

## INTRODUCTION

Prior to the three faunistic surveys undertaken by the Zoological Survey of India in 1969, 1973 and 1974 investigations of the marine fauna of the Andaman and Nicobar Islands had concentrated on macrofauna. The only information on meiobenthic organisms is contained in the report by R. B. S. Sewell (1940) on the copepods of the John Murray Expedition of 1933-34, although the Andaman and Nicobar Island samples were not collected on this expedition but "in previous years by the R.I.M.S. 'Investigator' ". The date of collection of these samples cannot be determined (Sewell gives no details) but certainly it must be in the early years of this century.

During these three more recent surveys one of us (G.C.R.) was able to make collections of meiofauna in the intertidal zone of several islands. All the groups of animals characteristic of this fauna, from Protozoa to Protochordata, were encountered. This paper deals with the harpacticoid copepods only, mostly collected from sandy beaches although some collections were made from mud and algae. Due to a lack of time only qualitative samples were taken and hence little can be said about distribution and abundance of the meiofauna. Within the samples copepods were abundant. Many, but not all, of the species recorded by Sewell were found but there can be no doubt that the species we discovered represent only a fraction of the total copepod fauna of these islands. The present paper reports the occurrence of 128 species in all.

## LOCATION OF THE SAMPLES

The Andaman and Nicobar Islands comprise an arcuate chain of 348 islands of varying size spread over a distance of about 1120 km between lower Burma and upper Sumatra in the eastern sector of the Bay of Bengal in 6°-14° north latitude and 92°-94° east longitude. The Andaman group with 324 islands forms the northern part of this archipelago and the Nicobar group, with 24 islands, the southern part. The islands have a total area of about 8300 km<sup>2</sup> and mostly consist of steep hills enclosing valleys clothed with dense tropical forest. The climate is tropical with heavy gales and copious rainfall. Some coastal areas support a rich growth of mangrove vegetation and fringing coral reefs abound. The beaches are narrow and extensive. Both exposed and sheltered locations are present and littoral substrata range from firm, clean siliceous or coralline sand through muddy sand to mud. Sheltered beaches tend to a high detritus content and may support algae and sea grasses.

The present investigations covered all the major groups of islands of the archipelago, *viz.*, North Andaman, Middle Andaman, South Andaman, Little Andaman, Car Nicobar, Nancowry and Great Nicobar, with collections made at the following 15 stations (Fig. 1).

- I : Seaward Bay, Sound Island, North Andaman, 12°58'06" N 92°59'17" E, 29 March 1969. Coarse and medium sands with fine shell gravel and little detritus. Sand siliceous, angular, mean grain size 350-700  $\mu\text{m}$ . Sea water temperature 28-30°C, salinity 33-34‰. Sample taken from 10-30 cm beneath the surface between low and half-tide levels.
- II : Seaward Bay, Mayabandar, North Andaman, 12°52'06" N 92°56'48" E, 12 March 1974. Algal sand rich in detritus. Fine to medium sand with a small amount of shell gravel. Sand siliceous and angular, mean grain size 150-500  $\mu\text{m}$ . Sea water temperature 28.6°C, salinity 33.6‰. Samples taken from surface to 20 cm deep between low and half-tide levels.
- III : Rangat Bay, Middle Andaman, 12°28'40" N 92°57'18" E, 24 March 1969. Medium sand with large amounts of fine shell gravel and rich in detritus. Sand mostly siliceous but with some coralline debris, mean grain size 300-500  $\mu\text{m}$ . Sea water temperature 29-30°C, salinity 33‰. Sample taken from 5-30 cm below the surface near the half-tide level.
- IV : West Point, Long Island, Middle Andaman, 12°22'48" N 92°56'28" E, 18 March 1974. Algal sands rich in organic detritus. Sand siliceous but mixed with coralline powder. Mean grain size 100-600  $\mu\text{m}$ . Sea water temperature 29.2°C, salinity 34‰. Samples taken from the surface to 20 cm deep between low and half-tide levels.
- V : North Bay, Havelock Island, South Andaman, 12°04'10" N 92°59'20" E, 18 May 1973. Medium to coarse sand with a small amount of fine shell gravel and little detritus. Sand exclusively coralline, subspherical, mean grain size 300-700  $\mu\text{m}$ . Sea water temperature 28.8°C, salinity 34.2‰. Sample taken from surface to 20 cm deep near the half-tide level.
- VI : West Point, Havelock Island, South Andaman, 11°58'42" N 92°57'18" E, 9 May 1973. Medium to coarse sand with a small amount of fine shell gravel. Sand mostly subspherical coralline particles, mean grain size 300-600  $\mu\text{m}$ . Sea water temperature 28.2°C, salinity 34‰. Sample taken from 5-20 cm beneath the surface between low and half-tide levels.
- VII : East Point, Havelock Island, South Andaman, 11°58'32" N 93°02'16" E, 5 April 1974. Algal sands rich in detritus. Fine to medium sands; a mixture of siliceous and coralline particles, angular to subspherical, mean grain size 200-500  $\mu\text{m}$ . Sea water temperature 29.6°C, salinity 34.4‰. Samples taken from surface to 20 cm deep near the half-tide level.
- VIII : North Bay, Neil Island, South Andaman, 11°52'02" N 93°04'30" E, 30 March 1974. Algal sands with fine shell gravel and little detritus. Texture varies from fine sand to coarse gravel, exclusively coralline and subspherical, mean grain size 200-700  $\mu\text{m}$ . Sea water temperature 29.4°C,

salinity 34.2‰. Sample taken from the surface to 20 cm deep near the half-tide level.

- IX : Aberdeen, Portblair, South Andaman, 11°36'12" N 92°43'20" E, 25 March 1974. Algal sand with fine shell gravel and little detritus. Fine to medium sand, siliceous and angular, mean grain size 100-500  $\mu\text{m}$ . Sea water temperature 28.8°C, salinity 33.6‰. Sample taken from the surface to 10 cm deep between low and half-tide levels.
- X : Chiriatapu, South Andaman, 11°29'06" N 92°46'12" E, 18 March 1969. Medium to coarse sand with very little detritus. Sand siliceous and angular to subangular, mean grain size 300-600  $\mu\text{m}$ . Sea water temperature 27-29°C, salinity 34.4‰. Sample taken from surface to 30 cm deep between low and half-tide levels.
- XI : Hut Bay, Little Andaman, 10°38'42" N 92°34'18" E, 8 March 1969. Medium to coarse sand with fine shell gravel and little detritus. Sand mostly siliceous except in areas of coral growth where there is a high percentage of coralline particles ; angular to spherical with a mean grain size of 400-700  $\mu\text{m}$ . Sea water temperature 27-30°C, salinity 33-34‰. Sample taken from 5-30 cm below the surface near the half-tide level.
- XII : Sawai Bay, Car Nicobar Island, 09°13'52" N 92°47'36" E, 13 March 1969. Fine to medium sand with a little fine shell gravel and rich in detritus. Sand mostly of spherical coralline particles, mean grain size 200-400  $\mu\text{m}$ . Sea water temperature 30.2°C, salinity 34.4‰. Sample taken from surface to 20 cm deep near the half-tide level.
- XIII : Chotina Bay, Kamorta Island, Nicobar, 08°07'12" N 93°32'06" E, 19 April 1973. Fine sand with a little coralline powder and mud, rich in detritus. Sand siliceous, subangular, mean grain size 150-350  $\mu\text{m}$ . Sea water temperature 29.8°C, salinity 34.2‰. Samples taken from surface to 10 cm deep near the half-tide level.
- XIV : East Point, Katchal Island, Nicobar, 07°57'14" N 93°24'32" E, 18 April 1973. Fine to medium sand without detritus. Sand siliceous, angular to subangular, mean grain size 200-500  $\mu\text{m}$ . Sea water temperature 29.2°C, salinity 34‰. Sample taken from 5-20 cm below the surface near the half-tide level.
- XV : Changappa Bay (=Campbell Bay), Great Nicobar Island, 06°58'32" N 93°57'28" E, 17 April 1973. Fine to medium sand with little detritus. Siliceous sand with a high proportion of coralline particles, mostly subspherical, mean grain size 200-400  $\mu\text{m}$ . Sea water temperature 29-30.2°C, salinity 34.6‰. Samples taken from the surface to 20 cm deep between low and half-tide levels.

## MATERIAL AND METHODS

This collection of Copepoda from the intertidal sediments was made during low tide, mostly near the half-tide level, where the bulk of the fauna usually occurred. The habitat varied from coarse sandy substrates to soft muddy sediments. Sediment samples taken from the surface to a depth of 30 cm were anesthetized with 5% formalin or 6% magnesium chloride solution for 10 minutes, vigorously stirred with filtered sea water and the supernatant water decanted through a 100  $\mu$ m mesh sieve. The material retained by the sieve was washed off with a jet of water and collected in a vial. Algae and grasses were washed with 2% formalin and the copepods collected. All the material was preserved in 5% neutral formalin containing 2% glycerol.

Standard terminology in the description of body parts and appendages are adopted in the text following Lang (1965). All measurements of the preserved material were made with a calibrated eye piece micrometer and the drawings with a camera lucida. Appendages were largely dissected before drawing, though some were drawn *in situ*. All the material examined has been preserved in 70% ethanol with glycerol added to 5% as a softening agent and phenol to 1% as fungicide. Slides were mounted in Reyne's Medium and ringed with Glyceel.

## TAXONOMIC ACCOUNT

### Family LONGIPEDIIDAE

#### 1. *Longipedia weberi* A. Scott, 1909

1909. *Longipedia weberi* A. Scott, *Siboga Exped.*, 29a : 196

*Material examined* : VII, 9 ♀ ♀ 2 ♂ ♂ ; VIII, 1 ♀ ; IX, 1 ♂

#### 2. *Longipedia kikuchii* It ♂ , 1980

1980. *Longipedia kikuchii* T. Ito, *J. nat. Hist.*, 14 : 18

*Material examined* : VII, 1 ♂ , VIII, 12 ♀ ♀ 6 ♂ ♂ , XIII, 3 ♀ ♀ 4 ♂ ♂ .

#### 3. *Longipedia andamanica* Wells, 1980

1980. *Longipedia andamanica* J. B. J. Wells, *Zool. J. Linn. Soc. Lond.*, 70 : 142

*Material examined* : VII, 14 ♀ ♀ 3 ♂ ♂

The above three species collected from these islands have been described or redescribed in the recent revision of the genus given by Wells (1980).

### Family CANUELLIDAE

#### 4. *Sunaristes tranteri* Hamond, 1973

1973. *Sunaristes tranteri* R. Hamond, *Proc. Linn. Soc. N. S. W.*, 97 : 167

*Material examined* : III, 2 ♀ ♀

*Remarks* : As Hamond (1973a) admits, the differences between three of the four species of *Sunaristes* are very small. We refer our two females to *S. tranteri* as they are more similar in the accessory spinulation of P.1-P.4 to this species than to any other. One specimen has the pattern of the right side and one that of the left side of the Holotype. Some differences from Hamond's material are apparent :

- (a) There are either seven or eight setae on the second exopod segment of the mandible.
- (b) The coxa of the maxillule has only two epipodal setae, the most distal seta described for one specimen by Hamond being absent.
- (c) There are some differences in proportion of the terminal setae of the distal exopod segment of P.3 and of the inner seta of the first endopod segment of P.4.

Dr Hamond has examined our specimens and agrees that they should be regarded as within the range of variation of *S. tranteri* at least until a thorough revision of the genus based upon a larger quantity of material than presently available is possible.

One further point to note is that the first exopod segment of the mandible bears two inner seta. Hamond thought that the proximal seta arose from the basis between the rami. On further examination he agrees with us that he was wrong.

#### 5. *Brianola sydneyensis* Hamond, 1973

(Figs. 2,6)

1973. *Brianola sydneyensis* R. Hamond, *Proc. Linn. Soc. N.S.W.*, 97 : 179

*Material examined* : IV, 1 juvenile ♀ (Stage V) ; VIII, 1 ♀

*Remarks* : There specimens were identified by direct comparison with two paratype females from Dr Hamond's collection. This showed that our adult female differed only in being slightly smaller (1.32 mm cf. 1.43 mm). However, the comparison did reveal some misinterpretations and omissions in the original description and also the fact that the legends for Figs. 26 and 28 require to be transposed.

The misinterpretations concern (a) the structure of the hyaline frill of the ultimate and penultimate segments and (b) the ornamentation of all the abdominal segments. The true condition is shown in Fig. 2. Each abdominal segment (except the first) is fringed posteriorly by a hyaline frill which in segments two and three is fully incised into sharp spine-like structures of equal length all around the segment. On segment four the frill is only semi-incised and the depth of incision is variable. Dorsally the frill is wide with the medial portion forming a concave pseudoperculum with deep incisions. Laterally the incisions are small but become larger again midventrally.

On the last segment the dorsal part of the frill is narrow and entire and forms the true operculum while laterally and ventrally the frill is narrow but fully incised, although immediately lateral to the operculum it is wider, forming the "spines" described by Hamond (1973a, Fig. 24). The abdominal ornamentation is more extensive than described by Hamond.

The omissions concern details of the ornamentation of the coxa and basis of P.1-P.4. In this respect these appendages are identical to those of our new species, *B. hamondi* (see Figs. 5, 6a). Also, in addition to the two longitudinal lateral rows of spinules, the caudal ramus has a diagonal ventral row of six or seven spinules (Fig. 2c). In all other respects Hamond's description is completely accurate.

6. *Brianola hamondi* n. sp.  
(Figs. 3-6)

*Material examined* : IV, 15 ♀ ♀ 5 ♂ ♂ ; VIII, 1 ♂ ; XIII, 13 ♀ ♀ 7 ♂ ♂

*Holotype* female, IV (C 2791/2) and *Paratypes* (C 2792/2) deposited with the Zoological Survey of India, Calcutta.

*Remarks* : This species is closely similar to *B. sydneyensis*, being identical in rostrum, antennule, mouthparts and P.5 of both sexes and nearly so in body shape and proportions and in P.1-P.4. In both species the entire body is minutely punctate with the cephalothorax and thoracic segments otherwise unornamented and with an entire hyaline frill. There are some slight differences in the genital field of both sexes although no inference should be taken from this as these structures are difficult to see, interpret and draw. The overall length is less than in *B. sydneyensis*. In the female the range is 0.865-1.122 mm, with a mean of 0.942 mm. In the male the range is 0.631-0.642 mm, with a mean of 0.637 mm.

There are considerable differences in the abdominal ornamentation of the female (Figs. 3c-e cf. Fig. 2). The spinule rows are more restricted and the two anterior rows of small hairs present in *B. sydneyensis* are absent in *B. hamondi*. The hyaline frill of segments two and three is not so deeply incised in the new species. The hyaline frill of segment four is similar except that in *B. hamondi* the pseudoperculum is not cleft medially. On the last segment the only difference is the absence in *B. hamondi* of the longer "spines" just lateral to the operculum. The caudal ramus lacks the ventral transverse row of spinules now known to be present in *B. sydneyensis* and there are many more lateral spinules.

The overall form of P.1-P.4 (Figs. 5, 6a) is identical in both species. This includes the relative proportions of the rami, and of segments of the rami, and the surface ornamentation of coxa, basis and rami. Differences are apparent in the nature and relative lengths of some of the marginal spines and setae, viz.,

	<i>hamondi</i>	<i>sydneyensis</i>
P.1 Enp. 1 outer spine	heavily bipectinate with curved teeth (Fig. 6b1)	very finely bipectinate with straight teeth (Fig. 6b2)
P.2 Exp. 1 inner seta	stoutly built ; heavily pectinate on distal inner edge ; extends beyond distal end of P. 2 Enp. 2 (Fig. 6c 1)	more lightly built ; only lightly pectinate on distal inner edge ; never extending beyond distal end of P. 2 Enp. 2 (Fig. 6c 2)
P.3 Enp. 1 inner seta	stoutly built ; heavily pectinate distally ; extends beyond distal end of P. 3 Enp. 2 (Fig. 6d 1)	more lightly built ; lightly pectinate on distal inner edge only ; never extends beyond distal end of P. 3 (Fig. 6d 2)
P.4 Enp. 1 inner seta	very short and stout : rather bulbous in shape (Fig. 6e 1)	short but extremely slender (Fig. 6e 2)

Most of these differences are subtle indeed but cannot be considered as minor details of no taxonomic significance. They are constant in the specimens examined and other species of *Brianola* show similar characteristic combinations of such features. Dr Hamond, whose opinion we share, believes that a true appreciation of the systematics of the Family Canuellidae will need to take account of such fine details.

The females have been directly compared with paratypes of *B. sydneyensis*. No such comparison has been possible for males. The male of *B. hamondi* differs from the female only in the antennule and P.5 (which are identical with those described for *B. sydneyensis*) and in the ornamentation of the abdomen (Fig. 4a-c).

*Variability* : Apart from the overall length no variability was noted in the six females and four males dissected.

*Etymology* : The trivial name is coined in honour of our good friend Dr. Richard Hamond.

#### 7. *Canuellina nicobaris* n. sp. (Figs. 7-10)

*Material examined* : XIII, 4 ♀ ♀ 10 ♂ ♂ 1 copepodid.

*Holotype* female, XIII (C 2793/2) and *Paratypes* (C 2794/2) deposited with the Zoological Survey of India, Calcutta.

## Description

*Female* : Length 1.37 mm. Body linear without pronounced demarcation between metasome and urosome, about five times as long as broad (Figs. 7a-b). Cephalothorax short, slightly broader than long. Second thoracic segment (i.e. the segment bearing the P.1) fused to the cephalothorax although still recognizable. Third to fifth thoracic segments very short while the sixth is very large and about as long as the three preceding segments together. Genital somite with suture lateral only. Genital field simple (Figs. 7d-e) with a long seta and a small heavily chitinized knob external to the seminal vesicle. The two halves of the field are widely separated. Rostrum large, broad and truncate at the tip with a pair of apical setae. Anal operculum simple and aetose.

*Somitic ornamentation* : All somites without a hyaline frill but with the posterior edge of all segments and the lateral edge of the cephalothorax and thoracic segments heavily chitinized. The only ornamentation is a pair of sensilla at the base of the rostrum although the posterior segments and the caudal rami are minutely punctate.

*Caudal rami* slightly divergent with a wide and somewhat bulbous basal portion rapidly tapering to the elongate main part (Fig. 7c). Ramus about as long as the last two abdominal segments together. Two terminal setae, the inner one elongate and bulbous at its base. One sub-apical dorsal seta and two setae on the distal part of the inner side.

*Antennule* (Fig. 8a) appears to be composed of only four segments but the second is complexly ornamented with setal bosses on the inner side and appears to have at least two traces of subdivision on the outer side. It is not at all clear if this is a single segment. Setation profuse and its distribution complex.

*Antenna* (Fig. 8b) with a single basal segment from which springs the very large seven-segmented exopod and a three-segmented endopod.

*Mandible* (Fig. 8c), *maxillule* (Fig. 8d), *maxilla* (Fig. 9a) and *maxilliped* (Fig. 9b) as shown. The articulations between the parts of the maxillule are difficult to see clearly.

*P.1-P.4* (Figs. 9c-f) : Coxa with a seta (P.1) or stout spine (P.2-P.4) at the inner distal corner. Basis with a very short outer side with a seta at the distal corner which is very small in P.1, short in P.2-P.3 but long in P.4. Inner distal corner with a stout spine in P.1 but bare in P.2-P.4. Exopod three-segmented, endopod of three segments in P.1-P.3 but only of two segments in P.4. Anterior face of many segments clothed with fine hairs. The segments tend to be heavily chitinized, particularly in the P.2. Setation as below.

*P.5* (Fig. 7d) reduced to a pair of small lappets each with four setae.



*Setal formula* (it is not possible to determine actual distribution of the setae and spines on the distal segment with any certainty).

	Exp.			Exp.		
P. 1	0.	1.	7.	1.	1.	6.
P. 2 ♀	0.	1.	6.	1.	1.	5.
P. 2 ♂	0.	1.	6.	1.	1.	4.
P. 3	0.	1.	4.	1.	1.	4.
P. 4	0.	1.	4.	1.	3.	

*Male* differs from the female in the following characters. Length 1.02 mm. Body more slender than the female with the first two abdomen segments distinct (Figs. 10a-b).

*Genital field* very large and complex (Fig. 10c-d).

*Antennule* strongly chirocerate (Fig. 10e). Appears to have only four segments but, as in the female, the second segment has two traces of subdivision.

*P. 2* endopod heavily chitinized. Distal segment with two long inner setae and two outer spines and with the distal edge expanded as a large blunt mucroniform process (Fig. 9g).

*P. 4* (Fig. 9h) : Distal segment of the exopod with the inner apical seta transformed into a short spine with a bifid tip. The segment is much broader and shorter than that of the female.

*Remarks* : *Canuellina nicobaris* differs from all other species in the genus in the genital field and in the presence of only two segments in the endopod of P. 4.

#### 8. *Scottolana longipes* (Thompson & A. Scott, 1903) (Figs. 10-13)

1903. *Sunaristes longipes* I. C. Thompson & A. Scott, *Rep. Govt. Ceylon Pearl Oyster Fish. Gulf Manaar*, 1 : 256

*Material examined* : XII, 2 ♂ ♂

*Description Male* : Length 1.213 mm. Body without a strong demarcation between metasome and urosome and slightly fusiform with the greatest width in mid-thorax (Figs. 11a-b). Second thoracic segment (i.e. the segment bearing the P.1) only partially fused with the cephalothorax; pleurotergite clearly distinct but apparently fused dorsally with the cephalothorax. Last abdominal segment extremely reduced. It is visible only as shown in Figs. 11a-c and there is no visible trace of articulation with the fourth segment. Genital field as in Fig. 10f. Caudal ramus (Figs. 11c-d)

elongate, with a hook-like projection near the inner basal corner. Dorsal surface with two setae and with a prominent ridge of chitin connecting the longer medial seta to the base of the ramus. Terminally with two well developed setae and one weak seta. The ramus also bears one ventral and one inner lateral seta. Rostrum very large.

*Somitic ornamentation* (Figs. 11a-d) : Entire body except for the cephalothorax and second thoracic segment minutely punctate and with a complex reticular pattern of naked striae. Cephalothorax with some sensilla. Hyaline frill of the abdominal segments plain.

*Antennule* (Fig. 11e) segments without clear demarcation; possibly a total of seven. The large bulbous segment characteristic of males is present but is followed by a truncated segment rather than by the usual unguiform terminal segment.

*Antenna* (Figs. 12a-b) : Endopod of two segments. Exopod apparently of eight segments the first of which is fused to the basis and bears two long setae. Segments two to seven each bear one long seta while the terminal segment has three setae.

*Mandible* (Figs. 11f-g) : Cutting edge large and complexly dentate. Coxa-basis small, with two setae. Endopod of two segments, the first with three and the second with eight plumose setae. Exopod indistinctly three-segmented, with a total of six setae.

*Maxillule* (Fig. 12c) : Pre-coxal arthrite with seven or eight spines and two setae. Coxa with three setae. Basis with four short setae. Endopod two-segmented, the first with four and the second with six setae. Exopod indistinctly two-segmented, with eleven long setae on the second segment.

*Maxilla* (Figs. 12d-e) of the primitive structure typical of the family. Pre-coxa with a bifid endite. Coxa distinct from pre-coxa and with two endites. Basis with a large claw and two setae. Endopod of three distinct segments with a proximal, fourth, segment fused to the basis and represented by setae only.

*Maxilliped* (Fig. 12f) : Coxa and basis not clearly demarcated and with a total of ten setae. Endopod of one segment with ten setae.

*P.1-P.4* (Figs. 12g-h, 13a-d) : P.1-P.3 with heavily chitinized broad segments, the proximal pair of each ramus in P.2-P.3 with prominent unguiform projections of the outer distal corner. In contrast the P.4 is very slender. The coxa, basis and rami are variously ornamented with minute spinules, setules or pustules. First endopod segment of P.2 small but with a large apophysis from the anterior side which lies over the second segment. Basis of P.3-P.4 with a recurved hook. Third endopod segment of P.3 with a peculiar 'slit', presumably glandular in function (Fig. 13b-c). Setation as below. Spines on the last two exopod segments and the last endopod segment of P.2-P.3 are very stout with blunt teeth along their edges.

P.5 (Fig. 10f) : Reduced to four setae springing from the edge of the segment.

*Setal formula* (it is not possible to determine actual distribution of the setae and spines on the distal segment with any certainty).

	Exp.			Enp.		
P. 1	0.	1.	7.	1.	1.	6.
P. 2	0.	1.	7.	1.	1.	5.
P. 3	0.	1.	5.	1.	1.	4.
P. 4	0.	1.	4.	1.	0.	4.

*Remarks* : These males are closely similar to those recorded by Wells (1967) as *S. longipes*. Re-examination of those specimens shows that they do have a similar reticulate somitic ornamentation with pustules (or are they punctae ?) and that the P.1-P.4 also possess a similar fine surface ornamentation. Similarly the antenna and mouthparts are as described here and not as described by Wells. The endopod of P.3 has the 'slit' and the caudal ramus has an unguiform basal projection. The genital field is nearly identical. The differences are that in the present males the terminal segment of the antennule is not unguiform, the rostrum is less pointed and there are small differences in the cutting edge of the mandible.

Thompson & A. Scott's (1903) description of *Sunaristes longipes* (the species was transferred to *Scottolana* by Por, 1967) is confined to the female and is rather rudimentary. The very slender P.4 was a character of this species only until Wells (1967) described *S. brevifurca*. Males have been described for *S. longipes* by Wells (1967) and Por (1964). They are somewhat different but possibly conspecific (Wells, 1967).

In the present highly confused state of taxonomy we believe it best to place all four sets of specimens within *S. longipes* at least until a detailed revision is possible and to suggest tentatively that geographic races could account for the observed differences. *S. longipes* has only been recorded from Sri Lanka (Thompson & A. Scott, 1903), Andaman Islands (this paper), Mozambique (Wells, 1967) and Israel (Por, 1964).

#### 9. *Scottolana oleosa* n. sp. (Figs. 13-15)

*Material examined* : IV 3 ♀ ♀ 1 ♂ ; VIII, 1 ♀ 1 ♂

*Holotype* female, IV (C 2795/2) and *Paratypes* (C 2796/2) deposited with the Zoological Survey of India, Calcutta.

#### Description

*Female* : Length 0.89 mm. Body slender, almost vermiform, about six times as long as broad (Figs. 13e-f). Second thoracic segment (i.e. the segment bearing the

P.1) not completely fused with the cephalothorax. Thoracic segments clearly separated from each other. Rostrum very large. Genital suture dorso-lateral only. The genital somite, in these females at least, contains an area filled with orange-brown oil droplets (Fig. 13g) which makes it impossible to see much of the internal details of the genital apparatus. Genital field externally rather simple, with a pair of short setae laterally (Fig. 13g). The three ovigerous females possessed only a single ovisac, with eight or nine eggs. There is no evidence that two sacs ever were present. Caudal ramus (Fig. 14a) elongate and without a pronounced basal unguiform process.

*Somitic ornamentation* (Figs. 13e-f, 14a) : Except for the cephalothorax and second thoracic segment the entire body is minutely punctate. Naked striae can be seen on the abdomen only and then only with difficulty. The pattern is not nearly as visible or as complex as in *S. longipes*. Cephalothorax without sensilla. Abdominal hyaline frill plain.

*Antennule* (Fig. 14b) short, of four or possibly five segments with indistinct articulation between the segments.

*Antenna* : Endopod as in *S. longipes* except that the outermost seta is not heavily spinulose. Exopod similar to *S. longipes* except that segments seven and eight are fused together (Fig. 14c).

*Mandible palp* as *S. longipes*. Cutting edge as Fig. 14d.

*Maxillule, maxilla and maxilliped* as *S. longipes*.

*P.1-P.4* (Figs. 14e, 15a-c) : P.1-P.3 less heavily chitinized than in *S. longipes* and the accessory spinules much more slender. They are also more numerous; far more are present than can be illustrated with clarity, with up to five overlapping rows of spinules in some cases. The form of the outer spines is also more delicate (see Fig. 19 and Table 1). Apophysis of the first endopod segment of P.2 is very long. P.4 less slender than in *S. longipes*, with the exopod relatively much longer and larger. The inner setae of P.3-P.4 are very reduced.

*P.5* reduced to four short setae borne on a minute lappet fused to the segment edge.

*Setal formula* (it is not possible to determine actual distribution of the setae and spines on the distal segment with any certainty).

	Exp.			Enp.		
P. 1	0.	1.	7.	1.	1.	6.
P. 2	0.	1.	7.	1.	1.	5.
P. 3	0.	1.	5.	1.	1.	4.
P. 4	0.	1.	4.	1.	0.	4.

*Male* differs from the female in the following respects. Length 0.75 mm. First two abdominal segments distinct.

*Antennule* (Fig. 14g) chirocerate, last segment unguiform.

*Genital field* as Fig. 14f. Receptaculum seminis as in *S. longipes*.

*Variability* : In one female the second endopod segment of P.4 lacked accessory spinules.

*Etymology* : The trivial name refers to the oil store in the female genital somite (*L. oleosus*—full of oil).

*Remarks* : This species is discussed later, together with *S. tumidiseta* and *S. rostrata*.

10. *Scottolana tumidiseta* n. sp.  
(Figs. 15-16)

*Material examined* : IV, 5 ♀ ♀ ; VIII, 1 ♀

*Holotype*, IV (C 2797/2) and *Paratypes* (C 2798/2) deposited with the Zoological Survey of India, Calcutta.

**Description**

*Female* : Length 1.06 mm. Body slender, about five times as long as broad (Figs. 15d-e) with the greatest width at the cephalothorax and with a slight taper from anterior to posterior. Thoracic segments not so widely separated as in *S. oleosa*. Second thoracic segment fully incorporated into the cephalothorax. Genital somite without the pronounced waist seen in *S. oleosa* ; suture dorso-lateral only. Genital field similar to *S. oleosa* in the presence of lateral setae but seemingly of a very different internal arrangement (Fig. 15f). Of the four ovigerous females two have a single ovisac and two have a pair. The number of eggs is 12-16 in each sac of a pair and 22-26 when only a single sac is present. Caudal ramus (Fig. 16a) more conical than in *S. oleosa*. The armature is similar but the two setae on the inner edge are in the form of small bulbs. In some specimens the proximal bulb-seta has a long flagellum ; the distal one never has this feature. The caudal rami are not divergent in five of the specimens (Fig. 15e) and widely divergent in the remaining one. It may be significant that this female had died with the abdomen markedly recurved back towards the thorax. All of the *S. oleosa* females are in this position (see Fig. 13f) and in all of them the rami are widely divergent (see Fig. 13e).

*Somitic ornamentation* : As in *S. oleosa* the entire body, except for the cephalothorax, is minutely punctate. Naked striae are visible on all segments but are much

more difficult to observe on the thorax. The abdominal pattern is mainly of simple circum-segmental striae. Cephalothorax with sensilla on the posterior lateral edge.

*Antennule, antenna and mouthparts* : The antennule segments are poorly differentiated. The first endopod segment of the mandible is relatively longer than in *S. oleosa* and the cutting edge a little more complex (Fig. 15g). In all other respects these appendages are identical in the two species.

*P.1-P.4* (Figs. 16b-e) differ from *S. oleosa* only in the form of the spines on P.1 (see Fig. 19 and Table 1) and in the proportional length of some setae on P.2-P.4, viz.

- (a) P.2 : Outer seta of basis very long and slender. Inner seta of first endopod segment reaches to halfway along the third segment (Fig. 16c).
- (b) P.3 : Inner seta of the last two exopod segments and the first two endopod segments is much more strongly developed (Fig. 16d).
- (c) P.4 : Inner seta of the last two exopod segments and the first endopod segment is much longer (Fig. 16e).

In both species the accessory spines of P.1-P.4 are slender and numerous.

*P.5* as in *S. oleosa*.

*Setal formula* as in *S. oleosa*.

*Male* unknown.

*Variability* : None was found in the three females dissected.

*Etymology* : The trivial name refers to the bulb-setae of the caudal ramus (*L. tumidus*—swollen, and *seta*).

*Remarks* : This species is discussed later, together with *S. oleosa* and *S. rostrata*.

### 11. *Scottolana rostrata* n. sp. (Figs. 16-18)

*Material examined* : VII, 2 ♀ ♀ 1 ♂ ; VIII, 1 ♀ ; IX, 1 ♀ 2 ♂ ♂

*Holotype* female, VII (C 2799/2) and *Paratypes* (C 2800/2) deposited with the Zoological Survey of India, Calcutta.

#### **Description**

*Female* : Length 0.97 mm. Body without taper from anterior to posterior, almost linear (Figs. 17a-b). Cephalothorax with a wide hyaline frill. Second thoracic segment

fully incorporated into the cephalothorax. Thoracic segments not widely separated from each other. Genital somite without a pronounced waist. Genital field (Figs. 17c-d) similar to that of *S. oleosa* and *S. tumidiseta* only in the presence of a lateral stout seta. As far as can be seen the genital apparatus is quite different from either of these species and includes a pair of sharply pointed laminate processes at the mid-line. Internally the apparatus is extremely complex. Caudal ramus (Fig. 16f) rather short. At the distal ventrolateral corner of each ramus is a patch of punctae which penetrate the chitin very deeply so that in optical section the thick chitin edge appears striated and in surface view this area is prominent with the punctae appearing to be wider and deeper.

*Somitic ornamentation* : Except for the cephalothorax the entire body is minutely punctate with fine circumsegmental naked striae on some abdominal segments and some striae on the caudal rami.

*Antennule* much as in *S. oleosa* (Fig. 18e). *Antenna* as in *S. tumidiseta*, with the last two exopod segments fused together. *Mandible* as in *S. oleosa*, with minor differences in the cutting edge (Fig. 16h). *Maxillule, maxilla* and *maxilliped* as in *S. oleosa*.

*P.1-P.4* (Figs. 18a-d) of very similar construction to those of both *S. oleosa* and *S. tumidiseta*, differing only in the proportional length of some setae, in the form of the spines on P.1 (see Fig. 19 and Table 1) and in the seemingly more dense punctation. In places these punctae may be replaced by minute spinules, as in the coxa of P.4 (Fig. 18d).

*P.5* (Fig. 17e) consists of four setae as in the other species of this genus but differs from *S. oleosa* and *S. tumidiseta* in the elongate innermost and outermost setae.

*Setal formula* as in *S. oleosa*.

*Male* : Three specimens which could be the male of this species were found but a little doubt must surround them because of the different armature of the caudal ramus. These males differ from the female in the following respects.

Length 0.94 mm. Body more slender with the thoracic segments more demarcated from each other than in the female. Somitic ornamentation as in the female, including the curious patch of punctae on the caudal ramus. Genital field (Figs. 17f-h) consists of a pair of strongly chitinized ridges and hooks projecting outwards from the body. These ridges, which may be tubular, are attached by a thinner piece of chitin to a pair of hirsute flaps which bear a seta posteriorly. Above the flaps is another, non-tubular, chitinous ridge. The second segment bears a pair of hirsute knobs (in one specimen these are amalgamated into a single large knob). Receptaculum seminis as in *S. longipes*. Caudal ramus (Fig. 16g) short, but less broad than in the female and with a single seta at each of the distal ventral corners in contrast with the female condition of two setae at the inner corner and none at the outer. Antennule (Fig. 18f) chirocerate, the terminal unguiform segment rather truncated.

One of these males appears to be juvenile. The genital apparatus is as in the mature male but a receptaculum seminis is absent. The antennule is similar to that of the adult female except that the outer edge of the penultimate segment is more convex and the inner edge bears a complex seta with a hirsute bulbous base and a flagellum (Fig. 18g).

*Remarks* : The conspecificity of these males with the female must be a little doubtful, although one example of sexual dimorphism in the caudal ramus exists among species that are relatively closely related (in *S. bulbifera* (Tschislenko, 1971)). The degree of difference is not great and the correspondence in other features is exact, particularly the form of the spines and setae of P.1-P.4.

*Etymology* : The trivial name refers to the pointed beak-like nature of the median projection of the female genital field when seen in lateral view (*L. rostrum*—a beak).

*Remarks on S. oleosa, S. tumidiseta and S. rostrata* : Due to deficiencies in the descriptions of most *Scottolana* species, it is entirely possible that any or all of the three species are conspecific with others already described. The three appear to be unique in their genital apparatus, of both sexes, although some resemblance can be seen to several other species, but sufficiently detailed descriptions do not exist for adequate comparisons to be made. *S. oleosa* bears some resemblance to *S. bulbifera* but obviously is not identical in the caudal furca. *S. tumidiseta* appears to be unique in its caudal ramus but it is possible that *S. bulbosus* (Por, 1964) is more similar than appears from its description. *S. rostrata* seems to be quite unique in its female genital field, but no valid comparisons can be made; that of the male could be similar to *S. bulbosus*.

#### Family ECTINOSOMATIDAE

##### 12. *Ectinosoma melaniceps* Boeck, 1864

1864. *Ectinosoma melaniceps* A. Boeck, *Forh. Vidensk. Krist.*, 1864 : 254.

*Material examined* : VII, 10 ♀ ♀ ; VIII, 10 ♀ ♀ 1 ♂ ; IX, 2 ♀ ♀

*Remarks* : These specimens accord well with the descriptions of Sars (1903) and Lang (1965). We point out, however, that the abdomen also possesses bands of pustules similar to those that we describe later in *E. dentatum*, with setules at the distal edge of the band. We believe that Lang must have failed to observe these pustules. The female P.5 shows a range of variability similar to that described by Lang (1965).

##### 13. *Ectinosoma dentatum* Steuer, 1940

(Figs. 20-22)

1940. *Ectinosoma dentatum* A. Steuer, *Zool. Anz.*, 132 : 124.

*Material examined* : I, 8 ♀ ♀ ; III, 2 ♀ ♀ 2 ♂ ♂ ; IV, 9 ♀ ♀ ; V, 2 ♂ ♂ ; VII, 33 ♀ ♀ 2 ♂ ♂ ; VIII, 6 ♀ ♀ 1 ♂ ; IX, 22 ♀ ♀ 1 ♂ ; X, 2 ♀ ♀ ; XII, 121 ♀ ♀ 14 ♂ ♂ 12 copepodids ; XIII, 5 ♀ ♀ 1 ♂ ; XV, 1 ♂



*Remarks* : Our specimens encompass one variable character which may prove to be of fundamental importance in the taxonomy of the genus. In the great majority of the specimens the distal segment of the exopod of P.3 and P.4 has only two setae on the outer edge, with a complete setal formula of 3.2.2. In a small proportion, however, eleven out of a total of 237, the outer edge has three setae, with a complete setal formula of 3.2.3. Lang (1965, pp. 15-16) has drawn attention to the difficulties of observing the correct setation and advocates caution in accepting earlier accounts. While that may be the case we do not know of any report of variability within a single population and have some suspicion that this character has been used as the prime character for distinguishing between species, even in recent papers. In fact Soyer (1971a) separates his new species, *E. vervoorti*, from *E. dentatum* precisely on this character, admitting their great similarity in other features. Undoubtedly the caution advocated by Lang (1965) has been noted by many recent authors but our discovery effectively removes this character as a useful taxonomic tool and raises doubts as to the validity of several species in which the somitic ornamentation is incompletely known. From the literature it would seem that many species of *Ectinosoma* are closely similar in ornamentation pattern and a thorough revision of the genus is urgently required.

Lang (1965, p. 548) expresses some doubts as to the validity of the *E. dentatum* of Vervoort (1964). With this in mind we have examined Vervoort's material and conclude that his specimens are identical to ours (except that none have the eight setose condition of P.3-P.4 referred to above). Further, we believe that our specimens are consistent with the original description, while admitting that it is not really sufficiently detailed. In the present state of knowledge of the genus we submit that Vervoort's (1964) material can be accommodated within *E. dentatum* Steuer and suspect that this may be true also for *E. paradentatum* Božić, 1965 and *E. vervoorti* Soyer, 1971a.

Lang (1965) refers to two features of Vervoort's (1964) *E. dentatum*, the female antennule and the male P.6, which made him doubt its validity. We can report that in both cases Vervoort is slightly inaccurate and that his material is identical with ours and that these structures are as illustrated in Figs. 21a and 22g respectively.

In this paper we give illustrations of the abdominal ornamentation and the mouth-parts, neither of which have previously been described. The abdomen is ornamented only by very small pustules (Figs. 20a-d) and lacks the minute setules that border the bands of pustules in *E. melaniceps*.

#### 14. *Ectinosoma reductum* Božić, 1955 (Figs. 23-24)

1955. *Ectinosoma reductum* B. Bozic, *Arch. Zool. exp. gen.*, 92 : 2.

*Material examined* : IV, 6 ♀ ♀ ; VIII, 4 ♀ ♀ 1 ♂

*Remarks* : This species, which has been recorded previously only from north-west Europe and the western Mediterranean Sea, has been divided into two sub-species

*E. reductum* s. str. and *E. r. listensis* Mielke, 1975, which differ only in the latter being smaller, having less eggs in the ovisac and a more delicate inner seta on the second exopod segment of P.1-P.4.

From the published descriptions it appears that our specimens differ from both subspecies in :

- (a) The body is ornamented with a complete cover of pustules (omitted from Figs. 23b-d).
- (b) The female P.5 has more surface ornamentation.
- (c) The male P.5 lacks a pore on the basendopod and has a small spinule row.
- (d) The P.1-P.4 are more heavily spinulose.
- (e) The male P.6.

We have been unable to examine Dr Božić's material but we have seen Mielke's *listensis*. This examination reveals that only (c)-(e) of the above characters are different between the two populations.

We believe that these differences do not warrant subspecific identify and, further, see no justification for the subspecies *listensis*.

The species is known only from the Irish Sea (Moore, 1979), Sylt, Germany (Mielke, 1975, 1976), Brittany (Božić, 1955) and mediterranean France (Soyer, 1970, Guille & Soyer, 1968, Bodiou, 1975, Bodin, 1964).

#### 15. *Halectinosoma tenuireme* (T. & A. Scott, 1896) (Fig. 25)

1896. *Ectinosoma tenuireme* T. Scott & A. Scott, *Trans. Linn. Soc. Lond.*, ser. 2, 6 (Zool) : 439.

*Material examined* : II, 1 ♀ ; XIII, 1 ♀ ; XV, 2 ♀ ♀

*Remarks* : We have compared our material with that from Korshavn, Norway described by Sars (1911), and now in the Oslo Museum, and find a perfect match. Thus Sars's description is wrong with regard to the female antennule and the P.5. In addition to Sars both T. & A. Scott (1896) and Kunz (1949) state that the antennule has seven segments but the minute seventh segment illustrated by Sars turns out to be the confluent base of the two terminal setae of the sixth segment (Fig. 25d). Sars's figure of the female P.5 shows the outer seta of the basendopod articulating with the ramus but in fact it is completely fused with it (Fig. 25e). Fig. 25 illustrates our specimens and, as we have stated, they are identical with those of Sars. Unfortunately Kunz's material no longer exists and we cannot trace the type-material. The somitic ornamentation (Figs. 25b-c) of the species has not been described before.

16. **Halophytophilus simplex** n. sp.  
(Figs. 26-27)

*Material examined* : VII, 1 ♀ ; VIII, 2 ♀ ♀

*Holotype*, VIII (C 2801/2) and *Paratypes* (C 2802/2) deposited with the Zoological Survey of India, Calcutta.

**Description**

*Female* : Length 315  $\mu$ m. Body shape in dorsal view rather squat, only about four times as long as the maximum breadth (Fig. 26a). Cephalothorax without a marked taper anteriorly and urosome not markedly tapering posteriorly. Rostrum short, with a very broad base, and directed ventrally. Genital somite narrow, with the suture represented only by a sensilla and a few patches of chitin dorso-laterally.

*Somitic ornamentation* (Figs. 26a-c) : Cephalothorax with a few dorsal sensilla. Cephalothorax and thoracic segments with a broad, plain hyaline frill. Entire body densely ornamented with minute punctae, which do not conform to any pattern. Abdominal segments with a broad hyaline frill, except on the last segment. That of the genital somite and segment three finely denticulate dorsally and more coarsely denticulate ventrally, particularly on the third segment. The ventral side of the hyaline frill of segment four is coarsely denticulate while the dorsal side is plain with the medial portion forming a relatively shallow pseudoperculum. Last segment with a fully denticulate hyaline frill ventrally; dorsally it is absent.

*Caudal ramus* (Figs. 26d-e) much broader than long; ventrally with a prominent median unguiform projection. With three well developed terminal setae, the median the longest. Inner terminal seta fused to the ramus.

*Antennule* (Fig. 26f) short, of six segments with an aesthete on segment three. The fourth segment and the outer part of the third segment coloured dark brown to black.

*Antenna* (Fig. 26g) with basis. Setae of the second endopod segment very stout and with strong accessory spinules. Exopod three-segmented, the first two very small and with one seta each, the third segment with one inner and two terminal setae.

*Mandible* (Fig. 26h) : Coxa not observed. Palp with an elongate basis, with two setae. Endopod and exopod each of one segment.

*Maxillule* not observed.

