

Cyclopoid Copepods Associated
with Asteroid Echinoderms in
New Caledonia

ARTHUR G. HUMES

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Introduction

For the vast area of the tropical Pacific Ocean there are only a few records of copepods living in association with Asteroidea. Kossmann (1877) briefly described *Stellicola semperi*, a species that has remained of uncertain validity, from *Ophidiaster miliaris* (actually *Linckia miliaris* (Linck) according to Monod and Dollfus (1932:142, footnote)) at Isabela, Philippine Islands. Stebbing (1900) described *Linckiomolgus caeruleus* (now placed in the genus *Stellicola*) from *Linckia* at Feather Island, China Straits, eastern end of New Guinea. Humes and Stock (1973) described *Stellicola illgi* from *Linckia laevigata* (Linnaeus) at Urukthapel, Palau Islands. They also recorded the presence of *Stellicola pollex* Humes and Ho, 1967, on *Linckia diplax* (Müller and Troschel), *Linckia multiflora* (Lamarck), and *Linckia guildingi* Gray in the Hawaiian Islands. Humes (1970) described *Stellicola acanthasteris* (now placed on the genus *Synstellicola*) from *Acanthaster planci* (Linnaeus) at Eniwetok Atoll, Marshall Islands. Humes and Stock (1973) reported *S. acanthasteris* from *Acanthaster planci* at Viti Levu, Fiji, and near Noumea, New Caledonia. Humes (1971) described *Astroxyneus culcitae* from *Culcita novaeguineae* Müller and Troschel at Eniwetok Atoll.

This paper includes reports on the following copepods from asteroids in New Caledonia:

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STELICOMITIDAE

1. *Astroxyneus culcitae* Humes, 1971
from *Culcita novaeguineae* Müller and Troschel

LICHOMOLGIDAE

2. *Metaxymolgus echinasteris*, new species
from *Echinaster luzonicus* (Gray)
3. *Stellicola novaecaledoniae*, new species
from *Linckia laevigata* (Linnaeus) and *Linckia guildingi* Gray
4. *Stellicola oreastriphilus* Kossmann, 1877
from *Culcita novaeguineae* Müller and Troschel (new host)
5. *Stellicola parvulipes*, new species
from *Culcita novaeguineae* Müller and Troschel
6. *Synstellicola acanthasteris* (Humes, 1970)
from *Acanthaster planci* (Linnaeus)
7. *Synstellicola pichoni* (Humes and Ho, 1966)
from *Protoreaster lincki* (de Blainville) (new host)

The collections in New Caledonia made during June-August 1971, and the subsequent study of the specimens were supported by a grant (GB-8381X) from the National Science Foundation. Mr. Roger C. Halverson from the University of California at Santa Barbara assisted in the field work. I wish to express my thanks to the staff of the Centre ORSTOM de Noumea for their generous assistance.

I am greatly indebted to Miss Maureen E. Downey of the National Museum of Natural History, Smithsonian Institution, Washington D.C., for the identifications of the host echinoderms.

All the 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 following abbreviations are used: A₁ = first antenna, A₂ = second antenna, MXPD = maxilliped,

and P_1 = leg 1. Specimens deposited in the National Museum of Natural History, Smithsonian Institution, are listed under the acronym "USNM" (for the collection numbers of the old United States National Museum).

Astroxynus culcitae Humes, 1971

FIGURE 1a

SPECIMENS COLLECTED (all from the cushion star, *Culcita novaeguineae* Müller and Troschel).—101 (both sexes) from one host, Rocher à la Voile, near Noumea, 22°18'24"S, 166°25'50"E, 13 June 1971; 63 from one host, in 2 m, Rocher à la Voile, 19 June; 24 from one host, in 1 m, east of Isle To N'du, near Noumea, 22°10'49"S, 166°17'12"E, 12 July; 13 from 5 hosts, in 10 cm, eastern side of Isle Maître, near Noumea, 22°20'35"S, 166°25'10"E, 16 July; and 5 from 7 hosts, intertidal, eastern end of Isle Maître, 22°20'35"S, 166°25'45"E, 31 July.

REMARKS.—These copepods agree in nearly all features with *Astroxynus culcitae* Humes, 1971, as described from *Culcita novaeguineae* at Eniwetok Atoll. The only significant difference found is the relative length of the outer seta on the coxa-basis of legs 3 and 4. In the New Caledonian specimens this seta (Figure 1a) is very long (about 90 μ m), exceeding slightly the length of the ramus (78 μ m), and easily seen in undissected copepods, while in the Eniwetok material the seta is short and inconspicuous.

Culcita novaeguineae is the only known host.

Metaxymoligus echinasteris, new species

FIGURES 1b-g, 2a-j, 3a-i, 4a-d

TYPE MATERIAL.—47 ♀♀, 44 ♂♂ from 20 orange-red to brown sea stars, *Echinaster luzonicus* (Gray), in a tidal pool, at the public beach west of Païta, near Noumea, New Caledonia, 22°07'00"S, 166°12'00"E, 22 July 1971. Holotype ♀, allotype, and 82 paratypes (42 ♀♀, 40 ♂♂) deposited in the National Museum of Natural History (under USNM numbers); the remaining paratypes (dissected) in the collection of the author.

OTHER SPECIMENS (all from *Echinaster luzonicus*).—48 ♀♀, 78 ♂♂, and 60 copepodids from 6 hosts, in 0.5 m, Ricaudy Reef, near Noumea,

22°19'00"S, 166°26'44"E, 5 June; 1 ♀, 9 ♂♂, and 2 copepodids from 5 hosts, in an intertidal pool, Ricaudy Reef, near Noumea, 25 July; and 16 ♀♀, 18 ♂♂, and 12 copepodids from 7 hosts, in 2 m, Rocher à la Voile (Pte. Pontillon), near Noumea, 22°18'24"S, 166°25'50"E, 2 June.

FEMALE.—Body (Figure 1b) with a moderately broad prosome. Length (without the setae on the caudal rami) 1.66 mm (1.50-1.77 mm) and the greatest width 0.99 mm (0.96-0.02 mm), based on 10 specimens in lactic acid. Segment of leg 1 separated from the cephalosome by a dorsal transverse suture. Epimeral areas of the segments of legs 2 and 3 rounded, those of the segment of leg 4 truncated. Ratio of the length to the width of the prosome 1.12:1. Ratio of the length of the prosome to that of the urosome 1.81:1.

Segment of leg 5 (Figure 1c) 104 × 200 μ m. Between this segment and the genital segment a short, weak ventral sclerite. Genital segment 208 × 313 μ m, much wider than long, with rounded lateral margins in dorsal view. Genital areas located dorsolaterally in the posterior half of the segment. Each area (Figure 1d) bearing two naked setae 28 and 17 μ m, and a small spinous process. Three postgenital segments from anterior to posterior 83 × 117, 60 × 107, and 86 × 107 μ m. Posteroventral margin of the anal segment smooth.

Caudal ramus (Figure 1e) 66 × 48 μ m, with the ratio of the length to the width 1.38:1. Outer lateral seta 99 μ m and naked. Dorsal seta 50 μ m and plumose. Outermost terminal seta 100 μ m and the innermost terminal seta 195 μ m, both with lateral and ventral spinules. Two long median terminal setae 330 μ m (outer) and 515 μ m (inner), both with lateral spinules along their midregions and both inserted dorsally to a small ventral flange with a smooth margin.

Body surface bearing small hairs (sensilla) as indicated in Figure 1b.

Egg sac (Figure 1b) elongated oval, 935 × 407 μ m, reaching to the tips of the longest ramal setae. Numerous eggs, each approximately 73 μ m in diameter.

Rostrum (Figure 1f) with an incomplete posteroventral margin.

First antenna (Figure 1g) 520 μ m long. Lengths of the seven segments (measured along their posterior nonsetiferous margins): 31 (78 μ m along the anterior margin), 205, 31, 86, 53, 40, and 23 μ m

