

CALONASTES IMPARIPES, NEW GENUS, NEW SPECIES
(COPEPODA, CYCLOPOIDA), ASSOCIATED WITH THE
ANTIPATHARIAN CORAL GENUS *STICHOPATHES* IN
PUERTO RICO

Arthur G. Humes and Carlos Goenaga

A B S T R A C T

The lichomolgid copepod *Calonastes imparipes* new genus, new species, characterized by the absence of an inner seta on the first endopod segment in legs 1 to 4 and by very strong sexual dimorphism in leg 5, is associated with two species of antipatharian corals in Puerto Rico, *Stichopathes luetkeni* Brook and an undescribed species of the same genus. This is the first record of copepods from Antipatharia in the Atlantic Ocean.

Although copepods probably occur on Antipatharia throughout the world, these associates have until now been known only from Madagascar, where four species have been found. The lichomolgs *Paramoligus insectus* (Humes, 1969) and *Paramoligus constrictus* (Humes, 1969) and the sabeliphilid *Thamnomoligus robustus* Humes, 1969, live with various species of *Antipathes* (Humes, 1969). The vahiniid *Vahinius petax* Humes, 1967, is found on both *Stichopathes* (Humes, 1967) and *Antipathes* (Humes, 1969).

This paper contains the first record of copepods from Antipatharia in the Atlantic Ocean (Puerto Rico). The scarcity of records seems to be based not only on the small number of interested investigators but also on the fact that antipatharians live in depths of 30 m or more and are thus not readily obtainable except by special methods such as SCUBA diving or dredging. The copepods studied in connection with this report were collected by C. Goenaga from antipatharians obtained during SCUBA dives.

Measurements have been made on paratypes. All figures have been drawn from paratypes with the aid of a camera lucida. The letter after the explanation of each figure refers to the scale at which it was drawn. The abbreviations used are: A_1 = first antenna, A_2 = second antenna, MD = mandible, MX_1 = first maxilla, MX_2 = sec-

ond maxilla, MXP = maxilliped, P_1 = leg 1, and P_2 = leg 2.