*Maxilla* (Fig. 27a) : Syncoxa elongate with one proximal endite. Basis elongate with one proximal, articulated endite (is this an exopod rudiment ?) and somewhat prehensile upon the syncoxa. Endopod of three (or four ?) well differentiated segments. Terminal setae short.

*Maxilliped* (Fig. 26i) very small, not prehensile. Coxa with one long seta. Basis without setae but with accessory spinules. Endopod of one segment with three setae.

*P. 1* (Fig. 27b) : Coxa large, unornamented. Basis narrow, with stout spinules at the outer part of the distal edge and as a curved row above the origin of the endopod; also with an inner and an outer seta. Exopod of three sub-equal segments copiously set with long spinules on their outer edge. Outer spines long and massive and set with stout accessory spinules. Endopod prehensile, of two segments and reaching only to the end of the exopod. First segment elongate, slightly more than three times as long as broad and more than four times as long as the small second segment. Outer edge set with stout spinules and there is a curved row of stout spinules near the proximal edge; inner seta distal in origin. Second segment with three terminal setae, the innermost elongate, the outer two claw-like. Setation as below.

*P.2-P.4* (Figs. 27c-d) : Coxa with a few spinules at the outer distal corner. Basis with stout spinules at the outer distal corner and with an elongate outer seta. Rami three-segmented, sub-equal in length. Outer edge of all segments of both rami set with long stout spinules. Outer spines massive and with stout accessory spinules. Setation as below.

*P. 5* (Fig. 27e) very large. Basendopod with a small row of spinules proximally and with a few spinules on the inner edge. The two setae of the inner expansion are long and are fused with the basendopod. Outer expansion seta extremely elongate. Exopod longer than broad, with three long terminal setae and a long accessory seta originating in the basal half of the ramus.

*Male* unknown.

#### *Setal formula*

	Exp.			Enp.		
P. 1	0.	1.	1.2.3.	1.	0.3.0.	
P. 2	1.	1.	2.2.3.	1.	1.	1.2.1.
P. 3	1.	1.	3.2.2.	1.	1.	1.2.1.
P. 4	1.	1.	3.2.2.	1.	1.	1.2.1.

*Remarks* : Four species have been described in this genus. The original description of *H. spinicornis* Sars, 1920 is good and *H. fusiformis* Brian, 1918 is adequately redescribed by Vervoort (1964) although he could not describe the mouthparts; this deficiency is partially filled by Pallares (1975b). The descriptions of *H. similis* Lang, 1948 and *H. triarticulatus* Klie, 1949 are not so good. The make is unknown in all species.

Despite the inadequacies of the published descriptions there can be little doubt that our specimens cannot be considered as conspecific with any of them. It is clear

from Sars's excellent illustrations of *H. spinicornis* that there are major differences in caudal ramus, abdominal hyaline frill, mouthparts and P.5 from our material. *H. triarticulatus* also is different in the caudal ramus and the three-segmented endopod of P.1 and *H. similis* in the caudal ramus and mouthparts. *H. simplex* appears to be closest to *H. fusiformis*. However, all these species have a total of five setae on the distal segment of the endopod of P. 2-P. 4 and the distal segment of the exopod has 7, 8 and 7 or 8 setae respectively, while the comparable numbers for our species are 4 and 7, 7 and 7. It is this reduced setation that is referred to in the choice of trivial name (*L. simplex*—simple).

17. ***Halophytophilus aberrans* n. sp.**  
(Figs. 28-29)

*Material examined* : VII, 1 ♀ ; VIII, 2 ♀ ♀

*Holotype*, VIII (C 2803/2) and *Paratypes* (C 2804/2) deposited with the Zoological Survey of India, Calcutta.

**Description**

*Female* : Length 360  $\mu\text{m}$ . Body shape and proportions and the rostrum are as in *H. simplex*. Genital somite narrow with the suture represented only by very small patches of chitin.

*Somitic ornamentation* : Cephalothorax and thorax as in *H. simplex*. Body densely ornamented with punctae. Abdomen (Figs. 28a-b) with a broad hyaline frill on all segments. That of the genital somite and the third segment finely denticulate on the dorsal side and rather more coarsely denticulate ventrally; the divisions are also deeper ventrally. Genital somite and third segment with a supplementary row of spinules on the ventral part of the frill. Ventral part of the frill of the fourth segment is deeply denticulate while the dorsal side is plain with the median portion forming a pseudopericulum. Last segment with a deeply denticulate ventral part; dorsally the frill is absent.

*Caudal ramus* (Figs. 28c-d) much broader than long. Ventrally with prominent median and outer unguiform projections. Three well developed terminal setae, the innermost fused to the ramus.

*Antennule* exactly as in *H. simplex* except for the absence of colouration.

*Antenna and mouthparts* as in *H. simplex*.

*P. 1* (Fig. 28e) : Coxa with a setulose distal edge. Basis with an inner and an outer spine and with a row of spinules on the anterior surface. Distal edge with stout spinules at the outer corner and with minute setules at the inner corner. Rami

three-segmented. Endopod not prehensile, longer than the exopod. Outer edge of all segments heavily spinulose and with massive outer spines each with stout accessory spinules.

*P. 2-P. 4* (Fig. 28f) : Coxa with stout spinules at the outer distal corner and with minute setules at the inner distal corner. Basis with very stout spinules at the outer distal corner and minute setules at the inner part of the distal edge. Rami three-segmented, endopod slightly longer than the exopod. Outer edge of all segments heavily spinulose. Setation as below.

*P. 5* (Fig. 29a) : Of similar general pattern to that of *H. simplex* and other species of the genus.

*Male* unknown.

*Setal formula*

		Exp.	Enp.
P. 1	0.	1. 1.2.3.	1. 1. 2.2.1.
P. 2	0.	1. 2.2.3.	1. 1. 2.2.1.
P. 3	0.	1. 2.2.3.	1. 1. 2.2.1.
P. 4	0.	1. 2.2.3.	1. 1. 2.2.1.

*Remarks* : In many respects this species is very similar to *H. simplex* with the principal differences being the endopod of P.1 and setation of the endopods of P.2-P.4. There are differences also in the accessory ornamentation of the P.1-P.4 and the abdomen, and in the caudal ramus and the P.5. The similarities argue in favour of congenericity. However, the endopod of P.1 poses a fundamental problem. The prehensile nature of this ramus is one of the striking features of *Halophytophilus* and shared in the family only with *Bradyellopsis* Brian. In our species the P.1 is of the normal family structure. There is a case, therefore, for considering our species as not congeneric with the other species in *Halophytophilus* but the degree of similarity that it does show with these species is such that we believe that it should be accommodated within *Halophytophilus*. There may well be a case for considering *H. aberrans* as representing a separate subgenus. The trivial name reflects the aberrant structure of the P.1 endopod (*L. aberro*—to go astray).

### 18. *Arenosetella germanica* Kunz, 1937

1937. *Arenosetella germanica* H. Kunz, *Kieler Meeresforsch.*, 2 : 95.

*Material examined* : X, 1 ♀ ; XIII, 1 ♀ ; XV, 3 ♀ ♀

*Remarks* : This species is very well described by Kunz. Božić (1955) adds a description of the abdominal hyaline frill and Mielke (1975) reviews the known variability in setation of P.1-P.4. Our specimens fall well within these limits.

The species is widespread, but not cosmopolitan. It has been recorded once only from the southern hemisphere (Wells, 1967; Mozambique) and once only from the northern Pacific (Chappuis, 1957; Puget Sound, U.S.A.), but this may reflect only a lack of collecting in these areas of the world. Of more significance is the fact that it has not been recorded from the eastern seaboard of north America.

19. *Arenosetella tricornis* n. sp.  
(Figs. 29-31)

*Material examined* : III, 6 ♀ ♀ 1 ♂ ; VI, 2 ♀ ♀ ; X, 3 ♀ ♀ ; XI, 1 ♀ 1 ♂ ; XII, 8 ♀ ♀ 2 ♂ ♂ 1 copepodid.

*Holotype* female, III (C 2805/2) and *Paratypes* (C 2806/2) deposited with the Zoological Survey of India, Calcutta.

### Description

*Female* : Length 525  $\mu$ m. Body linear and elongate. Cephalothorax rectangular, not attenuated anteriorly. Except for the pseudoperculum and a single circum-segmental row of minute setules on the third abdominal segment the body is unornamented. Abdominal segments (Fig. 29b) with a digitate hyaline frill ("fully incised obtusidigitate" in the terminology of Moore, 1976b). Pseudoperculum (Fig. 29c) parabolic and minutely pubescent. Last segment with a dorsal armature of three pairs of more or less straight spines which all appear to form one entire apparatus (Fig. 29c). Rostrum acute (Fig. 29d).

*Antennule* (Fig. 29d) six-segmented. First segment short and broad with a long plumose seta, which is broad proximally and attenuated distally, at the inner distal corner.

*Antenna* (Fig. 29e) : Coxa, basis and first endopod segment bare. Second endopod segment with two pectinate spines on the inner side and with three geniculate and three straight pectinate setae terminally. Exopod three-segmented, the first without a seta. Second segment short and with a pectinate seta at the inner distal corner. Third segment elongate with one pectinate and one plain terminal setae.

*Mandible* (Fig. 30a) palp well developed. Basis with three long setae and with long setules along the inner edge. Endopod with three setae set close together on the inner edge, one plumose seta on the outer edge and four setae terminally and subterminally. Exopod small; outer edge with long fine setules. Exopod with three setae, two of which are plumose and with the middle seta fused to the ramus. Coxa as in other species of the genus.

*Maxillule* (Fig. 30b) : Precoxal arthrite with four stout spines, one of which is pectinate. Basis with five setae. Exopod with two and endopod with five setae.

*Maxilla* (Fig. 30c) : Syncoxa with three endites, the middle one represented by a single seta. Basis very long, with two plumose setae and a spine near the base of the inner edge. Endopod with two strong curved setae and two finer setae.

*Maxilliped* (Fig. 30d) : Basis short and broad with a long slender seta at the inner distal corner. First endopod segment slender and elongate; inner edge with fine setules. Second segment about half as long as the first, with two terminal setae and one outer seta.

*P.1-P.4* (Fig. 30e) : Coxa with strong spinules at the outer distal corner. Basis with a weak outer seta and, in P.1 only, a weak inner seta. Both rami three-segmented, exopods reaching to the end of the second endopod segment. Endopod segments, particularly the first, stouter than the exopod segments, but all are elongate and relatively slender. Outer edge of all segments spinulose, those of the exopod being elongate. Setation as below.

*P. 5* (Fig. 31a) small with the rami fused together. Inner expansion of the basendopod with two setae. Exopod with three terminal setae and an accessory seta on the anterior surface. All setae elongate.

#### *Setal formula*

	Exp.			Enp.		
P. 1	0.	1.	1.2.2.	1.	1.	1.2.1.
P. 2	1.	1.	1.2.2.	1.	2.	1.2.1.
P. 3	1.	1.	1.2.2.	1.	2.	1.2.1.
P. 4	1.	1.	2.2.2.	1.	2.	1.2.1.

*Male* only slightly smaller than the female; differs from the female in the following respects.

*Abdomen* : First two segments distinct, the first segment with a digitate hyaline frill as on the other segments.

*Antennule* chirocerate.

*P. 5* (Fig. 31b) smaller than that of the female and with different setal proportions. Inner exopod seta plumose.

*P. 6* (Fig. 31c) : The pair of P.6 are confluent, with two setae and two teeth on each side.

*Remarks* : This species differs from all others in the genus in the armature of the last segment although it shows an obvious similarity to *A. kaiseri* Lang, 1965 and *A. incerta* Chappuis, 1953. This armature is also similar to that of *Arenosetella* sp.



aff. *incerta* Noodt, 1958 but this form has a different setation of P.1-P.4. The trivial name reflects the three-pronged nature of the armature of the last segment (L. tri-three, and *cornu*-a horn).

*Copepodid* : One Stage V copepodid was taken which possibly belongs to this species; certainly it occurred along with adults of *A. tricornis* but as *A. germanica* occurs elsewhere in the Islands the identity of this copepodid cannot be determined absolutely. The operculum of this specimen is arcuate and furnished with eight long spines and there are no claws on this last segment (Fig. 30f). A similar condition was recorded by Chappuis (1953) in an individual that he called *Arenosetella* sp. juv. and which Lang (1965) believes could be the Stage IV copepodid of *A. incerta*. Noodt (1952) found an example of an ovigerous female of *A. germanica* which had this juvenile condition. In discussing these two cases Lang (1965, p.13) expresses the belief that the change to the adult condition occurs at either the moult from Stage IV to Stage V or from Stage V to adult, the evidence being too imprecise to be certain but indicating variation between species at which moult it occurs. He also demonstrates that the phenomenon is not confined to *Arenosetella*, finding a similar condition in the Stage V copepodid of *Pseudobradya cornuta* Lang.

## 20. *Hastigerella leptoderma* (Klie, 1929)

(Fig. 31)

1929. *Ectinosoma leptoderma* W. Klie, *Zool. Jb. Syst.*, 57 ; 335.

*Material examined* : III, 18 ♀ ♀ 6 ♂ ♂ ; XI, 40 ♀ ♀ 6 ♂ ♂ ; XII, 16 ♀ ♀ ; XIV, 2 ♀ ♀ ; XV, 1 ♀

*Remarks* : Klie's description of this species is inaccurate in that the second segment of the endopod of P.2-P.4 bears two inner setae as is common in *Hastigerella*, and not one as he states. One seta always has its origin on the posterior surface. Noticing this first in the present specimens we have confirmed it by examination of the Holotype from the Zoologisches Institut und Museum, Kiel and have seen the same condition in material from England (Wells, 1961, 1968), France (Renaud-Debyser, 1963, Soyer, 1974), Portugal (Wells & Clark, 1965) and Mozambique (Wells, 1967 as *H. grandimandibularis*). Mielke (1975) reports this condition in specimens from the island of Sylt, Germany but in these the P.1 also possesses two inner setae, which is not the case in any of the material that we have examined and appears to be a local phenomenon only. The setal formula is thus (cf. Lang, 1948, p.191).—

	Exp.			Enp.		
P. 1	0.	1.	1.2.2.	1.	1-2.	2.2.1.
P. 2-P. 4	1.	1.	1.2.2.	1.	2.	2.2.1.

These investigations show that *H. grandimandibularis* Wells, 1967 is not valid and must sink as a synonym of *H. leptoderma*. We draw attention here to the fact that Wells's description is wrong in two respects—

- (a) The female antennule is five-segmented, not six, and thus is the same as all other material examined. However, the first segment shows traces of articulation (Fig. 31d), a feature not noticed before in *H. leptoderma* and which is not apparent in the other material that we have examined.
- (b) The male P.6 is not a single plate but consists of a pair of indistinctly defined lappets, each with two setae, between which lie a pair of sharp spiniform projections (Fig. 31e). This condition is similar in all material that we have examined.

*H. leptoderma* has a continuous distribution from Germany and the southern part of the British Isles to Portugal and the mediterranean coast of France. It has been reported also from the eastern seaboard of America (South Carolina) and from Mozambique.

#### 21. *Lineosoma intermedia* (Wells, 1967)

1967. *Noodtiella intermedia* J.B.J. Wells, *Trans. R. Soc. Edinb.*, 67 ; 245.

*Material examined* : XI, 2 ♂ ♂ ; XII, 1 ♀ 1 ♂

*Remarks* : These specimens agree in all respects with the type-material but we must report that the original description is wrong in that the second endopod segment of P.1 bears four terminal setae, not three. The species is known only from Mozambique (Wells, 1967).

#### 22. *Noodtiella mielkei* n. sp. (Figs. 31-32)

*Material examined* : II, 2 ♀ ♀ ; XIV, 1 ♀ 1 ♂

*Holotype* female, II (C 2807/2) and *Paratypes* (C 2808/2) deposited with the Zoological Survey of India, Calcutta.

#### Description

*Female* : Length 356  $\mu$ m. Body almost cylindrical and without any real demarcation between metasome and urosome; about seven times as long as broad. Genital somite without a suture. Without somitic ornamentation. Hyaline frill of the genital somite and the third adominal segment digitate, or palisaded, or, in the terminology of Moore, 1976b, a variant of the fully incised obtusidigitate condition (Fig. 31f). Anal segment without ornamentation. Caudal ramus (Figs. 31f-g) slightly broader than long, the distal edge of the ventral side with a median unguiform projection.

*Antennule* of six segments, the last the longest (Fig. 32a).

*Antenna* (Fig. 32b) with a two-segmented exopod, the first segment with one seta, the second with two setae.

*Mandible* (Fig. 32c) : Coxa not seen. Basis with two setae. Exopod of one small segment with three setae. Endopod of one segment with two lateral and three terminal setae.

*Maxillule* (Fig. 32d) : Pre-coxal arthrite with four claws. Basis distinct from the coxa, with two setae. Exopod and endopod distinct, with two and four setae respectively.

*Maxilla* very large and robust (Fig. 32e). Syncoxa elongate with one endite at the proximal inner corner, a seta near the base and a long seta at the inner distal corner which probably represents the rudiment of another endite. Basis elongate and prehensile on the syncoxa. Exopod without trace of segmentation but represented by four short setae.

*Maxilliped* elongate and slender (Fig. 32f). Basis and first endopod segment without setae, but the latter has long setules along the inner edge and some long fine hairs on the outer edge. Second endopod segment with one lateral and two terminal setae.

*P.1-P.4* (Figs. 32g-i) : Coxa elongate. Basis narrow, with a very small outer seta. Endopod of two elongate segments and always longer than the exopod. First segment with long setules on the inner edge and, in P.1 only, with a transverse row of spinules proximally. Second segment with a transverse row of spinules halfway along the length of the segment. Exopod of P.1-P.3 of three segments, of P.4 with two segments. Setation as in Table 2.

*P. 5* (Fig. 32j) : Basendopod well developed, with a pore at the base of the outer expansion. The two setae of the inner expansion appear to be fused to the ramus. Exopod with three terminal setae, the innermost fused to the ramus. No accessory seta on the exopod.

*Male* : Length 332  $\mu\text{m}$ . Differs from the female in the following respects. First two abdominal segments distinct; hyaline frill of the first segment palisaded.

*Antennule* haplocerate.

*P. 5* very small (Fig. 32k). Basendopod lacks the outer expansion and seta. Exopod fused to the basendopod, with three terminal setae and without an accessory seta. The pair of P.5 are confluent and fused to the segment.

*P. 6* (Fig. 32l) : Each side consists of a long seta and three spiniform projections. The pair of P.6 are confluent.

*Remarks* : The species of *Noodtiella* are remarkably uniform and largely are distinguished by the setation of P.1-P.4 (see Table 2) and on small differences in P.5 and caudal ramus. *N.mielkei* is similar to *N. gracile* and *N. frequentior* in having only two segments in the P.4 exopod. It differs from both in significant details of setation and from *N. frequentior* in the absence of a vault-like dorsal cavity of the last segment and its attendant long fine setules.

*Etymology* : We name this species in honour of Dr Wolfgang Mielke.

**23. *Noodtiella ornamentalis* n. sp.**  
(Figs. 32-33)

*Material examined* : III, 4 ♀ ♀ ; XII, 1 ♀

*Holotype*, III (C 2809/2) and *Paratypes* (C 2810/2) deposited with the Zoological Survey of India, Calcutta.

**Description**

*Female* : Length 360  $\mu$ m. Body linear, almost cylindrical and without demarcation between metasome and urosome (Fig. 33a). Rostrum small and truncated apically. Genital suture represented by a few patches of chitin. Cephalothorax and all segments except the last with a palisaded hyaline frill as in *N. mielkei* (see Fig. 31f). Cephalothorax with a few scattered sensilla. Dorsal surface of the last segment raised up as a pair of multidentate lamellae (Fig. 32 m). With these exceptions the body lacks ornamentation.

*Antennule, antenna, mandible, maxillule and maxilla* exactly as in *N. mielkei*.

*Maxilliped* (Fig. 33b) of similar construction but more slender than in *N. mielkei*.

*P.1-P.4* (Figs. 33c-d) : Coxa large, with spinules at the outer distal corner. Basis narrow and with a very small outer seta. Exopod three-segmented. Endopod two-segmented, the second segment with a suture on the anterior and outer surfaces marked by a row of spinules. Setation as in Table 2.

*P. 5* with the rami confluent (Fig. 33e). Outer expansion of the basendopod well developed. Inner expansion with two setae, the outer one spiniform, plumose and fused to the ramus. Exopod with three terminal setae, the inner two fused to the ramus. Exopod without an accessory seta.

*Male* unknown.

*Etymology* : The trivial name refers to the multidentate lamellae on the last segment (*L. ornamentum*-equipment; accoutrement).

*Remarks* : It is with some diffidence that we place this species in *Noodtiella*. The presence of a strongly differentiated armature on the last abdominal segment places it in a unique position within this genus, although *N. frequentior* has some long fine setules on this segment. The only other species of ectinosomatids with such an armature were grouped by Lang (1965) into the genus *Arenosetella* Wilson and this feature was used by Lang to differentiate *Arenosetella* from similar but unarmed species that he placed in *Hastigerella* Nicholls. There can be no doubt that our species is not congeneric with *Arenosetella* species but it could be that *N. ornamentalis* should be placed in a genus separate from *Noodtiella*.

#### Family PORCELLIDIIDAE

#### 24. *Porcellidium ravanae* Thompson & A. Scott, 1903 (Figs. 34-36)

1903. *Porcellidium ravanae* I. C. Thompson & A. Scott. *Rep. Govt. Ceylon Pearl Oyster Fish. Gulf Manaar*, 1 : 275.

*Material examined* : VII, 3 ♀ ♀ 3 ♂ ♂ ; IX, 1 ♀ 2 ♂ ♂

*Remarks* : Despite the incomplete original description we believe these specimens can be referred to *P. ravanae*. The species is distinctive in the shape of the female abdomen, caudal ramus and P.5. In these respects our specimens agree with the illustrations given by Thompson & A. Scott (1903), although they do lack the proximal lateral seta on the caudal ramus. The genus suffers from a plethora of incomplete and poor descriptions, a situation that Lang (1948) attempted to rationalize by recognizing some synonymies. The species of *Porcellidium* fall into two groups defined on the basis of the female caudal ramus. In the group containing *P. ravanae* it is attenuated posteriorly and nine species of this type have been described. Lang (1948), by synonymy, reduced this to four—

*P. tenuicauda* Claus, 1860 (synonym—*P. dentatum* Claus, 1860).

*P. ovatum* Haller, 1879 (synonyms—*P. parvulum* Haller, 1879, *P. scutatum* Claus, 1889, *P. acuticaudatus* Thompson & A. Scott, 1903). This species is redescribed by Geddes, 1968b.

*P. brevicaudatum* Thompson & A. Scott, 1903.

*P. ravanae* Thompson & A. Scott, 1903 (synonym—*P. tuberculatum* Wolfenden, 1906).

Of these our specimens undoubtedly resemble *P. ravanae* more than any other species.

Lang (1948) in synonymizing *P. tuberculatum* with *P. ravanae* disagrees with Gurney (1927b) who considered it to be a juvenile of *P. acuticaudatum*. In reality Wolfenden's (1906) description does not allow of a proper opinion.

The male of *P. ravanae* is described here for the first time.

### Description

*Female* : Length 640  $\mu\text{m}$ , greatest breadth 375  $\mu\text{m}$ . Body shape characteristic of the genus (Fig. 34a). Anterior margin of the cephalothorax evenly rounded. Lateral margin of the genital somite rounded (Fig. 34d). Abdomen reaching only to the beginning of the caudal ramus. P.5 does not reach beyond the caudal ramus (in contrast to Thompson & A. Scott, 1903, Pl. XII, fig. 15) although this does depend on how much pressure is applied to the specimen when mounting on the microscope slide. Without any such pressure the caudal rami in our preserved specimens are directed ventralwards rather than posteriorly and under these circumstances the pair of P.5 does tend to extend beyond the distal end of the caudal rami. Caudal ramus (Fig. 34d) elongate, with an oblique taper from the external edge of a rounded apex; with two dorsal setae and four apical and sub-apical setae. The whole body and the caudal ramus is ornamented with a pattern of rounded markings, except that the lateral edge of the segments is clear (Fig. 34c). Rostrum broadly truncate.

*Antennule* six-segmented (Fig. 35a). The second segment articulates laterally on the first. All segments except the first are copiously setose.

*Antenna* (Figs. 35c-e) : Coxa distinct. Basis short. First endopod segment short and without setae. Second endopod segment with three stout claws, each with an articulated tip, a stout spine and a bifurcate seta. Exopod of one segment with three lateral and three apical setae.

*Mandible* massive (Figs. 35f-g) : Pre-coxa elongate with a simple cutting edge. Palp enormous. Basis with four stout plumose spines. Endopod with nine setae and spines. Exopod with five curiously shaped plumose spines and a seta.

*Maxillule* (Fig. 35h) : Pre-coxal arthrite with eight terminal and two appendicular setae. Coxa and basis fused with the pre-coxa. Coxa with three setae. Basis with two endites, each with three setae. Exopod and endopod each of one segment, with two and six setae respectively.

*Maxilla* (Fig. 35i-j) : Pre-coxa and coxa fused, with two endites. Basis and endopod fused, with a total of six setae and spines.

*Maxilliped* (Figs. 35k-l) : Coxa fused with basis. Distal inner corner of coxa-basis prolonged. Endopod with four short claws.

*P. 1* of the type characteristic of the genus (Fig. 36a). Coxa indistinguishable. Basis with a massive, finely plumose outer spine. Exopod three-segmented, endopod two-segmented, the first segment lamelliform.

*P. 2-P. 4* (Fig. 36b-c, e-f) : Coxa differentiated from the basis by an indistinct articulation; together they form an elongate structure. Basis without an inner seta. Both rami three-segmented. Setation as below.

*P. 5* (Fig. 34f) : Basendopod with an inner unguiform process and one long seta and with one short seta on the outer side. Exopod a broad triangular lamella, very delicate and translucent on the inner side. Outer edge with two setae, with another small seta on the posterior surface.

#### *Setal formula*

	Exp.			Enp.		
<i>P. 1</i>	0.	0.	1.2.3.	1.	0.2.0.	
<i>P. 2</i> ♀	1.	1.	2.2.3.	1.	2.	1.2.1.
<i>P. 2</i> ♂	1.	1.	2.2.3.	1.	2.	1.1.1.
<i>P. 3</i>	1.	1.	3.2.3.	1.	2.	2.2.1.
<i>P. 4</i>	1.	1.	3.2.3.	1.	1.	1.2.1.

*Male* : Length 555  $\mu\text{m}$ , greatest breadth 370  $\mu\text{m}$ . Body ornamented as in the female. Body more rounded than in the female (Fig. 34b). Rostrum arcuate, very small. Anterior abdomen rounded laterally. The male differs otherwise from the female only in these respects.

*Antennule* sub-chirocerate, four-segmented (Fig. 35b). Articulation of the second segment is lateral upon the first, as in the female.

*P. 1-P. 4* are as the female except that the distal segment of the endopod of *P. 2* bears three setae only (Fig. 36d).

*P. 5* (Fig. 36g) : Basendopod of the pair of *P. 5* confluent, with an inner and an outer seta. Exopod a broad, almost rectangular lamella with six short, stout plumose spines.

#### Family PELTIDIIDAE

#### **Peltidium** Philippi, 1839

In his major review Lang (1948) lists 37 species of *Peltidium* and its three synonymous genera. By synonymy he reduces this number to 15 and gives to a further eight

the status of species *incertae sedis*. Since then another nine species have been described. Nicholls (1941a), in a paper not considered by Lang, discussed the problems of identification from incomplete or inadequate descriptions, which problem is particularly acute in this genus. It is clear that neither author was particularly happy with their conclusions. The fact is that the limits of variability for each species is not known and that species have been proposed on very dubious grounds. The genus is in urgent need of revision but this probably is not possible as the type-material of most species is lost.

Of the characters that are said to vary between species only a few can be accepted without contention for species differentiation. Among these would be the setation of P.2-P.4, which is incapable of misinterpretation in *Peltdium*, and the number of setae on the exopod of P.5 and on the second endopod segment of P.1. It is possible that the number of segments in the antennule and the presence or absence of modifications in the male antennule also offer a valid set of characters, but it is more than probable that some older descriptions may not be accurate in these respects and cannot be accepted uncritically. Most other characters that have been used are now known to vary within a species or are likely to have been founded on faulty observation. Among such characters are—

- (a) The skeletal pattern of chitin struts often has been used for species differentiation. While gross differences probably are valid the more minor differences are not justified. Vervoort (1964) has noticed variability within a species.
- (b) The form of the setae of the inner edge of the second endopod segment of P.1 can be variously interpreted from the literature as “thick setae”, “unmodified spines” or “modified spines, usually laminate or scroll-like” (Nicholls, 1941a, pp. 391-393, in his key to the genus). However, it is highly unlikely that the descriptions and illustrations given by earlier authors can be so readily accepted. It is known that the form of harpacticoid setae can appear quite different depending on the orientation of view (see, for example, Wells & McKenzie, 1973, Fig. 2a-d) and extreme care must be taken in their observation. It is more than probable that most species have “laminate or scroll-like setae”
- (c) The proportions of P.5 and of the setae of the exopod have also been used but early authors usually fail to describe these statistically. It would appear that some “species” have been differentiated on the basis of small proportional differences which could easily be within the intra-specific range of variation normally to be expected, or even within an intra-population range.

With these considerations it is extremely difficult to decide to which species our specimens belong. The collections contain four ‘kinds’ One, represented by both sexes, clearly is close to *P. ovale* Thompson & A. Scott, 1903 but the other three, represented by one female and two male forms, pose a severe



problem. The female seems most similar to *P. angulatum* Thompson & A. Scott, 1903 and is here described as such, together with comments on the validity of this species. The male of *P. angulatum* is unknown. The two kinds of male resemble our *P. angulatum* in all respects except for the peculiarly male characters but differ between themselves in these characters. Since all three forms are found together, and no pairs in copula were taken, it is impossible to be certain which male belongs to *P. angulatum*. Hence both males are here described as *Peltidium* sp.

25. ***Peltidium ovale*** Thompson & A. Scott, 1903  
(Fig. 37)

1903. *Peltidium ovale* I.C. Thompson & A. Scott, *Rep. Govt. Ceylon Pearl Oyster Fish. Gulf Manaar*, 1 : 273.

*Material examined* : VII, 1 ♀ 3 Stage V ♀ ♀ 10 Stage III-IV copepodids, 1 ♂

*Remarks* : Nicholls (1941a) argues persuasively that the original description refers to the male and not to the female as the authors presumed. He believes that the absence of modifications in the male antennule probably was responsible for the error. Sewell (1940) partially redescribes the "female" but, again, could be referring to the male. Gamo (1969) gives an excellent redescription of the male. According to the interpretation of Nicholls the female remains undescribed. The species has been recorded by Coull (1971b) and Zhang & Li (1976) but in both cases without details or description. The species is relatively distinct from all others except *P. simplex* Nicholls, 1941a in body shape and skeletal pattern and we have no doubt that the specimens of Thompson & A. Scott, Sewell, Gamo and ourselves all belong to the same species. In addition we are not convinced that *P. simplex* is a distinct species. Even its author had his doubts, stating that in some respects it is "very similar to *ovale*, and it is probably an Australian form of this species" (Nicholls, 1941a, p. 395).

Nicholls (1941a) in arguing that the *P. ovale* described by Thompson & A. Scott (1903) refers to the male relies on the sexual dimorphism in the endopod of P.1 displayed by other species of the genus. Undoubtedly he is correct in his assumption that Thompson & A. Scott's three specimens were not adult females but our specimens may indicate that they were not males either. Our material consists of one adult male, one ovigerous female, ten undoubted copepodids and three female specimens in which eggs can be seen developing within the ovary. Nicholls (1941a, p. 391) shows that males copulate with pre-adult females (i.e. with Stage V normally). It could be, therefore, that our females with developing eggs are Stage V copepodids and not adults. This possibility is enhanced by the weak development of the external genitalia compared with that of the ovigerous female. If this is so then our material displays one feature of extreme interest with regard to the endopod of P.1. That of the male (Fig. 37a) and ovigerous female (Fig. 37b) display the dimorphism known from other species. The difference in shape between Stage V female (Fig. 37c) and the male is much less marked however, and only the presence in the former of a setose lamella on the coxa shows the essential femaleness of this limb in this stage. In the Stage IV

specimens even this feature is absent (Fig. 37d), but it is, of course, not possible to know which sex these specimens are. Since it is not easy to distinguish Stage V females and the adult female (their size is similar) it is still possible that Thompson & A. Scott (1903) did not describe the male. It also indicates that extreme care is necessary in describing species of this genus.

*Description* : An excellent description of the adult male has been published by Gamo (1969). Our specimens agree entirely with his description in all features except those given below. Except for the P.1 and the absence of a P.6 the female is identical with the male.

*Length* : Ovigerous female 1.53 mm, Stage V female 1.53 mm, adult male 1.57 mm. Skeletal pattern as described by Gamo (1969) but the colouration that he notes is present only in our adult specimens.

*P. 1* of the male is more or less as described by Gamo except that in our specimens the outer part of the basis is more prolonged distally (Fig. 37a). In the ovigerous female (Fig. 37b) the coxa has an inner setose lamella and the endopod segments are broader than in the male. In the Stage V female (Fig. 37c) the coxa has an inner setose lamella and the endopod segments are only slightly broader than in the male, but they do have a more convex inner edge. In Stage IV (Fig. 37b) the coxa lacks an inner lamella and the endopod segments are more rectangular. It must be noted that in our specimens the inner seta of the second endopod segment is flattened and scale-like in all specimens, although its appearance depends on the orientation of view (cf. Figs. 37a, d with Figs. 37b-c) and also that only in the male is the seta of the first segment flattened and scale-like.

The species has been recorded from Sri Lanka (Thompson & A. Scott, 1903), Maldive and Nicobar Islands (Sewell, 1940), Andaman Islands (this paper), Japan (Gamo, 1969), Xisha Islands, China (Zhang & Li, 1976) and, possibly, from South Australia (Nicholls, 1941a as *P. simplex*). Coull (1971b) records it from the east coast of U.S.A. but this record must be considered doubtful on zoogeographic grounds.

## 26. *Peltidium angulatum* Thompson & A. Scott, 1903 (Figs. 37-40)

1903. *Peltidium angulatum* I.C. Thompson & A. Scott, *Rep. Govt. Ceylon Pearl Oyster Fish. Gulf Manaar*, 1 : 273.

*Material examined* : IV, 2 ♀ ♀ ; VII, 10 ♀ ♀ ; VIII, 1 ♀ ; IX, 1 ♀

### Description

*Female* : Length range of 11 specimens 700-1028  $\mu\text{m}$ ; with five at 700-760  $\mu\text{m}$  and six at 924-1028  $\mu\text{m}$ . Body ovate with the greatest width at the posterior end of the cephalothorax, about 60% of length (Fig. 37e). All segments with acutely pointed

epimera. Skeletal pattern strongly developed. All parts of the body with numerous circular "craters" with a raised rim and with a small setule in the centre of the crater (Fig. 37f). When viewed from the dorsum without the body being flattened the caudal furca does not reach to the end of the genital epimera. Caudal ramus (Figs. 40a-b) slightly less than twice as long as broad, with one external spine, an articulated seta dorsally and terminally with one well developed long seta, which is confluent at its base with another seta, and with two long setae external and slightly dorsal and a short seta internal to the well developed seta.

*Antennule* (Fig. 38a) of seven segments with, in some specimens, the last segment showing an indistinct division into two. Second segment articulates at approximately 90° to the first. An aesthete on segments three and four.

*Antenna* (Fig. 38b) : Coxa and basis distinct. Basis and first endopod segment each with one inner seta. Second endopod segment elongate, with a short plain seta, three articulated geniculate setae and a broad-bladed seta which is confluent at its base with a slender seta. Exopod of two segments, the first with one inner seta, the second with two slender setae and a pectinate spine.

*Mandible* (Fig. 38c) with a multi-dentate cutting edge. Palp small; without exopod and with a single segmented endopod with six setae.

*Maxillule* (Figs. 38d-e) : Pre-coxal arthrite with a complex set of setulose teeth. Basis, endopod and exopod all fused together. Basis with three setae. Endopod reduced to a small projection with one seta. Exopod a small process with two setae.

*Maxilla* (Fig. 38f) : Syncoxa with two endites, the proximal slender and with a single seta, the distal with three setae. Basis with a terminal claw and one inner and three outer setae.

*Maxilliped* very well developed (Fig. 38g). Endopod articulates at 90° to the basis. Basis without setae. First endopod segment ovoid with a setose inner edge. Second endopod segment a curved claw extending about two-thirds of the way along the first segment and prehensile upon it.

*P. 1* (Fig. 39a) : Coxa and basis broad, the inner edge being a setose lamella. Basis with an inner and an outer seta. Exopod of three segments, the first two elongate and the third very small. First segment without an inner seta. Second segment with a distal inner seta. Third segment with two large curved claws, one small claw, one spine and a small seta. Endopod two-segmented, both segments very broad, the first with an inner setose lamella. First segment with a stout inner seta. Second segment with two fine terminal setae and two flattened, scale-like setae on the inner edge (Fig. 39f); in one specimen the right leg had two such setae and the left had three.

*P.2-P.4* (Figs. 39b-d) : Coxa small. Basis transversely elongate. Both rami three-segmented, those of P.2-P.3 of equal length, but in P.4 the endopod is shorter than the exopod. Setation as below.

*P. 5* of two distinct segments (Fig. 39e). Inner expansion of the basendopod weakly developed with two setae, the outer very long. Outer expansion well developed, extending to more than three-quarters of the way along the length of the exopod. Exopod twice as long as broad, with five setae. The two outer setae are slender with the second outer seta of variable length—from as long as the outermost seta to only half its length. The three innermost setae are stout, the first and third plumose and the second pectinate (Fig. 39g).

*Setal formula*

	Exp.			Enp.		
P. 1	0.	1.	5.	1.	2.2.0.	
P. 2	1.	1.	2.2.3.	1.	2.	1.2.0.
P. 3	1.	1.	3.2.3.	1.	2.	3.2.0.
P. 4	1.	1.	3.2.3.	1.	2.	1.2.0.

The *male* is unknown but could be represented by either of the males described below as *Peltidium* sp. A and *Peltidium* sp. B.

27. *Peltidium* sp. A  
(Fig. 40)

*Material examined* : IV, 1 ♂ ; VII, 1 ♂

*Description of the male* : Length of two specimens 760 and 795  $\mu\text{m}$ . In all respects except the P.1 and the presence of a P.6 these males are identical to the female described above as *P. angulatum*. Note particularly that the antennule is exactly similar, as is the P.5.

*P. 1* (Figs. 40c-d) : Coxa and basis slender and without lateral setose lamellae. Origin of exopod far distal to that of the endopod. Exopod almost identical to *P. angulatum* female, with the terminal armature very similar. Endopod segments slender and with lateral setose lamellae. First segment rectangular in shape. Second segment shorter than the first. Inner edge with two scale-like setae. Distal edge with a curved blunt spine and a stout curved projection which is bifid at the tip.

*P. 6* of each side is a short lamella with three setae.

28. *Peltidium* sp. B  
(Fig. 40)

*Material examined* : VII, 11 ♂ ♂

*Description of the male* : Length 736-947  $\mu\text{m}$ . In all respects except the antennule, P.1 and in the presence of a P.6 these males are identical with the female described above as *P. angulatum*.

*Antennule* of seven segments (Figs. 40e-f). Second segment originates from the distal edge of the first. Third segment rounded, short. Fourth segment elongate. Outer edge of third and fourth segments heavily chitinized. An aesthete on segments three and four. Fifth and sixth segments with chitinous hooks.

*P. 1* (Fig. 40g) : Coxa and basis slender and without lateral setose lamellae. Origin of exopod far distal to that of the endopod. Inner edge of basis hirsute. Exopod very similar to that of the female *P. angulatum* and the male *Peltidium* sp. A but with the smallest of the terminal claws less well developed. First endopod segment rectangular. Second endopod segment longer than the first. Inner edge with two scale-like setae. Distal edge with one stout and one fine seta.

*P. 6* as in *Peltidium* sp. A, a short lamella with three setae.

*Remarks on P. angulatum, Peltidium spp. A and B* : With the reservations expressed earlier about the validity of many species of *Peltidium* the assignment of these females to *P. angulatum* cannot be considered as definitive. The following species of which the male is unknown are very similar to *P. angulatum*—

*P. perplexum* Thompson & A. Scott, 1903

*P. falcatum* A. Scott, 1909

*P. exiguum* A. Scott, 1909 (redescribed by Vervoort, 1964)

*P. hawaiiense* Pesta, 1935

*P. monardi* Pesta, 1935

*P. maldivanum* Sewell, 1940

Despite the careful redescription of *P. exiguum* by Vervoort (1964) we are not totally convinced that this species can be distinguished from *P. angulatum*, or indeed from the other species listed above.

A further complication is that *P. speciosum* Thompson & A. Scott, 1903 has been redescribed by Nicholls (1941a) who adds a description of the male. Again, we are not convinced that *P. speciosum* can really be distinguished from these other species. The male appears to be very similar to that described here as *Peltidium* sp. B. Nicholls includes yet another species, *P. minutum* A. Scott, 1909, in this complex as a synonym of *P. speciosum*.

## 29. *Eupelte aurulenta* n. sp.

(Figs. 41-42)

*Material examined* : IV, 1 ♀ ; VII, 2 ♀ ♀ 2 ♂ ♂ ; IX, 1 ♀

*Holotype* female, VIII (C 2811/2) and *Paratypes* (C 2812/2) deposited with the Zoological Survey of India, Calcutta.

**Description**

*Female* : Length 660  $\mu\text{m}$ . Body ovoid; metasome much wider than the urosome (Fig. 41a). Segments of urosome well demarcated. Skeletal pattern indistinct and obscured by the dense pattern of raised irregular polygons, which cover the entire surface. Lateral edges of the segments with long hairs, those of abdominal segments three and four very long. Posterior edge of segments crenulate, with some hairs (Fig. 41c). Rostrum broad and truncate (Fig. 41b). Caudal ramus (Figs. 41d-e) rounded, with two dorsal setae, four terminal setae and one shorter outer seta.

*Antennule* nine-segmented, the last five very small (Fig. 41f). Inner edge of first segment densely hirsute. An aesthete on segment four. First four segments golden-brown in colour in our preserved specimens.

*Antenna* with basis with one seta (Fig. 41g.) First endopod segment without setae. Second segment with four terminal articulated claws. Exopod of two small segments, the first with one seta and the second with three setae.

*Mandible* (Fig. 41h) : Pre-coxa elongate, cutting edge narrow. Coxa-basis small, with three setae. Exopod fused to the coxa-basis, with three setae. Endopod with one lateral and three terminal setae.

*Maxillule* (Fig. 41i) : Pre-coxal arthrite articulated with pre-coxa; with three setae and six spines. Coxa with three setae. Basis elongate, with five setae. Exopod of one small segment with three setae. Endopod represented by three setae only.

*Maxilla* (Fig. 41j) : Pre-coxa fused with coxa. One endite on the pre-coxa and two on the coxa. Basis with a terminal claw and one seta. Endopod represented by two setae only.

*Maxilliped* (Fig. 42a) : Coxa elongate. Basis short with two setae. First endopod segment ovoid; inner edge with a triple row of spinules and a large hook-shaped pad. Second segment a claw, prehensile upon the first segment.

*P. 1* (Fig. 42b) : Coxa elongate. Basis transversely elongate, with an inner and an outer seta. Exopod of three segments, the first moderately long. Second segment about twice as long as the first and with a distal inner seta. Third segment very small and with four long claws and a spine. Endopod two-segmented, with one and four setae respectively.

*P. 2-P. 4* (Figs. 42c-e) : Coxa and basis transversely elongate. Rami three-segmented, endopod shorter than exopod. Setation as below. All setae are very long. The proximal two inner setae of the third segment of the exopod of P.3-P.4 originate very close together. Middle inner seta of the third segment of the exopod of P.4 is broad, flattened and serrated.

*P. 5* of two distinct segments (Fig. 42f). Basendopod elongate. Outer expansion negligible. Inner expansion very short and with five setae. Exopod almost four times as long as broad, with four terminal and sub-terminal spines.

*Setal formula*

	Exp.			Enp.		
P. 1	0.	1.	5.	1.	1.2.1.	
P. 2	0.	1.	2.2.3.	1.	2.	2.2.1.
P. 3	0.	1.	3.2.3.	1.	2.	2.2.1.
P. 4	0.	1.	3.2.3.	1.	2.	2.2.1.

*Male* : Length 640  $\mu$ m. Differs from the female in the following respects.

*Antennule* eight segmented, modified (Fig. 42g).

*P. 5* smaller than the female (Fig. 42h). Inner expansion of basendopod negligible and with only one seta. Exopod with two terminal spines and two outer setae.

*P. 6* of each side represented by two stout setae.

*Etymology* : The trivial name refers to the colour of the antennule segments (*L. aurulentus*—of the colour of gold).

