

# CYCLOPOID COPEPODS ASSOCIATED WITH MARINE BIVALVE MOLLUSKS IN NEW CALEDONIA

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## RÉSUMÉ

*Plusieurs copépodes, associés aux bivalves marines en Nouvelle Calédonie, sont notés : Anthessius brevicauda (Leigh-Sharpe, 1934) à Atrina vexillum Born, la femelle redécrite et le mâle décrit pour la première fois ; Anthessius pinctadae n. sp. à Pinctada margaritifera (Linnaeus) ; Anthessius alatus Humes et Stock, 1965 et Anthessius amicalis Humes et Stock, 1965 à Tridacna squamosa Lamarck et Tridacna maxima (Röding), le dernier un hôte nouveau d'A. amicalis ; Lichomolgus chamarum Humes, 1968 à Chama iostoma Conrad ; Lichomolgus ieveri Thompson et A. Scott, 1903 à Pecten distans Lamarck, la femelle redécrite ; et Paclabius tumidus Kossmann, 1877 à Tridacna squamosa Lamarck, le mâle décrit pour la première fois.*

Only a few cyclopoid copepods living in association with Bivalvia are known from the tropical western Pacific Ocean. Such copepods are : *Paclabius tumidus* Kossmann, 1877, from *Tridacna* at Bohol, Philippine Islands; *Anthessius brevicauda* (Leigh-Sharpe, 1934) from *Pinna* sp., southeast of Celebes; *Anthessius saecularis* Stock, 1964, from *Tapes literatus* (Linnaeus) at Japen Island, New Guinea; *Anthessius solidus* Humes and Stock, 1965 (reported by HUMES, 1972) from *Tridacna squamosa* Lamarck at Eniwetok Atoll; *Anthessius amicalis* Humes and Stock, 1965 (reported by HUMES, 1972) from *T. squamosa* and *Hippopus hippopus* (Linnaeus) at Eniwetok Atoll; *Anthessius alatus* Humes and Stock, 1965 from *T. squamosa*, *Tridacna maxima* (Röding), and *Tridacna gigas* (Linnaeus) at Eniwetok Atoll; *Lichomolgus tridacnae* Humes, 1972 from *Tridacna gigas* at Eniwetok Atoll; and unidentified copepods (probably cyclopoids) from *Analina subrostrata* Lamarck, *Pandora elongata* Carpenter, and *Pinna* sp. in the Netherlands Indies (reported by PELSENEER, 1911, 1928). Associations of bivalves and cyclopoid copepods have not been reported from New Caledonia.

This paper contains :

- (1) a redescription of the female of *Anthessius brevicauda* and a description of the male for the first time,
- (2) a description of both sexes of *Anthessius pinctadae* n. sp.,
- (3) records of *Anthessius alatus*, *A. amicalis* (including *Tridacna maxima* as a new host), and *Lichomolgus chamarum*,
- (4) a redescription of the female of *Lichomolgus ieveri*, and
- (5) a description of the male of *Paclabius tumidus*.

The field work in New Caledonia during June-August, 1971, and the subsequent study of the copepods were supported by a grant (GB-8381X) from the National Science Foundation of the United States. Mr. Roger C. HALVERSON from the University of California at Santa Barbara assisted in making the collections. I wish to acknowledge with thanks the generous aid given by the staff of the Centre O.R.S.T.O.M. de Noumea.

I am much indebted to Dr. KENNETH J. BOSS and Mr. George BUCKLEY, Museum of Comparative Zoology, Harvard University, for the identifications of the bivalve hosts.

All figures have been drawn 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, L = labrum, MD = mandible, P = paragnath,  $MX_1$  = first maxilla, MXP = maxilliped, and  $P_1$  = leg 1.

### Family Myicolidae Yamaguti, 1936

*Anthessius brevicauda* (Leigh-Sharpe, 1934)

Figs. 1-31

This species, originally described as *Lichomolgus brevicaudis* by LEIGH-SHARPE (1934), was transferred to *Anthessius* by STOCK, HUMES, and GOODING (1963). These authors corrected the original spelling to *brevicauda*. STOCK (1964), after a study of the type specimens (from *Pinna* sp. at 6°4.7' S, 120°23.5' E, southeast of Celebes, and at an unknown locality in the East Indies), redescribed the female. *Anthessius brevicauda* was mentioned briefly by HUMES and HO (1965) in connection with their descriptions of new species.

The New Caledonian material of *A. brevicauda* has made possible a thorough redescription of the female and for the first time a description of the male.

**SPECIMENS COLLECTED.** — From the bivalve *Atrina vexillum* Born (Pinnidae) : 12 ♀♀, 13 ♂♂, and 12 copepodids from one host, in 2 m, Isles aux Serpents, west of Pte. Denouel, near Noumea, New Caledonia, 22°16'52" S, 166°25'12" E, 19 July; 4 ♀♀, 3 ♂♂ from one host, in 2.5 m, western edge of Isle Maitre, near Noumea, 22°20'05" S, 166°24'05" E, 11 June.

**FEMALE.** — Body (fig. 1) with length (not including setae on caudal rami) 1.99 mm (1.92-2.05 mm) and greatest width 0.97 mm (0.95-1.02 mm), based on 5 specimens in lactic acid. Prosome not unusually thickened dorsoventrally. Segment of leg 1 clearly separated dorsally from head. Epimera of segment of leg 2 expanded. Ratio of length to width of prosome 1.48:1. Ratio of length of prosome to that of urosome 2:1.

Segment of leg 5 (fig. 2)  $117 \times 335 \mu$ . Between this segment and genital segment no ventral inter-segmental sclerite. Genital segment in dorsal view  $265 \mu$  in length and  $290 \mu$  in greatest width (in its anterior half). Genital areas situated laterally on expanded anterior half. Each area (fig. 3) with 2 naked setae  $29 \mu$  and  $10 \mu$ . Three postgenital

segments  $125 \times 192 \mu$ ,  $83 \times 180 \mu$ , and  $81 \times 188 \mu$  from anterior to posterior. Anal segment with posteroventral row of small spinules on each side.

Caudal ramus (fig. 4) very short,  $42 \times 78 \mu$ , much wider than long. Outer lateral seta  $250 \mu$  and dorsal seta  $105 \mu$ , both naked. Outermost terminal seta  $308 \mu$  with inner spinules, innermost terminal seta  $425 \mu$  with bilateral spinules, and 2 long median terminal setae  $540 \mu$  (outer) and  $660 \mu$  (inner), both somewhat swollen proximally (especially inner) and with bilateral spinules. A naked setule  $27 \mu$  on proximal outer area of ramus. Posteroventral border of ramus near insertions of median terminal setae with minute spinules.

Dorsal surface of prosome and both surfaces of urosome with few hairs (sensilla) and refractile points.

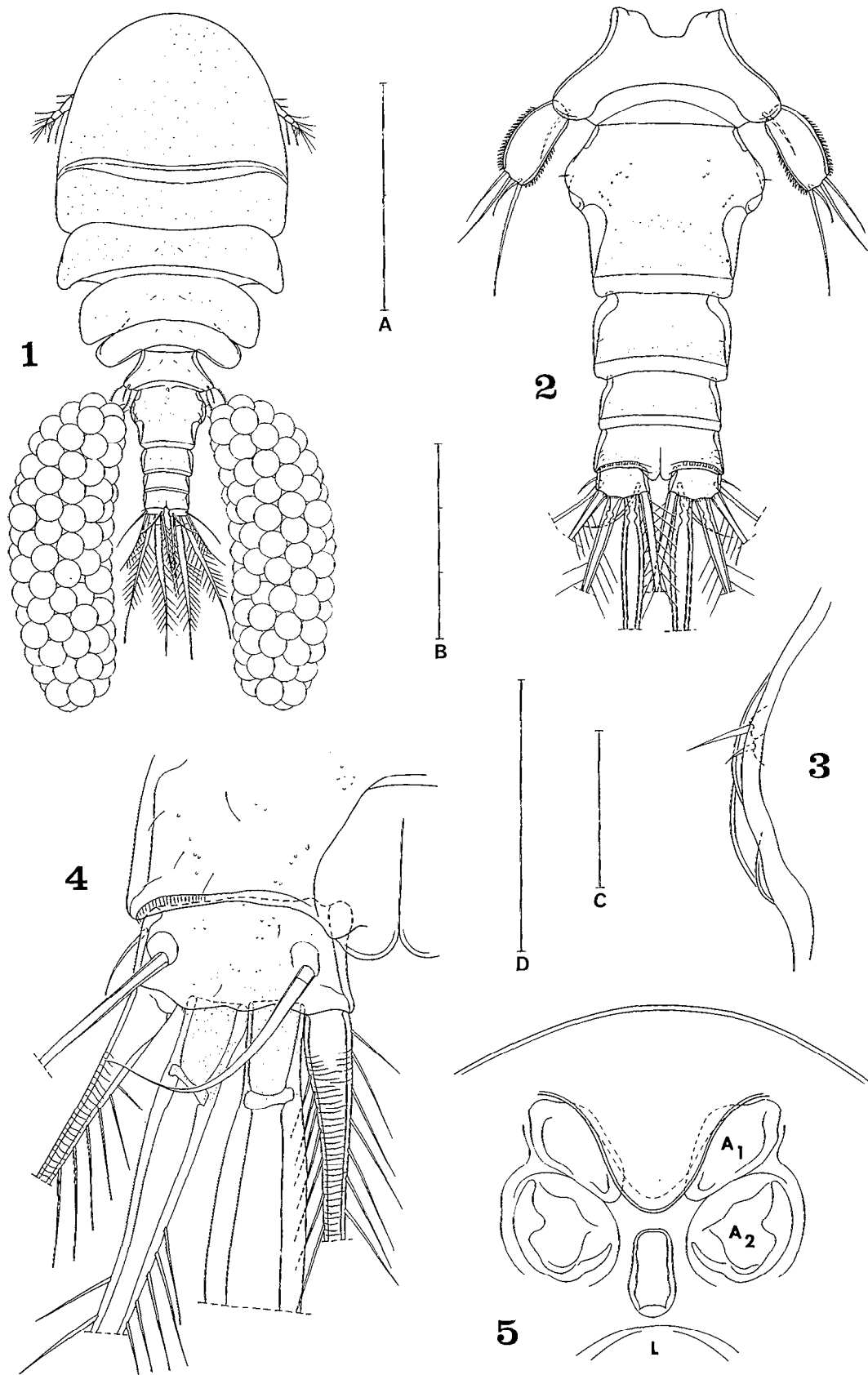
Egg sac (fig. 1) elongated,  $1300 \times 480 \mu$ , reaching beyond tips of ramal setae and containing numerous eggs about  $110 \mu$  in diameter.

Rostrum (fig. 5) linguiform. First antenna (fig. 6)  $650 \mu$  long. Lengths of 7 segments (measured along their posterior nonsetiferous margins) : 26 ( $94 \mu$  along anterior margin), 200, 44, 156, 106, 39, and  $29 \mu$  respectively. Formula for armature : 4, 13 (5+8), 6, 3, 4+1 aesthete, 2+1 aesthete, and 7+1 aesthete. Several setae feathered as indicated.