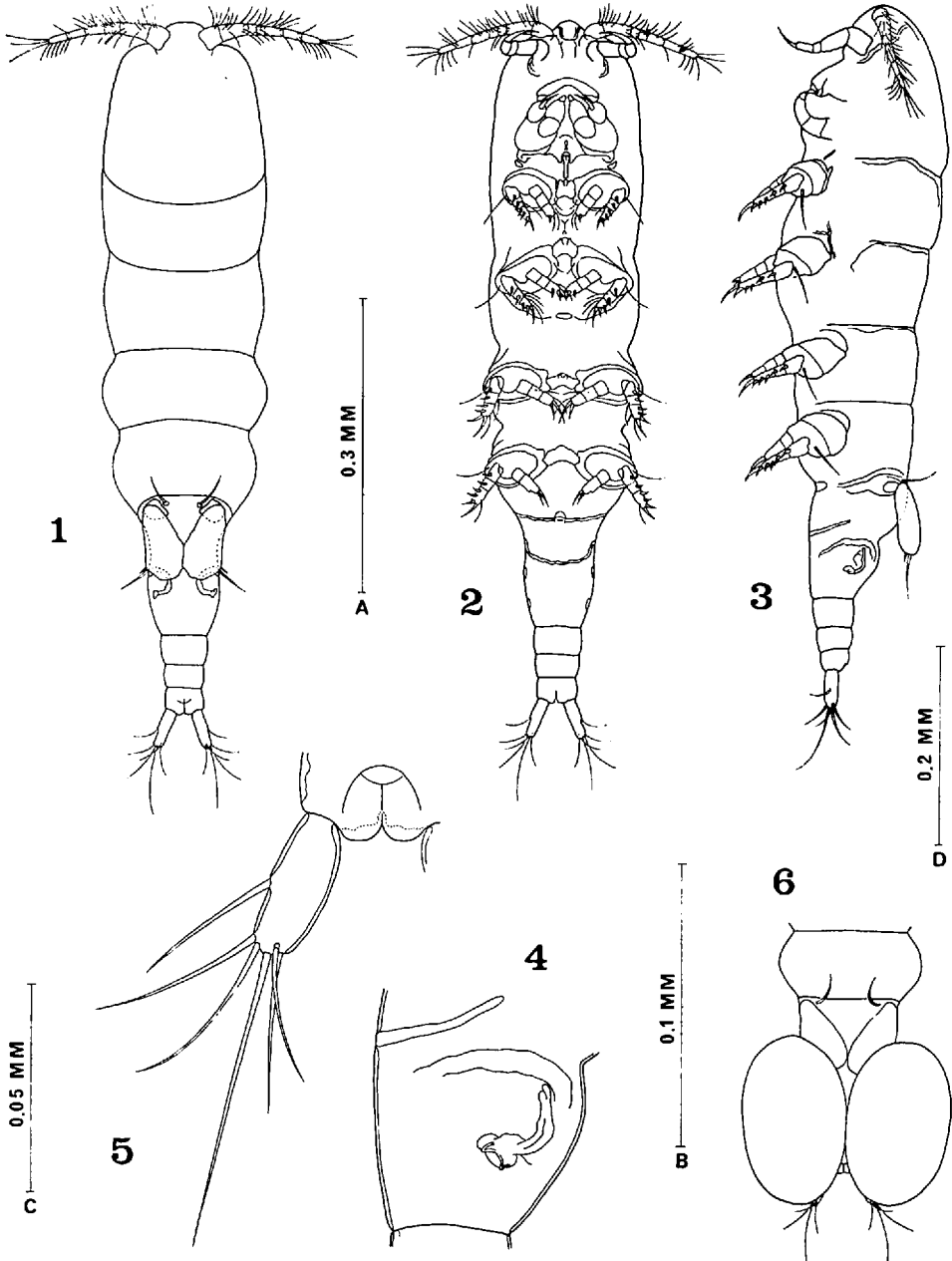
Calonastes new genus

Diagnosis.—Lichomolgidae. Body elongate. Urosome in female probably to be considered as 5-segmented, though segment of leg 5 and genital segment fused. In male urosome 6-segmented. Caudal ramus with 6 setae. Rostrum rounded posteroventrally. First antenna 7-segmented. Second antenna 4-segmented, with formula 1, 1, 3, and single terminal claw.

Labrum with 2 widely separated lobes. Mandible with simple base extended to form moderately long lash. First maxilla with 2 setae. Second maxilla 2-segmented, second segment with long lash. Maxilliped in female 3-segmented and without armature; in male 4-segmented (assuming that proximal part of claw represents fourth segment).

Legs 1-4 with 3-segmented rami except for 2-segmented endopod of leg 4. Armature of endopods of legs 1-4: 0-0; 0-0; I,2/0-0; 0-0; I,II,2/0-0; 0-1; II/and 0-0; II. Sexual dimorphism in spines on third segment of endopod of leg 2 in male.

Leg 5 in female with large free segment with 2 setae; in male leg lacking free segment and 2 setae arising instead from small prominence.



Figures 1-6. *Calonastes imparipes*, n. gen., n. sp., female: 1, dorsal (scale A); 2, ventral (A); 3, lateral (A); 4, genital area, lateral (B); 5, caudal ramus, dorsal (C); 6, last metasomal segment and urosome with egg sacs, dorsal (D).

Each egg sac containing one large egg.
Other features as in species described below.

Associated with antipatharian corals.

Type-species.—*Calonastes imparipes*, n. sp.

Etymology.—The generic name is a combination of *καλως*, a rope, and *ναστης*, a companion, alluding to the association of the copepod with ropelike antipatharians. The gender is masculine.

Comparison with other lichomolgid genera.

—The family Lichomolgidae comprises 57 genera. Fifty-one of these were listed in the revision of the family by Humes and Stock (1973). Six genera have been described since that publication: *Amaridopsis* Humes, 1974, *Botulosoma* Carton, 1974, *Cerioxynus* Humes, 1974, *Humesiella* Sebastian and Pillai, 1973, *Mycoxynus* Humes, 1973, and *Notoxynus* Humes, 1975. *Calonastes* may be distinguished from all these genera by the extreme sexual dimorphism in leg 5.

