BULLETIN OF MARINE SCIENCE, 44(3): 1195–1206, 1989 CORAL REEF PAPER

PLEOMOTHRA APLETOCHELES AND *GODZILLIOGNOMUS FRONDOSUS*, TWO NEW GENERA AND SPECIES OF REMIPEDE CRUSTACEANS (GODZILLIIDAE) FROM ANCHIALINE CAVES OF THE BAHAMAS

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ABSTRACT

Two new genera and species of the crustacean class Remipedia, *Pleomothra apletocheles* and *Godzilliognomus frondosus*, are described from anchialine caves on Abaco and Grand Bahama Island in the northern Bahamas. The new taxa are placed in the family Godzilliidae. The familial characters are revised, and a key to all species is included.

Extensive collecting efforts in anchialine caves of the West Indies and along the coast of Quintana Roo, Mexico, have produced a number of interesting crustacean species (Bowman, 1987; Holsinger and Yager, 1985; Yager, 1987b). Recent field studies in the Bahamas have resulted in the collection of two new genera and species of the crustacean class Remipedia. These new taxa are described below. Their description brings the total number of remipede species to nine. These new genera differ markedly from remipedes in the family Speleonectidae Yager (1981) and are placed in the family Godzilliidae (Schram et al., 1986). Because the diagnosis of this family was originally based on a single species from caves in The Turks and Caicos (Yager and Schram, 1986), discovery of these new taxa requires expanding the familial definition. In addition, a key to the nine described species of remipedes is given below.

The Bahamian archipelago is an area rich in drowned karst. Anchialine caves are submerged caves characterized by having inland surface openings and subsurface connections to the nearby sea. These caves are very common throughout the Bahamian island chain. The two new remipedes described below inhabit the aphotic zone of caves that also harbor a distinct community of troglobitic organisms (Yager 1987a, 1987c). Dan's Cave (Abaco Island) and Sagittarius Cave (Grand Bahama Island) are inhabited by five genera and six species of remipedes: *Speleonectes lucayensis, S. benjamini, Cryptocorynetes haptodiscus, Godzillius robustus,* plus *Godzilliognomus frondosus* and *Pleomothra apletocheles* described below. Many other crustacean species, such as hadziid amphipods, thermosbaenaceans, cirolanid isopods, and ostracods, are common to the two caves. The water column in Sagittarius Cave is euhaline from the surface to depths, lacking the fresh water lens of Dan's Cave. However, there is a density interface which is apparently maintained by temperature differential. Water above the density interface has a dissolved oxygen content of greater than 4 ppm ($mg \cdot liter^{-1}$) while below it is less than 1 ppm. In both caves the remipedes are always found beneath the density interface in more saline water of low dissolved oxygen content. The cave water usually has a remarkable visiblity, limited only by the brightness of one's dive light. Animals even the size of small copepods are easily seen in the clear water.

KEY TO THE SPECIES OF REMIPEDES

1a. Trunk pleura rounded posterolaterally; head shield subrectangular .. family Speleonectidae .. 2

1b. Trunk pleura pointed posterolaterally; head shield subtrapezoidal or convex laterally ..... family Godzilliidae 7

2a. Segments distal to elbow of maxilla 2 and maxilliped expanded distally and bearing discoid sensillae ..... *Cryptocorynetes haptodiscus*
2b. Segments distal to elbow of maxilla 2 and maxilliped not expanded distally, without discoid sensillae 3
3a. Maxilla 2 and maxilliped segment 3 rounded medially, biceps-like with moderate to long setae along rounded margin; distal claw complex with 1–2 anterior spines and posterior horseshoe-shaped arrangement of smaller spines ..... genus *Speleonectes* 4
3b. Maxilla 2 and maxilliped segment 3 subtriangular with rows of setae of equal length along entire margin of segment; distal claw complex tridentate, with long central spine flanked by 2 shorter subterminal spines ..... *Lasionectes entrichoma*
4a. Caudal rami elongate, over 3× length of anal segment ..... *Speleonectes tulumensis*
4b. Caudal rami less than 3× length of anal segment 5
5a. Antenna 1 long, ½–⅔ body length. Maxilla 1 terminal fang long, slender about 3× length of segment 6. Sternal plates with pointed posterolateral processes ..... *Speleonectes benjamini*
5b. Antenna 1 shorter, less than ⅓ body length. Maxilla 1 terminal fang less than 3× length of segment 6. Sternal plates absent or without posterolateral processes 6
6a. Maxilla 1 segment 4 endite with 1–2 robust, broad-based setae. Caudal rami about equal to length of anal segment ..... *Speleonectes lucayensis*
6b. Maxilla 1 segment 4 endite with 5 moderately stout to robust setae. Caudal rami about 1.4–2× length of anal segment ..... *Speleonectes ondinae*
7a. Head shield subtrapezoidal. Maxilla 1 segment 4 with club-like endite 8
7b. Head shield convex midlaterally; body size small, less than 10 mm. Maxilla 1 segment 4 lacking endite. Maxilla 2 and maxilliped with leaf-like setae on medial margin of segment distal to point of flexure ..... *Godzilliognomus frondosus*
8a. Maxilla 1 segment 4 endite produced distally forming chela; maxilla 2 and maxilliped with medial rows of candeliform setae; claw complex with 1 long medial spine and several shorter subterminal spines. Body length less than 20 mm ..... *Pleomothra apletocheles*
8b. Maxilla 1 segment 4 endite perpendicular to segment. Maxilla 2 and maxilliped with grappling hook-like claw complex of subequal spines. Body length up to 40 mm or more ..... *Godzillius robustus*

Family GODZILLIIDAE Schram, Yager, and Emerson, 1986

Diagnosis.—Cephalic shield subtrapezoidal or with convex lateral margins. Pleura of trunk segments with posterolateral projections. Maxilla 1 segment 3 lacking conical endite with robust setae. Maxilla 2 and maxilliped with massive, triangular segment proximal to point of flexure, with rows of densely packed setae of nearly equal lengths along entire flexor margin. Segment distal to flexure very long and narrow, with short setae along entire length of flexor margin.

