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CYCLOPOID COPEPODS ASSOCIATED WITH ANTIPATHARIAN COELENTERATES IN MADAGASCAR

by

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With 98 figures

Previous work (in 1960) at Nosy Bé, in northwestern Madagascar, resulted in the collection by dredging of the antipatharian *Stichopathes echinulata* Brook parasitized by the copepod *Vahinius petax* Humes, 1967. More recently (in 1964 and 1967) I have obtained by SCUBA diving several other antipatharians with which the copepods described below were associated.

The collection in 1964 was made as part of the U. S. Program in Biology of the International Indian Ocean Expedition. The collections in 1967 were made during field work supported by a grant (GB-5838) from the National Science Foundation of the United States. The study of the copepods has been aided by the same N. S. F. grant.

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, R = rostrum, L = labrum, MD = mandible, P = paragnath, MX_1 = first maxilla, MX_2 = second maxilla, MXPD = maxilliped, and P_1 = leg 1.

The measurements of the length of the body have been made in all cases from specimens in lactic acid and do not include the setae on the caudal rami. In the spine and setal formulas for legs 1 to 4 the Roman numerals indicate spines and the Arabic numerals represent setae. The lengths of the segments of the first antenna have been measured along their posterior non-setiferous margins.

I am greatly indebted to Dr. W. Vervoort of the Rijksmuseum van Natuurlijke Historie, Leiden, for the identifications of the several species of *Antipathes,* and to Dr. Elisabeth Deichmann of the Museum of Comparative Zoology, Harvard University, for the identification of the *Stichopathes.* I wish also to express my appreciation to Monsieur Pierre Laboute, diver at the Centre ORSTOM de Nosy Bé, who accompanied me on the SCUBA dives.

The new copepods described in this paper comprise the following: (1) *Lichomolgus constrictus* n. sp. from *Antipathes ericoides* Pallas, (2) *Lichomolgus insectus* n. sp. from *Antipathes* cf. *spinescens* Gray, *A. myriophylla* Pallas, and *A. abies* (Linnaeus), and (3) *Thamnomolgus robustus* n. gen., n. sp. from *Antipathes myriophylla, A.* cf. *spinescens, A. abies,* and *A. ericoides.*

The following is a new host record: (1) *Vahinius petax* Humes, 1967, from *Antipathes longibrachiata* (A. J. van Pesch)

LICHOMOLGIDAE Kossmann, 1877

Lichomolgus Thorell, 1859

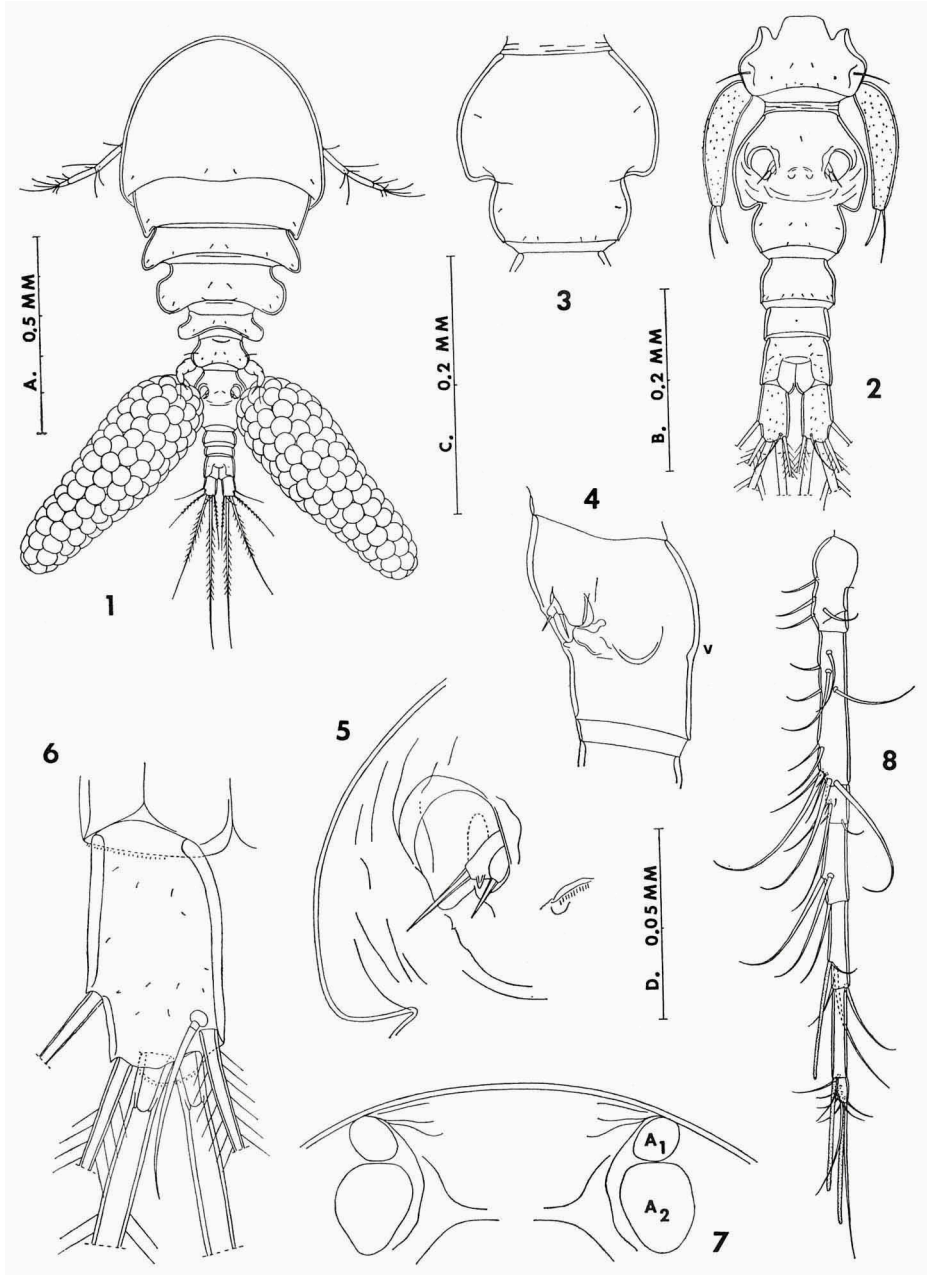
Lichomolgus constrictus n. sp. (figs. 1-31)

Type material. — 53 ♀♀, 115 ♂♂, and 93 copepodids, from *Antipathes ericoides* Pallas, in 25 m, on the northern side of Tany Kely, a small island south of Nosy Bé, Madagascar, August 14, 1967. Holotype ♀ (no. F 780), allotype (no. F 781), and 120 paratypes (40 ♀♀, 80 ♂♂) (no. F 782), deposited in the Rijksmuseum van Natuurlijke Historie, Leiden; the remaining paratypes in the collection of the author.

Other specimens (all from *Antipathes ericoides*). — 21 ♀♀, 22 ♂♂, and 5 copepodids, in 24 m, north of Ankazoberavina, 13°27.6'S 47°58.2'E, west of Nosy Bé, August 25, 1967; and 64 ♀♀, 60 ♂♂, and 99 copepodids, in 35 m, 13°15'50"S 48°08'35"E, west of Andilah, Nosy Bé, August 30, 1967.

Female. — The body (fig. 1) is moderately slender, with the prosome slightly thickened in lateral view. The length is 1.22 mm (1.10-1.27 mm) and the greatest width 0.52 mm (0.47-0.54 mm), based on 10 specimens. The ratio of the length to the width of the prosome is 1.45 : 1. The epimeral areas of the metasomal segments are formed as in the figure.

The segment of leg 5 (fig. 2) is 86 × 144 μ. Between this segment and the genital segment there is no ventral intersegmental sclerite. The genital segment is 160 μ long, in dorsal view (fig. 2) and in ventral view (fig. 3) divided into two parts by lateral constrictions, the anterior part 105 × 151 μ with rather angular posterolateral regions, the posterior part 55 × 107 μ with its sides rounded. This segment in lateral view (fig. 4) is only slightly thicker in its anterior part than in its posterior part. The areas of attach-



Figs. 1-8. *Lichomolgus constrictus* n. sp., female. 1, dorsal (A); 2, urosome, dorsal (B); 3, genital segment, ventral (C); 4, genital segment, letter V = ventral side, lateral (C); 5, area of attachment of egg sac, dorsal (D); 6, caudal ramus, dorsal (D); 7, rostral area, ventral (C); 8, first antenna, dorsal (C).

ment of the egg sacs are located dorsally, each area (fig. 5) bearing two naked setae 19 μ and 11 μ long, with a minute spiniform process between them. The three postgenital segments are 50 × 83 μ, 34 × 72 μ, and 52 × 81 μ from anterior to posterior. The anal segment has a row of minute spinules along its posteroventral margin on both sides.

The caudal ramus (fig. 6) is moderately elongated, 64 × 34 μ in greatest dimensions, about 1.9 times longer than wide. The outer lateral seta is 125 μ and the dorsal pedicellate seta 46 μ, both naked. The outermost terminal seta is 169 μ, the innermost terminal seta is 185 μ, and the two long median terminal setae are 363 μ (outer) and 462 μ (inner), both inserted between dorsal (unornamented) and ventral (with a marginal row of spinules) flaps. All four terminal setae have lateral spinules. The dorsal surface of the ramus has a few small hairs.

The dorsal surface of the prosome and the urosome bears a few minute hairs (sensilla); the ventral surface of the urosome has very few such hairs. The ratio of the length of the prosome to that of the urosome is 1.91 : 1.

The egg sac (fig. 1) is elongated, 627 × 209 μ, and tapered posteriorly. It reaches nearly to the ends of the longest ramal setae, and contains many eggs each about 52 μ in diameter.

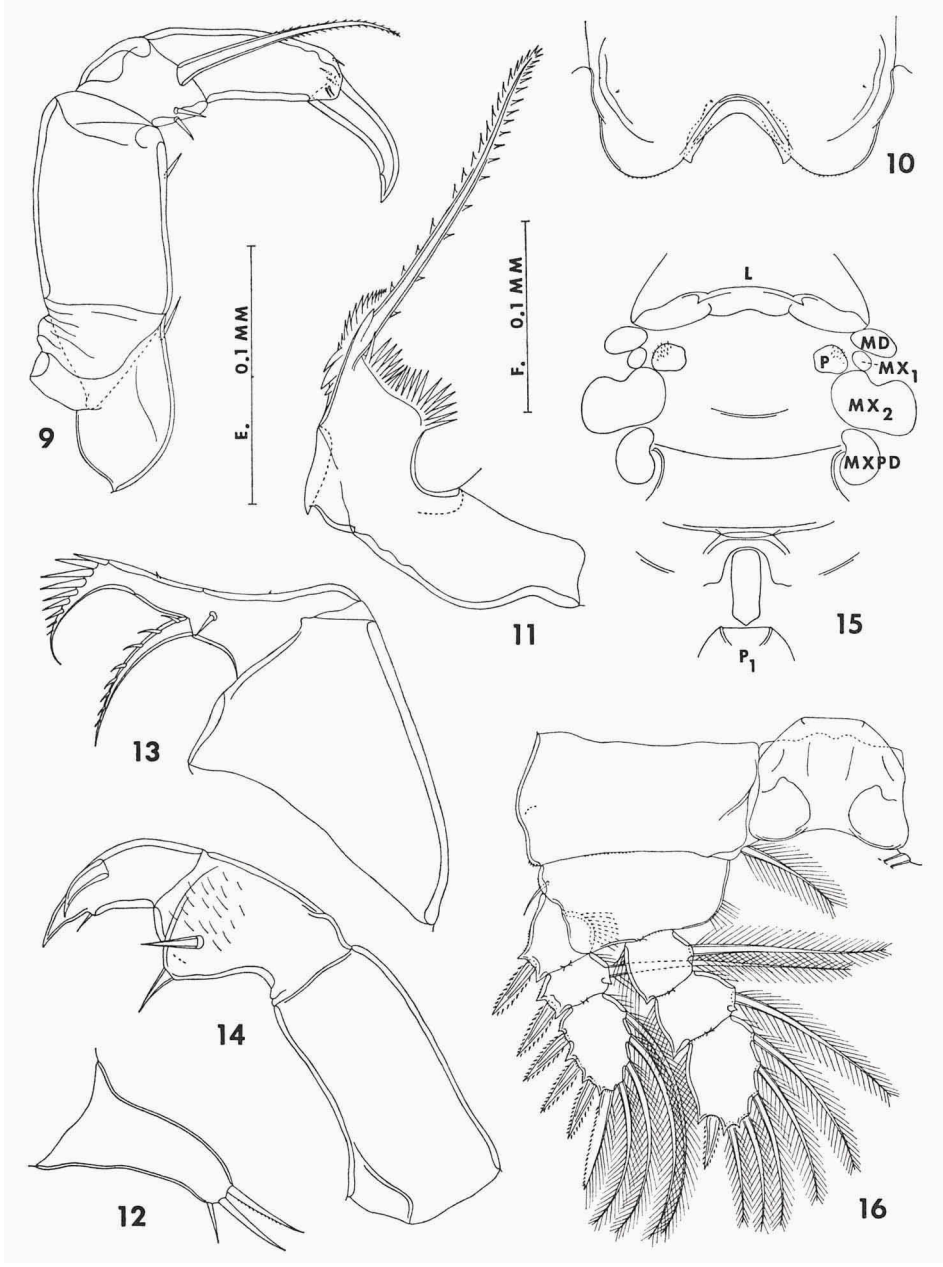
The rostrum (fig. 7) is weakly developed.