The absence of an inner seta on the first endopod segment of legs 1–4 is also distinctive of the genus in most cases. In *Amaridopsis*, *Cerioxynus*, *Mycoxynus*, *Ravahina* Humes and Ho, 1968, and *Amarda* Humes and Stock, 1972, however, where such a seta is absent, differentiation must be made on other grounds. The reduction in the number of segments in the endopods of one or more legs in these five genera separates them from *Calonastes*.

Calonastes imparipes new species

Type material.—32 ♀, 30 ♂ from the antipatharian *Stichopathes luetkeni* Brook, in 30 m, 8 km south of La Parguera, Puerto Rico, 12 March 1976. Collected by C. Goenaga. Holotype ♀, allotype, and 52 paratypes (26 ♀, 26 ♂) deposited in the National Museum of Natural History (NMNH), Smithsonian Institution, Washington, D.C. (listed under catalog numbers of former United States National Museum (USNM): holotype 168322, allotype 168323, paratypes 168324).

Other specimen.—1 ♂ from *Stichopathes* (undescribed species), same collection data as above.

Female.—Body (Figs. 1–3) slender and elongate, with prosome at level of leg 2 nearly as thick dorsoventrally as wide. Length (not including setae on caudal rami) 0.68 mm (0.65–0.70 mm) and greatest width 0.16 mm (0.15–0.17 mm), based on 10 specimens in lactic acid. Separations between segments of legs 1–5 distinct dorsally and laterally but not evident ventrally. Ratio of length to width of prosome approximately 2.46:1. Ratio of length of prosome to that of urosome 1.95:1.

Segment of leg 5 and genital segment fused (Fig. 3), their junction probably represented by transverse dorsal indentation of body wall. Genital areas located dorsolaterally. Each genital area (Fig. 4) bearing 2 small spiniform processes but no setae. Three small postgenital segments together making up only about 10% of body length.

