Cah. ORSTOM. sér. Océanogr., vol. IV, n° 3, 1966

CYCLOPOID COPEPODS ASSOCIATED WITH THE STARFISH *CHORIASTER GRANULATUS* (LÜTKEN) IN MADAGASCAR

by Arthur G. HUMES *and* JU-SHEY HO*

RÉSUMÉ

Quatre espèces des copépodes cyclopoïdes s'associent à l'étoile de mer Choriaster granulatus *à Tany Kely (près de Nosy Bé) et à Nosy Ovy (Isles Radama), au nord-ouest de Madagascar:* Asterocomes indica *Padmanabha Rao*, Stellicomes tumidulus *Humes et Cressey*, Stellicola pichoni *n. sp.*, *et* Stellicola oreastriphilus *Humes et Cressey. Certains traits d'*Asterocomes indica *et de* Stellicomes tumidulus *sont décrits, et cette dernière espèce est comparée avec* Stellicomes guineensis *Humes et Cressey (une espèce de l'Afrique Occidentale).*

The region of Nosy Bé, in northwestern Madagascar, has a rich fauna of echinoderms, including numerous species of asteroids. Many of these live intertidally or in shallow water. During several months collecting in these areas *Choriaster granulatus* (Lütken) was never seen. It was only when diving with aqualungs to greater depths (10-40 meters) began that this starfish was found, often in abundance. The 76 *C. granulatus* examined in this study came partly from Tany Kely (collected by Dr. Michel Pichon, to whom we wish to express our thanks) and partly from Nosy Ovy (collected by the first author).

The copepods were collected during 1963-64 as part of the work of the U.S. Program in Biology of the International Indian Ocean Expedition.

The study of the material has been aided by a grant from the National Science Foundation of the United States.

We wish to thank Dr. H. B. Fell, curator of invertebrate zoology at the Museum of Comparative Zoology, Harvard University, for the identification of the starfish and the staff of the Centre d'Océanographie et des Pêches at Nosy Bé for assistance in many ways.

Asterocomes indica Padmanabha Rao, 1962 (1)
Figs. 1-23

This species, known previously only from India, was recovered from washings of *Choriaster granulatus* in two localities as follows :

a) in 10-15 m at Tany Kely, a small island about 8 kms to the south of Nosy Bé, Madagascar : 27 females and 37 males from 5 starfishes, July 11, 1963 ; 10 females and 10 males from 4 hosts,

* Department of Biology, Boston University, Boston, Massachusetts, U.S.A.

(1) For the use of the feminine form of the adjective with *comes*, a Latin noun of either masculine or feminine gender, see the International Code of Zoological Nomenclature 1961, art. 30 (a) (i) (2).

August 1, 1963 ; 11 females and 8 males from 8 hosts, August 28, 1963 ; 5 females and 2 males from 6 hosts, September 10, 1963 ; 53 females, 64 males, and 2 copepodids from 12 hosts, September 17, 1963 ; 9 females and 27 males from 13 hosts, February 19, 1964; 6 females and 14 males from 6 hosts, March 20, 1964 ; and 32 females and 44 males from 13 hosts, April 11, 1964.

b) in 10 m at Nosy Ovy (= Berafia), Isles Radama, 13°59'S, 47°46'30"E, to the southwest of Nosy Bé : 31 females and 28 males from 9 hosts, October 1, 1964.

These collections represent a total number of 184 females, 234 males, and 2 copepodids from the 76 starfishes.

Through the kindness of Dr. S. Jones of the Central Marine Fisheries Research Institute at Mandapam Camp, India, we have been able to examine paratypes (a male and a female) of *A. indica*. The specimens from Madagascar agree in all significant characters with these paratypic specimens from the starfish *Pentaceros hedemanni* (Lütken) (1) from the southeastern coast of India. Based on our study of the abundant material from Madagascar, certain additions and modifications can be made, however, to Padmanabha Rao's original description. (In the following paragraphs those characters not discussed or figured may be considered as like those in the original description.)

Female. — The body (figs. 1 and 2) has a length of 0.76 mm (0.70-0.81 mm) and a greatest width of 0.36 mm (0.32-0.41 mm), based on 10 specimens. The urosome (fig. 3) is broader than long., 140×174 μ. The areas of attachment of the egg sacs lie dorsolaterally, overlapped by the posterolateral borders of the prosome; each area is unarmed. The egg sac (fig. 4) is oval, 143×120 μ, and contains a single egg. The caudal ramus (fig. 5) is represented by four naked hyaline setae, the longest 36 μ.

The rostrum is undeveloped (see fig. 21 for the male).

The first antenna (fig. 6) is probably composed of fourteen segments, though the segmentation is obscure. The second antenna (fig. 7) has two subequal terminal claws 28 μ in length. Other setae and spinules occur as shown in the figure; apparently there is no seta on the first segment. The mouth cone is shown in anteroventral view in fig. 8 and in ventral view *in situ* in fig. 9; in lateral view the cone projects slightly (fig. 10).

The mandible (fig. 11) consists of a protuberant area lateral to the mouth cone (see fig. 21 for the male) and bears a large spiniform seta and two adjacent slender setae. Paragnaths could not be identified. The first maxilla (fig. 11) is a small lobe bearing four terminal setae and located near the mandible. The second maxilla (fig. 12) has an indistinctly divided claw 110 μ in length (measured along its axis and not along its curvature) with a small subterminal hyaline process on its concave margin. The maxilliped (fig. 13) has a terminal claw 34 μ in length ; there are spinules along the inner margin of the slender fourth segment.

Leg 1 (fig. 14) has a small seta on the proximal anterior surface of the exopod (on the first segment, if the interruption in the inner sclerotization of the ramus indicates a joint). The hyaline endopod is long and slender, about 86×16 μ.

Leg 2 (fig. 15) apparently lacks the outer seta on the protopod. The distal part of the exopod is attenuated and hyaline. There are small spinules on the distal inner area of the endopod; this ramus bears two terminal setae.

Leg 3 (fig. 16) also lacks the outer seta on the protopod. The segments and their spines are ornamented as indicated in the figure.

Leg 4 (fig. 17) lacks the outer seta on the protopod. There is a short naked seta on the last segment as in the previous leg. The fourth leg lacks an intercoxal plate.

The spine and setal formula for legs 1-4 is as follows (the Roman numerals indicating the spines, the Arabic numerals the setae) :

(1) This name is a synonym of *Pentaceraster multispinosus* (von Martens).

P 1	protopod	1:0	exp.	1; 3,3
			end.	2
P 2	protopod	0:0	exp.	0:0; 0:1; 3,1
			end.	2
P 3	protopod	0:0	exp.	1:0; 1:0; 1,3
P 4	protopod	0:0	exp.	1:0; 1:0; 1

Leg 5 (fig. 18) is elongated, 25×10 μ, bearing four naked steae, one distinctly larger than the others.

Leg 6 is absent.

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

Male. — The body (fig. 19) has a length of 0.71 mm (0.67-0.76 mm) and a greatest width of 0.35 mm (0.33-0.38 mm), based on 10 specimens. The urusome (fig. 20) has a somewhat different form than in the female.

The rostral area, first antenna, second antenna, mouth cone, mandible, first maxilla, second maxilla, and maxilliped are like those in the female. Their relationships are shown in fig. 21.

Legs 1-4 resemble those in the female.

Leg 5 (see fig. 20) is similar to that of the female but smaller, the dimensions being 22×7 μ, and the four setae are relatively longer than in the female.

Leg 6 (see fig. 20) is a posterolateral protuberance on the genital area of the urosome bearing a single hyaline seta 7 μ in length

The spermatophore (fig. 22), dissected from the body of a male, is oval, 115×85 μ, not including the neck of 39 μ. *In situ* on the body of the male the spermatophore appears less oval (fig. 23), 100×86 μ, with the neck extending dorsally.