*Remarks* : The only comprehensive descriptions of species of *Eupelte* are those of *E. regalis* Hicks, 1971, *E. acutispinis* Zhang & Li, 1976 and that by Pallares (1968b) which she refers to *E. gracilis* Claus, 1860. There is every reason to suspect that Pallares's specimens are not that species. Lang (1948) synonymized *E. oblonga* Claus, 1863 with *E. gracilis* but the description of *E. oblonga* by Monard (1928) shows certain differences from that of Claus and it is possible that they represent a further species. Two more species, *E. setacauda* Monk, 1941 and *E. tristanensis* Wiborg, 1964, are not completely described. This state of confusion and inadequacy makes it impossible to assign our specimens to any of the known species. *E. tristanensis* and *E. regalis* differ markedly from all other species, and from our specimens, in the P.1. The *E. gracilis* of Pallares differs from our material in the caudal ramus and in leg setation. The partial description of *E. setacauda* reveals clear differences from our material, though the illustrations are not of ideal quality. If Pallares's *E. gracilis* is not that species then no adequate description of the type-species exists. Our specimens differ considerably from all forms described as *E. gracilis*, with the possible exception of those of Pesta (1959). There are some very real similarities with *E. acutispinis* but this species has only eight segments in the female antennule and the distal segment of the endopod of P.4 has only one inner seta. Reluctantly we are forced to describe our material as a new species.

## Family THALESTRIDAE

30. *Phyllothalestris mysis* (Claus, 1863)

1863. *Thalestris mysis* C. Claus, *Die freilebenden Copepoden*, p. 130.

*Material examined* : IV, 1 ♂ ; VII, 11 ♀ ♀ 11 ♂ ♂ 5 copepodids ; VIII, 2 ♀ ♀

*Remarks* : Except for the presence of only two inner setae on the distal exopod segment of P.2 these specimens agree completely with the description given by Sars (1905), which is accepted as the basic reference for this species. As to the difference in P.2 it seems obvious that Sars either was wrong or was dealing with an aberrant specimen (as has been argued previously by Sewell, 1940). In addition to this present material we have examined specimens from England (Wells, 1970) and Mozambique (Wells, 1967 as *P. sarsi*—see below for reasons why we believe this to be *P. mysis*), all of which have only two inner setae. Many other authors also report this and support Sewell's conclusions.

Lang (1948) recognized *P. mysis* as the only species in the genus, absorbing four others into its synonymy. Since then Noodt (1955a) has added *P. orientalis* Sewell, 1940 (a species not known to Lang) to this synonymy. On the other hand, Sewell (1940) proposed that *P. mysis harringtoni* Willey, 1935 is sufficiently distinctive to warrant specific status, a conclusion endorsed by Geddes (1969). Sewell (1940) added *P. sarsi* n. sp. to the genus and Geddes (1969) placed *P. lata* Nicholls, 1942 as a synonym of *P. sarsi*. The current opinion, therefore, is that three species of *Phyllothalestris* are known :

*P. mysis* (Claus, 1863)

synonyms : *Thalestris pontica* Czerniavski, 1868  
*T. brevicornis* Czerniavski, 1868  
*Dactylopina royi* Monard, 1928  
*Phyllothalestris paramysis* Monard, 1928  
*P. orientalis* Sewell, 1940

*P. harringtoni* Willey, 1935 (= *P. mysis* f. *harringtoni* Willey, 1935)

*P. sarsi* Sewell, 1940

synonym : *P. lata* Nicholls, 1942

A survey of the literature together with an examination of material in our collections and of the female recorded by Nicholls (1941a) shows that these three species can be differentiated only on the form of the setae of the female P.5, although *P. mysis* and *P. sarsi* males are slightly different in the P.2 endopod; the male of *P. harringtoni* is not known. Nicholls (1942) states that *P. lata* (= *P. sarsi*) has only one seta on



the basal segment of the antennal exopod and thus differs from *P. mysis* in which there are two setae. In fact our examination of his South Australian material (Nicholls, 1941a) reveals that there are two setae present, the proximal being very small and weak; unfortunately the Western Australian material (Nicholls, 1942) appears to have been lost. Sars's (1905) illustration shows this seta well developed in *P. mysis*. Sewell (1940) also describes this segment with one seta in *P. orientalis* (= *P. mysis*) and *P. sarsi*. We cannot locate his material. All the specimens of *P. mysis* that we have seen have a weak seta and thus while there may be some variability in this character it cannot be regarded as species specific.

Both Sewell (1940) for *P. sarsi* and Nicholls (1942) for *P. lata* (= *P. sarsi*) emphasize that the female genital somite is much broader than in *P. mysis* but actual measurements on Nicholls's material, the specimens of *P. mysis* that we have examined and measurements of available illustrations do not bear this out. All these measurements give a length to breadth ratio of 1:1, except for the illustration of *P. orientalis* (= *P. mysis*) by Sewell (1940) which is 1:0.75. Sewell draws attention also to the presence of "fine imbricated lines" on the genital somite and P.5 in *P. sarsi* without mentioning if they are present in *P. orientalis*. In fact it is obvious that both *P. mysis* and *P. harringtoni* possess these lines, which often are referred to in earlier literature as "finely squamous sculpture" (Sars, 1905, p.116).

If the relative size of the genital somite is not so obviously a distinguishing feature of *P. sarsi* as Sewell (1940) and Nicholls (1942) state then only the details of the setation of P.5 remains as the basis of species difference in *Phyllothalestris*. Willey's (1935) description and illustrations show that *P. harringtoni* is rather peculiar in this respect, a feature confirmed by Geddes (1969). *P. harringtoni* has only been recorded from Bermuda (Willey, 1935) and the Bahamas (Geddes, 1969). The differences between *P. mysis* and *P. sarsi* are less striking perhaps, but in *P. mysis* the second outer seta of the exopod is always in the form of a large spine. It is this feature that convinces us that the *P. sarsi* of Wells (1967) in reality is *P. mysis*. Accepting this as a valid distinguishing character nevertheless leaves the fact that variation in the form of other P.5 setae exists within both *P. mysis* and *P. sarsi*.

*P. sarsi* has only been recorded from the Maldiva and Nicobar Islands (Sewell, 1940), Gulf of Manaar (Krishnaswamy, 1957a), South Australia (Nicholls, 1941a) and Western Australia (Nicholls, 1942). *P. mysis* is virtually cosmopolitan, being found along the European coast from Norway to France, throughout the Mediterranean and Black Seas and in the Suez Canal. Elsewhere it has been recorded from Jamaica and the Canary Isles in the Atlantic Ocean, Mozambique and the Maldiva Islands in the Indian Ocean and from the Bay of Bengal, Sri Lanka and the Moluccas.

### 31. *Rhynchothalestris rufocincta* (Brady, 1880)

1880. *Thalestris rufocincta* G. S. Brady, *A Monograph of British Copepoda*, 2 : 125.

*Material examined* : IV, 1 ♀ 1 ♂ ; VII, 19 ♀ ♀ 7 ♂ ♂ 2 copepodids.

*Remarks* : In 1948 Lang synonymized *R. similis* A. Scott, 1909 with this species, a suggestion made independently by Sewell (1940). Later, Vervoort (1962) compared the males of the two forms and supported Lang's conclusion. According to Scott, *R. similis* differs from *R. rufocincta* in the relative proportions of the seventh and eighth segments of the female antennule and in the presence of only four (cf. five) setae on the basendopod of the female P.5, although this is apparent only from his illustration and is not mentioned in the text. Scott had no male specimens although Sewell (1940) points out that the male that Scott attributed to *R. rufocincta* is identical with that which was associated with the female that he (Sewell) found to be almost identical with Scott's *similis* female. Both Sewell (1940) and Vervoort (1962) compared their males with the description of the male of *rufocincta* by Sars (1905) and Sewell added Scott's male into the discussion. Their unified view is that the only real difference between *rufocincta* and *similis* males lies in the shape of the apical part of the terminal spine of the P.2 endopod, but we believe that this may be only a matter of the orientation of view.

The literature reveals that some variability exists in probably minor points within both *rufocincta* sens. lat. and *similis*. Such variability is only to be expected in such a widely distributed species; even the less common *similis* has been recorded in the large area between the Bay of Bengal and New Caledonia. Thus the only significant difference is in the number of setae on the female P.5 basendopod. Such variability is known to occur in many harpacticoids that are considered to be good species and even has been found to be an intrapopulation variant in a few species. It cannot be considered sufficient on its own for species differentiation.

Our specimens, of both sexes, show no difference from the description given by Sars (1905).

*R. rufocincta* is almost cosmopolitan in its distribution and often is a regular, even common member of the fauna. In the Atlantic Ocean it is known from Norway to the English Channel, from Nova Scotia to Bermuda, from Jamaica and from Madeira and the Canary Isles. It occurs throughout the Mediterranean Sea, but has not been recorded in the Black Sea. In the Indian Ocean it has been recorded in the Maldivé Archipelago and from Kerala, South India and from the Nicobar and Andaman Islands in the Bay of Bengal. Further east, it is known throughout the Indonesian Archipelago, from New Caledonia and from the Xisha Islands, China. To date it has not been reported from Africa (except in the Mediterranean Sea), South America, Australasia, Oceania and the entire western seaboard of America. It remains to be seen whether these gaps are real or simply reflect the small numbers of collections from these areas; we suspect the latter is more likely to be correct. It has not been recorded in the Arctic area nor from the Antarctic. These may well be real areas of absence.

### 32. *Diarthrodes cystoecus* Fahrenbach, 1954 (Figs. 43-45)

1954. *Diarthrodes cystoecus* W. H. Fahrenbach, *J. Wash. Acad. Sci.*, 44 ; 326.

*Material examined* : IV, 2 ♀ ♀ ; VII, 4 ♀ ♀ ; VIII, 3 ♀ ♀ ; IX, 6 ♀ ♀ 7 ♂ ♂

*Remarks* : Despite the supplementary description (Fahrenbach, 1962) this species is not completely described by its author but Pallares (1977) claims to have rediscovered the species and gives a good set of illustrations. She argues cogently that her specimens are conspecific with Fahrenbach's. The only other description which could refer to *D. cystoecus* is the *Pseudothalestris imbricata* female of Sewell (1940) which Lang (1965) rejects as being the previously unknown female of *D. imbricatus* (Brady, 1883) but states that "it may be identical with *cystoecus*" (Lang 1965, p. 182). Sewell's description reveals no essential differences between his material and that of Pallares, but it is not completely adequate. However, it may be reasonably assumed that *D. cystoecus* has now been recorded from California and Washington State, U.S.A. (Fahrenbach, 1954, 1962), Tierra del Fuego (Pallares, 1977) and the Maldive Islands (Sewell, 1940). In all probability the record from Madras by Krishnaswamy (1957a) also can be included as he determined his material by reference to Sewell's description.

In our collection there occurs a total of 15 females and 7 males which may be referable to *D. cystoecus* but, to a greater or lesser degree, they differ from the description of Pallares (1977) and there is a puzzling amount of variability among them that makes it difficult both to decide whether they are all conspecific and whether any are *D. cystoecus*. All the males are identical but four varieties of female are present.

#### **Description of features common to all specimens.**

*Female* (Fig. 43a) : Length 710-725  $\mu\text{m}$ . Body moderately pyriform. Cephalothorax large and deep, about as long as the free thorax. Rostrum (Fig. 43e) directed downwards, short and evenly rounded at the tip. Abdomen short and relatively broad. Genital suture complete lateral and dorsal. Genital field (Fig. 43b) with a prominent disc-shaped structure which is heavily chitinized and golden-brown in colour.

*Somitic ornamentation* : Cephalothorax and all succeeding segments except the last two with sensilla at the posterior edge; no further sensilla on the cephalothorax. Thoracic and abdominal segments with a deep plain hyaline frill. Last segment with spinules ventro-laterally at the posterior edge.

*Caudal ramus* much broader than long (Figs. 43b-c). Posterior edge spinulose. With one dorsal and one ventral seta. Five terminal setae, the outermost spiniform, with only two being well developed.

*Antennule* six-segmented (Fig. 43f). Third segment elongate, last segment short.

*Antenna* (Fig. 43h) : Pre-coxa and coxa distinct. Allobasis slender, with one seta. Second endopod segment elongate and with long terminal geniculate setae.

*Mandible* (Figs. 44a-b) : Pre-coxa large ; cutting edge with simple blunt teeth, a plumose spine and a pectinate lobe. Coxa-basis large and broad, with one terminal seta. Exopod with five, endopod with four setae.

*Maxillule* large (Fig. 44c). Pre-coxa with two claws and at least nine setae. Coxa with two stout setae. Basis with four long setae on the inner edge and one on the outer edge. Exopod and endopod small, with two setae each.

*Maxilla* (Fig. 43j) : Syncoxa with three endites. Basis a strong claw. No trace of an endopod.

*Maxilliped* prehensile (Fig. 44d). Coxa partially distinct. Basis with two setae and with some minute spinules. First endopod segment rather narrow, with a long seta on the inner edge. Inner edge liberally set with minute spinules. Second segment a claw, prehensile upon the first.

*P. 1* (Figs. 44e-f): Coxa broad, with long setules at the outer distal corner, a row of spinules near the inner distal corner, a row of spinules medially at the distal edge and with the inner distal quarter set with minute spinules. Basis with a spine at each of the distal corners, with some spinules above the origin. Distal edge above the origin of the endopod spinulose. Exopod two-segmented, reaching only to about one-third along the length of the first endopod segment. First segment without an inner seta ; outer and distal edges with long spinules. Endopod probably three-segmented, but the line of articulation between the second and third segments is difficult to see. First segment elongate. Outer edge with widely spread spinules. Inner edge with a seta whose origin is about one-third along the length of the segment. Third segment with two terminal claws. Two small setae arise about the point of separation of the second and third segments.

*P.2-P.4* (Figs. 44h, 45a-b) : Coxa short and broad, with small spinule rows. Basis short and broad, with a long outer seta. Inner distal corner an unguiform projection. Rami three-segmented, with the exopod longer than the endopod. All segments short and broad. Setation as below.

*P. 5* well developed (Fig. 45c). Basendopod broader than long. Inner expansion reaching almost to the end of the exopod, with five setae, the outermost rather short. Exopod only slightly longer than broad, with five setae. Inner seta very short, median seta short, remaining setae elongate.

#### *Setal formula*

	Exp.			Enp.		
P. 2	1.	1.	2.2.3.	1.	2.	2.2.1.
P. 3	1.	1.	3.2.3.	1.	2.	3.2.1.
P. 4	1.	1.	3.2.3.	1.	1.	2.2.1.

*Male* : Length 404-410  $\mu\text{m}$ . Body form as in the females. First two abdominal segments distinct. Caudal ramus as in the females.

*Somitic ornamentation* (Fig. 43d) : Cephalothorax and thorax as in the females. Abdominal segments with long spinules at the ventral and ventrolateral posterior edge of segments two to five.

*Antennule* haplocerate (Fig. 43g). Apparently it is of eight segments, with segments three and five very short.

*Antenna* : Pre-coxa, coxa, basis and endopod as in the females. Exopod two-segmented with five setae, as illustrated for the female varieties C and D (Fig. 43i).

*Mouthparts* as in the females.

*P. 1* of the same general form as is common to all the females. Spinule row at the outer proximal corner of the coxa is composed of small fine spinules (as in female varieties B and D). Inner spine of basis transformed (Fig. 43g) and the form of the spinules on the basis differs from any of the female varieties (Fig. 44g). Ratio between the length of the outer and inner claws on the third endopod segment is 1:3.

*P. 2-P. 4* : With the exception of the endopod of P.2 the general form is identical with that common to all the females. The spinule row at the outer proximal corner of P.2-P.3 is composed of small spinules (as in the female varieties B and D).

*P. 2 endopod* two-segmented (Fig. 45e). First segment as in the females. Second segment with two setae on the inner edge and a long plumose seta and a short stout plain seta terminally. Outer distal corner with a sickle-shaped (falciform) spine with three accessory spinules proximally. Outer edge with a finely pointed spiniform process.

*P. 5* (Fig. 45d) : The pair of P.5 are confluent. Inner expansion of basendopod with three stout setae. Exopod short, with five setae, the innermost short.

*P. 6* reduced to a pair of asetose lappets (Fig. 43d).

### **Description of variability among the females.**

*Variety A* (1 ♀ Stn. VII, 1 ♀ Stn. VIII).

1. Fourth abdominal segment with spinules mid-ventrally and ventrolaterally at the posterior edge (Fig. 43b).
2. Exopod of antenna distinctly three-segmented, the first with two setae, the second with one, the third with one terminal seta and one proximal lateral seta (Fig. 43h).
3. Second segment of the exopod of P.1 with six setae and spines, with a weak seta halfway along the inner edge (Fig. 44e).

4. Ratio between the length of the outer and inner claws of the third endopod segment of P.1 is 1:2 (Fig. 44e).
5. Spinule rows at the outer proximal corner of the coxa of P.1, P.2 and P.3 are composed of a small number of broad spinules (Fig. 44h).
6. Spinules above the origin of the endopod of P.1 are broad and short (Fig. 44e).

*Variety B* (1 ♀ Stn. IV).

- 1.-4. As in variety A.
5. Spinule row of a large number of minute spinules (Fig. 45a).
6. Spinules numerous, small and fine (as in Fig. 44f).

*Variety C* (3 ♀ ♀ Stn. VII, 2 ♀ ♀ Stn. VIII, 6 ♀ ♀ Stn. IX).

1. As in varieties A and B.
2. Exopod of antenna clearly only two-segmented, with the first two segments amalgamated. Disposition of the setae as in varieties A and B (Fig. 43i).
3. Second segment of the exopod of P.1 with only five setae and spines; lacks the seta on the inner edge (Fig. 44f).
4. Ratio of claws 1:3 (Fig. 44f).
- 5.-6. Spinule form as in variety A.

*Variety D* (1 ♀ Stn. IV).

1. Abdomen unornamented, except for the common characteristic of spinules on the fifth segment.
- 2.-4. As in variety C.
- 5.-6. As in variety B.

This information is summarized in Table 3, together with the state of these characters in the male.

*Remarks* : The descriptions of Fahrenbach (1954, 1962), Pallares (1977) and Sewell (1940) show some differences, notably in the female P.5 in the length of the outermost seta of the basendopod and of the innermost and median seta of the exopod, but all agree in the three-segmented exopod of the antenna, the six-setose condition of the

second exopod segment of P.1 and in the ratio of the claws of the endopod of P.1 (1:3). With respect to these agreed characters all of our specimens differ in at least one, but never in all three. Further, Pallares (1977, Lam. III, 14) shows a ventral spinule row on the third abdominal segment. Unfortunately she does not describe ornamentation in the text nor does she indicate the sex of the specimen illustrated, but the implication from a comparison with Fahrenbach (1962) is that it is a male. Our males have spinules also on the second segment, and thus differ. They also differ from those of Fahrenbach and Pallares in (a) the length of the outer seta of the basendopod of P.5 and (b) in the nature of the spinules on the basis of P.1; but they agree exactly in the endopod of P.2, which is generally considered reasonably species specific. The female P.1 illustrated by Fahrenbach (1962, Pl. 1, Fig. 16) and Pallares (1977, Lam. III, 15) is virtual identical to our variety A, except that the claw ratio is 1:3. Fahrenbach's females are stated to have the "posterior margins of the posterior 4 urosomal segments [i.e. the genital somite and all succeeding abdominal segments] ornamented ventrolaterally by rows of setules" (1962, p.309) and thus differ from all our females.

There can be no doubt that had our specimens been collected at geographically widely separated locations there would have been a strong case for considering that the females represent at least two species (or perhaps subspecies)—respectively A and B, C and D—but all come from the Middle and South Andamans. We believe that insufficient evidence exists to place them in separate species, and prefer to think that they belong to a single highly variable species. Their evident similarity to *D. cystoecus* leads us to place them in that species.

### 33. *Diarthrodes brevipes* n. sp.

(Figs. 46-47)

*Material examined* : IV, 2 ♀ ♀ ; VII, 8 ♀ ♀ ; VIII, 4 ♀ ♀

*Holotype*, VIII (C 2813/2) and *Paratypes* (C 2814/2) deposited with the Zoological Survey of India, Calcutta.

#### **Description**

*Female* (Fig. 46a) : Length 525  $\mu$ m. Body subpyriform in shape. Cephalothorax broad and deep, with a markedly hyaline edge. Thoracic segments large. Rostrum directed downwards. Abdomen relatively long. Genital suture complete dorsal and lateral. Genital field of the generic type but with the central disc rather pear-shaped and not very heavily chitinized; light golden brown in colour (Fig. 46b).

*Somatic ornamentation* (Fig. 46b) : Cephalothorax with scattered sensilla and with sensilla at the posterior edge. Thoracic and abdominal segments one to three also with posterior sensilla. Cephalothorax and all segments except the last with a deep hyaline frill. This is plain except on the genital somite and the third abdominal segment where it is finely denticulate (in the terminology of Moore, 1976b). Last three

abdominal segments with numerous scattered pores. Fourth abdominal segment with 10-12 broad sharp spinules mid-ventrally with minute spinules extending each side of the row to the ventrolateral position. Ventral, lateral and dorsolateral edge of the last segment with spinules. Body densely covered with punctae, but only on the fourth abdominal segment are these divided into blocks by striae, and then only on the dorsal and lateral parts of that segment.

*Caudal ramus* (Figs. 46b-c) much broader than long. Posterior edge spinulose ventro-laterally and with a spiniform projection mid-ventrally. One ventral and one dorsal seta, the latter articulated. Five terminal setae, of which two are well developed, two thin and weak and one spiniform.

*Antennule* of six short segments, the third segment not elongate (Fig. 46d).

*Antenna* short and stout (Fig. 46e). Neither the pre-coxa nor the coxa is distinct. Allobasis very broad, with one seta. Second endopod segment short and stout, all terminal setae short. Exopod distinctly three-segmented. First segment with two setae, second segment with one seta, third segment with one proximal lateral seta and two terminal setae.

*Mandible* (Fig. 46f) : Pre-coxa large; cutting edge simple. Coxa-basis large and broad, with two terminal setae. Endopod large, with five setae. Exopod with five setae.

*Maxillule* not clearly seen in the dissected specimens.

*Maxilla* (Fig. 46g) : Syncoxa with three endites. Basis a strong claw. No trace of an endopod.

*Maxilliped* prehensile (Fig. 46h). Coxa not distinct. Coxa-basis with two setae and a crescentic row of long spinules. First endopod segment with a seta and two rows of small spinules on the inner edge. Second segment a claw, as long as the first segment and prehensile upon it.

*P. 1* (Fig. 46i) : Coxa broad, with long setules at the distal corners. Distal edge spinulose. Basis with a spine at each corner with some spinules above the origin. Distal edge above the origin of the endopod with fine spinules. Exopod two-segmented, reaching to about halfway along the first endopod segment. First segment without an inner seta; outer and distal edges with long spinules. Second segment with six well developed setae and spines, the innermost originating at the extreme distal end of the inner edge. Endopod of three quite distinct segments. First segment short and broad, about 2.25 times as long as broad; inner seta originates about halfway along the segment. Second segment with two spines on the outer edge. Third segment with two claws and a short seta. Outer claw only slightly shorter than the inner claw.



*P.2-P.4* (Figs. 47a-c) : Coxa with a row of long spinules near the outer distal corner and with a row of small spinules just proximal to these. Basis with a slender outer seta, with spinules above its origin and with three or four spinules above the origin of the endopod. Inner distal corner an unguiform projection. Both rami three-segmented, the exopod longer than the endopod. Outer edge of segments spinulose. Outer distal corner of the first two exopod segments a large unguiform projection, particularly in *P.2*. Setation as below.

*P. 5* well developed (Fig. 46j). Basendopod broader than long. Inner expansion reaching almost to the end of the exopod, with five setae, of which the outermost is small and spiniform and only the middle seta is elongate. Exopod longer than broad, with five setae, middle seta the shortest.

*Male* unknown.

*Setal formula*

	Exp.			Enp.		
<i>P. 2</i>	1.	1.	2.2.3.	1.	2.	2.2.1.
<i>P. 3</i>	1.	1.	3.2.3.	1.	2.	3.2.1.
<i>P. 4</i>	1.	1.	3.2.3.	1.	2.	2.2.1.

*Etymology* : The trivial name reflects the short, stout nature of the endopod of *P.1* (*L. brevis*—short, and *pes*—a foot).

*Remarks* : This species appears to be unique in its particular combination of characters, although it must be stated that for many species the setation of *P.2-P.4* is not precisely known. Two inner setae on the middle segment of the endopod of *P.4* apparently occurs only in *D. major* (T. & A. Scott, 1895), *D. assimilis* (Sars, 1906) (according to the key to the genus given by Lang, 1965) and *D. lilacinus* Pallares, 1977. *D. major* and *D. lilacinus* both have an eight-segmented antennule and only five setae and spines on the second exopod segment of *P.1*. *D. major* has only one inner seta on the second endopod segment of *P.2* and *D. assimilis* has six setae on the exopod of *P.5*. In all three species the inner claw of the endopod of *P.1* is much longer than the outer claw.

**Dactylopodia** Lang, 1944

There exists some controversy over the validity of this genus name. Vervoort (1963) pleaded a case to the International Commission on Zoological Nomenclature for the suppression of *Dactylopodia* on the grounds that Lang (1944) was in error in replacing *Dactylopusia* Norman, 1903 by *Dactylopodia*. In 1964 Brinck commented adversely on Vervoort's proposal and, to date, no ruling has been made by the International Commission. Pending a decision we use *Dactylopodia* as this name is now in common usage.

34. **Dactylopodia tisboides** (Claus, 1863)  
(Fig. 47)

1863. *Dactylopus tisboides* C. Claus, *Die freilebenden Copepoden*, p. 127.

*Material examined* : IV, 3 ♀ ♀ ; VII, 7 ♀ ♀ ; VIII, 1 ♂ ; IX, 5 ♀ ♀

*Remarks* : This species is one of the few harpacticoids that definitely can be said to have a cosmopolitan distribution. It has been recorded from the littoral and sublittoral of all the oceans from the Arctic to Antarctic and at all latitudes. Moreover, it is a common member of the phytal and benthic fauna and often is abundant. Despite this its description is not quite complete. Although the original description is limited it is supplemented by the excellent general illustrations of Sars (1905), Pallares (1968a) and Vervoort (1964) and by details of ornamentation of the female by Lang (1965) but the somitic ornamentation of the male has not been described before.

Apparently the species is remarkably constant throughout its great range. The only source of real variation seems to be in the setation of the exopod of P.5. The condition usually reported in the literature is six setae in the female and five in the male. Gurney (1927b) recorded a male in which one exopod was normal while the other had six setae; he gives no illustrations. Lang (1965) recorded a female in which one exopod had seven marginal setae while the other had eight plus a curious, and clearly abnormal, accessory seta on the anterior surface. Only Pallares (1968a) gives what may be a further example. In the text of her paper she describes the male as having five setae but her illustration shows seven normal setae and spines. It is difficult to know how to interpret this.

One other source of variability quoted in the literature is the total length which, for the female for example, can be between 0.5 mm and 1.15 mm approximately, but in our experience this species is susceptible to extreme post-mortem contraction of the inter-segmental membranes. Since most authors neither state the base lines of their measurements nor comment on the state of contraction of their specimens this great range of variability probably is more apparent than real.

Finally, Sars (1905), Vervoort (1964) and Vilela (1965) have recorded the second endopod segment of the female P.2 with only one inner seta, which corresponds to the distal of the two setae reported by Lang (1965), Pallares (1968a) and Apostolov (1973). We believe that this is an error. Our specimens conform with the illustration given by Lang (1965, Fig. 116e) in which there are two setae, the proximal being long, thin, directed upwards and with an indistinctly marked origin on the posterior surface; thus there is no marginal notch on the segment. In some of our females this seta is absent but the point of origin still could be observed, though often this was difficult. We believe that Sars, Vervoort and Vilela failed to notice this in specimens in which this seta had become detached, which obviously happens quite easily.

Our specimens do show variation from six to seven setae on the exopod of the female P.5. The illustrations of the 'normal' exopod given by Lang (1965), Pallares

(1968a) and Vervoort (1964) all show a small step-like notch on the inner margin just proximal to the innermost seta, but without a seta. All other authors show this edge as smoothly convex. All our specimens have a notch and in two females this is the origin of a seta although in both cases only one of the pair of exopods actually have the seta. It is not as well developed as the 'extra' seta of the 'abnormal' female drawn by Lang (1965, Fig. 117c), which originates from a notch in the equivalent position. Even after careful observation we are not sure whether those of our specimens which lack this seta have lost it or never had it and, of course, we cannot comment on other authors material. At the very least however it indicates that a seven-setose condition is part of the normal range of variability

In ornamentation of P.1-P.4 our specimens, of both sexes, are identical with the females of Lang (1965), whose description is the most detailed available. In ornamentation of the female abdomen our specimens also are identical with Lang's, but only if he has misinterpreted the nature of the hyaline frill. He states in his description of the closely related *D. paratisboides* Lang, 1965 that the posterior ventral edge of the genital somite and of segments three and four has some spinules and is "set with delicate hairs" and his illustrations of *D. tisboides* are remarkably similar. We believe that the "delicate hairs" in fact are striae on the hyaline frill itself and that ornamentation proper is confined to the spinules ; this is the condition in our specimens. The arrangement of the spinules in our females is identical with Lang's but they are rather coarser in build.

The male is as described by Sars (1905) and Vervoort (1964). We add only a description of the abdominal ornamentation; the ventral side being as Fig. 47d with the dorsal and lateral sides unornamented except on segment five where the spinules extend laterally and dorso-laterally.

### 35. *Paradactylopodia brevicornis* (Claus, 1866)

(Fig. 47)

1866. *Dactylopus brevicornis* C. Claus *Schr. Ges. Beford. ges. Naturw. Marburg*, suppl. 1 : 29.

*Material examined* : IV, 1 ♀ ; VII, 18 ♀ ♀ 2 ♂ ♂ ; VIII, 4 ♀ ♀ 1 ♂ ; XIII, 2 ♀ ♀ .

*Remarks* : Lang (1948, p.555) has drawn attention to the great degree of variability among specimens assigned to this species. He accepts this as valid and as a consequence denies the existence of subspecies and absorbs *Dactylopusia fragilis* Monard, 1928 into the synonymy.

In the earlier literature the variability noted concerns only the shape and setation (five or six setae) of the exopod of the female P.5 and the number of inner setae on the middle endopod segment of P.2-P.4 (one or two setae). Several later authors also comment on these features but Pallares (1975a) reveals also that the exopod of the male P.5 may have five or seven setae and finds some differences from European specimens in the mandible and maxillule. The mouthparts probably received little

attention from earlier workers. Our specimens are more similar in this respect, and in the male P.5, to those illustrated by Sars (1905) than to those described by Pallares. The P.5 in our females seems to be different from any others illustrated in the literature, with the possible exception of *Dactylopusia fragilis*, in the shallow inner expansion of the basendopod (Fig. 47e).

This species clearly is closely related to *P. latipes* (Boeck, 1864). Indeed, Sars (1905, p.131) at first regarded Boeck's form as "unquestionably identical with Claus's species" Later (1911, p.370) he changed his opinion. As an indication of the similarity between the species we can refer to Sars's belief that the *Dactylopusia brevicornis* of T. Scott (1906a) "seems to be referable to the present species", i.e. to *latipes* (Sars, 1911, p.371). This opinion is not accepted by Lang (1948), although he does not directly discuss Sars's view. Sars distinguished between the species on two features. Firstly, that *latipes* is "of larger size and considerably more robust form of body" (Sars, 1911, p.371) and, secondly, that only in *latipes* is the inner apical seta of the caudal ramus dilated at its base. Size is not a good character to use and the difference in body shape does not appear to be that pronounced when all available illustrations are compared. At least one author, Pallares (1975a), has assigned specimens which have the dilated furcal seta to *brevicornis*. Possibly the crucial character in this debate is the endopod of the male P.2. Excellent illustrations of this are given by Sars (1905) and Pallares (1975a) for *brevicornis*, with which our specimens agree entirely. The only illustration of *latipes* that we can find is that of Lang (1936c) which, if correct, shows that *latipes* differs considerably from *brevicornis*. Some doubt is cast upon the accuracy of Lang's illustration by the unillustrated description given by de Vos (1945, p. 64) who states "P.2 inner ramus with a strong spine", which does not accord with Lang's illustration. This uncertainty means that the question of the validity of *P. brevicornis* as a species distinct from *P. latipes* remains unresolved.

### 36. *Eudactylopus robustus* (Claus, 1863)

(Fig. 48)

1863. *Thalestris robustus* C. Claus, *Die freilebenden Copepoden*, p. 129.

*Material examined* : IV, 1 ♀ ; VII, 1 ♀ ; VIII, 1 ♀

*Remarks* : As is pointed out by Itô (1974) one of the variable characters in this genus is the shape of the exopod of the female P.5. Several species have been described in which this is 'droplet-shaped'—basically a narrow, elongate triangle—and there are a variety of opinions as to their separate identity. The species are :—

*Eudactylopus robustus* (Claus, 1863) (= *Thalestris*)

*E. opima* (Brian, 1927a) (= *Plesiothalestris*)

*E. opima* (Brian) of Sewell, 1940

*E. striatus* Sewell, 1940

*E. fasciatus* Sewell, 1940

*E. australis* Nicholls, 1941a (the male is described by Nicholls, 1942)

*Plesiothalestris opima* was synonymized with *E. robustus* by Lang (1936b) but Sewell (1940) disagrees. Noodt (1955b) includes all of the species as synonyms of *E. robustus* but regards *E. fasciatus* as a distinct subspecies; this decision transgresses the 'rule' that subspecies cannot be sympatric (see, for example, Mayr, 1969, p.41) as both occur in Nankauri Harbour in the Nicobar Islands (Sewell, 1940). Lang (1965) apparently disagrees, at least with respect to *E. australis*, for he states his opposition to Kunz's (1963a) view that *australis* is a synonym of *robustus*. Lang (1965) also does not agree with Sewell (1940) that the latter's *E. opima* is the species described by Brian.

There is no doubt that the species are all very similar. The differences between them concern these features :—

- (a) Body shape, e.g. as between *E. robustus* and *E. australis*.
- (b) The degree to which the abdominal segments are subtended by the foliaceous P.5 in the female. Nicholls (1941a) uses this to distinguish between *E. australis* and *E. robustus*, and Lang (1965) agrees with him.

Regarding these features we restate the comments made several times elsewhere in this paper, namely that harpacticoids are susceptible to post-mortem contraction of the intersegmental membranes and that this can both alter the apparent shape of the body and the apparent relative length of its parts and also that the illustrations of early authors do not always inspire the highest degree of confidence in their accuracy. We believe that it is possible that the squat body of *E. robustus* as illustrated by Claus (1863) is due to it being maximally contracted while the elongate shape of *E. australis* as illustrated by Nicholls (1941a) reflects a fully extended specimen.

- (c) The segmentation of the antennal exopod, variously stated as one or two in these species. This point has been nicely refuted by Geddes (1969) who quotes Sewell's comment on his *E. opima* that "the line of demarcation between the two joints is not very clearly marked" (Sewell, 1940, p.207) and justifiably concludes that "the possibility of differing subjective interpretation is evident" (Geddes, 1969, p.14).
- (d) Abdominal ornamentation. This is a major factor in Lang's arguments. He is convinced that as a general rule the ornamentation of the cuticle is species specific in harpacticoids (Lang, 1965, p.7) and uses this conviction to refute Sewell's (1940) most positive statement that his *E. opima* females are identical with *E. opima* Brian, despite the fact that Sewell made a direct comparison with material sent to him by Brian. Lang seems to think that because Brian did not refer to ornamentation in *E. opima* it has none (Brian makes no statement on this feature, positive or negative), but it has been demonstrated many times recently that even some of the most obvious ornamentation patterns have been ignored, or perhaps simply not observed, by early workers. We are by no means convinced that Lang is correct in this particular case.

- (e) Differences in the setation of the exopod of the male P.5. There are six setae in *robustus*, *opima* and *australis* and five in the *opima* of Sewell, *striatus* and *fasciatus*. Differences also exist between the species in the relative lengths of these setae.
- (f) Difference in the relative proportions and the site of origin of the setae of the exopod of the female P.5 and slight differences in the shape of the rami of P.5. These characters of the P.5 may be valid differences but we consider that on their own they are not sufficient to preclude synonymy. Among harpacticoids many examples exist where such differences occur between local populations and even sometimes within populations.
- (g) The male P.2 endopod. It is unfortunate that in describing species of *Eudactylopus* insufficient attention has been paid to the endopod of the male P.2 (for example, Sewell, 1940 does not give an illustration of this ramus in *E. striatus* or in his *E. opima*) but there are some grounds for believing that the form is different between, at least, *E. opima* on the one hand and *E. fasciatus* and *E. australis* on the other.

In conclusion, we believe that Noodt (1955b) may well be correct and that all these species can be absorbed within *E. robustus*. The case cannot finally be decided until adequate redescriptions are available of *E. robustus* and *E. opima* from the Mediterranean Sea.

Our specimens agree well with the rather limited description of *E. opima* by Sewell (1940). The antennal exopod is a single segment with five setae, as he describes for his forma *minor*. They agree with the P.5 of *E. robustus* described by Geddes (1969). The abdominal segments are ornamented as described by Sewell for *E. opima* but also have the pattern of surface spinulation shown by Lang (1965) to exist in *E. latipes typica* (i.e. *E. atlanticus* Vervoort) (cf. Fig. 48a and Lang, 1965, Fig. 121e). This last point may indicate that in *Eudactylopus* somitic ornamentation may be species specific only in its finer details, and not in the gross pattern.

### 37. *Eudactylopus andrewi* Sewell, 1940

(Fig. 48)

1940. *Eudactylopus latipes* f. *andrewi* R.B.S. Sewell, *Scient. Rep. John Murray Exped.*, 7 : 202.

*Material examined* : IV, 1 ♀ 1 ♂ ; VII, 6 ♀ ♀ 3 ♂ ♂ ; VIII, 1 ♀ 1 ♂ ; XIII, 1 ♀

*Remarks* : The excellent description and discussion by Itô (1974) has brought to an end the debate about this species. Vervoort (1964) showed that *Dactylopus latipes* T. Scott, 1894 (= *Eudactylopus* after Lang, 1936b) is a junior primary homonym of *Dactylopus latipes* Boeck, 1864 (= *Paradactylopodia* after Lang, 1944) and also that *Eudactylopus andrewi* Sewell, 1940 is the earliest available name for Scott's species. Vervoort then proposed that the Indo-Pacific *andrewi* differed from the Atlantic race at the sub-species level and renamed the latter *E. a. atlanticus* n. ssp. An identical conclusion was reached independently by Lang (1965), but he did not formally propose subspecies. Itô (1974) demonstrated unequivocally that the

differences are greater than Vervoort and Lang had supposed and proposed that each rank as a full species—*E. andrewi* Sewell, 1940 and *E. atlanticus* Vervoort, 1964.

The species is known only from the Maldive Islands (Sewell, 1940), Sri Lanka (Thompson & A. Scott, 1903), Andaman Islands (this paper), Nicobar Islands (this paper, Sewell, 1940), Aru Islands (A. Scott, 1909), Caroline Islands (Vervoort, 1964), the Xisha Islands, China (Zhang & Li, 1976) and Japan (Kyushu—Tanaka & Jong, 1966, Hokkaido—It<sup>o</sup>, 1974).

Our specimens agree completely with It<sup>o</sup>'s description. This may mean that the relationship between *andrewi* and *atlanticus* is not as close as has been assumed since the abdominal segments of *E. andrewi* (Fig. 48b) lack the dense cover of broad spinules which give a scaly appearance to *E. atlanticus* (see Lang, 1965, Fig. 121e) while we have shown above (Fig. 48a) that such a scaly pattern occurs in our *E. robustus*, which is considerably different in the P.5.

#### **Neodactylopus Nicholls, 1945**

This genus is very similar to *Eudactylopus*, from which it may be distinguished on the much heavier build of the P.2-P.4 and by the fact that the endopod of P.1 is shorter than the exopod.

There is some controversy about the number of species contained in the genus. Originally Nicholls (1945a) assigned only his new species, *N. cyclopoides*, to it but in an addendum to the same paper he recognized that *Eudactylopus anomala* Sewell, 1940 was a congener. *N. cyclopoides* was described from a single female and *E. anomala* from a single male. Nicholls considered them to be distinct species but Por (1967) believes that he could have been mistaken. Although Por (1967) says that he found "many specimens of *Neodactylopus cyclopoides* Nicholls at Elat" he described only the female and we now know (F.D. Por, pers. comm.) that he found only this sex. Nevertheless Por states that "it also appears now that Sewell's male *E. anomala* is indeed the male of *N. cyclopoides*" Apparently he bases this conclusion on the fact that there are differences in the endopod of P.1 and the exopod of the antenna between his and Nicholls's females and thus that the slightly different form of these structures in Sewell's male no longer present a barrier to conspecificity. He could be correct but until more material of both sexes is available for study the question cannot be finally resolved.

#### **38. *Neodactylopus trichodes* n. sp.**

(Fig. 48-50)

*Material examined* : VII, 4 ♀ ♀ 2 ♂ ♂

*Holotype* female, VII (C 2815/2) and *Paratypes* (C 2816/2) deposited with the Zoological Survey of India, Calcutta.

## Description

*Female* : Length 1.10 mm. Anterior part of the body (cephalothorax and metasome) much broader and deeper than the urosome. Cephalothorax very deep. Epimera of cephalothorax and thoracic segments pronounced (Fig. 48c) leaving only a narrow 'channel' within which the P.1-P.4 can move. Rostrum (Fig. 48d) large, acute; with a sensillum each side well back from the apex. First three abdominal segments with pronounced unguiform projections of the distal dorsolateral corners (Figs. 49a-c). Genital somite with suture present lateral only and with the ventral side markedly concave. Ventral side of the third abdominal segment convex; together with the genital somite this ventral side forms the floor of a brood chamber which is roofed over by a dome formed from the pair of foliaceous P.5. Details of the genital field not clearly seen but apparently without complex internal structure. P.6 rudiment with three setae. Two ovisacs may be present within the brood chamber, each with 10-12 eggs. Anal operculum very small and unarmed. Caudal ramus (Figs. 49a-c) slightly longer than broad. The two well developed terminal setae are not plumose. In addition there are three sub-terminal setae and a spine.

*Somitic ornamentation* (Figs. 49a-c, f) : Entire body covered with broad hyaline spinules (as in Fig. 49f). On the first three abdominal segments these become very small in the region of the dorso-lateral projections. Abdominal segments with a plain hyaline frill ventral and lateral only. Ventral distal edge of the genital somite and third and fourth abdominal segments with long fine setae. Distal edge of the last segment with short blunt spinules.

*Antennule* nine-segmented, the last five segments small (Fig. 48e).

*Antenna* elongate; with allobasis with one seta. Exopod of one long segment with three lateral and two terminal setae. Proximal seta very small (Fig. 48f).

*Mandible* (Fig. 48g) : Pre-coxa relatively small. Cutting edge without teeth but with a broad pectinate spine and a pectinate rounded lobe. Palp of one segment in which the individual segments cannot be distinguished; with nine setae.

*Maxillule* : A clear preparation of the maxillule was not obtained but it is apparent that in general form it is similar to the illustrations of Nicholls (1945a) and Por (1967) of *N. cyclooides*.

*Maxilla* short and broad (Fig. 48h). Syncoxa with three endites, the proximal one facing forwards and fused to the segment. Basis consists of a large claw and three setae, one of which may represent the endopod.

*Maxilliped* prehensile (Fig. 48i). Coxa not distinguishable. Basis with two distal plumose setae and with setules distally and proximally. First endopod segment with a hirsute inner edge and with setules and spinules along the outer edge. Second segment a strong claw, with an accessory seta, and prehensile upon the first segment.



*P.1* rather slender (Fig. 49g). Precoxa-coxal suture clearly visible. Coxa and basis elongate. Coxa with setules at outer distal corner. Basis with an inner and an outer seta; the inner seta transposed to the posterior surface. Exopod elongate, three-segmented. Second segment elongate. Third segment with four setae and spines; the apical setae very long. Endopod two-segmented, not reaching to the end of the second exopod segment. Inner seta of first segment proximal in origin. Second segment with a long claw, a spine and a very thin seta.

*P.2-P.4* (Figs. 50a-c) of extremely robust build and heavily chitinized. Coxa with a crescent-shaped row of spinules near the outer distal corner and a patch of minute spinules near the inner distal corner. Basis with an outer seta which is long and thin in *P.3-P.4* but quite stout in *P.2*. Inner distal corner expanded as a rounded hyaline lamella. Both rami three-segmented with the segments short and broad (particularly in *P.2-P.3*) and heavily chitinized. All setae finely plumose; all spines short and thick. Setation as below.

*P.5* (Figs. 48c, 50d) : The pair of *P.5* form the dome of a large brood chamber which extends to the distal end of the third abdominal segment (Fig. 48c). The major component is the inner expansion of the basendopod. The more slender exopod lies partially beneath this. Both components are convex in antero-posterior and lateral axes and have a fringe of long fine hairs. Basendopod with four terminal setae, exopod with six setae situated on the outer edge. None of these setae are of the "pin-head" type reported by Nicholls (1945a) and Por (1967) for *N. cyclopoidea*.