Pleomothra new genus

Diagnosis.—Cephalic shield with prominent posterolateral, articulated, spine-like projections. Maxilla 1 robust, chelate; segment 4 endite developed distally as process that forms chela with opposing 2 distal segments; surface of club with many short, round tomentose sensillae. Maxilla 2 and maxilliped with many robust candeliform setae.

Type species.—*Pleomothra apletocheles* n. sp. by monotypy.

Etymology.—In keeping with the spirit of the first described godzilliid, the name is derived from the Japanese horror creature "Mothra" and the Greek word "pleo," meaning swim. The gender is neuter.

Pleomothra apletocheles new species
Figures 1–4

Material Examined.—Bahamas: Abaco Island, Dan's Cave, holotype, 12.3 mm, USNM 235301; 30 Oct 1984, coll. D. Williams. Paratypes, Dan's Cave, 2 adults, 8 Jan 1986; 1 juvenile, 26 July 1985,

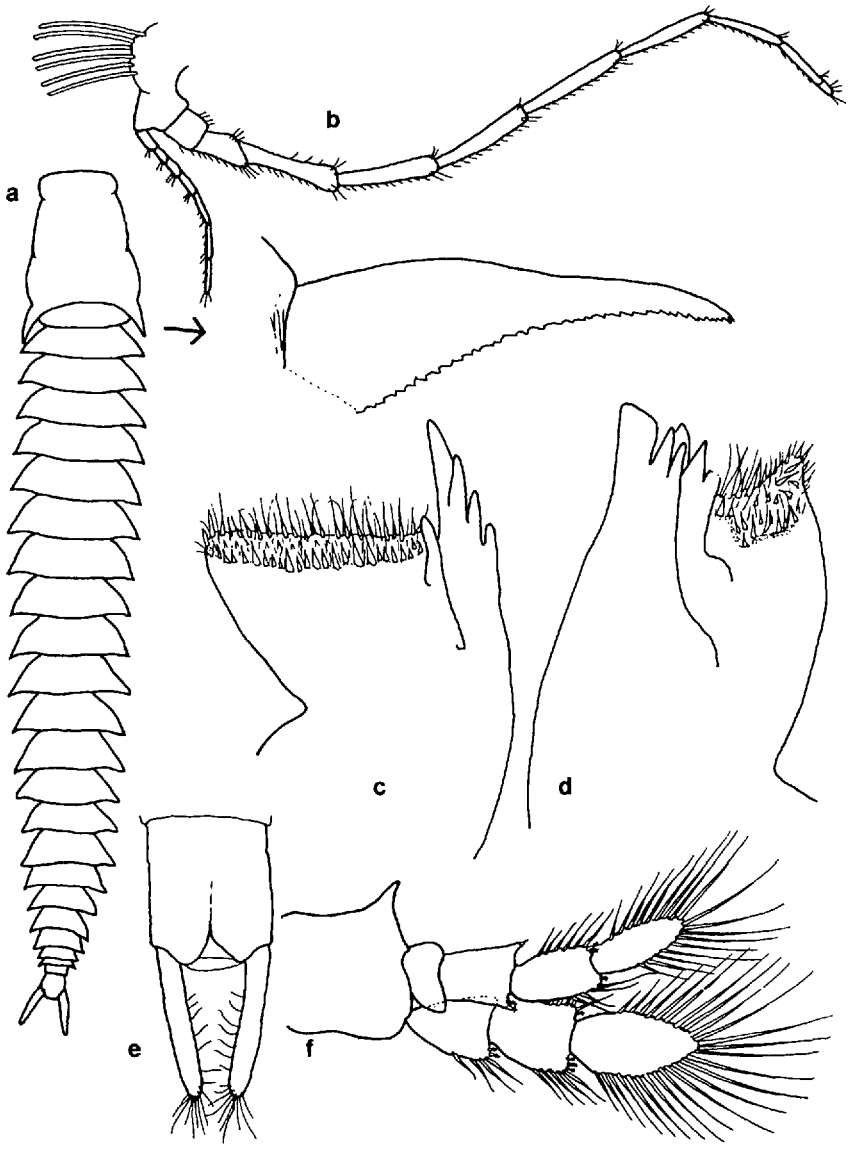

Figure 1. *Pleomothra apletocheles,* new genus, new species. a. Dorsal view, appendages omitted, with inset of cephalic shield posterolateral projection; b. Antenna 1; c. Left mandible; d. Right mandible; e. Anal segment; f. Trunk appendage (10th).

coll. D. Williams, J. Yager; Grand Bahama Island, Sweeting's Cay, Sagittarius Cave, 1 juvenile, 8 June 1987, 1 adult, 10 June 1987, coll. D. Williams, J. Yager. Paratypes in collection of author.