The first antenna (fig. 8) is slender, 416 μ long, and 7-segmented. The lengths of the segments are: 33 (69 μ along the anterior margin), 115, 28, 58, 64, 62, and 20 μ respectively. The formula for the armature is: 4, 13 (5 + 8), 6, 3, 4 + 1 aesthete, 2 + 1 aesthete, and 7 + 1 aesthete, as in many other species of *Lichomolgus*. All the setae are naked.

The second antenna (fig. 9) is 4-segmented. The fourth segment is 74 μ along its outer edge, 42 μ along its inner edge, and 25 μ wide at the middle. The armature of this appendage is: 1, 1, 3, I. One seta on the third segment is very long (85 μ) and barbed; the other two setae are short (8 μ) and naked. The terminal claw is 47 μ along its axis. Five minute hyaline setules occur on the last segment near the base of the claw.

The labrum (fig. 10) has two widely separated posteroventral lobes, their margins with very minute spinules.

The mandible (fig. 11) has on the concave side of its basal region a row of stout spinules and on the convex side of this region an unornamented hyaline scalelike area followed by a row of hyaline serrations, the first three of these directed proximally, the rest directed distally. The flagellum is long and has prominent barbs. The paragnath is a small hairy lobe internal to the base of the first maxilla (fig. 15). The first maxilla (fig. 12) has three setae. The second maxilla (fig. 13) is 2-segmented. The first segment is



Figs. 9-16. *Lichomolgus constrictus* n. sp., female. 9, second antenna, postero-inner (E); 10, labrum, ventral (F); 11, mandible, posterior (D); 12, first maxilla, posterior (D); 13, second maxilla, posterior (D); 14, maxilliped, antero-inner (D); 15, postoral area, ventral (C); 16, leg 1 and intercoxal plate (F).

large and unornamented. The second segment is elongated. Its slightly concave outer (ventral) margin bears a minute proximal spinule and a distal spiniform process. This segment is armed with an erect naked posterior surficial seta and a prominent seta with unilateral spinules on its inner (dorsal) margin. The terminal lash is short and bears unilateral spinules. The maxilliped (fig. 14) is 3-segmented. The first segment is unornamented; the second segment bears two naked setae and a patch of very fine spinules; and the third segment bears a stout recurved spine, a slender spinule, and a terminal spiniform process without an articulation, all three of these elements being naked.

The area between the maxillipeds and the first pair of legs (fig. 15) is only slightly protuberant just behind the level of the maxilipeds. A sclerotized line connects the bases of the maxillipeds.

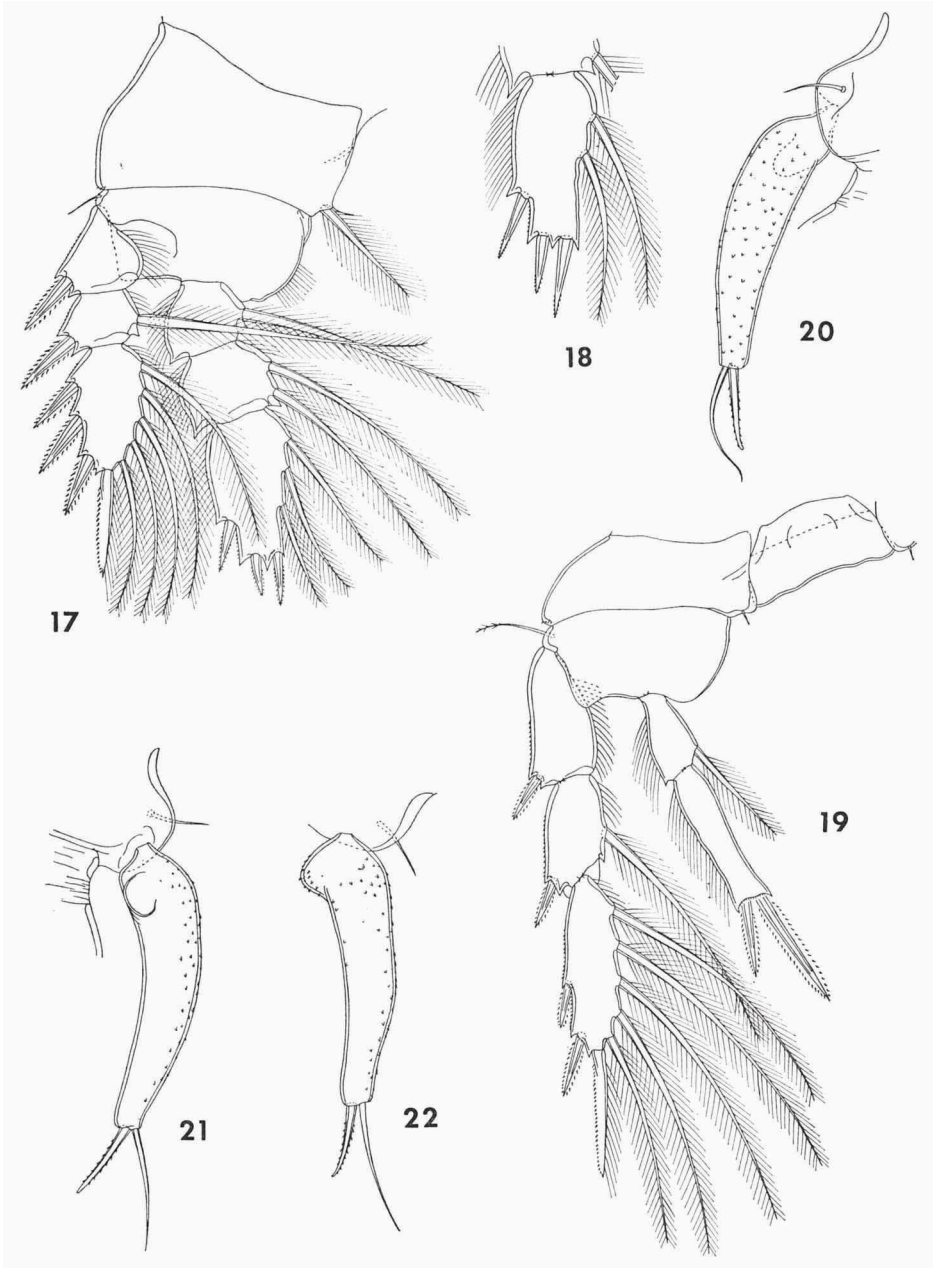
Legs 1 to 4 (figs. 16-19) have trimerous rami, except for the endopod of leg 4 which is 2-segmented. The armature is as follows:

P_1	coxa	0-1	basis	1-0	exp	I-0	I-1	III,I,4
					enp	0-1	0-1	I,5
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	0-2	I,II,2
P_4	coxa	0-1	basis	1-0	exp	I-0	I-1	II,I,5
					enp	0-1	II	

The inner seta on the coxa of legs 1 to 3 is large and feathered, but in leg 4 minute (10 μ long) and naked. The inner margin of the basis is haired in legs 1 to 3, but naked in leg 4. The endopod of leg 4 has hairs along the outer margins of both segments. The first segment is 44 $\times$ 24 μ, with its inner distal seta 60 μ long and feathered. The second segment is 79 μ long (including the terminal spiniform processes) and 20 μ in greatest width (15 μ in least width); the outer terminal spine is 39 μ, the inner spine 39 μ, both barbed.

Leg 5 (figs. 20-22) has an elongated free segment 133 μ in length, 28 μ wide at the middle, and 42 μ wide at the proximal expansion. This expansion is not easily recognized in dorsal or ventral views, but is clearly seen in a flat lateral view. The dorsal surface is covered with small blunt scalelike spines; the ventral surface has fewer such spines. Of the two terminal setae, one is spiniform, 42 μ long, with a few barbules, and with a blunt tip; the other is 77 μ and naked. The seta on the body near the insertion of the free segment is 38 μ and naked.

Leg 6 is probably represented by the two setae near the attachment of each egg sac (fig. 5).



Figs. 17-22. *Lichomolgus constrictus* n. sp., female. 17, leg 2, posterior (F); 18, last segment of endopod of leg 3, anterior (F); 19, leg 4 and intercoxal plate, anterior (F); 20, leg 5, dorsal (F); 21, leg 5, ventral (F); 22, free segment of leg 5, flat view of inner surface (F).

The color in life in transmitted light is opaque, the eye red, the egg sacs gray.

Male. — The body (fig. 23) in general form resembles that of the female. The length is 0.89 mm (0.81-0.94 mm) and the greatest width 0.32 mm (0.30-0.33 mm), based on 10 specimens. The ratio of the length to the width of the prosome is 1.74 : 1.

The segment of leg 5 (fig. 24) is 44 × 96 μ. There is no ventral intersegmental sclerite. The genital segment is 156 × 128 μ, longer than wide. The four postgenital segments are 36 × 54 μ, 33 × 54 μ, 25 × 51 μ, and 35 × 58 μ from anterior to posterior.

The caudal ramus is like that of the female, but smaller, 45 × 28 μ.

The surfaces of the body are ornamented with hairs as in the female. The ratio of the length of the prosome to that of the urosome is 1.55 : 1.

The rostrum is like that of the female.

