ova are ivory (those of *N. thornei* are reddish orange), its pereopods are shorter and stouter than those of *P. antipathophilus* and *N. thornei*, and the dactyls of pereopods 3–5 are bifid (the dactyls of *N. thornei* are simple).

Still another shrimp collected at Pine Cay from the gorgonian *Pseudoptero-gorgia americana* (depth 30.5 m) conformed in most respects with morphometric characters of *Hippolyte zostericola* as described in Chace (1972). Exceptions are 3 spine-setae on pereopods 3–5. This shrimp, like the others just mentioned, was transparent in life with a bright red ventrum. The gorgonian was partly dead and covered with filamentous algae, which suggests that the species might be free living.

*Ecology.*—The *P. iridescens* holotype was captured in a “tow-net” over water of 80–100 fathoms (Lebour, 1949). Considering these circumstances, the species could either be free living or associated with another organism. Whether *P. antipathophilus* sometimes lives freely or occupies *Antipathes* spp. to the exclusion of other organisms can only be determined by surveying a variety of potential associates and the substratum. Our isolated observations of association do not adequately test the hypothesis of exclusivity.

At Roatan we recovered *P. antipathophilus* from 3 species of *Antipathes*, suggesting a degree of facultative association. Limited field time did not permit sampling of the surrounding substratum or nearby gorgonians, hydroids, and other potential associates. At Pine Cay, gorgonians of a single species (*Pseudoptero-gorgia americana*) were sampled seasonally at 3 to 45 m over 1 year. *Periclimenes antipathophilus* was never found among the thousands of pontonine shrimps recovered. Other gorgonians of several species were swept periodically over 3 years with large nets, and these samples also were devoid of *P. antipathophilus*.

Hydroids are likely alternatives to antipatharians as *P. antipathophilus* associates. Criales (1984) recovered *P. iridescens* (sensu Criales, 1980, 1984) from the hydroid *Eudendrium carneum* in coastal Colombia. According to Bruce (1981), *P. granulimanus* at Heron Island (Great Barrier Reef) is sometimes found on the bushy hydroid *Lytocarpus philippinus*. In the same publication Bruce noted that the holotype of *P. granulimanus* was recovered off the northwest coast of Madagascar from an unidentified antipatharian. Antipatharians are the organisms with

Table 5. Species of pontoniine shrimps known to associate with antipatharians

Species	Location	Associate	References
<i>Dasycaria ceratops</i>	Australia	Antipatharian	Bruce (1977)
<i>D. zanzibarica</i>	Zanzibar	<i>Cirrhopathes anguinis</i>	Bruce (1973, 1974b)
<i>Neopericlimenes thornei</i>	Turks and Caicos Islands	<i>Cirrhopathes</i> sp. (provisional)	Heard et al. (1993)
<i>Periclimenes antipathophilus</i>	Turks and Caicos Islands	<i>Antipathes gracilis</i>	This report
<i>P. antipathophilus</i>	Roatan, Honduras	<i>Antipathes gracilis</i> , <i>A. pennacea</i> , <i>Antipathes</i> sp.	This report
<i>P. granulimanus</i>	Madagascar	Antipatharian	Bruce (1978)
<i>P. iridescens</i>	Bonaire and Curaçao, Netherlands Antilles	<i>Cirrhopathes</i> (= <i>Stichopathes</i> ) <i>gracilis</i>	<i>sensu</i> Criales (1980)
<i>P. iridescens</i>	Colombia	<i>Cirrhopathes leutkeni</i>	<i>sensu</i> Criales (1984)
<i>P. lepidus</i>	Kenya	Antipatharian (provisional)	Bruce (1974b)
<i>P. lepidus</i>	Madagascar	Antipatharian	Bruce (1978)
<i>P. nilandensis</i>	Kenya	Antipatharian	Bruce (1974b)
<i>P. nilandensis</i>	Maldives, Madagascar, Indonesia	Antipatharian	Bruce (1978)
<i>P. psamanthe</i>	Kenya	<i>Antipathes</i> cf. <i>plana</i>	Bruce (1974b)
<i>P. psamathe</i>	Kenya, Madagascar, Zanzibar, Maldives and Chagos Islands, Indonesia, New Caledonia, between Misool and New Guinea	Antipatharians	Bruce (1978, 1979)
<i>Periclimenes</i> sp.	Madagascar	Antipatharian	Bruce (1978)
<i>Periclimenes</i> sp.	Australia	Antipatharian	Bruce (1977)
<i>Pontonides sympathes</i>	Galapagos	<i>Antipathes galapagensis</i>	Ridder and Holthuis (1979), Robinson (1982)
<i>P. cf. unciger</i>	Hawaii	<i>Cirrhopathes</i> sp.	Castro (1971)
<i>P. cf. unciger</i>	Australia	<i>Cirrhopathes anguina</i>	Bruce (1983)
<i>P. unciger</i>	Kenya	Antipatharian	<i>sensu</i> Bruce (1974b)
<i>P. unciger</i>	Madagascar	Antipatharian	<i>sensu</i> Bruce (1978)
<i>P. unciger</i>	Borneo	<i>Cirrhopathes</i> sp.	<i>sensu</i> Davis and Cohen (1968), Russo (1985)
<i>P. unciger</i>	Iles Marquises	"Antipathaire"	<i>sensu</i> Monod (1979)
<i>Pontonides</i> sp.	Hawaii	<i>Antipathes grandis</i>	Grigg (1964)
<i>Pseudocoutierea conchae</i>	Colombia	<i>Cirrhopathes</i> (= <i>Stichopathes</i> ) <i>gracilis</i>	Criales (1984)
<i>P. edentata</i>	Colombia	<i>Cirrhopathes</i> (= <i>Stichopathes</i> ) <i>gracilis</i>	Criales (1984)
<i>Pseudopontonides principis</i>	Bonaire and Curaçao, Netherlands Antilles	<i>Cirrhopathes</i> (= <i>Stichopathes</i> ) <i>gracilis</i>	Criales (1980)
<i>P. principis</i>	Puerto Rico	<i>Virgularia</i> sp.	Heard (1986)
<i>P. principis</i>	Gulf of Mexico	<i>Cirrhopathes</i> spp.	Heard (1986)
<i>P. principis</i>	Turks and Caicos Islands	<i>Antipathes gracilis</i> , <i>Cirrhopathes</i> sp.	This report
<i>P. principis</i>	Roatan, Honduras	<i>Antipathes gracilis</i> , <i>A. pennacea</i> , <i>Cirrhopathes</i> sp.	This report
<i>P. principis</i>	Bonaire, Netherlands Antilles	<i>Antipathes pennacea</i> , <i>Cirrhopathes</i> sp.	This report