Relationship to the host. — The copepods are closely associated with the starfish and even under abnormal conditions (for example, when several starfishes are kept in a pail of sea water for several hours) do not leave the host. When the starfishes are washed in sea water plus a small amount of ethyl alcohol, very often no copepods will be recovered. If, however, the starfishes are left undisturbed in this weakly alcoholized sea water overnight, and then quickly and vigourously washed, the copepods appear in the sediment. Once the starfishes have been stimulated to the point where their ambulacral grooves close, no more copepods are obtained. It is then necessary to wait for the starfishes to relax the grooves, when the washing may be repeated. In this way specimens of *A. indica* were recovered even after nine successive washings. The copepods evidently cling to the host within the ambulacral grooves and only these successive vigorous washings can dislodge them all.

Behavior. — *A. indica* is unable to swim. When removed from the host to a dish of sea water, the copepods lie on their backs, with their appendages actively moving and clinging to any available debris. Their bodies are slightly contractile, and bend back and forth in very active motions. This contractility may produce slightly different body sizes in specimens treated with alcohol or formalin. In fact, this may be the explanation for the smaller body size of the Indian specimens compared to the specimens from Madagascar, since Padmanabha Rao's specimens were washed from the starfishes in 5 per cent formalin rather than with ethyl alcohol.

Stellicomes tumidulus Humes and Cressey, 1958
Figs. 24-29

This small species was recovered from washings of *Choriaster granulatus* as follows:

1 male from 5 starfishes, in 10 m, Tany Kely, near Nosy Bé, July 11, 1963.

1 female from 8 hosts, from the same locality, August 28, 1963.

1,012 copepods representing both sexes from 9 hosts, in 10 m, Nosy Ovy, Isles Radama, 13°59'S, 47°46'30''E, to the southwest of Nosy Bé, October 1, 1964.

During the study of these specimens from *Choriaster*, certain details of the external anatomy were noticed which at first seemed to be at variance with *Stellicomes tumidulus* as originally described. A comparison of the copepods from *Choriaster* with paratypes of *S. tumidulus* from *Protoreaster* and with other specimens from *Poraster* and *Culcita* shows, however, that all these copepods represent the same species. There are, nevertheless, certain minor modifications necessary in the original description of *S. tumidulus*. These slight inaccuracies have their origin in part on the fact that Humes and Cressey studied unstained dissections in glycerine, which is a rather inferior clearing medium for these very small copepods. We are now using lactic acid (after a light stain with chlorazol black E) with much more satisfactory results. The several features mentioned below are to be regarded as common to all specimens of *S. tumidulus* at Nosy Bé.

a) The body (fig. 24) shows dorsally a rather elaborate sclerotized framework.

b) The second segment of the first antenna (fig. 25) bears only setae, the element originally described as an aesthete being actually a seta.

c) The second antenna (fig. 26) has on the third segment a row of small spinules on the side opposite to the row of large spinules. The armature of the last segment consists of two long spinules on the outer side, two short spinules on the inner side, one seta, a simple subterminal claw, and a terminal claw (or claw-like process, since its articulation is indistinct) with a tripartite tip. (Figure 26 should be compared with Humes and Cressey's Pl. I, fig. 5.)

d) In leg 1 (fig. 27) the exopod has a short naked inner seta at one-third the distance from its base and all three long terminal setae have hairs along one side. (Compare Humes and Cressey's Pl. II, fig. 10).

e) In leg 3 (fig. 28) the exopod has a short naked seta on the terminal segment (in addition to the four long haired setae), and the two terminal setae of the endopod are lightly haired.

f) In the male leg 6 is represented by a single small seta (fig. 29). In connection with the restudy of *S. tumidulus* we have also reexamined paratypes of *S. guineensis* Humes and Cressey, 1958, from *Oreaster clavatus* Müller and Troschel in Sierra Leone, and find that corrections a, c, d, e, and f apply here also. In addition, on the terminal segment of the expod of leg 4 there is only one short naked seta (instead of two as in Humes and Cressey's Pl. V, fig. 28).

The major differences between *S. tumidulus* and *S. guineensis* may be summarized, after reexamination of paratypes of both species, as follows :

	S. tumidulus	*S. guineensis*
mouth cone	dentition rather weak	dentition coarser
terminal claw on maxilliped	simple, with a feeble subterminal tooth	forked (or with a strong subterminal tooth)
endopod of leg 1	with a single terminal seta	with two terminal setae
protopods of legs 2-4	with a seta	without setae
first segment of endopod of leg 2	with a simple naked seta	with a spiniform process instead of a seta
terminal segment of exopod of leg 3	no spinules	with a row of spinules
exopod of leg 4	1-0; I-1; 0-2	I-0; I-1; 0-1
egg sacs	oval (1.4:1)	more elongated (1.7:1).

A third species of *Stellicomes*, *S. pambanensis*, has recently been described by Padmanabha Rao (1964) from the starfish *Pentaceros hedemanni* (Lütken) in the Gulf of Mannar, southeastern India.

Stellicomes tumidulus is now known to occur on five asteroids in the region of Nosy Bé: *Protoreaster lincki* (Blainville), *Poraster superbus* (Möbius), *Pentaceraster mammillatus* (Audouin), *Culcita schmideliana* (Retzius), and *Choriaster granulatus* (Lütken).

Stellicola pichoni n. sp.
Figs. 30-59

Type material. — 25 females and 23 males washed from 9 *Choriaster granulatus* (Lütken), in 10 m, at Nosy Ovy, Isles Radama, 13°59'S, 47°46'30"E, to the southwest of Nosy Bé, Collected October 1, 1964. Holotype, allotype and 35 paratypes (18 females and 17 males) deposited in the United States National Museum, Washington, and the remaining paratypes in the collection of A. G. Humes.

Other specimens (all from *Choriaster granulatus* in 10 m at Tany Kely, a small island about 8 kms to the south of Nosy Bé). — 5 females and 2 males from 6 hosts, September 10, 1963; 4 females and 4 males from 13 hosts, February 19, 1964; 7 females and 2 males from 6 hosts March 20, 1964; and 12 females and 7 males from 13 hosts, April 11, 1964.

Female. — The body (fig. 30) has a moderately broadened prosome and a relatively slender urosome. The length (not including the setae on the caudal rami) is 0.79 mm (0.70-0.87 mm) and the greatest width, at the junction of the head and the segment of leg 1, is 0.37 mm (0.34-0.40 mm), based on 10 specimens. The ratio of length to width of the prosome is about 1.46:1. The segment of leg 1 is separated from the head dorsally and laterally by a furrow. The epimeral areas of the metasomal segments are rounded.

The segment of leg 5 (figs. 31 and 32) is narrow anteriorly but widened posteriorly where it bears laterally the two legs. The genital segment is elongated, with the posterior fourth (behind the areas of attachment of the egg sacs) constricted. The length is 143 μ, the greatest width 107 μ, and the width in the narrowed posterior fourth is 75 μ. The areas of attachment of the egg sacs are dorsolateral in position and each bears two unusually prominent setae, one 20 μ long and haired, the other 44 μ and annulated but naked; between the two setae there is a small spiniform process (fig. 33). The posteroventral margin of the genital segment bears a row of slender spinules on each side and between them a membrane with a ragged edge simulating small spinules. There are only two postgenital segments, the first 40×64 μ with its posteroventral margin ornamented as on the genital segment, the second (anal segment) 28×53 μ and lacking this posteroventral ornamentation. The posterodorsal margins of the genital and postgenital segments lack any special ornamentation.