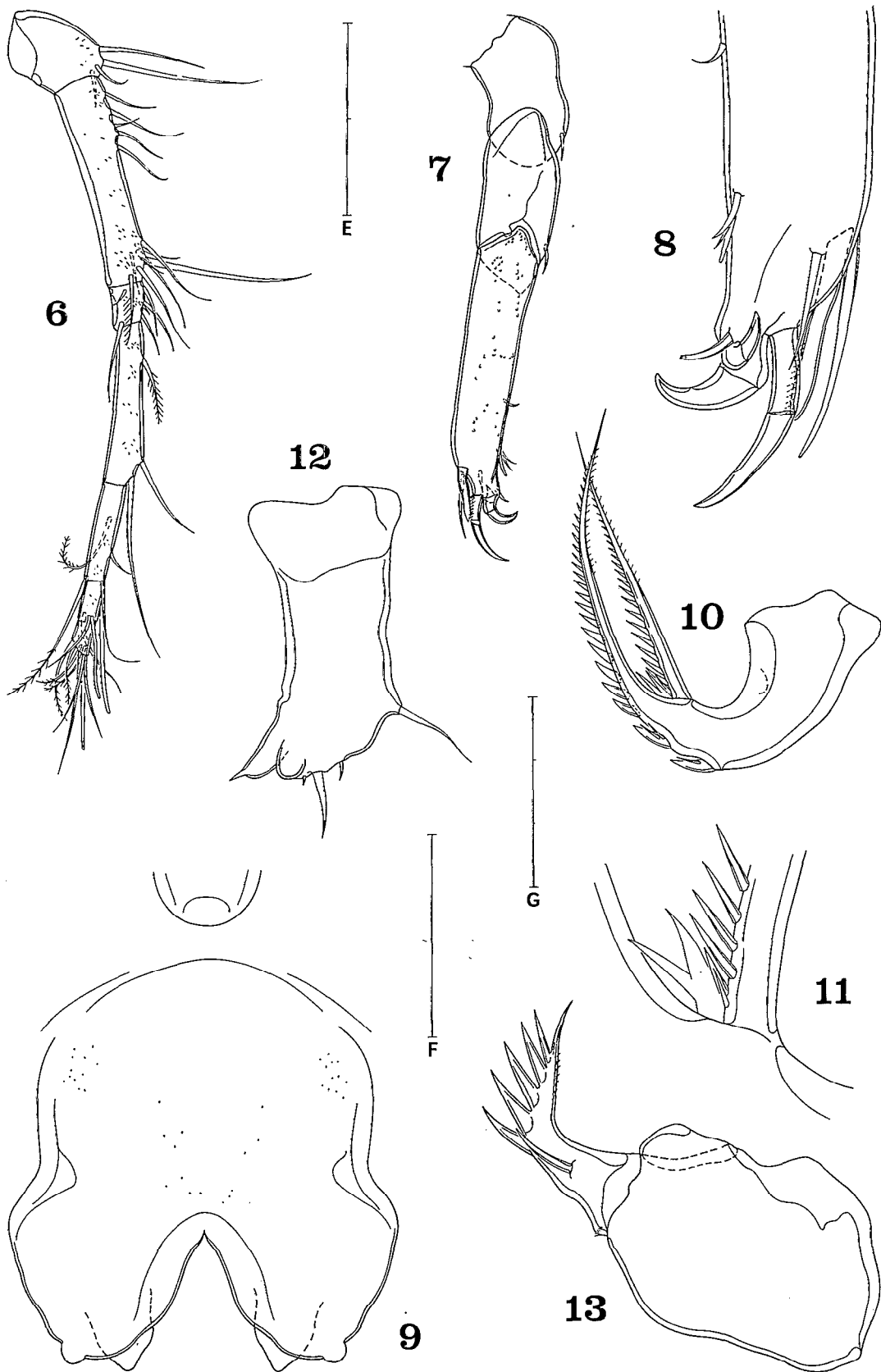
Second antenna (fig. 7) 3-segmented,  $500 \mu$  long, with third segment elongated and slender ( $268 \times 57 \mu$  without claws), its armature indicating fusion of 2 original segments. First 2 segments each with one seta. Third segment with numerous small bosses on anterodorsal surface and bearing 11 elements (fig. 8), prominent among these 4 terminal claws (one long and slender, one strong and recurved, one reflexed proximally on posteroventral surface of segment, and one small and slender, less unguiform and with a finely lobulate blunt tip) and 3 subterminal elements (2 naked setae and one broad lamellate seta with small spinules along one edge).

Labrum (fig. 9) with 2 broad posteroventral lobes, each with a small marginal hyaline excrescence. Mandible (fig. 10) resembling other *Anthessius* species; 2 hyaline lamellate lobes near insertion of long setiform element pointed (fig. 11). Paragnath (fig. 9) a small lobe. First maxilla (fig. 12) with several small terminal elements. Second maxilla (fig. 13) with large unornamented first segment; second segment with anterior surficial naked seta, distally 5 spiniform teeth plus terminal spine, and several minute spinules on proximal median surface. Maxilliped (fig. 14) indistinctly 3-segmented, with 2 small terminal elements.

Ventral area between maxillipeds and first pair



Figs. 1-5. — *Anthessius brevicauda* (Leigh-Sharpe, 1934), female. 1, dorsal (A) ; 2, urosome, ventral (B) ; 3, genital area, dorsal (C) ; 4, caudal ramus, dorsal (D) ; 5, rostrum, ventral (B). Scale A = 1.0 mm, B = 0.3 mm, C = 0.1 mm, D = 0.1 mm.



Figs. 6-13. — *Anthesius brevicauda* (Leigh-Sharp, 1934), female. 6, first antenna, dorsal (E); 7, second antenna, anterodorsal (E); 8, tip of second antenna, posteroventral (D); 9, labrum and paragnaths, ventral (F); 10, mandible, anterior (F); 11, hyaline lamella on mandible, posterior (G); 12, first maxilla, posterior (D); 13, second maxilla, anterior (F). Scale E = 0.2 mm, F = 0.1 mm, G = 0.03 mm.

of legs (fig. 15) not protuberant; weak lines connecting bases of maxillipeds.

Legs 1-4 (figs. 16, 17, 18, and 19) with segmentation and armature similar to other *Anthessius* species. Leg 4 with coxa having a well developed outer posterior distally directed lobelike expansion (this less well formed in leg 3 and absent in legs 1 and 2). Third exopod segment of leg 4 with III, I, 5.

Leg 5 (fig. 20) with free segment in dorsal view appearing more elongated,  $138 \times 68 \mu$ , than in ventrolateral view (when dissected from body),  $140 \times 83 \mu$  (fig. 21). Four naked distal setae 117, 143, 96, and  $180 \mu$  from outer to inner. Dorsal seta on body near free segment  $80 \mu$  and lightly feathered.

Leg 6 represented by 2 setae on genital area (fig. 3).

Living specimens in transmitted light slightly brownish and opaque, eye red, egg sacs reddish to brownish gray.

MALE. — Body (fig. 22) resembling that of female with similar ratios of prosome and urosome. Length 1.72 mm (1.66-1.79 mm) and greatest width 0.76 mm (0.75-0.77 mm), based on 5 specimens in lactic acid.

Segment of leg 5 (fig. 23)  $110 \times 275 \mu$ . No ventral intersegmental sclerite. Genital segment  $170 \times 230 \mu$ , subrectangular. Four postgenital segments  $86 \times 177 \mu$ ,  $86 \times 165 \mu$ ,  $58 \times 159 \mu$ , and  $65 \times 169 \mu$  from anterior to posterior.

Caudal ramus as in female but smaller,  $34 \times 71 \mu$ .

Body surface ornamented as in female.

Rostrum like that of female. First antenna similar to that of female but 2 setae added on second segment (fig. 24), armature of that segment being 15 (7+8). Second antenna, labrum, mandible, paragnath, and first maxilla like those in female. Second maxilla (fig. 25) with fewer teeth, usually 4 plus terminal spine but in one male left second maxilla with only 3 teeth (fig. 26). Maxilliped (fig. 27) 4-segmented (assuming proximal half of claw to represent fourth segment). First segment with 2 distal groups of long spinules. Second segment with naked seta, patch of spines, and double row of spines on its postero-inner surface, and with another naked seta and row of spines on its dorso-median margin. Short third segment with long naked seta and short spiniform process. Claw  $380 \mu$  along its axis, strongly recurved, incompletely divided about midway, with fringe of obtuse spinules along its concave edge and small proximal postero-inner seta.

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

Legs 1-4 like those of female except endopod

of leg 1 (fig. 28). Segments of this endopod more slender than in female and formula for last segment 1,4 instead of 1,5, with inner spine feathered proximally but fringed distally.

Leg 5 (fig. 23) with free segment (fig. 29)  $148 \times 65 \mu$ , more elongated than in female.

Leg (fig. 30) a posteroventral flap on genital segment bearing 2 naked setae  $50 \mu$  and  $55 \mu$  and a small spine  $5.5 \mu$ .

Spermatophore (fig. 31) elongated,  $180 \times 65 \mu$  (not including neck) with very thin wall.

Color as in female.

DISCUSSION. — The New Caledonian specimens have been compared directly with two dissected paratypic females of *Anthessius brevicauda* most kindly sent to the author from the Zoölogisch Museum at Amsterdam. No significant differences were found. The number of teeth on the second maxilla is greater in these paratypes than in the New Caledonian specimens (in one female 7 plus the terminal spine as Stock, 1964, showed; in the other female 6 plus the terminal spine on one second maxilla). Since the number of maxillary teeth in *Anthessius* is known to be variable in several species, as in *A. stylocheili* Humes and Ho, 1965 and *A. proximus* Stock, Humes, and Gooding, 1963, such numerical differences must be treated conservatively.

As Stock (1964) has already noted, *A. brevicauda* may be readily distinguished from all other species in the genus by its very short caudal rami and by the elliptical form of leg 5.

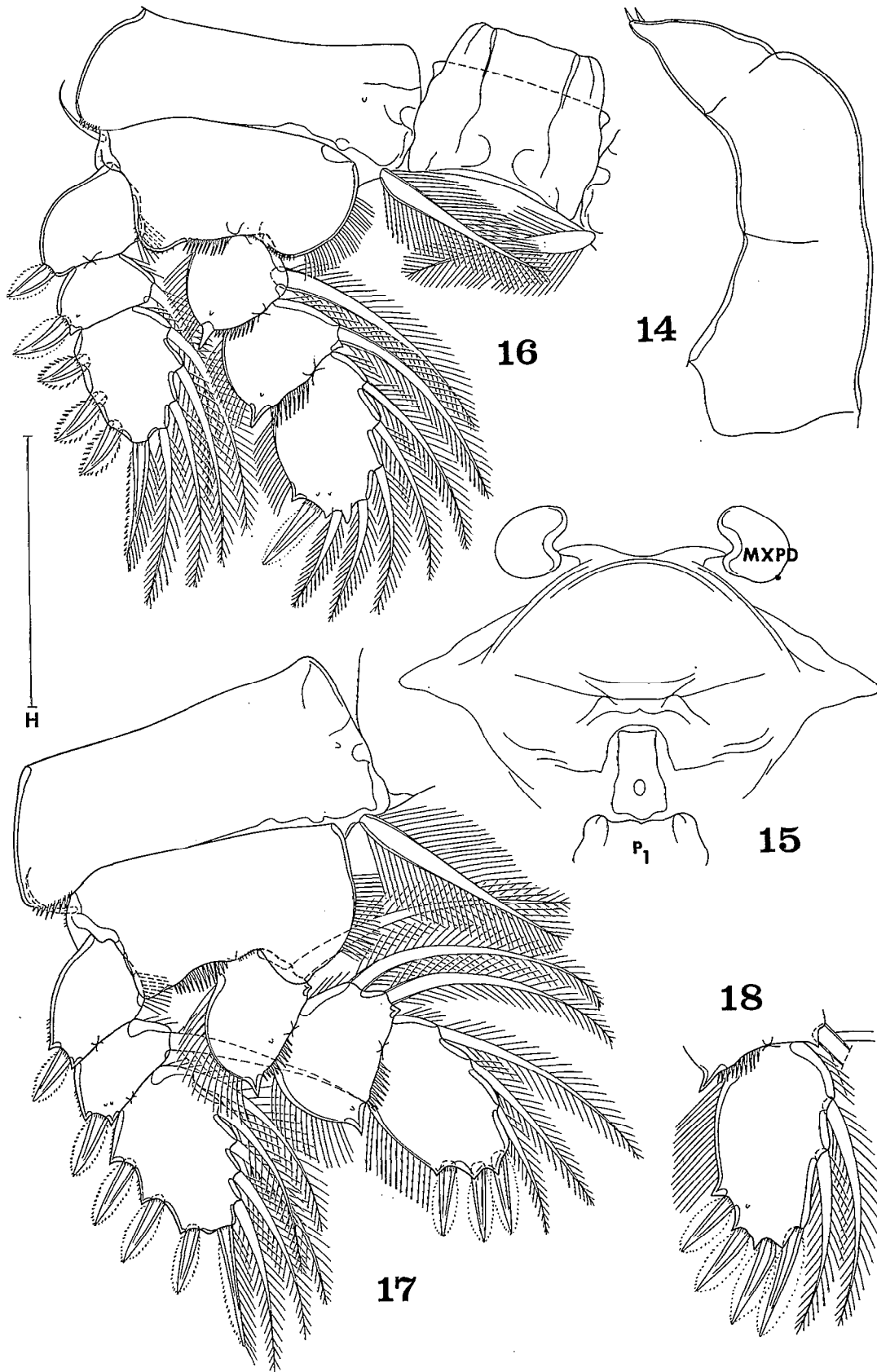
#### *Anthessius pincladae* n. sp.