#### *Setal formula*

		Exp.			Enp.		
<i>P. 1</i>	0.	1.	0.2.2.	1.	3.		
<i>P. 2</i> ♀	1.	1.	2.2.3.	1.	2.	2.2.1.	
<i>P. 2</i> ♂	1.	1.	2.2.3.	1.	2.	2.2.0.	
<i>P. 3</i>	1.	1.	3.2.3.	1.	2.	3.2.1.	
<i>P. 4</i>	1.	1.	3.2.3.	1.	1.	2.2.1.	

*Male* : Length 0.90 mm. Differs from the female in the following respects. First two abdominal segments distinct. Surface ornamentation of small spinules as in the female but the second and third abdominal segments have stout spinules on the ventral and ventrolateral distal edge (Fig. 49d-e).

*Antennule* haplocerate, with eight segments (Fig. 50e).

*P.2* (Fig. 50f) : Coxa and exopod as female. Hyaline lamella of inner distal corner of basis with a jagged, not rounded, edge. Endopod of three segments but with only a partial demarcation between the second and third. Third segment with four setae and spines. Innermost seta normal, the remaining three modified with the second outermost fused to the segment.

*P.5* (Fig. 49h) : The pair of *P.5* confluent, with the basendopod firmly fused to the segment without a line of demarcation. Inner expansion of basendopod reduced; with two setae terminally and a very reduced seta on the inner side. Exopod small, with five setae. Two of these are extremely reduced.

*P.6* (Fig. 48e) of each side a lamella fused to the segment and with three setae.

*Etymology* : The trivial name refers to the profusion of fine hairs on the second and third female abdominal segments (Gk. *trichodes*—hairy).

*Remarks* : Although these specimens clearly belong to *Neodactylopus* it is not at all obvious that they are conspecific with *N. cyclooides* or *N. anomala*. The material of Nicholls (1945a) and Sewell (1940) cannot be traced but we have examined that of Por (1967). In non-sexually dimorphic characters our specimens differ in the following respects.

1. Antennal exopod, clearly a single segment, has three lateral and two terminal setae which is the same as *N. anomala* but different from *N. cyclooides*, which has only two lateral setae.
2. Mandible palp has nine setae, compared to eight in *N. cyclooides* and seven in *N. anomala*.
3. The first endopod segment of *P.1* is slender (as in *N. cyclooides* by Por). The origin of the inner seta is more proximal than in *N. cyclooides* and more distal than in *N. anomala*.
4. The inner distal corner of the basis of *P.3-P.4* is an evenly rounded hyaline membrane, compared to the unguiform projection illustrated by Nicholls and Sewell. In Por's female the unguiform projection is relatively heavily chitinized.

In female characters our specimens differ from that of Por and the description given by Nicholls in these respects.

1. Antennule is nine-segmented (cf. eight).
2. *P.5* lacks pin-head setae and the distribution of the exopod setae differs. The basendopod lacks the innermost seta described by Por. Nicholls shows only two setae on this ramus but we suspect that the two innermost setae were lost in his specimen.

In male characters our specimens differ from the description of *N. anomala* in the following respects.

1. The endopod of P.2 is quite different. In *N. anomala* it is clearly two-segmented. The second segment bears two normal setae on its inner edge, whereas in segments two and three of our males there is a total of three such setae. The modified terminal setae are much shorter and stouter in our males.
2. The setation of the exopod of P.5 is quite different, although the number of setae is the same.

Given these differences our specimens must be described as a new species irrespective of the true relationship between *N. cyclooides* and *N. anomala*.

**39. *Idomene maldivae* (Sewell, 1940)**  
(Figs. 51-52)

1940. *Xouthous maldivae* R.B.S. Sewell, *Scient. Rep. John. Murray Exped.*, 7 : 198.

*Material examined* : VII, 2 ♀ ♀

*Description of the female* : Length 550  $\mu\text{m}$ . Our preserved specimens were a light translucent yellow with the first three free thoracic segments dark brown. Body extremely flattened dorso-ventrally (Fig. 51a). Cephalothorax rounded in front; rostrum absent. Abdomen tapering from the bulbous genital somite. Genital somite with suture incomplete dorsally. Genital field simple but strongly chitinized (Fig. 51i). Caudal ramus about as long as broad; terminal setae rather short (Fig. 51d-e).

*Somitic ornamentation* : Entire body densely punctate (see Figs. 51b-c, f). Cephalothorax with numerous sensilla. Free thoracic segments with a wide striated hyaline frill (Fig. 51f). First three free thoracic segments respectively with 3, 3 and 2 spines on the epimera (Fig. 51f). Abdominal segments (except the last) with the hyaline frill minutely denticulate ventrally and plain dorsally. Dorsal frill of the fourth segment forms an irregularly divided pseudoperculum (Fig. 51c). Genital somite and third abdominal segment with spinules lateral and ventrolateral, and with long fine hairs dorsally and ventrally just above the hyaline frill (Figs. 51b-c). Fourth segment with long fine hairs dorsally only and with spinules ventrolaterally only (Figs. 51b-c). Last segment with long fine hairs dorsally and with a few spinules ventrally (Figs. 51b-c).

*Antennule* short, six segmented (Fig. 51g).

*Antenna* (Fig. 51h) : Coxa visible. Allobasis with one seta. Exopod of two segments, with two and four setae respectively.

*Mandible* (Fig. 51i) : Pre-coxa elongate, with a simple dentate cutting edge. Coxa-basis short, with four setae and a row of spinules. Exopod with two inner laminate setae and four terminal setae. Endopod with a total of nine setae.

*Maxillule* (Fig. 51j) : Pre-coxal arthrite with four surface setae and at least seven terminal claws. Coxa-basis with four setae each. Exopod large, with four plumose setae, the outer two elongate. Endopod small, with three setae.

*Maxilla* (Fig. 51k) : Syncoxa with three endites. Basis a stout claw with one accessory seta. Endopod of two minute segments.

*Maxilliped* prehensile (Fig. 51l). Basis with copious spinules and one stout seta. First endopod segment with a hirsute inner edge and one seta. Second endopod segment a stout claw prehensile upon the first segment and with an accessory seta.

*P.1* (Fig. 52a) : Coxa with a row of minute setules near outer edge. Basis short, with spinules near the inner distal corner and along the distal edge. Outer seta massive, inner seta very small. Exopod of three segments. First endopod segment elongate and broad, extending beyond the end of the entire exopod. Inner edge with one seta in proximal half; outer edge with a double row of short spinules. Second segment with two setae and two terminal claws.

*P.2-P.4* (Figs. 52b-d) : Coxa with spinules at outer distal corner. Basis short, with an outer seta that is well developed in P.2 but thin and weak in P.3-P.4. Median part of distal edge expanded as a hyaline plate that lies between the rami in P.4 but partially beneath the endopod in P.2-P.3. Rami three-segmented, setation as below. Outer edge of all segments copiously spinulose. All outer spines heavily spinulose; all setae densely plumose.

*P.5* massive (Fig. 51e). Inner expansion of basendopod reaches to less than halfway along the exopod and has a basal row of stout spinules and some rows of minute spinules along the inner edge. Terminal setae very broad and flat. Seta of the outer expansion lies partially beneath the exopod. Exopod longer than broad and with six setae.

*Setal formula*

	Exp.	Enp.
P. 1	0. 1. 5.	1. 4.
P. 2	1. 1. 2.2.3.	1. 2. 2.2.1.
P. 3	1. 1. 3.2.3.	1. 1. 3.2.1.
P. 4	1. 1. 3.2.3.	1. 1. 2.2.1.

*Remarks* : This species was described by Sewell (1940) on the basis of a single female. We have been unable to trace this specimen and must presume it to be lost. Our two females, therefore, can only be compared with the published description, which is by no means complete. However, the P.5 is utterly distinctive and there is no doubt that our females are conspecific with Sewell's despite the presence of an additional (sixth) seta on the exopod in our specimens, whose discovery enables the description to be completed.

It is now certain that the presence of spines on the thoracic epimera is not unique to *I. simulans* (Brady, 1910), as was the case when Lang (1948) compiled his monograph. Such spines have now been recorded in *I. parasimulans* Medioni & Soyer, 1967 and *I. cookensi* Pallares, 1975b and for *I. laticaudata* (Thompson & A. Scott, 1903) by Wells (1967), *I. pectinata* (T. & A. Scott, 1898) by Kunz (1963b) and in the male of *I. purpurocineta* (Norman & T. Scott, 1905) by Lang (1965). Definite statements that they are absent are made only by Pallares (1968a) for *I. scotti* Lang, 1948 and by Vervoort (1964) for the female of *I. purpurocineta*.

*I. maldivae* has now been recorded from the Maldive Islands (Sewell, 1940), the Gulf of Manaar (Ummerkutty, 1966) and the Andaman Islands (this paper).

#### Family PARASTENHELIIDAE

##### **Parastenhelia** Thompson & A. Scott, 1903

Although it has been criticised by Sewell (1940) and Vervoort (1964) the revision of *Parastenhelia* by Lang (1934, 1944, 1948) in our opinion is still the best approach to the complex taxonomy of the genus. Lang grouped together in the species *P. spinosa* (Fischer, 1860) all the various forms in which the middle segment of the exopod of P.1 is at least four times as long as broad, with the exception of *P. gracilis* Brady, 1910. He maintained the identity of *P. gracilis* mainly on the difference in the site of origin of the inner seta of the first endopod segment of P.1 and the shape of the P.5. In other species the middle exopod segment of P.1 is only twice as long as broad at most.

*P. spinosa* as revised by Lang is one of the most variable species of harpacticoids, but no clear distinctions can be made between the various forms that he includes. Thus, although it may eventually be possible to divide the species into subspecies or geographic races enough data is not yet available (Vervoort, 1964). Lang's concept is preferable to the maintenance of a large number of ill-defined and over-lapping forms, the solution that is preferred by Sewell (1940).

Vervoort (1964) accepts Lang's concept of *P. spinosa* but believes that both *P. hornelli* Thompson & A. Scott, 1903 and *P. ornatissima* Monard, 1935a may also prove to be within the range of this species. However, we do not believe that the current data confirms this view and in this paper we follow Lang's revision.

Two species, *P. reducta* Apostolov, 1975 and *P. megarostrum* Wells, Hicks and Coull, 1982, have been added since Lang's last publication on the genus (Lang, 1948). There seems little doubt that *P. reducta* is similar to *P. ornatissima*, differing mainly in a reduced setation of P.2-P.4, and may eventually prove to be synonymous; *P. ornatissima* is not well described. *P. megarostrum* is most similar to *P. hornelli*.

We add a further new species, *P. oligochaeta*, in this paper.

40. *Parastenhelia spinosa* (Fischer, 1860)

1860. *Harpacticus spinosus* S. Fischer, *Ahb. Bayer. Akad. Wiss., Abt. 3*, 8 : 665

*Material examined* : II, 1 ♀ ; IX, 1 ♀ 1 ♂

*Remarks* : These three specimens seem to be most similar to forma *scotti* Sewell (1940), with eight segments in the female antennule, non-pectinate spines on the endopod of the antenna and relatively short exopod of P.1. The exopod of the male P.5 consists of three segments with six setae.

41. *Parastenhelia hornelli* Thompson & A. Scott, 1903  
(Figs. 52-55)

1903. *Parastenhelia hornelli*, I.C. Thompson & A. Scott, *Rep. Govt. Ceylon Pearl Oyster Fish. Gulf Manaar*, 1 : 263

*Material examined* : IV, 48 ♀ ♀ 17 ♂ ♂ ; V, 1 ♀ ; VII, 15 ♀ ♀ 9 ♂ ♂ ;  
VIII, 3 ♀ ♀ 2 ♂ ♂

Lang (1934) synonymized the two species *P. hornelli* and *P. similis* Thompson & A. Scott 1903 despite differences in the proportions of the antennule and shape of the exopod of P.5 of the female. The original descriptions are good, though incomplete ; the setation of P.2-P.3 is not given and the endopod of the male P.3 is entirely ignored. Later descriptions of specimens assigned to *P. hornelli* differ somewhat from the original and pose problems of identity. One may be dismissed immediately. Krishnaswamy (1957a) describes forma *krusadensis* nov. which differs so radically in the P. 1 and antenna that it cannot belong to *Parastenhelia*. The description is so bad that its true identity is impossible to determine.

An unillustrated short redescription is given by Noodt (1955b) of two females from the Sea of Marmara. He gives the full setation of P.2-P.4, noting that the inner seta on the third exopod segment of P.2 may be present or absent. This setation is compatible with that of the P.4 given by Thompson & A. Scott (1903) but Noodt reports that the antennal exopod is three-segmented. He states that the first segment has one seta but does not state how many setae are present on the second and third segments. As to the P.5, Noodt states that in form and setation it corresponds exactly to the illustrations of Thompson & A. Scott, but the shape of the exopod is different between *P. hornelli* and its synonym *P. similis* and thus it is not clear what the P.5 of Noodt's female is like.

Apostolov (1973) records both sexes from the coast of Bulgaria. He gives no description, other than stating that the male corresponds perfectly with the original description. He gives a set of illustrations from which it is apparent both that his statement on the male is not strictly accurate and that there are some differences from the original descriptions of the female. For the male he provides an illustration of the endopod of P.3, previously unknown, and the endopod of P.2 which is similar, if not identical, with that illustrated by Thompson & A. Scott. The P.5, however, differs significantly. It is only one-segmented and the setae all are very short. In the female

the exopod of P.5 is as described by Thompson & A. Scott for *P. hornelli* and the setation of P.2-P.4 is compatible with the original description of the P.4 and differs from that of Noodt (1955b) only in the absence of an inner seta on the first endopod segment of P.2. The major difference from the original descriptions lies, like Noodt's (1955b) females, in the three-segmented antennal exopod with its setation of 1.0.4. instead of two-segmented with setation of 2.3. It is probable that Noodt and Apostolov are describing the same species but perhaps a little doubtful that this is *P. hornelli*.

Two other specimens must be considered here. Vervoort (1964) describes a male and a female which he assigns to *P. spinosa* while recognizing that they "approach *P. hornelli* in several respects" In both the antennal exopod is identical with the original description and the P.1 is also of the form usual in *P. hornelli*, though this is not unique to this species. The female P.5 is not clearly described but the implication is that it is of the form described for *P. similis*. The setation of the female P.3-P.4 is rather different in lacking an inner seta on the first exopod segment of P.3-P.4 and in having three inner setae on the third segment while that of the male differs yet again (see Table 4). The male also appears to be unique in the genus in having a two-segmented exopod of P.5.

It is difficult to assess Vervoort's specimens, but as will be seen from the description that follows of our specimens the setation of P.2-P.4 may imply only that some variability exists (as it does in *P. spinosa*) and also that other authors may not have noticed the extremely reduced third seta on the distal exopod segments. Obviously the problem cannot be resolved at this moment but we believe that the best available interim measure is to place all these specimens, i.e. those of Noodt (1955b), Apostolov (1973) and Vervoort (1964) in *P. hornelli*.

We have also been able to examine two specimens of each sex from Mozambique (Wells, 1967) and New Zealand (Wells, Hicks & Coull, 1982). These all agree with the present material from the Andaman Islands in all important respects except for some slight difference in the female genital field.

*P. hornelli* (and *P. similis*) was first discovered on the pearl oyster grounds of Sri Lanka (Thompson & A. Scott, 1903). Subsequent records have extended its distribution eastwards to the Caroline Islands (Vervoort, 1964) and New Zealand (Wells, Hicks & Coull, 1982) and westwards into the Indian Ocean (Mozambique, Wells, 1967), the Black Sea region (Bulgaria, Apostolov, 1973 ; Sea of Marmara, Noodt, 1955b) and the Caribbean Sea (Barbados, Coull, 1970a ; Virgin Isles, Coull, 1971a, Hartzband & Hummon, 1974). Coull (1970a, 1971a) and Hartzband & Hummon (1974) give no descriptive details of their specimens.

### **Description of Andaman Islands material**

*Female* : Length : Two distinct sizes of females were present ; a small form about 630  $\mu\text{m}$  and a large form about 885  $\mu\text{m}$ . Body linear, about six times as long as broad.

Rostrum articulated with the cephalothorax, long and pointed apically, with a sub-apical sensillum. Genital somite with suture as a complete ring. Genital field simple. P.6 represented by a lappet with two setae. Anal operculum simple and naked (Fig. 53a).

*Somitic ornamentation* : Cephalothorax and all segments except the last with a deep hyaline frill with sensilla. The frill is digitate to about half its depth and each division has a finely denticulate edge (Fig. 53c). Extending the terminology of Moore (1976b), this type of frill may be called semi-incised denticulodigitate. Cephalothorax and thoracic segments not otherwise ornamented. Abdominal segments (Figs. 53a-b) with fine transverse striae, some naked and some with minute setules, and with small blind-ending pits in the chitin. Posterior edge of all segments spinulose, the type and distribution being variable between segments. Last segment without a hyaline frill. Hyaline frill of penultimate segment does not form a pseudoperculum.

*Caudal ramus* much broader than long (Figs. 53a-b). Inner terminal seta irregularly shaped at its base.

*Antennule* elongate, nine-segmented, with an aesthete on the fourth segment (Fig. 52e).

*Antenna* with a partially divided allobasis (Fig. 53d). Terminal geniculate setae of the endopod rather short. Exopod elongate, slender and two-segmented. First segment with two, second segment with four setae.

*Mandible* (Figs. 53e-f) : Pre-coxa robust ; cutting edge of massive, but simple, teeth. Coxa-basis with four setae. Endopod and exopod each of one segment with five and three setae respectively.

*Maxillule* (Fig. 53g) : Pre-coxal arthrite with eight (or nine ?) claws. Coxa and basis each with five setae. Endopod and exopod reduced and with two setae each.

*Maxilla* (Fig. 53h) : Syncoxa with three endites. Basis with a claw and three setae. Endopod reduced to one small segment with two setae.

*Maxilliped* prehensile (Fig. 53i) : Basis with two setae and some surface spinules. First endopod segment with a seta halfway along the inner edge, which bears a row of setules on each side of the mid-line and a further row towards the outer edge. Second segment largely transformed into a claw, prehensile upon the first segment, with a small seta at its base.

*P.1* (Fig. 53j) : Coxa with several rows of setules, including one at the line of demarcation from the pre-coxa. Basis short, with coarse spinules on the distal margin and with an inner and an outer spine. Exopod three-segmented, all segments



sub-equal, and extending only three-quarters of the length of the first endopod segment. Inner seta of the second segment weak. Endopod of two segments, the first elongate, the second small. Inner seta of the first segment originates in the proximal half of the segment. Terminal claws of the second segment elongate.

*P.2-P.4* (Figs. 54a-c): Coxa with setules near the outer distal corner and at the line of demarcation from the pre-coxa only. Basis short, without an inner seta. Distal edge with coarse spinules at outer distal corner and fine setules medially. Outer distal corner with a spine (P.2) or a thin seta (P.3-P.4). Both rami three-segmented, setation as below. Outer edge of all segments heavily spinulose. Exopod always much larger than endopod. Distal inner seta of the third exopod segment of P.3-P.4 short and very thin and weak.

*P.5* (Fig. 54d): Basendopod with a well developed inner expansion, with five setae. Exopod elongate, inner side straight ; with six setae.

#### *Setal formula*

	Exp.			Enp.		
P. 1	0.	1.	0.2.2.	1.	3.	
P. 2	1.	1.	1.2.3.	1.	1.	1.2.1.
P. 3	1.	1.	3.2.3.	1.	1.	2.2.1.
P. 4	1.	1.	3.2.3.	1.	1.	2.2.1.

*Male* : Differs from the female in the following respects. Length : All males were about 650  $\mu\text{m}$ . First two abdominal segments distinct.

*Somitic ornamentation* similar to the female but with a different arrangement of spinules (Figs. 55a-b).

*Antennule* haplocerate.

*P.2* (Fig. 55c) : Coxa, basis and exopod as in the female. Endopod two-segmented. Proportions of the first segment as in the female, but the inner seta is very reduced. Second segment obviously derived by amalgamation (or incomplete separation ?) of the two distal segments. This is shown by the similar setation to the female and an incipient articulation area.

*P.3* (Fig. 55d) : Coxa, basis and exopod as in the female except for the spination of the outer edge of the second segment of the exopod. Endopod of three segments. First segment as in the female. Second segment with an unguiform projection of the outer distal corner and an expanded anterior distal edge. Third segment with two terminal setae and with the outer distal corner a curved unguiform projection.

*P.5* (Fig. 54e) : The pair of *P.5* are confluent. Inner expansion of the basendopod with two setae. Exopod three-segmented with six setae. Inner side of second segment without a seta, but with a long spinule.

*Remarks* : Our specimens undoubtedly differ from the descriptions of Thompson & A. Scott (1903) in a number of features. Some of these may be real, e.g. the absence of an inner seta on the second exopod segment of the male *P.5*, but we believe that most may be due to a lack of precision in the original descriptions. A redescription of specimens from the type-locality is necessary to stabilise the knowledge of this species.

42. ***Parastenhelia oligochaeta*** n. sp.  
(Figs. 55-58)

*Material examined* : II, 3 ♀ ♀ ; X, 1 ♀ ; XII, 5 ♀ ♀ 3 ♂ ♂ ; XIV, 1 ♀ ; XV,  
14 ♀ ♀ 8 ♂ ♂

*Holotype* female, XV (C 2817/2) and *Paratypes* (C 2818/2) deposited with the Zoological Survey of India, Calcutta.

### Description

*Female* : Length 475  $\mu$ m. Body linear, about six times as long as broad (Figs. 55e-f). The long rostrum is defined at the base. Genital suture represented by a dorso-lateral strip of chitin. Genital field simple. *P.6* represented by a distinct lappet each side, with two setae (Fig. 56c).

*Somitic ornamentation* (Figs. 55e-f ; 56a-c) : All somites except the last segment have a deep hyaline frill incised to form lappets which have an entire distal border. They are not uniform in width and those of the cephalothorax are bifid or trifid. There are numerous sensilla at the posterior edge of the cephalothorax and thoracic segments, with a smaller number on the anterior abdominal segments. Last two abdominal segments without sensilla. One sensillum above each of the chitin strips of the genital suture. Cephalothorax also with dorsal sensilla. Posterior edge of the third abdominal segment with ventrolateral hairs and an incomplete row of small spinules ventrally. Posterior edge of last segment with large spinules ventrally and dorsolaterally. Dorsally with fine setules and a sensillum on each side of the hirsute anal operculum.

*Caudal ramus* much broader than long (Fig. 56d). Terminally with two well developed setae, a weak inner seta and a weak seta ventrally. Inner distal corner with strong spinules ventral and lateral. Two small setae near the outer distal corner on the ventral side.

*Antennule* (Fig. 56e) nine-segmented, the aesthete on the fourth segment. Most of the setae very long.

*Antenna* with defined coxa and basis (Fig. 56f). Basis with two small setules. First endopod segment with an inner seta. Second segment with two inner spines and terminally with two geniculate spines, two geniculate setae and two smaller setae. Exopod of two segments, the first with two setae, the proximal one weak. Second segment with two inner and two terminal setae.

*Mandible* (Fig. 56g) : Coxa large ; cutting edge with large simple teeth. Basis elongate, with two setae only. Endopod with two inner and four terminal setae. Exopod represented by a minute knob and one seta.

*Maxillule* (Fig. 56h) : Pre-coxa with a small spinule row. Pre-coxal arthrite with three terminal claws and a seta and with a pre-terminal lobe with two setae. Two long setae on outer edge. Coxa and basis confluent but each is produced apically, the coxa with four setae, the basis with three setae. Endopod of one small segment with two setae. Exopod represented by one long and one short seta. Basis with a row of long setules near the exopod and a long seta proximal to this row.

*Maxilla* (Fig. 55g) : Syncoxa with setules at the distal edge and with three endites. Basis with a terminal claw and two setae. Endopod of two distinct segments, the second with a pair of setae confluent at their base.

*Maxilliped* well developed, prehensile (Fig. 55h). Coxa and basis confluent but with a partial separation on the outer side. Basis with three setae at the inner distal corner. First endopod segment with a seta on the inner edge and a row of long spinules. Second segment a claw.

*P.1* (Fig. 57a) : Coxa with a short row of spinules on the posterior face near the outer proximal and distal corners and on the anterior face near the inner distal corner. Outer distal corner with fine hairs. Basis with a large spine at both outer and inner distal corners, each with some spinules above their insertion. Posterior edge spinulose above the insertion of both rami. Exopod of three segments of equal length. Outer edge of first two segments spinulose. Second segment with a very weak inner seta. Third segment with two terminal setae, the outer geniculate, and two outer spines. Endopod two-segmented, prehensile. First segment elongate, reaching well beyond the end of the entire exopod, about seven and a half times as long as the maximum breadth and about seven times as long as the small second segment ; with a plumose seta in the proximal part of the inner edge. Second segment with two terminal claws and a seta.

*P.2-P.4* (Figs. 57b-d) : Coxa with a spinule row on both anterior and posterior faces near the outer distal corner, which itself bears a few spinules. Basis with some long setules near the inner proximal corner and strong spinules above the insertion of the exopod, outer seta very weak. Both rami of three segments, the outer edge of each being spinulose. Exopods longer than endopods. Setation as below but attention is drawn to :—

- (a) The presence of a small setule at the inner distal corner of the first two exopod segments. That this is a true setule and not a very reduced seta is shown by the absence of a break in the segment edge and the fact that a true, but weak, seta just proximal to the setule exists on the second segment of P.2-P.4 and the first segment of P.4.
- (b) The inner setae of the first two exopod segments (where present) and the distal inner seta of the third exopod segment of P.3-P.4 are very small and weak and could easily be overlooked.

*P.5* very large, the exopod reaching as far as the end of the genital somite (Figs. 55f ; 58a). Inner expansion of basendopod well developed but barely reaching the middle of the exopod ; with four well developed plumose setae and a minute seta. The inner edge has a distinct "notch" distally which in all our specimens does not bear a seta or setule but is the site of a pore ; a similar condition is seen in *P. hornelli* (Fig. 54d). Outer lobe of basendopod weakly developed. Exopod elongate. Inner edge concave and very thin, almost membranous, and with long setules. Six setae altogether. The inner proximal corner is produced as a knob.

*Setal formula* (see also comments under P.2-P.4 above) :

	Exp.			Enp.		
P. 2	0.	1.	1.2.3.	0.	1.	0.2.1.
P. 3	0.	1.	3.2.3.	0.	1.	0.2.1.
P. 4	1.	1.	3.2.3.	0.	1.	0.2.1.

*Male* : Length 420  $\mu$ m. Differs from the female in the following characters.

*Abdomen* (Fig. 57e) : First two segments distinct. Posterior edge of the first segment with a hyaline frill as in other segments. Posterior edge of second and third segments with spinules between the two sensilla and fine hairs lateral to these sensilla to the mid-lateral region. In the third segment the three spinules in the mid-ventral line are larger than those flanking them and are inserted slightly anteriorly to the rest.

*Antennule* haplocerate.

*P.2* endopod of two segments, the first as in the female, the second elongate and obviously representing a fusion of the second and third segments (Fig. 57f).

*P.3* (Fig. 57g) endopod three-segmented, the first two as in the female except that the distal end of the second segment is expanded on its anterior surface to cover the insertion of the third segment. Third segment with two long terminal setae and with the outer distal corner an unguiform projection.

*P.5* (Fig. 57h) : Basendopod of both sides confluent but deeply cleft. Inner expansion with two setae only, one stout and plumose the other small and weak. The inner edge, as in the female, has a distinct "notch" without a seta. Exopod small, with two well developed and four weak setae. Inner proximal corner of exopod a knob as in the female.

*P.6* of each side a small plate fused to the segment with three setae, the middle one very long (Fig. 57e).

*Etymology* : The trivial name reflects the reduced setation of P.2-P.4 (GK. *oligos*—a few).

*Remarks* : This species, whose affinity with *Parastenhelia* is established by the nature of the male P.2-P.3, appears to be most similar to *P. hornelli*, *P. ornatissima* and *P. reducta*, Resembling all three species in the exopod of P.1 and some varieties of *P. hornelli* in the female P.5. Although the setation of P.2-P.4 is very variable in species of the genus the extreme reduction shown by *P. oligochaeta*, both in the absolute sense of the absence of setae on some segments and in the relative sense of the very weak setae on others, does seem to be a sufficient reason for establishing a new species.

It is interesting to note that *P. oligochaeta* does not occur together with *P. hornelli* in these samples. Both occur in the South Andamans, though on different islands ; *P. hornelli* occurs in the Middle Andamans and *P. oligochaeta* in the North Andamans. In the Nicobar Islands only *P. oligochaeta* was found.

#### Family DIOSACCIDAE

#### *Stenhelia* Boeck, 1864

#### Subgenus *Delavalia* Brady, 1868

The situation in these islands with regard to the subgenus *Delavalia* is extraordinary. If our opinion that *Melima* Por, 1964 is a synonym of *Delavalia* is accepted (see P. 89), there are twelve species in these collections of which only four can be assigned to known species. Two of the new species are represented by only a few specimens of each sex, one from females only and another from two males only. Despite this paucity of specimens we feel that we have to describe this diversity by erecting new species since none can be comfortably fitted into existing species. In many cases no single character is unique but the species is defined by a particular combination of characters which is unique. In some cases similarities with species from other regions are evident but in others the relationships seem to lie within the group of new species described here. In several species differences are more marked in one sex than the other. It is entirely possible that we are dealing with a number of *formenkreis*. Only more extensive sampling can hope to reveal the true relationships among this extremely diverse fauna, which is highlighted by the presence of eight species in a single sample from Neil Island (Table 5).

43. *Stenhelia (Delavalia) polluta* Monard, 1928  
(Figs. 58-59)

1928. *Stenhelia (Delavalia) polluta*, A. Monard, *Arch. Zool. exp. gen.*, 67 : 399

*Material examined* : IV, 9 ♀ ♀ 3 ♂ ♂ ; VII, 1 ♀ ; VIII, 3 ♀ ♀ 2 ♂ ♂

*Remarks* : At various times up to three forms or varieties have been recognized within *S. (D.) normani* (T. Scott, 1905)—*normani* T. Scott, 1905, var. *polluta* Monard, 1928 and form *acutirostris* Willey, 1935.

According to Willey, whose record remains unique, *acutirostris* differs from both *normani* and *polluta* in the rostrum, setation of the endopods of P.3 and P.4 and in the male P.5. While some suspicion may exist about the true setation of P.3-P.4, the other characters undoubtedly isolate *acutirostris*. We agree, therefore, with Sewell (1940) and Por (1964) that it must be accorded species status.

Monard (1928) first proposed *polluta* as a separate species but later (1937) reduced it to a variety of *normani*. Lang (1948) accepts Monard's last revision but Sewell (1940) still regards *polluta* as a separate species. Por (1964) states that it is a subspecies, even though he describes specimens which tend to be intermediate between *normani* and *polluta*.

The situation is complex since Por (1964) finds difficulty in separating *S. normani*, *S. polluta* and *S. elisabethae* Por, 1959. As described by Monard (1928) there are only three differences between *normani* and *polluta*—(a) the reduction in the latter to three setae on the basendopod of the female P.5, (b) the length of the caudal ramus and (c) the presence in *polluta* of spinule rows on the second to fourth female abdominal segments. In their discussions on *polluta* neither Sewell (1940) nor Por (1964) mention this last feature. Por (1964) found females in which the basendopod of P.5 possessed three well developed setae and one reduced seta. Clearly this is intermediate between the two conditions. He also states that his specimens lack an inner seta on the first exopod segment of P.2. Monard does not describe or illustrate P.2 in *polluta*, but it is known (e.g. Sars, 1906, Plate CXXIV) that this seta is very weak in *normani*. Por states that his "*polluta*" possesses a "supplementary seta on the last endopodite segment of P.IV", but this is also true in *normani* and in *polluta* as described by Monard. We presume that "endopodite" is a misprint for *exopodite* since the early descriptions show that segment of that ramus with only two well developed setae. However, Monard (1928) describes *S. normani* from Roscoff with such a weak third seta. As we state many times in this paper early describers often did not notice such fine setae and we do not believe it can be validly used as a taxonomic indicator unless modern data leaves no doubt about its presence or absence.

In summary, we do not believe that the P.5, the P.2 or the P.4 are good characters since intermediates either have been described or are entirely probable. Therefore separation can only be justified on the caudal ramus and the abdominal ornamentation. Lang (1965, p.7) lays great stress on the species constancy of ornamentation

patterns. Accordingly, if it can be proved that *S. normani* is naked then *S. polluta* should be accorded species status. The difference in caudal ramus proportions may also be relevant but detailed analysis is lacking on variability in any species of the genus.

Since in general we agree with Lang on the importance of somitic ornamentation we regard *S. polluta* as a distinct species.

We assign our specimens to *S. polluta* because they agree with the original description in possessing spinule rows on the female abdomen (Figs. 59a-b) and in the proportions of the female caudal ramus (length to breadth ration 2:1). They differ in having four well developed setae on the basendopod of the female P.5 (Fig. 58f) and in having a weak third seta on the distal exopod segment of P.4 (Fig. 58d). Also, they lack an inner seta on the first exopod segment of P.2 (Fig. 58c). Thus we demonstrate further that the female P.5 is variable in this species.

The male has not been described before. The abdominal ornamentation differs from that of the female in the usual manner of this genus ; segments two to four have ventral or ventral and lateral spinule rows well developed (Fig. 59c). The caudal ramus also differs in being only 1.5 times as long as broad.

#### 44. *Stenhelia (Delavalia) oblonga* Lang, 1965 (Fig. 60)

1965. *Stenhelia (Delavalia) oblonga*, K. Lang, *K. Svenska Vetensk.-Akad. Handl.*, Set. 4, 10(2) : 244

*Material examided* : IV, 1 ♀ ; VII, 5 ♀ ♀ ; VIII, 2 ♀ ♀ ; IX, 3 ♀ ♀ 1 ♂

*Remarks* : Our specimens are identical with Lang's except that they all lack an inner seta on the first exopod segment of P.2 (Fig. 60a). The species is known only from the present material and the single specimen of each sex found in California by Lang.

Lang points to the similarity with *S. elisabethae* Por, 1959 which Por (1964) considers to form "a clear Formenkreis" with *S. normani* and *S. acutirostris*. This view apparently is based on form and setation of P.1-P.5 and the caudal ramus. However it fails to take account of the radical differences in the maxilliped between *elisabethae* and *normani* (that of *acutirostris* is not known with certainty).

#### 45. *Stenhelia (Delavalia) breviseta* n. sp. (Figs. 60-62)

*Material examined* : IV, 20 ♀ ♀ 6 ♂ ♂ 8 copepodids ; V, 1 ♀ ; VI, 1 ♀ ; XIII  
21 ♀ ♀ 7 ♂ ♂ 3 copepodids.

*Holotype* female, IV (C 2819/2) and *Paratypes* (C 2820/2) deposited with the Zoological Survey of India, Calcutta.

### Description

*Female* : Length 400  $\mu\text{m}$ . Body somewhat pear-shaped with the greatest width at the distal end of the cephalothorax (Fig. 60b). Cephalothorax large. Rostrum not bifid (Fig. 60f). Genital somite with first segment much broader than the second. Abdomen not tapering (Figs. 60c-d). Anal operculum a large structure of the shape typical of the genus (Fig. 60c). Caudal ramus short, only slightly longer than broad (Fig. 60g) and with two well developed terminal setae, the inner about twice as long as the outer. Neither terminal seta is thickened at the base. Genital suture dorso-lateral only. Genital field simple (Fig. 60h).

*Somitic ornamentation* (Figs. 60b-d) confined to sensilla on the cephalothorax and at the distal edge of all segments except the last two and to spinules on the distal edge of the last segment. Hyaline frill plain, though faintly striated.

*Antennule* of eight short segments, with an aesthete on the fourth segment (Fig. 61a).

*Antenna* (Fig. 61c) : Coxa not fused with basis. Allobasis with one seta and a row of setules which mark the distal edge of the short basis component. Endopod elongate. Exopod long and slender, three-segmented. First segment elongate, with one seta ; second segment short, with one seta ; third segment elongate with one lateral and three terminal setae, one of which is very weak. The two well developed setae have a common base.

*Mandible* (Fig. 61d) : Pre-coxa with a complex cutting edge. Coxa-basis spinulose near the base of the inner edge and with three setae distally. Exopod a single elongate segment with six setae. Endopod curved. Inner edge with three setae ; outer edge with two thin distal setae and a pair of stout setae with a long conjoint base. Terminal setae of the usual build—very long and stout, reaching almost to the end of the cephalothorax.

*Maxillule* (Fig. 61e) : Pre-coxal arthrite with two slender setae on the surface and with six plain setae and claws and two plumose claws terminally. Coxa with two setae. Basis with a bilobed apex, with eight setae altogether. Exopod and endopod fused to basis, with two and four setae respectively.

*Maxilla* (Fig. 61f) : Syncoxa with three endites. Basis terminating in a stout claw. Endopod two-segmented.

*Maxilliped* not prehensile (Fig. 60i) Basis with three setae. Endopod of one bi-lobed segment with two stout setae on one lobe and two slender setae and a minute seta on the other.



*P.1* (Fig. 62a) : Coxa with a small row of spinules near the outer edge and a large transverse row near the inner distal corner. Basis with stout spines at outer and inner distal corners. Distal edge with stout spinules ; inner edge with fine setules. Exopod of three sub-equal segments. First segment without an inner seta. Endopod two-segmented and about as long as the exopod. Second segment longer than the first. Outer edge of all segments of both rami with stout spinules. Setation as below.

*P.2-P.4* (Fig. 62b-d) : Coxa of P.2-P.3 with two short rows of spinules near the outer edge. In P.4 the proximal row is absent. Basis with a slender outer seta and a transverse row of fine setules across the inner edge. Rami three-segmented. Endopod longer than the exopod on P. 2, about as long as the exopod in P.3 and shorter than the exopod in P.4. Setation as below. Inner setae tend to be short, stout and plumose but the distal seta on the third segment of both rami in P.3 and P.4 and the seta on the first segment of the endopod of P.2 are very small and weak. Outer edge of all segments stoutly spinulose.

*P.5* (Fig. 62f) : The pair of P.5 are not confluent. Inner expansion of basendopod not well developed ; with four setae, the outer three elongate, the inner one short, stout and plumose. Exopod elliptical with five setae. The middle three setae are terminal, with the central seta being very small. The outermost and innermost setae are sub-terminal. The outermost seta is of curious shape (Fig. 62g). The outer edge of the exopod is set with long setules.

#### *Setal formula*

	Exp.			Enp.		
P. 1	0.	1.	0.2.2.	1.	2.2.0.	
P. 2 ♀	0.	1.	2.2.3.	1.	2.	1.2.1.
P. 2 ♂	0.	1.	2.2.3.	1.	2.2.0.	
P. 3	0.	1.	3.2.3.	1.	1.	3.2.1.
P. 4	0.	1.	3.2.3.	1.	1.	2.2.1.

*Male* differs from the female in the following respects.

*Abdomen* (Fig. 60e) : First two segments distinct. Segments two to four with a ventral row of spinules at the distal edge.

*Antennule* sub-chirocerate (Fig. 61b).

*P.2* (Fig. 62e) : Coxa, basis and exopod as in the female. Endopod two-segmented. First segment as in the female. Second segment with two stout, plumose inner setae and terminally with a normal plumose seta and a curved seta. Distal edge with an unguiform process. Outer edge with an unguiform process halfway along its length.

*P.5* (Fig. 62h) : The pair of *P.5* reduced to a single transverse plate. Exopod represented by three stout spines and a weak seta. Inner portion of basendopod with two stout spines.

*P.6* (Fig. 60e) of each side a lappet, with three small setae.

*Etymology* : The trivial name refers to the short stature of the setae of *P.2-P.4* (*L. brevis*—short, and *seta*).

*Remarks* : This species clearly is related to *S. (D.) oblonga*. This is particularly apparent in the rostrum and anal operculum. Similarities with *S. (D.) elisabethae* also are obvious, particularly in the male *P.2*. However, *S. (D.) breviseta* differs from both in the short, stout inner setae of *P.2-P.4*, the absence of an inner seta on the first exopod segment of *P.3-P.4* and in details of *P.5* of both sexes.

#### 46. *Stenhelia (Delavalia) madrasensis* Wells, 1971

1971. *Stenhelia (Delavalia) madrasensis* J.B.J. Wells, *J. nat Hist.*, 5 : 508.

*Material examined* : IV, 26 ♀ ♀ 20 ♂

*Remarks* : Reexamination of the type-material of *S. madrasensis* shows that *S. (D.) krishnensis* Radhakrishna & Reddy, 1978 is identical and must sink as a junior subjective synonym. Radhakrishna & Reddy apparently were unaware of the description of *madrasensis* as they do not discuss their species in relation to it. Their description is excellent and includes the male, which was not found by Wells.

Two differences exist between our specimens and the original description; one is genuine, the other spurious.

1. In the type-material the female antennule is of seven segments only, but with the sixth segment showing an incipient articulation. In the present specimens the antennule clearly is eight-segmented with a distinct articulation across "segment six"
2. Wells (1971) states that the maxilliped is non-prehensile and that the "exopod" lacks a second segment. The word "exopod" is a typographic error for *endopod* and in any case the statement is wrong. In fact there is a small second segment, exactly as described by Radhakrishna & Reddy (1978).

With the discovery of the male of *S. madrasensis* and with the new description of both sexes of *S. (D.) longifurca* Sewell, 1934 by Reddy & Radhakrishna (1980) an assessment of the relationships of *S. madrasensis* is now possible. These two species are closely similar in many important respects, including the maxilliped, setation of *P. 2-P. 4*, *P. 5* of both sexes and the male *P. 1*. They are equally clearly differentiated on the caudal ramus and the male *P. 2*. Both species are widely eury-

haline, occurring in all conditions from fully marine to completely fresh water. The curious modifications to the male P. 1 place them apart from all other species in the genus.

Radhakrishna & Reddy (1978) compare *S. krishnensis* (= *S. madrasensis*) with *S. (D.) inopinata* (A. Scott, 1902). This species was described by Scott from the female only and we believe that the description is too rudimentary for any sensible comparison to be made. In 1924 Sewell described a male that he thought could be attributed to this species. There are considerable similarities between this male and that of *S. madrasensis* as described by Radhakrishna & Reddy (1978) and it is more likely that it is the male of *S. madrasensis*. The only other record of *S. inopinata* is that of Wells (1967) and we have established by reexamination of these specimens that they are the species we describe in this paper as *S. (D.) mixta* n.sp. (see p. 77).

The known distribution of *S. madrasensis* is, therefore—

- (a) The estuary of the Vellar River, Porto Novo, Tamil Nadu, India (Wells, 1971); salinity unknown.
- (b) Rambha Bay, Chilka Lake, Orissa, India, which is a region subject to wide and irregular variations in salinity (Sewell, 1924).
- (c) The lower reaches of the River Krishna, Andhra Pradesh, India, where “purely freshwater conditions prevail throughout the year” (Radhakrishna & Reddy, 1978, p. 152).
- (d) Intertidal sand on Long Island, Middle Andaman Islands, where the salinity at the time of collection was 34‰.

#### 47. *Stenhelia (Delavalia) mixta* n.sp.

(Figs. 62-65)

*Material examined* : IV, 1 ♀; XIII, 9 ♀ ♀ 1 ♂

*Holotype* female, XIII (C 2821/2) and *Paratypes* (C 2822/2) deposited with the Zoological Survey of India, Calcutta.

#### Description

*Female* : Length 400  $\mu$ m. Body markedly pear-shaped (Fig. 63a) with the greatest width at the posterior end of the cephalothorax, which is relatively short. Abdomen without pronounced taper from anterior to posterior (Figs. 64a-b). Rostrum with a bifid tip (Fig. 63b). Genital somite with the suture weakly developed and with the first segment much wider than the second. Genital field as Fig. 64d. Anal operculum as Fig. 64a. Caudal ramus (Fig. 64a-b) about seven times as long as the narrowest part. Of the two well developed apical setae the outer one is very short and thick.

*Somitic ornamentation* : Cephalothorax without sensilla; thoracic and abdominal segments with sensilla at their distal edge. Hyaline frill plain, though faintly striated. Abdomen (Figs. 64a-b) with dorsal and dorsolateral rows of spinules at the distal edge of all segments except the last and with a pattern of curved striae dorsally and laterally, some of which bear minute spinules. Last segment with stout spinules at the ventral distal edge.

*Antennule* of seven segments, the sixth the longest; with an aesthete on the fourth segment (Fig. 63c).

*Antenna* (Fig. 63d) : Coxa clearly demarcated. Allobasis with one seta and some spinules on the inner edge. Origin of exopod very proximal. Exopod elongate, three-segmented. First segment elongate, with one seta; second segment very short, with one seta; third segment elongate, with one lateral and two terminal setae with a common base.