Description.—Body (Fig. 1a) elongate, slender, without pigment or eyes. Maximum length of specimens examined 17.1 mm. Cephalic shield subtrapezoidal, with articulated spine-like posterolateral projection with denticulate medial margin (see Fig. 1a inset). Trunk segment numbers varying with age; maximum number of trunk segments in material examined = 25; first trunk segment reduced; pleura from second segment posteriad with posterolateral projections. Sternal

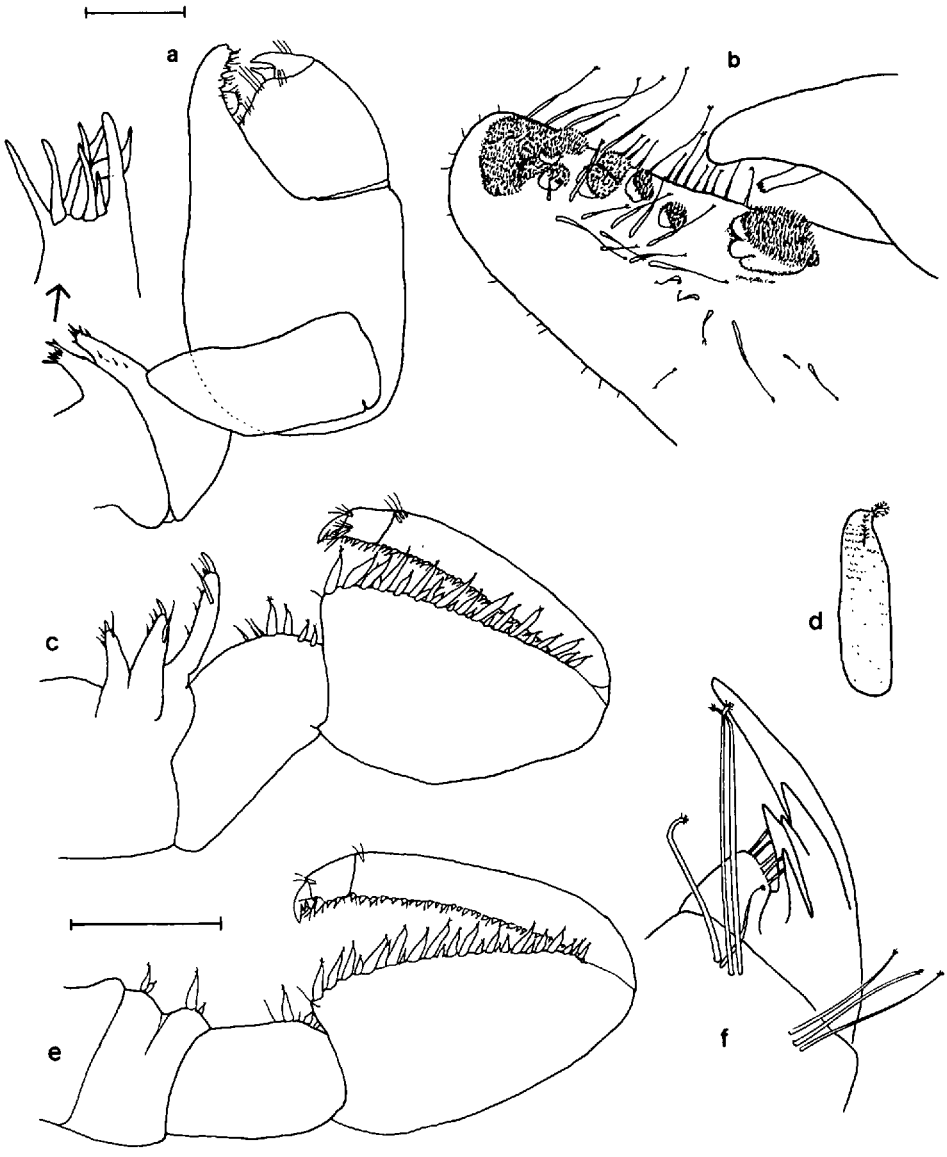

Figure 2. *Pleomothra apletocheles,* new genus, new species. a. Maxilla 1, with inset of segment 1 endite; b. Maxilla 1 segment 4 endite with tomentose sensillae; c. Maxilla 2; d. Candeliform seta of maxilla 2 and maxilliped; e. Maxilliped; f. Terminal claw complex of maxilla 2 and maxilliped showing tufted setae. Scale bars = 0.5 mm.

plates present, sternal bars narrow, undifferentiated, with posterolateral projections (Fig. 3c).

Frontal filaments cylindrical, with slender medial process. Antenna 1 (Fig. 1b) peduncle 2-segmented; proximal segment enlarged, bearing rows of long esthetascs (not all shown); distal segment bifurcate. Dorsal ramus 10-segmented, short setae along medial margin, clusters of setae and esthetascs (not all shown) on medial and lateral distal corners. Ventral ramus short, with 6–7 segments, setation as in dorsal ramus. Antenna 2 similar in morphology to other remipedes; protopod 2-segmented with medial setae. Endopod 3-segmented; segment 1 with setae on