Figs. 32-58

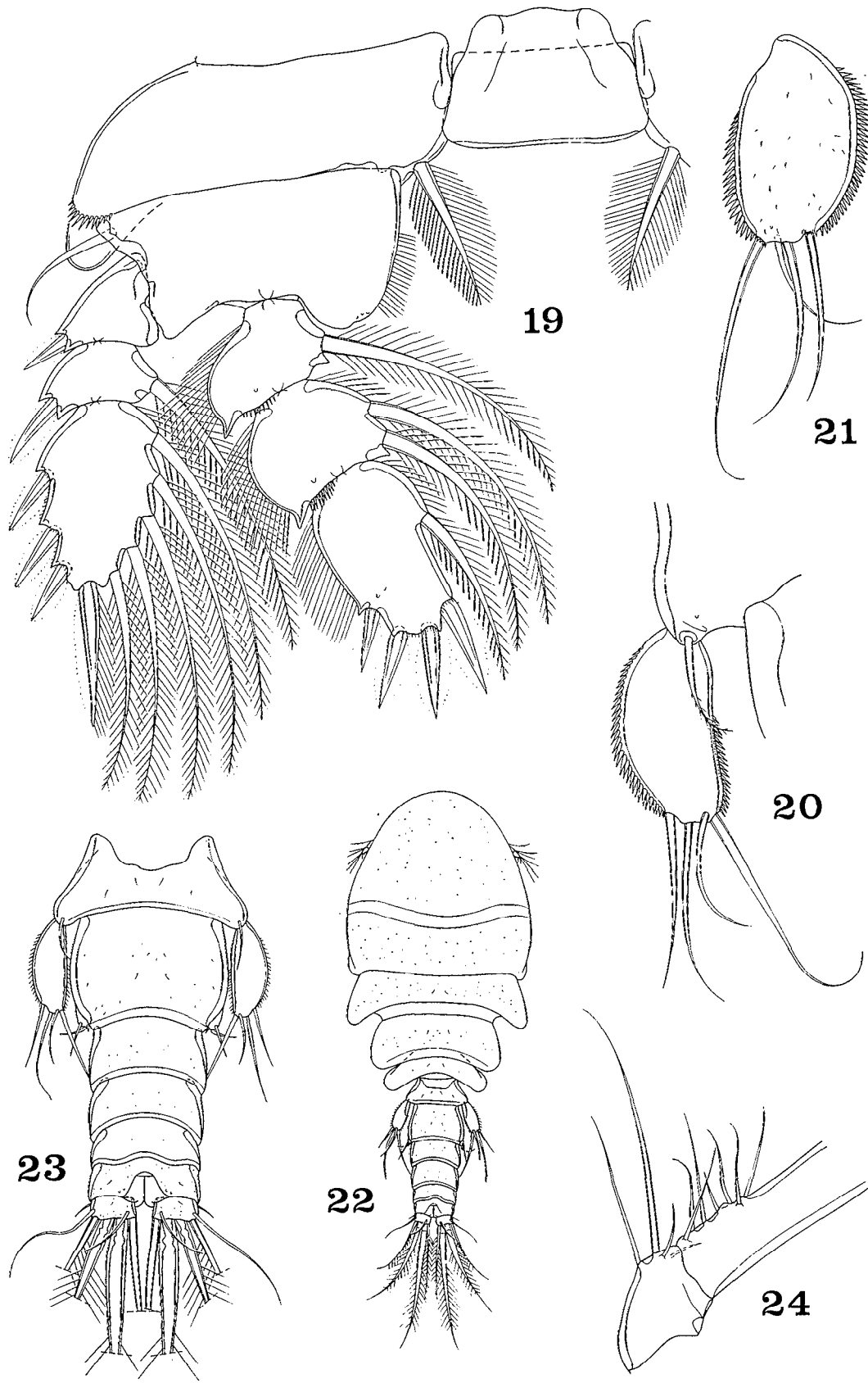
TYPE MATERIAL. — 1 ♀, 2 ♂♂ from 4 pearl oysters, *Pinclada margaritifera* Linnaeus (Pteriidae), intertidal, eastern end of reef at Isle Maître, near Noumea, New Caledonia,  $22^{\circ}20'35''$  S,  $166^{\circ}25'10''$  E, 31 July. Holotype ♂, allotype ♀ (with  $A_1$ ,  $A_2$ , MD,  $MX_1$ ,  $MX_2$ , MXP, and  $P_5$  on left side removed), and paratype ♂ (dissected) deposited in National Museum of Natural History (USNM), Washington.

OTHER SPECIMEN. — 1 ♂ from *Pinclada margaritifera*, intertidal on reef at Goro, south of Yate, southeastern New Caledonia,  $22^{\circ}18'00''$  S,  $167^{\circ}02'00''$  E, 6 August. This specimen in USNM.

MALE. — Body (fig. 32) moderately slender, with prosome not unusually thickened dorsoventrally. Length (not including setae on caudal rami) and greatest width of holotype  $1.98 \times 0.62$  mm, of paratype  $1.95 \times 0.61$  mm, measured in lactic acid. Ratio of length to width of prosome 1.69:1. Ratio of length of prosome to that of urosome 1.18:1.

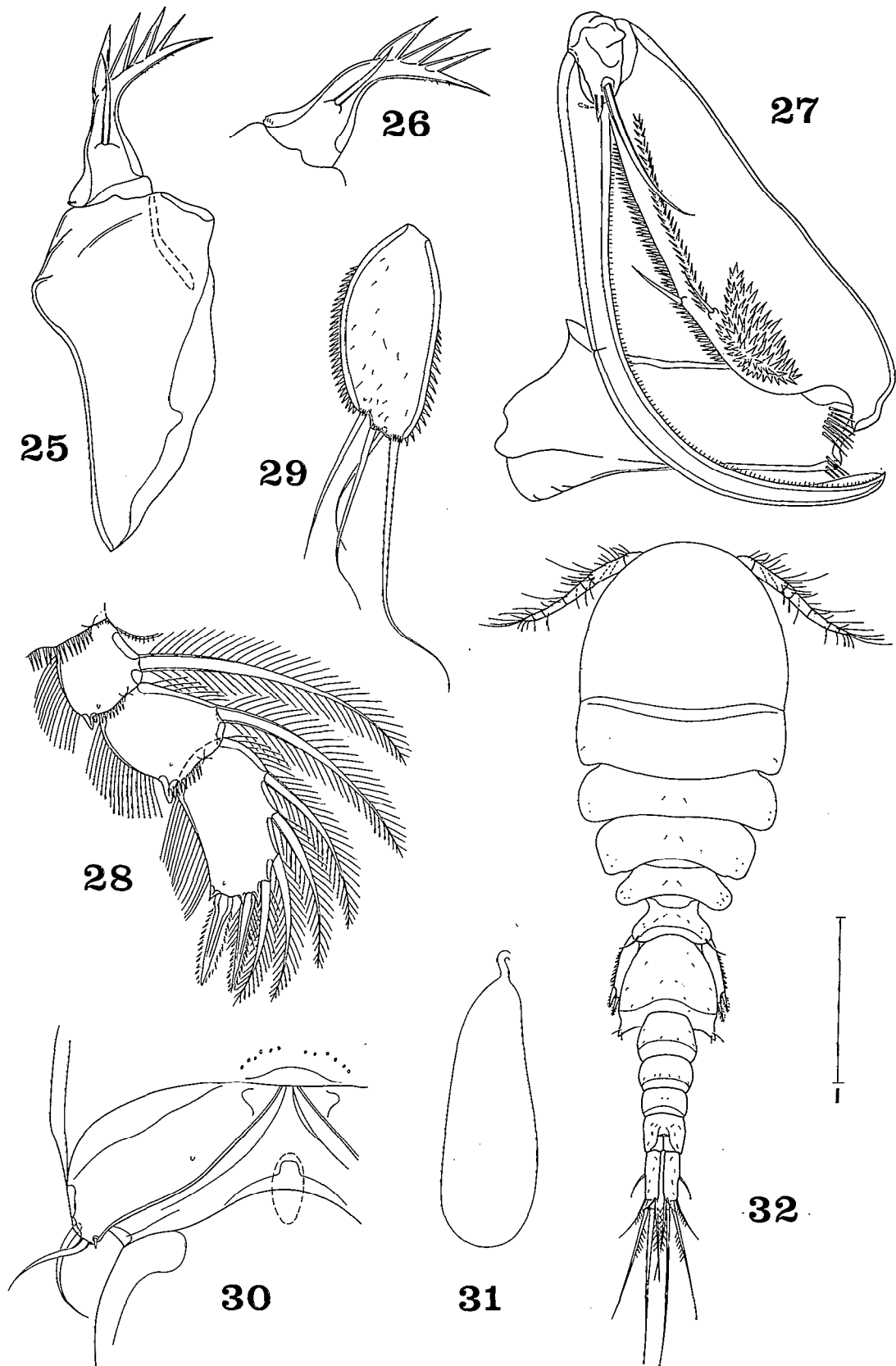


Figs. 14-18. — *Anthessius brevicauda* (Leigh-Sharpe, 1934), female. 14, maxilliped, posterior (F); 15, area between maxillipeds and first pair of legs, ventral (E); 16, leg 1 and intercoxal plate, anterior (H); 17, leg 2, anterior (H); 18, third segment of endopod of leg 3, anterior (H). Scale H = 0.2 mm.



Figs. 19-21. — *Anthessius brevicauda* (Leigh-Sharpe, 1934), female, 19, leg 4 and intercoxal plate, anterior (H); 20, leg 5, dorsal (H); 21, free segment of leg 5, ventrolateral (H).

Figs. 22-24. — *Anthessius brevicauda* (Leigh-Sharpe, 1934), male. 22, dorsal (A); 23, urosome, dorsal (B); 24, first and proximal part of second segment of first antenna, dorsal (H).



Figs. 25-31. — *Anthesius brevicauda* (Leigh-Sharpe, 1934), male. 25, second maxilla, anterior (F); 26, second segment of second maxilla, anterior (F); 27, maxilliped, posterior and inner (H); 28, endopod of leg I, anterior (H); 29, free segment of leg 5, ventrolateral (H); 30, leg 6, ventral (F); 31, spermatophore, detached from female, dorsal (H).

Fig. 32. — *Anthesius pictadae* n. sp., male. 32, dorsal (I). Scale I = 0.5 mm.



Segment of leg 5 (fig. 33)  $117 \times 242 \mu$ . Between this segment and genital segment no ventral intersegmental sclerite. Genital segment  $297 \times 290 \mu$  (including posteriorly directed pointed area of leg 6). Four postgenital segments  $122 \times 153 \mu$ ,  $114 \times 135 \mu$ ,  $83 \times 117 \mu$ , and  $107 \times 112 \mu$  from anterior to posterior. First 3 segments with posterior irregularly dentate fringe. Anal segment anteroventrally on right and left with 2 rows of 5 large spines (fig. 34), and posteriorly with a marginal row of small spinules on each side.