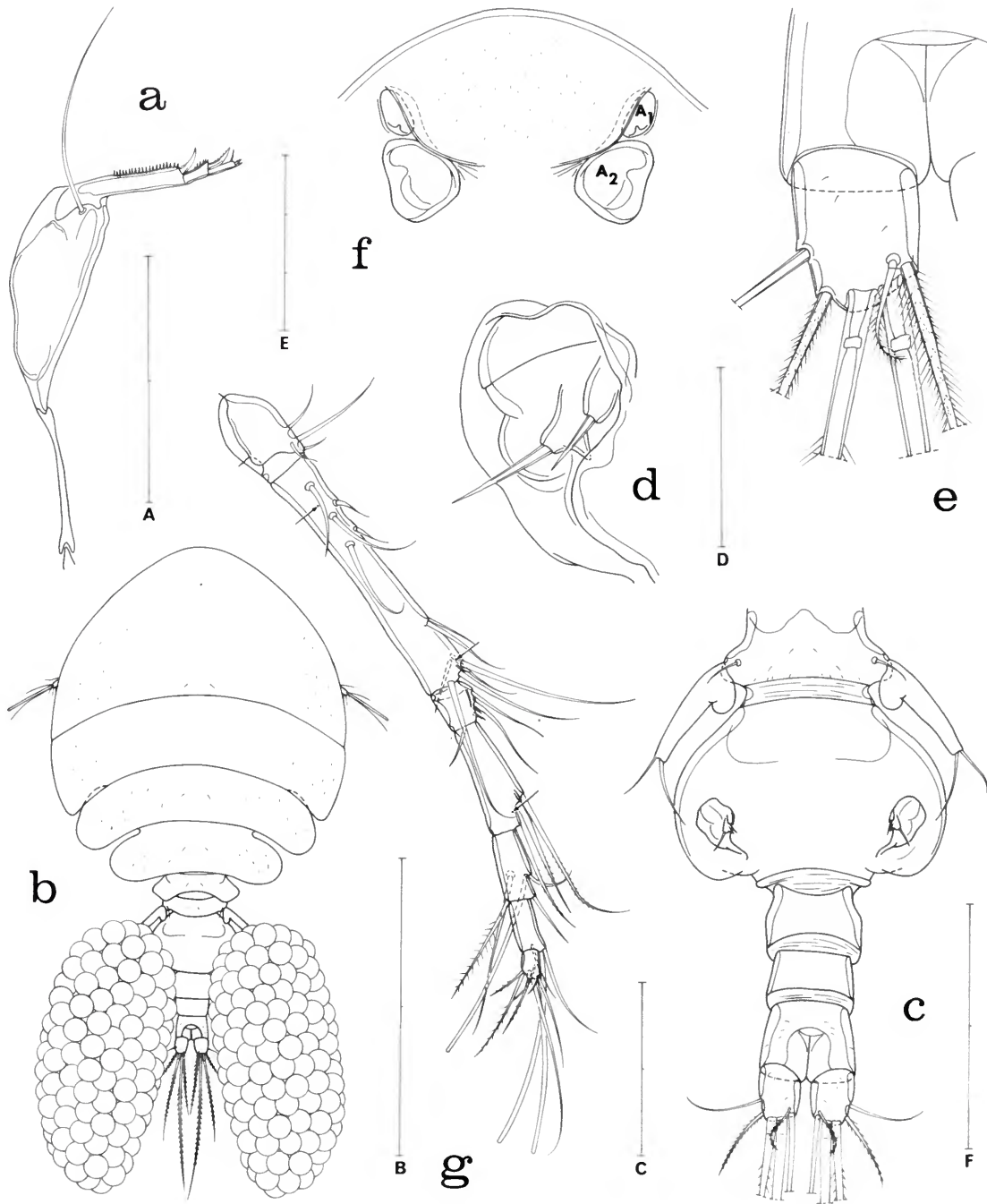


FIGURE 1.—*Astroxynus culcitae* Humes, 1971, female: a, leg 3 and intercoxal plate, posterior (A). *Metaxymolgus echinasteris*, new species, female: b, dorsal (B); c, urosome, dorsal (C); d, genital area, dorsal (D); e, caudal ramus, dorsal (A); f, rostrum, ventral (E); g, first antenna, dorsal (F). (Scale A = 0.1 mm, B = 1.0 mm, C = 0.2 mm, D = 0.05 mm, E = 0.3 mm, F = 0.2 mm.)

respectively. Formula for the armature: 4, 13, 6, 3, 4 + 1 aesthete, 2 + 1 aesthete, and 7 + 1 aesthete. Certain setae on the distal segments with lateral spinules.

Second antenna (Figure 2a) 380 μm long. Formula for the four segments: 1, 1, 3, and II + 5. Fourth segment 104 μm along its outer edge, 75 μm along its inner edge, and 34 μm wide. Two claws very unequal, the larger claw stout and recurved, 78 μm along its axis, the smaller claw slender and almost setiform, 26 μm . All the elements naked.

Labrum (Figure 2b) with two rather slender divergent posteroventral lobes. Mandible (Figure 2c) having in succession on its convex margin a scalelike area with a row of spinules, a small tooth, and a deeply serrated hyaline fringe. Concave margin beyond the indentation with a row of long slender spinules. Lash long and barbed distally. Paragnath (Figure 2d) a small hairy lobe. First maxilla (Figure 2e) bearing four elements. Second maxilla (Figure 2f) with an unornamented first segment. Elongated second segment with a small setule on its proximal outer (ventral) surface, a smooth surficial posterior seta, an inner (dorsal) distal spine with 4-5 large spines along the distal edge and a few small barbules along the proximal edge. Segment produced to form a lash, which bears outwardly four teeth of unequal sizes followed by a row of spinules, and inwardly a row of spinules near its tip. Maxilliped (Figure 2g) with an unarmed first segment. Second segment carrying two very unequal setae, both finely barbed. Third segment bearing a slender setule and a recurved spine, both naked, and terminating in a small claw-like process.

Ventral area between the maxillipeds and the first pair of legs (Figure 2h) not protuberant. A line connecting the bases of the maxillipeds.

Legs 1-4 (Figures 2i-j, 3a-b) having the same segmentation and armature as in other species of *Metaxymolgus*, for example, *M. securiger* (Humes, 1964). Two of eleven females examined showing III, I, 5 instead of the usual II, I, 5 on the third segment of the exopod of leg 4. Inner coxal seta in leg 3 distinctly shorter than in legs 1 and 2; in leg 4 this seta minute (20 μm) and naked. Inner margin of the basis with a row of hairlike spinules in legs 1-3 but smooth in leg 4. Exopod of leg 4 187 μm . First segment of the endopod 52 \times 41 μm (not including the spiniform processes), and its inner

plumose seta 83 μm . Second segment 88 \times 28.5 μm (greatest width, and length not including the spiniform processes). Two terminal fringed spines 33 μm (outer) and 66 μm (inner), with their tips bifurcated (Figure 3c). Outer margins of both segments with a row of hairs.

Leg 5 (Figure 3d) with an elongated unornamented free segment 130 μm in length, having a large proximal inner rounded expansion. Width at the level of the expansion 55 μm , and more distally 24 μm . Two terminal naked setae 65 and 81 μm .

Leg 6 represented by the two setae on the genital area (Figure 1d).

Living specimens in transmitted light pale orange, the eye red, the egg sacs orange.

MALE.—Body (Figure 3e) with a less broadened prosome than in the female. Length (excluding the setae on the caudal rami) 1.35 mm (1.31-1.38 mm) and the greatest width 0.62 mm (0.61-0.64 mm), based on 10 specimens in lactic acid. Epimera of the segment of leg 2 subtruncated and those of the segment of leg 4 rounded. Ratio of the length to the width of the prosome 1.29:1. Ratio of the length of the prosome to that of the urosome 1.19:1.

Segment of leg 5 (Figure 3f) 52 \times 133 μm . No ventral intersegmental sclerite. Genital segment 270 \times 270 μm . Four postgenital segments from anterior to posterior 44 \times 88, 44 \times 86, 31 \times 81, and 57 \times 86 μm .

Caudal ramus resembling that of the female, but smaller, 47 \times 35 μm .

Body surface with small hairs (Figure 3e-f) as in the female.

Rostrum like that of the female.

First antenna similar to that of the female, but three long aesthetes added (at points indicated by arrows in Figure 1g), the formula thus becoming: 4, 13 + 1 aesthete, 6, 3 + 1 aesthete, 4 + 1 aesthete, 2 + 1 aesthete, and 7 + 1 aesthete. Second antenna (Figure 3g) showing sexual dimorphism. Setae on the first and second segments, and one of the three setae on the third segment, more prominent than in the female and pectinate along the proximal (inner) side. Inner surface of the second segment bearing numerous small spinules. Fourth segment relatively longer than in the female, its outer edge 105 μm , its inner edge 66 μm , and its width 24 μm . Larger claw 62 μm and the smaller claw 24 μm .

Labrum, paragnath, first maxilla, and second

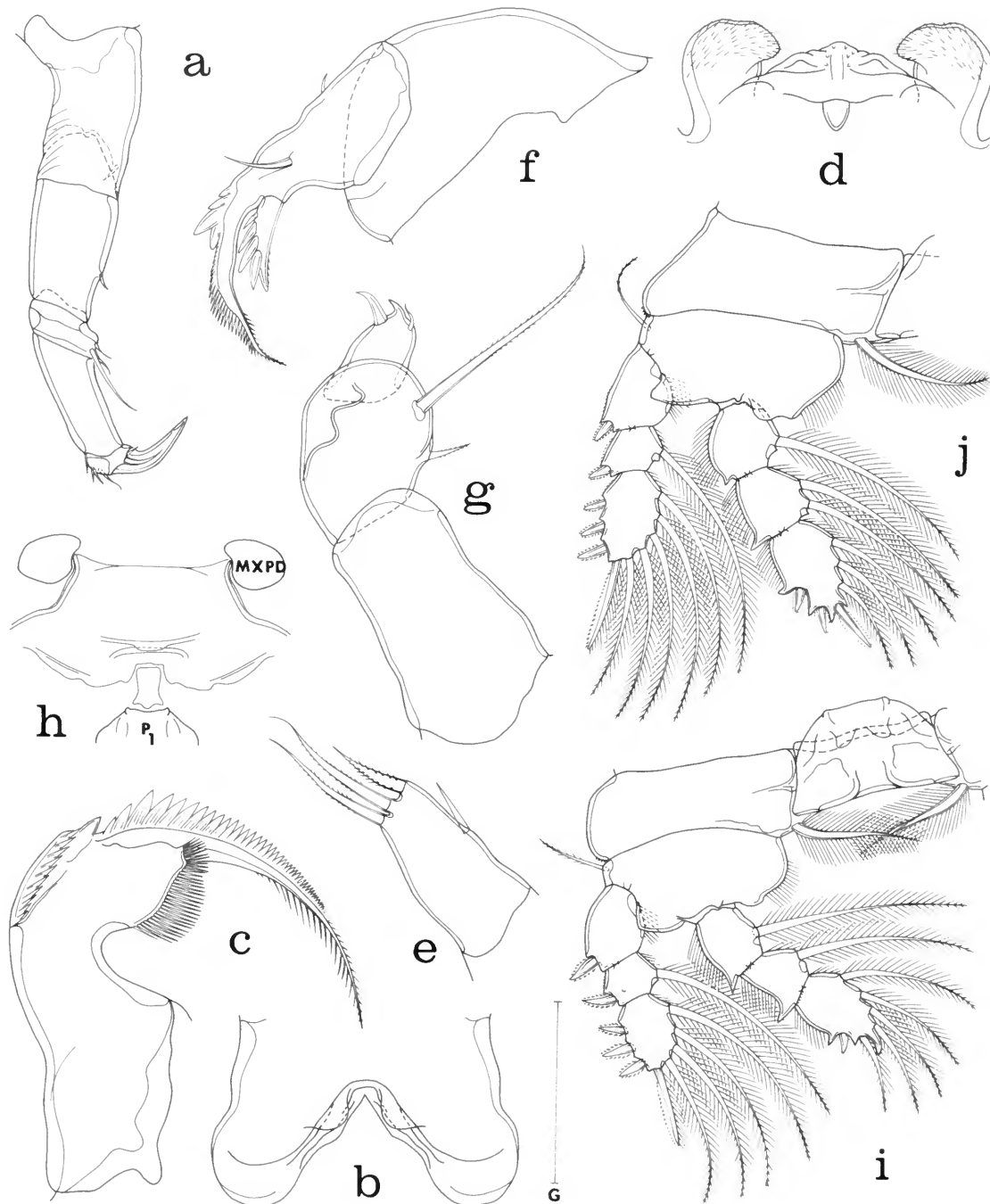


FIGURE 2.—*Metaxymolgus echinasteris*, new species, female: *a*, second antenna, postero-inner (F); *b*, labrum, ventral (G); *c*, mandible, posterior (D); *d*, paragnaths, posteroventral (A); *e*, first maxilla, anterior (D); *f*, second maxilla, posterior (A); *g*, maxilliped, posterior (A); *h*, area between maxillipeds and first pair of legs, ventral (C); *i*, leg 1 and intercoxal plate, anterior (F); *j*, leg 2, anterior (C). (Scale G = 0.1 mm.)

maxilla like those in the female. Maxilliped (Figure 3*h*) long and slender. First segment unornamented. Second segment bearing two setae (one smooth, the other finely pectinate along the proximal edge), a long row of spines on the inner surface, and a cluster of short spines at the distal anterior corner of the segment. Small third segment unarmed. Claw 218 μm along its axis (including the terminal lamella), incompletely divided about midway, and bearing two proximal unequal setae, the longer seta finely pectinate along one side.