The caudal ramus (fig. 34) is inserted ventrally on the anal segment and is only slightly longer than wide, 28×23 μ. On the outer side there is a long hyaline submarginal setule. The pedicellate dorsal seta is 52 μ long and haired. The naked outer lateral seta is 78 μ long and inserted close to the outermost subterminal seta which is 117 μ long and haired. The innermost subterminal seta is 175 μ long and apparently naked. The two long terminal setae, 314 and 470 μ long respectively, bear short lateral spinules, and their basal portions proximal to the « joint » are finely punctate ; these two setae are inserted somewhat ventrally on the ramus between two slight flaps, the ventral one of which bears a marginal row of long slender spinules. There is a small hair on the ventral surface of the ramus.

The dorsal surface of the prosome bears scattered refractile points and hairs. The dorsal and ventral surfaces of the urosome bear hairs and refractile points as shown in the figures. The ratio of the length of the prosome to that of the urosome is 2:1.

The egg sac (fig. 35) is moderately elongated about 325 × 112 μ, and contains numerous small eggs. (In the egg sac drawn, which was the only relatively intact sac found, part of the eggs had already hatched.)

The rostral area (fig. 36) is well-defined.

The seven segments of the first antenna (fig. 37) have the following lengths (measured along their posterior non-setiferous margins): 20 (44 μ along the anterior margin), 65, 26, 36, 25, 13, and 12 μ respectively. The formula for the armature is 4, 13 (5+2+6), 6, 3, 4+1 aesthete, 2+1 aesthete, and 7+1 aesthete. The setae are naked except for certain ones with short lateral hairs (one in the distal group on segment 2, one on segment 3, one on segments 5 and 6, and five on segment 7). The aesthetes are very slender and often resemble setae; the aesthete on segment 7 arises from a common base with one of the long terminal setae and shows a few annulations in its proximal half. On the proximal ventral region of segment 3 there is a sclerotization suggesting an intercalary segment.

The second antenna (figs. 38 and 39) is slender and 3-segmented, though the last segment is incompletely divided. The first segment bears a smooth annulated seta and more proximally a cluster of short hairs. The second segment has a pilose seta and the third three such setae. The anterior surfaces of segments 2, 3, and 4 bear numerous long hairs as indicated in fig. 38. Terminally there is a single claw 42 μ in greatest length along its axis, near the base of which there are three slender setae and one shorter and rather blunt seta.

The labrum (fig. 40) has two posteroventral lobes without ornamentation.

The mandible (fig. 41) has on its basal region an outer row of spinules and an inner large proximal spine-like process (articulated?) followed by a row of fairly stout spinules; the terminal lash has short lateral spinules. The paragnath (fig. 42) is a short rounded lobe bearing hairs.

The first maxilla (fig. 43) is a single segment bearing four setae, the outermost long and slender with lateral hairs, the next stout with coarser hairs, and the two inner setae short and naked. The second maxilla (fig. 44) is 2-segmented. The basal segment is large and unarmed. The slender distal segment terminates in a spiniform process bearing lateral spinules; on the outer base of this process there is a large sclerotized spine. On the inner side of the second segment there are two setae, one slender and haired, the other large, spiniform, and provided with spinules. The maxilliped (fig. 45) is 3-segmented, the first segment being unarmed, the second with two haired setae and an elliptical row of slender spinules. The short third segment (fig. 46) terminates in a spiniform process with lateral digitiform ornamentations and bears two setae, one slender and naked, the other stout and spiniform with short lateral digitiform processes.

The area between the maxillipeds and the first pair of legs (fig. 47) is only slightly produced, and a weak sclerotization connects the bases of the maxillipeds.

The rami of legs 1-4 (figs. 48, 49, 51, and 52) are 3-segmented, except for the endopod of leg 4 which is weakly 2-segmented. The spine and setal formula is as follows (the Roman numerals representing the spines, the Arabic numerals the 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-II-2
P 4	protopod	0-1;	1-0	exp.	I-0; I-1; II-I-5
				end.	0-1; II-1

The inner seta on the coxa is long and feathered in legs 1-3, but short (33 μ) and naked in leg 4. A row of hairs is present on the inner margin of the basis in legs 1-3, but these hairs appear to be absent in leg 4. The expansion of the basis lying over the anterior surface of the first segment of the exopod is rather acute, instead of being broadly rounded as is often the case in other lichomolgids. Between the two terminal spines on the last segment of the endopod of leg 2 there is a bifurcated spinous process (fig. 50). On the second segment of the exopod of leg 4 the inner seta lies (in alcoholic specimens) at an angle across the posterior surface of the ramus and is shorter and less conspicuously haired than in the seta on the last segment. The endopod of leg 4 (fig. 53) is only indistinctly divided into two segments. The overall length of this ramus is 57 μ; the first segment being 19×19 μ, the second 38×16 and 10 μ (the greatest and least widths respectively). The seta on the first segment is 100 μ, the seta on the second segment 45 μ, and the two terminal spines 80 and 51 μ in length. The second segment is ornamented with a row of hairs along the proximal half of its outer margin and with a distal row of minute spinules at the insertions of the two terminal spines.

Leg 5 (fig. 54) has an elongated free segment 65×21 μ. The two terminal setae are very unequal in length, one 120 μ and the other 40 μ, both with short lateral spinules. The seta on the body near the insertion of the free segment is 40 μ long and lightly feathered.

Leg 6 is probably represented by the two setae on the area of attachement of the egg sac (see figs. 31 and 33).

The color in life in transmitted light is pale amber, the eye red.

Male. — The body form (fig. 55) resembles that of the female, though the urosome is relatively more elongated. The length (without the setae on the caudal rami) is 0.64 mm (0.60-0.68 mm and the greatest width is 0.27 mm (0.24-0.27 mm), based on 10 specimens. The ratio of the length of the prosome to its width is 1.44:1. The segment of leg 1 is separated from the head only by lateral furrows.

The genital segment (fig. 56) is elongated, 107×88 μ, with its lateral margins in dorsal view slightly rounded. There are three postgenital segments, 51×62, 41×56, and 25×47 μ respectively from anterior to posterior, ornamented ventrally as in the female.

The caudal ramus resembles that of the female.

The dorsal surface of the prosome and the dorsal and ventral surfaces of the urosome bear refractile points and hairs. The ratio of the length of the prosome to that of the urosome is 1.46:1.

The rostral area, first antenna, second antenna, labrum, mandible, paragnath, first maxilla, and second maxilla are similar to those in the female.

The maxilliped (fig. 57) is 4-segmented and slender. The basal segment is unarmed. The second segment bears two slender naked setae and two rows of spinules. The third segment is very short and unarmed. The fourth segment forms part of the terminal claw and bears two setae, one very small and hyaline (8 μ long), the other long (47 μ), recurved and bearing a row of spinules along the distal half of its concave edge. The entire claw is 110 μ long (measured along its axis and not along its curvature), is slightly arcuate, and has along its concave edge a striated fringe which is interrupted near the middle of the claw. At the level of this interruption a break in the sclerotization of the claw may be seen, apparently indicating the distal limit of the fourth segment. The tip of the claw lacks a lamella.

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

Legs 1-4 resemble those of the female. The endopod of leg 4, however, seems to be slightly longer and more slender (52×15 μ in greatest overall dimensions) and the outer hairs on the second segment appear to be less prominent.

Leg 5 is similar to that of the female, but smaller, the free segment being 23×6 μ, the two terminal setae 91 and 32 μ, and the seta on the body near the free segment 30 μ.

Leg 6 (fig. 58) consists of a posterolateral flap on the ventral surface of the genital segment. It bears a minute spiniform process (6 μ), a long naked seta (104 μ), and an adjacent feathered seta (40 μ long). In a view of the entire urosome, as in fig. 56, the long setae of this leg are unusually conspicuous.