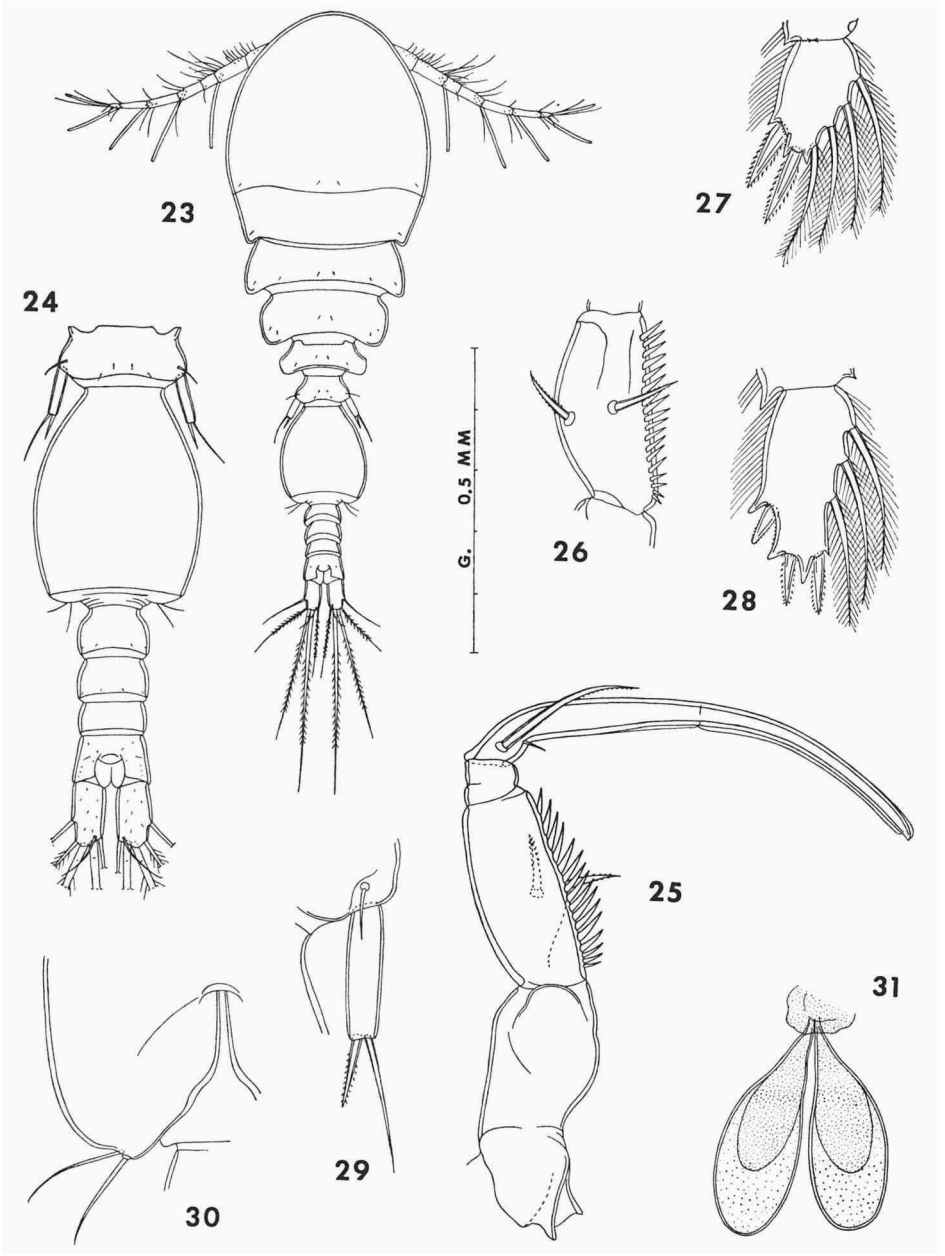
The first antenna is segmented and armed as in the female, but one aesthete is added on segment 2 and another on segment 4, so that the formula is: 4, 13 + 1 aesthete, 6, 3 + 1 aesthete, 4 + 1 aesthete, 2 + 1 aesthete, and 7 +1 aesthete. All the setae are naked.

The second antenna, labrum, mandible, paragnath, first maxilla, and second maxilla are like those of the female. The maxilliped (fig. 25) is slender and 4-segmented, assuming that the proximal part of the claw represents a fourth segment. The first segment is unornamented. The second segment (in anterior view slightly inflated as in fig. 26) has a row of spinules and two slightly barbed setae, and the third segment is small and unarmed. The claw is slender, 168 μ along its axis, with a minute terminal lamella, and with weak indication of division about midway. There are two very unequal setae on the proximal part of the claw, the larger one with minute spinules distally on one side.

The area between the maxillipeds and the first pair of legs is like that of the female.

Legs 1 to 4 are segmented and armed as in the female, except for the last segment of the endopod of leg 1 (fig. 27) where the formula is I,I, 4 instead of I,5 as in the female. There is slight sexual dimorphism in the last segment of the endopod of leg 2 (fig. 28), where the lengths of the three spines from outer to inner are 16, 19, and 24 μ, instead of 26, 21, and 28 μ in the female.

Leg 5 (fig. 29) has a small unornamented free segment 35 × 10 μ, with parallel sides and without a proximal expansion. The two terminal setae are 20 and 36 μ long. The seta on the body near the free segment is about 16 μ in length.



Figs. 23-31. *Lichomolgus constrictus* n. sp., male. 23, dorsal (G); 24, urosome, dorsal (C); 25, maxilliped, inner (E); 26, second segment of maxilliped, anterior (E); 27, last segment of endopod of leg 1, anterior (E); 28, last segment of endopod of leg 2, anterior (E); 29, leg 5, dorsal (D); 30, leg 6, ventral (E); 31, spermatophores, attached to female, dorsal (C).

Leg 6 (fig. 30) consists of a posteroventral flap on the genital segment, bearing two naked setae 31 and 35 μ long.

The spermatophore (fig. 31), attached to the female in pairs, is tear-shaped, about 155 × 60 μ, not including the neck.

Etymology. — The specific name *constrictus,* from Latin = constricted, refers to the shape of the genital segment in the female.

Comparison with related species. — There are twenty-five species in the genus *Lichomolgus* which, as in *L. constrictus,* have a single claw on the second antenna and the formula II,I,5 on the last segment of the exopod of leg 4. In none of these, however, is the genital segment of the female deeply constricted as in the new species.

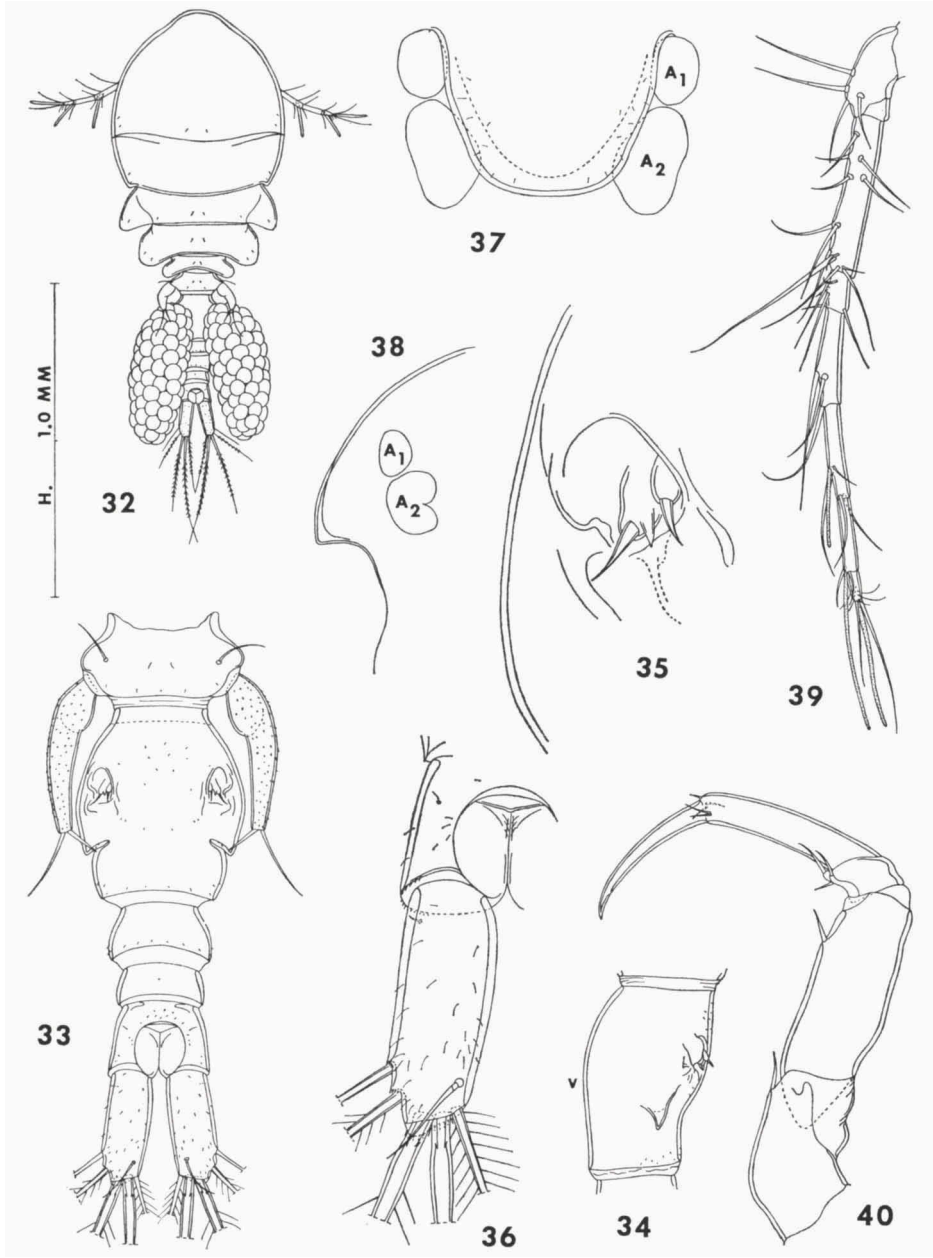
In *L. elegans* Thompson & A. Scott, 1903, the original description of which was based upon a single female from washings of dredged invertebrates in Ceylon, the genital segment has a "wedge-shaped notch near the centre on each side", thus somewhat resembling the condition in *L. constrictus.* The formula for the exopod of leg 4 is unknown, but the second antenna has a single claw as in the new species. This Ceylonese species is distinct from *L. constrictus* in having very short caudal rami, about as broad as long, and in the second segment of the first antenna being three times the length of the fourth, instead of twice the length of that segment as in the new species. Unfortunately the type specimen of *L. elegans* is no longer extant, the Andrew Scott collection having been discarded (see in this connection Humes & Ho, 1967: 209). I have examined the single specimen which A. Scott (1909) recorded as *L. elegans,* now in the Zoölogisch Museum, Amsterdam, no. 0.100.945, and have found it to be not *L. elegans* but another species (probably a fifth copepodid male) with the formula of III,I,5 for the last segment of the exopod of leg 4.

Lichomolgus insectus n. sp. (figs. 32-63)

Type material. — 147 ♀♀, 193 ♂♂, and 50 copepodids, from *Antipathes* cf. *spinescens* Gray, in 25 m, on the northern side of Tany Kely, a small island south of Nosy Bé, Madagascar, August 14, 1967. Holotype ♀ (no. F 786), allotype (no. F 787), and 180 paratypes (80 ♀♀, 100 ♂♂) (no. F 788) deposited in the Rijksmuseum van Natuurlijke Historie, Leiden; 70 paratypes (30 ♀♀, 40 ♂♂) in the United States National Museum, Washington; 40 paratypes (15 ♀♀, 25 ♂♂) in the Zoölogisch Museum, Amsterdam; and the remaining paratypes in the collection of the author.

Other specimens. — From *Antipathes* cf. *spinescens*: 17 ♀♀, 9 ♂♂, and 4 copepodids, in 23 m, Tany Kely, June 30, 1967; and 4 ♀♀, 11 ♂♂, in 24 m, north of Ankazoberavina, 13°27.6'S 47°58.2'E, west of Nosy Bé, August 25, 1967.

From *Antipathes myriophylla* Pallas: 13 ♀♀, 10 ♂♂, and 18 copepodids, in 24 m, Banc des Frères, Isles Mitsio, 12°58'30"S 48°28'00"E, northeast of Nosy Bé, August 17, 1967.



Figs. 32-40. *Lichomolgus insectus* n. sp., female. 32, dorsal (H); 33, urosome, dorsal (B); 34, genital segment, letter V = ventral side, lateral (B); 35, area of attachment of egg sac, dorsal (D); 36, caudal ramus, dorsal (F); 37, rostrum, ventral (C); 38, outline of rostrum, lateral (B); 39, first antenna, dorsal (C); 40, second antenna, postero-inner (F).