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

Legs 1–4 segmented as in the female and with the same spine and setal formula except for the third segment of the endopod of leg 1 (Figure 3*i*), which has the formula I,1,4 instead of I,5 as in the female. Outer distal spiniform process on the first segment of this endopod smaller than in the female. Legs 2 and 3 like those in the female. Leg 4 resembling that of the female except for slight sexual dimorphism in the endopod (Figure 4*a*). Here the two terminal spines on the second segment measuring 52 μm (outer) and 57 μm (inner), more nearly equal in length than in the female. (In the specimen drawn the tip of the inner spine trifurcated, rather than bifurcated as in all other specimens seen.) One of the eleven males examined with the formula III,1,5 instead of the usual II,1,5 on the third segment of the exopod of leg 4.

Leg 5 (Figure 4*b*) having a slender unornamented free segment $55 \times 11 \mu\text{m}$, with a proximal inner expansion. Two naked terminal setae 66 and 31 μm .

Leg 6 (Figure 4*c*) consisting of a posteroventral flap on the genital segment bearing two naked setae 55 and 74 μm , and a minute spiniform process.

Spermatophore (Figure 4*d*), attached to the female, $260 \times 125 \mu\text{m}$.

Living specimens paler orange than in the female, the eye red.

ETYMOLOGY.—The specific name *echinasteris* is derived from the generic name of the sea star serving as host.

COMPARISON WITH RELATED SPECIES.—By the nature of the long free segment of leg 5 in the female, unornamented and with a large proximal inner expansion, *Metaxymolgus echinasteris* may be distinguished from all species assigned to the genus

by Humes and Stock (1973) except possibly *M. securiger* (Humes, 1964). The latter differs conspicuously from the new species, however, in its smaller size (female 1.22 mm), the nearly equal claws on the second antenna, and the rather globular female genital segment, which is only slightly wider than long.

The very unequal claws on the second antenna of *M. echinasteris* serve to distinguish it from most of the 23 known species in the genus, in which both claws are distinctly clawlike and recurved though one may be much shorter than the other. In two species, *Metaxymolgus gracilipes* (A. Scott, 1909) and *M. simplex* (Thompson and A. Scott, 1903), the lesser claw seems to approach the condition in the new species, judging from the scanty information in the original descriptions. Both of these species differ, however, in other ways from the new species. In *M. simplex* the female is only about half as long as the New Caledonian form, the genital segment is about as long as wide, and the free segment of leg 5 lacks a proximal expansion. In the female of *M. gracilipes* the genital segment is about as long as wide and the free segment of leg 5 lacks a proximal expansion.

Stellicola novaecaledoniae, new species

FIGURES 4*e-i*, 5*a-k*, 6*a-i*

TYPE MATERIAL.—146 ♀♀, 173 ♂♂, and 95 copepodids from the body surface of 24 bright blue sea stars, *Linckia laevigata* (Linnaeus), in 0.5 m, on the reef at Goro, southeastern New Caledonia, 22°18'00"S, 167°02'00"E, 6 August 1971. Holotype ♀, allotype, and 220 paratypes (100 ♀♀, 120 ♂♂) deposited in the National Museum of Natural History (USNM), Smithsonian Institution; the remaining paratypes in the collection of the author.

OTHER SPECIMENS.—From *Linckia laevigata*: 33 ♀♀, 42 ♂♂, and 4 copepodids from 14 hosts, in 0.1–1 m, on the reef about 5 kms south of Yaté, southeastern New Caledonia, 22°11'00"S, 166°59'00"E, 23 June 1971. From *Linckia guildingi* Gray: 75 ♀♀, 77 ♂♂, and 42 copepodids from 40 hosts, in 1–2 m, west of Isle Ngou, near Noumea, 22°13'44"S, 166°23'01"E, 3 August; 13 ♀♀, 19 ♂♂, and 2 copepodids from 20 hosts, in 1–2 m, west of Isle Ngou, 29 July; 19 ♀♀, 27 ♂♂ from 10 hosts, in

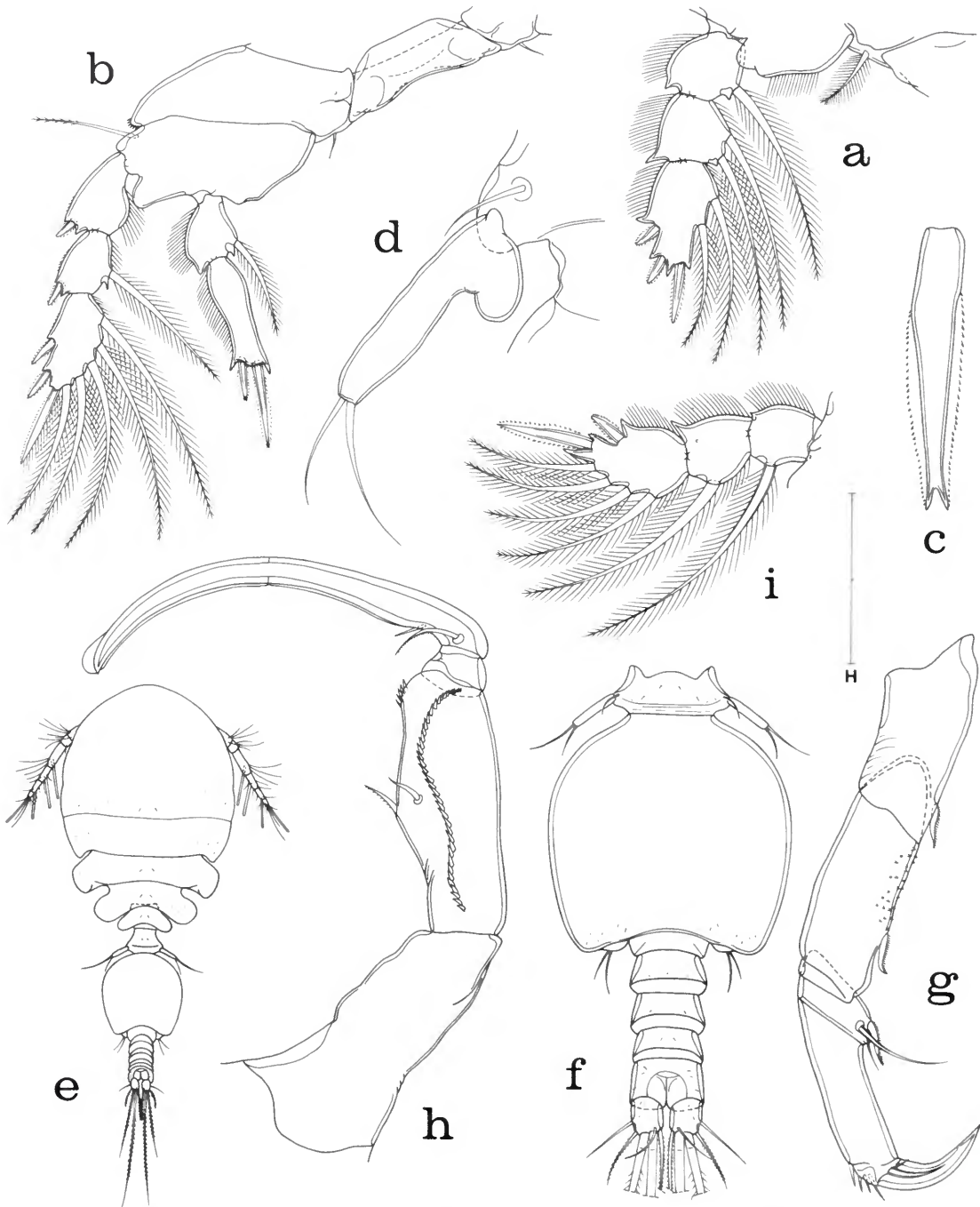


FIGURE 3.—*Metaxymolgus echinasteris*, new species, female: a, endopod of leg 3, with inner edge of coxa and basis, anterior (F); b, leg 4 and intercoxal plate, anterior (F); c, outer spine on second segment of endopod of leg 4, anterior (H); d, leg 5, dorsal (G). *Metaxymolgus echinasteris*, new species, male: e, dorsal (B); f, urosome, dorsal (C); g, second antenna, postero-inner (G); h, maxilliped, inner (G); i, endopod of leg 1, anterior (G). (Scale H = 0.02 mm).