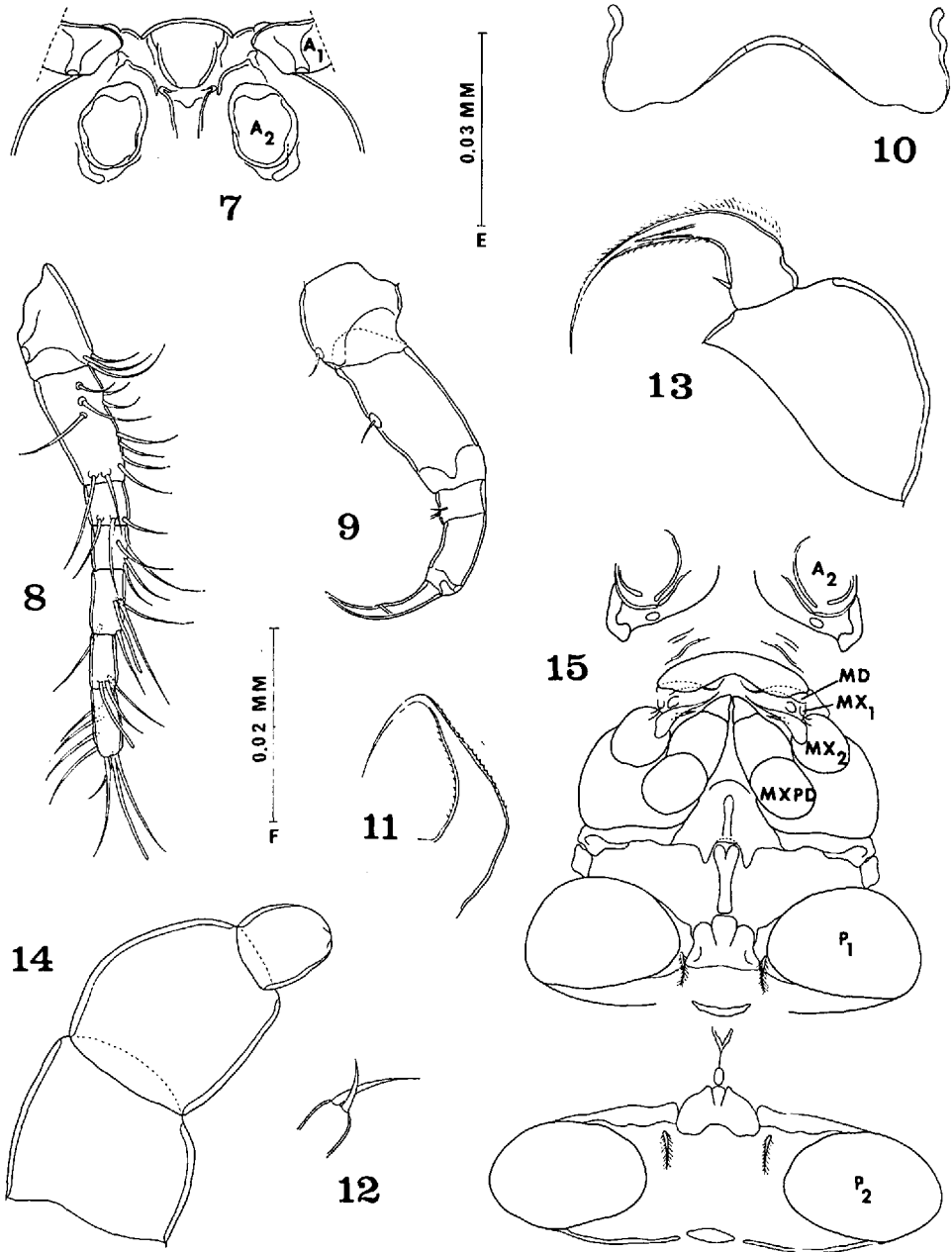
Caudal ramus (Fig. 5) $34 \times 14 \mu\text{m}$, ratio of length to width 2.43:1. Outer lateral seta $39 \mu\text{m}$ long, dorsal seta $32 \mu\text{m}$, outermost terminal seta $42 \mu\text{m}$, innermost terminal seta $36 \mu\text{m}$, and 2 median terminal setae $40 \mu\text{m}$ (outer) and $68 \mu\text{m}$ (inner). All setae naked.

Body surface smooth, without sensilla.

Each egg sac (Fig. 6) containing one large egg approximately $165 \times 100 \mu\text{m}$.

Rostrum (Fig. 7) small with rounded posteroventral margin. First antenna (Fig. 8) $115 \mu\text{m}$ long. Lengths of seven segments (measured along their posterior non-setiferous margins): 12 ($25 \mu\text{m}$ along anterior margin), 27.5, 10, 10, 14, 12, and $16.5 \mu\text{m}$ respectively. Formula for armature: 3, 11, 3, 4, 4 + 1 aesthete, 2 + 1 aesthete, and 7 + 1 aesthete. All setae naked.

Second antenna (Fig. 9) $85 \mu\text{m}$ long without claw and 4-segmented. Both first and second segments having small naked inner seta. Small third segment bearing 3 very small naked setae. Fourth segment $21 \mu\text{m}$



Figures 7–15. *Calonastes imparipes*, n. gen., n. sp., female: 7, rostrum, ventral (scale B); 8, first antenna, anterodorsal (C); 9, second antenna, anterior (C); 10, labrum, ventral (E); 11, mandible, posterior (F); 12, first maxilla, anterior (F); 13, second maxilla, posterior (F); 14, maxilliped, anterior (F); 15, mouthparts and first two pairs of legs *in situ*, ventral (B).

along outer side, 13 μm along inner side, and 10 μm wide. Terminal claw 28 μm along its axis.

Labrum (Fig. 10) with 2 widely separated posteroventral lobes. Mandible (Fig. 11) having simple base with minute spinules along both edges and attenuated to form moderately long lash. Paragnath not clearly identified, though perhaps represented by small lobe medial to first maxilla. First maxilla (Fig. 12) a small lobe with 2 setae. Second maxilla (Fig. 13) 2-segmented, with large first segment unarmed and smaller second segment bearing small inner seta and posterior surficial spine and terminating in long lash with bilateral spinules. Maxilliped (Fig. 14) 45 μm long and 3-segmented, lacking armature as far as determined.