*Mandible* (Fig. 63e) : Pre-coxa with a complex cutting edge. Coxa-basis with three setae. Exopod elongate, with six setae. Endopod with five setae and terminally with the usual very long stout seta.

*Maxillule* (Fig. 63f) : Pre-coxal arthrite with two slender setae and six stout claws. Coxa with two setae. Basis bi-lobed, each lobe with two setae. Exopod and endopod fused to the basis and with two and four setae respectively.

*Maxilla* (Fig. 62i) : Syncoxa with three endites. Basis terminating in a large claw. Endopod two-segmented.

*Maxilliped* not prehensile (Fig. 62j). Basis with three setae. Endopod of one segment with three setae.

*P. 1* (Fig. 64g) : Coxa with several rows of minute spinules and one row of larger spinules near the outer distal corner. Basis with a stout seta at the inner and outer distal corners. Distal edge spinulose. Exopod of three sub-equal segments. Endopod two-segmented, slightly longer than the exopod. Second segment longer than the first. Outer edge of all segments in both rami spinulose. Setation as below.

*P. 2-P. 4* (Fig. 65a-c) : Coxa with a row of spinules on the anterior surface and near the outer distal corner. Basis with spinules only at the distal edge above the origin of the exopod and with a slender outer seta. Rami of three segments. Endopod slightly longer than the exopod in *P. 2*, about equal to the exopod in *P. 3*, but much shorter than the elongate exopod of *P. 4*. Outer edge of all segments spinulose. Setation as below. Distal inner seta of the third exopod segments small and weak.

*P. 5* (Fig. 63g) : The pair of *P. 5* are confluent. Basendopod not produced ; with four relatively short setae. Exopod well developed, broader than long, with five terminal setae.

*Setal formula*

	Exp.			Enp.		
P. 1	0.	1.	0.2.2.	1.	2.2.0.	
P. 2 ♀	1.	1.	2.2.3.	1.	2.	1.2.1.
P. 2 ♂	1.	1.	2.2.3.	1.	2.2.0.	
P. 3	1.	1.	3.2.3.	1.	1.	3.2.1.
P. 4	1.	1.	3.2.3.	1.	1.	2.2.1.

*Male* differs from the female in the following respects.

*Abdomen* (Fig. 64c) : First two segments distinct. On segments two to four the spinule rows extend across the ventral surface. Striae present as in the female.

*Antennule* sub-chirocerate (Fig. 64f).

*P. 2* (Fig. 65d) : Coxa, basis and exopod as in the female. Endopod two-segmented. First segment as in the female except that the inner seta is weaker. Second segment with two stout inner setae and a notch on the outer edge representing the site of division between a second and a third segment. Terminally with two stout setae and with an unguiform projection of the distal edge.

*P. 5* (Fig. 63h) : The pair of *P. 5* are confluent. Basendopod with a stout spine and a much smaller spine and with a spinulose distal edge. Exopod small but free, about as long as broad, with one inner and three terminal setae.

*P. 6* (Fig. 64e) of both sides forming a single plate with a spine and two setae each side.

*Etymology* : The trivial name reflects that the uniqueness of this species lies in its particular combination of characters (*L. mixtus*—a mixture).

*Remarks* : This species is unique in its particular combination of characters and its relationships are not obvious. Taken individually each of a number of characters (rostrum, setal formula, *P. 5* of both sexes, male *P. 2*, caudal ramus) is similar to that of other species but none is like *S. mixta* in more than two of these.

By direct comparison we now know that *S. mixta* is identical with the *S. inopinata* (A. Scott, 1902) of Wells (1967) but, on reflection, we do not consider that our females can be identified with Scott's. The caudal ramus appears to be much longer and there are differences in the *P. 5*. As we have stated earlier (p. 75) we doubt that it is possible to identify specimens with Scott's species and, further, that the male described as that of *S. inopinata* by Sewell (1924) probably is *S. madrasensis*.

48. *Stenhelia* (*Delavalia*) *hirtipes* n.sp.  
(Figs. 65-68)

*Material examined* : VII, 3 ♀ ♀ 2 ♂ ♂

*Holotype* female, VII (C 2823/2) and *Paratypes* (C 2824/2) deposited with the Zoological Survey of India, Calcutta.

### Description

*Female* : Length 485  $\mu\text{m}$ . Body not markedly pear-shaped, cephalothorax rather short (Fig. 66a). Rostrum large, bifid at the tip (Fig. 65e). Genital suture weakly developed. Genital field as Fig. 66i. Anal operculum as Fig. 66b. Caudal ramus (Figs. 66g-h) more or less cylindrical, with parallel sides, and almost four times as long as the narrowest part; both apical setae well developed.

*Somitic ornamentation* : Cephalothorax without sensilla. Thoracic and abdominal segments with sensilla near the distal edge. Hyaline frill plain. Abdomen (Figs. 66b-d) with striae dorsal and dorso-lateral on all segments except the last; the dorsolateral components with minute spinules. Distal dorsolateral corner of all segments except the last with a few coarse spinules. Six large coarse spinules mid-ventrally on the second segment. Last segment with long spinules ventral and lateral.

*Antennule* (Fig. 65f) seven-segmented, the sixth elongate.

*Antenna* (Fig. 65g) : Coxa distinct, with some spinules along the outer edge. Allobasis with one seta and a transverse row of spinules basally on the inner side. Exopod three-segmented. First segment with one seta; second segment with one seta; third segment with one lateral and three terminal setae.

*Mandible* (Fig. 67a) : Pre-coxa with complex cutting edge. Coxa-basis with three setae. Exopod elongate, with six setae. Endopod of usual construction, with a long stout terminal seta.

*Maxillule* (Fig. 65h) : Pre-coxal arthrite with six stout claws and with two slender setae on the surface. Coxa with four setae. Basis with seven setae. Exopod and endopod fused to the basis and with two and four setae respectively.

*Maxilla* (Fig. 65i) : Syncoxa with three endites. Basis terminating in a large claw with a stout seta at its base. Endopod of one segment.

*Maxilliped* not prehensile (Fig. 65j). Basis with three setae. First endopod segment with two setae. Second endopod segment fused to the first; with two setae.

*P. 1* (Fig. 67b) : Coxa with rows of small spinules. Basis with large spinules at the origin of the stout inner and outer setae and on the distal edge. Exopod of three sub-equal segments. Endopod two-segmented, slightly longer than the exopod. Second segment longer than the first. Outer edge of endopod segments with stout spinules. Outer edge of first two exopod segments with a multitude of fine hairs.

*P. 2-P. 4* (Figs. 67c-e) : Coxa with rows of small spinules. Basis with a small outer seta. Inner edge with a transverse row of fine hairs. Rami three-segmented. Endopod slightly longer than the exopod in *P. 2*, about equal to the exopod in *P. 3* and much shorter in *P. 4*. Setation as below. Note that in two females the proximal inner seta of the second endopod segment of *P. 2* is absent. Proximal inner seta of the third exopod segment of *P. 3-P. 4* is small and weak.

*P. 5* (Fig. 68b) : The pair of *P. 5* are confluent. Basendopod not produced, with four setae. Exopod with five setae and with a double row of spinules along the outer edge.

#### *Setal formula*

	Exp.			Enp.		
<i>P. 1</i>	0.	1.	0.2.2.	1.	2.2.0.	
<i>P. 2</i> ♀	0.	1.	2.2.3.	1.	1-2.	1.2.1.
<i>P. 2</i> ♂	0.	1.	2.2.3.	0.	2.2.0.	
<i>P. 3</i>	1.	1.	3.2.3.	1.	1.	3.2.1.
<i>P. 4</i>	1.	1.	3.2.3.	1.	1.	2.2.1.

*Male* differs from the female in the following respects.

*Abdomen* (Figs. 66e-f) : First two segments distinct. Segments two to four with stout spinules ventrally and ventrolaterally.

*Antennule* sub-chirocerate (Fig. 68a).

*P. 2* (Fig. 67f) : Coxa, basis and exopod as in the female. Endopod two-segmented. First segment without inner seta. Second segment simple; outer edge without a notch, distal edge without an unguiform projection.

*P. 5* (Fig. 68c) : The pair of *P. 5* are confluent. Basendopod with two setae, the outer very small, and with some spinules on the distal edge. Exopod small, slightly longer than broad; with five setae of which the outermost is robust.

*P. 6* (Fig. 66e) of each side a distinct lappet with three setae.

*Etymology* : The trivial name refers to the *P. 1* exopod (L. *hirtus*—hairy, and *pes*—a foot).

*Remarks* : The female is similar in many respects to several species of the genus and may only be distinguished on the particular combination of the moderately elongate caudal ramus, the "hairy" P. 1 and details of the mouthparts. The male, which shares these characteristics with the female, is almost unique in the simplicity of the endopod of P. 2 and resembles only *S. mixta* in the P. 5.

49. *Stenhelia* (*Delavalia*) *clavus* n.sp.  
(Figs. 68-70)

*Material examined* : II, 1 ♀ ; VIII, 11 ♀ ♀ 4 ♂ ♂

*Holotype* female, VIII (C 2825/2) and *Paratypes* (C 2826/2) deposited with the Zoological Survey of India, Calcutta.

**Description**

*Female* : Length 515  $\mu$ m. Body more or less cylindrical with a slight and even taper from anterior to posterior (Fig. 69a). Rostrum with a bifid tip (Fig. 68d). Genital suture strongly developed laterally (Fig. 69b). First abdominal segment much broader than the second and not rounded distally. Genital field as Fig. 69c. Anal operculum well developed (Fig. 70b). Caudal ramus extremely elongate (Fig. 69d), tapering distally, about ten times as long as the basal part. Both apical setae well developed, with the inner seta very long.

*Somitic ornamentation* : Sensilla present at the distal edge of the cephalothorax and of all succeeding somites except the last two. Anal operculum with a sensillum each side. Last segment with spinules ventral and lateral. Without other surface spinulation, but the entire body, and all appendages, is minutely punctate.

*Antennule* (Fig. 68e) of eight short segments, but with the articulation between segments six and seven rather indistinct.

*Antenna* (Fig. 68f) : Coxa not entirely distinct. Allobasis with a seta and two transverse rows of spinules on the inner edge. Exopod elongate, of three segments. First segment with one seta; second segment with one seta; third segment with one lateral and three terminal setae.

*Mandible* (Fig. 68g-h) of the genus type. Coxa-basis rather short. Exopod with six setae. Distal seta of the endopod is extremely long.

*Maxillule* and *maxilla* exactly as in *S. mixta*.

*Maxilliped* not prehensile (Fig. 68i). Coxa and basis totally fused together, without trace of division. Endopod of one segment, but with a faint indication of the line of fusion; with four setae.



*P. 1* (Fig. 69e) : Coxa with spinules near the distal corners. Basis with an outer seta and an inner spine. Strong spinules at the origin of these and along the distal edge. Exopod of three sub-equal segments; outer edge of all three segments with a multitude of fine hairs. Endopod two-segmented, slightly longer than the exopod; second segment longer than the first. Outer edge with strong spinules. Distal edge of the second segment with an unguiform projection.

*P. 2-P. 4* (Figs. 69f-h) : Coxa with spinule rows near the proximal and distal outer corners. Basis with a transverse row of fine spinules on the inner edge. Rami three-segmented. Endopod slightly longer than the exopod in *P. 2*, about as long as the exopod in *P. 3* and substantially shorter in *P. 4*. Endopod of *P. 4* very slender and with a reduced setation. Setation as below.

*P. 5* (Fig. 70f) : The pair of *P. 5* are confluent. Basendopod moderately produced; with four setae, the innermost stout and plumose. Exopod longer than broad, inner edge with a few spinules; with four freely articulated setae. Outer distal corner is a large unguiform projection.

*Setal formula*

	Exp.			Enp.		
<i>P. 1</i>	0.	1.	0.2.2.	1.	2.2.0.	
<i>P. 2</i> ♀	0.	1.	1.2.3.	1.	2.	1.2.1.
<i>P. 2</i> ♂	0.	1.	1.2.3.	1.	2.2.0.	
<i>P. 3</i>	0.	1.	1.2.3.	1.	1.	1.2.1.
<i>P. 4</i>	0.	1.	2.2.2.	1.	0.	0.2.1.

*Male* differs from the female in the following respects.

*Abdomen* (Fig. 70a) : First two segments distinct. Segments two to four with spinules ventrally.

*Antennule* sub-chirocerate (Fig. 70c).

*P. 2* (Fig. 70d-e) : Coxa, basis and exopod as in the female. Endopod two-segmented. First segment as in the female. Second segment with an unguiform projection on the distal edge and another midway along the inner edge.

*P. 5* (Fig. 70g) : The pair of *P. 5* are confluent. Basendopod with two spiniform setae, the outer very small, and with spinules along the distal edge. Exopod with the distal outer corner produced as a massive unguiform projection. Main part of the exopod very small, with three freely articulating setae.

*P. 6* (Fig. 70a) of each side a lappet with three setae. The lappets are fused together along part of their inner edge and the right *P. 6* is larger than the left.

*Etymology* : The trivial name refers to the exopod of P. 5 of both sexes (*L. clavus*—a nail or spike).

*Remarks* : The relationships of this species seem to lie with three other species described in this paper—*S. hirtipes*, *S. paraclavus*, *S. valens*—and, possibly, with *S. unisetosa* Wells, 1967. All have a non-prehensile maxilliped and a similarly modified male P. 2 endopod. Except in *S. unisetosa* and *S. paraclavus* the outer edge of the exopod of P. 1 has a multitude of hairs or very fine spinules. All except *S. hirtipes* have a reduced setation of P. 2-P. 4; in particular they lack a seta on the second endopod segment of P. 4. All except *S. valens* have the second endopod segment of P. 1 longer than the first.

*S. clavus* shares with the obviously closely related *S. paraclavus* the modification to the P. 5 exopod. The transformation of the outer seta into a very stout, long spine is seen also in the male of *S. hirtipes* and *S. unisetosa*, although in these species the spine is not fused to the ramus as a unguiform projection and the female is normal. A similar sexual dimorphism to that of *S. hirtipes* and *S. unisetosa* is seen in *S. latipes* Lang, 1965. The male of *S. coineauae* Soyer, 1971b is very like that of *S. clavus* and *S. paraclavus* but the female is unmodified. Only in *S. cornuta* Lang, 1936a is the P. 5 of both sexes modified in the *clavus* manner. However, in all three species (*latipes*, *coineauae* and *cornuta*) the male P. 2 endopod is quite different from *S. clavus*, the maxilliped is fully prehensile and the second endopod segment of P. 1 is shorter than the first.

50. *Stenhelia* (*Delavalia*) *paraclavus* n.sp.  
(Figs. 70-71)

*Material examined* : VIII, 2 ♂ ♂

*Holotype*, VIII (C 2827/2) and *Paratype* (C 2828/2) deposited with the Zoological Survey of India, Calcutta.

**Description**

*Female* unknown.

*Male* : These two males are identical to *S. (D.) clavus* in body shape, rostrum, antennule, antenna, maxilla and P. 6. They differ in the following respects.

*Length* : 430  $\mu$ m.

*Caudal ramus* (Fig. 70h) only four times as long as the narrowest part.

*Somitic ornamentation* : Without surface spinules, except ventrally and laterally on the last segment; not minutely punctate.

*Mandible* (Fig. 71f) : Pre-coxa as *S. clavus*. Coxa-basis with only one transverse row of spinules. Endopod much as in *S. clavus* except that there appears to be only three setae in addition to the elongate one.

*Maxilliped* not prehensile (Fig. 70i) : Coxa and basis form one segment but the site of former articulation is visible. Endopod of one segment without trace of subdivision; with four setae.

*P. 1* (Fig. 71a) : Coxa with spinules only at the outer distal corner. Rami of similar proportions to those of *S. clavus* and the distal edge of second endopod segment has an unguiform projection. Outer edge of the exopod segments with a single row of spinules.

*P. 2-P. 4* (Figs. 71b-e) : Coxa with only one row of spinules. Basis without a transverse row of spinules. Rami of similar proportions to those of *S. clavus*, especially in the endopod of *P. 4*. Setation as below; differs from *S. clavus* only in the distal segment of the exopod of *P. 3* and the endopod of *P. 4*. The second segment of the exopod of *P. 4* has a curious hyaline structure at the outer distal corner (Fig. 71e).

*P. 2 endopod* (Fig. 70j) similar in overall form to that of *S. clavus* but with the inner apical seta simple and the first segment relatively longer.

*P. 5* (Fig. 70k) is very similar to that of *S. clavus*, differing only in the absence of accessory spinules on the basendopod.

#### *Setal formula*

	Exp.			Enp.		
<i>P. 1</i>	0.	1.	0.2.2.	1.	2.2.0.	
<i>P. 2</i> ♂	0.	1.	1.2.3.	1.	2.2.0.	
<i>P. 3</i>	0.	1.	2.2.3.	1.	1.	1.2.1.
<i>P. 4</i>	0.	1.	2.2.2.	1.	0.	1.2.1.

*Remarks* : Although this species must be closely related to *S. clavus* the differences noted above are too widespread and in most cases too serious to warrant conspecificity.

#### 51. *Stenhelia (Delavalia) valens* n.sp. (Figs. 71-73)

*Material examined* : VIII, 8 ♀ ♀

*Holotype* VIII (C 2829/2) and *Paratypes* (C 2830/2) deposited with the Zoological Survey of India, Calcutta.

## Description

*Female* : Length 550  $\mu\text{m}$ . Body with an even taper from anterior to posterior (Fig. 72a). Genital suture strongly chitinized dorsolaterally. Genital field and anal operculum as in *S. clavus*. Rostrum (Fig. 71g) with a bifid tip. Caudal ramus exactly as in *S. paraclavus*, about four times as long as the narrowest part, with both apical setae well developed.

*Somitic ornamentation* : Body and all appendages minutely punctate but without other ornamentation except for ventral and lateral spinules on the last segment. Sensilla at the posterior edge of the cephalothorax and of all segments except the last two.

*Antennule* (Fig. 71h) of eight short segments, all well demarcated from each other.

*Antenna* (Fig. 71i) : Coxa distinct. Allobasis with one seta and a few spinules on the inner edge. Exopod robust, of three segments with one, one and three setae respectively.

*Mandible* (Fig. 71j) is essentially similar to other species in the genus. Exopod with six setae. Endopod with one stout elongate seta with four normal setae at its base.

*Maxillule* (Fig. 71k) : Pre-coxal arthrite with six claws and one plain seta. Coxa with two setae. Basis with six setae. Exopod and endopod fused to the basis, with two and four setae respectively.

*Maxilla* (Fig. 71l) : Syncoxa with three endites. Basis with a terminal claw and a seta of similar shape. Endopod of one segment.

*Maxilliped* not prehensile (Fig. 72c). Basis with three setae. The two endopod segments are totally fused together; with three setae.

*P. 1* (Fig. 72d) : Coxa with two rows of spinules at the outer distal corner. Basis with stout inner and outer spines with spinules above their origin, and with spinules on the distal edge. Exopod short and robust with the first segment longer than the second or third. Endopod of two equal segments and about as long as the exopod. Outer edge of both rami with a multitude of fine spinules.

*P. 2-P. 4* (Figs. 72e-g) : Coxa with a row of spinules at the proximal and distal outer corners. Basis with an outer seta and, in *P. 2* only, with a transverse row of fine setules on the inner edge. Rami three-segmented. Exopod and endopod of *P. 2* and *P. 3* approximately equal in length and with stoutly built segments. *P. 4* much more slender; endopod much shorter than the exopod. Outer edge of exopod segments with multiple rows of slender spinules. Setation as below.

P. 5 (Fig. 73a) : The pair of P. 5 are confluent. Basendopod moderately produced, with four setae. Exopod with five setae.

*Setal formula*

	Exp.			Enp.		
P. 1	0.	1.	0.2.2.	1.	2.2.0.	
P. 2	0.	1.	1.2.3.	1.	1.	1.2.1.
P. 3	0.	1.	1.2.3.	1.	1.	1.2.1.
P. 4	0.	1.	1.2.2.	1.	0.	0.2.1.

*Male unknown.*

*Etymology* : The trivial name reflects the robust nature of P. 1-P. 3 (*L. valens*, made strong).

*Remarks* : This species appears to be unique in the stout build and heavy chitization of P. 1-P.3, although the description of some species may be difficult to interpret in this respect. Clearly, there are considerable resemblances to *S. hirtipes*, *S. clavus* and *S. paraclavus*; these have already been discussed (p. 82).

52. *Stenhelia (Delavalia) fustiger* n.sp.  
(Fig. 73)

*Material examined* : VIII, 1 ♀ ; IX, 1 ♂

*Holotype* female, VIII (C 2831/2) and *Paratype* male (C 2832/2) deposited with the Zoological Survey of India, Calcutta.

**Description** : This species is so similar to *S. (D.) longipilosa* Lang, 1965 from California that it can best be described by comparison with his excellent description.

*S. fustiger* is identical to *S. longipilosa* in size, shape of the body (including the rather spatulate female abdomen) female genitalia, caudal ramus, abdominal ornamentation of both sexes, rostrum, antennule of both sexes, antenna, maxillule, P. 1, P. 2, P. 3, male P. 2 endopod, male P. 5 and male P. 6. It differs slightly in the maxilla, coxa of P. 4 and in the female P. 5, more seriously in the mandible and maxilliped and considerably in the male P. 4.

*Mandible* (Fig. 73b) : The general shape and proportions are as in *S. longipilosa*, including the elongate coxa-basis, but the median terminal seta of the endopod is very much longer and stouter and is fused to the segment, i.e. its condition is more typically *Stenhelia*-like. Also the exopod has three apical setae, giving a total of six on this ramus.

*Maxilla* : The only difference here is that the middle endite of the syncoxa has three setae instead of two.

*Female P. 4* (Fig. 73d) : The coxa bears a small row of spinules at the outer proximal corner and thus is identical to that of P. 2 and P. 3.

*Female P. 5* (Fig. 73g) : The outermost seta of the basendopod is much shorter and the exopod is more triangular in shape than in *S. longipilosa*.

*Maxilliped* (Fig. 73c) : Though prehensile the maxilliped of *S. fustiger* is quite different to that of *S. longipilosa*. The first endopod segment is short and its outer edge has a bulge surrounded by a circlet of spinules; one of the terminal setae is very long.

*Male P. 4* (Figs. 73e-f) : The coxa and basis are as in the female. In the exopod the general structure is identical with that of the female but the inner seta of the first exopod segment is much better developed. The endopod is radically different to that of the female. The segments are shorter, particularly the first two, and the inner setae of the third segment are transformed into stout club-like spines, the tip of which have blunt teeth (Fig. 73f).

*Etymology* : The trivial name refers to the setae of the endopod of the male P. 4 (*L. fustus*—a club or cudgel).

*Remarks* : With the exception of the maxilliped our female is remarkably similar to *S. longipilosa*; so much so that despite the maxilliped we would regard it as conspecific considering the disparate distribution. However, the presence of sexual dimorphism in the male P. 4 adds another dimension to the argument. As far as we are aware (the male of several species is unknown) this appendage is sexually dimorphic only in *S. unisetosa* Wells, 1967 and *S. paraclavus* n.sp., but in both these species the dimorphism concerns the second exopod segment. The phenomenon, thus, is rare. It is possible, of course, that our male and female themselves are not conspecific, with the female belonging to *S. longipilosa*, but the exact similarity in somitic ornamentation between Lang's male and ours militates against this hypothesis. Lang himself would probably have regarded the exact similarity in this feature as conclusive evidence that, other male differences notwithstanding, the sets of specimens were all conspecific. We prefer to consider our form as a separate species.

53. *Stenhelia* (*Delavalia*) *indica* Krishnaswamy, 1957  
(Figs. 74-76)

1957. *Stenhelia* (*Delavalia*) *indica* S. Krishnaswamy, *Studies on the Copepoda of Madras* : 53

*Material examined* : VIII, 7 ♀ ♀ 4 ♂ ♂

## Description

*Female* : Length 350  $\mu\text{m}$ . Body rather elongate (Fig. 74a) and, except for spinules ventral and lateral on the last segment, is totally without ornamentation. Anal operculum simple. Rostrum a curious structure, with an upper hyaline part beneath which is a strongly chitinized "beak" with a bifid apex (Fig. 74d-e). Genital field very simple (Fig. 74c). Caudal ramus (Fig. 74b) about twice as long as broad with parallel sides.

*Antennule* (Fig. 76a) of eight short segments.

*Antenna* (Fig. 74f) with distinct coxa. Allobasis with one seta. Exopod three-segmented, rather short.

*Mandible* (Fig. 75a) : Pre-coxa with a complex cutting edge. Coxa-basis rather broad and with three distal setae. Exopod a single elongate segment with six setae. Endopod with three slender setae on the basal part; terminally with two elongate setae, one of which is stout and has a spatulate tip.

*Maxillule* (Fig. 74g) : Pre-coxal arthrite apparently without surface setae and only has terminal claws and setae. Coxa with two setae. Basis with six terminal setae. Exopod and endopod fused to the basis. Exopod with two broad setae fused to the segment; endopod with one such seta and three normally articulated setae.

*Maxilla* (Fig. 74h) : Syncoxa with three endites. Basis terminating in a stout claw. Endopod apparently a single segment.

*Maxilliped* prehensile (Fig. 74i) but extremely small. Basis with three setae. First endopod segment with two distal setae and with a double row of spinules on the inner edge. Second segment with a terminal claw and seta.

*P. 1* (Fig. 75b) : Coxa with spinules at the distal corners. Basis with a stout inner spine and an elongate outer seta; distal edge with fine spinules. Exopod of three segments. Endopod two-segmented, the first twice as long as the second. First segment without an inner seta. Second segment with only three setae; distal edge with a long mucroniform process.

*P. 2-P. 4* (Figs. 75c-f) : Coxa naked. Basis with an outer seta and, in *P. 2* only, a transverse row of long setules on the inner edge. Rami three-segmented. Outer distal corner of endopod segments with a massive mucroniform process. Outer setae of all exopod and some endopod segments massive and broadly pectinate (Fig. 75f). Setation as below.

*P. 5* (Fig. 75g) of each side distinct. Basendopod with four setae. Exopod elongate, with five setae.

*Setal formula*

	Exp.			Enp.		
P. 1	0.	0.	0.2.2.	0.	1.2.0.	
P. 2	0.	1.	0.2.2.	1.	1.	2.2.0.
P. 3	0.	1.	1.2.2.	1.	1.	2.2.1.
P. 4	1.	1.	3.2.2.	1.	1.	2.2.1.

*Male* differs from the female in the following respects. Note particularly that the P. 2 endopod is not modified.

*Abdomen* (Fig. 76c) with first two segments distinct.

*Antennule* (Fig. 76b) weakly haplocerate.

P. 5 (Fig. 76c) of both sides fused together to form a single plate with three setae each side.

P. 6 (Fig. 76c) forms a pair of simple lappets confluent medially and without setae.

*Remarks* : Krishnaswamy's description (the sole record of this species) is not good and there are some contradictions between text and illustrations. He found only females and gives their size as 0.95 mm. Despite this huge difference in size, which must to a large extent be real, and the inadequacies of the description we are confident that we have correctly identified our specimens. *S. indica* is peculiar in the form of P. 1-P. 4 and in their very reduced setation. The curious rostrum, clearly indicated as such in Krishnaswamy's illustration, may be unique within the genus. The only species of *Stenhelia* with any resemblance is *S. (D.) bifidia* Coull, 1976 which shows the even more curious phenomenon of a sexually dimorphic rostrum. Examination of females from the type-locality, kindly supplied by Dr Coull, shows that the condition is only superficially similar, as is clearly indicated by the site of origin of the sub-apical setae (cf. Figs. 74d-e with Figs. 74j-k). The only record among diosaccids of a rostrum genuinely similar to that of *S. indica* is in the two species of *Cladorostrata* Shen & Tai, 1963, which we do not believe to be closely related to *Stenhelia*.

The male is unique amongst species presently assigned to *Stenhelia* in the total absence of modifications to P. 1-P. 4. However, Por (1964) distinguished his new genus *Melima* from *Stehlenia* primarily on this character. *Melima* (now known from *M. caulerpae* Por, 1964 and *M. bisetosa* Coull, 1971b) also has a distinctive endopod of P. 1, to which Por attached some weight in arriving at his decision. The value of this feature is diminished with the description of *S. (D.) latipes* Lang, 1965 as this species also has a curious endopod of P. 1, but in a manner quite different from any other species of *Stenhelia*, and also quite different from *Melima*. With



this knowledge Coull (1976) discusses the validity of *Melima*. He inclines to the view that a lack of sexual dimorphism is not sufficient to warrant genus status for *Melima* since it is so similar to *Stenhelia* in all other respects, especially in the mandible. *S. indica* confirms this view since it also lacks sexual dimorphism and has a similar male P. 5 and P. 6 to *M. caulerpae* while the P. 1 endopod is not drastically different from the typical *Stenhelia* condition. Thus, we formally propose that *Melima* sink as a synonym of *Stenhelia*.

*S. indica* has only been found previously at Madras, India (Krishnaswamy, 1957a).

54. *Stenhelia (Delavalia) ovalis* n.sp.  
(Figs. 76-79)

*Material examined* : IV, 3 ♀ ♀ ; VII, 3 ♀ ♀ ; VIII, 2 ♀ ♀ , XIII, 17 ♀ ♀

*Holotype* female, XIII (C 2833/2) and *Paratype* females (C 2834/2) deposited with the Zoological Survey of India, Calcutta.

**Description**

*Female* : Length 425  $\mu$ m. Body rather elongate; metasome wider than the urosome but both parts without marked taper or curvature (Fig. 76d). Body without ornamentation except for some sensilla. Rostrum with a pronounced rounded apex (Fig. 76e). Genital suture lateral and dorsolateral. Genital field extremely simple (Fig. 79e). Caudal ramus (Fig. 76f) tubular, slightly more than twice as long as the broadest part.

*Antennule* (Fig. 77a) elongate, eight-segmented.

*Antenna* (Fig. 77b) : Coxa not visible. Allobasis with one seta. Second endopod segment elongate. Exopod of three segments, the first segment elongate; first two segments each with one seta, third segment with one lateral and three apical setae.

*Mandible* (Fig. 77c) : Pre-coxa with a complex cutting edge, the teeth rather robust. Coxa-basis elongate, with three setae, and with a row of spinules above the origin of the exopod. Exopod of one elongate segment with five setae, Endopod with three small setae on the inner side and apically with a long stout seta fused to the ramus and one normally articulated seta.

*Maxillule* (Figs. 77d-e) : Pre-coxal arthrite with two setae on the surface and terminally with two setae and five claws (Fig. 77e). Coxa with two setae. Basis with seven setae. Exopod with two broad setae fused to the ramus. Endopod with three long setae and a short plumose spine.

*Maxilla* (Fig. 77f) : Syncoxa with three endites. Basis terminating in a sharp claw with two setae at its base. Endopod large and of three distinct segments.

*Maxilliped* (Fig. 77g) small but normally developed and fully prehensile. Basis with three setae. First endopod segment with spinules and two setae along the inner edge. Second segment prehensile upon the first and transformed into a long claw with a seta at its base.

*P. 1* (Fig. 78a) : Coxa naked. Basis with a long outer seta and a stout inner spine; with spinules along the distal edge above the origin of the rami and with fine setules on the anterior surface at the junction with the coxa and around the inner edge. Exopod of three sub-equal segments. Endopod of two segments. First segment oval in shape and with a small seta at the distal end of the inner side. Second segment elongate with one small apical seta and with two curiously shaped spines, one apical and one of the outer edge. Endopod longer than the exopod.

*P. 2-P. 4* (Figs. 78b-c, 79a) : Coxa with a few spinules only; rather broad in *P. 2*. Basis with a small outer seta and with some fine setules around the inner edge. Both rami three-segmented, setation as below. Outer distal corner of the endopod segments and the first two exopod segments forms a mucroniform process which is massive in the exopod. Outer edge of segments with very small spinules. Segments rather broad with the outer edges heavily chitinized. Outer spines stout and pectinate. All setae in *P. 2* and *P. 3* are short, some very reduced, but in *P. 4* the setae are long and plumose.

*P. 5* (Fig. 79d) of each side distinct. Basendopod with four setae, exopod with five setae. Exopod without accessory ornamentation.

#### *Setal formula*

	Exp.			Enp.		
<i>P. 1</i>	0.	1.	0.2.2.	1.	0.2.1.	
<i>P. 2</i>	0.	1.	0.2.2.	1.	1.	0.2.1.
<i>P. 3</i>	1.	1.	2.2.2.	1.	1.	2.2.1.
<i>P. 4</i>	1.	1.	3.2.2.	1.	1.	2.2.1

*Male* unknown.

*Etymology* : The trivial name refers to the shape of the first endopod segment of *P.1* (Fr. *ovale*—oval, from L. *ovum*—an egg).

*Remarks* : The nearest relatives of this species are those which originally were described in the genus *Melima* Por (*S. caulerpae* and *S. bisetosa*). We have already (p. 89) given our reasons for considering *Melima* to be synonymous with *Stenhelina*.

The differences between these three species are relatively small and our initial inclination was to include all three as synonymous but on further reflection we believe that they can sustain specific identify. The unifying character of the species,

and that which distinguishes them from all other species of *Stenhelia*, is the remarkable modification to the endopod of P. 1 and in particular the spines of the second segment. The differences are summarized in Table 6. Certain trends can be detected, but they have no consistency, viz.,

- (a) Reduction in setation of the first and third exopod segments of P. 2, with one inner seta in *bisetosa* and *caulerpae*, none in *ovalis*.
- (b) Reduction in the number of inner setae on the third exopod segment of P. 3, from three in *bisetosa* to two in *ovalis* and one in *caulerpae*.
- (c) A trend to ovality in the first endopod segment of P. 1, from rectangular in *bisetosa* to the oval shape of *ovalis*, with *caulerpae* intermediate.
- (d) Reduction in ornamentation of the coxa of P. 2-P. 4, from that in *bisetosa* through *caulerpae* to *ovalis*.
- (e) The tendency for the P.2-P.3 to be less robust in *caulerpae* than in *bisetosa*, with *ovalis* being the most robust.
- (f) Coxa-basis of the mandible has most ornamentation in *bisetosa*, less in *ovalis* and none in *caulerpae*.
- (g) The pre-coxal arthrite of the maxillule has one seta and six claws in *caulerpae*, six claws only in *bisetosa* and two setae and five claws in *ovalis*.

It is the inconsistency of these "trends" that persuades us to maintain specific status for the three species; clearly, also, there is not a direct ancestor-descendant relationship in these species.

Among other species of *Stenhelia* there is some resemblance between *caulerpae*, *bisetosa* and *ovalis* to *S. indica*, particularly in the genital field, maxillule exopod, reduced setation of P. 2-P. 4 and in the absence of male modifications in the only known male, that of *S. caulerpae*, but in the present state of our understanding of the genus these pointers cannot bear too much emphasis.

We are very grateful to Professor Por and Dr Coull for sending us specimens of *S. caulerpae* and *S. bisetosa* for study. During our examination of them it became apparent that in a few respects the descriptions of these species are not quite accurate, viz.,

1. Por (1964, p. 85) states that the maxilliped of *S. caulerpae* "has a very reduced apical armature" This is not so. Although small the maxilliped is normally developed, fully prehensile and exactly the same as in *S. ovalis* (Fig. 77g).

2. Por (1964, p. 85) states that in *S. caulerpae* the "median segment of the exopodite [of P. 1] bears no inner seta" and his illustration (Fig. 115) indicates that the first endopod segment also lacks an inner seta. In fact both segments bear a very weak seta (Fig. 78d).
3. Both Por, for *S. caulerpae*, and Coull, for *S. bisetosa*, make incorrect statements about the setation of the antennal exopod. In both this ramus is exactly as in *S. ovalis* (Fig. 77b). Coull (1971b, p. 208 and Fig. 36) has misinterpreted the segment boundaries so that he attributes two setae to the first segment. He also shows only two apical setae on the third segment. Por (1964, p. 85) states only that the third segment has three setae, without indicating their origins. All specimens that we examined have three apical setae, but in some orientations the small outer apical seta is masked by the long median seta and the impression of only two setae can then be gained.

**55. *Diosaccus hamiltoni* (Thompson & A. Scott, 1903)**  
(Fig. 80)

1903. *Diosaccus hamiltoni* I.C. Thompson & A. Scott, *Rep. Govt. Ceylon Pearl Oyster Fish, Gulf Manaar*, 1 : 270

*Material examined* : VII, 3 ♀ ♀

*Remarks* : This species is confined to the region of the Bay of Bengal having been found only in the Gulf of Manaar (Thompson & A. Scott, 1903, Krishnaswamy, 1957a), the Andaman and Nicobar Islands (Sewell, 1940) and at Waltair (Ganapati & Shanthakumari, 1961).

Sewell (1940) supplements the original description of the female and describes the male. Our females differ slightly from Sewell's description and we take this opportunity to add further supplementary detail.

*Abdominal ornamentation* is confined to some minute spinules on the ventral distal edge of the last segment. The genital field is identical with that described later for *D. monardi* (Fig. 80g).

*Rostrum* (Fig. 80a) is an elongate narrow based triangle, slightly downturned at the tip.

*Antennal exopod* has only one segment, as in Sewell's illustration; one of Sewell's specimens had two segments.

*Mandible* (Fig. 80b) The pre-coxal cutting edge consists of three large blunt teeth. The palp is as described by Sewell except that the endopod bears two lateral setae.

*Maxillule* large (Figs. 80c-d) : Pre-coxal arthrite with a complex series of large curved spines and with two truncated spines which are plumose along their distal edge. Coxa small, with two setae. Basis elongate, with six setae and spines. Exopod with two, endopod with four plumose setae.

*Maxilla* (Fig. 80e) much as illustrated by Sewell except that the endopod is not a stout claw but is a well developed segment that terminates in a stout plumose seta and two plain setae.

*P. 1-P. 4* much as described by Sewell. In the *P. 1* the articulation between the last two endopod segments is complete. The coxa and the basis of *P.1-P.4* are naked. All setae of *P. 2-P. 4* are plumose, with the outer apical seta of the exopod having long fine plumes on the inner side and short spinules on the outer side.

*P. 5* : The form of the setae and spines is as described by Sewell but the outer two spines of the exopod and the inner spine of the basendopod are pectinate.

#### 56. *Diosaccus monardi* Sewell, 1940

(Figs. 80-81)

1940. *Diosaccus monardi* R.B.S. Sewell, *Scient. Rep. John Murray Exped.*, 7 : 244.

*Material examined* : VII, 74 ♀ ♀ 43 ♂ ♂

As with *D. hamiltoni* this species has been recorded only in the region of the Bay of Bengal—Gulf of Manaar (Krishnaswamy, 1957a) and the Nicobar Islands (Sewell, 1940).

Sewell's description is based on a single female and is perfectly adequate for identifying the species, which is unique in the genus in the short endopod of *P. 1*, but he does not describe some of the appendages and omits some details. Consequently we supplement his description. Krishnaswamy (1957a) recorded both sexes and gives a description of the male. He also records some females of a rather larger size than Sewell's and accords them the name of forma *major*. There can be no justification for this distinction. Our females range in size from 0.84 mm to 1.03 mm, effectively filling the gap between Sewell's female (0.85 mm) and Krishnaswamy's large specimens (1.15 mm). Our males were all between 0.82 mm and 0.85 mm.

#### Supplementary description

*Female* Rostrum short and broad (Fig. 80f). Genital suture almost complete, absent only mid-ventrally. Genital field as Fig. 80g. Abdomen without ornamentation except for minute spinules on the ventral distal edge of the last segment. Caudal ramus as Fig. 81c. The principal seta is not as bulbous as its base as is depicted by Sewell (1940, text-fig. 49A).

*Antennule* : First segment with small spinules on the first segment, exactly as in the male (Fig. 81d).

*Mandible* (Fig. 80h) : Pre-coxa very large, cutting edge with a large spine and four strong teeth. Coxa-basis elongate and with two rows of spinules distally; only one seta at the distal end. Exopod with one lateral and three terminal setae. Endopod absent.

*Maxillule* highly modified (Fig. 80i). Pre-coxal arthrite with two setae on the surface and a series of projections distally, all of which are fused to the segment. Despite many attempts the precise number and nature of these projections could not be seen clearly; Fig. 80i must be treated as an approximation. From the proximal end of the pre-coxa arises a leaf-like structure which bears a total of eight setae; there is no trace of differentiation into coxa, basis, exopod and endopod.

*Maxilla* modified (Fig. 80j). Syncoxa possibly without endites, but probably with a single distal endite bearing one seta. Basis terminating in a short blunt claw with one minute seta at its base. Endopod rudimentary, with two setae.

*Maxilliped* (Fig. 80k) : Coxa partially fused to the basis, with a row of spinules marking the junction. Basis with three distal setae and a row of spinules, plus a patch of hairs on the inner side. First endopod segment with an approximately straight hirsute inner edge, with one seta. Second endopod segment prehensile on the first and terminating in two minute setae and a claw.

*P. 1-P. 4* : Sewell (1940) accurately describes the general form. Figs. 81g, j and k illustrate the ornamentation of the coxa and basis (P. 3 is identical to P. 2). All the long setae of the rami are plumose, with both apical setae of the distal exopod segment of P. 2-P. 4 being of the form illustrated by Sewell for the outer apical seta of P. 4 (Sewell, 1940, text-fig. 49I).

*Male* differs from the female in the following respects.

*Abdomen* (Figs. 81a-b) : First two segments distinct. Ventral distal edge of segments two to four with spinules. Caudal ramus basically as in the female but the principal apical seta, while similarly curved, is not modified at its base.

*Antennule* sub-chirocerate, with segment four complex in structure (Fig. 81d-f).

*P. 1* (Fig. 81h) : Coxa as in the female except that the spinule row is composed of shorter spinules. Inner distal corner of the basis with a hyaline spine.

*P. 2* (Figs. 81l-n) : Coxa with only one spinule row on the outer edge and this is composed of longer spinules; distal edge with a mucroniform process. Basis as in the female except that the outer seta is stouter. Exopod similar to that of the female except that the third segment is much shorter. Outer spines of exopod much shorter and stouter than in the female. Endopod of two segments, and modified.

*P. 5* (Fig. 81o) : The pair of *P. 5* are confluent, with the exopod almost completely fused to the basendopod. Basendopod with a spine and a plumose seta. Exopod with two spines and two setae.

*P. 6* (Fig. 81a) a single plate with a long spine and two setae each side.

*Remarks* : In addition to the short endopod of *P.1* this species probably is unique in the genus with respect to the mandible, maxillule and maxilla. In those species in which the mandible has been described it always has an endopod, though it may be reduced to a rudiment and one seta. The pre-coxal arthrite of the maxillule is always curiously modified, but in a totally different manner to that of *D. monardi* (see, for example, *D. ezoensis* It<sup>o</sup>, 1974 and *D. spinatus* Campbell as redescribed by Lang, 1965). No other species appears to be modified in the coxa, basis and rami portion of the maxillule. Similarly the syncoxal endites of the maxilla are modified, but in other species there are always two well developed endites present. The endopod is present in some species (e.g. *D. ezoensis*) and absent in others (e.g. *D. spinatus*).

*D. monardi* thus appears to occupy an isolated apomorphic position within *Diosaccus*.

57. **Robertsonia propinqua** (T. Scott, 1894)  
(Fig. 82)

1894. *Robertsonia propinqua* T. Scott, *Trans. Linn. Soc. Lond.*, Sec. 2, 6 (Zool.) : 99

*Material examined* : II, 1 ♀ ; IV, 1 ♀ ; VII, 1 ♀ 2 ♂ ♂ ; VIII, 2 ♀ ♀ 2 ♂ ♂ ; XIII, 10 ♀ ♀ 3 ♂ ♂

This species has been described, in full or in part, five times from widely separated locations—T. Scott (1894) from the Gulf of Guinea; Sewell (1924) from Chilka Lake (as *Amphiascus scotti*); Candeias (1959) from Angola; Pallares (1970) from Argentina; Hamond (1973b) from Australia. Unfortunately there is sufficient disagreement between these descriptions for it still to be uncertain that they all refer to the same species. All agree that

- (a) the abdomen is densely clothed with spinules of a variety of sizes,
- (b) the female antennule is moderately long and five-segmented, though the terminal segment may show traces of subdivision,
- (c) the first endopod segment of *P. 1* is about as long as the entire exopod and that the second and third segments are approximately equal in length and not markedly reduced,
- (d) the first exopod segment of *P. 2-P. 4* possesses an inner seta, and
- (e) the two innermost setae of the basendopod of the female *P. 5*, and both setae of the male, are stout and bifid.

They disagree in the setation of some of the mouthparts and of the third exopod segment of P. 2-P. 4.

With regard to the mouthparts—

*Mandible* : Coxa-basis with several rows of spinules (Pallares), one row only (Hamond), without spinules (Sewell). Coxa-basis with five setae (Pallares), three setae (Hamond), two setae (Sewell). Endopod with five terminal setae (Pallares), six (Hamond) and three (Sewell). Exopod with three setae (Pallares) or four (Hamond). Sewell's illustration shows the exopod to be absent. We think that this is most unlikely and thus treat with caution his whole description. Scott and Candeias do not describe the mandible.

