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LECANURIUS KOSSMANNIANUS, A NEW CYCLOPOID COPEPOD PARASITIC IN HOLOTHURIANS IN MADAGASCAR

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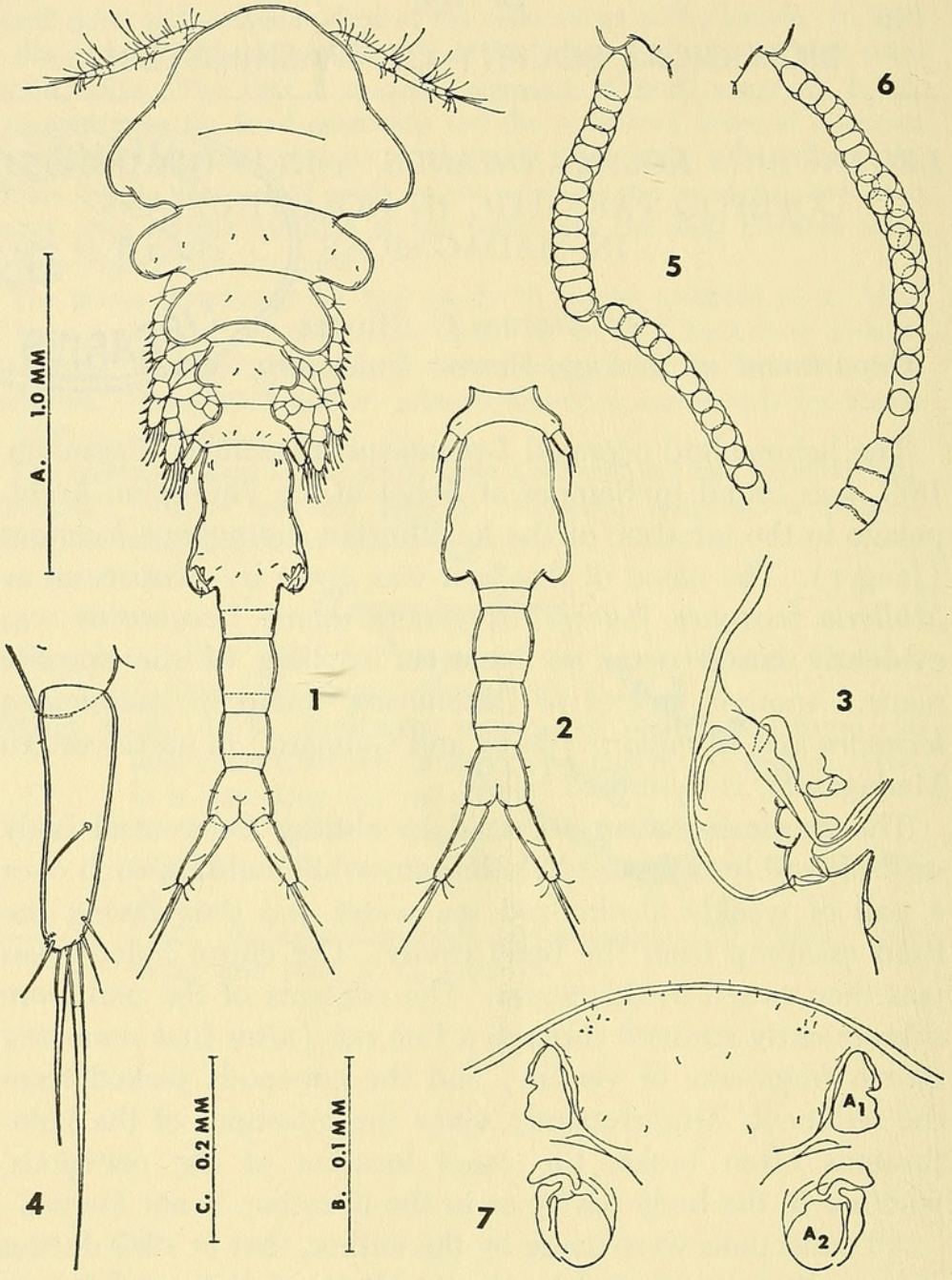
The lichomolgid copepod *Lecanurius intestinalis* Kossmann, 1877, was found by Semper at Bohol in the Philippine Archipelago in the intestine of the holothurian *Actinopyga lecanora* (Jaeger). The name of this host was given by Kossmann as *Müelleria lecanura* Jäger. His generic name *Lecanurius* was evidently based upon an incorrect spelling of the specific name. Another species of *Lecanurius*, found in *Actinopyga lecanora* and *A. miliaris* (Quoy and Gaimard) in northwestern Madagascar, is described below.

The specimens were obtained by slitting the ventral body wall of freshly collected holothurians while holding each over a pail of weakly alcoholized sea water and thus saving the fluid escaping from the body cavity. The entire holothurian was then rinsed in this water. The contents of the pail were subsequently strained through a fine net (after first removing coarse fragments of viscera) and the copepods picked from the sediment. Unfortunately, since the intestines of the holothurians often broke, the exact location of the copepods, whether in the body cavity or in the intestine, is not known.