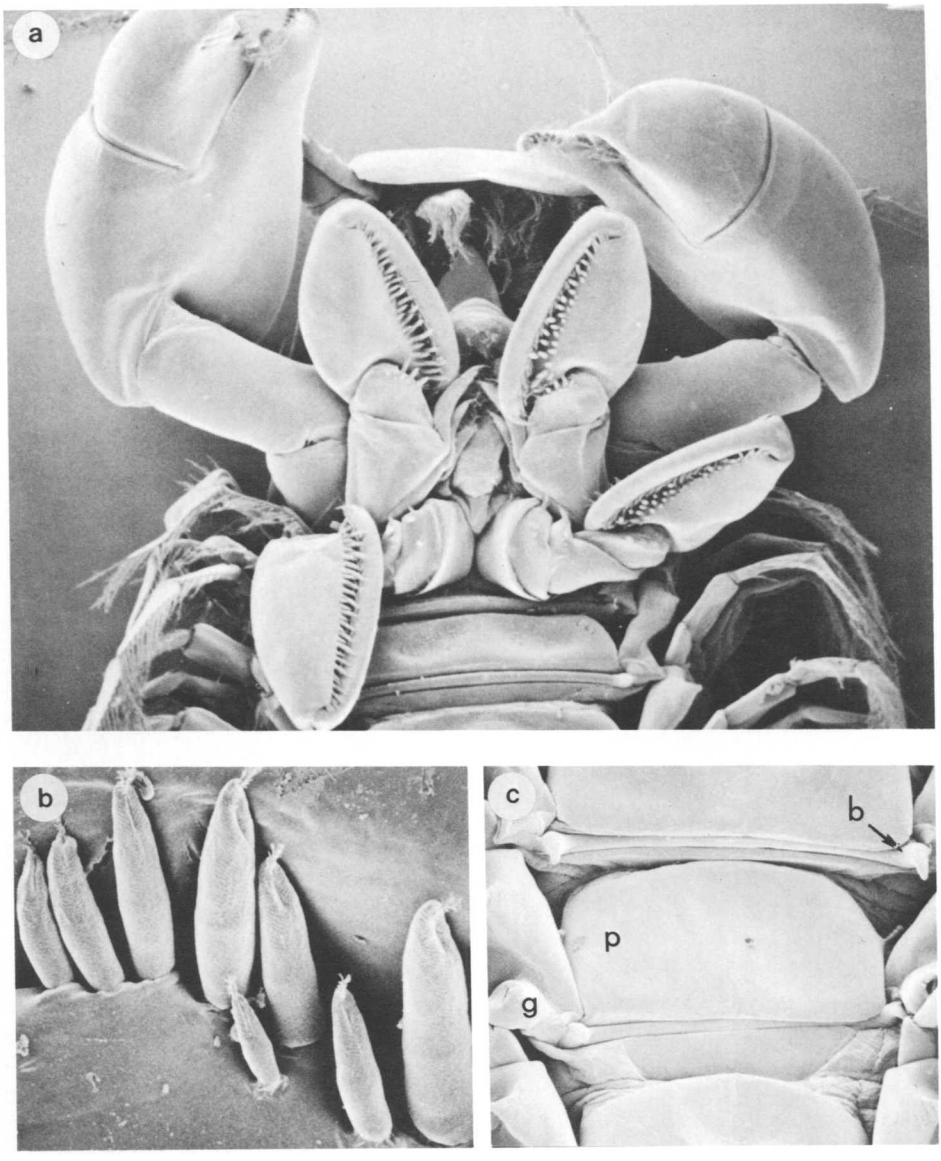

Figure 3. *Pleomothra apletocheles*, new genus, new species. a. Head, ventral view (16×); b. Candeliform setae (398×); c. Sternal plates (p), sternal bar (b), and male gonopore (g) (55×).

medial margin, segment 2 with double row of setae on medial margin; segment 3 with setae along entire margin, becoming double row along anterior and distal part of segment. Exopod a single oval scale with about 34 long setae. All setae plumose.

Labrum prominent, bilobed; anterior lobe with triangular apex, posterior lobe broad, with setose medial margin. Paragnath a setose lobe overlying mouth area. Left mandible (Fig. 1c) with 4-cusped incisor process; lacinia mobilis with 1–2 prominent cusps. Right mandible (Fig. 1d) with 3-cusped incisor process and lacinia mobilis. Molar processes well developed, bearing dense rows of short, broad-based setae and rows of longer setae along margin.

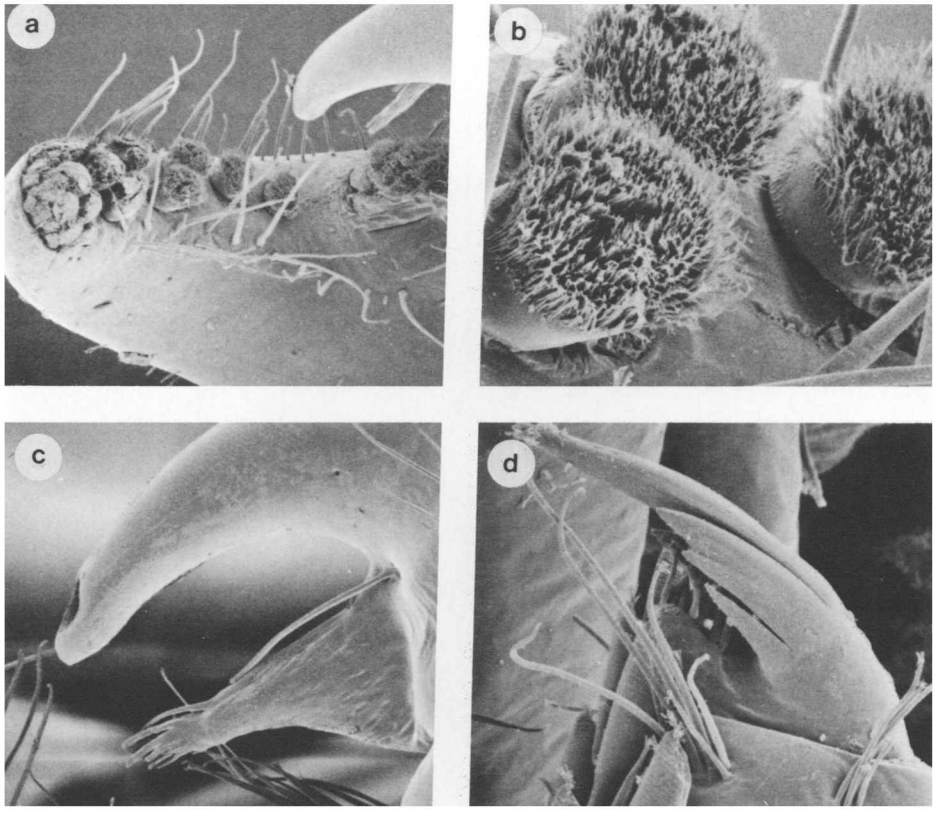

Figure 4. *Pleomothra apletocheles,* new genus, new species. a. Maxilla 1 segment 4 endite with tomentose sensillae (163×); b. Tomentose sensillae (744×); c. Maxilla 1 terminal fang and subterminal triangular endite; (263×); d. Maxilla 2 claw complex (398×).