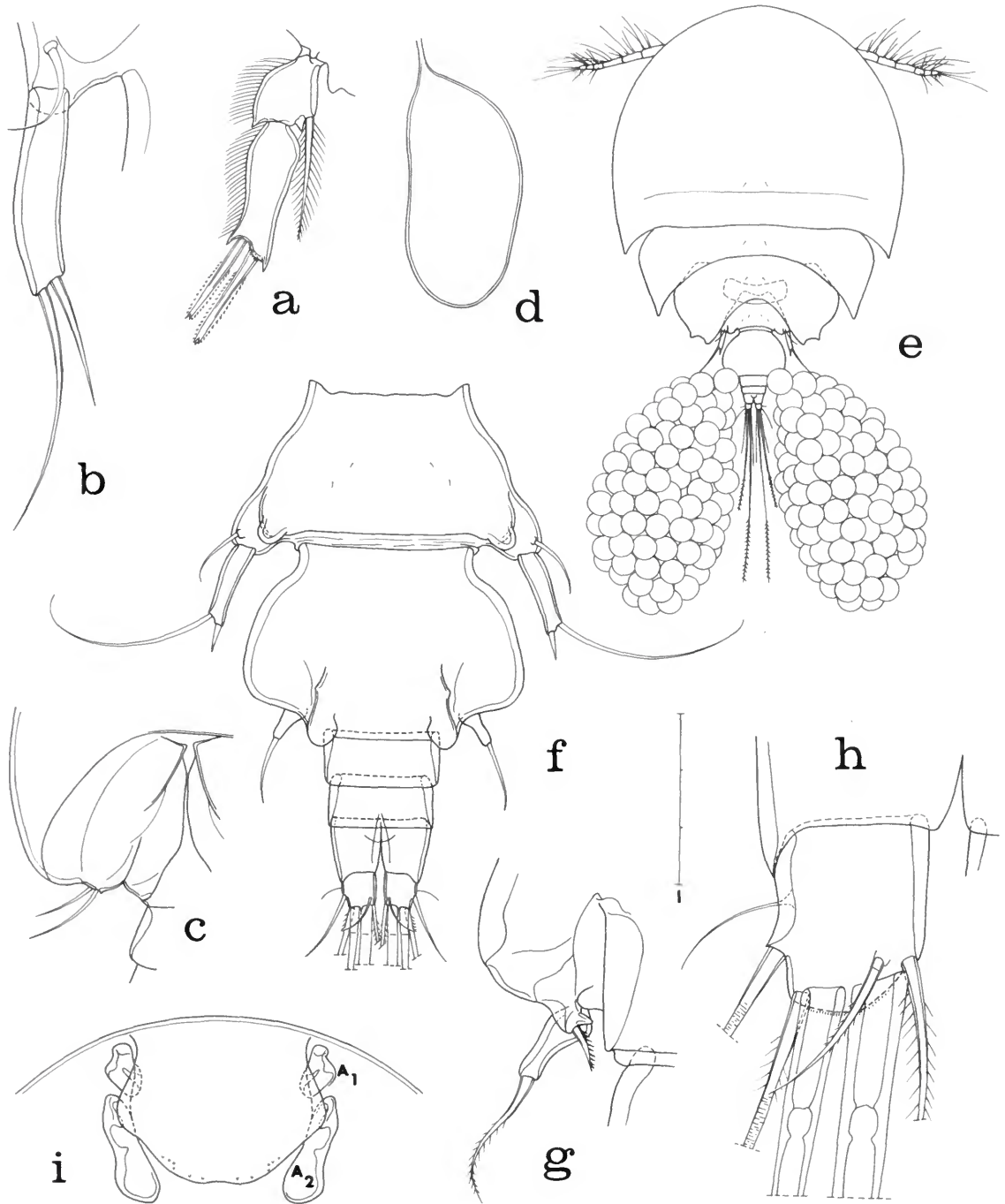


FIGURE 4.—*Metaxymolgus echinasteris*, new species, male: *a*, endopod of leg 4, anterior (G); *b*, leg 5, dorsal (D); *c*, leg 6, ventral (F); *d*, spermatophore, attached to female, dorsal (D). *Stelliicola novaecaledoniae*, new species, female: *e*, dorsal (B); *f*, urosome, dorsal (F); *g*, genital area, ventral (A); *h*, caudal ramus, dorsal (I); *i*, rostrum, ventral (E). (Scale I = 0.03 mm.)

1-2 m, Ricaudy Reef, near Noumea, 19 June; and 2 ♀♀, 1 ♂ from 2 hosts, in 2 m, west of Isle Ngou, 3 August.

FEMALE.—Body (Figure 4e) with a broad flattened prosome and a relatively short urosome. Length (not including the setae on the caudal rami) 1.28 mm (1.25–1.35 mm) and the greatest width 0.97 mm (0.94–1.02 mm), based on 10 specimens in lactic acid. Ratio of the length to the width of the prosome 1:1. Segment of leg 1 incompletely fused with the cephalosome. Epimera of the segments bearing legs 1–3 formed as in *S. illgi* Humes and Stock, 1973. Segment of leg 4 small and almost completely covered in dorsal view by the tergum of the preceding segment. Ratio of the length of the prosome to that of the urosome 2.5:1.

Segment of leg 5 (Figure 4f) $125 \times 247 \mu\text{m}$. Between this segment and the genital segment no ventral intersegmental sclerite. Genital segment $159 \times 221 \mu\text{m}$, wider than long. Genital areas located ventrolaterally in the posterior part of the segment. Each area (Figure 4g) bearing a plumose seta $55 \mu\text{m}$ mounted on an elongated pedicel, a unilaterally spinulose seta $16 \mu\text{m}$, and a small spiniform process. Three postgenital segments from anterior to posterior 49×91 , 44×82 , and $53 \times 68 \mu\text{m}$ (the width taken at the middle). Posterior margin of the anal segment smooth.

Caudal ramus (Figure 4h) short, $32 \times 25 \mu\text{m}$. Outer lateral seta $73 \mu\text{m}$ and naked. Dorsal seta $38 \mu\text{m}$ with a few short spinules. Outermost terminal seta $135 \mu\text{m}$ with a few proximal spinules. Innermost terminal seta $122 \mu\text{m}$ with spinules. Two median terminal setae $375 \mu\text{m}$ (outer) and $600 \mu\text{m}$ (inner), both with distal spinules and inserted dorsally to a small ventral flange with minute marginal spinules. On the proximal outer edge of the ramus a long setule ($19 \mu\text{m}$).

Body surface bearing a few small hairs (sensilla) as indicated in Figure 4e–f.

Egg sac (Figure 4e) in dorsal view elongated oval, $880 \times 480 \mu\text{m}$, reaching beyond the tips of the longest ramal setae. In side view the egg sac flattened, with only three layers of eggs at its thickest part. General form of the egg sac leaflike. Numerous eggs each about $72 \mu\text{m}$ in diameter.

Rostrum (Figure 4i) resembling that of *S. illgi*.

First antenna (Figure 5a) about $425 \mu\text{m}$ long. Lengths of the seven segments (measured along their posterior nonsetiferous margins): 39 (61 μm

along the anterior margin), 180, 62, 66, 32, 17.5, and $21 \mu\text{m}$ respectively. Formula for the armature the same as in *Metaxymolgus echinasteris*. All the setae naked. Third segment having an oblique suture on its ventral surface, this suture being absent on the dorsal surface.

Second antenna (Figure 5b) $440 \mu\text{m}$ long and 3-segmented. Formula for the armature: 1, 1, 3 + I + 5 small subterminal elements. All the setae naked. Third segment $218 \mu\text{m}$ along its outer edge, $140 \mu\text{m}$ along its inner edge, and $35 \mu\text{m}$ wide. Claw (Figure 5c) $91 \mu\text{m}$ along its axis.

Labrum (Figure 5d) with two broad divergent posteroventral lobes. Median postoral surface immediately behind the labrum finely spinulose.

Mandible (Figure 5e) similar to that of *S. illgi*. Paragnath a small hairy lobe. First maxilla (Figure 5f) with four naked elements. Second maxilla (Figure 5g) resembling that of *S. illgi* in major respects. Maxilliped (Figure 5h) also similar to that species, but one of the setae on the second segment with spinules.

Ventral surface between the maxillipeds and the first pair of legs (Figure 5i) not protuberant.

Legs 1-4 (Figures 5j–k, 6a–b) having the same segmentation and armature as in *S. illgi*. Intercoxal plate of leg 1 with a medially indented ventral margin (Figure 5j); in legs 2-4 this margin smooth. Inner coxal seta of legs 1-3 long and plumose, but this seta in leg 4 very small, $6 \mu\text{m}$, and naked. Exopod of leg 4 $78 \mu\text{m}$ long. First segment of the endopod $35 \times 16.5 \mu\text{m}$, with its inner distal naked seta $33 \mu\text{m}$. Second segment $36 \times 11 \mu\text{m}$, with its two barbed spines $26 \mu\text{m}$ (outer) and $65 \mu\text{m}$ (inner) and its inner plumose seta $67 \mu\text{m}$. Hairs present on the outer margins of both segments and on the inner margin of the second segment.

Leg 5 (Figure 6c) having an unornamented free segment $65 \times 15.5 \mu\text{m}$ (greatest length, width at the middle) about 4.2 times longer than wide. Two very unequal terminal elements $20 \mu\text{m}$ (finely barbed) and $115 \mu\text{m}$ (naked). Seta on the body near the insertion of the free segment about $40 \mu\text{m}$ and lightly plumose.

Leg 6 represented by the two setae on the genital area (Figure 4g).