The spermatophore (fig. 59), attached to a female, is elongated, 85×34 μ, not including the neck.

The color in life in transmitted light resembles that of the female.

(This species is named for Dr. Michel Pichon, of the Centre d'Océanographie et des Pêches at Nosy Bé, who made collections of the host starfishes at Tany Kely while diving with aqualungs.)

Relationship to the host. — *Stellicola pichoni* was mostly recovered after only a single washing of the starfishes, in contrast to the case of *Asterocomes indica*, where several consecutive washings were required. This could indicate that these lichomolgids live more freely on the surface of the host, from which they are easily dislodged by the alcoholized sea water.

Comparison with other species. — Stock (1957) has briefly defined the genus *Stellicola* Kossmann, 1877, as comprising those lichomolgids which have a 3-segmented second antenna armed with a single terminal claw and in which the second segment of the endopod of leg 4 has two terminal and one inner setae. In this sense he included *S. thorelli* Kossmann, 1877, *S. pleurobranchi* Kossmann, 1877, *S. oreastriphilus* Kossmann, 1877, *S. caeruleus* (Stebbing, 1900), *S. curticaudatus* (Thompson and A. Scott, 1903), *S. gracilis* (Thompson and A. Scott, 1903), *S. lankensis* (Thompson and A. Scott, 1903), and *S. asterinae* (Bocquet, 1952). Bocquet and Stock (1962, p. 90) have pointed out that the four West African species of *Lichomolgus* described by Humes and Cressey (1958) belong to *Stellicola*, namely, *S. frequens*, *S. astropectinis*, *S. luidiae*, and *S. lautus*. The genus also includes *S. holothuriae* (Ummerkutty, 1961) and probably *S. longicaudatus* (Thompson and A. Scott, 1903). Adding to these *S. pichoni*, there are fifteen species about which we have sufficient information to place them in the genus *Stellicola* as defined by Stock. The members of this genus, judging from those cases where an association with a host is known, are associated with starfishes, except for *S. pleurobranchi* which lives on a gastropod and *S. holothuriae* which was recovered from washings of holothurians.

Stellicola pichoni is rather unusual in having a reduced number of postgenital segments (two instead of three in the female and three instead of four in the male). Only two other species in the genus show such a reduction, namely, *S. gracilis* and *S. lankensis*. From both of these Ceylonese species *S. pichoni* differs in several important respects. In them the prosome of the female is relatively narrower (a ratio of length to width of about 1.7:1 being obtained by measuring figs. 1 and 25, pl. XV, of Thompson and A. Scott), the caudal ramus is more elongated (about 4 times longer than wide in *S. gracilis* and about 2.2 times, based on measurement of fig. 25, pl. XV, in *S. lankensis*), the free segment of leg 5 is shorter and less slender, and the genital segment has a rather different form.

The number of urosomal segments within the genera of the Lichomolgidae is usually constant, except for sexual differences. A reduction in the number of these segments as seen in the three species of *Stellicola* is not unknown, however, in other lichomolgids. Ummerkutty (1961) described it in his *Lichomolgus indicus*, and Stock, Humes and Gooding (1963, pp. 56-57 and p. 70) have shown it to exist in *Pseudanthessius* and *Meomicola*.

Stellicola oreastriphilus Kossmann, 1877

Three females were recovered from 9 *Choriaster granulatus* in 10 m at Nosy Ovy, Isles Radama October 1, 1964. This species is already known from four starfishes in the region of Nosy Bé: *Protoreaster lincki* (Blainville), *Culcita schmideliana* (Retzius), *Pentaceraster mammillatus* (Audouin) and *Poraster superbus* (Möbius) (see Humes and Cressey, 1961).

The specimens from *Choriaster* agree in all significant details with those from the other starfishes at Nosy Bé.

It is of interest that *S. oreastriphilus* in the Nosy Bé area has been found in relatively large numbers on *Protoreaster*, *Culcita*, and *Pentaceraster*, which were collected intertidally or in very shallow water (1 m or less), while it is much rarer on *Poraster* and *Choriaster*, both of which were collected in deeper water (4-10 m or more) This copepod thus seems to prefer starfishes in intertidal areas or in very shallow water, and its presence on hosts in deeper water may be more or less accidental.

That *S. oreastriphilus* should occur on *Choriaster* even accidentally is perhaps not surprising. however, since all five genera of hosts belong to the same family, the Oreasteridae.

On the *Choriaster* from Nosy Ovy *S. oreastriphilus* occurred in company with *Asterocomes indica*, *Stellicomes tumidulus*, and *Stellicola pichoni*.

(Manuscrit déposé en octobre 1965.)

References

BOCQUET, C. 1952. — Copépodes semi-parasites et parasites des échinodermes de la région de Roscoff. Description de *Lichomolgus asterinae* n. sp. Bull. Soc. Zool. France 77 (5-6) : 495-504.

BOCQUET, C. and STOCK, J. H. 1962. — Copépodes parasites d'invertébrés des côtes de la Manche. IX. Cyclopoïdes associés à *Marthasterias glacialis* (L.). Arch. Zool. exp. gén. 101, notes et revue, no. 2, pp. 79-91.

HUMES, A. G. and CRESSEY, R. F. 1958. — A new family containing two new genera of cyclopoid copepods parasitic on starfishes. J. Parasitology 44 (4) : 395-408.

— 1958. — Four new species of lichomolgid copepods parasitic on West African starfishes. Bull. Inst. Français Afrique-noire 20 (ser. A), No. 2, pp. 330-341.

— 1961. — *Lichomolgus oreastriphilus* (Kossmann) copépode cyclopoïde parasite des étoiles de mer à Madagascar. Mém. Inst. Sc. Madagascar, 1959, sér. F, 3 : 83-92.

KOSSMANN, R. 1877. — Entomostraca (1. Theil : Lichomolgidae). In : Zool. Ergeb. Reise Küstengeb. Rothen Meeres, Erste Halfte, IV, pp. 1-24.

PADMANABHA RAO, C. A. 1962. — A new genus and species of a cyclopoid copepod parasitic on a starfish. J. Mar. biol. Ass. India 4 (1) : 100-105.

— 1964. — *Stellicomes pambanensis*, a new cyclopoid copepod parasitic on a starfish. J. Mar. biol. Ass. India 6 (1) : 89-93.

STEBBING, T. R. R. 1900. — On Crustacea brought by Dr. Willey from the South Seas. Zoological Results based on material from New Britain, New Guinea, Loyalty Islands and elsewhere collected during the years 1895, 1896 and 1897, part 5, pp. 605-690.

STOCK, J. H. 1957. — Some notes on the genus *Macrochiron* Brady, 1872 (Copepoda, Cyclopoida). Ann. Mag. Nat. Hist. (12) 10 : 378-382.