Maxilla 1 (Figs. 2a, 3a) huge, chelate, uniramous, 6-segmented. Segment 1 short, with slender endite terminating in 1 long anterior spine and 6–8 long spines arranged as opposing pairs (Fig. 2a inset). Segment 2 short, with plate-like endite bearing at least 3 short terminal spines flanked by tiny setae; several short to moderate setae along anterior and posterior margins. Segment 3 a narrow, elongate pedestal. Segment 4 extremely bulbous, with endite developed distally (Figs. 2b, 4a). Medial surface of endite with short, round, tomentose sensillae (Figs. 4a, 4b); lateral rows of short to long setae with filamentous apical tuft; proximal part of endite conical, bearing thick clusters of many tomentose sensillae. Segment 5 short, with several clusters of moderate to long tufted setae on medial margin and on anterior and posterior distolateral margins. Segment 6 greatly reduced, with subterminal medial endite with many small, finger-like projections along apex, each with filiform margin (Fig. 4c); terminal fang short, stout, with visible subterminal pore (Fig. 4c).

Maxilla 2 (Fig. 2c) uniramous, 6-segmented, subchelate. Segment 1 with three digitiform endites increasing in length distally, each bearing a long curved terminal spine and several subterminal spine-like setae. Segment 2 short, with several medial candle-like setae tapered distally and bearing terminal filamentous tuft (Fig. 2d, 3b) and several fine setae with tufted tips (see Fig. 2f). Segment 3 longer than segment 2, expanded medially, subtriangular, bearing several rows of can-

deliform setae along entire medial margin. Principal flexure of appendage between segments 3 and 4. Segment 4 nearly as long as segment 3, very narrow, bearing short candeliform setae interspersed with small tufted setae along medial margin; distolateral corner with cluster of several moderately long tufted setae. Segment 5 very short, with medial candeliform setae and clusters of long tufted setae on anterior and posterior distomedial and distolateral margins. Segment 6 (Fig. 4d) short, terminating in claw complex of long apical spine and 3–4 shorter subapical spines. Thumb-like pad bearing many setae opposing claw complex.

Maxilliped (Fig. 2e) similar in form to maxilla 2, with 4 segments proximal to point of flexure. Segments 1–3 short, with several low medial lobes bearing candeliform setae. Segment 4 subtriangular, bearing medial rows of candeliform setae. Principal flexure between segments 4 and 5. Segment 5 about as long as segment 4, with medial candeliform setae. Segment 6 about 1/6 as long as segment 5, with distal clusters of tufted setae and candeliform setae on medial margin. Segment 7 (Fig. 2f) short, bearing claw complex and opposable thumb-like pad similar to maxilla 2.

Trunk appendages (Fig. 1f) becoming smaller and less setose posteriorly. Trunk appendage 7 bears female gonopore; 14th bears bulbous male gonopore (Fig. 3c). Protopod large, distomedial corner produced into triangular process. Endopod 4-segmented; segment 1 reduced; segment 2 with distomedial triangular extension bearing small spine, distolateral apex with several short comb setae; segment 3 with long plumose marginal setae and several distal comb setae; segment 4 oval with plumose setae along both margins. Exopod 3-segmented; segment 1 with several lateral plumose and 1–2 distal comb setae; segments 2 and 3 similar to segments 3 and 4 of endopod. Anal segment (Fig. 1e) slightly longer than wide, with triangular cuticular flap; caudal rami slightly longer than anal segment, with many medial and terminal setae.

Etymology.—The name is derived from the Greek word "apleto" meaning immense, and "chele," meaning claw, in reference to the enormous chelate first maxilla.

Relationships.—*P. apletocheles* is similar to *Godzillius robustus* and *Godzilliognomus frondosus* n. gen., n. sp., in the morphology of the second maxilla and maxilliped. These appendages have a robust sub-triangular segment proximal to the point of flexure and bear rows of nearly equally long setae along the entire flexor margin. Beyond the point of flexure are several long, very narrow segments. Additionally, the three species share similar trunk pleura morphology, with posterolateral projections. *Pleomothra* and *Godzillius* have similar cephalic shields, both subtrapezoidal in shape. However, *Godzillius* lacks the prominent posterolateral processes of *Pleomothra.*

Godzilliognomus new genus

Diagnosis.—Body length short, less than 10 mm. Cephalic shield with convex lateral margin at insertion of antenna 1; posterior margin obtusely triangular. Antenna 1 dorsal ramus long, more than half length of body; ventral ramus very short, 2-segmented, about ⅛ length of dorsal ramus. Maxilla 1 smaller than maxilla 2 and maxilliped. Maxilla 2 and maxilliped with robust triangular segment proximal to point of flexure; segment distal to point of flexure elongate, very narrow, with short, grooved, foliaceous setae along medial margin; terminal segment with 5-pronged grappling-hook claw arrangement.

Type species.—*Godzilliognomus frondosus* n. sp. by monotypy.

Etymology.—The name is derived from *Godzillius,* the largest known remipede and the New Latin word "gnomus," meaning a diminutive fabled being. The gender is masculine.