Ventral area between maxillipeds and first pair of legs as in Fig. 15.

Legs 1-4 (Figs. 16-19) with 3-segmented rami except for 2-segmented endopod of leg 4. Spine and setal formula as follows (Roman numerals representing spines, Arabic numerals setae):

P_1	coxa 0-1	basis 1-0	exp I-0; I-1; III,I,3
		enp 0-0; 0-0; I,2	
P_2	coxa 0-1	basis 1-0	exp I-0; I-1; III,I,3
		enp 0-0; 0-0; I,II,2	
P_3	coxa 0-0	basis 1-0	exp I-0; I-1; III,I,1
		enp 0-0; 0-1; II	
P_4	coxa 0-0	basis 1-0	exp I-0; I-0; III,I,1
		enp 0-0; II	

Coxa in legs 1 and 2 with inner feathered seta but in legs 3 and 4 such a seta absent. Inner margin of basis smooth in leg 1 but with row of delicate hairs in legs 2-4. Spines and setae in all 4 legs smooth. First 2 segments of endopod of legs 1 and 2 unarmed.

In endopod of leg 3 first segment unarmed but second segment bearing inner seta. In leg 4 exopod 54 μm long. First segment of endopod 13 \times 13 μm , with outer side of segment haired; second segment 23 \times 14 μm , with 2 terminal setae 11.5 μm (outer) and 24 μm (inner), inner margin of segment haired and outer margin haired at either side of small thornlike process.

Leg 5 (Fig. 20) held dorsally over segment from which it arises and anterior part of genital segment (Figs. 1,3). Large free segment 75 \times 41 μm in greatest dimensions, broadened distally with slightly irregular margins. Two very unequal smooth terminal setae 8 μm and 24 μm . Adjacent dorsal seta 42 μm and smooth.

Leg 6 probably represented by 2 small spiniform processes on genital area (Fig. 4).

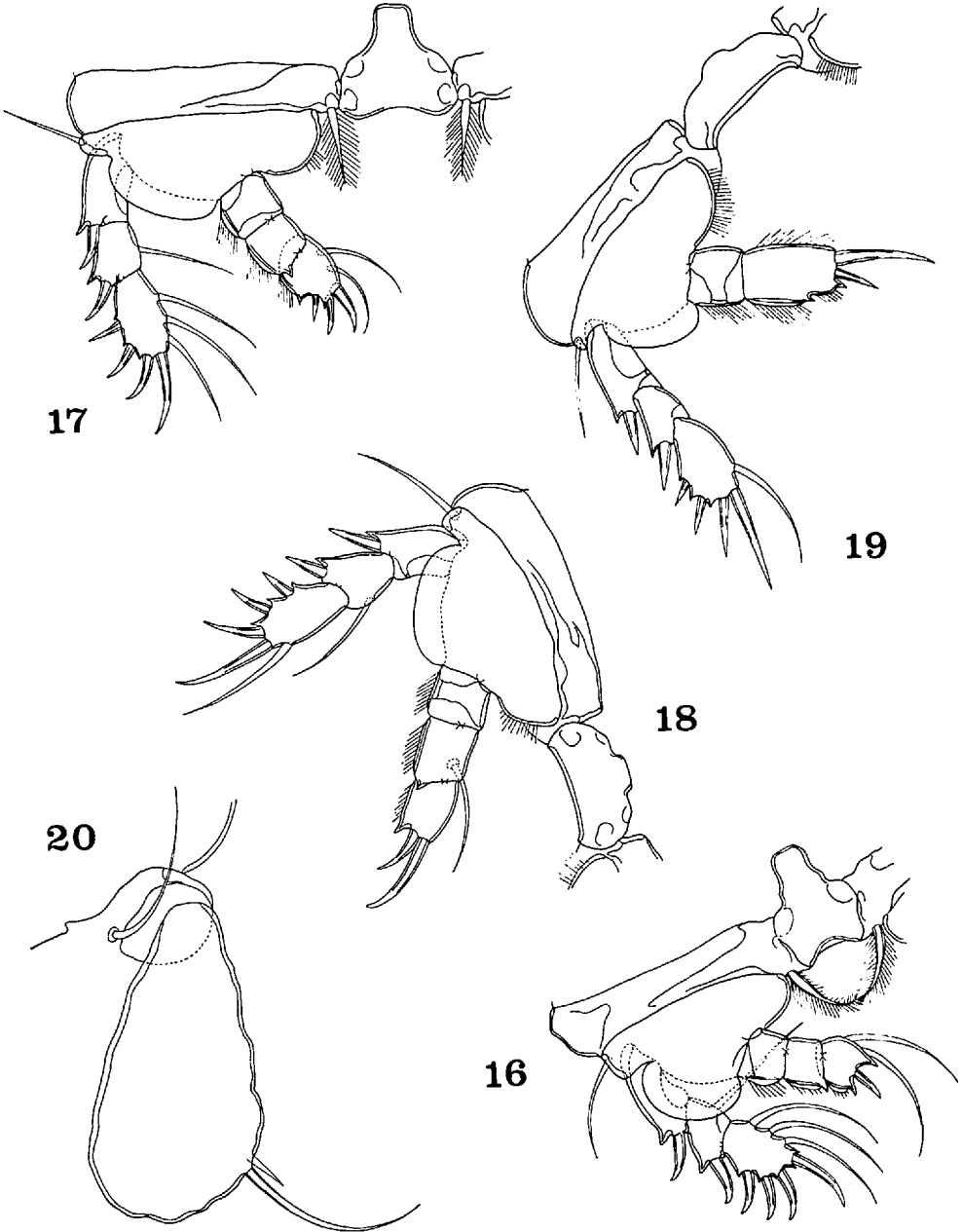
Living specimens in transmitted light pale salmon in color.