All collections were made by the author, that in 1960 during an expedition sponsored by the Academy of Natural Sciences of Philadelphia and those in 1967 during field work aided by a grant (GB-5838) from the National Science Foundation. This grant has also supported the study of the specimens.

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:



FIGURES 1–7. *Lecanurius kossmannianus* new species, female. 1, body, dorsal (A); 2, urosome, ventral (A); 3, area of attachment of egg sac, dorsal (B); 4, caudal ramus, dorsal (C); 5, right egg sac, incomplete, ventral (A); 6, left egg sac, incomplete, ventral (A); 7, rostral area, ventral (C).

A_1 = first antenna, A_2 = second antenna, MXPD = maxilliped, and P_1–P_4 = leg 1–leg 4. The measurements of the length of the body have been made from specimens in lactic acid and do not include the setae on the caudal rami.

I thank Dr. Elisabeth Deichmann of the Museum of Comparative Zoology, Harvard University, for the identifications of the holothurians.

FAMILY LICHOMOLGIDAE KOSSMANN, 1877

GENUS *LECANURIUS* KOSSMANN, 1877

Lecanurius kossmannianus new species

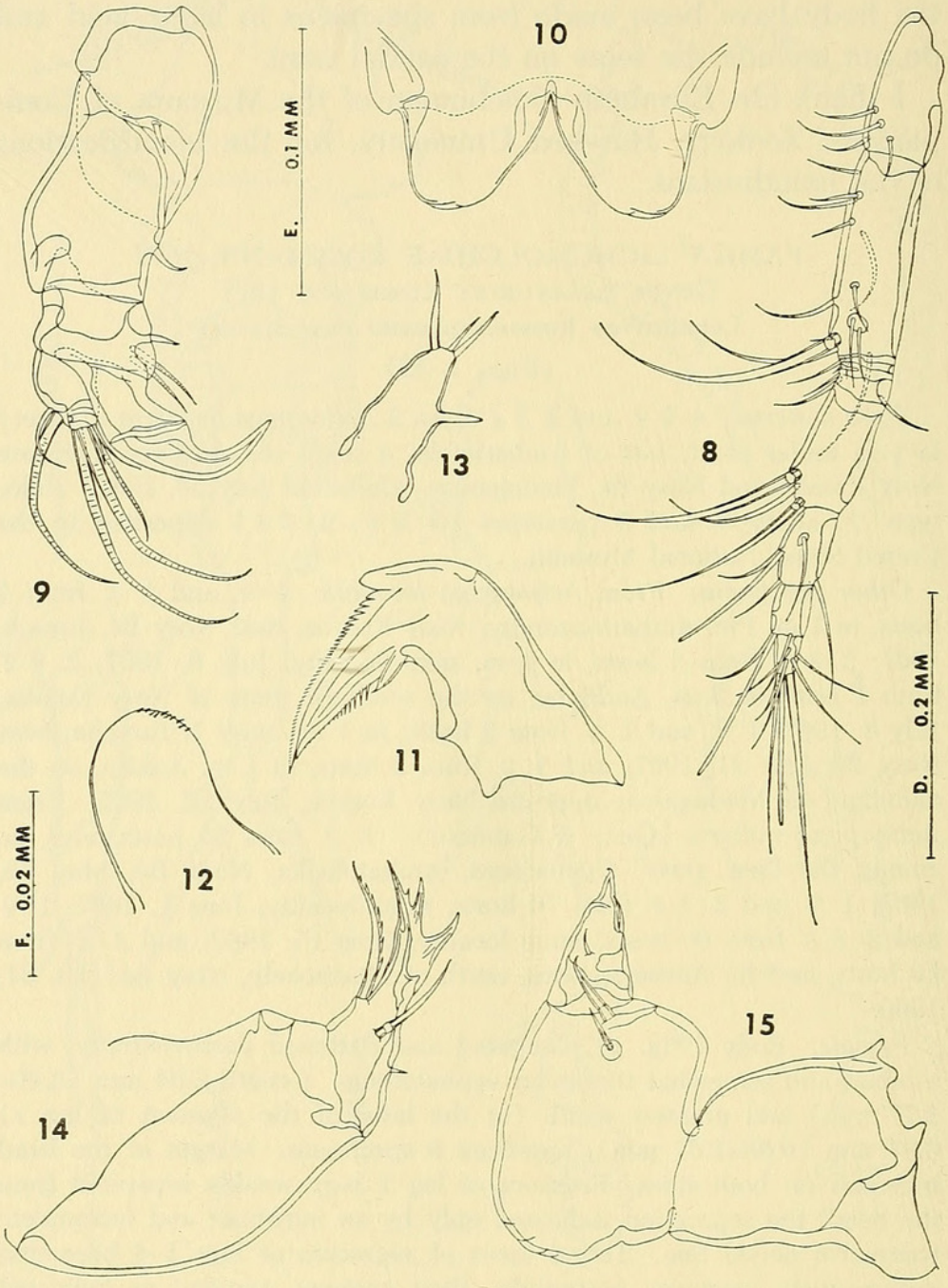
(Figs. 1–32)

Type material: 4 ♀♀ and 3 ♂♂ from 2 *Actinopyga lecanora* (Jaeger) in 1 m under coral, east of Ambariotelo, a small island almost between Nosy Komba and Nosy Bé, Madagascar. Collected July 20, 1967. Holotype ♀, allotype, and 5 paratypes (3 ♀♀, 2 ♂♂) deposited in the United States National Museum.