Caudal ramus (fig. 35) elongated,  $156 \times 49 \mu$ , or 3.18 times longer than wide. Outer lateral seta  $90 \mu$  and dorsal seta  $50 \mu$ , both naked. Outermost terminal seta  $155 \mu$  with few inner spinules, innermost terminal seta  $235 \mu$  with bilateral spinules, and 2 long median terminal setae  $375 \mu$  (outer), with a few inner spinules, and  $525 \mu$  (inner), naked. Ramus ornamented with a few hairs and with a proximal dorsal slender setule. Posteroventral flap near insertions of median terminal setae with minute marginal spinules.

Dorsal surface of prosome and both surfaces of urosome with hairs (sensilla) and refractile points.

Rostrum (fig. 36) not well delimited and with a median refractile spot.

First antenna (fig. 37)  $440 \mu$  long. Lengths of 7 segments (measured along their posterior nonsetiferous margins): 26 ( $65 \mu$  along anterior margin), 130, 34, 91, 60, 26, and  $25 \mu$  respectively. Formula for armature: 4, 16+3 aesthetes, 5, 3+1 aesthete, 4+1 aesthete, 2+1 aesthete, and 7+1 aesthete. All setae naked except one (feathered) on second segment.

Second antenna (fig. 38)  $300 \mu$  long (including claws), 3-segmented, but third segment with its armature indicating fusion of 2 original segments. Seta on first segment long ( $130 \mu$ ) and finely pectinate along one side. Seta on second segment short ( $26 \mu$ ) and naked. Third segment with 11 naked elements: a single inner seta, a more distal group of 3 setae (one of them slightly clawlike), 2 posterior very unequal setae, 2 subequal outer setae, and 3 terminal recurved claws, the strongest about  $80 \mu$  along its axis.

Labrum (fig. 39) with 2 rather widely divergent posteroventral lobes. Mandible (fig. 40) resembling other species of *Anthessius*; a single hyaline pointed lamellate lobe near insertion of long setiform element. Paragnath (fig. 39) a small lobe. First maxilla (fig. 41) with several naked terminal elements. Second maxilla (fig. 42) with unornamented first segment having an outer gibbosity. Second segment with anterior surficial naked seta, a few very minute spinules and small spiniform process on proximal

median surface, and lash with 5 or 6 teeth on convex side and 2 spinules on concave side. Maxilliped (fig. 43) similar to that in *A. brevicauda*, with claw  $320 \mu$  along its axis.

Ventral area between maxillipeds and first pair of legs (fig. 44) not protuberant.

Legs 1-4 (figs. 45, 46, 47, and 48) with segmentation and armature like that in females of *Anthessius* except for leg 1 endopod where third segment is I, I, 4. In all 4 legs first exopod segment with prominent outer spines. Basis of leg 1 with short inner spines near insertion of endopod, but these absent in legs 2-4. Third exopod segment of leg 4 with III, I, 4.

Leg 5 (fig. 49) with elongated free segment,  $195 \times 57 \mu$  in ventral aspect, ratio 3.42:1. Three fringed spines 78, 59, and  $61 \mu$  from inner to outer and slender naked seta  $50 \mu$ . Spinules along margin of segment as indicated. Dorsal seta on body near insertion of segment about  $40 \mu$  and naked.

Leg 6 (fig. 50) a posteroventral flap on genital segment, drawn out into a point and bearing somewhat dorsally 2 naked setae  $35 \mu$  and  $21 \mu$ .

Spermatophore not seen.

Living specimens in transmitted light opaque, eye red.

FEMALE. -- Body (fig. 51) slightly broader than in male. Length (without ramal setae) and greatest width of allotype  $2.78 \times 0.93$  mm, measured in lactic acid. Ratio of length to width of prosome 1.75:1. Ratio of length of prosome to that of urosome 1.29:1.

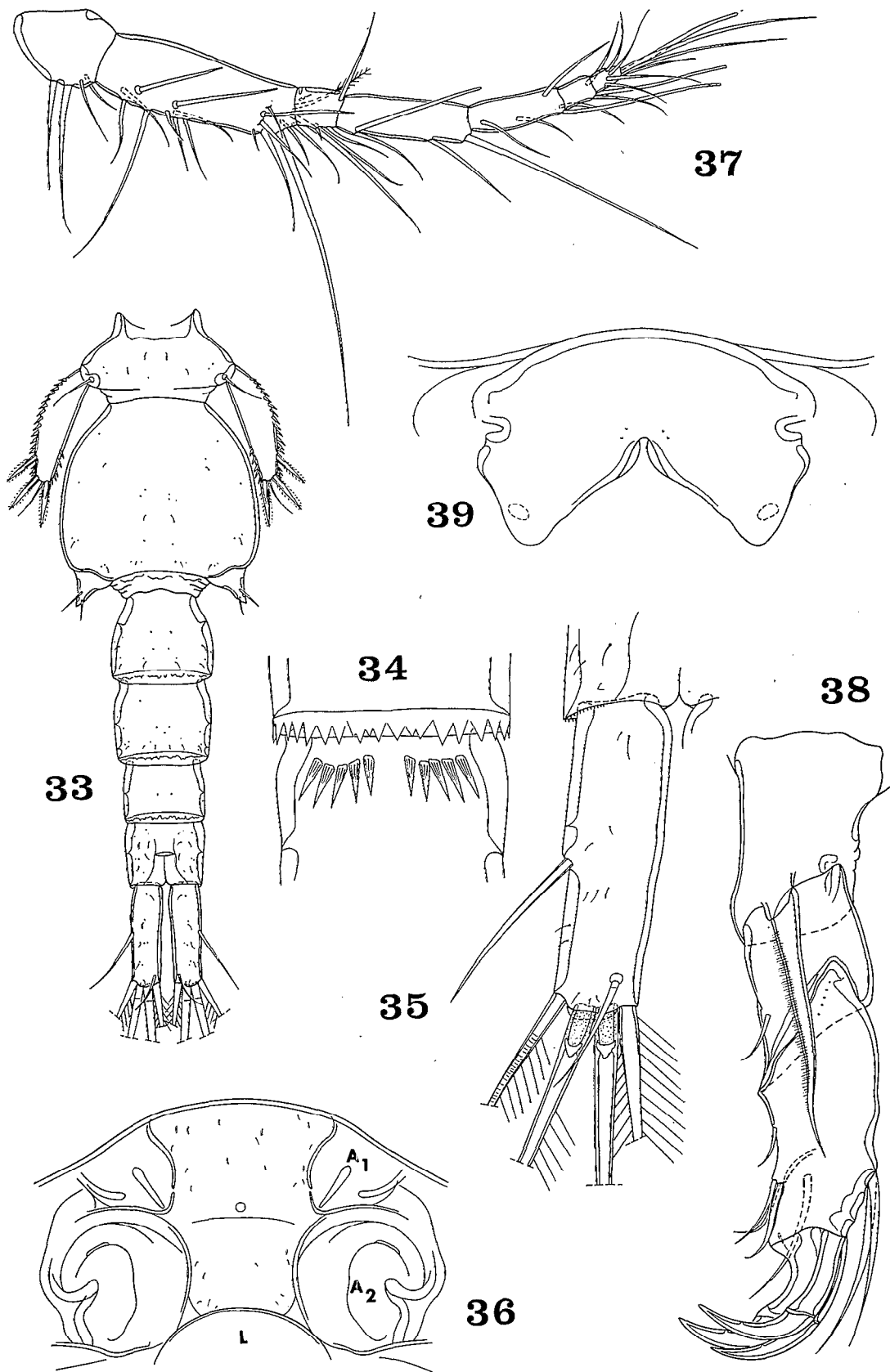
Segment of leg 5 (fig. 52)  $220 \times 390 \mu$ . No ventral intersegmental sclerite. Genital segment  $308 \times 300 \mu$  in dorsal view, broadened in anterior half, posterior half with sides nearly parallel. Genital areas located dorsolaterally in posterior part of anterior half. Three postgenital segments  $176 \times 187 \mu$ ,  $125 \times 165 \mu$ , and  $165 \times 154 \mu$  from anterior to posterior. Anal segment with 7 spines in each row.

Caudal ramus  $220 \times 62 \mu$ , ratio 3.55:1.

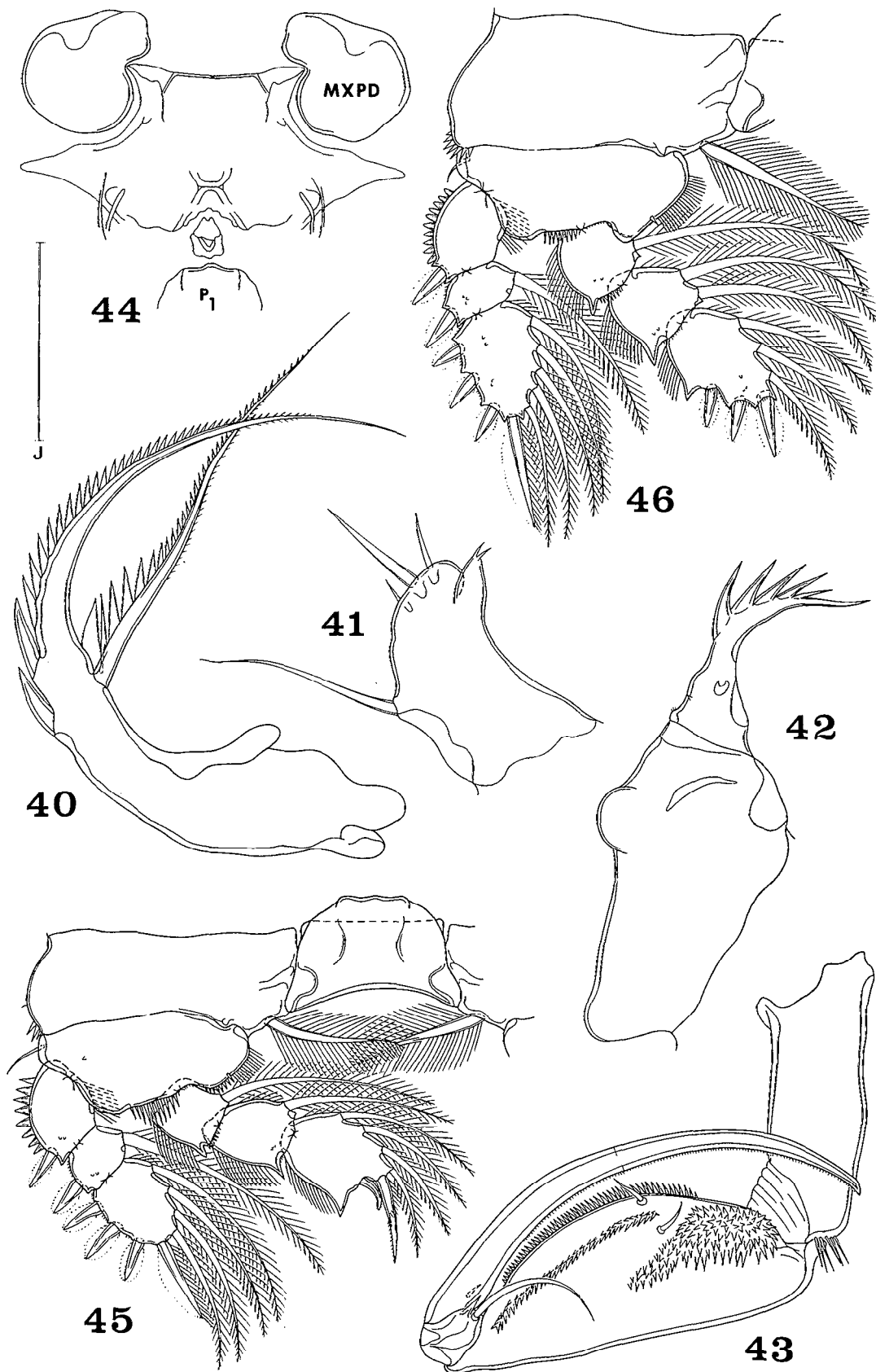
Rostrum like that of male. First antenna similar to that of male, but lacking 3 aesthetes; formula 4, 16, 5, 3, 4+1 aesthete, 2+1 aesthete, and 7+1 aesthete. Lengths of segments (measured along their posterior nonsetiferous margins): 31 ( $83 \mu$  along anterior margin), 159, 44, 112, 81, 34, and  $32 \mu$  respectively.