From *Antipathes abies* (Linnaeus): 2 ♀♀, 3 ♂♂, and 4 copepodids, in 24 m Banc des Frères, Isles Mitsio, 12°58'30"S 48°28'00"E, August 17, 1967; 7 ♀♀, 7 ♂♂, and 1 copepodid, in 22 m, Tany Kely, June 17, 1967; and 8 ♀♀, 5 ♂♂, and 4 copepodids, in 20 m, Tany Kely, August 25, 1964.

Female. — The body (fig. 32) is more slender than in *L. constrictus,* with the prosome slightly thickened in lateral view as in that species. The length is 1.34 mm (1.28-1.47 mm) and the greatest width 0.55 mm (0.54-0.57 mm), based on 10 specimens. The ratio of the length to the width of the prosome is 1.47:1. The epimeral areas of the metasomal segments resemble those in *L. constrictus.*

The segment of leg 5 (fig. 33) is 96 × 180 μ. Between this segment and the genital segment there is no ventral intersegmental sclerite. The genital segment is 208 μ long, in dorsal and ventral views divided into two parts by deep lateral notches, the anterior part 135 × 187 μ with rather pointed posterolateral regions, the posterior part 73 × 148 μ with rounded sides. In lateral view (fig. 34) the posterolateral corners of the anterior part are pointed rather than rounded as in *L. constrictus.* The areas of attachment of the egg sacs are situated dorsolaterally in the middle of the anterior part, each area (fig. 35) having two naked setae 14 μ and 10 μ long, with a small spiniform process between them. The three postgenital segments are 70 × 114 μ, 40 × 94 μ, and 78 × 112 μ from anterior to posterior. The anal segment has a row of minute spinules outwardly on both posterodorsal and posteroventral margins on both sides.

The caudal ramus (fig. 36) is more elongated than in *L. constrictus,* 133 × 49 μ in greatest dimensions, about 2.65 times longer than wide. The outer lateral seta is 120 μ, the dorsal pedicellate seta is 44 μ, the outermost terminal seta is 186 μ, the innermost terminal seta is 226 μ, and the two long median terminal setae are 315 μ (outer) and 418 μ (inner), both inserted between dorsal (unornamented) and ventral (with a marginal row of spinules) flaps. The lateral spinulation on these setae is as in *L. constrictus.* There are small spinules near the insertions of the lateral and outermost terminal setae. The dorsal surface of the ramus bears hairs; the ventral surface has fewer hairs and has a proximal outer spinule.

The dorsal surface of the prosome and the urosome has a few minute hairs (sensilla); the ventral surface of the urosome almost entirely lacks such hairs. The ratio of the length of the prosome to that of the urosome is 1.56 : 1.

The egg sac (fig. 32) is elongated, 475-560 × 200 μ, is slightly tapered posteriorly, reaches just beyond the caudal rami, and contains many eggs each about 60 μ in diameter.

The rostrum (fig. 37) has a subtruncated posteroventral margin and projects in lateral view (fig. 38).

The first antenna (fig. 39) is slender, 421 μ long. The lengths of the segments are: 35 (69 μ along the anterior margin), 119, 25, 67, 66, 52, and 23 μ respectively. The formula for the armature is the same as in *L. constrictus*. All the setae are naked.

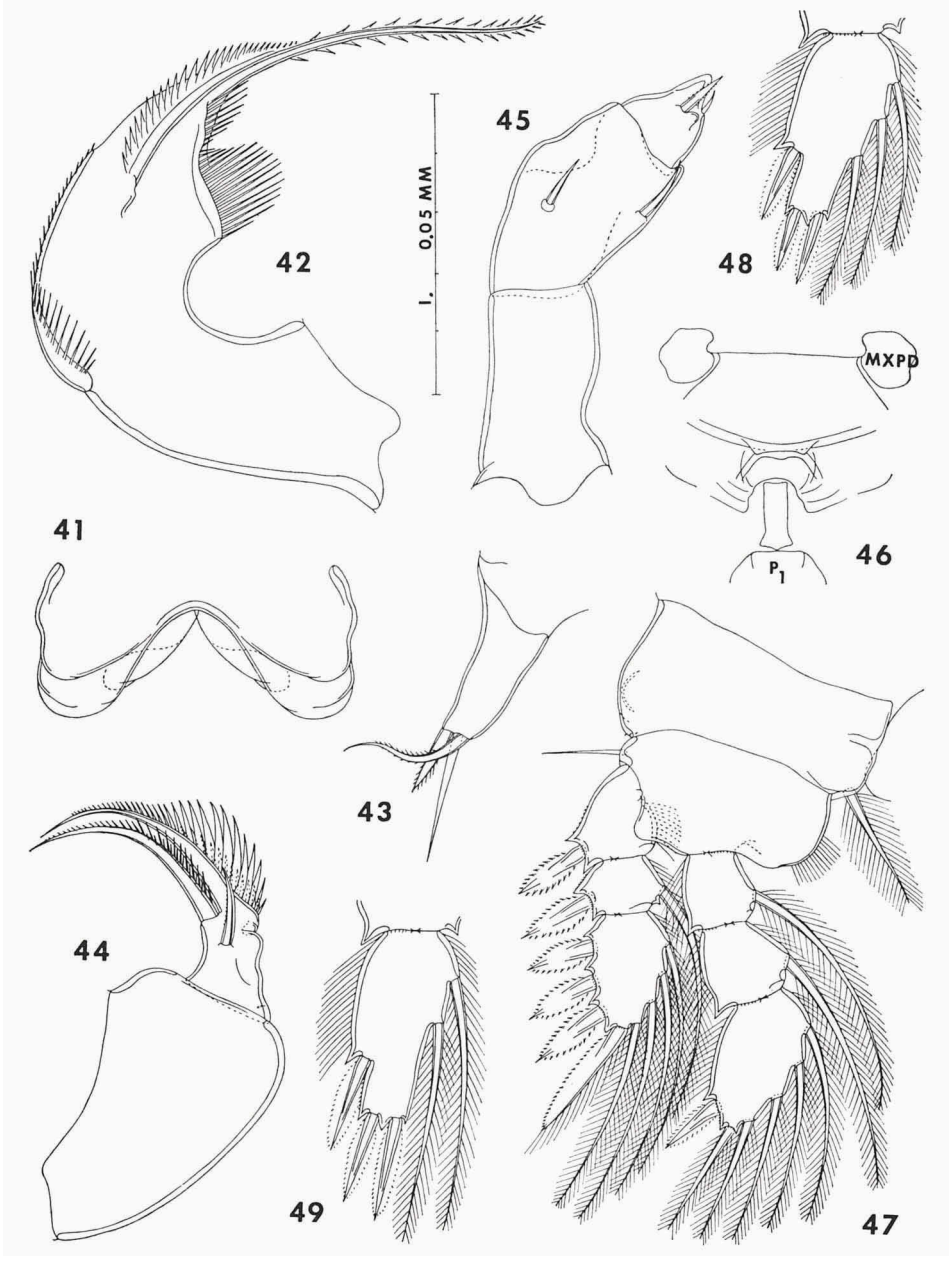
The second antenna (fig. 40) is 4-segmented and slender. The fourth segment is 99 μ along its outer edge, 66 μ along its inner edge, and 18 μ wide at the middle. All three setae on the third segment are relatively short and naked. The last segment has a single slender claw 80 μ long, and bears five small hyaline setules near the insertion of the claw.

The labrum (fig. 41) has two divergent and rather elongated lobes, their distal margins hyaline.

The mandible (fig. 42) has on the concave side of its basal region an interrupted row of slender spinules and on the convex side of this region a scalelike area with a row of spinules, followed by a dentate hyaline fringe along the base of the flagellum. The flagellum is long and barbed. The paragnath is a small hairy lobe as in *L. constrictus*. The first maxilla (fig. 43) has three setae. The second maxilla (fig. 44) has a large first segment as in *L. constrictus*, but the second segment is shorter than in that species. On the second segment the posterior surficial seta has spinules along one edge but the other edge has a narrow smooth lamella, the inner (dorsal) seta is long with two rows of spinules along its distal edge, and the long terminal lash has three rows of spinules (the spinules of the third row the shortest and not shown in the figure). The maxilliped (fig. 45) is 3-segmented and has the same arrangement of elements as in *L. constrictus*. The second segment lacks surficial spinules. The third segment bears a spinule and a finely barbed spine, and terminates in a blunt process with a hyaline tip.

The area between the maxillipeds and the first pair of legs (fig. 46) is in major respects similar to that of *L. constrictus*.

Legs 1 to 4 (figs. 47-50) are segmented as in *L. constrictus* and have the same spine and setal formula as in that species. The fine ornamentation is also much like that of *L. constrictus*. The coxa of leg 1 has a rounded protuberance on the posterior outer surface. The inner seta on the coxa of leg 4 is about 23 μ long and delicately feathered. The first segment of the endopod of leg 4 is 45 $\times$ 31 μ (the length including the spinous processes), and its inner distal feathered seta is 84 μ. The second segment is 91 $\times$ 24 μ (in greatest dimensions, including the processes), its outer terminal spine 39 μ, its inner spine 75 μ, both barbed.



Figs. 41-49. *Lichomolgus insectus* n. sp., female. 41, labrum, ventral (E); 42, mandible, posterior (I); 43, first maxilla, posterior (D); 44, second maxilla, posterior (D); 45, maxilliped, antero-inner (D); 46, area between maxillipeds and leg 1, ventral (C); 47, leg 1, anterior (F); 48, last segment of endopod of leg 2, anterior (F); 49, last segment of endopod of leg 3, anterior (F).

Leg 5 (fig. 51) resembles that of *L. constrictus*. The free segment is 152 μ long, 25 μ wide at the middle, and 42 μ wide at the proximal expansion (fig. 52). The dorsal surface has small blunt scalelike spines, and the ventral surface has fewer such spines. Of the two terminal setae, one is spiniform and barbed, 48 μ, the other is slender and naked, 94 μ. The seta on the body near the insertion of the free segment is 66 μ and naked.

Leg 6 is probably represented by the two setae near the attachment of each egg sac (fig. 35).

The color in life in transmitted light is opaque gray, the eye red, the egg sacs dark gray.

Male. — The body (fig. 53) is slender. The length is 0.94 mm (0.89-0.98 mm) and the greatest width 0.31 mm (0.30-0.34 mm), based on 10 specimens. The ratio of the length to the width of the prosome is 1.90: 1.

The segment of leg 5 (fig. 54) is 52 × 81 μ. There is no ventral intersegmental sclerite. The genital segment is 170 × 133 μ. The four postgenital segments are 36 × 60 μ, 34 × 57 μ, 18 × 53 μ, and 42 × 68 μ from anterior to posterior.

The caudal ramus is similar to that of the female, but smaller, 79 × 29 μ.

The surfaces of the body are ornamented with hairs as in the female. The ratio of the length of the prosome to that of the urosome is 1.48 : 1.

The rostrum (fig. 55) has a pair of small knoblike protuberances on its posteroventral margin.

The first antenna is segmented and armed as in the female, but, as in the male of *L. constrictus*, has two aesthetes added, so that the formula is the same as for the male of that species.