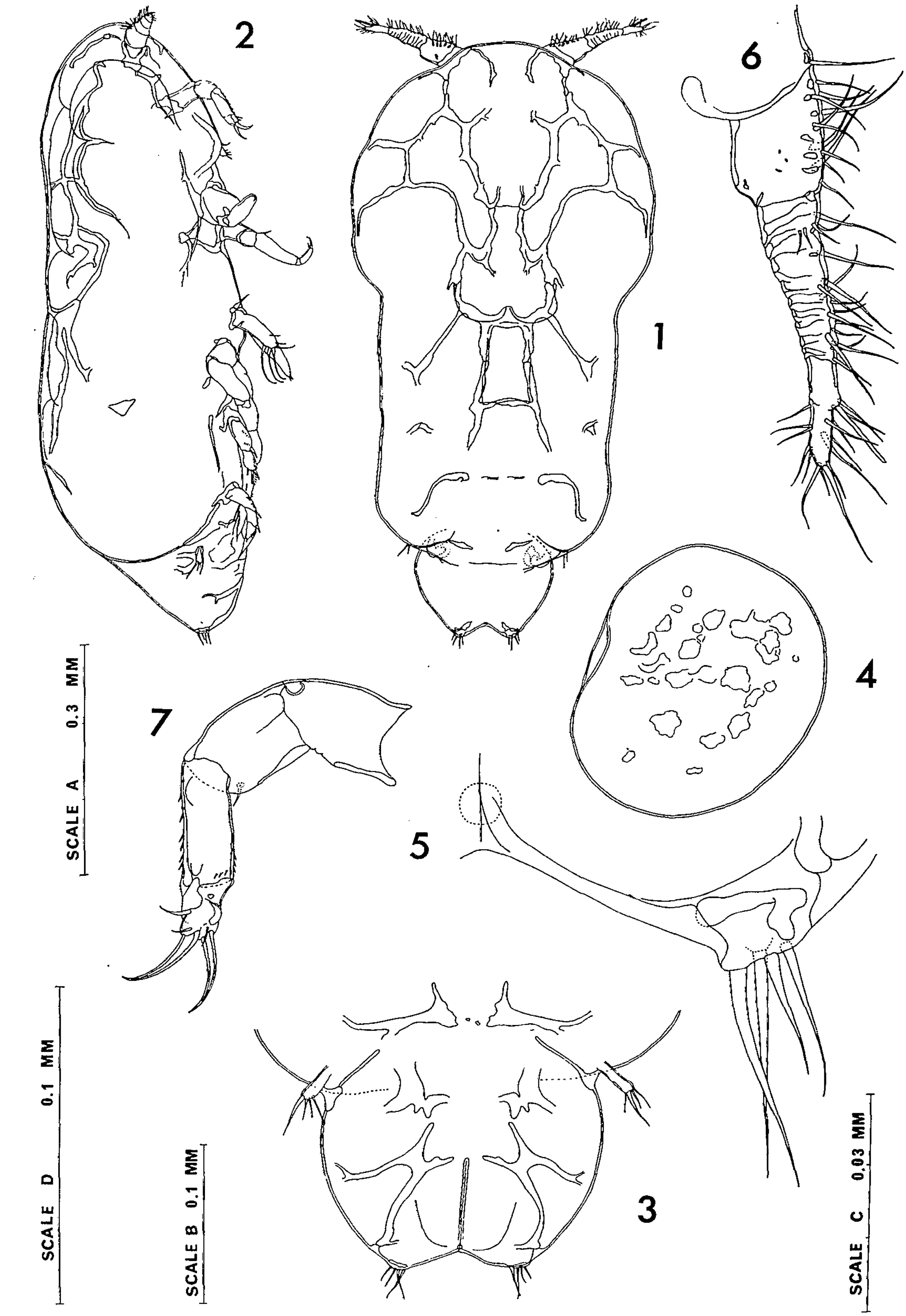
STOCK, J. H., HUMES A. G., and GOODING, R. U. 1963. — Copepoda associated with West Indian invertebrates. IV. The genera *Octopicola*, *Pseudanthessius* and *Meomicola* (Cyclopoida, Lichomolgidae). Studies on the Fauna of Curaçao and other Carribbean Islands 18 (77) : 1-74.

THOMPSON, I. C. and SCOTT, A. 1903. — Report on the Copepoda collected by Professor Herdman at Ceylon in 1902. Rept. Govt. Ceylon Pearl Oyster Fish. Gulf of Manaar, part I, suppl. rept. 7, pp. 227-307.

UMMERKUTTY, A. N. P. 1961. — Studies on Indian copepods. 5. On eleven new species of marine cyclopoid copepods from the south-east coast of India. J. Mar. biol. Ass. India 3 (1 & 2) : 19-69.

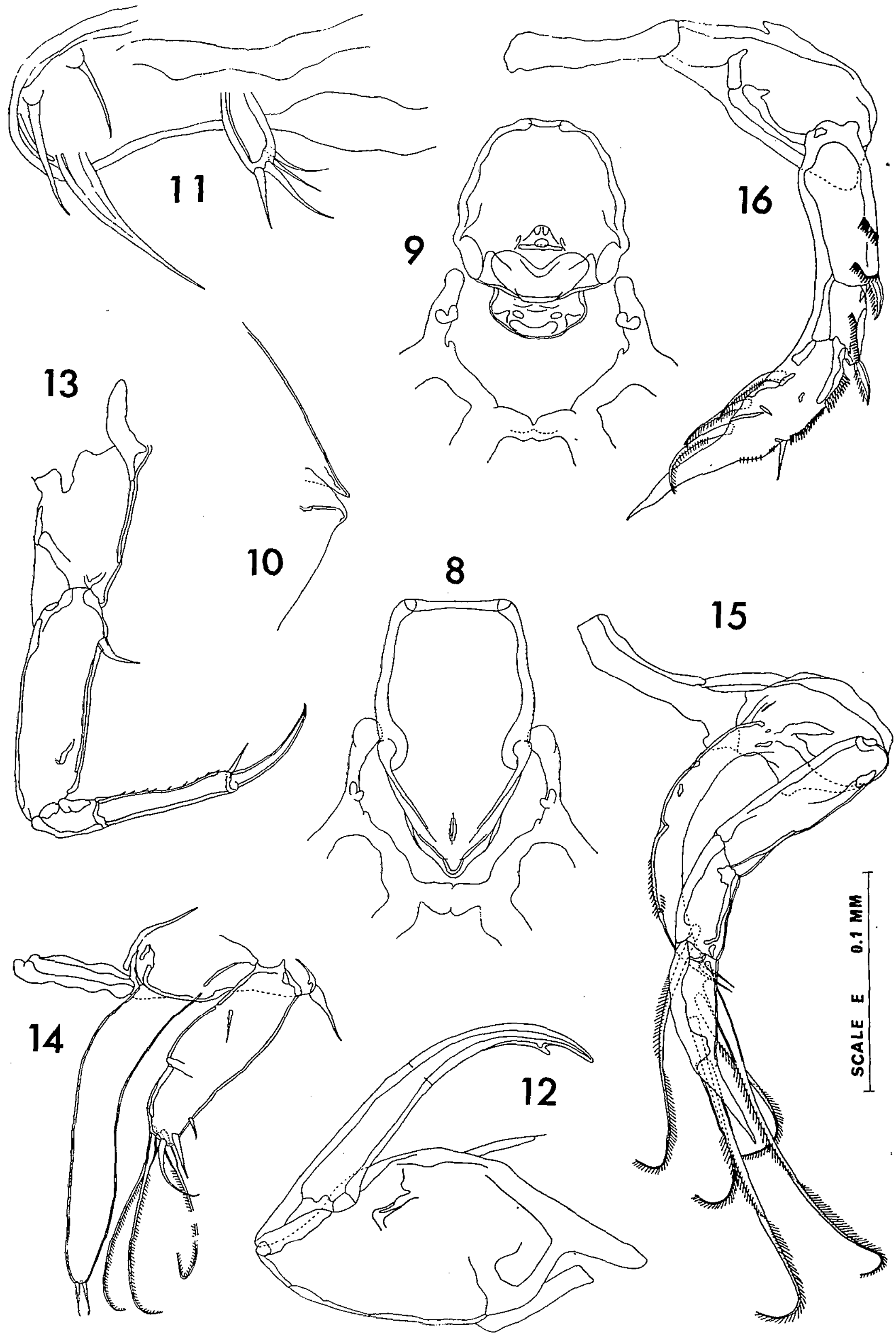
Explanation of the figures

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 the figure was drawn.