Other specimens: From *Actinopyga lecanora:* 1 ♀ and 1 ♂ from 2 hosts, in 1 m, Pte. Ambarionaomby, Nosy Komba, near Nosy Bé, June 8, 1967; 2 ♂♂ from 3 hosts, in 1 m, same locality, July 6, 1967; 2 ♀♀ from 1 host, in 3 m, Andjiabe, on the southern shore of Nosy Komba, July 8, 1967; 1 ♀ and 1 ♂ from 3 hosts, in 1 m, Nosy N'Tangam, near Nosy Bé, July 21, 1967; and 1 ♀ from 3 hosts, in 1 m, Ankify, on the mainland of Madagascar opposite Nosy Komba, July 22, 1967. From *Actinopyga miliaris* (Quoy & Gaimard): 1 ♀ from 25 hosts, in 1 m, among the "sea grass" *Cymodocea,* Ambatoloaka, Nosy Bé, May 28, 1967; 1 ♀ and 2 ♂♂ from 70 hosts, same locality, June 1, 1967; 1 ♀ and 2 ♂♂ from 60 hosts, same locality, June 15, 1967; and 1 ♂ from 50 hosts, in 1 m, Antsamantsara, north of Madirokely, Nosy Bé, Oct. 31, 1960.

Female: Body (Fig. 1) elongated and flattened dorsoventrally, with a broad and somewhat triangular cephalosome. Length 2.64 mm (2.40–2.77 mm) and greatest width (at the level of the segment of leg 1) 0.97 mm (0.88–1.01 mm), based on 8 specimens. Margin of the head indented on both sides. Segment of leg 1 very weakly separated from the head, the separation indicated only by an indistinct and incomplete transverse dorsal line. Tergal areas of segments of legs 1–4 becoming progressively narrower posteriorly, their epimera rounded as indicated in the figure. Ratio of length to width of the prosome 1.30 : 1.

Segment of leg 5 (Fig. 2) 165 μ × 352 μ. Between this segment and the genital segment no ventral intersegmental sclerite. Genital segment (Figs. 1 and 2) elongated, in dorsal view indented laterally near the junction of its anterior two-thirds, expanded posteriorly to form two lateral lobes, and then abruptly constricted in its posterior third (where there is ventrally a transverse line). Greatest length of the genital



FIGURES 8–15. *Lecanurius kossmannianus* new species, female. 8, first antenna, ventral (D); 9, second antenna, anterior (B); 10, labrum, ventral (E); 11, mandible, posterior (E); 12, paragnath, ventral (F); 13, first maxilla, posterior (E); 14, second maxilla, posterior (E); 15, maxilliped, antero-inner (E).

segment 540 μ, greatest width 396 μ, width in its anterior third 300 μ, and width at the level of the lateral indentations 280 μ. Areas of attachment of the egg sacs situated dorsally and posteriorly on the lateral lobes, each area (Fig. 3) bearing two naked setae 18 and 21 μ in length. Three postgenital segments 220 μ × 198 μ, 198 μ × 176 μ, and 188 μ × 180 μ from anterior to posterior. First and second of these segments with a transverse line ventrally. Anal segment with a row of minute spinules along its posteroventral margin on each side, and bearing a pair of relatively large dorsolateral setules.

Caudal ramus (Fig. 4) elongated, about 4 times longer than wide, tapering slightly distally, its greatest length 265 μ, its greatest width near its base 83 μ, and its width near middle 65 μ. Mid-dorsal seta (corresponding to the outer lateral seta in other lichomolgids) 63 μ long, distal dorsal setae 58 μ, outermost terminal seta 68 μ, innermost terminal seta 64 μ, and the two long median terminal setae 211 μ (outer) and 330 μ (inner). All setae naked. A minute lateral spinule 6 μ long on the outer proximal area of the ramus, and the distal outer corner of the ramus with a dorsal group of small spiniform processes and a marginal row of minute spinules.

Dorsal surface of prosome and urosome with a few small hairs as in Fig. 1. Urosome longer than the prosome, the ratio being 1 : 1.20.

Egg sacs in the single ovigerous female collected very long and slender, but incomplete. Eggs in the right egg sac (Fig. 5) in a linear series, the distalmost egg 78 μ in diameter. This incomplete egg sac 1.5 mm long. Eggs in the left sac (Fig. 6) partly linear and partly in two rows.