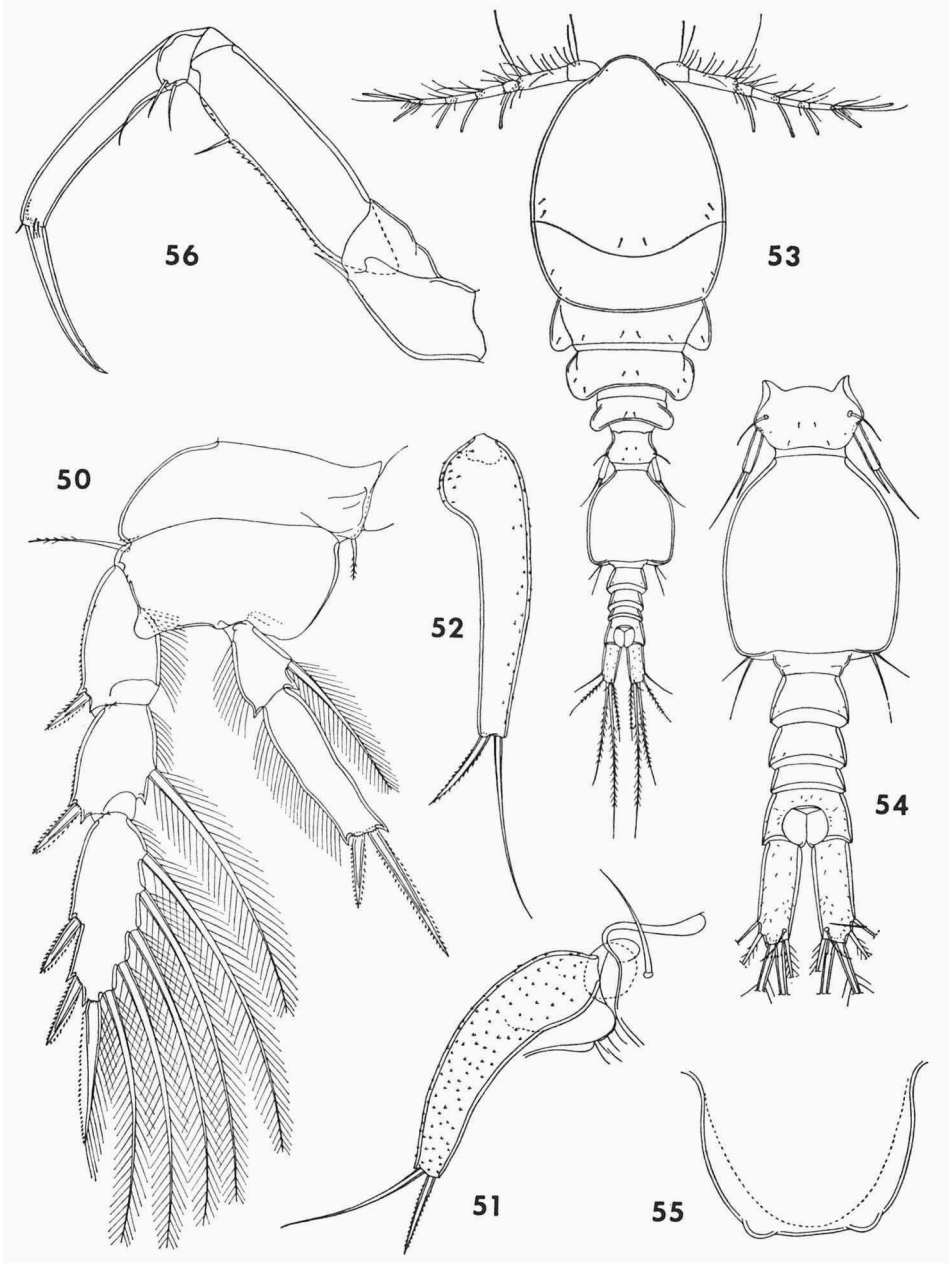
The second antenna (fig. 56) resembles that of the female, but the second segment has small spines along its inner edge.

The labrum, mandible, paragnath, first maxilla, and second maxilla are like those of the female. The maxilliped (fig. 57) is slender, with its armature and ornamentation similar to *L. constrictus*. The claw is 172 μ along its axis (including the terminal lamella) and has a few striations on its proximal inner surface (fig. 58).

The area between the maxillipeds and the first pair of legs is like that in the female.

Legs 1 to 4 are segmented and armed as in the female, except for the last segment of the endopod of leg 1 (fig. 59) which has the formula I, I, 4, as in the male of *L. constrictus*. Very slight sexual dimorphism occurs in the last segment of the endopod of leg 2, where the three spines are 32, 24, and 26 μ from outer to inner, instead of 39, 34, and 37 μ in the female.

Leg 5 (fig. 61) has a small unornamented free segment 35 × 9 μ,



Figs. 50-52. *Lichomolgus insectus* n. sp., female. 50, leg 4, anterior (F); 51, leg 5, dorsal (F); 52, free segment of leg 5, inner (F).
Figs. 53-56. *Lichomolgus insectus* n. sp., male. 53, dorsal (G); 54, urosome, dorsal (C); 55, rostrum, ventral (E); 56, second antenna, postero-inner (E).

resembling that of *L. constrictus*. The terminal setae are 20 and 56 μ. The seta on the body near the free segment is 33 μ.

Leg 6 (fig. 62) consists of a posteroventral flap on the genital segment, bearing two naked setae 50 and 24 μ long.

The spermatophore (fig. 63), attached to the female in pairs, is elongated, 164 × 32 μ, not including the neck, and shows faint transverse striations distally.

Etymology. — The specific name *insectus*, from Latin = notched, alludes to the lateral notches on the genital segment of the female.

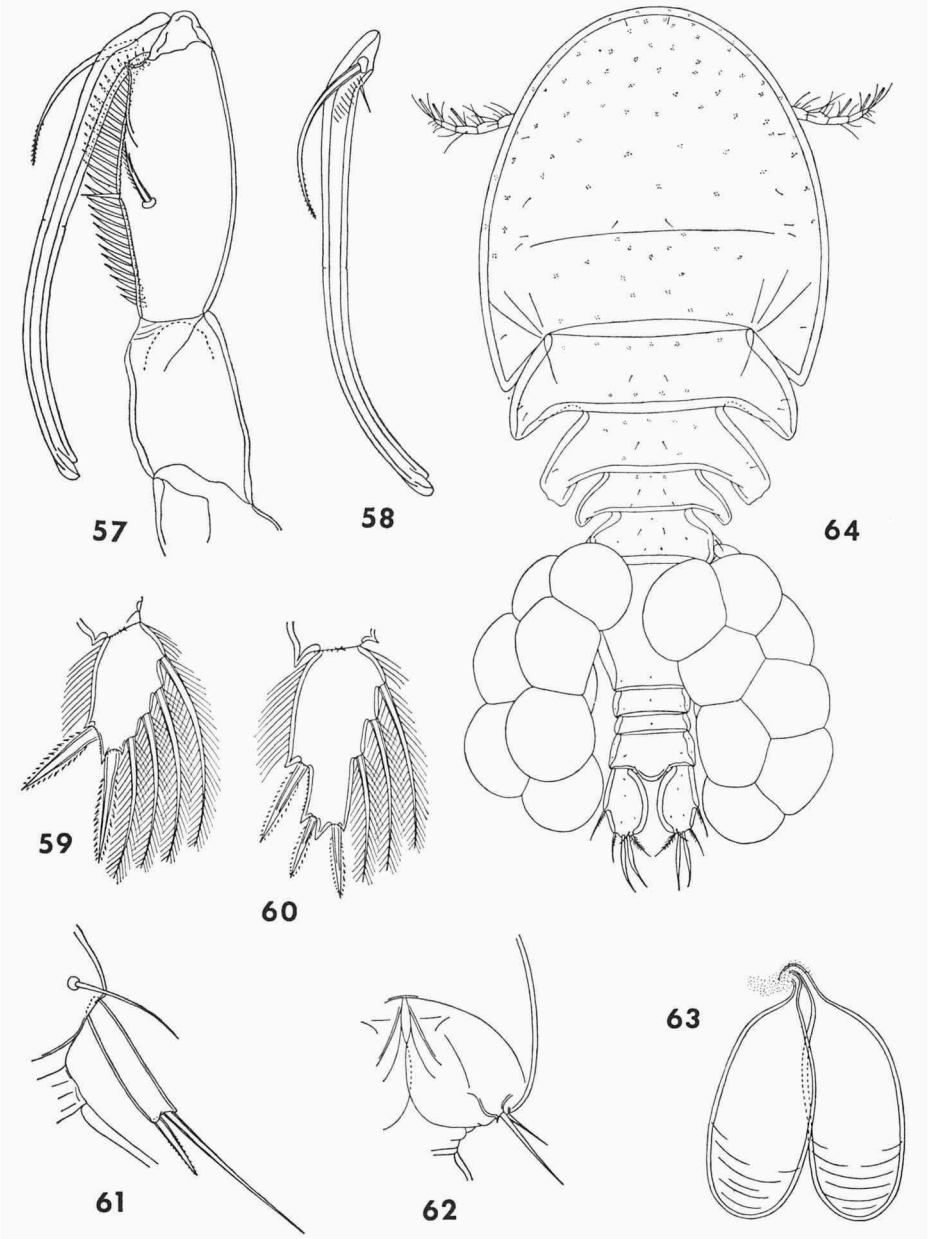
Comparison with other species. — *L. insectus* may be distinguished by the form of the genital segment in the female from other species in the genus which have a single claw on the second antenna and the formula II, I, 5 on the last segment of the exopod of leg 4. Among such species only *L. constrictus* has a deeply incised genital segment in the female.

The new species, while apparently closely related to *L. constrictus*, as indicated principally by similarities in the body form, first antenna, legs 1 to 4, and leg 5, shows several readily observable differences. These in the female *L. insectus* are chiefly the relative size and shape of the egg sac, the shape of the genital segment, the ratio of length to width of the caudal ramus (2.65:1 instead of 1.9:1), the well-formed rostrum, the absence of an elongated seta on the third segment and the long slender terminal claw of the second antenna, and the form of the mandible, the second segment of the second maxilla, and the maxilliped. In the male the conspicuous differences are the slender body, the pair of knoblike protuberances on the rostrum, and the spines along the inner edge of the second segment of the second antenna.

L. elegans Thompson & A. Scott, 1903, has a notched genital segment in the female, as mentioned above, but in this Ceylonese species the caudal rami are very short, about as broad as long, and the second segment of the first antenna is said to be three times the length of the fourth.

Thamnomolgus n. gen.

Body cyclopoid. Segment of leg 1 incompletely separated from the head by a dorsal furrow. Urosome 5-segmented in the female, 6-segmented in the male. Caudal ramus with six relatively short setae. Rostrum with a broadly truncated posteroventral margin. First antenna 7-segmented, with lichomolgid armature. Second antenna 4-segmented, the third segment short with three setae. Labrum subquadrate with two well-sclerotized lobes separated by a very shallow indentation. Mandible a simple blade without a proximal constriction. Paragnath a hairy lobe. First maxilla with two



Figs. 57-63. *Lichomolgus insectus* n. sp., male. 57, maxilliped, outer (E); 58, claw of maxilliped, inner (E); 59, last segment of endopod of leg 1, anterior (E); 60, last segment of endopod of leg 2, anterior (E); 61, leg 5, dorsal (D); 62, leg 6, ventral (F); 63, spermatophores, attached to female, lateral (C).

Fig. 64. *Thamnomolgus robustus* n. gen., n. sp., female. 64, dorsal (G).

setae. Second maxilla 2-segmented, the small second segment with a slender blade corresponding to the lash in other lichomolgids. Maxilliped in the female 3-segmented, in the male 4-segmented (the fourth segment probably represented by the proximal part of the claw).

Legs 1 to 4 with 3-segmented rami and with the same armature in both sexes. Endopod of leg 1 in the male showing strong sexual dimorphism. Endopod of leg 4 with the formula 0-1; 0-1; II. Leg 5 in the female with a free segment bearing two setae; in the male this segment fused with the body but also with two setae.

Other features as in the species described below.

Associated with antipatharian coelenterates.

Type and only known species: *Thamnomolgus robustus* n. sp.

Gender masculine.

Etymology. — The generic name is a combination of Θάμνος = a bush, alluding to the bushy appearance of the antipatharian hosts, and μολγός = a sack made of leather, a frequently used combining form in lichomolgid genera.