*Maxillule* : Basis with six setae (Pallares), five (Hamond) or four (Sewell). Endopod with three setae (Pallares) or four (Hamond and Sewell). Scott and Candeias do not describe the maxillule.

*Maxilla* : Pallares's illustration places the endopod lateral in position and reduced to a knob supporting four setae. This clearly is incorrect; presumably she is describing accessory setae of the basis. The endopod consists of three setae only. Hamond's illustration shows no trace of "accessory setae" located as described by Pallares. In the endopod position are two setae with a third close by which could be a seta of the basis. The other authors do not describe the maxilla.

*Maxilliped* : According to Scott the distal end of the basis is covered with minute hairs. The other authors do not show this but Sewell describes a row of long setules about halfway along the segment and Hamond shows a single spinule at the base of the proximal seta. Scott also depicts three plumose setae, one at the inner distal corner and two halfway along the inner side. All other authors except Pallares agree that there is a distal seta but only Hamond has a seta proximally, and then only one. The basis in Pallares's illustration is quite naked, but it is drawn in such a manner as to give the strong impression that she did not see this segment clearly. All authors agree that the inner side of the first endopod segment is hirsute but there is a considerable difference among them as to the degree of hairyness. All except Hamond depict only one seta, at the distal end; Hamond shows a second, about the middle of the inner side. The second endopod segment has a claw and a seta (Scott, Sewell Candeias, Pallares) or only a claw (Hamond). The inner distal corner is drawn out into a blunt projection according to all except Scott and Candeias.

Our individuals are as follows—

*Mandible* (Fig. 82a) : Coxa-basis with one row of large spinules distally and with some more on the inner edge. Coxa-basis with three setae. Endopod with five terminal setae. Exopod with four setae.

*Maxillule* agrees completely with Hamond's.



*Maxilla* (Fig. 82b) : The basis has no trace of the structure described by Pallares, but has two accessory setae at the base of the terminal claw. The endopod is well developed and indistinctly three-segmented.

*Maxilliped* (Fig. 82c) : Coxa has several rows of long spinules but the distal part is not hirsute in the sense depicted by Scott. There are three setae; one at the inner distal corner, one just external to this and one halfway along the inner edge. First endopod segment with two setae. Second endopod segment with a claw and two setae and with the inner distal corner drawn out into a blunt projection.

With regard to the third exopod segment of P. 2-P. 4—

*P. 2* : Undoubtedly there are two inner setae. According to Pallares and Candeias the distal seta is moderately well developed though shorter than the proximal seta. According to Hamond it is small and weak. Sewell's illustration of the juvenile male also shows a weak seta but in his illustration of the adult male, and in Scott's illustration also, it is absent. We believe this to be an oversight and to indicate that the seta is very thin and weak.

*P. 3* : Only Hamond describes this appendage, and the distal inner seta is small and weak.

*P. 4* : Pallares and Hamond both describe two well developed setae with a third seta distally. In all probability Scott's illustration of P. 3 refers to P. 4; it has similar setation to the P. 4 of Pallares and Hamond. Sewell does not describe this appendage. Candeias's description is radically different. There are only two setae and since the second of these has an extremely distal origin there can be no doubt that a third weak seta is not present. Also, the segment is relatively much shorter than that described by Scott, Pallares and Hamond. There is no way of knowing if this is a genuine difference or due to a developmental abnormality.

In our specimens the P. 2 is very similar to that described by Pallares and the P. 3 and P. 4 very similar to those described by Hamond.

These differences could be due to local variation, but while this may be a credible argument for the differences in leg setation and relative proportions of the setae not enough is known about inter-population variability in harpacticoid mouthparts for a reasonable judgment about these differences to be made. As Hamond (1973b, p. 430) states "whether more than one species is concealed under this name cannot be stated at present"; our specimens only add to this confusion.

As presently constituted this species is very widely distributed, having been reported from U.S.A. (South Carolina), Bermuda, Argentina, Angola, Ghana and the Gulf of Guinea, mediterranean France, the Suez Canal, Mozambique, Aldabra, Maldives Islands, Nicobar and Andaman Islands, Chilka Lake, Australia (Queensland), New Zealand and Puget Sound (U.S.A.).

58. **Robertsonia knoxi** (Thompson & A. Scott, 1903)

1903. *Robertsonia knoxi* I.C. Thompson & A. Scott, *Rep. Govt. Ceylon Pearl Oyster Fish. Gulf Manaar*, 1 : 262

*Material examined* : IV, 1 ♀ 4 ♂ ♂ ; VII, 3 ♀ ♀ 1 ♂ ; VIII, 2 ♀ ♀

*Remarks* : Por (1973) has given a detailed refutation of the view (Gurney, 1927b) that *R. salsa* Gurney, 1927a is synonymous with *R. knoxi*. Given this information we are confident that our specimens are to be referred to *R. knoxi* s. str. However, the descriptions of *R. knoxi* by Thompson & A. Scott (1903), Gurney (1927b), Sewell (1940), Marinov (1971) and Por (1973) show that there is some variability in the species. This is particularly true of the proportions of the segments of the endopod of P. 1 and our specimens agree most closely with those of Thompson & A. Scott. Por (1973) refers to the relative proportions of the apical spines of the caudal ramus in distinguishing *R. knoxi* and *R. salsa*. Our specimens agree with his in the proportions of the spines but the inner spine is plain and not pectinate. Marinov (1971) also shows this spine as plain.

Por's work possibly casts some doubt on the validity of earlier records of *R. knoxi* but, bearing in mind that he has shown that *R. salsa* is typically associated with hypersaline waters, it is most likely that all records of *R. knoxi*, with two exceptions, do refer to that species. One exception is that of Yeatman (1976). His description is not detailed enough for certainty but the P. 1 is quite unlike *R. knoxi* and is similar only to that of our new species *R. robusta*, whose description follows later. The exopod of the female P. 5 is more elongate than in any species of *Robertsonia*.

The other exception is that of Jakobi (1954a) who describes a new subspecies *R. k. brasiliensis*, from the male only. He bases his subspecific distinction on the presence of modifications to the P. 2 exopod, in which the outer spines are said to be more massive than in the female. It is not clear to us how he made this comparison since as far as we know the female P. 2 has not been described in detail for *R. knoxi*. Nevertheless it is clear even from Jakobi's poor illustration that the spines are large. Por (1973), even in his detailed account, does not comment on such a feature and our specimens do not show any such sexual dimorphism. Later in this paper, however, we do show that it does occur in *R. adduensis* (Sewell, 1940). The P. 1 of Jakobi's male has a much more slender first endopod segment than has been reported in *R. knoxi*. An estimation of the true nature of *R. knoxi brasiliensis* awaits the discovery of females and a complete redescription.

If the records of Jakobi (1954a) and Yeatman (1976) are discounted *R. knoxi* has now been recorded from U.S.A. (North Carolina), Bermuda, mediterranean France, Algeria, Yugoslavia, Sea of Marmara, Bulgaria, Israel coast and the Sirbonian Lagoon, the Suez Canal, Gulf of Aqaba, Mozambique, Maldivé Islands, Gulf of Manaar, and the Andaman Islands.

59. **Robertsonia adduensis** (Sewell, 1940)  
(Figs. 82-84)

1940. *Robertsonia adduensis* R.B.S. Sewell, *Scient. Rep. John Murray Exped.*, 7 : 314

*Material examined* : VII, 16 ♀ ♀ 5 ♂ ♂

*Remarks* : The female of this species has been described by Sewell in sufficient detail for us to be certain that our specimens are referable to it. Compared with other species of the genus it has the distinctive combination of a P. 1 in which the first endopod segment is considerably longer than the entire exopod, the lack of an inner seta on the first exopod segment of P. 2-P. 4, a distinctive setation of the third exopod segment of P. 2-P. 4 and the form of the principal apical seta of the caudal ramus.

Our sample contain males which agree with the females in all these respects except for the caudal seta and thus we associate them together. However, the males show some small modifications to the exopods of P. 2-P. 4. The outer spines, and particularly that of the second segment, are generally stouter. The differences are not marked but are quite real (cf. Figs. 84a and b). Such sexual dimorphism is unknown in the genus except for the problematical *R. knoxi brasiliensis*.

The species has been recorded only in the Maldive Islands (Sewell, 1940), Gulf of Manaar (Krishnaswamy, 1957a) and the Andaman Islands.

**Supplementary description**

*Female* : Length 875  $\mu\text{m}$  (cf. 640-660  $\mu\text{m}$  by Sewell, 600  $\mu\text{m}$  by Krishnaswamy). Body shape and rostrum as depicted by Sewell. Cephalothorax and thorax unornamented except for some spinules laterally on the fourth free thoracic segment. Genital field as Fig. 83a. Abdominal segments with distal spinules and lateral spinule rows as in Figs. 83a-b. Caudal ramus twice as broad as long; principal apical seta relatively short and expanded at its base, the form of this basal portion is variable.

*Antennule* as depicted by Sewell except that in our specimens there are six distinct segments.

*Antenna* as depicted by Sewell.

*Mandible* (Fig. 82d) of similar design to that of other species in the genus but lacking in accessory spinule rows.

*Maxillule* and *maxilla* exactly as in our specimens of *R. propinqua*.

*Maxilliped* of the normal genus type (Fig. 82e).

*P. 1-P. 4* generally as depicted by Sewell. We need only to add further details of the ornamentation of the coxa and basis (Figs. 84a, d, f; *P. 3* is identical to *P. 2*) and state that the transverse spinule row on the first exopod segment depicted by Sewell only on *P. 4* is present on *P. 1-P. 4*.

*P. 5* as depicted by Sewell except that the two inner setae of the basendopod are bifid.

*Male* differs from the female in the following respects.

*Length* 660  $\mu\text{m}$ .

*Abdomen* (Figs. 83c-d) : First two segments distinct. Distinct ventral spinule rows on segments two to four. Caudal ramus as in the female except that the principal apical seta is elongate and not swollen at its base (Fig. 83e).

*P. 1* : Rami as in the female. Coxa with an additional distal spinule row. Basis without spinules above the spine but with a striated spatulate outgrowth at the inner distal corner (Fig. 84e).

*P. 2-P. 4* : Coxa and basis as in the female. Outer spines of the exopod segments somewhat stouter, especially that of the middle segment of *P. 2* (Fig. 84b). Endopods as in the female except for that of *P. 2* which is modified as shown in Figs. 84b-c.

*P. 5* (Fig. 82f) : The pair of *P. 5* are confluent. Basendopod with two stout bifid spines. Exopod with six setae and spines.

*P. 6* (Fig. 83c) of each side a lappet fused to the segment with some surface spinules and with a long seta flanked on each side by a short plumose spine.

**60. *Robertsonia robusta* n.sp.**  
(Figs. 84-87)

*Material examined* : XIII, 1 ♀ 4 ♂ ♂

*Holotype* male, XIII (C 2835/2) and *Paratypes* (C 2836/2) deposited with the Zoological Survey of India, Calcutta.

**Description**

*Female* : Length 750  $\mu\text{m}$ . Body with pronounced demarcation between metasome and urosome; cephalothorax relatively short (Fig. 85a). Rostrum large. Hyaline frill plain on the cephalothorax and free thoracic segments but finely denticulate on the abdomen. Caudal ramus (Figs. 85b-c) about twice as broad as long,

with two well developed apical setae. Genital suture dorsal and lateral only, with the first segment of the genital somite well demarcated dorsally (Fig. 85b). Genital field as Fig. 85c.

*Somitic ornamentation* : Last free thoracic segment with lateral and dorsal spines and rows of spinules. Abdomen copiously supplied with spines and rows of spinules (Figs. 85b-c).

*Antennule* (Fig. 84g) short and robust; five-segmented.

*Antenna* (Fig. 84h) short and robust. Coxa visible but fused with the allobasis. Second endopod segment copiously spinose. Exopod short, three-segmented.

*Mandible* (Fig. 85d) and *Maxilliped* (Fig. 84i) of usual genus type. *Maxillule* and *Maxilla* exactly as in *R. propinqua* (Figs. 82a-b).

*P. 1-P. 4* (Figs. 86a-c, 87a) very similar in general form and in accessory spinulation to other species of the genus, but rather shorter and stouter. *P. 1* (Fig. 86a) with the first endopod segment longer than the entire exopod. Second and third segments reduced.

*P. 5* (Fig. 87b) : Inner expansion of the basendopod extends to the distal end of the exopod; with five setae, the inner two being bifid. Exopod almost circular in shape, with six setae.

#### *Setal formula*

	Exp.			Enp.		
P. 1	0.	1.	0.2.3.	1.	1.	2.
P. 2	0.	1.	2.2.3.	1.	1.	1.2.1.
P. 3	0.	1.	2.2.3.	1.	1.	3.2.1.
P. 4	0.	1.	3.2.3.	1.	1.	2.2.1.

*Male* differs from the female in the following respects.

*Length* 630  $\mu\text{m}$ .

*Abdomen* (Figs. 87c-d) : First two segments distinct. Ventral distal edge of segments two to four with a complete row of strong spinules.

*Antennule* sub-chirocerate (Fig. 87e).

*P. 1* : Coxa and rami as in the female. Basis (Fig. 86d) with the inner spine relatively shorter. Inner edge of basis with a spatulate projection.

*P. 2* : Coxa, basis and exopod as in the female. Endopod modified (Fig. 85e).

*P. 5* (Fig. 86e) : The pair of *P. 5* are confluent. Basendopod with two bifid spines. Exopod short and broad, with six setae and spines.

*P. 6* (Fig. 87d) of each side a lappet with three setae.

*Etymology* : The trivial name refers to the short and robust nature of the antennule, antenna and *P. 1-P. 5* (*L. robustus*—strong).

*Remarks* : In general the species of *Robertsonia* are separated from each other on rather small points of difference in setation and in proportions of the *P. 1*. Ornamentation of the abdomen may prove to be a useful character but it is still imprecisely known for some species. Nevertheless, it is clear that ornamentation is extensive in several species and *R. robusta* is similar to, at least, *R. propinqua*, *R. knoxi* and *R. angolensis* Monard, 1934 in this respect. In setation of *P. 2-P. 4* it is closer to *angolensis* than to *propinqua* or *knoxii*. In terms of proportions of the endopod of *P. 1*, with the last two segments reduced in size, *R. robusta* is similar to *R. hamata* Willey, 1930, *R. flavidula* Willey, 1930 and *R. monardi* Klie, 1937 but in these species the proportions of the endopod to the exopod are rather different. Also, *R. robusta* seems to be unique in the short stature and robust nature of the antennule and antenna.

#### 61. *Amphiascus propinquus* Sars, 1906

1906. *Amphiascus propinquus* G. O. Sars, *An Account of the Crustacea of Norway. V. Copepoda Harpacticoida* : 158

*Material examined* : II, 3 ♀ ♀ 2 ♂ ♂ ; III, 4 ♀ ♀ 6 ♂ ♂

*Remarks* : Wells (1968) considers that *A. angustipes* Gurney, 1927b is a synonym. The only complete and detailed description of *A. propinquus* is that of Vervoort (1962, as *A. angustipes*) though several authors give partial descriptions, viz.,

Thompson & A. Scott (1903)—*Stenhelia minuta* n.sp. (= *Amphiascus angustipes* nom. nov. Gurney, 1927b),

Sars (1906)—*Amphiascus propinquus* n. sp.,

Gurney (1927b)—*A. angustipes* nom. nov.,

Brian (1927b)—*A. sinuatus* var. *indistinctus* nov. (removed to *A. angustipes* by Lang, 1948),

Monard (1928)—*A. imus* (removed to *A. angustipes* by Lang, 1948),

Willey (1930)—*A. propinquus* (removed to *A. angustipes* by Lang, 1948),

Petkovski (1955a)—*A. angustipes*,

Noodt (1955b)—*A. angustipes*,

Bodin (1964)—*A. angustipes*,

Marinov (1974a)—*A. angustipes*.

These descriptions give tantalising glimpses of possible sources of variation which, if known in detail, might form the basis for a rational taxonomy. They are—

- (a) Abdominal ornamentation of both sexes.
- (b) Relative proportions of the segments of the female antennule.
- (c) Relative proportions of the segments of the endopod of P. 1.
- (d) Relative proportions of the basendopod to exopod in the female P. 5.
- (e) Length to breadth ratio and general shape of the exopod of the female P. 5.
- (f) Setation of the exopod of the male P. 5.

There are references also to differences in setation of the third exopod segment of the P. 4 and to the form of the endopod of the male P. 2. However, in the former it is purely a matter of whether some authors have overlooked the presence of a fine and weak distal seta and in the latter the differences probably are due to the orientation of observance of this ramus.

At present we support Wells's (1968) contention that there is insufficient evidence to counter a suggestion that *A. propinquus* and *A. angustipes* are synonymous.

Our specimens agree with those of Vervoort (1962) in abdominal ornamentation, the female antennule and the P. 1. They are identical to those of Sars (1906) in the P. 5 of both sexes.

As presently constituted, and accepting all reported finds as valid, the species is widely distributed in warm waters from Bermuda, throughout the Mediterranean Sea, the western Black Sea, the Suez Canal, Mozambique and Aldabra in the Indian Ocean, Sri Lanka, Andaman Islands and New Caledonia. It is also present in north west Europe (Norway, Sweden, Kiel Bay and south west England) and there is even a single record from the Arctic Ocean (Beaufort Sea ; Montagna & Carey, 1978).

## 62. *Amphiascus parvus* Sars, 1906

1906. *Amphiascus parvus* G.O. Sars, *An Account of the Crustacea of Norway, V. Copepoda Harpacticoida* : 162

*Material examined* : II, 1 ♀ ; VII, 15 ♀ ♀ 5 ♂ ♂ ; VIII, 2 ♀ ♀ 1 ♂

*Remarks* : Our specimens seem to be referable to this relatively common species. They agree in all essential details with the original description of the female (Sars, 1906), particularly in the antennule, P. 1 and P. 5, which are the variable features in the *pacificus*-group of *Amphiascus*. They also agree with the limited descriptions of the male given by Monard (1928) and Willey (1935).

However, the abdomen is relatively unornamented; in fact, the ornamentation is identical to another member of this group, *A. undosus* Lang, 1965. This is in direct contrast to the type-material in which, according to Lang (1948), all abdominal segments have a distal spinule row. It was because of a statement by Monard (1928)

that his material lacked such ornamentation that Lang (1948) recorded as uncertain his 1926a and 1928 records of *A. parvus*. For this reason there must be some doubt that our specimens are conspecific with the type-material, but in view of the known variability in other species of *Amphiascus* we prefer to include them in *A. parvus* until a proper revision is made. Such a revision will need to be based on material collected over the entire geographic range of the species, which is—Iceland, Norway, Heligoland, British Isles, east coast of U.S.A., Bermuda, mediterranean France, Italy, northern Adriatic Sea, Algeria, Tunisia, Sea of Marmara, Red Sea, Madras and the Andaman Islands.

63. *Amphiascus cinctus* (Claus, 1866)  
(Figs. 88-90)

1866. *Amphiascus cinctus* C. Claus, *Schr. Ges. Befr. d. ges. Naturw. Marburg*, Supplement 1 : 27

*Material examined* : IV, 4 ♀ ♀ 13 ♂ ♂ ; V, 1 ♀ ; VI, 1 ♀ ; VII, 15 ♀ ♀ 9 ♂ ♂ ; VIII, 13 ♀ ♀ 12 ♂ ♂ ; IX, 14 ♀ ♀ 7 ♂ ♂ ; XIII, 30 ♀ ♀ 25 ♂ ♂

*Remarks* : Following Lang's (1948, 1965) widely accepted reviews *A. cinctus* can be accepted either as a virtually cosmopolitan species (absent only in the Arctic and Antarctic) with a high degree of inter-population variability or as a species complex with, at present, indefinable boundaries between the component species. The variability is extensive and affects almost all parts of the body. Different populations overlap in parts of this variation and Lang (1965) suggests that only crossing experiments can solve the problem.

While the degree of inter-population variation can be estimated from the literature as being extensive, only Willey (1935) has recorded a significant example of intra-population variation. Willey could only comment on females. He found two types which differed in (a) the exopod of P.5, (b) the degree of constriction of the third abdominal segment, (c) the proportions of P. 1 and (d) colour. He considered that one type of female which did not have ovisacs but sometimes carried an attached spermatophore was a "submature" form which received the spermatophore. These females proceeded to become "mature" and could then "extrude" the eggs. This maturation process did not, he believed, require an ecdysis.

Our populations show a similar type of phenomenon but with more specimens for study we can show that it may have little to do with maturation and may be a true example of intra-population variability between adults of both sexes.

Like Willey we have two types of female, but we also have two corresponding types of males. The varieties are distinguished largely on the ornamentation of the abdomen, though there are differences also in other features.

*Type 1*. In which the major spinule groups are composed of large sharply pointed spinules with relatively few spinules in each row. The mid ventral rows on the female third and fourth segments are divided into two groups. Segments three and four



may have some naked striae (Figs. 88a-c, 90a-c). The first endopod segment of P. 1 is longer than the entire exopod and the distal segments of both rami are short (Fig. 88d). The exopod of the female P. 5 is not deeply emarginate (Fig. 88g). Coxa and basis of P. 1-P. 4 as Figs. 88e-f.

*Type 2.* In which the spinule groups on the dorsal surface are composed of a relatively large number of narrow truncated spinules with parallel sides. The mid ventral row on segment three of the female is a single row, as is the very short row on segment four. The spinules on the ventral distal edge of the last segment also are numerous and truncate. Segments two and three of the female bear rows of minute spinules rather than naked striae (Figs. 89a-c, 90d). The first endopod segment of P. 1 is only as long as the entire exopod and the distal segment of both rami is relatively long (Fig. 89d). The exopod of the female P. 5 is deeply emarginate (Fig. 89f). Coxa and basis of P. 1-P. 4 as Fig. 89e. In addition many females of Type 2 were found in which the mid ventral spinule row was absent on segment three and sometimes on segment four also.

Both types are identical in antennule, antenna and mouthparts and in these appendages they agree entirely with the material described by Lang (1965). Males of both types are identical in their ventral spinulation.

The distribution of these varieties lends credence to the belief that they do represent two morphs within a single population. In only one sample (Stn. IX) was there no variability. A further point in favour of this view is that one male at Station VII and two females at Station VIII were intermediate in spinule type. In each case the number of spinules was as large as in Type 2 but they were smaller and were sharply pointed.

Ovigerous females of both types were found and an empty spermatophore was found attached to one female of each type. All the males had well developed spermatophores within their bodies. None of the Type 2 females with reduced ventral spinulation was ovigerous and only one had a spermatophore attached.

The distribution of the morphs is as follows. In this list we have differentiated the Type 2 females with reduced ventral spinulation from those with complete spinulation.

Stn.	♀ Type 1	♀ Type 2		♂ Type 1	♂ Type 2
		complete	reduced		
IV	0	3	1	1	12
V	0	1	0	0	0
VI	0	1	0	0	0
VII	7	6	2	6	3
VIII	3	6	4	1	11
IX	14	0	0	7	0
XIII	3	22	5	0	25

We conclude from these data that while they do not entirely refute Willey's (1935) views they do indicate that intra-population variation is more deeply seated than he supposed. They show that it is extensive and to some extent support the proposition that *A. cinctus* is a single species rather than a species complex.

Lang (1965) regarded both *A. longipes* Nicholls, 1941a and *A. australis* Nicholls, 1941a as possible synonyms of *A. cinctus*. There can be no doubt that he is correct for *A. longipes* but *A. australis* has significant differences in the rostrum and female antennule and may well represent a distinct species.

**64. *Metamphiascopsis hirsutus* (Thompson & A. Scott, 1903)**  
(Figs. 90-91)

1903. *Metamphiascopsis hirsutus* I.C. Thompson & A. Scott. *Rep. Govt. Ceylon Pearl Cyster Fish, Gulf Manaar*, 1 : 269

*Material examined*: IV, 15 ♀ ♀ 5 ♂ ♂ ; VII 12 ♀ ♀ 12 ♂ ♂ ; VIII, 4 ♀ ♀ 6 ♂ ♂ ; IX, 10 ♀ ♀ 8 ♂ ♂

*Remarks* : Both sexes of this species have been adequately redescribed by Sewell (1940) and Yeatman (1976) and the male by Vervoort (1964). Our specimens agree well with these descriptions and we add only further detail about the ornamentation of the abdomen (Figs 91a-f). and of the coxa and basis of P. 1-P. 4 (Figs. 91g-i). The species has a very wide distribution—Bermuda, Jamaica, Cape Verde Islands, Mediterranean Sea, the Suez Canal, Maldive Islands, Gulf of Manaar, Andaman Islands, Western Australia, Caroline Islands, Japan, China—and shows some variability. Willey (1931, 1935) distinguished Bermudan specimens as a distinct subspecies on the form of the spinules of the outer edge of the basendopod of the female P. 5. This seems to us to be a very small difference on which to make subspecific distinction but Willey's illustration is quite clear on this point and Yeatman (1976) finds a similar condition in specimens from Jamaica. As Sewell (1940) and Vervoort (1964) point out, there is some variability in the exopod of the mandible which is variously reported as absent (Monard, 1928), two-segmented (Sewell, 1940) or one small segment fused to the basis (Vervoort, 1964). In our specimens, of both sexes, it is either one segment with an indistinct separation into two, or two clearly defined segments.

**65. *Metamphiascopsis nicobaricus* (Sewell, 1940)**  
(Figs. 92-93)

1940. *Metamphiascopsis nicobaricus* R.B.S. Sewell, *Scient. Rep. John Murray Exped.*, 7 : 252.

*Material examined* : IV, 5 ♀ ♀ 3 ♂ ♂ ; VII, 10 ♀ ♀ 5 ♂ ♂ ; VIII, 14 ♀ ♀ 15 ♂ ♂

*Remarks* : This species is characterized chiefly by the presence of only two inner setae on the third exopod segment of the P. 4. In his description Sewell (1940) chooses to contrast it with *M. banyulensis* (Monard, 1928) rather than with the sympatric

*M. hirsutus*. There is no doubt that it is a good species well differentiated from *M. hirsutus* on size, P. 4 setation, P. 5 of both sexes (cf. Figs. 90g and 91k with Figs. 93a-b), abdominal ornamentation (cf. Figs. 91a-f and 92a-f), ornamentation of the coxa and basis of P. 1-P. 4 (cf. Figs. 91g-i and 92g-i) and in the length to breadth ratio of the caudal ramus (cf. Figs. 91a-f and 92a-f).

Our specimens differ slightly from Sewell's in that—

- (a) The exopod of the mandible may be a single segment or indistinctly separated into two segments. In both cases it differs from *M. hirsutus* in bearing only three setae.
- (b) In the female P. 5 (Fig. 93a) the outer edge of the basendopod bears far more spinules and the fourth and fifth setae (from the inner edge) of the exopod are much longer.
- (c) In the male P. 5 (Fig. 93b) the innermost seta of the exopod is much shorter and the outermost seta much longer.

*M. nicobaricus* has also been reported from the Nicobar and Maldiva Islands (Sewell, 1940), Gulf of Manaar (Krishnaswamy, 1957a) and Fiji (Wells, 1978). However, reexamination of the Fijian material shows it to be *M. hirsutus*.

**66. *Bulbamphiascus imus* (Brady, 1872)**  
(Fig. 93)

1872. *Bulbamphiascus imus* G.S. Brady, *Ann. Mag. nat. Hist.*, 4(10) : 436

*Material examined* : II, 1 ♀

*Remarks* : The genus *Bulbamphiascus* was erected by Lang (1944) as part of his revision of *Amphiascus*. As conceived by him (Lang, 1944, 1948) it contained only two species—*B. imus* and *B. denticulatus* (Thompson, 1893)—distinguished mainly on the presence in the latter of a spur on the second antennule segment. Lang synonymised several species with *B. imus* and thus admitted an amount of variability in the species, mainly with respect to the shape and setal proportions of the female P. 5. At that time the male was very inadequately described. The situation is little better now, the only additional information being the descriptions of the male P. 5 by Bodin (1964) and Wells (1961). In view of the lack of detailed descriptions Lang's definition of *B. imus* was, and remains, plausible. Four further species of the genus have now been described. Of these *B. minutus* Dinet, 1971 is quite different in P. 5 and the setation of P. 2-P. 4 and undoubtedly is a good species. *B. chappuisi* Rouch, 1962 has such a peculiar female P. 5 that it also can stand alone. No such case can be made for the two remaining species.

*B. angustifolius* Klie, 1950, known only from the female, appears to differ from *B. imus* (sensu Lang, 1948) only in degree. Firstly, the terminal setae of the basendopod of P. 5 are both very short, but this condition is closely approached by *Stenhelina longirostris* Norman & T. Scott, 1905 (a synonym of *B. imus*). Secondly, the

fourth exopod seta is normal and not "bulb-shaped", but the degree of variation in this character is considerable and the *angustifolius* condition is very similar to that of the *B. imus* of Dinet (1971). We propose that *B. angustifolius* sink as a synonym of *B. imus*.

*B. inermis* (Sewell, 1940), described as *Amphiascus*, is known only from the male. The species has been recorded since (Castel, 1980 ; Castel & Lasserre, 1976, 1979 ; Lasserre *et al.*, 1975 ; Marcotte & Coull, 1974), but these records do not carry with them a description of the species. Sewell correctly rejects conspecificity with *B. denticulatus* but he makes no comparison with species now contained within *B. imus*. There seems to be nothing exceptional about *B. inermis*. The setation of P. 1-P. 4 is *imus*-like. The male P. 5 is slightly different from that described by both Bodin (1964) and Wells (1961), but these differ between themselves. Otherwise they are identical with males of *B. imus* we have examined, i.e. the records of Wells (1961, 1963, 1967). We propose, therefore, that *Amphiascus inermis* also sink as a synonym of *B. imus*.

There is in our collection a single female which is typical of *B. imus* in all respects except for the basendopod of P. 5, in which the third seta is entirely absent (Fig. 93c). The fourth seta of the exopod is reduced to a small "bulb" Given the variability within *B. imus* we believe that this specimen should be placed in this species.

*B. imus* as we now constitute it must be considered a cosmopolitan species, having been recorded from the Arctic, mainland Europe from Norway to the English Channel, the British Isles, North Carolina, Bermuda, U.S. Virgin Isles, Argentina, throughout the Mediterranean and Black Seas, Mozambique, the Andaman and Nicobar Islands, Western and South Australia, New Zealand and Puget Sound.

#### 67. *Robertgurneya rostrata* (Gurney, 1927)

1927. *Robertgurneya rostrata* R. Gurney, *Trans. Zool. Soc. Lond.*, **22** : 527

*Material examined* : II, 2 ♀ ♀ 1 ♂ ; IV, 7 ♀ ♀ 3 ♂ ♂ ; VII, 2 ♀ ♀ ; VIII, 1 ♀ 2 ♂ ♂ ; IX 30 ♀ ♀ 22 ♂ ♂ ; XII, 2 ♀ ♀ ; XIII, 2 ♀ ♀

*Remarks* : This species has been completely redescribed by Vervoort (1964) whose material agrees with that of Gurney (1927b), Monard (1928), Klie (1942) and Noodt (1955b) in having only one inner seta on the distal segment of the exopod of P. 3. Our present specimens also have only one seta, as do those of Wells (1967), which we have reexamined. Sewell's (1940) female, in which this segment has two inner setae, is thus the only report of variability in this species.

*R. rostrata* appears to be confined to relatively warm waters, having been reported from North Carolina, Bermuda, Caribbean Sea, throughout the Mediterranean Sea, Sea of Marmara, the Suez Canal, Mozambique, Maldiv Islands, Nicobar and Andaman Islands, and the Caroline Islands.

68. *Robertgurneya brevipes* n.sp.  
(Figs. 93-95)

*Material examined* : VIII, 4 ♀ ♀

*Holotype* female, VIII (C 2837/2) and *Paratypes* (C 2838/2) deposited with the Zoological Survey of India, Calcutta.

**Description :**

*Female* : Length 410  $\mu$ m. Body about four times as long as broad (Fig. 93d), almost linear in shape with the metasome only slightly wider than the urosome and the abdomen without taper. Cephalothorax rounded anteriorly, becoming slightly broader posteriorly. Rostrum (Fig. 93h), long, narrow and acutely pointed, extending almost to the end of the second antennule segment; articulating with the cephalothorax. Genital suture complete dorsally and extending well on to the ventral side. Anal operculum simple. No trace of a pseudoperculum. All somites, except the last, with a deep, plain hyaline frill. Caudal ramus (Figs. 93f-g) much broader than long; with two well developed terminal setae, the outer being much shorter than the inner. Genital field simple. P. 6 rudiment with only two setae.

*Somatic ornamentation* : Cephalothorax and all segments except the last two with sensilla. The only other ornamentation is a group of spinules mid-ventrally on the second abdominal segment and spinules on the distal edge of the last segment. (Fig. 93e).

*Antennule* relatively short (Fig. 93h); of eight segments of which segments five to seven are extremely short. An aesthete on segment four.

*Antenna* (Fig. 94a) : Coxa clearly distinguishable. Allobasis with a partial separation between the basis and endopod on the posterior surface only. Exopod robust, three-segmented. Second segment with a seta. Third segment with one lateral and two terminal setae, these being short and stout.

*Mandible* (Fig. 94b), *maxillule* (Fig. 94c), *maxilla* (Fig. 94d) and *maxilliped* (Fig. 94e) are of the genus type and show no remarkable features.

*P. 1* (Fig. 94f) : Pre-coxa large. Coxa with several rows of spinules of a variety of form. Basis with an outer plumose seta and a massive inner spine which has large accessory spinules distally. Both rami three-segmented. Middle exopod segment not elongate; distal segment much longer than broad. All exopod segments lack an inner seta. First endopod segment very short for a species of *Robertgurneya*, not reaching to the end of the exopod. Second and third segments relatively long. Outer edge of all segments with massive spinules.

*P. 2-P. 4* (Figs. 94g, 95a-b) : Pre-coxa large and clearly distinct in P. 2 and P. 3, much reduced in P. 4; with the demarcation from the coxa marked on the anterior

surface by a row of minute spinules. Coxa with a row of long, fine spinules at the outer distal corner and, in P. 2 and P. 3 only, with a transverse row of small spinules towards the inner side. Basis with a weak outer seta. Both rami three-segmented. Endopod longer than the exopod in P. 2 and P. 3, shorter than the exopod in P. 4. Outer edge of all segments with massive spinules, though these are somewhat smaller on the basal segments of P. 4. Setation as below.

*P. 5* (Fig. 94h) : Inner expansion of the basendopod not reaching to halfway along the exopod; with four setae only. The two inner setae are stout and pectinate and the two outer setae elongate and thin. Exopod about twice as long as broad, the sides nearly parallel; with five setae only, all of them well developed.

*Setal formula*

	Exp.			Enp.		
P. 1	0.	0.	0.2.2.	1.	1.	0.2.1.
P. 2	0.	1.	1.2.3.	0.	2.	1.2.1.
P. 3	0.	1.	1.2.3.	1.	1.	1.2.1.
P. 4	0.	1.	2.2.3.	1.	1.	1.2.1.

*Male* unknown.

*Etymology* : The trivial name refers to the very short endopod of P. 1 (*L. brevis*—short, and *pes*—a foot).

*Remarks* : The species of *Robertgurneya* present a series of reductions in quantity of somitic ornamentation and in complexity of setation of P. 2-P. 5 from the presumably primitive condition displayed by, for example, *R. spinulosa* Sars, 1911. These trends are not always correlated together. *R. brevipes* is among the least ornamented of species and thus bears some resemblance to *R. ilievecensis* Monard, 1935a (re-described by Hamond, 1973c). However, it is unique in the endopod of P. 1 to such an extent that the diagnosis of the genus (Lang, 1944) requires amendment to accommodate it. We place it in this genus because of the general similarity to other species in body shape, genital field, form of the P. 2-P. 5, caudal ramus and the last segment. Except for *Amphiascoides* (?) *arabicus* Noodt, 1964, referred with reservations to *Robertgurneya* by Lang (1965), it is unique in the genus in bearing only one inner seta on the third endopod segment of P. 3.

69. *Typhlamphiascus ovale* n.sp.  
(Figs. 95-97)

*Material examined* : II, 3 ♀ ♀ ; III, 1 ♀ 1 ♂

*Holotype* female, II (C 2839/2) and *Paratypes* (C 2840/2) deposited with the Zoological Survey of India, Calcutta.

## Description

*Female* : Length 1.23 mm. Body slender, almost linear (Fig. 96a). Cephalothorax and all segments except the last with a deep hyaline frill which is plain on the cephalothorax and thoracic segments but is finely divided to about one-third of its depth on the abdomen (semi-incised subulate in the terminology of Moore, 1976b). Genital suture dorsal and lateral. Genital field simple (Fig. 96d). Anal operculum simple; no trace of a pseudoperculum. Rostrum slender, elongate, acutely pointed and without a marked basal dilation (Fig. 95c). Caudal ramus (Figs. 96e-f) barely longer than broad; both edges slightly convex.

*Somitic ornamentation* (Fig. 96b) : All somites except the last two with sensilla. Abdomen ornamented only with a small group of spinules on either side of the mid-ventral line of segment three and with small spinules on the distal edge of the last segment.

*Antennule* relatively long, eight-segmented (Fig. 95d).

*Antenna* (Fig. 95e) : Coxa clearly distinguishable. Allobasis with a partial separation between the basis and endopod on the posterior surface only. Exopod three-segmented; first segment elongate, second segment short and without a seta. Third segment with one lateral and three terminal setae.

*Mandible* (Fig. 95f), *maxillule* (Fig. 95g), *maxilla* (Fig. 95h) and *maxilliped* (Fig. 95i) all of the form typical of the genus and differing only slightly from other species.

*P.1* (Fig. 97a) : Pre-coxa rudimentary. Coxa with several rows of spinules. Basis with the outer portion reduced; with strong spines at both distal corners. Both rami three-segmented, the endopod prehensile. Exopod segments normal; middle segment not elongate, terminal segment not reduced. First endopod segment elongate but not extending to the end of the exopod. Second segment short, third segment relatively long. Setation as below.

*P.2-P.4* (Figs. 97b-d) : Pre-coxa distinct. Coxa with several rows of spinules. Basis with the outer portion reduced. Outer distal corner with a stout spine in P.2 and a weak seta in P.3-P.4. Both rami three-segmented; those of P.2 and P.3 approximately equal in length. Endopod of P.4 considerably shorter than the exopod. Setation as below.

*P.5* (Fig. 97e) : Inner expansion of the basendopod extends only to about half-way along the exopod; with five setae, the outer two reduced and the inner two bifid. Exopod oval in shape; with six setae of which the second and fourth from the outer side are reduced to spinule-like proportions.

*Setal formula*

	Exp.			Enp.		
P.1	0.	1.	0.2.3.	1.	1.	3.
P.2	1.	1.	1.2.3.	1.	2.	1.2.1.
P.3	1.	1.	1.2.3.	1.	1.	2.2.1.
P.4	1.	1.	2.2.3.	1.	1.	1.2.1.

*Male* differs from the female in the following respects.

*Length* 1.21 mm. *Abdomen* (Fig. 96c) : First two segments distinct. Ventral distal edge of segments two to four spinulose.

*Antennule* sub-chirocerate (Fig. 96g).

*P.1* (Fig. 96h) : Basis with a knob of chitin at the inner proximal corner and with a complex palmate structure at the inner distal corner.

*P.2 endopod* modified as in Figs. 96i-j.

*P.5* (Fig. 96k) : The pair of P.5 are confluent. Basendopod with two large bifid spines. Exopod with six setae; all except the inner two are very reduced.

*P.6* (Fig. 96c) of each side a lappet with three long setae.

*Etymology* : The trivial name refers to the shape of the exopod of the female P.5 (Fr. *ovale*, from L. *ovum*—an egg).

*Remarks* : This species is distinguished from all those in this genus that have been adequately described in the form of the abdominal ornamentation, and from most in its sparseness. The exopod of the female P.5 is shorter and more ovoid than in any other species. The caudal ramus is distinctive. *T ovale* seems to resemble *T lamellifer* (Sars, 1911) more than any other, and in particular the subspecies *T.1. capensis* Kunz, 1975, but there are numerous differences which in our view prevent conspecificity.

### 70. *Amphiascoides subdebilis* (Willey, 1935)

1935. *Amphiascus subdebilis* A. Willey, *Ann. mag. nat. Hist.*, 10 : 64

*Material examined* : II, 35 ♀ ♀ 31 ♂ ♂ ; IV, 1 ♀ ; VI, 30 ♀ ♀ 10 ♂ ♂ ; VII ♀ ♀ ; VIII, 2 ♀ ♀ 2 ♂ ♂ ; IX, 26 ♀ ♀ 17 ♂ ♂ ; XII, 5 ♀ ♀ 2 ♂ ♂ ; XIV, 11 ♀ ♀ 13 ♂ ♂

*Remarks* : This species is not completely described by Willey and supplementary information on specimens assigned to it has been published by Noodt (1955b), Bodin



(1964), Vervoort (1964), Tschislenko (1967), Drzycimski (1969) and Pallares (1975a). In addition Lang (1948) placed the *A. debilis* of Monard (1928) in the species.

Lang (1965) makes the point that from Willey's description it can be logically inferred that *A. subdebilis* is similar to *A. debilis* (Giesbrecht, 1881) in all features that he chose not to describe and thus that the fourth female antennule segment is not elongate (being about as broad as long), the endopod of P.1 is slender with the first segment longer than the entire exopod and with the third segment more than twice as long as broad. It is also clear that the endopod of the male P.2 differs from *A. debilis*, perhaps significantly. In *A. debilis*, as in most species of the genus, the second segment has the apex extended into a long smoothly tapering mucroniform process. Also, the inner side bears two distal setae, the proximal of which is very short and the distal elongate. In *A. subdebilis* as described by Willey (1935) the apical process is perhaps not such a smooth continuation of the segment and the relative proportions of the inner setae are reversed.

In the subsequent descriptions of *A. subdebilis*, and in our specimens, there are some differences which could be considered significant.

1. In Vervoort's (1964) female the endopod of P.1 is quite stout. The first segment cannot be described as slender and it is barely as long as the exopod. The third segment is only just twice as long as broad and is not significantly longer than the second segment.
2. In Tschislenko's (1967) female the fourth antennule segment is rather longer than broad.
3. In the males described by Noodt (1955b), Drzycimski (1969) and Pallares (1975a) the endopod of P.2 is barely distinguishable from that of *A. debilis*.
4. In our females the P.1 is slender and *debilis*-like but the fourth antennule segment is twice as long as broad. The male P.2 is indistinguishable from that described by Noodt (1955b) and Pallares (1975a).
5. Abdominal ornamentation of the female differs among the several descriptions. According to Willey only the third segment has a mid-ventral row of spinules. Our survey of the literature, together with a re-examination of material in the senior author's collection, and of Vervoort's material, reveals this amount of variation :—

absent entirely	Vervoort (1964) Caroline Islands
on segment 3 only	Willey (1935) Bermuda
on segments three and four	Wells (1965b) Scotland Wells (1967) Mozambique
	present paper Andaman and Nicobar Islands
on segments two, three and four	Monard (1928) mediterranean France Wells (unpublished) California

How significant is this variation? Lang (1948, 1965), by placing the *A. debilis* of Monard (1928) and *A. subdebilis* var. *intermixtus* Willey, 1935 firmly in *A. subdebilis*, accepts variability in the P.5 and abdominal ornamentation at least, despite his frequently stated strong views on the species constancy of the latter. We believe that until the genetic basis of these sources of variation is known it is fruitless to speculate on whether more than one species are presently held together in *A. subdebilis*, but we do have some basic doubts regarding the differences in the male P.2. This is an important adjunct in the mating process but as we have no knowledge of precisely how it functions we cannot make a judgement on the importance of small differences in structure. One thing is certain; a redescription of material from the type-locality is a necessary prerequisite for any revision of *A. subdebilis*.

### 71. *Paramphiascella robinsoni* (A. Scott, 1902)?

1902. *Dactylopus robinsoni* A. Scott, *Proc. Trans. L'pool biol. Soc.*, **16** : 415.

*Material examined* : IV, 5 ♀ ♀ 5 ♂ ♂ ; VII, 6 ♀ ♀ 1 ♂ ; VIII, 1 ♀ 1 ♂ ; IX, 26 ♀ ♀ 56 ♂ ♂

*Remarks* : This species was originally described from females only. The male was described later by Gurney (1927b) and Willey (1930) whose descriptions apparently were overlooked by Sewell (1940) who believed that his *Amphiascus* sp. could be the male of *P. robinsoni*. Later still Pallares (1968a) described a male as *P. robinsoni* apparently also in ignorance of the descriptions by Gurney and Willey, as well as of the *Amphiascus* sp. of Sewell, since none of these papers are referred to in her bibliography of the species.