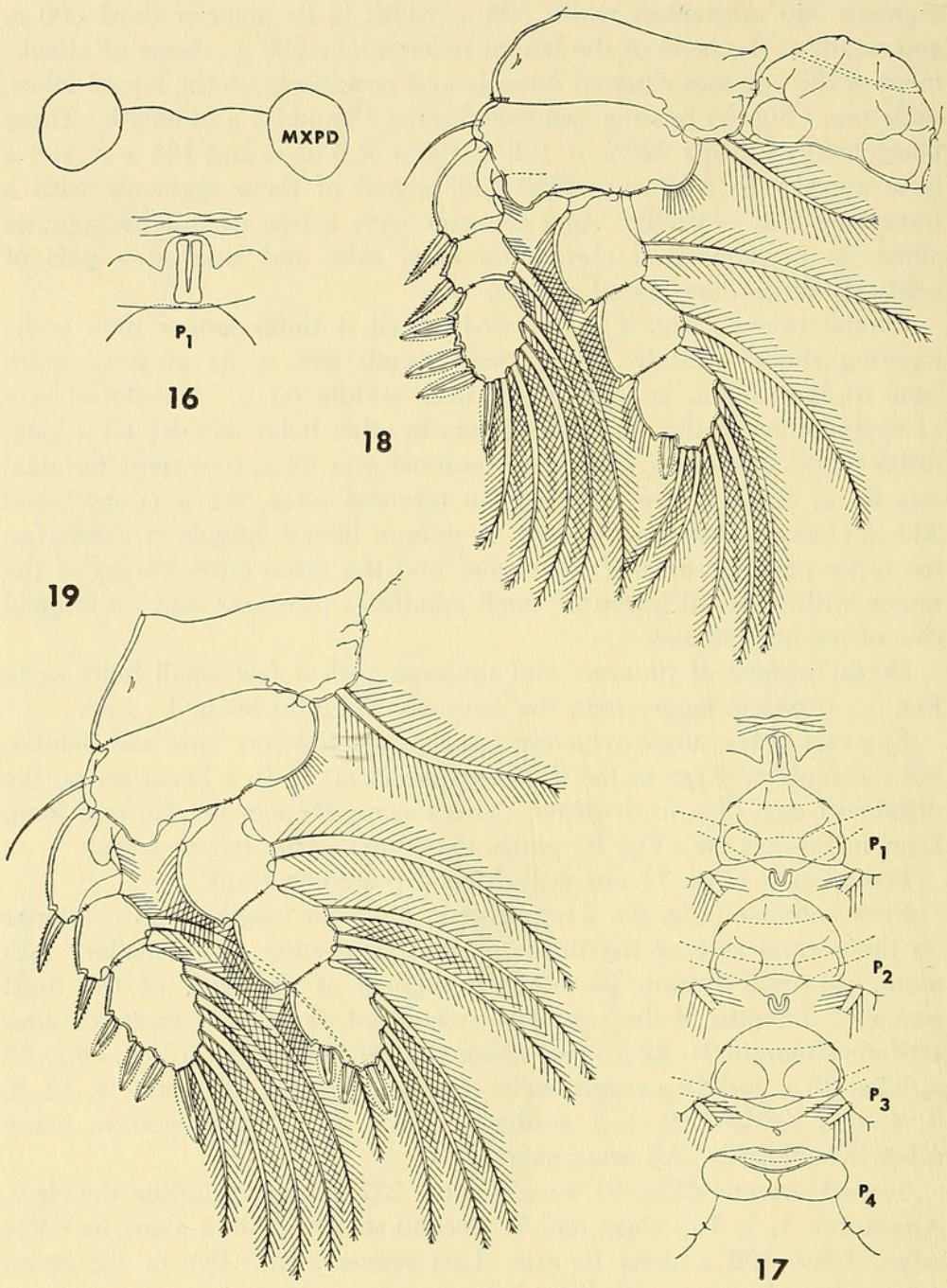
Rostral area (Fig. 7) not well defined posteroventrally.

First antenna (Fig. 8) 7-segmented, 470 μ in length, with a sclerite on the ventral side of the third segment suggesting an intercalary segment. A slight flexure in the first antenna at the level of the third segment. Lengths of the segments (measured along their posterior non-setiferous margins): 42 μ (99μ along the anterior edge), 138 μ, 36 μ, 78 μ, 52 μ, 38 μ, and 29 μ respectively. Formula for the armature: 4, 13, 6, 3, 4 + 1 aesthete, 2 + 1 aesthete, and 7 + 1 aesthete, as in many other lichomolgids. All setae naked.

Second antenna (Fig. 9) 4-segmented, 237 μ long, including the claw. Armature: 1, 1, 3 + claw, and 7. Second segment 109 μ along its outer edge. Claw 109 μ along its axis. Last segment with five of the seven setae arising from a small distal lobe.

Labrum (Fig. 10) with two posteroventral lobes.