which *P. granulimanus* associates at Tany Keli, Madagascar (Bruce, 1983). At Heron Island *L. philippinus* also harbors *P. nilandensis*, although this shrimp has been recovered from gorgonians at many locations: Zanzibar, Kenya, Madagascar, the Maldive Islands, Indonesia, and the northern South China Sea (Bruce, 1981).

Pontoniine shrimps known to associate with antipatharians have been listed in Table 5. We hesitate to call any of them "commensals" because the nature of the associations has not been examined for any species. Consistent with this argument is use of the term "host," which we consider provisional and not descriptive. In contrast with the situation in the western North Atlantic, several species of *Periclimenes* in the Indo-West Pacific are recognized associates of black corals: *P. granulimanus*, *P. lepidus*, *P. nilandensis*, *P. psamanthe*, and *Periclimenes* spp. (Bruce, 1978).

The pontoniine shrimps *Pseudopontonides principis* and *Neopericlimenes thornei*, reported previously from antipatharians in western North Atlantic waters (Criales, 1980; Heard, 1986; Heard et al., 1993), occur at Pine Cay on the antipatharian *Cirrhopathes* sp., although the association involving *N. thornei* is provisional (Heard et al., 1993). Criales (1980) collected the type specimens of *Pseudopontonides* (= *Neopontonides*) *principis* (redescribed by Heard, 1986) at Curaçao and Bonaire, Netherlands Antilles, in association with *Cirrhopathes* (= *Stichopathes*) *gracilis*. At Roatan, *P. principis* occurs with *P. antipathophilus* on *A. gracilis* and *A. pennacea*. We also recovered *P. principis* from *Cirrhopathes* sp. at both Pine Cay and Roatan. Three *P. principis* were collected in 1991 at Bonaire (S. Spotte, coll.) from hosts other than *S. gracilis*: 28 December (2 shrimp, 43 m from *A. pennacea*), 29 December (1 shrimp, 36.5 m from *Antipathes* sp.) The association of *P. principis* with *Antipathes* spp. has not been reported previously.

#### ACKNOWLEDGMENTS

Dr. D. M. Opreko (Oak Ridge National Laboratory) identified the antipatharians and advised on antipatharian taxonomy). Mr. G. Adams (Three Rivers Community College) advised on data analysis. Drs. D. Held (Connecticut College) and R. M. Overstreet (Gulf Coast Research Laboratory) advised on etymology, and Ms. C. McCaughan inked the illustrations. The Allan Hancock Foundation graciously allowed us to examine shrimps from its Venezuelan collection of *Periclimenes* cf. *iridescens*. Research was sponsored in part by the Oakleigh L. Thorne Foundation through a grant to Stephen Spotte. We thank Mr. O. B. Thorne, members and employees of the Meridian Club on Pine Cay, and the Turks and Caicos Islands government for help and encouragement. This is Contribution No. 254 of the Marine Sciences Institute, No. 81 of Sea Research Foundation, and No. 6 of the Turks and Caicos Islands Coral Reef Ecology Program.

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- DATE ACCEPTED: December 9, 1993.

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