Most living specimens in transmitted light pale blue, the eye red, the egg sacs brownish gray. A few females lacking the blue color entirely and slightly opaque. Blue color quickly changing to reddish

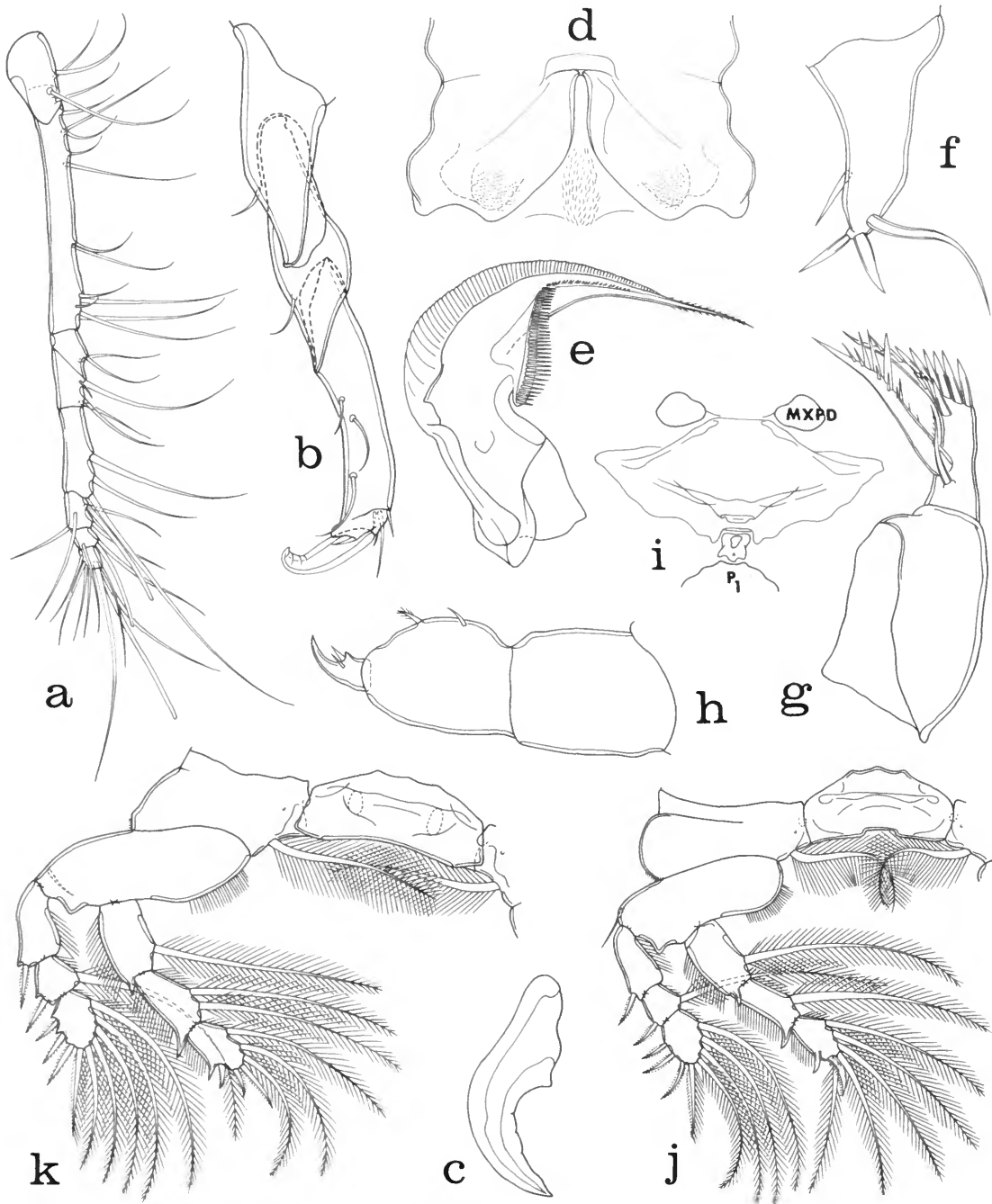


FIGURE 5.—*Stellicola novaecaledoniae*, new species, female: *a*, first antenna, ventral (F); *b*, second antenna, posterior (F); *c*, claw of second antenna, posterior (A); *d*, labrum and spinulose postoral area, with paragnaths indicated by broken lines, ventral (A); *e*, mandible, posterior (A); *f*, first maxilla, posterior (D); *g*, second maxilla, posterior (A); *h*, maxilliped, posterior (A); *i*, area between maxillipeds and first pair of legs, ventral (C); *j*, leg 1 and intercoxal plate, anterior (F); *k*, leg 2 and intercoxal plate, anterior (F).

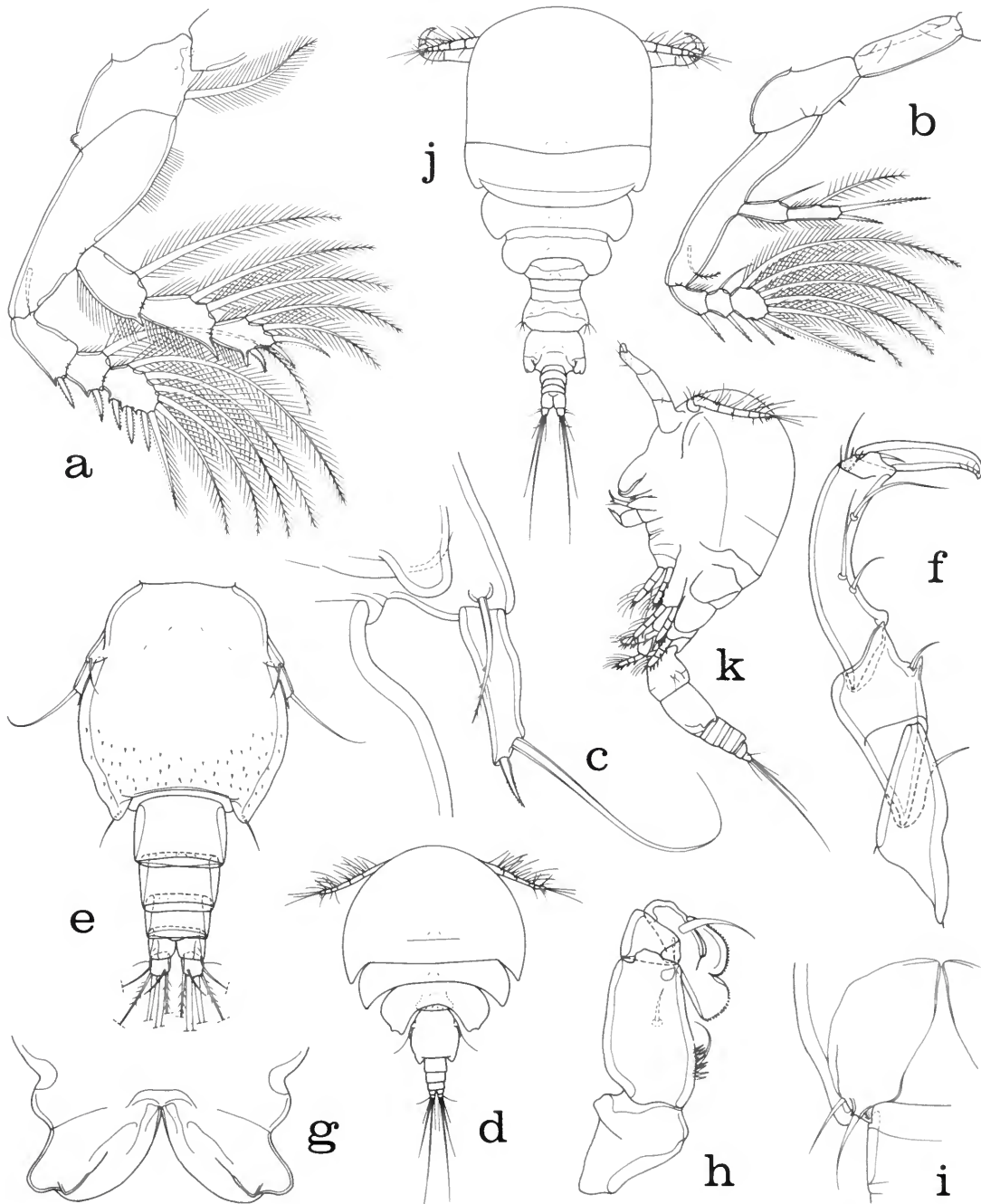


FIGURE 6.—*Stellicola novaecaledoniae*, new species, female: a, leg 3, anterior (F); b, leg 4 and intercoxal plate, anterior (F); c, leg 5, dorsal (A). *Stellicola novaecaledoniae*, new species, male: d, dorsal (B); e, urosome, dorsal (F); f, second antenna, posterior (G); g, labrum, ventral (A); h, maxilliped, posterior (D); i, leg 6, ventral (G). *Stellicola parvulipes*, new species, female: j, dorsal (E); k, lateral (E).

orange when the copepods were placed in 70 percent ethyl alcohol.

MALE.—Body (Figure 6d) with a broad prosome, its outline in dorsal view more spherical than in the female. Length (without the ramal setae) 0.83 mm (0.75–0.89 mm) and the greatest width 0.56 mm (0.55–0.58 mm), based on 10 specimens in lactic acid. Ratio of the length to the width of the prosome 1:1.1, slightly wider than long. Ratio of the length of the prosome to that of the urosome 1.78:1.

As in other species of *Stellicola* the segment bearing leg 5 fused with the genital segment (Figure 6e), the combined segment being $180 \times 164 \mu\text{m}$. Posterior third of the dorsal surface of this segment covered with small spinules. Four postgenital segments from anterior to posterior 47×73 , 39×65 , 30×57 , and $29 \times 47 \mu\text{m}$ (width at the middle).

Caudal ramus $31 \times 26 \mu\text{m}$, resembling that of the female.

Rostrum and first antenna (without added aesthetes) like those of the female.

Second antenna (Figure 6f) $275 \mu\text{m}$ long. Two features of sexual dimorphism evident: (1) a prominent inner spiniform process just proximal to the seta on the second segment and (2) the distinct curvature of the third segment. Claw $69 \mu\text{m}$.

Labrum (Figure 6g) with the configuration of the two lobes slightly different from the female. Mandible, paragnath, first maxilla, and second maxilla like those of the female. Maxilliped (Figure 6h) small, its entire length only about $83 \mu\text{m}$, and 4-segmented. First segment unarmed. Second segment bearing two naked setae, with prominent spinules near the insertion of the more proximal seta. Third segment small and unarmed. Elongated fourth segment ($37 \mu\text{m}$ long) not clawlike, but with a broad serrated tip; bearing distally a bladelike process bent back upon the segment and provided with minute spinules along its outer edge. In addition, the segment carrying proximally two very unequal naked setae, the larger one on the posterior surface of the segment, the smaller one on the anterior surface.

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

Legs 1–4 similar to those in the female.

Leg 5 also resembling that of the female, but the free segment smaller, $26 \times 8 \mu\text{m}$.

Leg 6 (Figure 6i) a posteroventral flap on the

genital segment bearing two naked setae 30 and $39 \mu\text{m}$ and a small spiniform process.

Spermatophore not observed.