Male.—Body (Figs. 21, 22) elongate as in female. Length (excluding setae on caudal rami) 0.67 mm (0.64-0.69 mm) and greatest width 0.15 mm (0.14-0.16 mm), based on 10 specimens in lactic acid. Ratio of length to width of prosome 2.73:1. Ratio of length of prosome to that of urosome 1.67:1.

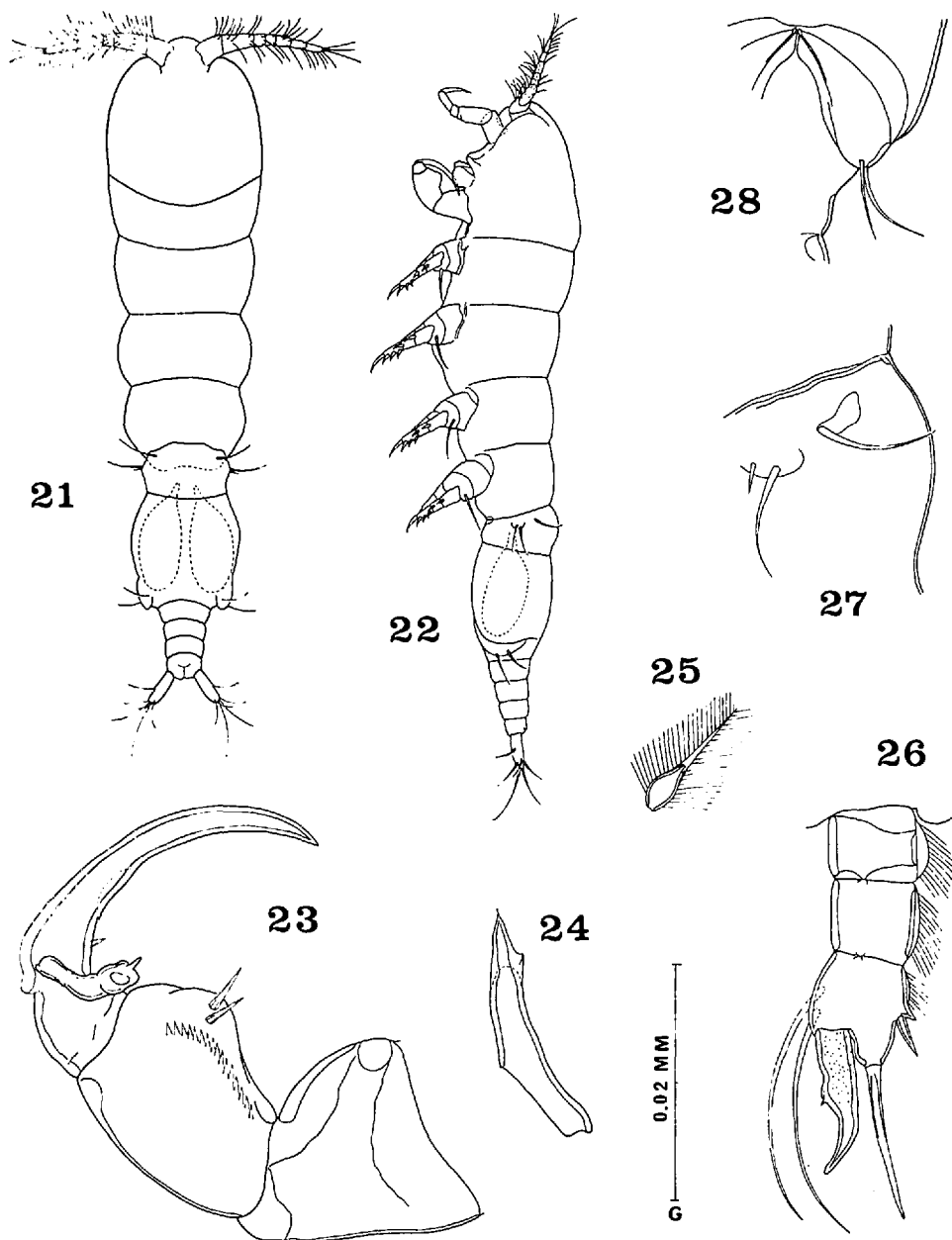
Segment of leg 5 and genital segment separated by fine suture (Fig. 22). Four postgenital segments occupying about 12% of body length.

Caudal ramus like that of female both in size and form.

Rostrum, first antenna, second antenna, labrum, mandible, first maxilla, and second maxilla resembling those of female. As in female paragnath not identified with certainty. Maxilliped (Fig. 23) 4-segmented, assuming that proximal part of claw represents fourth segment. First segment unarmed. Second segment expanded inwardly and bearing 2 setae and row of spines. Small third segment unarmed. Claw 55 μm along its axis, with proximally 2 very unequal setae, larger seta highly modified (Fig. 24).



Figures 16–20. *Calonastes imparipes*, n. gen., n. sp., female: 16, leg 1 and intercoxal plate, anterior (scale C); 17, leg 2 and intercoxal plate, anterior (C); 18, leg 3 and intercoxal plate, anterior (C); 19, leg 4 and intercoxal plate, anterior (C); 20, leg 5, dorsal (B).



Figures 21–28. *Calonastes imparipes*, n. gen., n. sp., male: 21, dorsal (scale A); 22, lateral (A); 23, maxilliped, inner (E); 24, modified seta on proximal part of maxilliped claw, inner flat view (G); 25, inner coxal seta of leg 1, anterior (E); 26, endopod of leg 2, anterior (E); 27, leg 5, lateral (C); 28, leg 6, ventral (B).

Ventral area between maxillipeds and first pair of legs similar to that in female.

Legs 1-4 segmented as in female, with same armature. Inner coxal setae on legs 1 and 2 slightly more swollen proximally (Fig. 25) than in female. Third segment of endopod of leg 2 showing strong sexual dimorphism (Fig. 26). Except for these two points of dimorphism legs resembling closely those of female.

Leg 5 (Fig. 27) lacking free segment. Two setae corresponding to those on free segment of female, 10 μm and 39 μm , arising from slight prominence. Adjacent seta 36 μm . All three setae naked.

Leg 6 (Fig. 28) consisting of posteroventral flap on genital segment, bearing 2 naked setae 33 μm and 42 μm .

Spermatophore, seen only inside body of male (Fig. 21), approximately $100 \times 39 \mu\text{m}$.