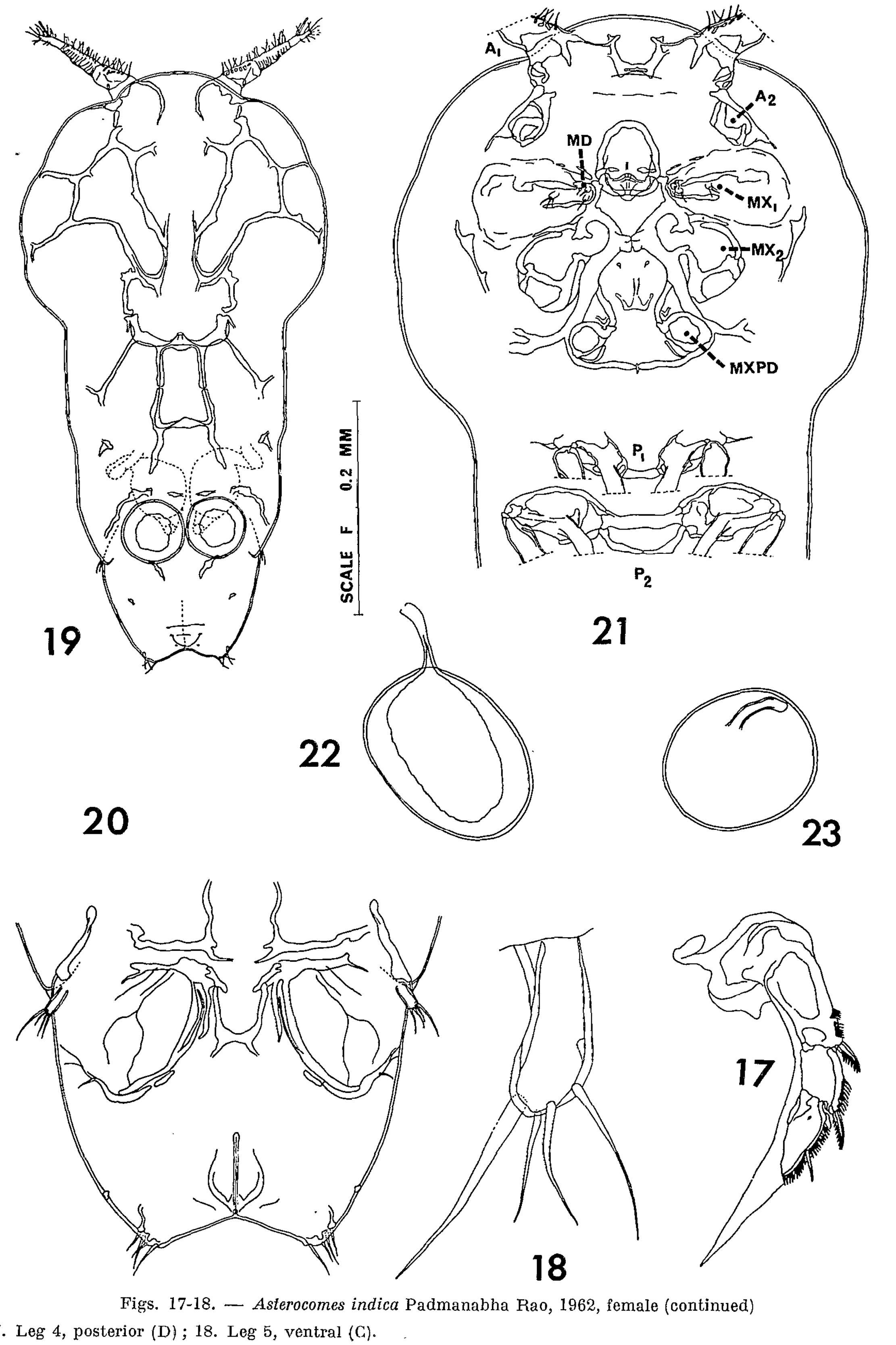
Figs. 1-7. — *Asterocomes indica* Padmanabha Rao, 1962, female

1. Body, dorsal (A) ; 2. Body lateral (A) ; 3. Urosome, ventral (B) ; 4. Egg sac (B) ; 5. Caudal ramus, ventral (C) ; 6. First antenna, dorsal (D) ; 7. Second antenna, anterior and ventral (D).



Figs. 8-16. — *Asterocomes indica* Padmanabha Rao, 1962, female (continued)

8. Labrum, ventral and anterior surface (D) ; 9. Mouth cone and labrum, ventral *in situ* (D) ; 10. Outline of mouth cone, lateral (D) ; 11. Mandible and first maxilla, ventral (C) ; 12. Second maxilla, posterior (D) ; 13. Maxilliped anteromedial (D) ; 14. Leg 1, anterior (D) ; 15. Leg 2, anterior (E) ; 16. Leg 3, anterior (D).