Second antenna (fig. 53) in general like that of male, but seta on first segment short and naked like that on second segment.

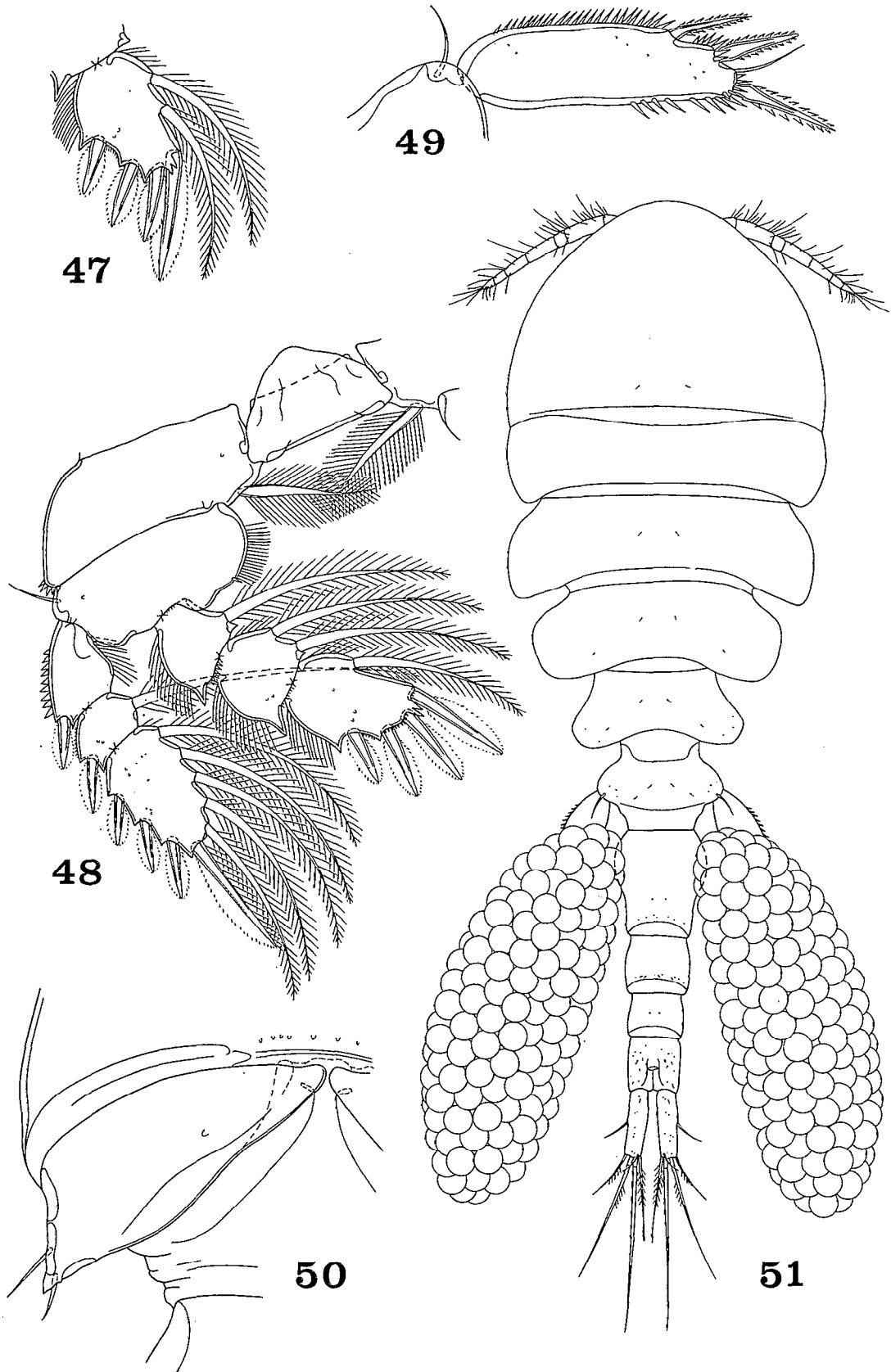
Labrum, mandible, paragnath, and first maxilla like those of male. Second maxilla (fig. 54) resembling



Figs. 33-39. — *Anthessius pictadae* n. sp., male. 33, urosome, dorsal (B); 34, spines on anal segment, ventral (F); 35, caudal ramus, dorsal (F); 36, rostrum, ventral (H); 37, first antenna, ventral (H); 38, second antenna, anterior (F); 39, labrum, with position of paragnaths indicated by broken lines, ventral (F).



Figs. 40-46. — *Anthessius pincladae* n. sp., male. 40, mandible, anterior (J); 41, first maxilla, anterior (J); 42, second maxilla, anterior (D); 43, maxilliped, posterior and inner (H); 44, area between maxillipeds and first pair of legs, ventral (E); 45, leg 1 and intercoxal plate, anterior (H); 46, leg 2, anterior (H).



Figs. 47-50. — *Anthessius pictadae* n. sp., male. 47, third segment of endopod of leg 3, anterior (H) ; 48, leg 4 and intercoxal plate, anterior (H) ; 49, leg 5, ventral (H) ; 50, leg 6, ventral (F).

Fig. 51. — *Anthessius pictadae* n. sp., female. 51, dorsal (I).

that of male, but without gibbosity on first segment and with 8 teeth on lash. Maxilliped (fig. 55) weakly segmented. Second segment with a row of 6 minute elements. Attenuated third segment with 2 very small spinules on roughened outer surface and a small subterminal digitiform hyaline element.

Ventral area between maxillipeds and first pair of legs slightly protuberant (fig. 56).

Endopod of leg 1 (fig. 57) with 1.5 on third segment. Otherwise legs 1-4 as in male.

Leg 5 (figs. 52 and 58) with free segment broader than in male,  $275 \times 140 \mu$ , ratio 1.96:1.

Leg 6 not observable on genital area of single female.

Living specimens in transmitted light slightly reddish-orange, especially in prosome, eye red, egg sacs reddish gray.

DISCUSSION. — Of the 31 species currently placed in the genus *Anthessius* only four have, as in the new species, the combination of three second antennal claws and the formula III,1.5 on the third segment of leg 4 exopod. These differ from *A. pincladae* in easily noted characters.

In *A. concinnus* (A. Scott, 1909), as partly redescribed by STOCK, HUMES, and GOODING (1963, pp. 35-36), the rows of spines on the anal segment are lacking, the mandible has a pectinate lamella between the lash and the setiform element, and sexual dimorphism in the form of modified spines occurs in the male on the endopods of legs 2-4.

In *A. hawaiiensis* (C. B. Wilson, 1921), as redescribed by ILLG (1960), the length of the female is 4.0 mm and that of the male 2.85 mm, the caudal ramus of the female has the ratio of 2.5:1, and the second maxilla has a short spinelike apex with fine teeth.

In *A. ovalipes* Stock, Humes, and Gooding, 1963, the caudal ramus of the female is about 2:1, the mandible has a pectinate lamella between the lash and the setiform element, and sexual dimorphism occurs in the form of modified spines on the endopods of legs 2 and 3.

In *A. pectinis* Tanaka, 1961, the caudal ramus of the female is very long with a ratio of 12:1 and the free segment of leg 5 is nearly quadrate.

In four other species the element on the first segment of the second antenna of the male is enlarged, with spinules along one edge: *A. dolabellae* Humes and Ho, 1965, *A. proximus* Stock, Humes, and Gooding, 1963, *A. stylocheili* Humes and Ho, 1965, and *A. varidens* Stock, Humes, and Gooding, 1963. In 14 species there is no sexual dimorphism in this

element, and in 13 species the second antenna is insufficiently described or completely unknown.

#### *Anthessius alatus* Humes and Stock, 1965

This species has been reported from *Tridacna noae* (Röding) in the Red Sea and *Tridacna squamosa* Lamarck in Madagascar (Humes and Stock, 1965) and from *T. squamosa*, *Tridacna maxima* (Röding), and *Tridacna gigas* (Linnaeus) at Eniwetok Atoll, Marshall Islands (Humes, 1972).

SPECIMENS COLLECTED. — From *Tridacna squamosa* (Tridacnidae): 6 ♀♀, 15 ♂♂, and 5 copepodids from 2 hosts, lengths 21.5 and 24 cm, in 1 m, western side of Isle Maitre, near Noumea, New Caledonia, 22°20'05" S, 166°24'05" E, 11 June.

From *Tridacna maxima*: 2 ♀♀, 7 ♂♂ from 1 host, length 15 cm, on reef about 5 kms south of Yate, southeastern New Caledonia, 22°11'00" S, 166°59'00" E, 23 June; 1 ♀ from 1 host, length 14 cm, in 0.5 m, eastern end of Isle Maitre, near Noumea, 22°20'35" S, 166°25'10" E, 8 June; 3 ♀♀, 1 ♂ from 1 host, in 1 m, west of Isle Mando, near Noumea, 22°18'59" S, 166°09'30" E, 1 July; 4 ♀♀, 1 ♂ from 3 hosts, length about 19 cm, in 20 cm, eastern side of Isle Maitre, near Noumea, 22°20'35" S, 166°25'10" E, 8 June.

#### *Anthessius amicalis* Humes and Stock, 1965

This copepod is known from *Tridacna squamosa* in Madagascar and *Tridacna elongata* Lamarck in the Red Sea (Humes and Stock, 1965) and from *T. squamosa* and *Hippopus hippopus* (Linnaeus) at Eniwetok Atoll (Humes, 1972).

SPECIMENS COLLECTED. — From *Tridacna squamosa*: 13 ♀♀, 14 ♂♂, and 1 copepodid from 2 hosts, lengths 21.5 and 24 cm, in 1 m, western side of Isle Maitre, near Noumea, 22°20'05" S, 166°24'05" E, 11 June; 3 ♀♀, 9 ♂♂ from 1 host, length 19 cm, in 2 m, Isle aux Serpents, west of Pte. Denouel, near Noumea, 22°16'52" S, 166°25'12" E, 19 July; 17 ♀♀, 3 ♂♂ from 1 host, length 35 cm, in 4 m, west of Isle N'Gou, near Noumea, 22°13'44" S, 166°23'01" E, 3 August.