Thamnomolgus robustus n. gen., n. sp. (figs. 64-97)

Type material. — 23 ♀♀, 9 ♂♂, and 11 copepodids, from *Antipathes myriophylla* Pallas, in 24 m, Banc des Frères, Isles Mitsio, 12°58'30"S 48°28'00"E, northeast of Nosy Bé, Madagascar, August 17, 1967. Holotype ♀ (no. F 783), allotype, (no. F 784) and 25 paratypes (19 ♀♀, 6 ♂♂) (no. F 785) deposited in the Rijksmuseum van Natuurlijke Historie, Leiden; the remaining paratypes in the collection of the author.

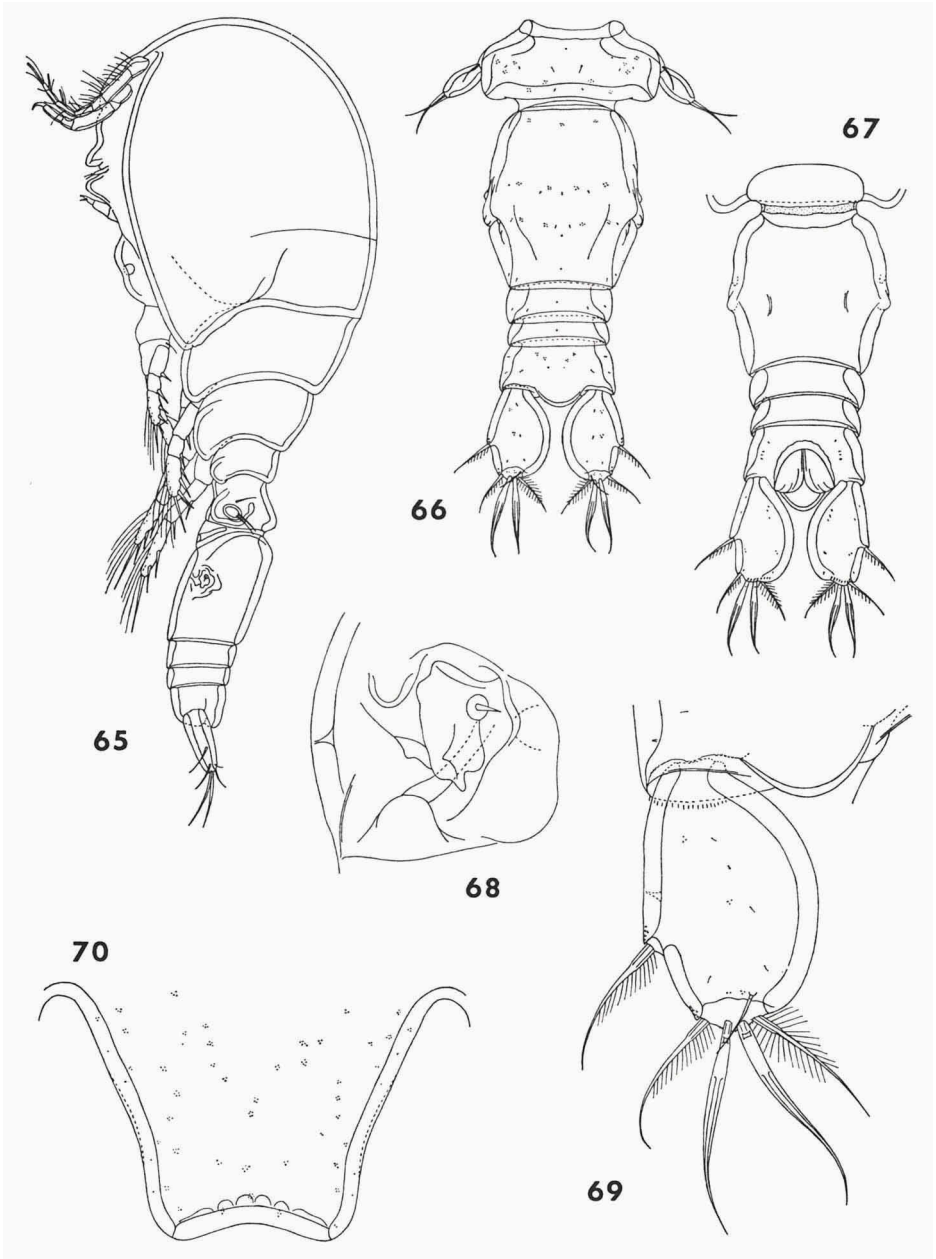
Other specimens. — From *Antipathes* cf. *spinescens* Gray: 9 ♀♀, 10 ♂♂, and 3 copepodids, in 24 m, north of Ankazoberavina, 13°27.6'S 47°58.2'E, west of Nosy Bé, August 25, 1967; 6 ♀♀, 4 ♂♂, and 9 copepodids, in 24 m, Banc des Frères, Isles Mitsio, 12°58'30"S 48°28'00"E, August 17, 1967; and 3 ♀♀, 12 ♂♂, in 25 m, Tany Kely, a small island south of Nosy Bé, August 14, 1967.

From *Antipathes abies* (Linnaeus): 1 ♀, 2 ♂♂, and 1 copepodid, in 22 m, Tany Kely, June 17, 1967; 2 ♀♀, in 20 m, Tany Kely, August 25, 1964; and 2 ♂♂, 5 copepodids, in 24 m, Banc des Frères, Isles Mitsio, 12°58'30"S 48°28'00"E, August 17, 1967.

From *Antipathes ericoides* Pallas: 1 ♂, in 35 m, north of Nosy Sakatia, 13°15'50"S 48°08'35"E, August 30, 1967.

Female. — The body (fig. 64) is moderately slender and well-sclerotized, with the prosome somewhat thickened in lateral view (fig. 65). The length is 1.21 mm (1.15-1.25 mm) and the greatest width is 0.53 mm (0.51-0.56 mm), based on 10 specimens. The ratio of the length to the width of the prosome is 1.41 : 1. The segment of leg 1 is incompletely delimited from the head. The epimeral areas of the segments of legs 1 and 2 are rather pointed, those of the segment of leg 3 are truncated, and those of the segment of leg 4 are small and only slightly pointed.

The segment of leg 5 (fig. 66) is 86 × 208 μ. Between this segment and



Figs. 65-70. *Thamnomolgus robustus* n. gen., n. sp., female. 65, lateral (G); 66, urosome, dorsal (B); 67, genital and postgenital segments, ventral (B); 68, area of attachment of egg sac, lateral (I); 69, caudal ramus, dorsal (E); 70, rostrum, antero-ventral (F).

the genital segment there is a short ventral intersegmental sclerite (fig. 67). The genital segment is 190 × 177 μ, a little longer than wide and only slightly expanded laterally. The areas of attachment of the egg sacs are situated laterally, each area (fig. 68) bearing a single minute naked seta 5 μ long. The three postgenital segments are 42 × 118 μ, 31 × 112 μ, and 60 × 130 μ from anterior to posterior. The anal segment bears a row of small spinules along its posteroventral margin on both sides, and has a prominent semilunar operculum which in dorsal view conceals the anal opening (fig. 66).

The caudal ramus (fig. 69) is flattened and subelliptical, 102 × 66 μ in greatest dimensions, about 1.55 times longer than wide. The outer lateral seta is 55 μ with spinules along one edge, the dorsal pedicellate seta is 19 μ and naked, the outermost terminal seta is 55 μ with spinules along one edge, and the innermost terminal seta is 55 μ with spinules along both sides. The two median terminal setae are relatively short, 85 μ, naked, swollen, and hyaline, both inserted dorsally: the margin of the ramus ventral to their bases bears a row of minute spinules. A few very small knobs occur near the insertions of the two outer setae. The dorsal and ventral surfaces of the ramus bear a few hairs and groups of refractile points.

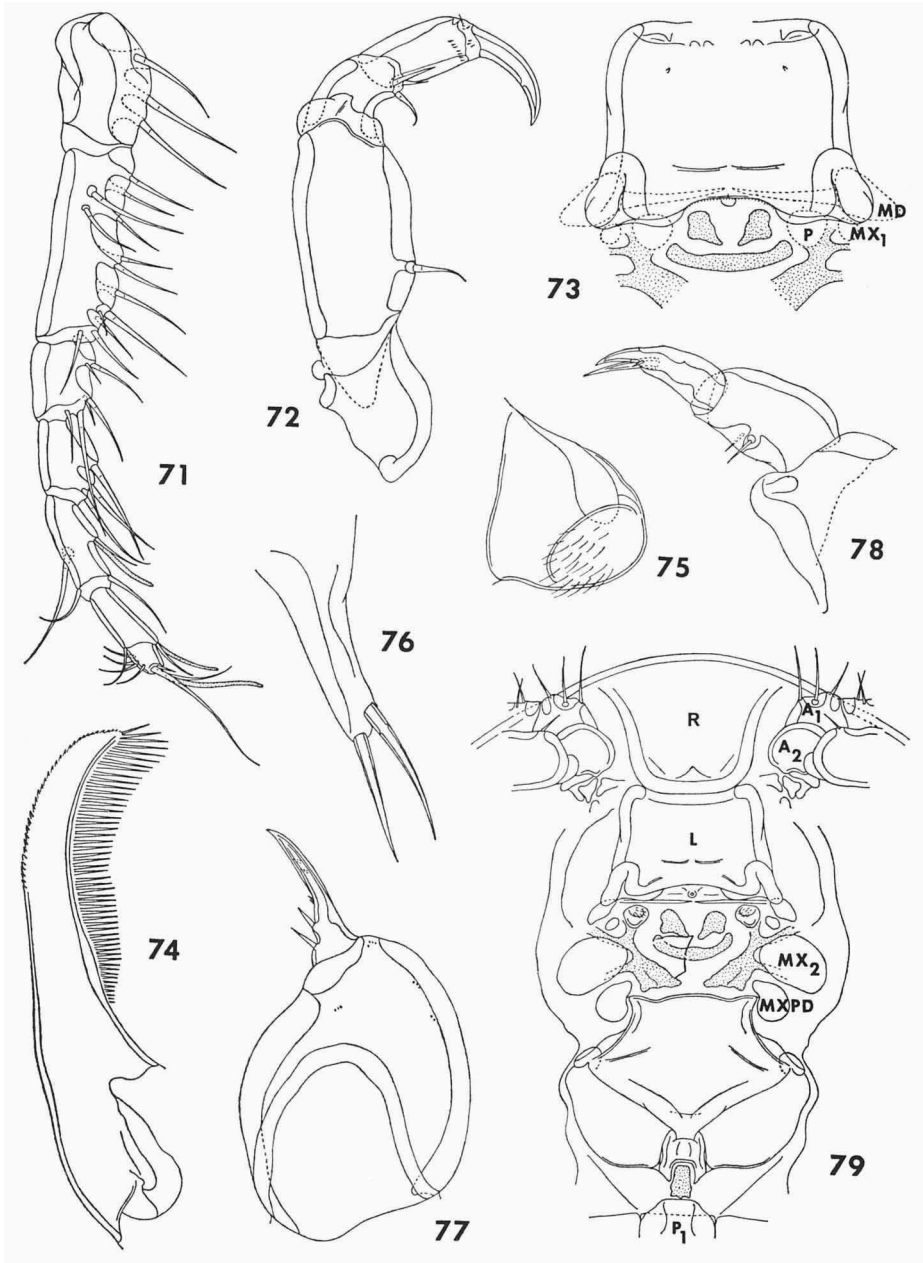
The dorsal surface of the prosome and the urosome has a few hairs (sensilla) and many groups of refractile points; the ventral surface of the urosome is sparsely ornamented. The ratio of the length of the prosome to that of the urosome is 1.54 : 1.

The egg sac (fig. 64) is elongated oval, 460 × 220 μ in greatest dimensions, reaches just beyond the caudal rami, and contains 3-9 large eggs (usually 8 or 9), each egg 125 μ in diameter.

The rostrum (fig. 70) has a broadly truncated posteroventral margin which fits closely against the anterior part of the labrum (fig. 79).