Living specimens paler blue than in the female.

ETYMOLOGY.—The specific name *novaecaledoniae* refers to the presence of this species in New Caledonia.

COMPARISON WITH OTHER SPECIES.—There are presently 10 species in the genus *Stellicola* (Humes and Stock, 1973). The female of the new species may be distinguished by its elongated free segment in leg 5 (more than 3:1) from all these species except *S. femineus* Humes and Ho, 1967, and *S. illgi* Humes and Stock, 1973. It may be separated from *S. femineus*, which has a large toothlike spine on the terminal lash of the second maxilla. The male of the new species is easily distinguished by the form of its maxilliped from all species except *S. illgi*. (Males of four species are unknown. See Humes and Stock, 1973).

Stellicola novaecaledoniae is closer to *S. illgi* than to any other member of the genus. There are, however, several easily recognizable differences between the two species as indicated in Table 1.

LICHOMOLGID COPEPODS ASSOCIATED WITH *Linckia*.—There are now four species of the lichomolgid genus *Stellicola* known to live on *Linckia*, a genus of sea stars widely distributed through the tropical Indian and Pacific oceans. Three of these copepods are definitely associated with *Linckia laevigata*. They are *Stellicola pollex* Humes and Ho, 1967, in Madagascar (Humes and Ho, 1967), *Stellicola illgi* Humes and Stock, 1973, in the Palau Islands and Fiji, and the new species *Stellicola novaecaledoniae* in New Caledonia. A fourth copepod, *Stellicola caeruleus* (Stebbing, 1900), was reported from a "blue *Linckia*" in New Guinea by Stebbing (1900). Clark (1921:636) later listed this copepod (under the name *Linckiomolgus caeruleus* Stebbing) as associated with *Linckia laevigata*.

Two of these four *Stellicola* species are not restricted to *Linckia laevigata*, but occur also on other sea stars in this genus. Humes and Stock (1973) have reported *Stellicola pollex* from *Linckia diplax*, *Linckia multiflora*, and *Linckia guildingi* in Hawaii. *Stellicola novaecaledoniae* occurs on *Linckia guildingi* as reported above.

Sufficient collections are not available to establish the range of the various *Stellicola* on *Linckia*. The occurrence of *Stellicola pollex* in both Mada-

gascar and Hawaii, and of *Stellicola illgi* in the Palaus and Fiji (for records see Humes and Stock, 1973), indicates a wide distribution for these copepods.

Stellicola oreastriphilus Kossmann, 1877

SPECIMENS COLLECTED (all from the cushion sea star *Calcita novaeguineae* Müller and Troschel, a new host).—9 ♀♀, 5 ♂♂, and 1 copepodid from one host, in 0.5 m, eastern end of Isle Maître, near Noumea, 22°20'35"S, 166°25'10"E, 8 June 1971; 1 ♀, 4 ♂♂, and 1 copepodid, from one host, in 1 m, Rocher à la Voile, near Noumea, 22°18'24"S, 166°25'50"E, 13 June; 2 ♀♀, 3 ♂♂ from one host, in 2 m, Rocher à la Voile, 19 June; 7 ♀♀, 11 ♂♂, and 1 copepodid from one host, in 1 m, east of Isle To N'du, near Noumea, 22°10'49"S, 166°17'12"E, 12 July; 11 ♀♀, 5 ♂♂ from 5 hosts, in 10 cm, eastern end of Isle Maître, near Noumea, 22°20'35"S, 166°25'10"E, 16 July; 23 ♀♀ from 7 hosts, intertidal, eastern end of Isle Maître, near Noumea, 22°20'35"S, 166°25'45"E, 31 July.

REMARKS.—*Stellicola oreastriphilus* is a euryxenous species known to live on eight different asteroids. In the Red Sea Kossmann (1877) found it on *Asterope carinifera* (Lamarck). In Madagascar it was reported by Humes and Cressey (1961) on *Protoreaster lincki* (de Blainville), *Calcita schmid-*

eliana (Retzius), *Pentacaster mammillatus* (Audouin), and *Poraster superbus* (Möbius), by Humes and Ho (1966) on *Choriaster granulatus* (Lütken), and by Humes and Ho (1967) on *Protoreaster nodosus* (Linnaeus).

Stellicola parvulipes, new species

FIGURES 6j-k, 7a-k, 8a-i, 9a-k

TYPE MATERIAL.—13 ♀♀, 3 ♂♂ from one cushion star, *Calcita novaeguineae* Müller and Troschel, in 1 m, east of Isle To N'du, near Noumea, New Caledonia, 22°10'49"S, 166°17'12"E, 12 July 1971. Holotype ♀, allotype, and 14 paratypes (12 ♀♀, 2 ♂♂) deposited in the National Museum of Natural History (USNM), Smithsonian Institution.

OTHER SPECIMENS (all from *Calcita novaeguineae*).—6 ♀♀ from one host, in 2 m, Rocher à la Voile, near Noumea, 22°18'24"S, 166°25'50"E, 19 June; 5 ♀♀, 3 ♂♂ from 5 hosts, in 10 cm, eastern end of Isle Maître, near Noumea, 22°20'35"S, 166°25'45"E, 16 July.

FEMALE.—Body (Figure 6j-k) with an anteriorly subtruncated prosome, which is moderately thickened dorsoventrally. Length (excluding the setae on the caudal rami) 0.65 mm (0.64–0.66 mm) and the greatest width 0.29 mm (0.28–0.30 mm), based on 10 specimens in lactic acid. Ratio of the length

TABLE 1.—Selected characters useful in distinguishing *Stellicola novaecaledoniae* and *Stellicola illgi*

Characters	<i>S. novaecaledoniae</i>	<i>S. illgi</i>
FEMALE		
Lateral contour of genital segment	slightly angular	rounded
Ratio of length to width of free segment of leg 5	4.2:1	3.3:1
Body length	1.28 mm (1.25–1.35 mm)	1.00 mm (0.94–1.06 mm)
MALE		
Sexual dimorphism in second antenna	present	absent
Length of process bent back upon fourth segment of maxilliped	half length of segment	short, less than one fourth length of segment*
Body length	0.83 mm (0.75–0.89 mm)	0.60 mm (0.55–0.64 mm)

* This small process was not mentioned in the original description of Humes and Stock (1973). Reexamination of paratypes of *S. illgi* has shown that it is present, though much smaller than in the new species and easily overlooked.

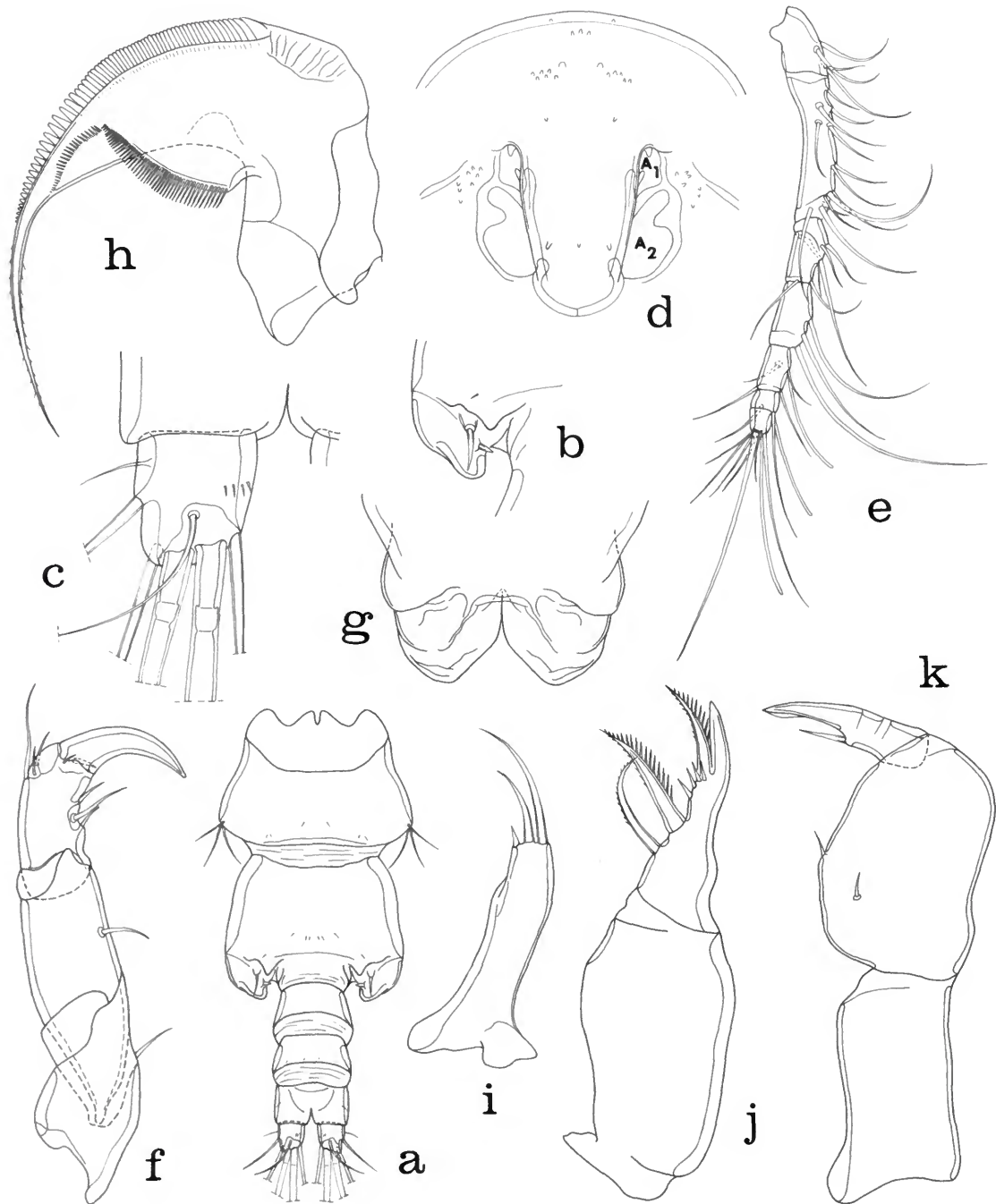


FIGURE 7.—*Stellicola parvulipes*, new species, female: a, urosome, dorsal (C); b, genital area, dorsal (D); c, caudal ramus, dorsal (H); d, rostrum, ventral (F); e, first antenna, dorsal (A); f, second antenna, posterior (A); g, labrum, ventral (A); h, mandible, posterior (I); i, first maxilla, posterior (I); j, second maxilla, posterior (I); k, maxilliped, posterior (I).

to the width of the prosome 1.54:1. Segment of leg 1 separated from the cephalosome by a weak transverse dorsal furrow. Epimera of the segments of legs 1–3 rounded. Ratio of the length of the prosome to that of the urosome 2.24:1.