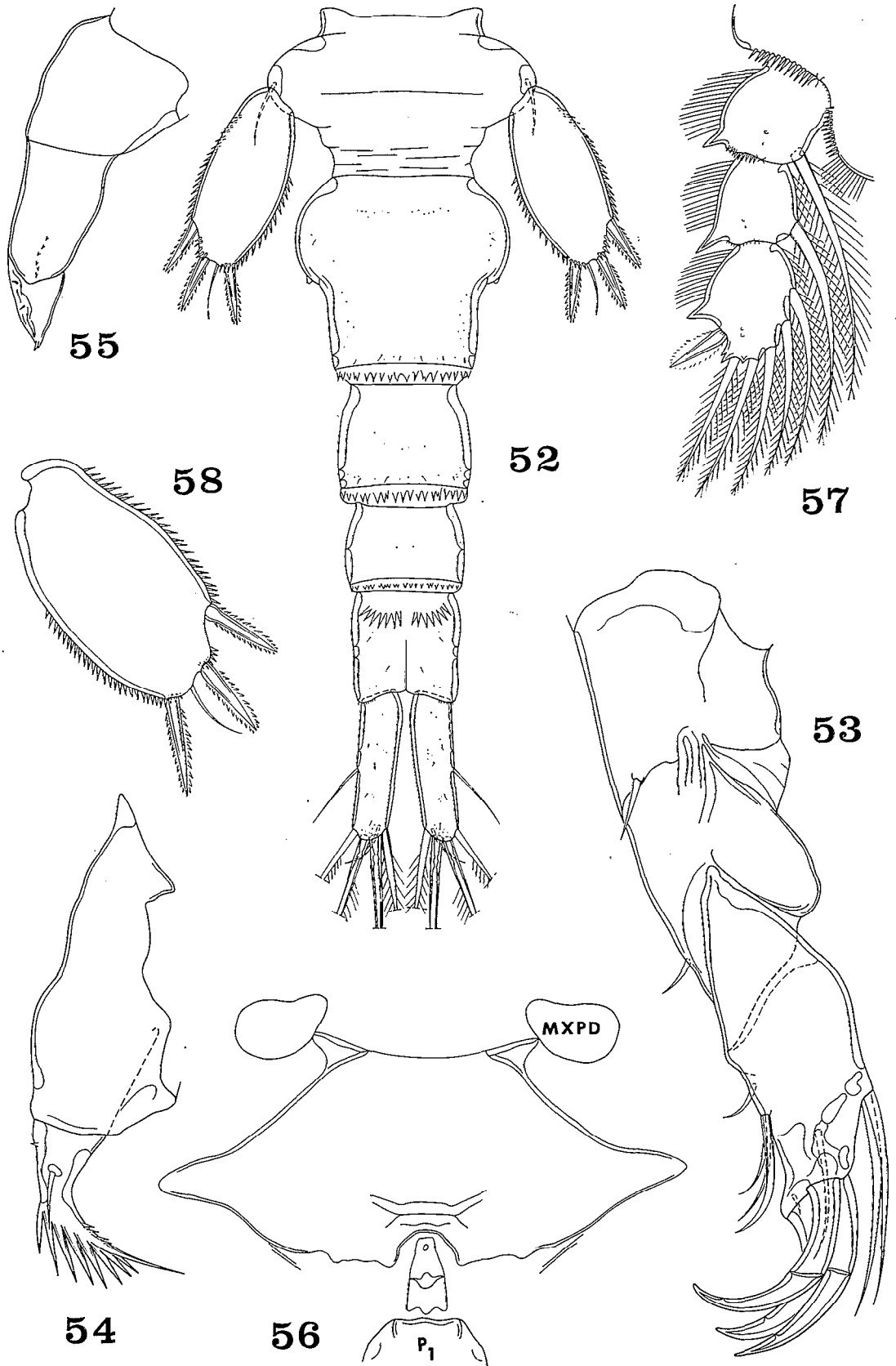
From *Tridacna maxima*: 1 ♀ from 1 host, length 28 cm, in 0.5 m, on reef at Goro, south of Yate, southeastern New Caledonia, 22°18'00" S, 167°02'00" E, 6 August.

*Tridacna maxima* is a new host for this species.

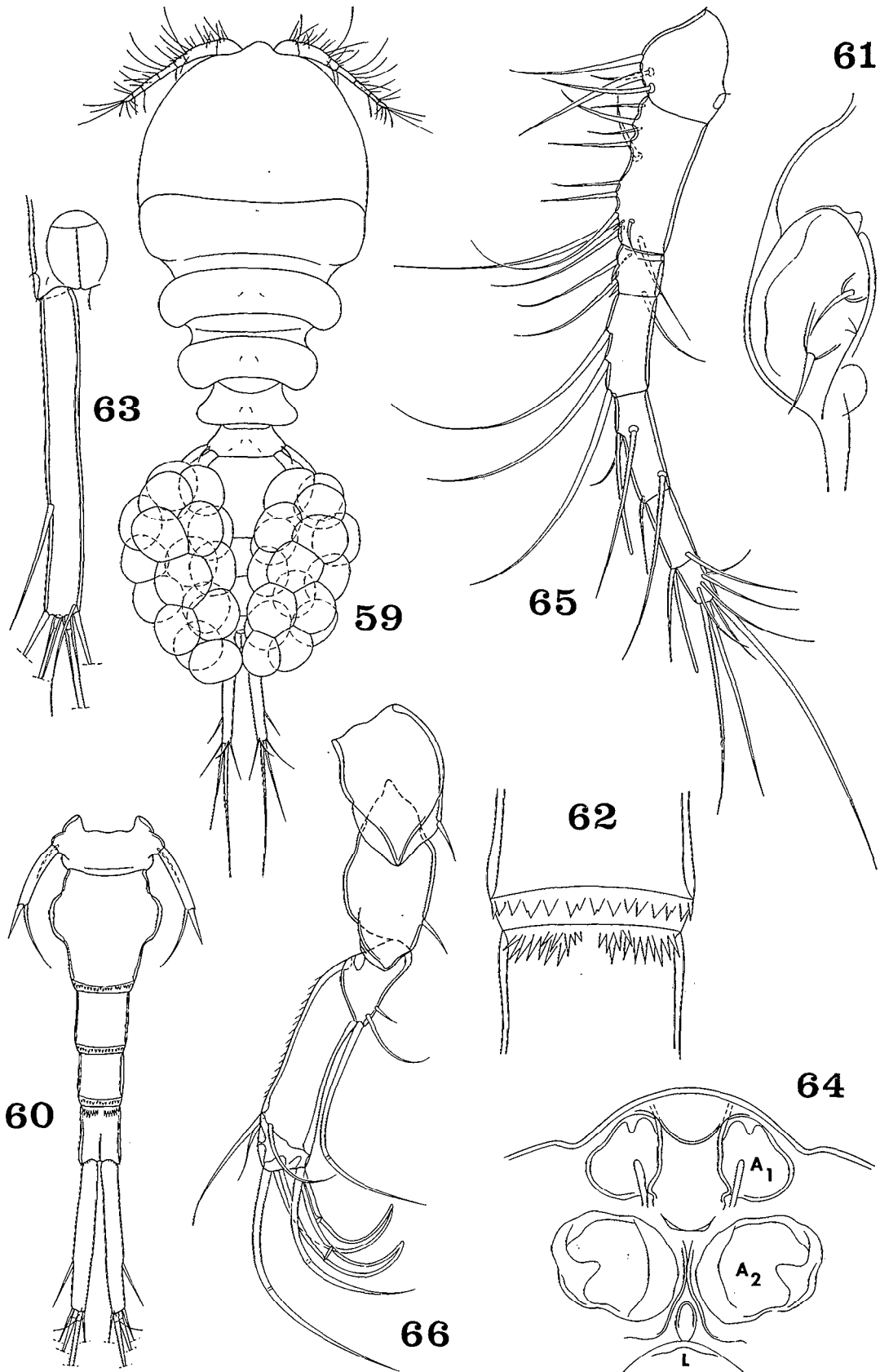
#### Family Lichomolgidae Kossman, 1877

##### *Lichomolgus chamarum* Humes, 1968

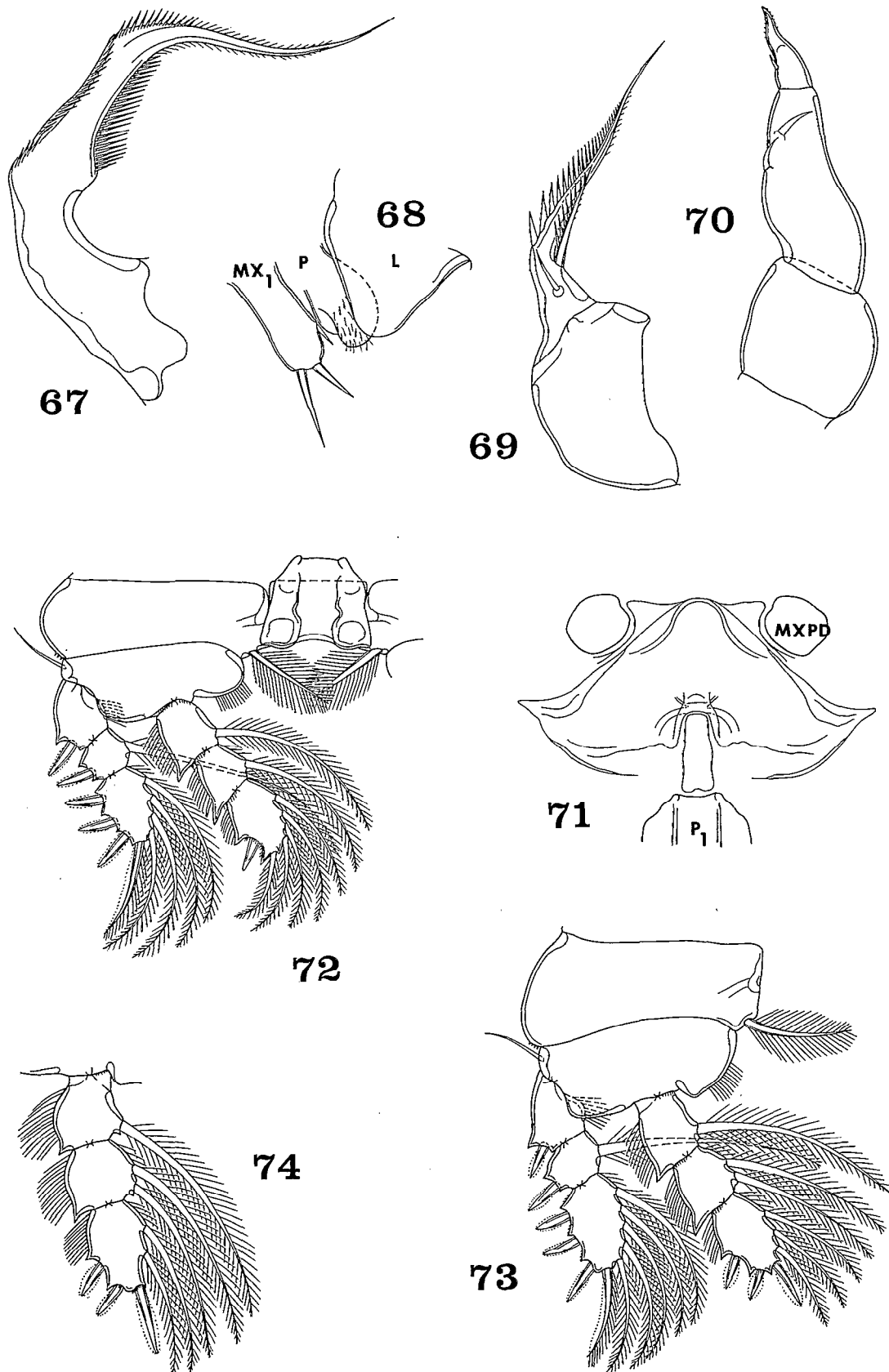
This copepod was described by Humes (1968) from *Chama iostoma* Conrad (Chamidae) in the



Figs. 52-58. — *Anthessius pincladae* n. sp., female. 52, urosome, ventral (B) ; 53, second antenna, anterior (F) ; 54, second maxilla, anterior (F) ; 55, maxilliped, posterior (H) ; 56, area between maxillipeds and first pair of legs, ventral (E) ; 57, endopod of leg 1, anterior (H) ; 58, free segment of leg 5, dorsal (E).



Figs. 59-66. — *Lichomolgus ieversi* Thompson and A. Scott, 1903, female. 59, dorsal (B); 60, urosome, ventral (E); 61, genital area, dorsal (G); 62, spines on anal segment, ventral (J); 63, caudal ramus, dorsal (F); 64, rostrum, ventral (D); 65, first antenna, ventral (D); 66, second antenna, posterior (D).



Figs. 67-74. — *Lichomolgus ieversi* Thompson and A. Scott, 1903, female. 67, mandible, anterior (G); 68, labrum (one half only), paragnath, and first maxilla, ventral and anterior (J); 69, second maxilla, posterior (J); 70, maxilliped, inner (J); 71, area between maxillipeds and first pair of legs, ventral (F); 72, leg 1 and intercoxal plate, anterior (F); 73, leg 2, anterior (F); 74, endopod of leg 3, anterior (F).



vicinity of Nosy Bé, Madagascar. The New Caledonian specimens agree in all essential details with the original description.

SPECIMENS COLLECTED. — 5 ♀♀, 3 ♂♂, and 1 copepodid from 3 *Chama iostoma* Conrad, in 4 m, reef between Isle Ndié and Mt. Kumuru, north of Presqu'île Ducos, near Noumea, New Caledonia, 22°13'24" S, 166°24'11" E, 29 July.