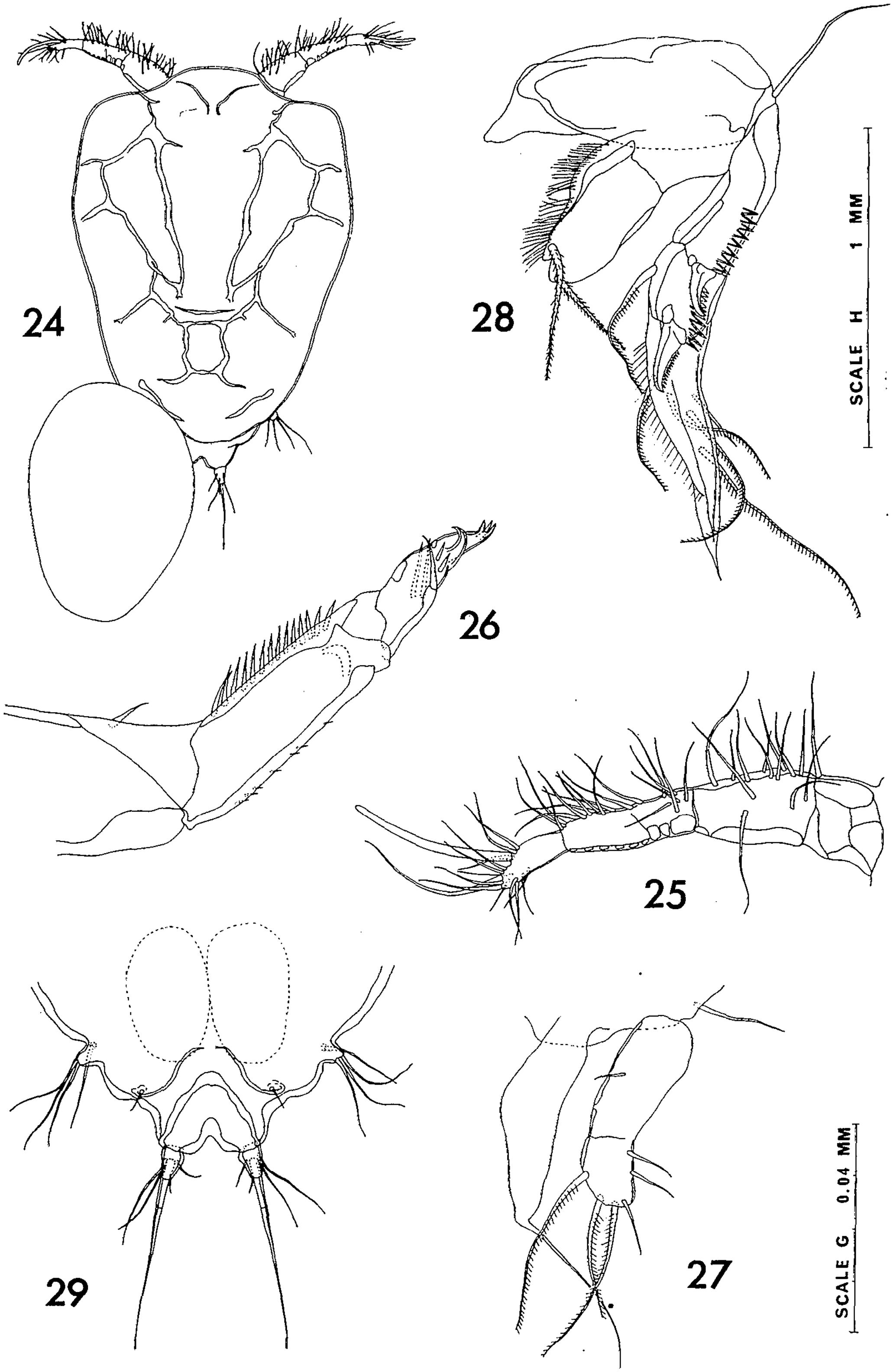


Figs. 17-18. — *Asterocomes indica* Padmanabha Rao, 1962, female (continued)

17. Leg 4, posterior (D) ; 18. Leg 5, ventral (C).

Figs. 19-23. — *Asterocomes indica* Padmanabha Rao, 1962, male

19. Body, dorsal (A) ; 20. Urosome, ventral (B) ; 21. Cephalosome, ventral (F) ; 22. Spermatophore, dissected out of male (B) ; 23. Spermatophore *in situ* in male (B).

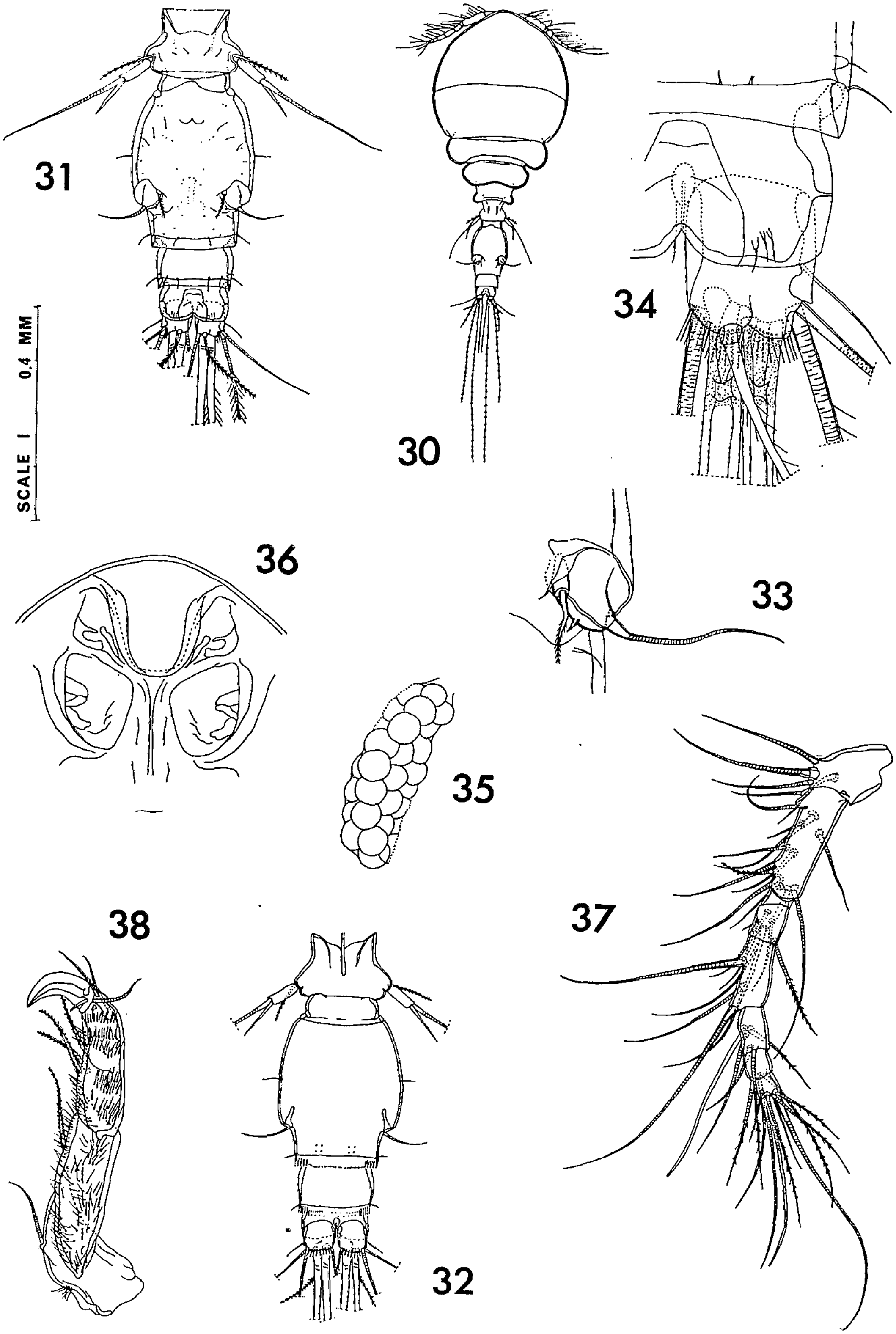


Figs. 24-28. — *Stellicomes tumidulus* Humes and Cressey, 1958, female.

24. Body, dorsal (F); 25. First antenna, dorsal (D); 26. Distal half of second antenna, inner (C); 27. Leg 1, anterior (G); 28. Leg 3, anterior (G).