Species of *Paramphiascella* are distinguished from each other by a number of small differences among which is the exact nature of the endopod of the male P.2. For some species this is the only available character since the females are more or less identical or differ in characters inadequately described for some species (Marcotte, 1974). Even here, however, some of the earlier descriptions need to be treated with caution since it has been noted, by Karl Lang among others, that the modified spines and setae of the male P.2 can appear to be quite different when viewed in alternative orientations.

*P. robinsoni* has a three-segmented exopod of the antenna, which is of the common diosaccid form with a minute aetose second segment. The endopod of the P.1 is only as long as, or a little shorter than, the entire exopod. The caudal ramus is much broader than long and the caudal setae are not modified. The rostrum is not bifid and the antennule segments are rather short. The female abdomen lacks ornamentation. The exopod of P.5 is a distinctive shape in both sexes, particularly in the female. Our specimens agree with all these features except for the antennal exopod, which definitely is only two-segmented.

According to both Gurney (1927b) and Willey (1930) the second segment of the male P.2 endopod has a terminal modified spine but is without lateral inner setae; the inner edge has a small conical protuberance. Our males are identical to those of Pallares (1968a) and are very similar to those described by Gurney and Willey but they do have two inner setae. We examined males in a variety of orientations and found that while we could orient the P.2 endopod so that the terminal spine was partially masked by the terminal mucroniform process of the segment we could not totally obscure the lateral setae without also obscuring from view the conical projection of the inner edge. Our observations support the specimens of Gurney and Willey as conspecific and explain the differences between them, but they must throw doubt on whether our males (and Pallares's) can be included in the same species. However, we can offer an hypothesis which may explain these differences. It is just possible that both Gurney and Willey examined specimens in which the lateral setae had become detached. This actually happened to one of our specimens during an attempt to alter its orientation. When it was then viewed in anterior view the sites of the origin of these setae could not be detected. It is for this reason, backed up by the correspondence in all other features except the antennal exopod that we are prepared to place our specimens in *P. robinsoni*, albeit tentatively.

The *Amphiascus* sp. male of Sewell (1940) is radically different in that it lacks a terminal spine and is of a quite different overall shape. Marcotte (1974) considers it to be the male of *P. mediterranea* Lang, 1948.

If we accept all the records of *P. robinsoni* as valid, its distribution is—North Carolina, Bermuda, Argentina, the Suez Canal, Mozambique, to the east of the Laccadive Islands, off the coast of Kerala, Gulf of Manaar, Andaman Islands.

## 72. *Schizopera spinifer* n. sp. (Figs. 97-99)

*Material examined* : IV, 1 ♀; XIV, 1 ♂

*Holotype* male, XIV (C 2841/2) and *Paratype* female (C2842/2) deposited with the Zoological Survey of India, Calcutta.

### **Description**

*Female* : Length 535  $\mu$ m. Body linear, about six times as long as broad. Cephalothorax rounded anteriorly. Cephalothorax and thoracic segments with a plain hyaline frill; that of the abdominal segments is finely divided for about half its depth (semi-incised subulate in the terminology of Moore, 1976b). Rostrum long, narrow and pointed, and extending to the end of the second antennule segment (Fig. 97f). Genital suture dorsolateral and lateral only. Genital field as Fig. 98a. Caudal ramus (Fig. 99a) less than 1.5 times as long as the broadest part. Inner distal corner with spinules. Two well developed terminal setae, the outer rather

short; neither is modified. Outer distal corner with a short, stout spine. Entire body without ornamentation other than spinules at the distal edge of the last segment and the usual sensilla at the distal edge of all somites except the last. Anal operculum a simple semi-lunar flap.

*Antennule* (Fig. 97g) eight-segmented with segments five to seven rather short.

*Antenna* (Fig 98b) with distinct coxa. Allobasis with the separation between the basis and endopod visible on one side only. Endopod segments rather short. Exopod of two equal and rather long segments. First segment with one seta at the inner distal corner. Second segment with three terminal setae, one of which is stout and bifid.

*Mandible* (Fig. 98c) with a complex cutting edge. Exopod a small stump fused to the basis. Endopod of the usual form.

*Maxillule* (Fig. 98d) : Pre-coxal arthrite with four stout spines and a single seta only. Coxa and basis of the usual form. Exopod and endopod reduced to small stumps fused to the basis.

*Maxilla* (Fig. 98e) : Syncoxa with three endites, all fused to the segment, proximal one very reduced. Basis terminating in a claw and a stout seta. Endopod of one segment with four setae.

*Maxilliped* prehensile (Fig. 98f); of the usual genus form.

*P1.* (Fig. 98g) : Pre-coxa large; articulation with the coxa marked by a row of small spinules. Coxa with long spinules near the inner edge and with several diagonal rows of spinules on the outer half of the anterior surface. Basis with stout inner and outer spines. Exopod of three sub-equal segments. Endopod two-segmented, prehensile. First segment extending to about the middle of the third exopod segment. Second segment elongate, about one-third the length of the first. Outer edge of all segments with large spinules. First exopod segment with a proximal transverse spinule row.

*P.2-P.4* (Fig. 99h-i) are all of similar slender build, with the rami about equal in length. Pre-coxa distinguishable but firmly fused to the narrow coxa. Basis with a stout outer spine. Rami three-segmented; outer edge of all segments with large spinules. First exopod segment with a proximal transverse spinule row. Setation as below.

*P.5* very small (Fig 99h). Inner expansion of the basendopod extends to about half the length of the exopod; with two inner pectinate spines, a long plumose seta and a short outer bifid spine. Exopod about 1.5 times as long as broad, with three inner setae and three outer plumose spines.

*Setal formula*

	Exp.			Enp.		
P.1	0.	0.	0.2.2.	1.	3.	
P.2	0.	0.	0.2.2.	0.	1.	1.2.1.
P.3	0.	0.	0.2.2.	1.	1.	0.2.1.
P.4	0.	0.	0.2.2.	1.	1.	0.2.1.

*Male* differs from the female in the following respects.

*Length* : 460  $\mu\text{m}$ . *Abdomen* with the first two segments distinct.

*Antennule* sub-chirocerate (Fig. 99b).

*P.1* with the inner side of the basis bearing a large pointed chitinous projection and with the inner spine displaced medially (Fig. 99c).

*P.2* endopod modified as shown in Figs. 99d-f.

*P.3* as in the female except for the presence of the characteristic flattened hyaline spine on the inner edge of the third exopod segment (Fig. 99g).

*P.5* (Fig. 99i) : The pair of *P.5* are confluent. Basendopod with two stout spines, the inner elongate and plumose, the outer short and pectinate. Exopod with two inner plumose spines and three outer setae.

*P.6* of each side a simple semi-lunar lappet without setae.

*Etymology* : The trivial name refers to the outer spines of the exopod of the female *P.5* (*L. spinifer*—thorn bearing).

*Remarks* : This species would appear to be most similar to *S. lacusamari* Por & Marcus, 1972 from the Great Bitter Lake in the Suez Canal. The resemblances are numerous—two-segmented antennal exopod, two-segmented *P.1* endopod, general size and shape of the caudal ramus and the form of its outer distal spine, and, particularly, the *P.5* and female genital field. In the *P.5* *S. lacusamari* and *S. spinifer* appear to be unique in the genus in the form of the three outer spines of the female exopod. *S. lacusamari* differs in setation of the endopod of *P.2* and *P.3*, a somewhat shorter first endopod segment of *P.1*, the modified terminal setae of the caudal ramus and in the highly modified male antennule. The mouthparts of *S. lacusamari* are not well described and a comparison with *S. spinifer* is not possible. Wells & Rao (1976) have amended the description of *S. lacusamari*, pointing out that the male does have the characteristic hyaline spine on *P.3*.

73. *Eoschizopera reducta* Wells & Rao, 1976

1976. *Eoschizopera reducta* J.B.J. Wells & G.C. Rao, *Zool. J. Linn. Soc. Lond.*, **58** : 84.

*Material examined* : III, 5 ♀ ♀ 2 ♂ ♂

74. *Helmutkunzia variabilis* n. sp.

(Fig. 99-102)

*Material examined* : II, 7 ♀ ♀ 2 ♂ ♂ ; VI, 8 ♀ ♀ ; XII, 5 ♀ ♀ 1 ♂

*Holotype* female, II (C 2843/2) and *Paratypes* (C 2844/2) deposited with the Zoological Survey of India, Calcutta.

**Description**

*Female* : Length 370-390  $\mu$ m. Body linear, about six times as long as broad; cephalothorax rounded anteriorly (Fig. 100a) All somites except the last with a deep hyaline frill which is plain on the cephalothorax and thorax but on the abdomen is divided for about half its depth into moderately broad "teeth" (a version of the semi-incised subulate condition of Moore, 1976b). Genital suture lateral and dorsolateral only. Genital field as Fig. 100b. Rostrum elongate, narrow and pointed. Anal operculum simple. No trace of a pseudoperculum. Caudal ramus (Figs. 100c-d) about as long as broad, inner side with a transverse row of spinules. Median two apical setae not modified. Outer distal corner with a long seta bulbous at its base.

*Somatic ornamentation* confined to sensilla on all somites except the last two, fine setules on the anal operculum and spinules on the distal edge of the last segment and on the caudal ramus (Figs. 100c-d).

*Antennule* (Fig. 100e) eight-segmented, the last four very small and together about as long as the third and fourth segments combined. Second segment elongate. An aesthete on the fourth segment.

*Antenna* (Fig. 100f) : Coxa well differentiated from the basis. Basis weakly defined from the endopod. Exopod three-segmented, first segment elongate, with a seta at the outer distal corner. Second segment minute and without setae. Third segment with one inner and two terminal setae, one of the latter being very thick.

*Mandible* (Fig. 99j) : Cutting edge complex. Coxa-basis broad, with four setae. Exopod a single segment with six setae. Endopod of two clearly defined segments but with traces of subdivision in the proximal segment.

*Maxillule* (Fig. 99k) : Individual parts not well defined. Pre-coxal arthrite with seven or eight spines and two setae terminally; without surface setae. Coxa and

basis each with two setae. Endopod and exopod large, the former a single lobe with two setae, the latter bilobed with four setae.

*Maxilla* (Fig. 100g) : Syncoxa with three endites, each with two setae. Basis terminating in a broad claw with a seta at its base. Endopod of three fused segments.

*Maxilliped* (Fig. 100h) : Coxa well defined. Basis with two setae at the inner distal corner. First endopod segment with a seta towards the distal end of the inner side, which also bears spinules. Second endopod segment well defined and large, with two setae and a terminal claw.

*P.1* (Fig. 100i) : Pre-coxa very large and well defined. Coxa with a number of rows of spinules of a variety of sizes. Basis with a small outer spine and a massive inner spine; spinules above the origin of the inner spine and on the distal edge above the origin of the endopod. Exopod three-segmented, the first segment the longest. Endopod three-segmented. First segment extends to the end of the entire exopod; about 1.4 times as long as the second and third segments together. Third segment elongate, about twice as long as the second segment. Outer edge of all segments spinulose.

*P.2-P.4* (Figs. 101a-c) : Pre-coxa well defined. Coxa with large spinules at the outer distal corner and with a transverse row of spinules on the inner half of the segment. Basis with an outer seta and with the inner distal corner produced as a small unguiform projection. Rami three-segmented and approximately equal in length. Outer edge of all segments spinulose. Setation as below.

*P.5* (Figs. 102a-d) : Inner expansion of the basendopod extends almost to the end of the exopod. Exopod without much curvature of the sides, about twice as long as broad. This appendage is variable in its setation. In the large majority (16 of the 20) each ramus has five setae (Fig. 102a). In two females the right P.5 is normal while the left has six setae on the basendopod and a normal exopod (Fig. 102b). In one the left P.5 is normal while the right has six setae on the basendopod and four on the exopod (Fig. 102c). In one other female both rami have only four setae in the right P.5, the left being normal (Fig. 102d). In all cases the two inner setae of the basendopod are spiniform.

#### *Setal formula*

	Exp.			Enp.		
P.1	0.	0.	0.2.2.	1.	1.	3.
P.2	0.	1.	0.2.2.	1.	1.	0.2.1.
P.3	0.	1.	0.2.2.	1.	1.	1.2.1.
P.4	0.	1.	1.2.2.	1.	1.	1.2.1.

*Male* differs from the female in the following respects.

Length 340  $\mu\text{m}$ . Abdomen with the first two segments distinct.

Antennule haplocerate (Fig. 101d).

*P.1 basis* with a heavily chitinized projection of the inner edge; inner spine large, curved and displaced medially (Fig. 101e).

*P.2 endopod* (Fig. 101f) two-segmented. First segment with an inner seta. Second segment without modified spines; with a seta at the proximal end of the inner side and with one terminal seta. Distal edge prolonged as a short mucroniform projection.

*P.5* (Fig. 102e) : The pair of *P.5* are confluent. Basendopod with two stout plumose spines. Exopod small, with five setae.

*P.6* (Fig. 102f) : The *P.6* consists of a medial aetose lappet with a distinct notch laterally separating it from a more heavily chitinized portion which bears three short setae.

*Etymology* : The trivial name refers to the variable nature of the female *P.5* (*L. variabilis*—variable).

*Remarks* : This species seems to be more primitive than the only other member of the genus, *H. hartmannorum* (Kunz, 1971) and thus is a closer link to the presumed ancestral genus, *Eoschizopera* Wells & Rao, 1976, and less close to the presumed descendent genus, *Balucopsylla* Rao, 1972 (see Wells & Rao, 1976, for a discussion of these affinities). The similarity in antennule, antenna, female genital field, caudal ramus and male *P.2* establish the two species as congeneric. *H. variabilis* is more primitive in the *P.5* of both sexes and in the male *P.2*.

#### 75. *Balucopsylla triarticulata* n. sp. (Figs. 103-104)

*Material examined* : I, 1 ♀ 4 ♂ ♂ ; II, 22 ♀ ♀ 7 ♂ ♂ ; III, 100 ♀ ♀ 42 ♂ ♂ ; VI 20 ♀ ♀ 1 ♂ ; X, 21 ♀ ♀ 7 ♂ ♂ ; XII, 7 ♀ ♀ 2 ♂ ♂ ; XIII, 6 ♀ ♀ 1 ♂ ; XIV, 2 ♀ ♀ 3 ♂ ♂ ; XV, 18 ♀ ♀ 8 ♂ ♂

*Holotype* female, III (C 2845/2) and *Paratypes* (C 2846/2) deposited with the Zoological Survey of India, Calcutta.

#### Description

*Female* : Length 460-600  $\mu\text{m}$ . Body linear, about eight times as long as broad (Fig. 103a). Cephalothorax elongate, rounded anteriorly and about as long as the three succeeding segments together. Thoracic segments short, abdominal segments



elongate. Abdomen about as long as the cephalothorax and thorax together. Rostrum elongate, narrow and pointed (Fig. 103d). Genital suture represented by a small dorsolateral patch of thickened chitin. Genital field as Fig. 103c, setae of the P.6 very long. Anal operculum absent; hyaline frill of the penultimate segment forms a shallow pseudoperculum (Fig. 103b). Caudal ramus (Fig. 103b) slightly longer than broad; the two median apical setae not modified but the outer distal corner bears a short bulbous spine. Cephalothorax and all somites except the last and the fourth free thoracic segment with a wide hyaline frill, which is plain on the cephalothorax and thorax but finely divided on the abdomen (semi-incised subulate in the terminology of Moore, 1976b).

*Somitic ornamentation* is confined to sensilla and to large dorsolateral spinules on the distal edge of the last segment.

*Antennule* (Fig. 103d) eight-segmented with segment two elongate and segments five to seven very small. The last four segments together are only about one quarter of the length of the first four.

*Antenna* (Fig. 103e) with basis without setae. First endopod segment bare. Exopod three-segmented, the second very small and without a seta. One plumose seta on the first segment. Third segment with one lateral and one terminal seta.

*Mandible* (Fig. 103f) : Cutting edge with two unguiform projections and four multidentate teeth. Palp well developed. Coxa-basis rather narrow, with three setae and a spinule. Endopod of one segment. Exopod of two segments, the second with a flattened, blunt spine laterally and a spine and a seta terminally.

*Maxillule* (Fig. 103g) : Pre-coxal arthrite with four teeth and at least three setae. Two long setae on the pre-coxa. Coxa with two terminal setae. Basis with two lateral setae and terminally with two spines and a seta. Exopod and endopod each of one segment.

*Maxilla* (Fig. 103h) : Syncoxa with three endites. Basis with a terminal unguiform projection. Endopod represented by two setae.

*Maxilliped* well developed and prehensile (Fig. 103i). Coxa fused with the basis, which has two setae at the inner distal corner. Inner edge of the first endopod segment with long spinules, a small plumose seta about halfway along and a seta at the distal corner. Second segment large, with a terminal claw and seta.

*P.1* (Fig. 104a) : Pre-coxa small. Coxa large, with a transverse row of long spinules on the inner part and two rows of spinules near the outer distal corner. Basis with the outer part very short; with an outer seta and an inner spine. Rami three-segmented. Exopod segments elongate, the first the longest. First endopod segment reaches to the end of the entire exopod. Second and third segments well developed, the third about twice as long as the second. Outer edge of all segments spinulose.

*P.2-P.4* (Figs. 104b-d) : Pre-coxa small. Coxa large, with a row of spinules at the outer distal corner and another, medial row. Basis with the outer half shorter than the inner, but much less so than in *P.1*; with a weak outer seta. Rami three-segmented, elongate and slender. Outer edge of all segments spinulose, except the first of the endopod. Setation as below.

*P.5* (Figs. 104e-f) : Inner expansion of the basendopod well developed, with three setae and a massive pectinate spine. Exopod with five setae. See below for comments on variability in this appendage.

*Setal formula*

	Exp.			Enp.		
<i>P.1</i>	0.	0.	0.2.2.	1.	1.	2.
<i>P.2</i>	0.	1.	0.2.2.	0.	1.	0.2.1.
<i>P.3</i>	0.	1.	0.2.2.	1.	1.	0.2.1.
<i>P.4</i>	0.	1.	1.2.2.	1.	1.	0.2.1.

*Male* without sexual dimorphism in *P.2-P.4* ; differs from the female in the following respects.

*Length* : 450-580  $\mu\text{m}$ .

*Abdomen* : First two segments distinct.

*Antennule* (Fig. 104g) sub-chirocerate; of eight clearly defined segments, the second elongate as in the female.

*P.1* (Figs. 104h-i) : Inner edge of the basis heavily chitinized and with a large unguiform projection. The inner spine is very stout and curved and is displaced medially.

*P.5* (Fig. 104j) : The pair of *P.5* are confluent. Inner expansion of the basendopod reaches halfway along the exopod; with one small seta and a massive plumose spine. Exopod oval, with five setae, the middle seta very long.

*P.6* (Fig. 104k) of both sides fused together forming a single plate with three setae each side, the middle seta very long.

*Variability* : The size distribution of both sexes is distinctly bi-modal. The majority of females measure between 460  $\mu\text{m}$  and 480  $\mu\text{m}$  but about 20% lie between 560-600 $\mu\text{m}$ . Not all locations have large females, which are most common at Stn. X. Most males measure between 450  $\mu\text{m}$  and 480  $\mu\text{m}$  but a few at Stn. X are in the range 560-580 $\mu\text{m}$ .

Variability also was observed in the female P.5, with two distinct morphs. The usual P.5 is that illustrated in Fig. 104e in which the inner seta of the exopod is slender, the pectinate spine of the basendopod is only marginally set on the posterior surface and the whole exopod is a short oval. In some of the large females, but not all, the P.5 is as illustrated in Fig. 104f, with the inner seta of the exopod bulbous at its base and tapering to a fine lash and with the pectinate spine of the basendopod more massive and distinctly originating on the posterior surface. The whole exopod is longer and less oval in shape. Females of this type also have a longer and less bulbous outer terminal spine on the caudal ramus. The large males show no difference, except their size, to the small ones.

*Etymology* : The trivial name refers to the three-segmented exopod of the antenna (L. *tri*—three, and *articulus*—a joint).

*Remarks* : This species is more primitive than the only other species in the genus, *B. similis* Rao, 1972, in the exopod of the antenna but is more advanced in the greater reduction of setation of the endopods of P.2 and P.3. The absence of sexual dimorphism in the P.2 endopod establishes that the two species are congeneric and distinct from *Helmutkunzia* Wells & Rao, 1976. The three-segmented antennal exopod reinforces our opinion (Wells & Rao, 1976) that the two genera are closely related.

#### **Parialysus Nicholls 1941b**

This genus was erected to receive *Tydemanella robusta* Nicholls, 1941a as its sole species. Nicholls give a detailed justification for the distinction of this species at the genus level from *Tydemanella* A. Scott, 1909 and *Ialysus* Brian, 1927a. We see no reason to doubt his judgement. In 1940 Sewell described two new species as *Ialysus investigatoris* and *I. proximus*. In doing so he admitted that they showed certain fundamental differences from *Ialysus* and *Tydemanella* and concluded by stating "It may therefore be necessary in future to erect a new genus for these two species" (Sewell, 1940, p. 236). In 1941 Nicholls was unaware of Sewell's paper but he discusses these species in an addendum to a later paper (Nicholls, 1945a, p. 15). His conclusion is rather curious in that he believes that *I. proximus* "at first sight would appear to be congeneric with *Parialysus*", but does not state why he would exclude *I. investigatoris*. He points out that the setal formula given for *I. investigatoris* is unusual but can be explained by assuming that Sewell mistakenly identified P.3 as P.2, P.4 as P.3 and P.2 as P.4, which remains the only logical explanation. Unfortunately we cannot trace Sewell's material. We are forced, therefore, to rely on logic and we propose formally that *Ialysus investigatoris* and *I. proximus* be transferred to *Parialysus*. As Sewell admits, *I. proximus*, of which only the male is known, may be only a variant morph of *I. investigatoris*, but there are differences and this issue cannot at present be resolved. The major difference between *P. robustus* and Sewell's species is that the mandible palp is two-segmented in the former but only one-segmented in the latter.

76. *Parialysus robustus* (Nicholls, 1941)  
(Fig. 105)

1941. *Tydemanella robusta* A. G. Nicholls, *Rec. S. Aust. Mus.*, 6 : 417.

*Material examined* : IV 2 ♀ ♀ ; VII, 7 ♀ ♀ 3 ♂ ♂

*Remarks* : This species has been described, in full or in part, four times—by Nicholls from South Australia (1941a), Western Australia (1945a) and the Red Sea (1944), and by Vervoort (1964) from the Caroline Islands. Differences exist between these descriptions and between them and our specimens, but most of these are due to faulty observation by Nicholls or Vervoort. We have examined the type-material (one specimen of each sex), now lodged in the South Australian Museum, and two of Vervoort's animals lodged as dissected specimens on slides in the United States National Museum. Vervoort states that he found two adult females and two juveniles, one a Stage V male. His slides are labelled "ad. ♀" and "♀ cop." but we find that the former is a Stage V female and the latter probably a Stage IV female. It seems unlikely that Vervoort actually had a mature female since his description clearly is of a copepodid (e.g. see his Fig. 96f). If this is so then some of the differences, notably the stubby antennule, are easily explained. However that may be we can make the following statements about the nature of this species.

1. The third exopod segment of P.1 always bears four setae and spines. Nicholls's statement (1941a) that there are only three is wrong in that his male has four and in the female the impression that only three were present is due to the spine at the outer distal corner being broken off flush with the segment edge.
2. It must now be suspected that the caudal ramus always bears a total of five apical setae, with their proportions being as depicted by Vervoort (1964). The South Australian specimens are identical with Vervoort's and with ours. It is obvious that Nicholls failed to observe both minute setae (1941a) and the outer apical seta (1945a).
3. The mandible palp always has four setae on the second segment, two being apical and two subapical, one on each side.
4. The maxilla does not have a syncoxal endite as Vervoort illustrates it in any of the specimens that we have examined. The basis bears four setae as in Fig. 105e.
5. The basis of the maxilliped always has fine hairs arranged in two transverse rows proximal to the origin of the setae. Vervoort indicates the position but not the extent of these rows.
6. Vervoort states that "all abdominal segments are nude" in his immature male and that they "bear no spinules" in the mature female. Our observations

of his two immature females show that a short row of spinules is present mid-ventrally on the distal edge of segment four and that segment five bears a sinuous row of spinules ventrally. Nicholls does not mention ornamentation and apart from the usual small spinules above the origin of the cadual rami, the type-material female is quite naked. Our specimens are ornamented as shown in Figs. 105a-c, with the male being identical to the female except for the ventral distal spinulation. Nicholls's male is identical to ours. Note that our specimens do not have ventral spinules on segment five.

7. There is a slight difference in the length of the inner seta of the P.5 exopod between our males (Fig. 105g), and that of Nicholls (1941a). Nicholls fails to note the small spinules on the outer edge of the basendopod of both sexes; they are not present on Vervoort's immature females.

We do not believe that these differences preclude conspecificity of all specimens.

#### Family METIDAE

##### 77. *Metis holothuriae* (Edwards, 1891)

1891. *Abacola holothuriae* C.L. Edwards, *Arch. Naturgesch.*, **57** : 92

*Material examined* : II, 1 ♀ ; IV, 4 ♀ ♀ 1 ♂ ; VI, 2 ♀ ♀ ; VII, 2 ♀ ♀ ; VIII, 1 ♀ 3 ♂ ♂ ; XIII, 13 ♀ ♀ 7 ♂ ♂

*Remarks* : This eurytopic species is found in coastal waters and sediments in warm temperate and tropical areas throughout the world, extending into colder waters on the east coast of north America and in the English Channel. It has been described many times and shows no remarkable variation throughout its range, which is—east coast of North America from Massachusetts to Florida, Bermuda, Bahamas, Jamaica, U.S. Virgin Isles, Brazil, Angola, Gulf of Guinea, Canary Isles, English Channel, throughout the Mediterranean Sea (but not in the Black Sea), Suez Canal, Red Sea, Aden, Mozambique, Aldabra, Maldive Islands, Sri Lanka, Nicobar Islands, Andaman Islands, Thailand, Lombok, Celebes, Borneo, Fiji, Samoa, Western and South Australia, Caroline Islands, Easter Island in the Pacific Ocean, Japan.

#### Family AMEIRIDAE

##### 78. *Ameira longipes* Boeck, 1864

1864. *Ameira longipes* A. Boeck, *Forh. Vidensk Selsk. Krist.*, 1864 : 273

*Material examined* : IV, 3 ♀ ♀ ; VII, 1 ♀ 2 ♂ ♂ ; VIII, 1 ♀ 2 ♂ ♂ ; IX, 12 ♀ ♀ 4 ♂ ♂

*Remarks* : These specimens accord well with the redescription by Lang (1965), differing only in the rather shorter endopod of P.3. The species probably is cosmopolitan, with the gaps in its distribution reflecting scant collecting rather than real

absence, though it is difficult to explain the lack of records from the western coast of the north Atlantic in this manner. Commonly it is sympatric with *A. parvula*. In these circumstances it is usually much less abundant and thus there exists a potential for misidentification. It is, perhaps, more widely distributed than *A. parvula* in Arctic waters. Its known distribution is—Arctic Ocean (Spitzbergen, White Sea, Franz-Josef Land, Hoffnung Islands, Grinell Peninsula), Hudson Bay, European Atlantic from Norway to Portugal, British Isles, Argentina, the Mediterranean Sea, Bulgaria, Mozambique, Andaman Islands, Caroline Islands, China, California, Puget Sound.

79. *Ameira parvula* (Claus, 1866)  
(Figs. 106-107)

1866. *Canthocamptus parvula* C. Claus, *Schr Ges. Beford. ges. Naturw. Marburg*, Supplement 1: 30

*Material examined* : II, 2 ♀ ♀ 1 ♂ ; IV, 9 ♀ ♀ ; VI, 4 ♀ ♀ 8 ♂ ♂ ; VII, 5 ♀ ♀ ; VIII, 6 ♀ ♀ ; IX, 3 ♀ ♀ ; XIII, 3 ♀ ♀ 3 ♂ ♂ ; XV, 1 ♀ 2 ♂ ♂

*Remarks* : The enormous variability of this widely distributed species is reviewed by Moore (1976a). Further variation has been reported by Mielke (1974, 1975) and now our specimens add to this record.

While some of the reported variability may be due to faulty observation (Moore, 1976a) it is clear that most is genuine and, further, that it cannot be correlated with distribution. Present data, therefore, can only support the concept of a highly variable species. However, it may be concluded with confidence that the third exopod segment of P.4 always has three inner setae, the distal of which is thin, small and weak (Fig. 107d). Thus forma *tenuiseta* Willey, 1929 has no validity.

Since the only difference between *A. parvuloides* Lang, 1965 and *A. parvula* is that the antenna exopod is of one segment with three terminal setae in the former and of one or two segments with only two terminal setae in the latter, the validity of their separate specific status is doubted by Moore (1976a). Although the antenna exopod in *A. parvula* has been variously reported as being of one or two segments Moore (1976a) believes that the articulation between the very small second segment and the much larger first segment has not been observed by many earlier workers, and even by more recent authors (e.g. Dinet 1971, Kunz 1975, Pallares 1975a). Observations on a range of material in our possession supports Moore's contention that two segments are always present, as shown in Fig. 106h. However, since it is quite apparent that the condition of the antenna exopod in *A. parvuloides* cannot be derived from *A. parvula* by the simple fusion of the two segments, as this would result in there being two terminal setae and one sub-terminal seta, we believe that *A. parvuloides* must be regarded as a distinct species.

Our specimens fall within the reported range of variation except for some differences in the male P.5 (Fig. 106k). No variability exists among our specimens.

*A. parvula* almost certainly is a cosmopolitan species. As stated above it is often found together with *A. longipes*. Compared with that species it seems to be less widespread in the Arctic Ocean (only recorded from Spitzbergen, the White Sea and Franz-Josef Land) but is well known on the eastern coasts of north America from the Gulf of St. Lawrence to the Virgin Isles and Bermuda; it has been recorded in the Canary Isles and South Africa, Maldive Islands, New Caledonia and New Zealand but not from China or the west Coast of U.S.A. *A. parvula* has been collected at many more localities on the European Atlantic coast and the Mediterranean and Black Sea littoral than has *A. longipes*.

#### 80. *Sicameira langi* Rao, 1972

1972. *Sicameira langi* G. C. Rao, *Cah. biol. mar.*, 13 : 316.

*Material examined* : III, 3 ♀ ♀ ; X 1 ♀

*Remarks* : These specimens agree entirely with the original description. The male remains unknown.

#### 81. *Psyllocamptus (Psyllocamptus) minutus minutus* Sars, 1911

1911. *Psyllocamptus minutus* G.O. Sars, *An Account of the Crustacea of Norway. V. Copepoda Harpacticoida* : 423.

*Material examined* : XIII, 1 ♀

*Remarks* : This specimen is placed in the the nominate subspecies as the antenna exopod has three setae; without males the identification is tentative (Wells & McKenzie, 1973). In abdominal ornamentation it agrees with specimens of this subspecies from Mozambique (Wells, 1967) and Aldabra (Wells and McKenzie, 1973).

#### 82. *Nitocra spinipes* Boeck, 1864

1864. *Nitocra spinipes* A. Boeck, *Forh. Vidensk Selsk. Krist.*, 1864 : 274.

*Material examined* : III, 2 ♀ ♀ 1 ♂ ; V, 4 ♀ ♀ ; VI, 4 ♀ ♀ 4 ♂ ♂ ; XI, 2 ♀ ♀ 1 ♂ ; XII, 101 ♀ ♀ 17 ♂ ♂ ; XIV, 2 ♀ ♀ ; XV, 2 ♀ ♀ 1 ♂

*Remarks* : This variable and euryhaline species has been divided into three subspecies, largely on differences in ornamentation of the female abdomen, and principally on two points, viz.,

- (a) Presence (*spinipes* s.str. and *armata* Lang, 1965) or absence (*orientalis* Sewell, 1924) of an anterior lateral spinule row on segments three and four.

- (b) The distal spinule row on segments two to four is lateral and ventral only (*spinipes*), lateral and dorsal only (*orientalis*) or more or less circum-segmental (*armata*).

The male shows corresponding differences but these are less well documented.

Other characteristics are variable also, in particular the number of spines on the anal operculum and the number of setae on the basendopod of the male P.5 (Douwe, 1905; Gurney, 1932; Lang, 1965; Noodt, 1955b; Roe, 1958 as *N. parafragilis* which Lang (1965) considers a synonym), but these variations overlap between the subspecies. There are eight to fourteen anal operculum spines in *spinipes*. The early literature records the same range for *orientalis*, but the single male found by Wells (1967) has only five spines. There are ten to twelve spines in *armata*. There are from two to five setae on the male P.5 basendopod in *spinipes* and *orientalis* and four in *armata*.

We have examined in detail about half of the females and all of the males from Station XII and all specimens from the rest of the Stations. All have six to eight anal spines except for four females from Stn. V and one female and three males from Stn. VI which have only three spines. All males have four setae on the P.5.

Distribution lends support to the concept of subspecies in *N. spinipes*—

*spinipes* s.str.—Atlantic Ocean northwards from Brazil [*N. fragilis paulistana* Jakobi, 1956, which Lang (1965) considers a synonym] to Massachusetts in the west and from the Canary Isles to Iceland in the east; Mediterranean and Black Seas.

*orientalis*—Suez Canal, Red Sea, Mozambique, Bay of Bengal and, possibly, Japan (Tanaka & Jong, 1966).

*armata*—California.

However, this discrete pattern is disturbed by the five females and three males from our present collection already noted as unique in their anal operculum spines and a single female from the Sea of Marmara (Noodt, 1955b) which have an abdominal ornamentation as in *armata*.

If we add to this the known variability of ornamentation in *spinipes* s.str. (e.g. compare Gurney, 1932 and Lang, 1965) and *orientalis* (cf. Sewell, 1924 and Gurney, 1932) and the fact that, with the exceptions already noted, our present specimens lack the anterior lateral spinule row but have circum-segmental rows, i.e. they are intermediate between *orientalis* and *armata*, the concept of subspecies must be rejected in favour of one that recognizes a species with a wide general variability with perhaps some regional trends.

The peculiar females from Stns. V and VI show a unique variation—the presence of only four (two long outer and two short inner) setae on the P.5 basendopod.



83. *Nitocra quadriseta* n.sp.  
(Figs. 107-109)

*Material examined* : VI, 1 ♀ 1 ♂ ; XV, 2 ♀ ♀

*Holotype* female, VI (C2847/2) and *paratypes* (C2848/2) deposited with the Zoological Survey of India, Calcutta.

### Description

*Female* : Length 390  $\mu$ m. Body linear, about four times as long as broad (Fig. 107e). Hyaline frill absent on the cephalothorax, deep and plain on the throacic segments and semi-incised obtusidigitate (Moore, 1976b) on the abdomen. Rostrum short, pointed and fused to the cephalothorax. Genital suture a weak ridge of chitin dorsal and lateral. Genital field simple (Fig. 108b). Caudal ramus (Figs. 108a-b) about as long as broad. Somitic ornamentation confined to the abdomen (Figs. 108a-b).

*Antennule* (Fig. 108c) slender, eight-segmented.

*Antenna* (Fig. 108d) with basis. Exopod of one segment with three terminal setae.

*Mandible* (Fig. 108e) : Coxa-basis with one plumose seta. Exopod absent. Endopod of one segment with two inner and five terminal setae.

*Maxillule* (Fig. 108f) : Pre-coxal arthrite with two claws, a plumose spine and two plain setae. Coxa with two setae. Basis and rami apparently fused together.

*Maxilla* (Fig. 108g) : Syncoxa with two endites. Endopod represented by two setae.

*Maxilliped* (Fig. 108h) prehensile. Basis with one seta. Second endopod segment a claw, shorter than the first segment.

*P.1* (Fig. 109a) : Pre-coxa clearly distinct. Basis with a large spine at each distal corner. Exopod of three equal segments; second segment with a weak inner seta, third segment with two geniculate setae and three spines. All outer spines of exopod massive. Endopod three-segmented, prehensile; first segment only slightly longer than the entire exopod, second segment longer than the third.

*P.2-P.4* (Figs. 109b-c) : Pre-coxa clearly distinct. Basis with a massive spine (P.2) or slender seta (P.3-P.4) at outer distal corner. Both rami three-segmented, exopods much longer than endopods. First endopod segment small and without an inner seta. Setation as below.

*P.5* (Fig. 109d) : Inner expansion of basendopod reaching to halfway along the exopod; with five setae. Exopod oval, with five setae.

*Setal formula*

	Exp.			Enp.		
P.1	0.	1.	0.2.3.	1.	1.	0.3.0
P.2-P.4	0.	1.	2.2.3	0.	1.	1.2.1

*Male* differs from the female in the following respects.

*Abdomen* (Figs. 109e-f) : First two segments distinct. Distal spinule rows more complete than in the female.

*Antennule* (Fig. 109g) haplocerate.

*P.1* (Fig. 109h) as female except for the modified inner spine of the basis.

*P.5* (Fig. 109i) : The pair of P.5 confluent. Basendopod with two small setae and two longer, and peculiarly curved, spines. Exopod oval, with six setae.

*P.6* (Fig. 109f) of both sides confluent ; each side a lappet with two setae.

*Etymology* : The trivial name refers to the setation of the endopods of P.2-P.4.

*Remarks* : Inter-specific relationships in *Nitocra* have not been studied in any detail and thus it is difficult to assess the position of *N. quadriseta* in the genus. It is unique in the combination of (a) P.2-P.4 without an inner seta on the first endopod segment; (b) third endopod segment of P.2-P.4 each with four setae and spines; (c) third exopod segment of P.2-P.4 each with seven setae and spines; (d) P.5 basendopod and exopod with five and five setae in the female and four and six setae in the male; (e) third exopod segment of P.1 with five setae and spines.

**Karllangia** Noodt, 1964

This genus was erected by Noodt (1964) for a new species, *K. arenicola*, from the Red Sea. Wells (1967) added a second species, *K. psammophila*, from Mozambique. We now report on a form which has such clear resemblances to both species that all three must be considered conspecific. On the other hand Kunz (1975) has described *K. tertia* which is more primitive in setation of P.2-P.4, male P.5 and mouthparts. *K. tertia* was found at East London, South Africa, which may indicate a southern origin for this genus.

84. *Karllangia arenicola bengalensis* n.ssp.  
(Fig. 110)

*Material examined* : II, 2 ♀ ♀ 8 ♂ ♂ ; XII, 1 ♀ 4 ♂ ♂

*Holotype* female, II (C2849/2) and *paratypes* (C2850/2) deposited with the Zoological Survey of India, Calcutta.

### Description

*Female* : Length 300  $\mu\text{m}$ . Body shape, rostrum and genital somite as in the other subspecies. Somitic ornamentation, anal operculum and caudal ramus exactly as in *K. a. psammophila*.

*Antennule* (Fig. 110a) eight-segmented, the distal four very short compared with the proximal four. Inner distal corner of first segment not an unguiform projection.

*Antenna* : Endopod as in the other subspecies. Exopod (Fig. 110c) of two distinct segments; the first with one sparsely plumose seta, the second with one lateral seta and apically with one seta and four spinules.

*Mandible, maxillule, maxilla* and *maxilliped* all exactly as in *K. a. psammophila*.

*P. 1* (Fig 110d) of the shape and proportions characteristic of the genus. Middle exopod segment bears a thin, weak inner seta.

*P.2-P.4* : Shape and proportions as in the other subspecies.

*P.5* (Fig. 110e) : Basendopod similar in shape to that of the other subspecies; with five setae whose form is nearer to that of *K. arenicola* s.str. than to *K. a. psammophila*. Exopod rectangular, resembling that of *K. a. psammophila*; with five setae, the second outermost being small.

### Setal formula

	Exp.			Enp.		
P.2	0.	1.	2.2.3.	1.	1.	1.2.1.
P.3-P.4	0.	1.	3.2.3.	1.	1.	2.2.1.

*Male* differs from the female in the following respects.

*Length* 295  $\mu\text{m}$ .

*Abdomen* : First two segments distinct. First segment ornamented as in *K. a. psammophila*.

*Antennule* (Fig. 110b) weakly chirocerate. First segment without an unguiform projection.

*Antenna* : Exopod modified exactly as in *K. a. psammophila*.

*P.5* (Fig. 110f) : Basendopod of both sides confluent and weakly produced; with two setae, the inner one stout, the outer very small. Exopod small, with four setae, the outermost very long.

*P.6* of each side confluent with the segment; with three setae.

*Remarks* : From the description and Table 7 it is clear that the present specimens are more or less intermediate between *K. arenicola* s.str. and *K. a. psammophila*. It is possible, of course, that geographically intermediate populations will be found that will demonstrate that these differences are but part of a set of continuous variations. At the moment, however, we are faced with the common problem of how to treat similar, but differing, allopatric populations. We consider it best to accept them as morphs of a polytypic species and to grant subspecific status to each. We formally propose, therefore, that *K. psammophila* sink into the synonymy of *K. arenicola*.

#### 85. *Praeleptomesochra africana* (Kunz, 1951)

1951. *Leptomesochra africana* H. Kunz, *Kieler Meeresforsch.*, 8 : 76

*Material examined* : III, 1 ♀ 4 ♂ ♂

*Remarks* : This rare species has been reported only from Namibia (Kunz, 1951), Bermuda (Coull, 1970b) and Bulgaria (Marinov, 1973). Our specimens are identical with the original description.

#### 86. *Parapseudoleptomesochra trisetosa* (Krishnaswamy, 1957) (Fig. 110)

1957. *Ameira trisetosa* S. Krishnaswamy, *Studies on the Copepoda of Madras* : 230

*Material examined* : II, 1 ♀ ; XV, 1 ♀

*Remarks* : This species has been recorded previously only from littoral sands of the Indian mainland. Originally described, as *Ameira*, by Krishnaswamy (1957a, b) from Madras it is now known from Orissa (Rao, 1969; Nagabhushanan & Rao, 1969), Waltair (Rao and Ganapati, 1968, 1969b) and Kerala (Rajan & Nair, 1979).

Rao & Ganapati (1969b) distinguish their specimens as a new subspecies, *waltirensis*, because of these differences from the original description—

	<i>trisetosa</i>	<i>waltirensis</i>
length	0.85-1.00 mm	0.32-0.36 mm
♀ A.1	aesthete on seg. 6	aesthete on seg. 4
A.2 Exp.	2 segs.	1 seg.
P.3 Enp.	1 terminal seta	2 terminal setae
♀ P.5 Exp.	4 setae	5 setae

Their comparison was made with Krishnaswamy's descriptions only. Their inability, and ours, to obtain the type-material is unfortunate since it is most unlikely that Krishnaswamy is correct in his placement of the antennule aesthete, and we find it difficult to accept his account of the animals length as accurate. It is also highly probable that he mistook the stout terminal spine of the antenna exopod for a second segment. The differences in setation of P.5 may be real, particularly as our present specimens show further variability in setation by having four setae on the basendopod of P.5 (Fig. 110h) instead of the three setae reported by both Krishnaswamy and Rao & Ganapati. Our specimens also differ from both descriptions in having an eight-segmented antennule (Fig. 110g).

By the criteria used by Rao & Ganapati our specimens should be given subspecific status but we prefer not to do this as the status of the type-material is so uncertain and a description of the Kerala material is not available. In the antenna, P.3 and exopod of the female P.5 our specimens are identical to those of Rao & Ganapati; at 290  $\mu\text{m}$  they are even smaller.

### 87. *Parevansula elongatus* n.sp.

(Fig. 111)

*Material examined* : IX, 1 ♂ ; XIII, 1 ♀

*Holotype* female, XIII (C2851/2) and *paratype* male (C2852/2) have been deposited with the Zoological Survey of India, Calcutta.

#### Description

*Female* : Length 440 $\mu\text{m}$  Body vermiform, about six times as long as broad. Rostrum minute, fused to the cephalothorax. Genital somite without any trace of suture. Genital field (Fig. 111f) very simple, without setae. Anal operculum well developed, with fine setules exactly as described for *P. vermiformis* Moore, 1976a. Abdominal segments, except the last, with a plain hyaline frill. Entire body without surface ornamentation. Caudal ramus (Fig. 111e) a truncated cone, about twice as long as the breadth at its base.

*Antennule, antenna and mouthparts* exactly as in *P. vermiformis*.

*P.1* (Fig. 111a) : Coxa with three short transverse rows of spinules. Basis unornamented; with a small outer seta. Exopod of three segments. Endopod two-segmented. First segment extends only to the end of the second exopod segment. Second segment elongate, almost as long as the first.

*P.2-P.4* (Figs. 111b-c) : Coxa with two short transverse rows of spinules on the outer side. Basis unornamented; with a slender outer seta. Exopod of three equal, elongate segments. Endopod two-segmented, extending only to about the end of the first endopod segment; first segment very short. *P.2* and *P.3* identical. Setation as below.

*P.5* (Fig. 111d) very small. Basendopod with a single seta on the inner expansion. Exopod with four setae.

*Setal formula*

	Exp.			Enp.	
<i>P.1</i>	0.	0.	0.2.2.	1.	0.2.0.
<i>P.2-P.3</i>	0.	0.	0.1.2.	0.	1.1.0.
<i>P.4</i>	0.	0.	1.1.2.	0.	0.1.0.