*Lichomolgus ieversi* Thompson and A. Scott, 1903  
Figs. 59-76

SPECIMENS COLLECTED. — 3 ♀♀ from 5 *Pecten distans* Lamarck (Pectinidae) washed up on sandy beach during high wind, Ricaudy Reef, near Noumea, New Caledonia, 26 July. Two ♀♀ in National Museum of Natural History (USNM), Washington; third ♀ (dissected) in collection of A. G. Humes.

FEMALE. — Body (fig. 59) with rather quadrate cephalosome and with rostral area protruding slightly anteriorly. Prosome not thickened dorsoventrally. Length (not including setae on caudal rami) 1.05 mm (1.00-1.10 mm) and greatest width 0.31 mm (0.30-0.33 mm), based on 3 specimens in lactic acid. Ratio of length to width of prosome 1.65:1. Ratio of length of prosome to that of urosome 1.19:1.

Segment of leg 5 (fig. 60) 52×104 μ. Between this segment and genital segment no ventral intersegmental sclerite. Genital segment in dorsal view moderately expanded anterior to its midregion. Greatest dimensions 126×111 μ. Genital areas situated dorsolaterally on expanded part of segment. Each area (fig. 61) with 2 naked setae about 11 μ and a small spiniform process. Three postgenital segments 60×58 μ, 55×49 μ, and 60×47 μ from anterior to posterior. Posterior border of genital and first 2 postgenital segments with a fringe bearing uneven serrations resembling hyaline spines. Anal segment with a row of minute spinules posteroventrally on each side and with 2 groups of spines anteroventrally on right and left sides (fig. 62).

Caudal ramus (fig. 63) very elongated, 160×18 μ, or 8.9 times longer than wide. Outer lateral seta 55 μ, dorsal seta 40 μ, outermost terminal seta 74 μ, innermost terminal seta 77 μ, and 2 long median terminal setae 125 μ (outer) and 244 μ (inner). All setae naked.

Surface of body with very little ornamentation.

Egg sac (fig. 59) elongated ovoid, 350×165 μ, reaching a little beyond anal segment, and containing numerous large eggs of variable shape but about 65-75 μ in diameter.

Rostrum (fig. 64) small, weak, rounded posteroventrally.

First antenna (fig. 65) 210 μ long. Lengths of 7 segments (measured along their posterior nonsetiferous margins) : 14 (36 μ along anterior margin), 47, 17, 35, 34, 25, and 15.5 μ. Formula for armature : 4, 13, 6, 3, 4+1 aesthete, 2+1 aesthete, and 7+1 aesthete. All setae naked.

Second antenna (fig. 66) 200 μ long including claws, 4-segmented. Formula I,1,3, and II,5. Fourth segment 79 μ along outer edge, 52 μ along inner edge, and 15.5 μ wide at middle; 2 claws 46 μ and 55 μ. Longest seta on third segment and 2 long setae on fourth segment weakly articulated. All setae naked.

Labrum (fig. 68) with 2 posteroventral lobes. Mandible (fig. 67) attenuated into a long lash with spinules along both sides. Paragnath (fig. 68) a hairy lobe. First maxilla (fig. 68) with 3 elements. Second maxilla (fig. 69) with first segment unarmed. Second segment with a surficial posterior naked seta, an inner distal spinulose spine, and a long terminal lash with prominent graduated spinules along one side. Maxilliped (fig. 70) 3-segmented. Second segment with 2 naked setae. Third segment with one small seta and with very small spinules on both sides of attenuated tip.

Ventral area between maxillipeds and first pair of legs (fig. 71) not protuberant.

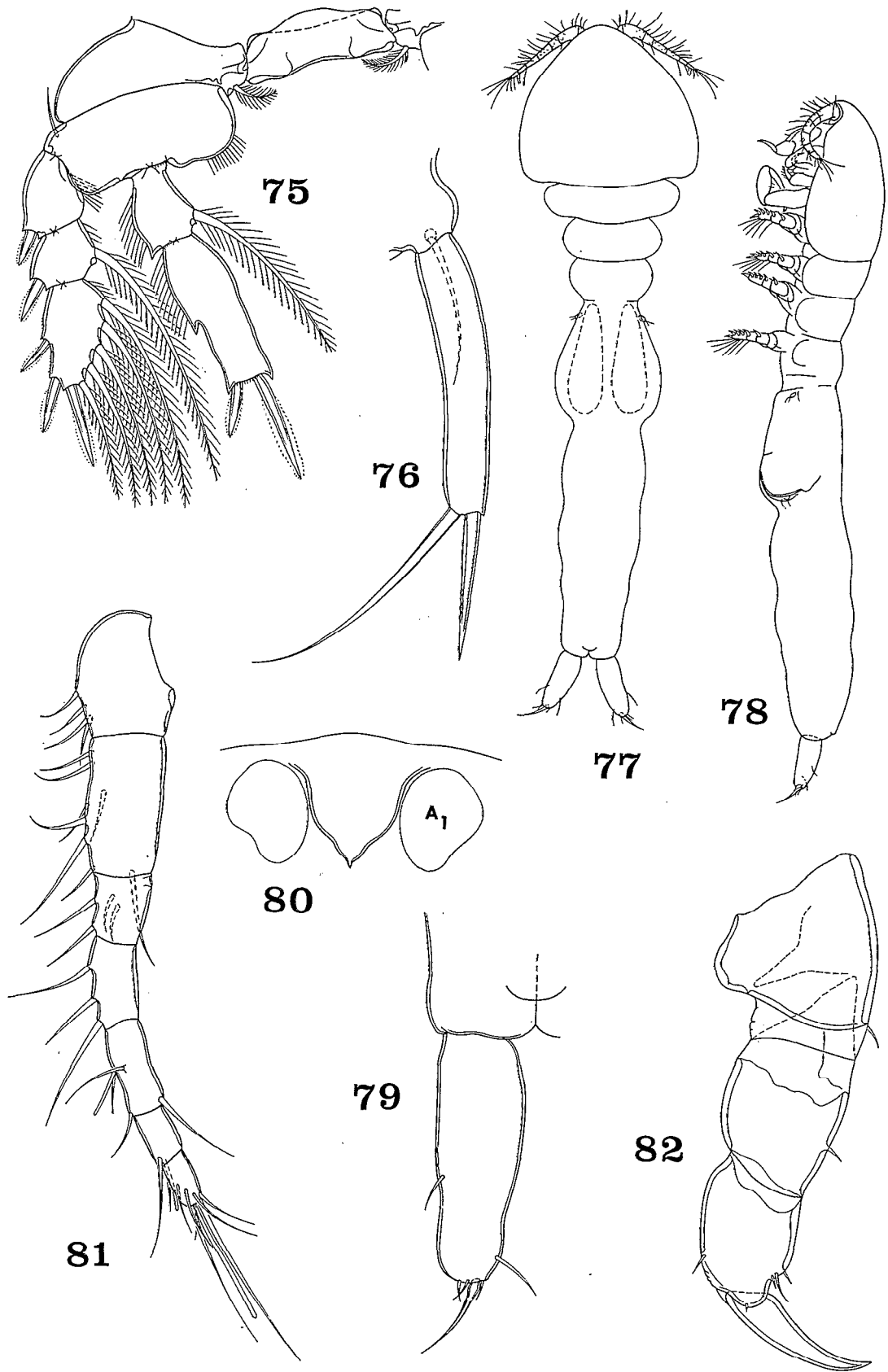
Legs 1-4 (figs. 72, 73, 74, and 75) segmented and armed as in other species in genus (compare formula for *L. bridacnae* Humes, 1972, or for *L. chamarum* Humes, 1968). Leg 4 endopod as long as exopod (both about 115 μ). Third exopod segment with II, I, 5. First endopod segment 33×29 μ (including spiniform processes) and inner seta 99 μ. Second endopod segment 82 μ long (including processes), 29 μ wide proximal to outer notch, 21 μ wide distal to notch; outer terminal spine 26 μ, inner 57 μ.

Leg 5 (fig. 76) with elongated unornamented free segment, 66×11 μ. Two naked terminal elements, outer spine 34 μ, inner seta 64 μ. Dorsal seta on body near insertion of free segment 39 μ and naked.

Leg 6 represented by 2 setae on genital area (fig. 61).

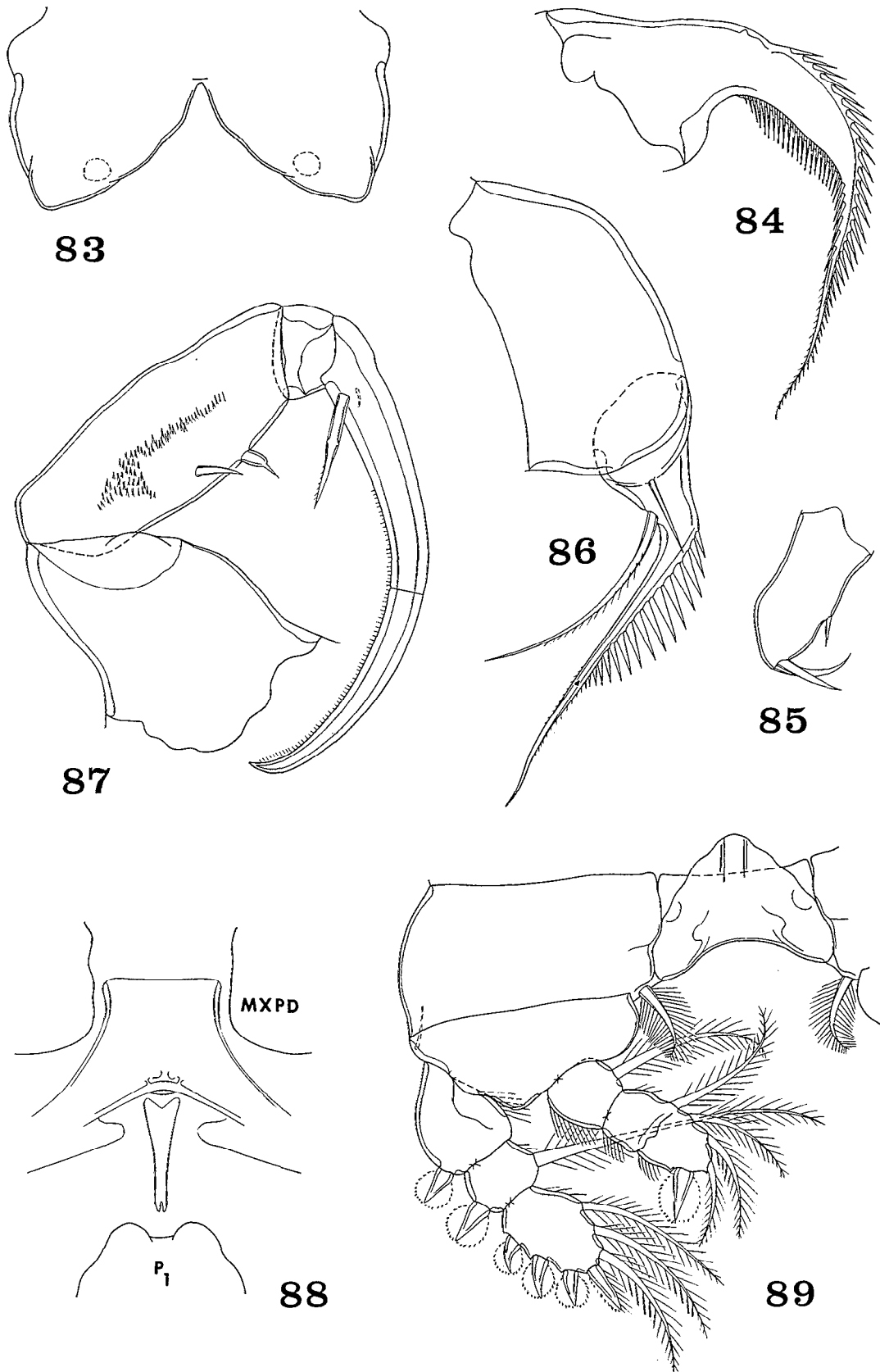
Living specimens in transmitted light opaque gray, eye red, egg sacs blackish gray.