Godzilliognomus frondosus new species
Figures 5–7

Material.—Bahamas: Grand Bahama Island, Sagittarius Cave, holotype 7.3 mm, USNM 235300, 11 March 1987, coll. J. Yager; paratype 7.8 mm, USNM 235299, 11 March 1987, coll. D. Williams. Additional paratypes from Virgo Cave, Lucy's Cave, Asgard Cave, Sagittarius Cave (Grand Bahama Island), and Dan's Cave (Abaco Island) in collection of author.

Description.—Body (Fig. 5a) short, less than 10 mm; average length of specimens examined 6.9 mm. Cephalic shield with convex lateral margins anterior to mid-length; posterior margin triangular; folded anteriorly as protective rim (see Fig. 7a). Maximum number of trunk segments in specimens examined = 16; pleura with posterolateral projections. Sternites forming plates with posterolateral projections; sternal bars narrow, undifferentiated.

Frontal filaments (Fig. 5c) long, cylindrical; medial process slender, long. Antenna 1 (Fig. 5b) with 2-segmented peduncle; proximal segment with rows of long esthetascs. Dorsal ramus 11-segmented, long, over ½ to ⅔ length of body; distomedial margins with single esthetasc and several short setae. Ventral ramus very short, 2-segmented, about ⅛ length of dorsal ramus; segment 1 naked, segment 2 with 3 esthetascs along medial margin and 1 at apex. Antenna 2 (Fig. 5d) with 2-segmented protopod having setose medial margin. Endopod 3-segmented; segments 1 and 2 with 4–6 setae on medial margins, segment 3 with setae along all margins. Exopod a single oval scale with about 20 long marginal setae. All setae plumose.

Labrum (Fig. 5e) with setose posterior margin. Paragnath a lobe with densely setose margin. Left mandible (Fig. 5f) with 4-cusped incisor process and 3-cusped lacinia mobilis. Right mandible (Fig. 5g) with 3-cusped incisor process and lacinia mobilis. Molar process with moderately long, dense, multi-tipped setae.

Maxilla 1 (Fig. 6a) small, about ½ length of maxilla 2 and maxilliped; 7-segmented, prehensile. Segment 1 with endite bearing 1 stout anterior spine and 3 pairs of opposing spines (Fig. 6a inset). Segment 2 with spatulate endite bearing short to moderate setae along apical margin. Segment 3 short, with 1–2 small medial setae. Segment 4 long, with 2 medial rows of 6–8 long setae each. Segment 5 shorter than segment 4, with 1–2 setae on distomedial margin. Segment 6 short, with medial and lateral clusters of long setae on anterior and posterior distal corners. Segment 7 with long fang, about 3 times as long as segment 6; 1–2 long setae at medial base of fang.

Maxilla 2 (Fig. 6b) 6-segmented, subchelate, robust. Segment 1 with 3 digitiform endites each with small apical spine and several subterminal setae. Segment 2 short, rounded endite bearing 1–2 broad-based setae. Segment 3 huge, expanded proximally into subtriangular endite bearing several rows of dense, short to moderate grooved plumose setae (Fig. 7b). Setal rows form groove for distal segments when appendage is flexed. Segment 4 elongate, very narrow, bearing medial row of foliaceous setae (Fig. 7c). Division between segment 4 and 5 weakly defined. Segment 5 about ⅓ length of segment 4, with foliaceous setae on proximomedial third, 1–2 distolateral setae, and small rounded distomedial process bearing 3 long esthetasc-like setae (see Fig. 6c-inset). Segment 6 short, with 5-pronged grappling hook claw complex; opposable thumb-like pad with several moderately long setae.

Maxilliped (Fig. 6c) similar in form to maxilla 2, 6-segmented; suture indistinct