Living specimens with color similar to that of female.

Etymology.—The specific name *imparipes*, from Latin *impar* = unlike and *pes* = a foot, draws attention to the very dissimilar leg 5 in the two sexes.

Natural History

In the course of an investigation by C. Goenaga of the biology of antipatharians belonging to the genus *Stichopathes*, it became evident that two sibling species are present at depths of 25-70 m about Puerto Rico, especially on highly sloped surfaces. These are *Stichopathes luetkeni* Brook and an undescribed species. *S. luetkeni* is brown in life and bears spines averaging 0.29 mm in length. The undescribed species is yellowish green in life and bears spines averaging 0.21 mm. Both species occur in the same area in approximately equal proportion and at densities of 0.5 and 0.2 per m^2 respectively. The colonies, up to 2 m in length, are unbranched and firmly attached to the undersurface of corals.

Portions of 42 colonies of *S. luetkeni*

and 45 of the undescribed species were examined for copepods. Approximately 73% of the first species and 6% of the second species were infested with *Calonastes imparipes*. The copepods live between the coenenchyme and the sclerenchyme of the antipatharian. They were removed by peeling off the coenenchyme with forceps and aspirating with a pipette. Copepod densities were as high as 1.2 per cm of colony. The copepods were never seen on the surface of the antipatharians, and even in the most heavily infested colonies no damage was apparent. The copepods, pale salmon in life, can readily be seen scurrying beneath the coenenchyme of the living *Stichopathes*.

Two external symbionts occur with the two species of *Stichopathes*, a palaemonid shrimp and a polychaete, possibly of the family Pilargidae.

ACKNOWLEDGMENTS

The study of the copepods was supported by a grant to AGH from the National Science Foundation (BMS 74 17652).

LITERATURE CITED

- Carton, Y. 1974. Copépodes parasites de Madagascar II.—Description de *Boiulosoma endoarrhenum* n. gen., n. sp. (Lichomolgidae) parasite d'*Othilia purpurea* (Echinodermata, Asteridae); étude de ses relations anatomiques avec l'hôte. *Crustaceana* 26: 65-79.
- Humes, A. G. 1967. *Vahinius petax* n. gen., n. sp., a cyclopid copepod parasitic in an antipatharian coelenterate in Madagascar. *Crustaceana* 12: 233-242.
- . 1969. Cyclopid copepods associated with antipatharian coelenterates in Madagascar. *Zool. Med.* 44: 1-30.
- . 1973. Cyclopid copepods (Lichomolgidae) from fungiid corals in New Caledonia. *Zool. Anz.* 190: 312-333.
- . 1974. Cyclopid copepods associated with the coral genera *Favia*, *Favites*, *Platygyra*, and *Merulina* in New Caledonia. *Pacific Sci.* 28: 383-399.
- . 1975. Cyclopid copepods (Lichomolgidae) associated with alcyonaceans in New Caledonia. *Smithsonian Contrib. Zool.* No. 191: 1-27.
- , and J.-S. Ho. 1968. Lichomolgid copepods (Cyclopoida) associated with corals in

Madagascar. Bull. Mus. Comp. Zool. 136: 353-413.

———, and J. H. Stock. 1972. Preliminary notes on a revision of the Lichomolgidae, cyclopoid copepods mainly associated with marine invertebrates. Bull. Zool. Mus., Univ. Amsterdam 2: 121-133.

———. 1973. A revision of the family Lichomolgidae Kossmann, 1877, cyclopoid copepods mainly associated with marine invertebrates. Smithsonian Contrib. Zool. No. 127, pp. i-v, 1-368.

Sebastian, M. J., and N. K. Pillai. 1973. *Humesiella corallicola* n. g., n. sp., a cyclopoid copepod associated with coral on the south east coast of India. Hydrobiol. 42: 143-152.

DATE ACCEPTED: February 1, 1977.

ADDRESSES: (A.G.H.) Boston University Marine Program, Marine Biological Laboratory, Woods Hole, Massachusetts 02543. (C. G.) Department of Marine Sciences, University of Puerto Rico, Mayaguez, Puerto Rico 00708.