Mandible (Fig. 11) having at the base of the pectinate blade a blunt process on the convex side and a pointed process on the concave side. Paragnath (Fig. 12) a small lobe with a few small spinules, located close to the inner side of the base of the first maxilla. First maxilla (Fig. 13) with three terminal setae and a subterminal hyaline seta. Second maxilla (Fig. 14) 2-segmented. First segment unarmed. Second segment having on its outer (ventral) margin a small proximal hyaline seta, on its posterior surface a naked seta jointed basally, on its inner (dorsal)



FIGURES 16–19. *Lecanurius kossmannianus* new species, female. 16, area between maxillipeds and first pair of legs, ventral (D); 17, midsternal areas of legs 1–4, with intercoxal plates pushed somewhat posteriorly, ventral (C); 18, leg 1, anterior (D); 19, leg 2, anterior (D).

margin a seta with hyaline serrations along its distal edge, and terminating in a short lash bearing two long teeth arising from a hyaline expansion followed by a small hyaline tooth. Maxilliped (Fig. 15) 3-segmented. First segment unarmed. Second segment rather tumid in outline

and bearing two naked setae. Third segment with two naked setae and terminating in a spiniform process with a slightly recurved tip.

Area between the maxillipeds and the first pair of legs (Fig. 16) not protuberant; a sclerotized line between the bases of the maxillipeds. Ventral sclerite of the segments of legs 1 and 2 projected posteriorly in a median pointed process, which is surrounded by a small semilunar sclerite (Fig. 17). Ventral sclerite of leg 3 without this pointed process and only a trace of the semilunar sclerite present. Ventral sclerite of leg 4 not evident and the semilunar sclerite absent.

Legs 1–4 (Figs. 18, 19, 20, and 22) with 3-segmented rami. Armature as follows (Roman numerals indicating spines, Arabic numerals setae):

P_1	protopod	0–1	1–0	exp	I–0	I–1	III,I,4
				end	0–1	0–1	I,5
P_2	protopod	0–1	1–0	exp	I–0	I–1	III,I,5
				end	0–1	0–2	I,II,3
P_3	protopod	0–1	1–0	exp	I–0	I–1	III,I,5
				end	0–1	0–2	I,III,2
P_4	protopod	0–1	1–0	exp	I–0	I–1	II,I,5
				end	0–1	0–1	I,I,1,1,1

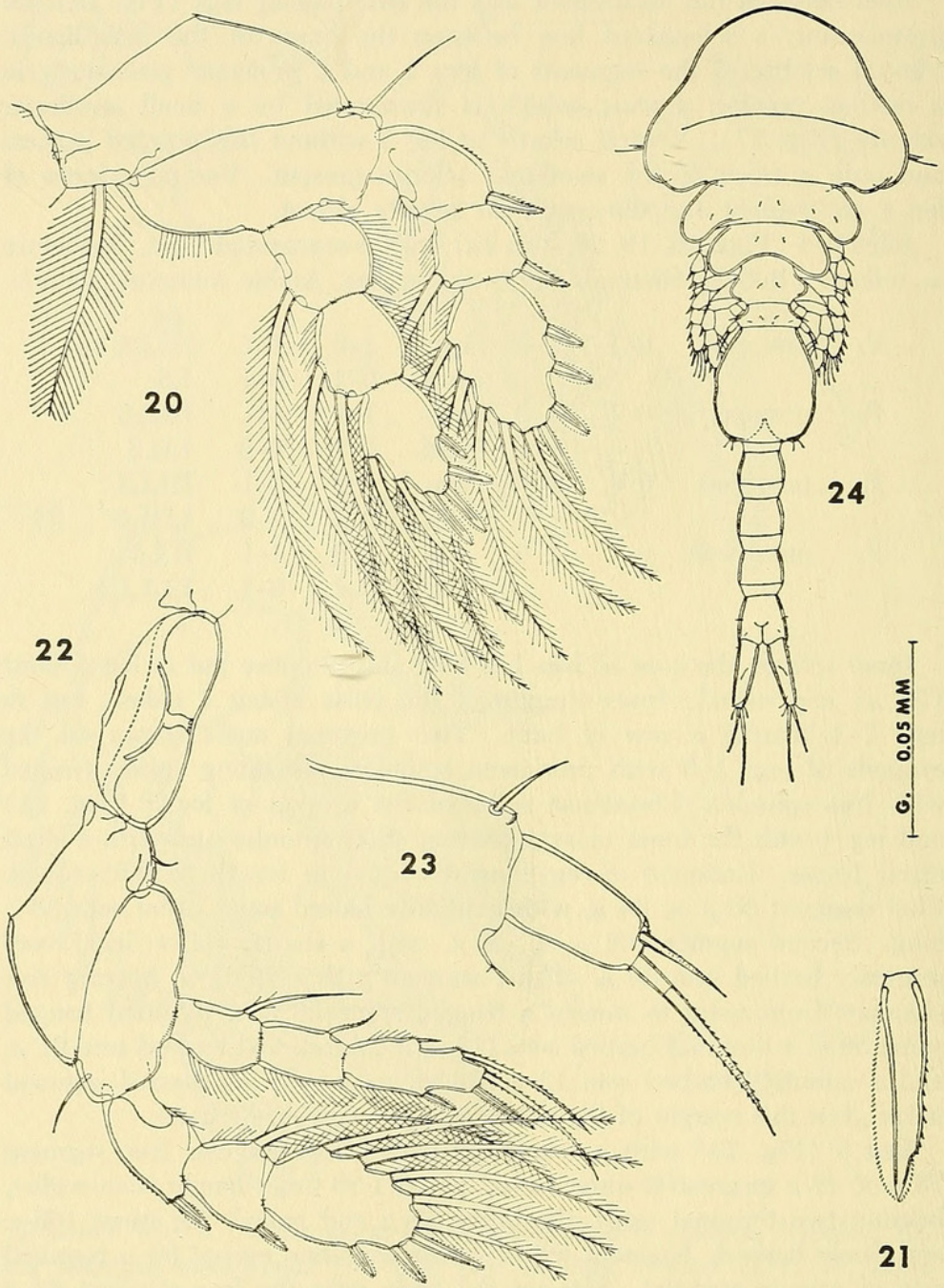
Inner seta on the coxa of legs 1–3 long and plumose but in leg 4 short (24 μ) and naked. Inner margin of the basis in leg 4 naked, but in legs 1–3 bearing a row of hairs. Two proximal outer spines on the exopods of legs 1–3 with prominent spinules; remaining spines fringed with fine spinules. Distalmost spine of the exopod of leg 3 (Fig. 21) and leg 4 with the inner margin bearing short spinules and with a short distal fringe. Endopod of leg 4 nearly equal in length to the exopod. First segment 68 μ × 44 μ, with a slightly haired inner distal seta 88 μ long. Second segment 68 μ × 39 μ, with a shorter inner distal very minutely barbed seta 39 μ. Third segment 101 μ × 42 μ, bearing five elements from outer to inner: a fringed spine 26 μ, a terminal fringed spine 56 μ, a terminal barbed seta 112 μ, a subterminal barbed seta 91 μ, and a minutely barbed seta 13 μ. Inner margin of the second segment naked, but this margin of the third segment with a few hairs.