Segment of leg 5 (Figure 7a) $72 \times 103 \mu\text{m}$. Between this segment and the genital segment no ventral intersegmental sclerite. Genital segment a little flattened dorsoventrally; in dorsal view subquadrate, $77 \times 97 \mu\text{m}$, somewhat wider than long. Genital areas situated dorsally on a pair of posteriorly projecting lobes. Each area (Figure 7b) bearing two unequal naked setae approximately 9 and 3 μm respectively. Three postgenital segments from anterior to posterior 30×50 , 22×45 , and $21 \times 42 \mu\text{m}$. Posterior border of the anal segment smooth.

Caudal ramus (Figure 7c) $15.5 \times 13.5 \mu\text{m}$. Outer lateral seta 25 μm , the dorsal seta 33 μm , the outermost terminal seta 44 μm , the innermost terminal seta 39 μm , and the two long median terminal setae 130 μm (outer) and 210 μm (inner), both inserted dorsally to a small ventral flange with a smooth margin. All the setae naked. Proximally on the outer edge of the ramus a slender setule and near the middle of the ramus several inner spinules.

Body surface with a few small hairs (sensilla) as indicated in Figures 6j and 7a.

Egg sac not observed.

Rostrum (Figure 7d) elongated and rounded posteroventrally.

First antenna (Figure 7e) 170 μm long. Lengths of the seven segments (measured along their posterior nonsetiferous margins): 12 (30 μm along the anterior margin), 55, 22, 25, 17.5, 9, and 9.5 μm respectively. Configuration of the last two segments suggesting their fusion, but in actuality a weak suture existing between the segments. Formula for the armature the same as in *Stellicola novaecaledoniae*. All the setae naked. Segment 3 with a diagonal suture on its ventral surface.

Second antenna (Figure 7f) 192 μm long and 3-segmented. Armature: 1, 1, 3 + I + 5 small subterminal elements. All the setae naked. Third segment 51 μm along the outer edge, 35 μm along the inner edge, and 23 μm wide. Claw 53 μm along its axis.

Labrum (Figure 7g) with two broad posteroventral lobes with smooth margins.

Mandible (Figure 7h) resembling in general form that of *S. novaecaledoniae*, but the elements in the

fringe along the convex side of the mandible, though slender and closely packed at first, becoming broader and separated distally. Paragnath a small hairy lobe. First maxilla (Figure 7i) slender with three terminal naked elements, one much shorter than the others. At the region where a subterminal fourth element occurs in other species, here a slight swelling of the wall, but a distinct element not seen. Second maxilla (Figure 7j) resembling in major respects that of *S. novaecaledoniae*, but the spinules on the large inner spine here of a more uniform size and the lash having a very large but slender proximal tooth followed by slender spinules. Maxilliped (Figure 7k) 3-segmented, with the first segment unarmed, the second with two small naked setae, and the third with one seta in addition to the terminal spiniform process.

Ventral surface between the maxillipeds and the first pair of legs (Figure 8a) not protuberant.

Legs 1–4 (Figure 8b–e) with the same segmentation and armature as in *S. novaecaledoniae*. Basis of leg 4 not greatly elongated as it is in other species of the genus. In this leg the inner coxal seta vestigial. Exopod 46 μm long. First segment of the endopod $16.5 \times 10 \mu\text{m}$, with its inner distal seta 45 μm ; the second segment $20 \times 10 \mu\text{m}$, with its three elements from outer to inner 14, 26, and 52 μm .

Leg 5 (Figure 8f–g) not clearly separated from the body and consisting of a minute lobe, corresponding to the free segment in other species, largely hidden in dorsal view; its two terminal setae about 22 μm .

Leg 6 represented by the two setae on the genital area (Figure 7b).

Living specimens in transmitted light opaque, the eye red.

MALE.—Body (Figure 8k) with the prosome more rounded anteriorly and somewhat less thickened dorsoventrally than in the female. Length (without the ramal setae) 0.59 mm (0.59–0.60 mm) and the greatest width 0.25 mm (0.24–0.25 mm), based on 4 specimens in lactic acid. Ratio of the length to the width of the prosome 1.27:1. Ratio of the length of the prosome to that of the urosome 1.25:1.

Segment of leg 5 fused with the genital segment (Figure 8i), whose lateral borders are slightly irregular in dorsal view. Combined segment $125 \times 130 \mu\text{m}$. Four postgenital segments from anterior to

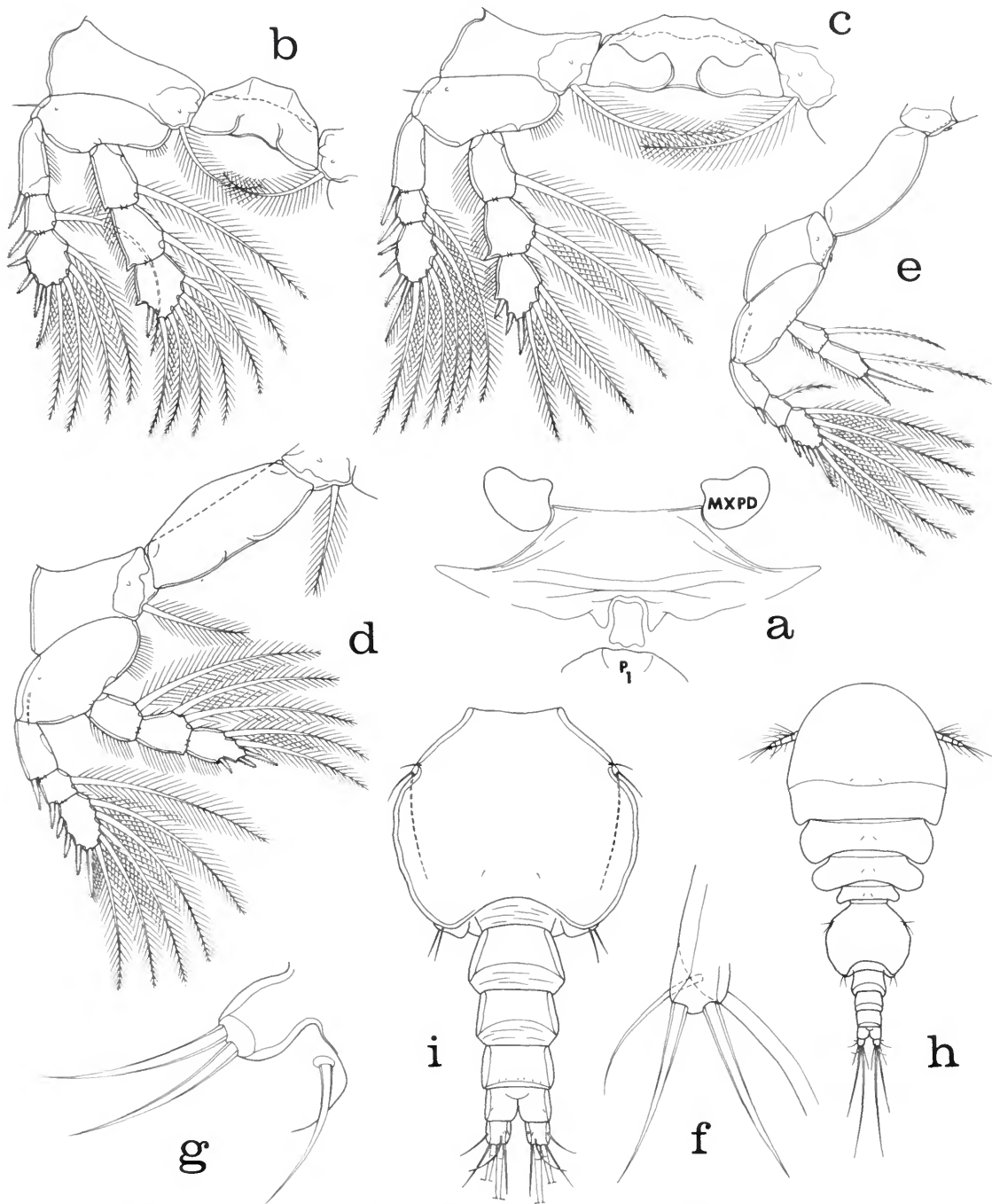


FIGURE 8.—*Stellicola parvulipes*, new species, female: a, area between maxillipeds and first pair of legs, ventral (A); b, leg 1 and intercoxal plate, anterior (A); c, leg 2 and intercoxal plate, anterior (A); d, leg 3 and intercoxal plate, anterior (A); e, leg 4 and intercoxal plate, anterior (A); f, leg 5, ventral (H); g, leg 5, lateral (H). *Stellicola parvulipes*, new species, male: h, dorsal (E); i, urosome, dorsal (G).