DISCUSSION. — Although THOMPSON and A. SCOTT'S (1903) original description of *Lichomolgus ieversi* is brief and their figures incomplete, sufficient information is contained therein to substantiate the specific identity of the New Caledonian females. About the only seeming discrepancy of importance is the number of second antennal segments, said to be three by THOMPSON and A. SCOTT. Their figure 12,

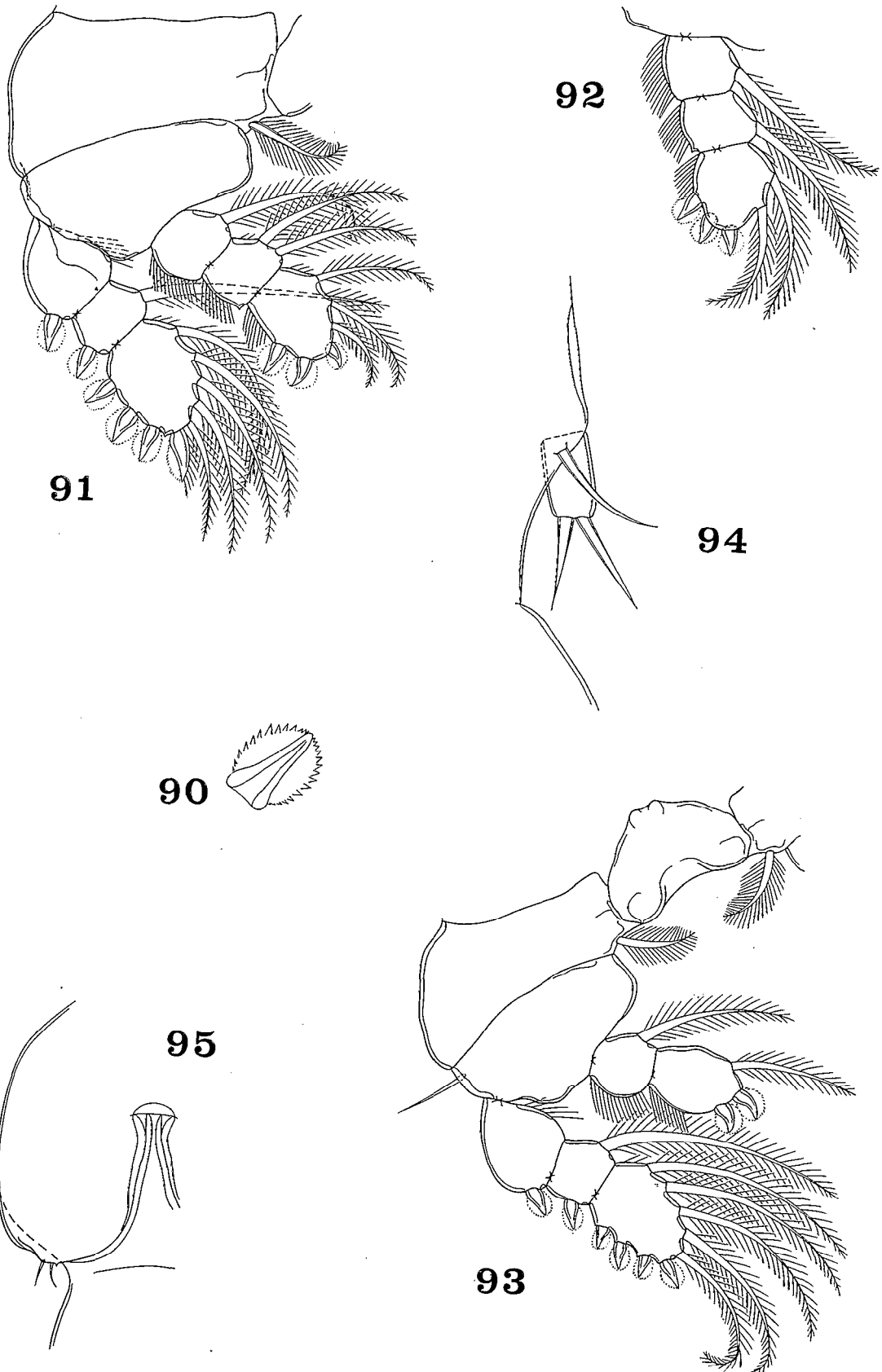


Figs. 75-76. — *Lichomolgus ieversi* Thompson and A. Scott, 1903, female. 75, leg 4 and intercoxal plate, anterior (F) ; 76, leg 5, ventral (J).

Figs. 77-82. *Paclabius tumidus* Kossmann, 1877, male. 77, dorsal (I) ; 78, lateral (I) ; 79, caudal ramus, dorsal (H) ; 80, rostrum, ventral (H) ; 81, first antenna, posteroventral (F) ; 82, second antenna, inner (F).



Figs. 83-89. — *Paclabius tumidus* Kossmann, 1877, male. 83, labrum, with position of paragnaths indicated by broken lines, ventral (D); 84, mandible, anterior (J); 85, first maxilla, anterior (J); 86, second maxilla, posterior (J); 87, maxilliped, inner (D); 88, area between maxillipeds and first pair of legs, ventral (F); 89, leg I and intercoxal plate, anterior (F).



Figs. 90-95. — *Paclabius tumidus* Kossmann, 1877, male. 90, outer spine on second segment of leg 1 exopod, anterior (D); 91, leg 2, anterior (F); 92, endopod of leg 3, anterior (F); 93, leg 4 and intercoxal plate, anterior (F); 94, leg 5, dorsal (J); 95, leg 6, ventral (E).

plate XV, shows four segments, however, as in the New Caledonian specimens.

Since there is no means of comparing type material, the A. Scott collection having been lost (see HUMES and Ho, 1967, p. 209), one must resort to comparison of the description and figures only. It is fortunate that in this instance there is virtually complete agreement between THOMPSON and A. SCOTT's description and the New Caledonian specimens. Thus after nearly 70 years the validity of this poorly known species can be affirmed.

*Paclabius tumidus* Kossmann, 1877

Figs. 77-95

**SPECIMENS COLLECTED.** — From the bivalve *Tridacna squamosa* Lamarck : 4 ♂♂ from 1 host, length 35 cm, in 4 m, west of Isle N'Gou, near Noumea, 22°13'44" S, 166°23'01" E, 3 August. Three males in National Museum of Natural History (USNM), Washington; fourth male (dissected) in collection of author.

**MALE.** — Body (figs. 77 and 78) elongated, with prosome flattened and moderately broadened. Length (excluding ramal setae) 2.08 mm (2.03-2.11 mm) and greatest width 0.51 mm (0.45-0.56 mm), based on 4 specimens in lactic acid. Segment of leg 1 fused with head. Ratio of length to width of prosome 1.56:1. Ratio of length of prosome to that of urosome 1:1.28, with urosome distinctly longer than prosome.

Segment of leg 5, genital segment, and post-genital segments fused, without visible lines of separation. Width of genital segment 330 μ. Four postgenital segments indicated in dorsal view by very slight lateral swellings.

Caudal ramus (fig. 79) elongated, 174 × 62 μ, 2.8 times longer than wide. Armature consisting of 6 elements : outer lateral seta (22 μ), dorsal seta (33 μ), and 4 terminal setae (3 very short and weak, about 17 μ, one long, 64 μ, and more strongly developed). All setae naked.

Surface of body smooth, without noticeable sensilla or refractile points.

Rostrum (fig. 80) linguiform, with small mucronate tip.

First antenna (fig. 81) 7-segmented, 288 μ long. Lengths of segments (measured along their posterior nonsetiferous margins) : 24 (60 μ along anterior margin), 66, 35, 36, 44, 25, and 23 μ respectively. Formula for armature : 4, 8, 4, 3, 4+1 aesthete, 2+1 aesthete, and 7+1 aesthete. All setae naked.

Second antenna (fig. 82) 3-segmented. First and second segments both with a small seta. Third segment with 5 small setae and a terminal claw 81 μ long and not strongly recurved.

Labrum (fig. 83) with 2 somewhat pointed postero-ventral lobes. Mandible (fig. 84) with base slender and merging into long slender attenuated lash with spinules along both sides. Paragnath (fig. 83) a very small knob concealed in ventral view by labrum. First maxilla (fig. 85) with 3 elements, 2 terminal and 1 lateral. Second maxilla (fig. 86) 2-segmented. Large first segment unarmed. Small second segment bearing an inner seta barbed along one side, a naked posterior surficial seta, and a terminal lash with prominent spines along proximal half of outer (ventral) margin. Maxilliped (fig. 87) 4-segmented (assuming proximal half of claw to be fourth segment). First segment unarmed. Second segment with 2 naked inner setae (one peculiarly bulbous in its proximal half) and a patch of small spinules. Third segment small and unarmed. Claw gently recurved, 160 μ along its axis, divided about midway, and bearing a fringe on concave margin and 2 unequal proximal setae.

Ventral area between maxillipeds and first pair of legs (fig. 88) not protuberant.

Legs 1-4 (figs. 89, 91, 92, and 93) with spine and setal formula as follows (Roman numerals indicating spines, Arabic numerals setae) :

$P_1$	coxa	0-1	basis	1-0	exp	I-0; I-1; III,I,3
					enp	0-1; 0-1; I,3
$P_2$	coxa	0-1	basis	1-0	exp	I-0; I-1; III,I,5
					enp	0-1; 0-2; I,II,3
$P_3$	coxa	0-1	basis	1-0	exp	I-0; I-1; III,I,5
					enp	0-1; 0-1; I,II,2
$P_4$	coxa	0-1	basis	1-0	exp	I-0; I-1; III,I,5
					enp	0-1; II,1

Inner coxal seta in all 4 legs plumose. Outer spines on exopods with broad spinulose lamellae, those on leg 1 with more strongly spinulose margins (fig. 90) than in succeeding legs. Endopod of leg 1 with second and third segments partly fused, line of separation apparent only on anterior surface. Leg 4 exopod about 122 μ long. First segment of leg 4 endopod 28 × 31 μ and its seta 60 μ; second segment 45 × 33 μ with both terminal spines about 15 μ and seta 57 μ.

Leg 5 (fig. 94) with small rectangular unornamented free segment 22 × 12 μ, bearing 2 terminal setae 25 μ and 28 μ. Dorsal seta on body 31 μ. All setae naked.

Leg 6 (fig. 95) a posteroventral flap on genital segment bearing 2 slender setae 29 μ and 26 μ and a minute spiniform process.

Spermatophore not seen except partly formed within male.

Living specimens in transmitted light opaque, eye red.

REMARKS. — The identification of the New Caledonian males as *Paclabius tumidus* is necessarily based upon a comparison with KOSSMANN's original description and figures. The deposition of his two females is unknown. The species has not been rediscovered since the original finding. A careful study of KOSSMANN's description of the female strongly suggests that the males from New Caledonia represent the same species. His figures, though crude, of the rostrum, first antenna, second antenna, mandible, and second maxilla contain many features of the New Caledonian specimens. Although KOSSMANN stated that leg 4 has two 3-segmented rami and so illustrated this leg in his fig. 9, pl. VI, I am convinced that he confused leg 3 with leg 4. The formula of the endopod in his fig. 9 is that of the endopod of leg 3. If the errors, omissions, and relative crudity of KOSSMANN's description are taken into account, the trustworthy anatomical features of his *P. tumidus* may be reconciled with the males from New Caledonia. The difference in length (6 mm for KOSSMANN's females, 2 mm for

the males reported here) may well be simply an expression of sexual dimorphism.

KOSSMANN's material came from the pericardium of a *Tridacna* (species not given) at Bohol in the Philippine Islands. The four males collected in New Caledonia from one *Tridacna squamosa* were obtained from washings of the opened bivalve. It is possible that, when the adductor muscle was cut, the pericardium may have been opened, thus releasing the males. Their exact location in the *Tridacna* is not known, however.

In the search for copepods associated with *Tridacna squamosa* four of these bivalves were examined in New Caledonia. Previously eleven had been examined at Eniwetok Atoll (HUMES, 1972). *Paclabius* was found only the single time reported here.

On the basis of the New Caledonian specimens Humes and Stock (in press) have placed *Paclabius* in the Lichomolgidae, as used in their revised sense.

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