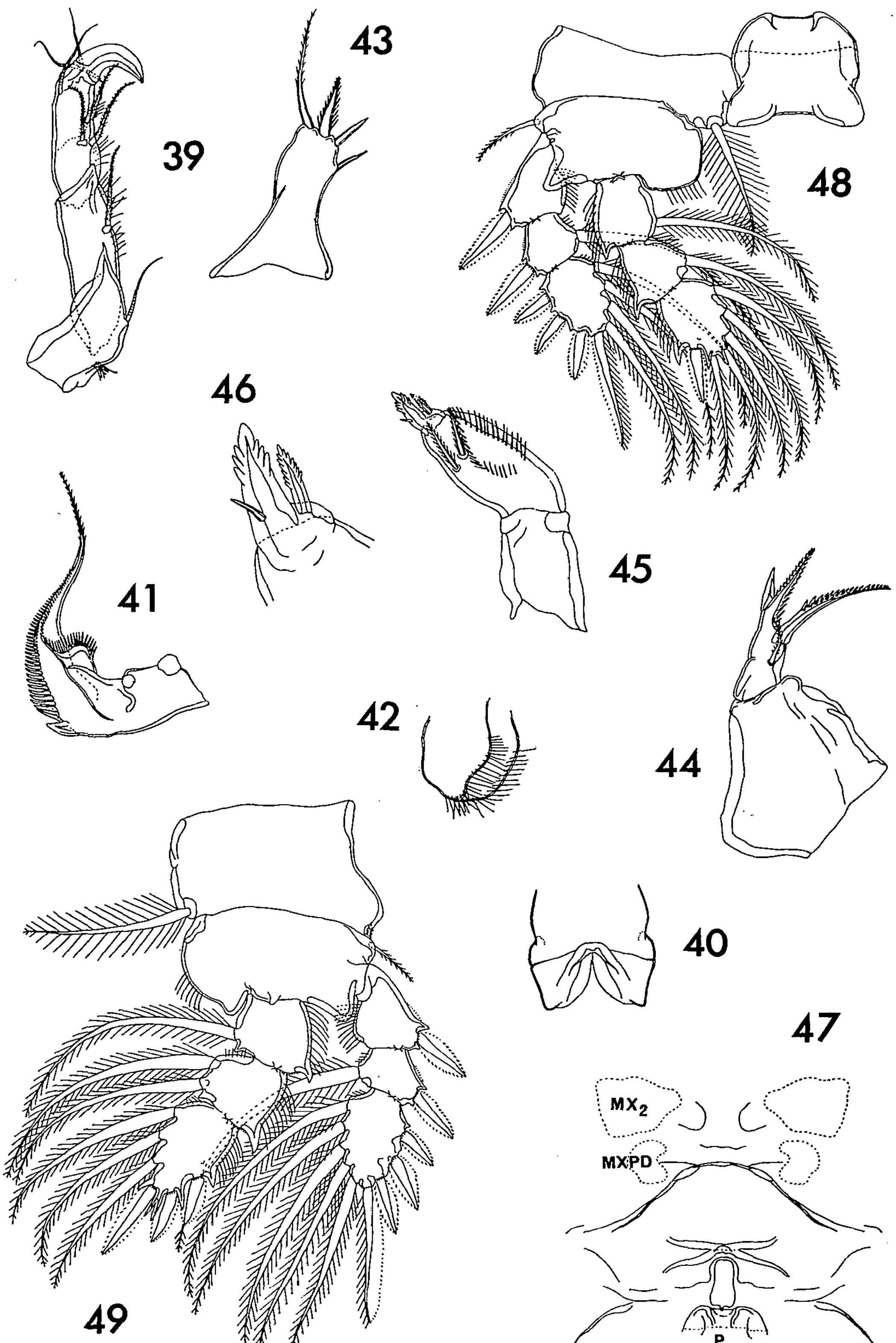
Fig. 29. — *Stellicomes tumidulus* Humes and Cressey, 1958, male.

29. Urosome, ventral (H).



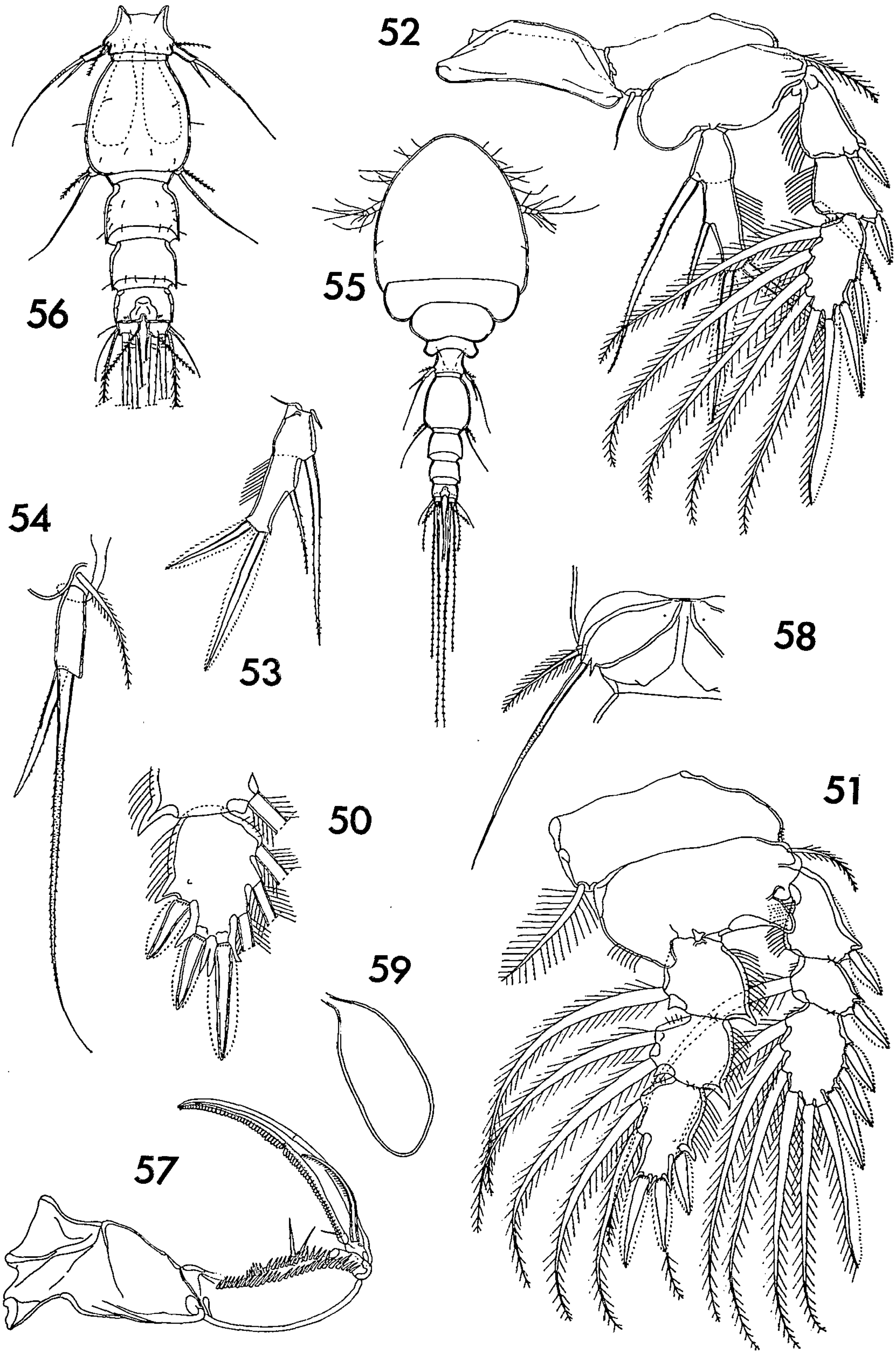
Figs. 30-38. — *Stellicola pichoni* n. sp., female.

30. Body, dorsal (H) ; 31. Urosome, dorsal (F) ; 32. Urosome, ventral (F) ; 33. Area of attachment of egg sac, dorsal (D) ; 34. Caudal ramus, dorsal (G) ; 35. Egg sac, dorsal (I) ; 36. Rostral area, ventral (B) ; 37. First antenna, ventral (B) ; 38. Second antenna, anterior (B).



Figs. 39-49. — *Stellicola pichoni* n. sp., female (Continued)

39. Second antenna, posterior (B) ; 40. Labrum, ventral (B) ; 41. Mandible, posterior (D) ; 42. Paragnath, ventral (G) ; 43. First maxilla, anterior (G) ; 44. Second maxilla, posterior (D) ; 45. Maxilliped, anterior (D) ; 46. Last segment of maxilliped, anterior (C) ; 47. Area between maxillipeds and leg 1, ventral (B) ; 48. Leg 1, anterior (E) ; 49. Leg. 2, anterior (E).



Figs. 50-54. — *Stellicola pichoni* n. sp., female (continued)

50. Third segment of endopod of leg 2, anterior (D) ; 51. Leg 3, anterior (E) ; 52. Leg 4, anterior (E) ; 53. Endopod of leg 4, anterior (E) ; 54. Leg 5, dorsal (D).

Figs. 55-59. — *Stellicola pichoni* n. sp., male.

55. Body, dorsal (I) ; 56. Urosome, dorsal (F) ; 57. Maxilliped, anterior (E) ; 58. Leg 6, ventral (E) ; 59. Spermatophore attached to female (E).

IMPRIMERIE A. BONTEMPS, LIMOGES (FRANCE) — Dépôt légal : 2e trimestre 1967.