Leg 5 (Fig. 23) with a relatively small subrectangular free segment 78 μ × 42 μ in greatest dimensions (about 1.86 times longer than wide), bearing two terminal setae, the outer 55 μ and naked, the inner 106 μ and finely barbed. Segment without ornamentation except for a terminal row of minute spinules. Seta on the body near the free segment 44 μ and naked, with a row of small spinules between it and the free segment.

Leg 6 probably represented by the two setae near the attachment of each egg sac (see Fig. 3).

Color in life in transmitted light opaque and slightly brownish, eye red, intestine brown, eggs light tan.

Male: Body (Fig. 24) resembling in general form that of the female. Length 1.97 mm (1.92–2.08 mm) and greatest width 0.79 mm (0.75–



FIGURES 20–23. *Lecanurius kossmannianus* new species, female. 20, leg 3, anterior (D); 21, distalmost spine on exopod of leg 3, anterior (G); 22, leg 4, anterior (D); 23, leg 5, dorsal (B).

FIGURE 24. *Lecanurius kossmannianus* new species, male. 24, body, dorsal (A).

0.81 mm), based on 7 specimens. Ratio of length to width of the prosome 1.13 : 1.

Segment of leg 5 (Fig. 25) 86 μ × 208 μ. No ventral intersegmental sclerite. Genital segment (Fig. 25) only a little longer than wide, 341 μ × 335 μ. (In males where the genital segment does not contain formed spermatophores the segment is somewhat longer, as in Fig. 24, where the dimensions are 363 μ × 308 μ.) Four postgenital segments 133 μ × 156 μ, 151 μ × 153 μ, 127 μ × 140 μ, and 135 μ × 151 μ from anterior to posterior.

Caudal ramus (Fig. 25) similar in form to that of the female but relatively a little shorter, 198 μ × 58 μ, or 3.4 times longer than wide.

Dorsal surface of the body ornamented with hairs as in the female. Urosome longer than the prosome, the ratio being 1 : 1.52.

Rostral area, first antenna, second antenna, labrum, mandible, paragnath, first maxilla, and second maxilla like those of the female. Maxilliped (Figs. 26 and 27) 4-segmented, assuming that the proximal part of the claw represents a fourth segment. First segment unarmed. Second segment with two short naked setae and two groups of two or three short stout spines. Third segment small and unarmed. Claw 242 μ along its axis (including the terminal lamella), with a spiniform prominence (keeled on its posterior surface) on its concave margin, and bearing two very unequal naked setae proximally.