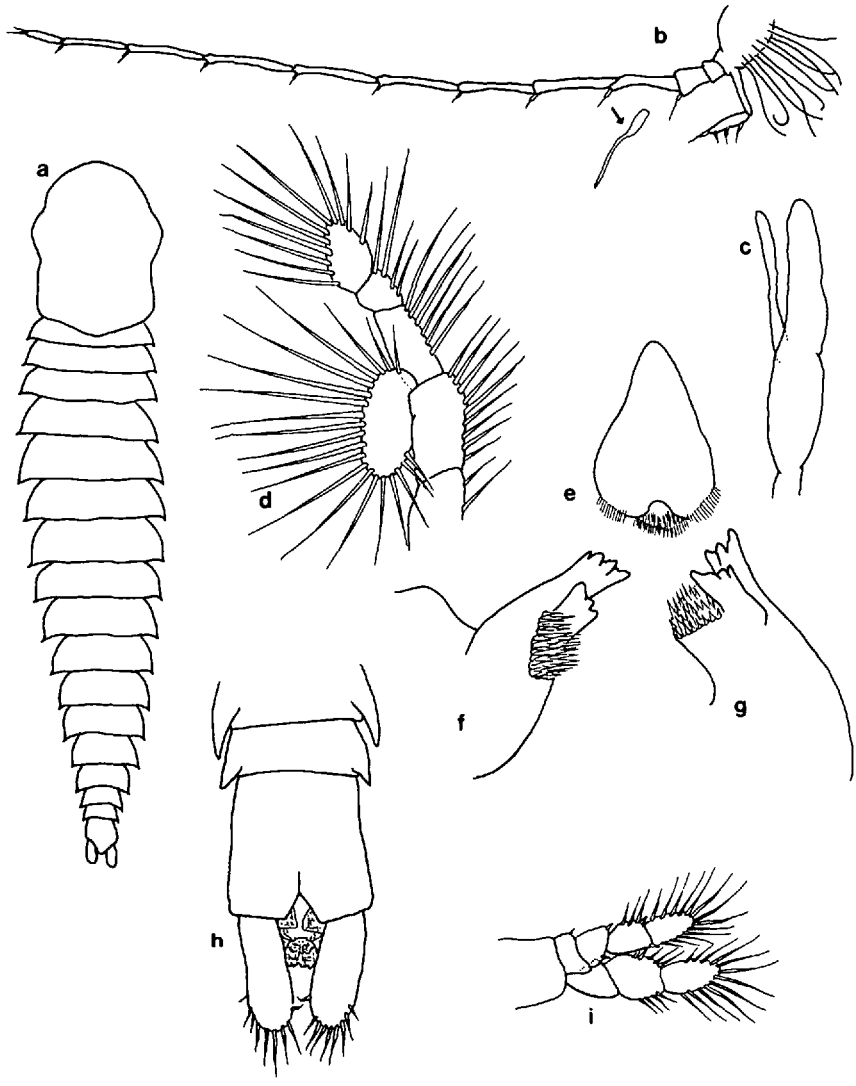

Figure 5. *Godzilliognomus frondosus,* new genus, new species. a. Dorsal view, appendages omitted; b. Antenna 1, with inset of esthetasc; c. Frontal filament; d. Antenna 2; e. Labrum; f. Left mandible; g. Right mandible; h. Anal segment; i. Trunk appendage (16th).

between segments 1 and 2. Segment 1 with 2 low rounded endites bearing several short to moderate length setae. Segment 2 with low rounded endite, bearing at least 2 broad-based setae. Segments 3, 4, 5, and 6 as in maxilla 2.

Trunk appendages (Fig. 5i) becoming smaller and less setose posteriorly. Protopod large; protopod of 14th trunk appendage greatly enlarged into medial triangular flap covering male gonopore and genital plate. Endopod 4-segmented; segment 1 reduced, with single, short, stout, spine-like distomedial seta; segment 2 with single spine-like seta at distomedial and distolateral corners, 0–2 medial plumose setae; segment 3 with single distolateral and distomedial comb seta, several medial plumose setae; segment 4 with long plumose setae along both margins. Exopod 3-segmented; segment 1 naked or with several lateral setae,

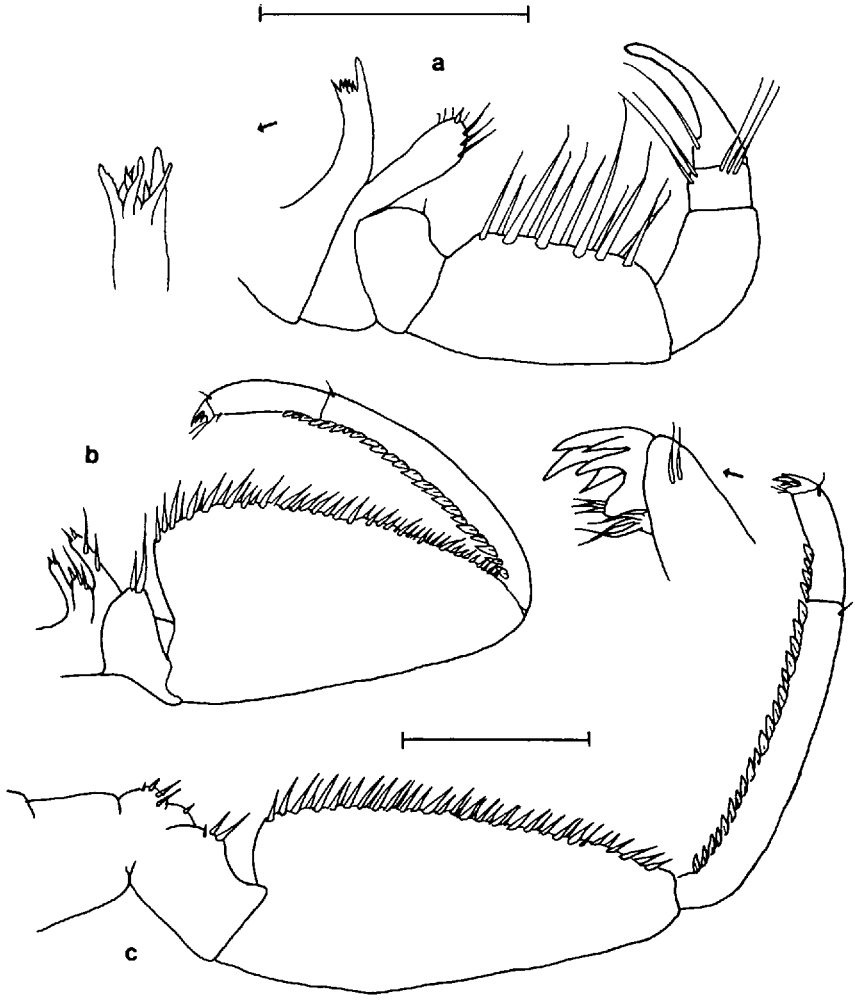

Figure 6. *Godzilliognomus frondosus*, new genus, new species. a. Maxilla 1, with inset of segment 1 endite; b. Maxilla 2; c. Maxilliped, with inset of terminal claw complex. Scale bars = 0.5 mm.

segment 2 with lateral and medial setae, segment 3 with setae along both margins; all setae plumose. Anal segment (Fig. 5h) nearly as long as wide; ventral surface with tiny, short setae. Caudal rami slightly shorter than anal segment, not tapered distally, bearing setose apical and distolateral margins; anus with bulbous, convoluted terminus (see Fig. 5h).