The first antenna (fig. 71) is 7-segmented, 253 μ long. The lengths of the segments are: 29 (48 μ along the anterior margin), 72, 29, 28, 40, 22, and 14 μ respectively. The formula for the armature is: 3, 13, 6, 3, 4 + 1 aesthete, 2 + 1 aesthete, and 7 + 1 aesthete (thus closely resembling the condition in *Lichomolgus*). All the setae are naked and many show very weak proximal joints.

The second antenna (fig. 72) is 4-segmented. The first segment is unarmed. The second segment has a proximal inner naked seta. Between these two segments there is an outer membranous spherical protrusion. The third segment bears three relatively short naked setae. The fourth segment is 44 μ along its outer edge, 25 μ along its inner edge, and 19 μ wide, bearing distally a row of minute spinules, subterminally a few very



Figs. 71-79. *Thamnomolgus robustus* n. gen., n. sp., female. 71, first antenna, anterodorsal (E); 72, second antenna, postero-inner (E); 73, labrum, ventral (F); 74, mandible, posterior (I); 75, paragnath, ventral (I); 76, first maxilla, posterior (I); 77, second maxilla, anterior (D); 78, maxilliped, anterior (D); 79, cephalosome, ventral (C).

small spinules and a hyaline setuliform element, and terminally a recurved claw 45 μ along its axis.

The labrum (fig. 73) is rather quadrate, its posteroventral border showing a broad and very shallow indentation (its margin very finely pectinate) separating two strongly sclerotized lobes, medial to each of which there is a narrow hyaline lamella.

The mandible (fig. 74) is an elongated gently recurved blade with long spinules on its concave margin and small dentiform spinules on its convex margin. The paragnath (fig. 75) is a small lobe with a hairy tip situated medially to the mandible and first maxilla (fig. 79). The first maxilla (fig. 76) is a slender lobe with two naked setae. The second maxilla (fig. 77) is 2-segmented. The first segment is very large and ornamented with a few groups of refractile points (probably representing openings of ducts from glands). The second segment is small and slender, proximally with two naked setae, distally forming a slender blade (corresponding to the lash in *Lichomolgus*) bearing a few spinules. The maxilliped (fig. 78) is 3-segmented, though the unarmed first segment is not well-separated from the body. The second segment bears two naked setae. The third segment bears a small spinule and a long spine, and terminates in a spiniform process without a definite articulation, all these elements being naked.

The relationships of the mouthparts and the sclerites of the postoral area are shown in fig. 79. The area between the maxillipeds and the first pair of legs (fig. 79) is slightly protuberant (fig. 65). A sclerotized line connects the bases of the maxillipeds.

Legs 1-4 (figs. 80-83) have trimerous rami. The armature is as follows:

P_1	coxa	0-1	basis	1-0	exp	I-0	I-1	III,I,4
					enp	0-1	0-1	I,5
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	0-2	II,2
P_4	coxa	0-1	basis	1-0	exp	I-0	I-1	II,I,5
					enp	0-1	0-1	II

The inner seta on the coxa of legs 1 to 3 is long and plumose, but in leg 4 it is shorter (39 μ) and very weakly feathered. The inner margin of the basis of legs 1, 2, and 4 is smooth, but in leg 3 has a row of hairs. In the series of legs the endopods become shorter and more slender posteriorly. The endopod of leg 4 (fig. 83) is short and slender (88 μ long), less than half the length of the exopod (194 μ). The first segment is 24×17 μ, its seta 72 μ. The second segment is 29×14 μ, its seta 80 μ. The third segment is 31×8 μ, its outer spine 34 μ, its inner spine 86 μ, both finely

barbed. All three segments have hairs along their outer margins, but their inner margins are smooth.

Leg 5 (fig. 84) has a small suboval free segment 47 × 25 μ, armed with two naked terminal setae 41 and 46 μ. The dorsal surface of the segment is ornamented with two proximal rows and a distal patch of small spines. The seta on the body near the insertion of the free segment is 33 μ and naked.

Leg 6 is probably represented by the seta near the attachment of each egg sac (fig. 68).

The color in life in transmitted light is as follows: the prosome (especially the metasomal segments) pale brown, the urosome light amber, the eye red, the egg sacs black.

Male. — The body (fig. 85) resembles in most respects that of the female, but the cephalosome is relatively shorter. The length is 1.05 mm (1.02-1.10 mm) and the greatest width 0.46 mm (0.44-0.47 mm), based on 10 specimens. The ratio of the length to the width of the prosome is 1.39:1.

The segment of leg 5 (fig. 86) is 60 × 180 μ. Between this segment and the genital segment there is no ventral intersegmental sclerite. The genital segment is quadrate, 177 × 208 μ, a little wider than long. The length of this segment, including leg 6, is 205 μ. The four postgenital segments are 25 × 89 μ, 21 × 94 μ, 17 × 99 μ, and 41 × 117 μ from anterior to posterior.

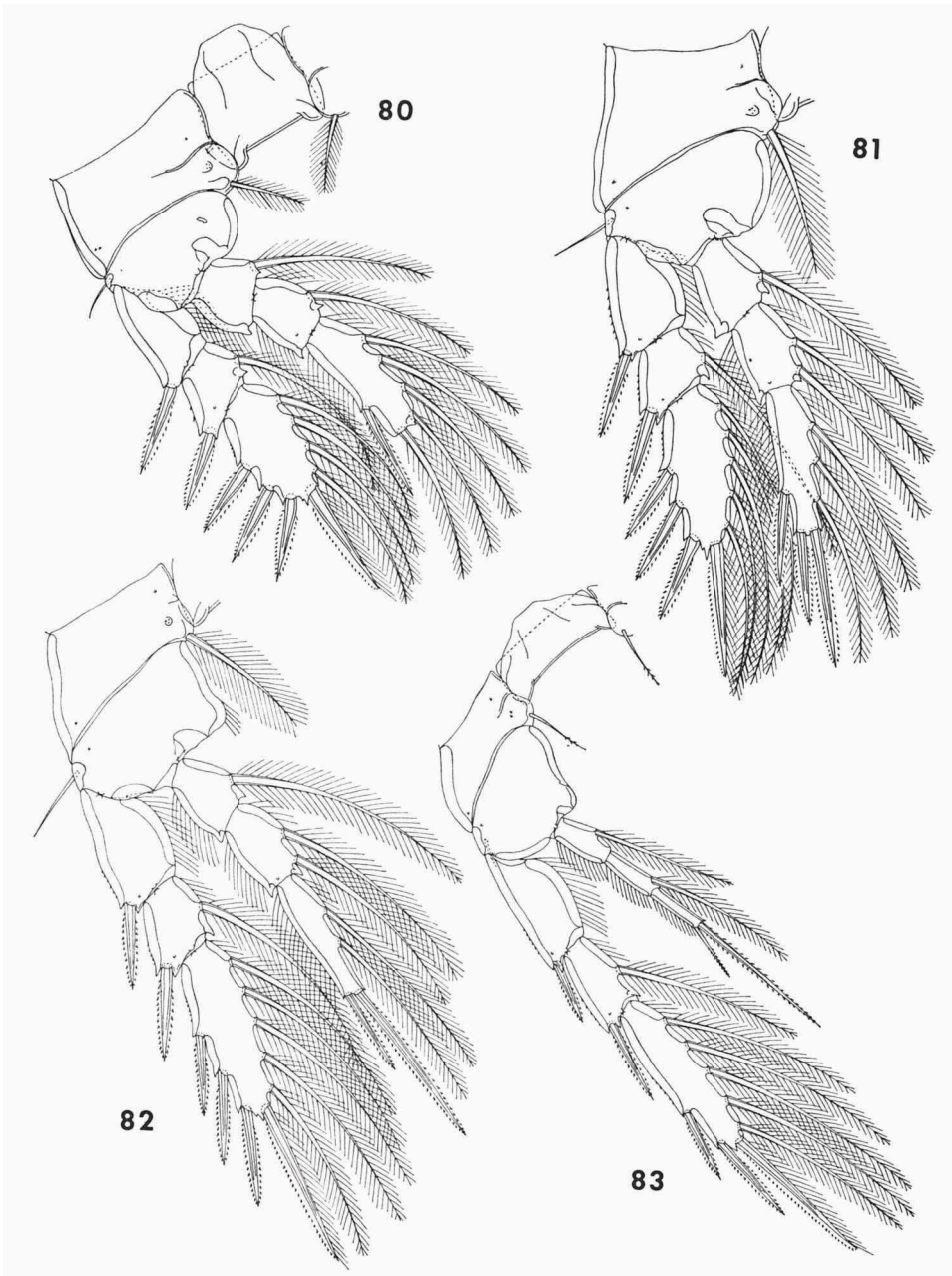
The caudal ramus resembles that of the female, but is smaller, 88 × 57 μ.

The dorsal surface of the prosome and the dorsal and ventral surfaces of the urosome have fine ornamentation as in the female. The ratio of the length of the prosome to that of the urosome is 1.51:1.

The rostrum is like that of the female.

The first antenna (fig. 87) is similar to that of the female, but two aesthetes are added on segment 2 and one on segment 4, so that the formula is: 3, 13 + 2 aesthetes, 6, 3 + 1 aesthete, 4 + 1 aesthete, 2 + 1 aesthete, and 7 + 1 aesthete. The second antenna is like that of the female except for the presence of minute knobs on the inner distal surface of the second segment (fig. 88).

The labrum, mandible, paragnath, first maxilla, and second maxilla resemble those of the female. The maxilliped (fig. 89) is 4-segmented, assuming that the proximal part of the claw represents a fourth segment. The first segment is small, unarmed, and not clearly delimited from the body. The second segment bears two naked setae (fig. 90); the outer margin of this segment is inflated, the inner margin is fairly straight and



Figs. 80-83. *Thamnomolgus robustus* n. gen., n. sp., female. 80, leg 1 and intercoxal plate, anterior (F); 81, leg 2, anterior (F); 82, leg 3, anterior (F); 83, leg 4 and intercoxal plate, anterior (F).

ornamented with a proximal row of several dentiform processes and with a distal row of minute knobs. The third segment is small and unarmed. The claw (fig. 91) is 112 μ along its axis, with two very unequal naked proximal setae and showing a weak indication of division about midway.

The area between the maxillipeds and the first pair of legs is similar to that in the female. On the ventral surface of the cephalosome lateral and somewhat posterior to the base of each maxilliped there is a peculiar ocelliform sclerotized area (not present in the female) consisting of an approximately circular depression bordered by an internal ribbed ring (fig. 92).

Legs 1 to 4 have the same spine and setal formula as in the female. The exopod of leg 1 is like that of the female, but the endopod of this leg is strongly modified (figs. 93, 94). Segments 1 and 2 are short, wider than long. Segment 3 has on its outer margin, between the spine and the terminal seta, a dark brown spiniform process strongly recurved anteriorly; medial to this process there is a slightly swollen area bearing long slender spinules; the two terminal setae are inflated proximally. The exopod of leg 2 is like that of the female, but the endopod (fig. 95) has slightly different proportions than in that sex. Legs 3 and 4 are like those of the female.

Leg 5 (fig. 96) lacks a free segment. The region representing this segment is reduced to a small lobe fused with the body, bearing two naked setae 28 and 35 μ. The adjacent seta on the body is 25 μ and naked.

Leg 6 (figs. 86, 97) consists of a posteroventral flap on the genital segment, extended as a conspicuous well-sclerotized subconical projection bearing dorsally two small naked setae 15 and 8 μ and ventrally a few minute spinules.

The spermatophore was not observed.

Etymology. — The specific name *robustus,* from Latin = sturdy or robust, alludes to the strong sclerotization of the body wall in this species.