Exopods of legs 1–3 and both rami of leg 4 segmented and armed as in the female. Endopods of legs 1–3 with the same arrangement of spines and setae as in the female, but showing sexual dimorphism. (Spine and setal formula of the male is thus similar to that of the female, taking into account the fusion of the second and third segments of the endopods in legs 1 and 2.) Endopod of leg 1 (Fig. 29) 2-segmented, with the last two segments fused, but the original articulation still indicated by an outer marginal spiniform process and a transverse row of spinules. Endopod of leg 2 (Fig. 30) 2-segmented, with the original articulation between the last two segments indicated as in leg 1. Endopod of leg 3 with the four spines on the last segment somewhat different in length from those in the female; these spines from proximal to distal in the male 10 μ, 11 μ, 17 μ, and 23 μ, in the female 27 μ, 33 μ, 44 μ, and 55 μ.

Leg 5 (Fig. 31) resembling that of the female, but the free segment smaller, 42 μ × 21 μ (about twice as long as wide), its two terminal setae 39 μ (outer) and 83 μ (inner).

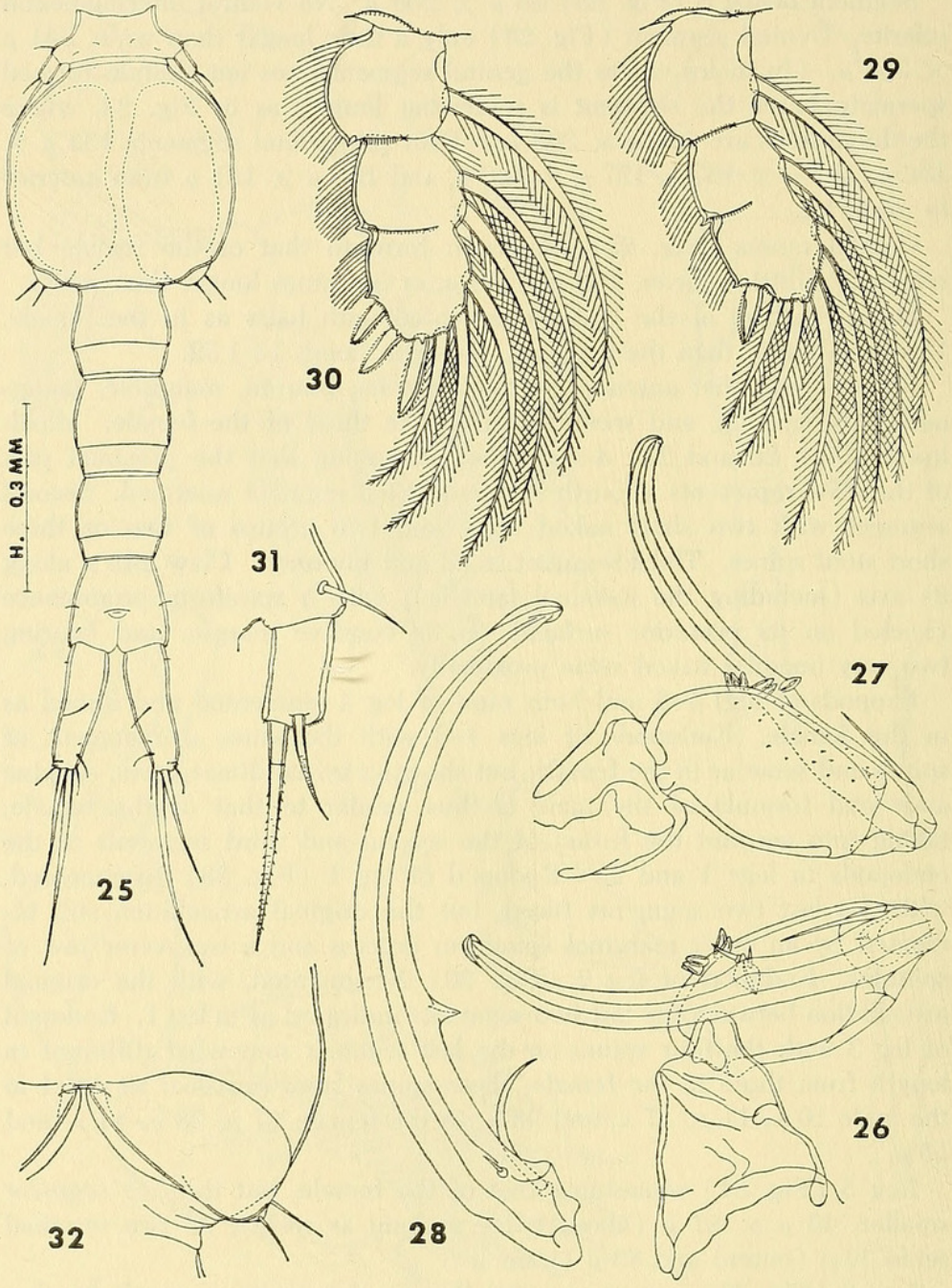
Leg 6 (Fig. 32) a posteroventral flap on the genital segment bearing two slender naked setae 36 μ and 44 μ in length.

Spermatophore not observed.

Color in life similar to that of the female.

(This species is named for Dr. Robby Kossmann, who first described the genus *Lecanurius*.)