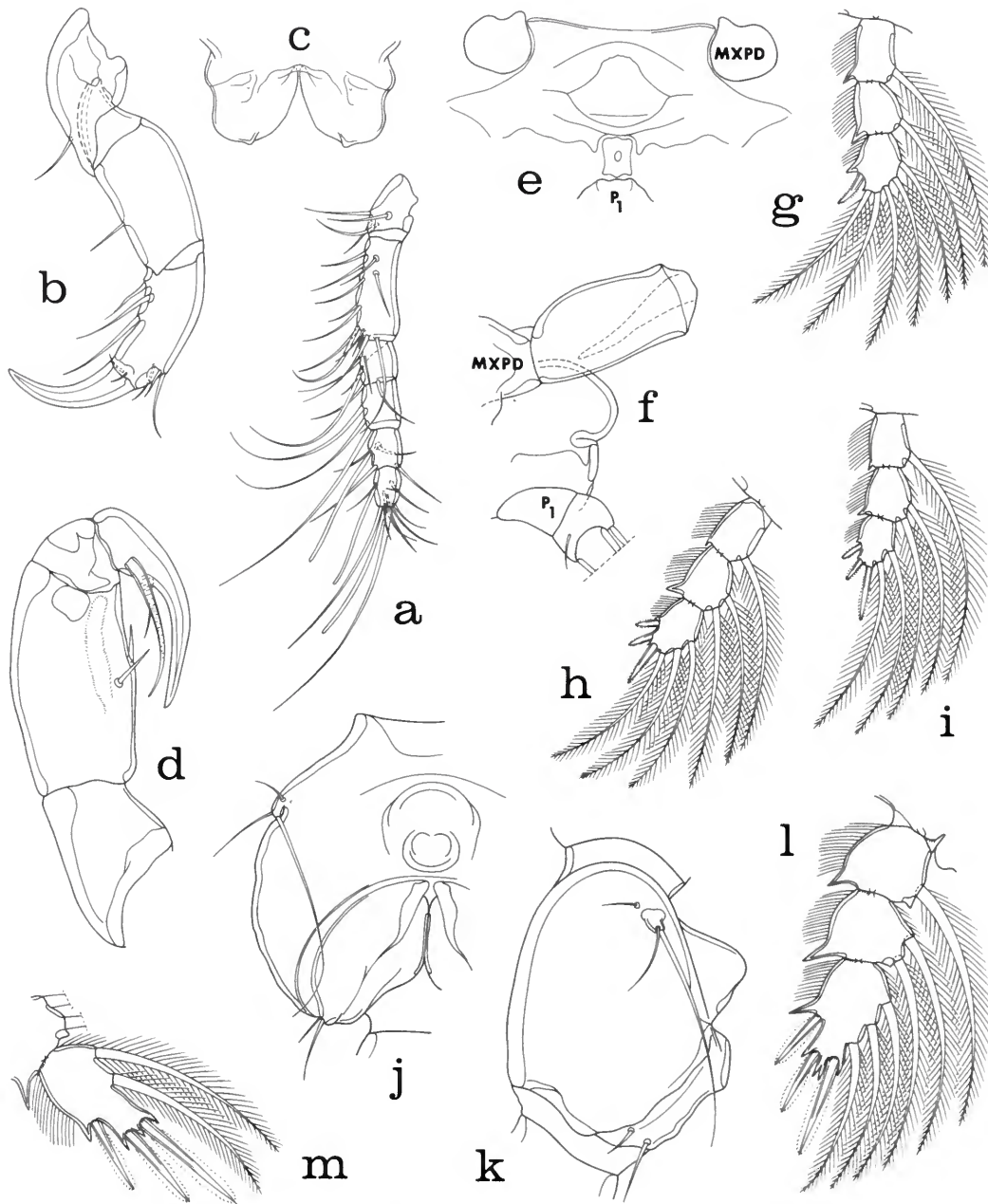


FIGURE 9.—*Stellicola parvulipes*, new species, male: *a*, first antenna, dorsal (A); *b*, second antenna, posterior (A); *c*, labrum, ventral (A); *d*, maxilliped, postero-inner (D); *e*, area between maxillipeds and first pair of legs, ventral (A); *f*, same, lateral (A); *g*, endopod of leg 1, anterior (A); *h*, endopod of leg 2, anterior (A); *i*, endopod of leg 3, anterior (A); *j*, right half of fused segment of leg 5 and genital segment, showing both leg 5 and leg 6, ventral (A); *k*, fused segment of leg 5 and genital segment, lateral (A). *Synstellicola pichoni* (Humes and Ho, 1966), female: *l*, endopod of leg 3, anterior (G); *m*, third segment of endopod of leg 3, anterior (G).

posterior 33×52 , 29×47 , 27×42 , and 16×36 μm .

Caudal ramus 14×14 μm , similar to that of the female.

Rostrum like that of the female. First antenna (Figure 9a) 130 μm long. Lengths of the segments (measured as in the female): 9 (25 μm along the anterior edge), 37, 15.5, 17.5, 15.5, 10, and 6.5 μm respectively, with certain segments relatively shorter than in the opposite sex. Armature like that in the female. Last two segments not completely separated.

Second antenna (Figure 9b) 155 μm long. Third segment relatively longer than in the female, being 57 μm along its outer edge, 42 μm along its inner edge, and 21 μm wide. Claw 50 μm along its axis.

Labrum (Figure 9c) with two broad posteroventral lobes, each with a small sclerotized process on the margin. Mandible, paragnath, first maxilla, and second maxilla like those in the female. Maxilliped (Figure 9d) relatively short. First segment unarmed. Second segment with two short naked setae and a long narrowly U-shaped row of minute spinules. Small third segment unarmed. Relatively short claw, 58 μm along its axis, bearing proximally two unequal setae.

Ventral surface between the maxillipeds and the first pair of legs (Figure 9e) strongly protuberant. Protuberance best seen in lateral view (Figure 9f).

Legs 1-4 segmented and armed as in the female. Endopods of legs 1-3 (Figure 9g-i) differing slightly from those in the female in the development of the outer distal spiniform processes on segments 1 and 2. Leg 4 like that of the female.

Leg 5 (Figure 9j-k) a small lobe not separated from the body, thus resembling that of the female. Two terminal setae, however, here very unequal, 32 and 85 μm .

Leg 6 (Figure 9j-k) a posteroventral flap on the genital segment bearing two naked setae, one 28 μm , the other 13 μm and hyaline. Median edges of the two flaps projecting ventrally (as in Figure 9k). Just anterior to the sixth legs a conspicuous median ventral process (Figure 9j-k).

Spermatophore not observed.

Living specimens colored as in the female.

ETYMOLOGY.—The specific name *parvulipes*, from the Latin *parvulus* = very small and *pes* = foot, alludes to the minute leg 5 in this species.

COMPARISON WITH OTHER SPECIES.—With the addition of the two new species of *Stellicola* described

in this work there are now 12 species in the genus *Stellicola* Kossmann, 1877, as defined by Humes and Stock (1973). *Stellicola parvulipes* differs from all others in three respects: (1) the female is shorter (0.65 mm), all other species being close to 1 mm or more in length; (2) the epimera of the metasomal segments are rounded rather than pointed as in other species; and (3) instead of leg 5 having a free segment (that is, separated from the body by an articulation), it is fused with the body.

Seven species of *Stellicola* have a greatly elongated basis in leg 4 (*S. pollex* Humes and Ho, 1967, *S. caeruleus* (Stebbing, 1900), *S. illgi* Humes and Stock, 1973, *S. longicaudatus* (Thompson and A. Scott, 1903), *S. pleurobranchi* Kossmann, 1877, *S. thorelli* Kossmann, 1877, and *S. novaecaledoniae* described above). The remaining four species have a much less elongated basis, approaching the condition in the new species. These may be easily distinguished from *S. parvulipes* as follows: in *S. femineus* Humes and Ho, 1967, the female genital segment is very wide with rounded lateral margins and the male has a female-like maxilliped; in *S. oreastriphilus* Kossmann, 1877, the lash of the second maxilla has more than one large spine and the female genital segment is much wider; in *S. curticaudatus* (Thompson and A. Scott, 1903) the lash of the second maxilla has a series of graduated spines, none markedly larger than the others; and in *S. holothuriae* (Ummerkutty, 1962) the lash of the second maxilla has several spines instead of a single strongly developed one.

Synstellicola acanthasteris (Humes, 1970)

SPECIMENS COLLECTED (all from the crown of thorns sea star *Acanthaster planci* (Linnaeus)).—18 ♀♀, 11 ♂♂ from one host, in 4 m, west of Isle Ngou, northwest of Noumea, $22^{\circ}13'44''\text{S}$, $166^{\circ}23'01''\text{E}$, 3 August 1971; 7 ♀♀, 7 ♂♂ from one host, in 2 m, Ricaudy Reef, near Noumea, $22^{\circ}19'05''\text{S}$, $166^{\circ}26'28''\text{E}$, 20 July. (These two records have been published by Humes and Stock, 1973, but are repeated here for the sake of completeness.)

REMARKS.—This copepod is associated only with *Acanthaster planci*. It was described from Eniwetok Atoll, Marshall Islands (Humes, 1970) and has since been reported from Viti Levu, Fiji (Humes and Stock, 1973).

Synstellicola pichoni (Humes and Ho, 1966)

FIGURE 9l-m

SPECIMENS COLLECTED.—4 ♀♀, 12 ♂♂ from one sea star, *Protoreaster lincki* (de Blainville), a new host, in 0.5 m, western side of Isle Maître, near Noumea, 22°20'05"S, 166°24'05"E, 8 August 1971.

REMARKS.—These copepods agree closely with paratypic material from *Choriaster granulatus* (Lütken) in Madagascar. The New Caledonian specimens are a little larger, however, the female being 1.08 mm (1.05–1.11 mm) in length and 0.48 mm (0.42–0.51 mm) in greatest width (based on 4 specimens in lactic acid), and the male 0.89 mm

(0.73–0.98 mm) in length and 0.35 mm (0.26–0.40 mm) in greatest width (based on 6 specimens in lactic acid). The spines on the third segment of the endopod in leg 2 (Figure 9l) and leg 3 (Figure 9m) are relatively longer than in the Madagascar specimens. Otherwise the copepods from the two hosts and localities are similar. (The dimensions for the free segment of leg 5 in the female given by Humes and Ho, 1966, page 99, are erroneous and should read 28 × 9 μm, instead of 65 × 21 μm).

Synstellicola pichoni is now known to live on two species of sea stars, in localities remote from one another (on *Choriaster granulatus* in Madagascar and on *Protoreaster lincki* in New Caledonia).

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In the *bibliography* (usually called "Literature Cited"), spell out book, journal, and article titles, using initial caps with all words except minor terms such as "and, of, the." For capitalization of titles in foreign languages, follow the national practice of each language. Underscore (for italics) book and journal titles. Use the colon-parentheses system for volume, number, and page citations: "10(2):5-9." Spell out such words as "figures," "plates," "pages."

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