Comparison of *Thamnomolgus* with related genera. — The new genus may be compared with five other genera of the Lichomolgidae which also have a 3-segmented endopod in leg 4 with the formula 0-1; 0-1; II. *Thamnomolgus* differs from all of these, however, in the last segment of the endopod of leg 3 having the formula II, 2. It differs also (from those genera in which both sexes are known) in having a free segment in leg 5 in the female but in the male this segment being united with the body. In addition, each of the five genera shows other differences from *Thamnomolgus.* Those species of *Paranthessius* Claus, 1889 (for the synonymy of this genus see Illg, 1949) which have the endopod of leg 4 armed as 0-1; 0-1; II differ in having a more or less prehensile rostrum, a deeply cleft labrum, the last segment of the endopod of leg 3 armed as I, II, 2, and the free segment of

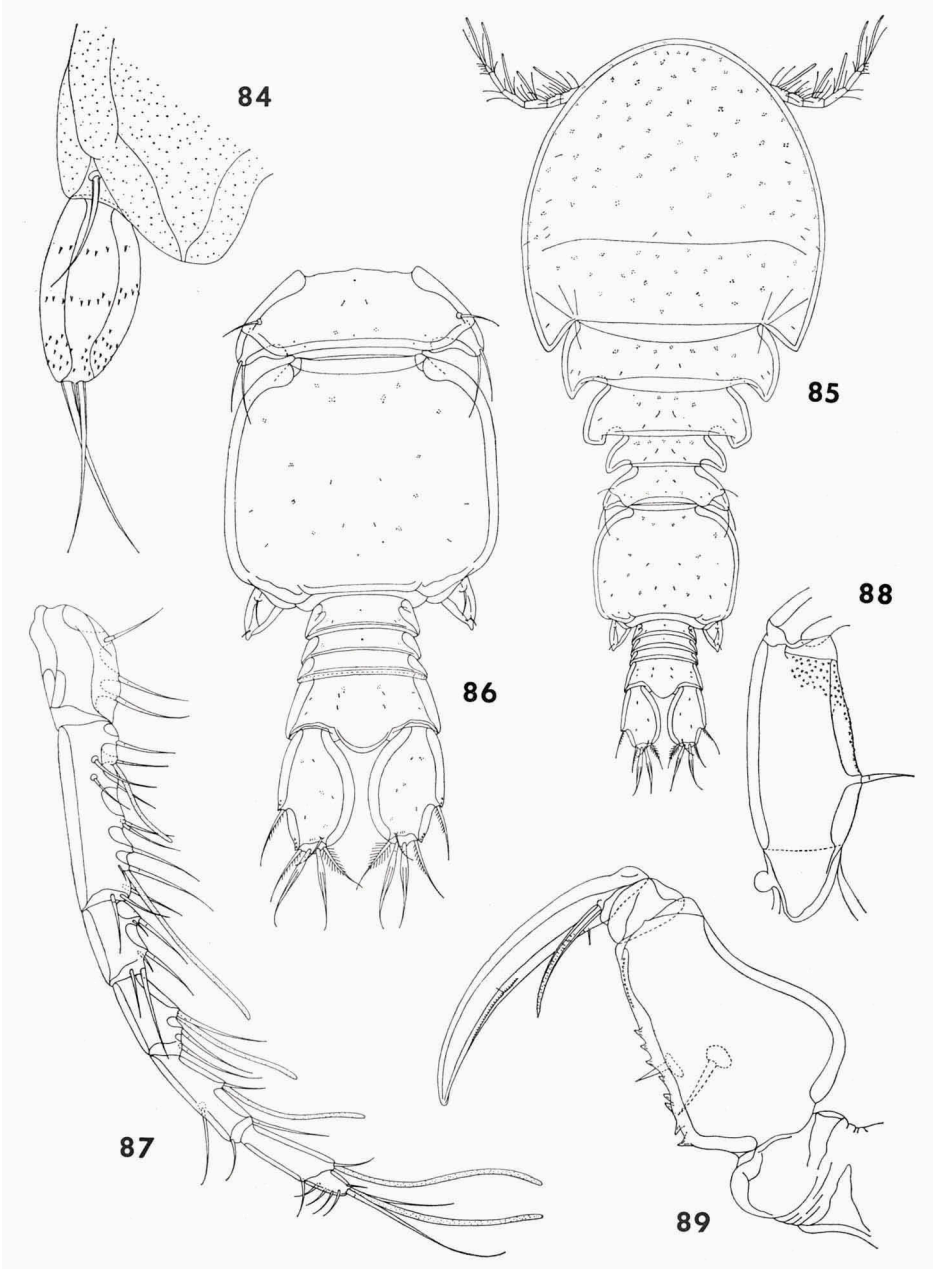


Fig. 84. *Thamnomolgus robustus* n. gen., n. sp., female. 84, leg 5, dorsal (D).
Figs. 85-89. *Thamnomolgus robustus* n. gen., n. sp., male. 85, dorsal (G); 86, urosome, dorsal (C); 87, first antenna, anterodorsal (E); 88, segment 2 of second antenna, antero-outer (E); 89, maxilliped, inner (E).

leg 5 armed with a spine and a seta. *Sabelliphilus* M. Sars, 1862 (for a discussion of this genus see Bocquet & Stock, 1964) differs in having a bifid rostrum, the first antenna with the first two segments expanded, the second antenna with hooklike spines on segments 3 and 4, the last segment of the endopod of leg 3 armed as I, II, 2, and leg 5 with a free segment in both sexes. *Modiolicola* Aurivillius, 1883 (for a discussion of this genus see Reddiah & Williamson, 1959) differs in having the last segment of the endopod of leg 3 armed as II, II, 2 and leg 5 with a free segment in both sexes. *Lichomolgidium* Kossmann, 1877, has a 3-segmented second antenna (fide Kossmann) and the last segment of the endopod of leg 3 armed as III, 2. *Urocopia* G. O. Sars, 1917, differs in having a 6-segmented first antenna, a deeply cleft labrum, the last segment of the endopod of leg 3 armed as I, II, 2, and a rudimentary leg 5 in both sexes.

Thamnomolgus has certain additional characteristic features not seen in other lichomolgids, namely, the form of the rostrum and the labrum, the strong sexual dimorphism in the endopod of leg 1 in the male with a shortening of the first two segments, and the conspicuously projected leg 6 in the male.

VAHINIIDAE Humes, 1967

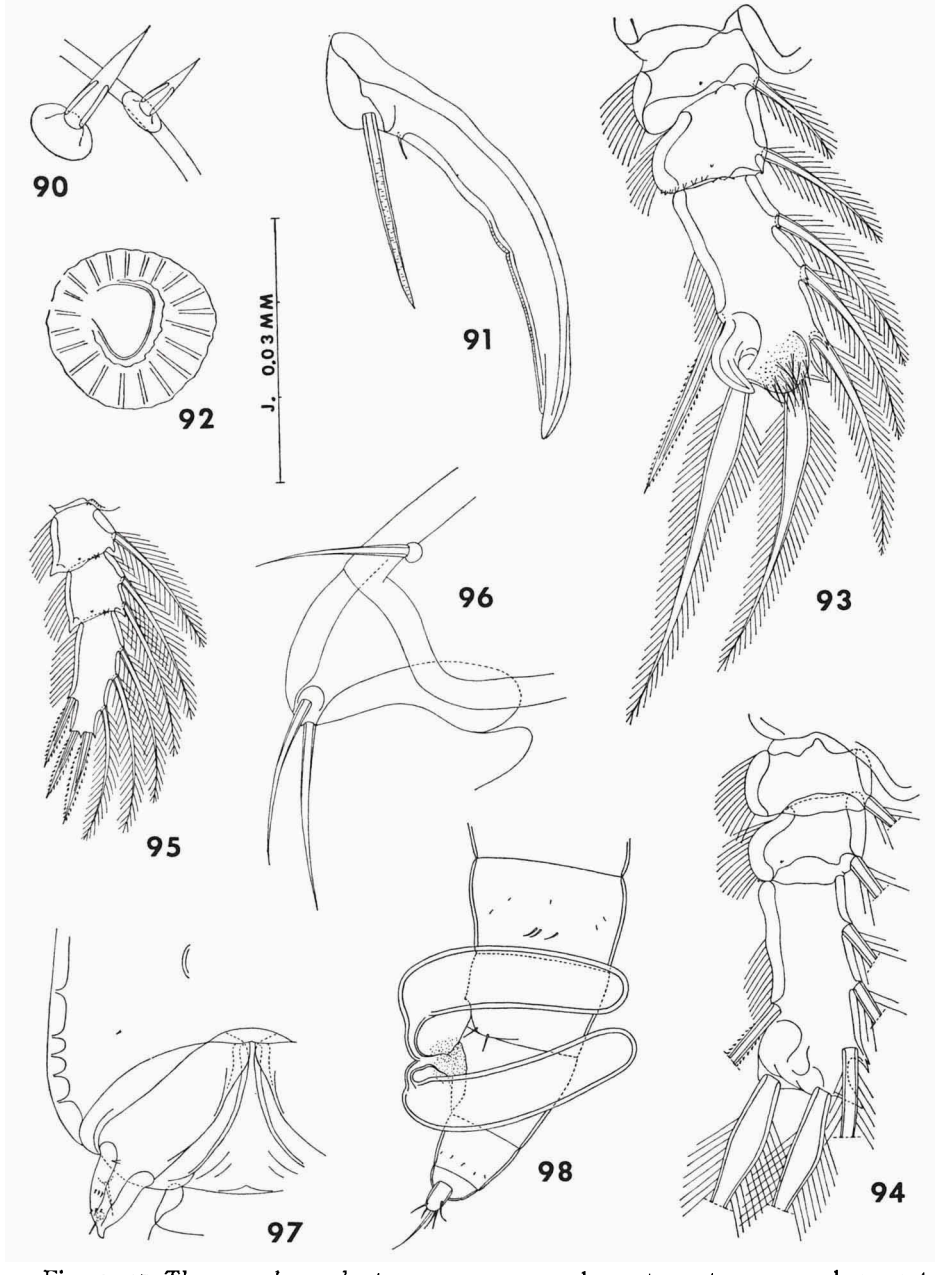
Vahinius Humes, 1967

Vahinius petax Humes, 1967 (fig. 98)

This species has until now been known only from several incomplete specimens of *Stichopathes echinulata* Brook dredged in 30 m, 13°32′18″S 48°12′30″E, south of Tany Kely, near Nosy Bé, Madagascar (Humes, 1967). Further collections from *Stichopathes echinulata* are: 17 ♀♀, 10 ♂♂, and 2 copepodids, from 6 hosts, in 30 m, west of Tany Kely, 13°29′05″S 48°11′05″E, July 12, 1967; 12 ♀♀, 4 ♂♂, and 15 copepodids, from 16 hosts, in 34 m, 1 km south of the crater, near Ambatoloaka, Nosy Bé, July 24, 1967; and 5 ♀♀, 10 ♂♂, from 5 hosts, in 29 m, 1 km south of the crater, near Ambatoloaka, August 21, 1967.

Vahinius petax is now reported from a new host, *Antipathes longibrachiata* (A. J. van Pesch), in 23 m, Tany Kely, June 30, 1967, from which 137 ♀♀ and 128 ♂♂ were recovered.

None of the specimens of *V. petax* from *S. echinulata* carried spermatophores. Only one specimen among those from *A. longibrachiata* had spermatophores attached. This copepod, however, was a male rather than a female.



Figs. 90-97. *Thamnomolgus robustus* n. gen., n. sp., male. 90, two setae on second segment of maxilliped, outer (I); 91, claw of maxilliped, inner (D); 92, ocelliform sclerotized area lateral and posterior to maxilliped, ventral (J); 93, endopod of leg 1, anterior (D); 94, endopod of leg 1, posterior (D); 95, endopod of leg 2, anterior (F); 96, leg 5, dorsal (I); 97, leg 6, ventral (F).

Fig. 98. *Vahinius petax* Humes, 1967, male. 98, urosome, with spermatophores attached to first postgenital segment, lateral (C).

The two elongated spermatophores, each about 180 × 47 μ and joined to a common neck, were fixed to the first postgenital segment (fig. 98). An explanation for this unusual „homosexual" condition is not apparent.

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