Comparison with Lecanurius intestinalis *Kossmann:* There are several features whereby *L. kossmannianus* appears to be distinct from *L. intes-*



FIGURES 25–32. *Lecanurius kossmannianus* new species, male. 25, urosome, dorsal (H); 26, maxilliped, antero-inner (B); 27, maxilliped, postero-outer (B); 28, claw of maxilliped, anterior (E); 29, endopod of leg 1, anterior (B); 30, endopod of leg 2, anterior (B); 31, leg 5, dorsal (E); 32, leg 6, ventral (D).

tinalis. However, since Kossmann's specimen was evidently a male (judging from his figure of the maxilliped), only males can be compared. In *L. kossmannianus* the length of the body of the male is greater (1.97 mm) than in *L. intestinalis* (1.46 mm), the cephalosome is laterally indented (but approximately semicircular in *L. intestinalis*), the genital segment is a little longer than wide or its length is nearly equal to its width (but twice as wide as long in Kossmann's figure of *L. intestinalis*), the claw of the maxilliped has one pointed prominence (but two blunt protuberances in *L. intestinalis*), and the free segment of leg 5 is 42 μ long (but 130 μ in *L. intestinalis*).

The armature of legs 1 and 4 of *L. kossmannianus* differs in certain respects from that of *L. intestinalis*. Kossmann mentioned two setae on the inner side of the second segment of the endopod of leg 1, but in the Madagascan species there is only one such seta. (Perhaps this is a *lapsus* by Kossmann, since the presence of two setae on the inner side of this segment would be indeed remarkable in a lichomolgid copepod.) In the exopod of leg 4 of Kossmann's species the outer spines on the first two segments are absent; on the endopod the inner element on the first segment is absent, that on the second segment is a spine rather than a seta, and the elements on the last segment are 3 spines and 2 setae (in his text) or 3 spines and 3 setae (in his figure).

The males of both *L. intestinalis* and *L. kossmannianus* show striking similarities in their general body form, and in the nature of the second antenna, mandible, and second maxilla.

Relationship of Lecanurius *to* Scambicornus: The genus *Lecanurius* shows certain characters which are similar to those of *Scambicornus* Heegaard, 1944 (= *Preherrmannella* Sewell, 1949), a genus of which many species live externally on holothurians. Stock (1964) has already suggested that the two genera are related, noting the similarity in the second antennae (the third segment with a large claw) and in the armature (5 elements) of the third segment of the endopod of leg 4. In addition, both genera have a bladelike mandible, without a long lash, and both have 2-segmented endopods in legs 1 and 2 of the male.

There are, however, important differences between *Lecanurius* and *Scambicornus*. In *Lecanurius* the body is elongated, with a much broadened cephalosome, while in *Scambicornus* the form of the body is more typically lichomolgid. In *Lecanurius* the egg sacs (as far as known) are very long and the eggs are in a more or less linear series, rather than sacciform with massed eggs as in *Scambicornus*. In *Lecanurius* the mandible bears processes at both sides of the base of the blade, rather than a single process (on the concave side) or none as in *Scambicornus*. In *Lecanurius* the lash of the second maxilla is short and bears only a few large teeth, whereas in *Scambicornus* it is longer and has a row of several teeth. In *Lecanurius* the five elements on the last segment of the endopod of leg 4 consist of both spines and setae, but in *Scambicornus* these elements are spines. *Lecanurius* lives inside the holothurians, while *Scambicornus* lives on the outside of these hosts.

In view of these differences it seems best to retain Kossmann's genus *Lecanurius* for *L. intestinalis* and *L. kossmannianus*. If in the future species intermediate between the two genera (in respect to the several differences listed above) are discovered, *Lecanurius* might be considered as a senior synonym of *Scambicornus*. This position is untenable now, however, in the present state of knowledge of these genera.

Hosts of Lecanurius: Both *L. intestinalis* and *L. kossmannianus* live in members of the genus *Actinopyga*. In fact, both of these copepods are known from the same species of host, *A. lecanora*, though in widely separated regions,—*L. intestinalis* in the Philippines, and *L. kossmannianus* in Madagascar. The new species occurs also in *Actinopyga miliaris* in Madagascar, although apparently less commonly than in *A. lecanora*. Sixteen specimens were recovered from 14 *A. lecanora*, but only 8 from 205 *A. miliaris*.

A single copepodid of what is possibly a *Lecanurius* was found in another holothurian, *Synapta maculata* (Chamisso and Eysenhardt), at Ambariobe, near Nosy Bé, October 6, 1963 (during field work of the U. S. Program in Biology, a part of the International Indian Ocean Expedition). The immaturity of this specimen made it impossible to determine the genus with certainty, but some of its features suggest Kossmann's *Lecanurius*.

Associated with both hosts of *L. kossmannianus* there is a species of *Scambicornus*, *S. campanulipes* (Humes and Cressey, 1961), which lives on the exterior of *A. lecanora* and *A. miliaris* in Madagascar (Humes, 1967).

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