Etymology.—The name is derived form the Latin word "frondosus" meaning leafy, in reference to the foliaceous setae on the second maxilla and maxilliped.

Relationships.—*G. frondosus* shares several characters with *Godzillius robustus*. The ventral ramus of the first antenna of both species is very short and consists of only 2–3 segments. The second maxilla and maxilliped are similar in form with grappling-hook claw arrangements.

Observations.—This species is easily distinguished in situ, as it lacks the sinuous, elongate body plan of its relatives. The animal hangs relatively motionless in the

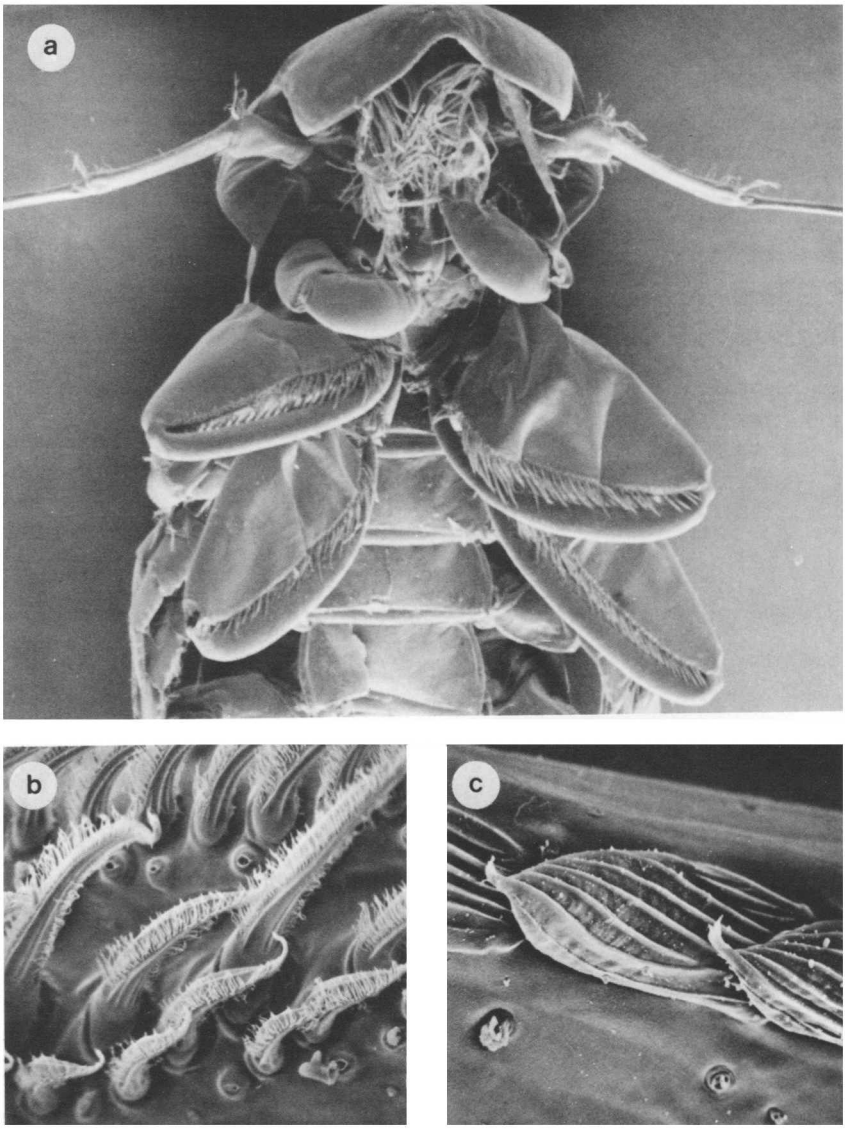

Figure 7. *Godzilliognomus frondosus*, new genus, new species. a. Head, ventral view (22×); b. Maxilla 2 segment 3 setae (682×); c. Maxilla 2 segment 4 foliaceous setae (961×).

water, with the wave-like metachronal swimming pattern barely perceptible. The long first antennae extend out laterally and are very evident. During attempts to capture specimens with a plastic squeeze bottle, the animals were able to detect the approach and "jumped" through the water column for distances of about 8–12 cm. During observations of live specimens with a dissecting microscope, anal pumping was seen on several occasions.

Remarks.—*Godzilliognomus frondosus* is the "juvenile-like" species referred to recently by Yager (1987a). The species is not only the most abundant remipede found in Sagittarius Cave and Dan's Cave, it is also the smallest species of rem-

ipede found to date. Among described remipedes, *G. frondosus* has the most consistent number of trunk segments. Of 88 specimens collected from caves on the Little Bahama Bank, all but six of the smallest individuals have 16 trunk segments, while the small ones have 15. The total body length is between 3.7 mm and 9.3 mm. The protopod of the 14th trunk appendage is greatly expanded medially, and underneath it is the male gonopore. Beneath and slightly posterior to this gonopore is a porous area referred to as the genital plate. This plate was mistakenly said to overhang the gonopore by Yager (1987a: 317). With the aid of a scanning electron microscope, secretions have been observed coming out of many of the pores. The function of the genital plate has not yet been determined. The protopod of the 7th trunk appendage bears the female gonopore which appears as a semicircular groove over a small papilla (Ito and Schram 1988). Despite the small size of this species, sexually mature individuals have been confirmed using histological techniques. Sections through the testicular region have revealed sperm in various stages of development as well as mature sperm in the male gonopore region. Also, the same individuals contained mature oocytes in the oviducts, making this species a simultaneous hermaphrodite. Fertilized eggs have not yet been found.

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