*Male* : This specimen is incomplete, the last three abdominal segments and the caudal rami are missing. Differs from the female only in the weakly haplocerate antennule, the separation of the first two abdominal segments, the modified spine on the basis of *P.1* and the presence of simple *p.6*. In *P.1* and *P.6* it is identical to *P. vermiformis*.

*Etymology* : The trivial name refers to the elongate second segment of the *P.1* endopod.

*Remarks* : *Parevansula* Guille & Soyer, 1966 is reviewed by Moore (1976a) who synonymizes *Philoleptomesochra* Wells, 1967 with this genus. Moore includes six species but was ignorant of the description of *Philoleptomesochra elegans* Marinov, 1974b. It is evident that these seven species and *P. elongatus* are essentially similar in body shape and proportions, antennule, antenna and mouthparts, and in the general form of *P.1-P.5*. Species are differentiated on small differences of setation and proportions of *P.1-P.5*. *P. elongatus* agrees only with *P. elegans* in the setation of *P.1-P.5* but can be distinguished on the distribution of the setae on the exopod of *P.5* and on the nature of the endopod of *P.1*.

88. *Paraleptomesochra minima* Wells, 1967

1967. *Paraleptomesochra minima* J.B.J. Wells, *Trans. R. Soc. Edinb.*, 67 : 297.

*Material examined* : III, 16 ♀ ♀ 5 ♂ ♂ ; X, 11 ♀ ♀ 3 ♂ ♂ ; XII, 5 ♀ ♀ 2 ♂ ♂ .

*Remarks* : Although Rao (1972) has described a second species (*P. wellsi*) from Waltair, these specimens are identical with the geographically much more distant

species, *minima*, from Mozambique. They conform absolutely to the original description, save only that the lappets of the hyaline frill of the abdominal segments tend to be divided again at their tip.

Family PARAMESOCHRIDAE

89. *Paramesochra helgolandica* Kunz, 1937

1937. *Paramesochra helgolandica* H. Kunz, *Kieler Meeresforsch.*, 2 : 355

*Material examined* : XII, 1 ♀ ; XIV, 6 ♀ ♀

*Remarks* : Our females agree entirely with the original description. Mielke (1975) draws attention to the great similarity between this species, *P. similis* Kunz, 1937 and *P. longicaudata* Nicholls, 1945b. Although *P. helgolandica* had been recorded from nearby Bulgaria, Noodt (1955b) found only *P. longicaudata* in the Sea of Marmara; this latter species is otherwise known only from Australia and Mozambique. *P. similis* has been found only in association with *P. helgolandica* (at Heligoland, Bulgaria and in sediments from the Irish Sea). Perhaps all represent a single species with some inter- or intra-population variability.

90. *Kliopsyllus holsaticus* (Klie, 1929)

(Fig. 111)

1929. *Paramesochra holsatia* W. Klie, *Zool. Jb. Syst.*, 57 : 556

*Material examined* : II, 6 ♀ ♀ 6 ♂ ♂ ; III, 81 ♀ ♀ 14 ♂ ♂ ; V, 2 ♀ ♀ 1 ♂ ; VI, 1 ♀ ; X, 9 ♀ ♀ 9 ♂ ♂ ; XI, 4 ♀ ♀ 1 ♂ ; XII, 6 ♀ ♀ 4 ♂ ♂ ; XIV, 1 ♀ ; XV, 9 ♀ ♀ 4 ♂ ♂

*Remarks* : *K. holsaticus* is a common species on fine sandy shores in western Europe and was previously unknown outwith that area. However, it is entirely possible that *K. arenicolus* (Krishnaswamy, 1957a) and *K. wilsoni* (Krishnaswamy, 1957a) both endemic to the Indian Bay of Bengal coast, are not specifically distinct from *K. holsaticus*. Both species require redescription.

Kunz (1981) has redescribed the type-material of *K. holsaticus* and partially reviewed variability within the species. In the characters known to vary, our specimens have (a) caudal ramus length/width ratio of 2.9-3.1:1, (b) three setae on the antenna exopod, (c) a spatulate seta and a small spinule on P.4 endopod (the variability reported in the shape of this seta undoubtedly is an artefact of orientation), (d) three setae on male P.5 exopod, (e) a spinulose anal segment, and (f) four setae on the distal segment of P.2 exopod. Thus they do not fit within any of the three subspecies presently recognized (see Kunz, 1981, Table 4), nor do they equate exactly with the closely similar *K. paraholsaticus* Mielke, 1975 or *K. longifurcatus* Scheibel, 1975. We are not

convinced that *paraholsaticus*, *longifurcatus*, *arenicolus* and *wilsoni* are species distinct from *holsaticus* and thus prefer to place our specimens within *holsaticus* and to recognize a great deal of variability within this species. Solution of this problem requires redescriptions of the two Indian species and a thorough ecological analysis of the possibly sympatric *holsaticus*, *paraholsaticus* and *longifurcatus* on the southern shores of the North Sea. It seems to us that the present subspecies of *holsaticus* have little meaning.

#### 91. *Kliopsyllus spiniger* Wells, Kunz & Rao, 1975

1975. *Kliopsyllus spiniger* J.B.J. Wells, H. Kunz & G.C. Rao, *Mikrofauna Meeresbodens*, 53: 179

*Material examined* : I, 2 ♀ ♀ ; III, 1 ♀ ; X, 6 ♀ ♀ 2 ♂ ♂ ; XI, 1 ♂ ; XII, 17 ♀ ♀ 3 ♂ ♂ ; XIV, 11 ♀ ♂ 2 ♂ ♂

#### 92. *Apodopsyllus madrasensis* (Krishnaswamy, 1951) (Figs. 112-113)

1951. *Leptopsyllus madrasensis* S. Krishnaswamy, *Ann. Mag. nat. Hist.*, 12(4) : 276.

*Material examined* : II, 2 ♀ ♀ ; III, 2 ♂ ♂ ; VIII, 1 ♂

*Remarks* : Despite the deficiencies of the original description and our inability to obtain the type-material for comparison, we are satisfied that we have correctly identified these specimens. While species of *Apodopsyllus* generally are separated on small differences in leg setation (see Coull & Hogue, 1978, for a review) *A. madrasensis* is remarkable in the elongate endopod of P.1. In this respect it is similar only to *A. unguiformis* Coull & Hogue, 1978 but is distinguished from that species on the P.5. *A. madrasensis* has been found previously only in "sand dredged off the Madras coast and a sample taken casually at Porto Novo" (Krishnaswamy, 1951).

We find several discrepancies between our specimens and Krishnaswamy's description. The most serious concern the maxillule and maxilla. Krishnaswamy does not describe or illustrate these appendages but states that they are "as in *L.* [now *Apodopsyllus*] *spinipes* Nicholls" In our specimens the maxillule (Fig. 112f) lacks both endopod and exopod and the maxilla (Fig. 112g) lacks an endopod; thus they are not at all similar to *A. spinipes*. Krishnaswamy states that the exopod of P.1 is two-segmented but in our specimens the division into two segments is not seen (Fig. 112i). Body segments are well defined only in the abdomen; thoracic segments are very ill-defined, a phenomenon now known from many species of this genus.

We record the male for the first time. It differs from the female only in the subchirocerate antennule and in the P.5-P.6 (Figs. 113a-b).



93. *Apodopsyllus camptus* Wells, 1971

1971. *Apodopsyllus camptus* J.B.J. Wells, *J. nat. Hist.*, 5 : 512

*Material examined* : V, 1 ♂ ; X, 9 ♀ ♀ 2 ♂ ♂ ; XI, 1 ♂ ; XII, 8 ♀ ♀ 4 ♂ ♂ ; XV, 60 ♀ ♀ 26 ♂ ♂

*Remarks* : By direct comparison with Paratypes we have established that these specimens agree completely with the material from Porto Novo, the only previous record. However, we wish to make two corrections to the original description.

1. The antenna exopod possesses three setae, as described in the text; the illustration (Wells, 1971, Fig. 20) inadvertently omits the middle seta.
2. The "inner seta" of the female P.5 is not a seta but an unarticulated spinous projection probably representing the last remnant of the inner expansion of the basendopod.

*Tisbisoma* Božić, 1964<sup>v /</sup>

This genus is transferred to Paramesochridae from Tisbidae by Kunz (1981).

94. *Tisbisoma triarticulatum* Wells, 1967  
(Fig. 33)

1967. *Tisbisoma triarticulatum* J.B.J. Wells, *Trans, R. Soc. Edinb.*, 67 : 254.

*Material examined* : I, 1 ♀ ; III, 1 ♀ 1 ♂ ; XII, 124 ♀ ♀ 39 ♂ ♂

*Remarks* : Our specimens are identical with the type-material but the original description has some inaccuracies. The hyaline frill of the abdominal segments is minutely denticulate and a spinule row is present on the ventral side of segment four immediately above the hyaline frill (Figs. 33g-h). The illustrations (Wells, 1967, text-figs. 35 B-C) do not adequately represent the stoutness of the accessory spinules of the abdomen. Wells also overlooked the presence of an inner seta on the first endopod segment of P.1 (Fig. 33i).

Family TETRAGONICIPITIDAE

95. *Tetragoniceps unguis* n.sp.  
(Figs. 115-116)

*Material examined* : II, 2 ♀ ♀ 4 ♂ ♂ ; III, 2 ♀ ♀ 1 cop. ; V, 2 ♀ ♀ 3 ♂ ♂ ; IV, 16 ♀ ♀ 26 ♂ ♂ ; X, 9 ♀ ♀ 9 ♂ ♂ ; XII, 1 ♂ ; XV, 9 ♀ ♀ 16 ♂ ♂ 3 cop.

*Holotype* male, VI (C2853/2) and *Paratypes* (C2854/2) deposited with the Zoological Survey of India, Calcutta.

## Description

*Female* : Length 325-377  $\mu\text{m}$ . Body shape, rostrum and somitic ornamentation identical with that of *T. brownei* Wells, 1967.

*Caudal ramus* (Figs. 115a-b) similar to that of *T. brownei*, with a prominent, almost membranous dorsal keel. Principal terminal seta with a thickened base and a very fine terminal portion. The second terminal seta is confluent at its base with the principal seta.

*Antennule* (Fig. 115e) eight-segmented. First segment large and elongate with a prominent and slightly recurved hook at the outer distal corner. An aesthete on segments 4 and 8.

*Antenna* (Fig. 115f) with a weak separation between the basis and endopod. First endopod segment bare. Second segment with six terminal setae. Exopod one-segmented with three setae, the outer confluent with the segment.

*Mandible, maxillule, maxilla* and *maxilliped* identical with those of *T. brownei*.

*P.1* (Fig. 116a) : Coxa bare. Basis with an inner plumose spine and a short row of spinules near the inner proximal corner, and a weak outer seta. Exopod three-segmented, not reaching to the end of the first endopod segment. First two segments equal in length and longer than the third. Inner edge of second segment spinulose, outer edge of the first two segments with a few spinules. Second segment without an inner seta. Third segment with four setae. Endopod two-segmented, prehensile. First segment elongate, about five times as long as broad and four times as long as the second segment, with a stout plumose seta about halfway along the inner edge which itself is set with long setules proximal to this seta. Second segment with two claws.

*P.2-P.4* (Figs. 116 b-d) : Basis with an outer seta and in P.2 only with a short spinule row on the inner edge. Exopods three and endopods two-segmented. Endopods do not reach the end of the second exopod segment. First segment with a very long stout plumose seta. Segments of exopods more or less equal in length, with those of P.4 elongate. Setation as below.

*P.5* (Fig. 116e) with distinct and elongate rami. Inner expansion of basendopod with one weak terminal seta and three lateral setae, the distal one very small and weak and the proximal two short, stout and plumose. Exopod reaches beyond the basendopod, with four setae, the middle two very weak.

*Male* differs from the female in the following characters. Length 312-338  $\mu\text{m}$ . *Abdomen* : First two segments distinct. First segment with a dorsal pair of sensilla and a plain hyaline frill.

*Caudal ramus* (Figs. 115 c-d) more or less cylindrical but with a convex inner edge; a little more than three times as long as the maximum breadth. Setation similar to that of the female, but there is no dorsal keel.

*Antennule* (Fig. 115f) haplocerate. First segment as in the female.

*P.2-P.4* : Coxa, basis and exopod as in female. Endopods of the same relative length as in the female, and the first segment with a similar elongate seta. Second segments differ—P.2 (Fig. 116f) with three setae, but the outer one is small and the inner one confluent with the segment; P.3 (Fig. 116g) with three setae, but the two inner setae are thin and very long; P.4 (Fig. 116h) with two setae only.

*P.5* (Fig. 116i) with distinct rami. Basendopods of both sides confluent, inner expansion with three setae. Exopod drawn out terminally into a long unguiform projection. Three setae on the exopod, the distal two very thin and weak.

*P.6* (Fig. 116j) of each side distinct, with three long lateral setae.

*Setal formula* :

	Exp.			Enp.	
P.2	1.	0.	0.2.2.	1.	0.2.1.
P.3	1.	0.	0.2.1.	1.	0.2.1.
P.4	1.	0.	2.2.1.	1.	0.2.1. (1. 0.1.1. ♂)

*Etymology* : The specific name refers to the claw-like shape of the exopod of the male P.5 (*L. unguis*—a claw).

*Remarks* : This species has some obvious similarities with *T brownei* particularly in the female caudal ramus and the setation of P.2-P.4 exopod, but there are differences in the setation of P.2-P.4 endopod, P.5, ornamentation of the coxa and basis of P.2-P.4 and in the male. *T brownei* exhibits sexual dimorphism in the caudal ramus and in the first antennular segment in addition to the usual sexual characters. In the present species the first antennule segment is as in the female and although the caudal ramus differs from the female it is not like that of *T brownei*. Also, the P.5 is quite different and there are dimorphic differences in the P.2-P.4 endopods. As more information becomes available it can be seen that the species of *Tetragoneps* exhibit sexual dimorphism of a similar order to that known for other genera of the family.

#### **Phyllopodopsyllus** T. Scott, 1906b

Though not quite as dramatic as the situation with *Stenhelia* (p.150), the presence of six species of this genus in this archipelago is still remarkable, as is the sympatric occurrence of three or four at several locations. In terms of density it is most probable that *Phyllopodopsyllus* (especially as represented by *P. gracilipes* and *P. stigmus*)

is the most abundant genus in the islands; though we hasten to add that our samples are not quantitative, nor can they account for periodicity in reproduction, etc. The distribution of the genus in this archipelago as revealed by our samples is summarized in Table 8; no earlier records exist.

**96. *Phyllopodopsyllus aegypticus* Nicholls, 1944**  
(Fig. 117)

1944. *Phyllopodopsyllus aegypticus* A. G. Nicholls, *Ann. Mag. nat. Hist.*, **11** (11) : 493

*Material examined* : VI, 2 ♀ ♀ 5 ♂ ♂ ; XIV, 1 ♀

*Remarks* : We have no doubts that our specimens belong to this species (which is peculiar in its rostrum, mandible, maxillule, maxilla, P.3 exopod and female P.5) despite the apparent differences in the cadual ramus (cf. Fig. 117a and Nicholls, 1944, Fig. 4). Nicholls (1944, p. 495) describes the cadual ramus as "about as long as the anal segment and subconical in shape, being wide basally and tapering distally" In our specimens this shape is seen only in dorso ventrally squashed preparations, when the resemblance to Nicholls' description and illustration is good. In the natural condition the cadual ramus of our specimens is not subconical, but has a distinct inner basal bulge (Figs. 117a-b).

In all other respects, except one, our material agrees with Nicholls' description. The exception is that the distal segment of the P.4 exopod has seven setae, with the formula 3.2.2., the outermost being very small. Nicholls describes and illustrates only six setae, there being no equivalent of the small outer seta of our specimens. Unfortunately the type-material, deposited with the British Museum (Natural History), has been lost (G.A. Boxshall, pers. comm.) and it is thus not possible to determine if Nicholls failed to observe the small outer seta or whether it was absent in his material; we suspect that the former is more likely to be true.

*P. aegypticus* has only been recorded once before, at Ghardaqa on the Red Sea (Nicholls, 1944). The male is described here for the first time.

**Supplementary description**

*Female* : Length 810 $\mu$ m. (cf. 670 $\mu$ m by Nicholls, 1944). Body linear, about 4.8 times as long as broad. Cephalothorax with scattered sensilla. Entire body clothed with long fine hairs, most densely on the abdomen, but in no defined pattern. Hyaline frill plain except for the ventral side of the third abdominal segment, which has long fine setules. Anal operculum setose. Genital suture complete dorsally. Genital field as in *P. crenulatus* (Fig. 120e). Caudal ramus (Figs. 117a-c) 1.6-1.7 times as long as the maximum width. Inner side with a pronounced basal expansion. Dorsally with a transverse ridge. Dorsal articulated seta extremely lateral and distal in origin. Principal terminal seta not bulbous. Distal segment of P.4 exopod with seven setae and spines, the outermost very small (Fig. 117f). P.1 exopod of three

short segments, not extending to the origin of the inner seta of the first endopod segment. First endopod segment elongate, slender, about seven times as long as broad and seven times as long as the second segment. Origin of inner seta about 7/10 of the way along the edge. P.2-P.4 endopods (Figs. 117g-i) are slightly more complex than is described by Nicholls.

*Male* differs from the female in the following respects.

*Length* : 540-550  $\mu\text{m}$ . *Abdomen* with first two segments distinct.

*Caudal ramus* (Figs. 117d-e) longer than the anal segment; conical, about 2.1 times as long as the maximum breadth. Without dorsal keel or ridge but with a small conical ventral protuberance. Origin of dorsal articulated seta not as distal as in the female.

*Antennule* (Fig. 117m) strongly haplocerate.

*P.2 endopod* (Fig. 117j) without distal unguiform process. Outer terminal spine more slender and fused to the segment. Median seta very stout, short. Inner seta very much smaller than in the female.

*P.3 endopod* (Fig. 117k) very similar to the female, differing only in the relatively more stout outer terminal spine.

*P.4 endopod* (Fig. 117l) : Distal segment with reduced unguiform process and with only two stout terminal spines.

*P.5* (Fig. 117n) of both sides confluent. Inner expansion of basendopod with three setae, the innermost very stout, curved and plumose only on the outer side. Exopod with five setae.

*P.6* (Fig. 117b) of each side a small protuberance of the segment edge with two long setae and a long outer spine.

#### 97. *Phyllopodopsyllus longipalpatus* (Chappuis, 1953) (Figs. 118-119)

1953. *Paraphyllopodopsyllus longipalpatus* P. A. Chappuis, *Vie Milieu*, 4 : 263

*Material examined* : III, 12 ♀ ♀ 3 ♂ ♂ 1 cop. ; V, 1 ♀ ; VI, 1 ♂ ; X, 1 ♀ 1 cop. ; XIII, 1 ♀

*P. longipalpatus*, *P. biarticulatus* Wells, 1967 and *P. punctatus* Kitazima, 1981 are closely similar species separated from all others in the genus on three characters—the very reduced nature of the mandible exopod; the absence of an inner seta on

the first endopod segment of P.1; the presence of only four setae on the exopod of the male P.5. There are some small differences between them in the caudal ramus and abdominal ornamentation, though the importance of these is difficult to assess due to the poor quality of Chappuis' description of *P. longipalpatus*. More easily assessed are differences in segmentation and setation—

	<i>longipalpatus</i>	<i>biarticulatus</i>	<i>punctatus</i>
P.1 Exopod—no. of segs.	3	2	3
Md. Exopod—no. of setae	1	1	2
♀ P.4 Exp. 3—no. of setae and spines	6	6	7
♂ P.4 Exp. 3—no. of setae and spines	6	6	6
♀ P.2-P.4 Enp. 2—no. of setae	2.2.2.	2.2.2.	3.3.3.
♂ P.2-P.4 Enp. 2—no. of setae	3.3.2.	2.3.2.	3.3.2.

Our present specimens would appear to be referable to *P. longipalpatus*, with the only serious difference from Chappuis's description being the presence of seven setae and spines on the distal exopod segment of the female P.4.

### Supplementary description

*Female* : Length 500 $\mu$ m (cf. 700 $\mu$ m by Chappuis, 1953) (Figs. 118a-b).

*Somitic ornamentation* : All segments minutely pubescent and minutely punctate. The punctae are not distributed as densely as in some other species. Cephalothorax with scattered sensilla. Posterior edge of thoracic segments with a narrow plain hyaline frill. Each segment with a few sensilla. Sensilla also along the suture of the genital somite. Posterior edge of the genital somite and the third and fourth segments with a dorsolateral row of very small setules. A ventrolateral row of longer setules on the genital somite. Third segment with setules ventrally and ventrolaterally. A few sensilla are also present on all these somites. The last abdominal segment has dorsolateral setules at its posterior edge.

*Caudal Ramus* (Figs. 118c-e) : Some variation was noted in the relative proportions of the rami between individuals. The general shape and setation was similar.

*P.1-P.4* (Figs. 119a-d) are of the general shape described by Chappuis. We add these details. Coxa with rows of setules on both anterior and posterior faces as illustrated. Inner edge of basis of P.1 with long setules. Inner and outer edge of exopod and endopod segments with setules and spinules as figured.

P.5 as Fig. 118i.

*Setal formula*

	Exp.			Enp.
P.2	1.	0.	0.2.2.	0.2
P.3	1.	0.	0.2.2.	0.2
P.4	1.	0.	3.2.2.	0.2

This setation agrees with the description (Chappuis, 1953) of specimens from Latium, Italy in P.2 and P.3, although there are some minor and relative differences in the size of the setae and spines of the P.2 (Chappuis does not figure P.3), but differs in the presence of an additional seta—the outermost—on the third segment of the exopod of P.4. Chappuis (who does not figure P.4 either) considers the third segment to have three subapical spines on the outer edge, a subapical seta on the inner edge and a large spine and a large seta apically. Assigning setae and spines to a particular edge of this segment is open to interpretation but using the terminology of Coull (1973), Chappuis' statement gives the formula as 3.1.2. The additional, apical, seta present in the Andaman specimens is very thin and delicate and could easily have been overlooked by Chappuis. The correspondence in antennule and, especially, in the caudal ramus and mandible (Fig. 118h) and P.1 between his females and ours leaves us in no doubt that they are conspecific. Unfortunately his material apparently no longer exists, so the observed discrepancy cannot be checked.

*Male* : Length 400 $\mu$ m (cf. 650 $\mu$ m by Chappuis, 1954)

According to Chappuis (1954), and apart from the usual differences in antennule and P.5, the male differs from the female in :

(a) The caudal ramus: Our males agree with Chappuis' description in general but differ in the presence of a dorsal keel (Figs. 118f-g). This keel is small and very thin, almost membranous, and could easily have been overlooked by Chappuis.

(b) Endopod of P.2 with three setae on the second segment: This is true of our specimens also (Fig. 119e).

(c) Endopod of P.3 of three segments, the middle one with a curved spine at its outer distal corner. In our specimens the ramus is two-segmented (Fig. 119f) but other details are comparable, a curved spine springing from the anterior face subterminally.

Chappuis writes that the distal segment of the exopod of P.4 is identical to that of the female but his figure shows it with five setae and spines only. In our males

there are six, the one missing with respect to our females being the third inner (Fig. 119h). The male setal formula is :

	Exp.			Enp.
P.2	1.	0.	0.2.2.	0.3
P.3	1.	0.	0.2.2.	0.2 (+1 curved spine on anterior face)
P.4	1.	0.	2.2.2.	0.2

These differences notwithstanding, the correspondence in the important features of mandible and endopod of P.3 lead us to the same conclusion expressed above in discussing the female.

98. *Phyllopodopsyllus crenulatus* n. sp.  
(Figs. 119-121)

*Material examined* : I, 5 ♀ ♀ 1 ♂ ; III, 1 ♀ 2 ♂ ♂ ; VI, 1 ♂ ; X, 3 ♀ ♀ ; XIII, 1 ♀

*Holotype* female, I (C2855/2) and *Paratypes* (C2856/2) deposited with the Zoological Survey of India, Calcutta.

### Description

*Female* : Length 560µm. Body linear, about 4.6 times as long as broad (Figs. 120a-b). Cephalothorax rounded anteriorly. Rostrum (Fig. 119j) short and broad, articulated with the cephalothorax; apex truncate, slightly concave, and with a long median seta. Genital suture complete dorsally; denticulate. Genital field of normal genus type (Fig. 120e). Anal operculum naked. Caudal ramus (Figs. 120i-k) in dorsal view about 2.5 times as long as the broadest part, longer than the last two abdominal segments, tapering from base to apex; with a small dorsal keel in the proximal half of the ramus. Principal terminal seta with a bulbous base to which is fused the base of the two minor terminal setae.

*Somitic ornamentation* (Fig. 120c-d, f) : Entire body and appendages minutely pubescent, with small broad setules. All free somites with a hyaline frill denticulate at dorsal and dorsolateral edge. Abdominal segments two to four with the ventrolateral edge finely setose; on segment four these setules extend ventrad. Genital suture denticulate.

*Antennule* (Fig. 119j) nine-segmented, the first about as long as the succeeding four. Second segment with a prominent unguiform projection whose base does not occupy the whole length of the segment.



*Antenna* (Fig. 1191) with basis. Exopod one-segmented with one lateral and two terminal setae, the outermost fused to the segment.

*Mandible* (Fig. 119m) : Coxa with bidentate pars incisiva. Coxa-basis with three setae. Exopod one-segmented, elongate but shorter than the endopod; with three setae. Exopod with two lateral and seven terminal setae, two pairs of which have a common base.

*Maxillule* (Fig. 119n) : Arthrite of pre-coxa with two surface setae and with four setae and seven spines terminally. Coxa with three terminal setae and an epipod represented by one seta. Basis with six terminal setae. Endopod with three terminal setae, the inner one massive and plumose; inner edge with very long setules. Exopod with four setae.

*Maxilla* (Fig. 119o) : Syncoxa with four endites and a seta. Endopod three-segmented.

*Maxilliped* (Fig. 119p) prehensile. Basis with three terminal setae, one spiniform; inner edge setose. First endopod segment with one inner seta. Second segment small, slender; with three terminal setae, one long and spiniform.

*P.1* (Fig. 121a) : Coxa with three rows of setules near the outer edge and a transverse row on both the anterior and posterior surface. Basis with a few long setules on inner edge and an outer stout seta and an inner curved spine. Exopod of three slender segments extending to the origin of the inner seta of the first endopod segment; third segment shorter than the sub-equal first two. Outer edge of all segments with small spinules. Endopod prehensile, two-segmented, relatively short. First segment about five times as long as broad and three times as long as the second segment; origin of inner seta about 4/5 of the way along the edge. Inner edge with long setules and a large plumose spiniform seta near the distal end. Second segment with two long stout geniculate setae.

*P.2-P.4* (Fig. 121b-d) : Coxa variously ornamented with long, short and minute setules on the outer edge and on both anterior and posterior surfaces. Basis bare; with an outer seta which is spiniform in P.2. Exopods of three, endopods of two segments; outer edge of most segments setose. Inner distal corner of second exopod segment in P.2-P.4 and first segment in P.2-P.3 with setules. Setation as below.

*P.5* (Fig. 121i) of the usual generic pattern and functioning as a brood pouch. Outer edge very thin and granular.

*Setal formula*

	Exp.			Enp.	
P.2	1.	0.	1.2.2.	1.	3.
P.3	1.	0.	2.2.2.	1.	3.
P.4 ♀	1.	1.	3.2.2.	1.	3.
P.4 ♂	1.	1.	3.1.2.	1.	2.

*Male* differs from the female in the following respects.

*Length* 410  $\mu\text{m}$ .

*Abdomen* (Figs. 120g-h) : First two segments distinct. Posterior edge of segments two to four with a pair of sensilla and with the hyaline frill denticulate on dorsal half, finely setose on ventral half. Anal operculum with minute setules.

*Caudal ramus* (Figs. 120i-n) very similar to the female but more slender and almost four times as long as broad. Dorsal keel not quite so pronounced. Principal terminal seta bulbous at the base but without the inner projection.

*Antennule* (Fig. 119k) strongly haplocerate.

*P.2 endopod* (Fig. 121e) reaching halfway along the third exopod segment. Terminal setae of different proportions to those of the female; the outermost fused to the segment.

*P.3 endopod* (Fig. 121f) of similar proportions to the female but with relatively shorter terminal setae and with outer distal corner of second segment forming a small unguiform projection.

*P.4* (Fig. 121g) : Distal segment of endopod with two setae only, the outer short and stout, the inner long and curved. Distal segment of exopod with only six setae and spines.

*P.5* (Fig. 121j) : The pair of P.5 confluent. Exopod distinct, with five setae. Basendopod with a small inner expansion with one inner and two terminal setae.

*P.6* (Fig. 120h) of both sides fused together, each side with three setae.

*Etymology* : The trivial name refers to the crenulate borders to the segments (*L. crena*—notch).

*Remarks* : This species is unique in no single character but the combination is not matched by any other species of the genus.

#### 99. *Phyllopodopsyllus stigmus* n. sp.

(Figs. 122-123)

*Material examined* : II, 5 ♀ ♀ 15 ♂ ♂ ; III, 15 ♀ ♀ 13 ♂ ♂ 7 cop.; V, 1 ♀ 2 ♂ ♂ ; X, 38 ♀ ♀ 28 ♂ ♂ 1 cop. ; XII, 2 ♀ ♀ 2 ♂ ♂ ; XV, 171 ♀ ♀ 143 ♂ ♂ 44 cop.

*Holotype* female, XV (C2857/2) and *Paratypes* (C2858/2) deposited with the Zoological Survey of India, Calcutta.

## Description

*Female* : Length about 425  $\mu\text{m}$ . Body linear, widest at the genital somite, about five times as long as broad (Figs. 122a-b). Rostrum short, broad, with a concave apex, and articulated with the cephalothorax (Fig. 122c). Cephalothorax rather square anteriorly. Genital suture complete dorsally. Genital field as Fig. 122g. Anal operculum pronounced; setose. Caudal ramus (Figs. 122d-f) elongate, slender, tapering from base to apex, without dorsal keel; in dorsal view 3.75-4.03 times as long as the maximum breadth and almost as long as the last three abdominal segments. Principal terminal seta with a bulbous base which incorporates the base of a second terminal seta.

*Somitic ornamentation* : All somites, the first antennule segment, the caudal rami and the coxa and basis of P.1-P.4 minutely punctate; the punctae not arranged in any discernible pattern. Spinules present only on the distal edge of the last segment. Anal operculum setose. Hyaline frill absent.

*Antennule* (Fig. 122h) eight-segmented. First segment very long—as long as the succeeding five segments. Second segment with a very large unguiform process whose base occupies the whole length of the segment.

*Antenna, maxillule and maxilliped* as in *P. crenulatus*.

*Mandible* of the same construction as *P. crenulatus*; with elongate exopod and endopod. Inner seta of exopod situated about halfway along the segment (Fig. 122i).

*Maxilla* as in *P. crenulatus*, except for the absence of the long seta on the syncoxa.

*P.1* (Fig. 123a) : Coxa with a small row of setules near the outer distal corner, otherwise unornamented. Basis without ornamentation. Exopod of three slender segments extending to origin of the inner seta of first endopod segment. All segments with spinulose outer edge. Second segment with long setules on inner edge, but without inner seta. Endopod two-segmented, prehensile. First segment elongate, about five times as long as broad and slightly more than three times as long as the second segment; origin of inner seta about  $\frac{3}{5}$  of the way along the edge. Inner edge with a few long setules proximally. Second segment with two very long and slender geniculate setae.

*P.2-P.4* (Figs. 123b-d) : Coxa and basis unornamented. Basis with a well developed outer seta in P.2 and P.3, a weak seta in P.4. Exopods three, endopods two-segmented. Exopod segments of equal length, relatively short in P.2 and P.3, elongate in P.4. Endopod segments of equal length in P.2 and P.3. P.2 endopod reaching almost to the end of the second exopod segment. P.3 endopod reaching only to less than halfway along the second exopod segment. Endopod of P.4 small, not reaching to the end of the first exopod segment; first segment minute and about

half the length of the second. Outer edge of all exopod segments spinulose in P.2 and P.3 but naked in P.4. Setation as below.

P.5 (Fig. 123i) of the usual generic type.

*Setal formula*

	Exmp.			Enp.	
P.2	1.	0.	1.2.2.	0.	3.
P.3	1.	0.	2.2.2.	1.	3.
P.4 ♀	1.	1.	3.2.2.	1.	3.
P.4 ♂	1.	1.	2.2.2.	1.	2.

*Male* differs from the female in the following respects.

*Length* about 400 $\mu$ m. *Abdomen* : First two segments distinct. Ornamentation as female. *Caudal ramus* differs only slightly, being somewhat more slender and more tapering with the base of the terminal seta less bulbous.

*Antennule* (Fig. 123i) strongly haplocerate. Unguiform projection on second segment is very large.

*P.2 endopod* (Fig. 123f) : Second segment with three terminal setae, the outermost fused to the segment.

*P.3 endopod* (Fig. 123g) relatively larger and longer than in the female. Outer distal corner of second segment forms a small unguiform projection.

*P.4* : Distal exopod segment with six setae only (Fig. 123e). Distal endopod segment with two short terminal setae only (Fig. 123h).

*P.5* (Fig. 123j) : The pair of P.5 confluent. Inner expansion of basendopod with three setae. Exopod with five setae; the outer distal corner an unguiform projection.

*P.6* (Fig. 123k) of both sides fused together, with two setae and a strong spine on each side.

*Variability* : Ten of each sex were dissected and examined in detail. No variation was observed other than that noted in total length and in length/breadth ratio of the caudal rami.

*Etymology* : The trivial name refers to the punctate ornamentation of the body (*L. stigmosus*—full of points, or marks.)

*Remarks* : In setation of P.2-P.4 and in many other features this species closely resembles *P. furciger* Sars, 1907, in which the setation is variable, and *P. parafurciger*

Geddes, 1968a. From both it differs radically in the caudal ramus which neither has a dorsal keel nor a markedly assymetrical bulbous base to the terminal seta (cf. *furciger*), nor marked sexual dimorphism (cf. *parafurciger*). Similar uncomplicated caudal rami are found in several other species but most can be rejected on the sum of characters. *P. minor* (Thompson & A. Scott, 1903) can be considered, but its description is too fragmentary for an adequate comparison to be made. It is similar in some respects to *P. longicaudatus* A. Scott, 1909 (the female being described by Vervoort, 1964) but differs in the eight-segmented antennule, the shorter caudal ramus with a bulbous seta, relative proportions of the setae of P.2-P.4 and in details of P.5 (though one wonders how variable this appendage can be with respect to exact shape and size, and indeed number, of small setae). There are resemblances to *P. tenuis* n.sp. (described herein), particularly in proportions of the caudal ramus. However, setal origins on the caudal ramus are different and the leg setation is far more primitive.

100. *Phyllopodopsyllus tenuis* n. sp.  
(Figs. 124-125)

*Material examined* : II, 2 ♀ ♀ 1 ♂

*Holotype* female, II (C2859/2) and *Paratypes* (C2860/2) deposited with the Zoological Survey of India, Calcutta.

**Description**

*Female* : Length 490 $\mu$ m. Body linear, elongate, without taper, about seven times as long as broad (Figs. 124a-b). Rostrum short, tapering to a rounded apex; articulated with the cephalothorax (Fig. 124e). Genital suture complete dorsally. Genital field as *P. crenulatus*. Anal operculum pronounced, spinose (Fig. 124c). Caudal ramus (Fig. 124c) elongate, slender, tapering from base to apex, without dorsal keel; triangular in cross-section with the dorsal side much wider than the ventral so that the lateral setae appear to be set ventrally when the ramus is viewed from the dorsum. In dorsal view about 3.6 times as long as the maximum breadth; shorter than the last two abdominal segments. Principal terminal seta with a bulbous base that incorporates the base of one of the two minor setae.

*Somatic ornamentation* : Punctae on the cephalothorax, thorax, basal segments of the antennule and mouthparts; spinules on anal operculum and distal edge of the anal segment. Hyaline frill plain.

*Antennule* (Fig. 124d) eight-segmented. First segment relatively short; only about as long as the succeeding three segments. Second segment with a massive unguiform process, whose base does not occupy the whole length of the segment.

*Antenna, maxillule and maxilliped as P. crenulatus.*

*Mandible and maxilla as P. stigmosus.*

*P.1* (Fig. 124f) : Coxa without ornamentation. Basis with a few long setules on inner edge, a stout curved plumose inner spine and a weak, slender outer seta. Exopod of three slender segments extending to the origin of the inner seta of the first endopod segment. Endopod two-segmented, prehensile. First segment elongate, about 5.2 times as long as the second segment; origin of inner seta 3/5 of the way along the edge. Second segment with two long, stout geniculate setae.

*P.2-P.4* (Figs. 125a-c) : Coxa with one crescentic row of spinules. Inner part of basis elongate; outer seta long and slender. Exopods three, endopods two-segmented. Setation as below; outermost seta of P.4 endopod very small.

*P.5* (Fig. 124g) of the usual generic type. Both females had two eggs in the brood pouch.

#### *Setal formula*

	Exp.			Enp.	
P.2	1.	0.	0.2.2.	0.	3.
P.3	1.	0.	0.2.2.	1.	3.
P.4	1.	0.	2.2.1.	1.	2.

*Male* differs from the female in the following respects.

*Length* 425 $\mu$ m. *Abdomen* : First two segments distinct.

*Caudal ramus* : Proportions as in the female but longer than the last two abdominal segments and thus relatively longer compared to the body size. *Antennule* strongly haplocerate (Fig. 124e).

*P.2 endopod* (Fig. 125d) : Outer spine of second segment transformed as a long slender process fused to the segment.

*P.3 endopod* (Fig. 125e) : Inner seta of first segment and median seta of second segment much shorter.

*P.4 endopod* (Fig. 125f) : Terminal spine long, stout, curved, not plumose.

*P.5* (Fig. 125g) : The pair of P.5 confluent. Inner expansion of basendopod with three setae. Exopod rectangular with outer distal corner an unguiform projection; with five setae and spines, the innermost massive and pectinate.

*P.6* (Fig. 125h) of each side with only two setae.

*Etymology* : The trivial name reflects the slender, elongate form of the body (*L. tenuis*—slender).

*Remarks* : This species resembles several others in one or two characters but appears to be most similar to *P. simplex* Kitazima, 1981, to which species the similarity in shape of the appendages and the points of origin, and form, of their setae is very close. *P. tenuis* can be distinguished on the relatively shorter caudal ramus and on small differences in leg setation.

#### 101. *Phyllopodopsyllus gracilipes* n. sp.

(Figs. 126-127)

*Material examined* : I, 17 ♀ ♀ 8 ♂ ♂ 2 cop. ; II, 151 ♀ ♀ 150 ♂ ♂ 66 cop. ; V, 299 ♀ ♀ 123 ♂ ♂ 162 cop. ; VI, 361 ♀ ♀ 187 ♂ ♂ 319 cop. ; VII, 1 ♂ ; X, 34 ♀ ♀ 16 ♂ ♂ 2 cop. ; XIII, 4 ♀ ♀ 2 ♂ ♂ 2 cop. ; XV, 28 ♀ ♀ 19 ♂ ♂ 8 cop.

*Holotype* female, V (C2861/2) and *Paratypes* (C2862/2) deposited with the Zoological Survey of India, Calcutta.

#### Description

*Female* : Length 660-680  $\mu\text{m}$ . Body shape and proportions as *P. crenulatus*; about five times as long as broad. Rostrum (Fig. 126a) short and broad with a slightly convex, truncate apex. Genital suture complete dorsally; denticulate. Genital field as *P. crenulatus*. Anal operculum spinulose. Caudal ramus (Figs. 126c-e) in dorsal view 2-2.5 times as long as the maximum breadth and slightly longer than the anal segment; with a small dorsal keel in the proximal half. Origin of dorsal seta at the distal end of the dorsal keel, about midway along the ramus. Principal terminal seta with a bulbous base which incorporates the base of the outer minor terminal seta.

*Somatic ornamentation* : very similar to *P. crenulatus*, with the entire body and appendages set with small broad setules and with the distal margin of all somites denticulate at dorsal and dorsolateral edge. It differs in that the ventrolateral and ventral edge of abdominal segments two to four has fine setae. Genital somite denticulate. Anal operculum spinulose.

*Antennule* (Fig. 126a) nine-segmented. First segment about as long as the succeeding four. Second segment without a projection.

*Antenna, maxillule and maxilliped* as *P. crenulatus*.

*Mandible* (Fig. 126b) : Exopod elongate, with lateral seta proximal in origin.

*Maxilla* as in *P. stigmatosus*.

*P.1* (Fig. 126f) : Coxa with complex spinulation. Basis with a stout, curved inner spine and a stout outer seta. Exopod of three very slender segments not quite extending to the origin of the inner seta of the first endopod segment. Endopod two-segmented, prehensile. First segment elongate, about six times as long as broad and six times as long as the second segment; origin of inner seta about 3/4 of the way along the edge. Second segment with two short geniculate setae of approximately equal length.

*P.2-P.4* (Fig. 127a-c) : Coxa less spinulose than in *P.1*. Outer seta of basis short and stout in *P.2*, long and thin in *P.3-P.4*. Exopods three, endopods two-segmented. Setation as below.

*P.5* (Fig. 126h) of the usual generic type; 2-4 eggs in the brood pouch.

*Setal formula*

	Exp.			Enp.	
<i>P. 2</i>	1.	0.	1.2.2.	1.	3.
<i>P. 3</i>	1.	0.	2.2.2.	1.	3.
<i>P.4 ♀</i>	1.	1.	2.2.2.	1.	3.
<i>P.4 ♂</i>	1.	1.	2.2.2.	1.	2.

*Male* differs from the female in the following respects.

*Length* : 500-575  $\mu\text{m}$ . *Abdomen* : First two segments distinct. Ornamentation as in *P. crenulatus*. *Caudal ramus* of similar proportions and setation to that of the female but the dorsal keel is less prominent and the terminal seta is not bulbous.

*Antennule* (Fig. 126g) strongly haplocerate.

*P.2 endopod* (Fig. 127d) of similar proportions to that of the female; outer terminal seta is fused to the segment and the other setae are much shorter.

*P.3 endopod* (Fig. 127e) very similar to that of the female, differing only in that the outer distal corner is more pronounced and the inner spine is not plumose.

*P.4 endopod* (Fig. 127f) relatively shorter than in the female; distal segment with only two setae.

*P.5* (Fig. 126i) : The pair of *P.5* confluent. Inner expansion of basendopod with three setae. Exopod with five setae.



*Variability* : Ten specimens of each sex have been dissected; variation was found only in the degree of surface ornamentation of the rami of the P.1-P.4 and in total length.

*Etymology* : The trivial name refers to the elongate P.1. (*L. gracilis*—slender; *pes*—a foot).

*Remarks* : Among the species of *Phyllopodopsyllus* that lack a spur on the second antennule segment this species, with its primitive setation of P.2-P.4, resembles most closely *P. thiebaudi* Petkovski, 1955b, but is clearly differentiated on the caudal ramus. In this respect it is more similar to several other species from which it is differentiated by its primitive leg setation. The crenulate distal margin to the segments is only known in this genus in *P. crenulatus*, *P. opisthoceratus* Geddes, 1968a, *P. setouchiensis* Kitazima, 1981 and, possibly, *P. thiebaudi* (in the description of *P. intermedium* Noodt, 1955c, a synonym).

#### **Laophontella** Thompson & A. Scott, 1903

Three species are presently recognized in this genus, which has a complicated taxonomic history—

*Laophontella typica* Thompson & A. Scott, 1903.

Type-species by monotypy. Placed by Lang (1948) as *incerta sedis* in the Family Laophontidae. Known from a single female from the Gulf of Manaar.

*Phyllopodopsyllus armatus* Willey, 1935.

Placed by Lang (1948) as *incerta sedis* in *Phyllopodopsyllus*. Removed to *Laophontella* by Sewell (1940), who describes a new subspecies as var. *indica*. Partially redescribed by Geddes (1968a). Both sexes known. Distribution—Bermuda (type-locality), Bahamas, Mozambique, Maldivé Islands.

*Willeyella horrida* Por, 1964.

*Willeyella* Por, 1964 was described to accommodate this species and *Phyllopodopsyllus armatus*, the latter being declared the type-species. Lang (1965) recognized the synonymy of *Willeyella* with *Laophontella*. Guille & Soyer (1966) recognized that the *Phyllopodopsyllus* sp. of Bodin (1964) is *W. horrida*. Both sexes known. Distribution—Mediterranean Sea only (Gulf of Haifa, Marseille, Banyuls).

It is our opinion (see below for detailed argument) that the single known specimen of *L. typica* is a juvenile male and that the adult stages of the species have been described as *Phyllopodopsyllus armatus*, which name thus becomes a junior subjective synonym of *L. typica*.

102. *Laophontella typica* Thompson & A. Scott, 1903

1903, *Laophontella typica* I. C. Thompson & Scott, A., *Rep. Govt. Ceylon Pearl Oyster Fish. Gulf Manaar*, 1 : 267.

*Material examined* : IV, 1 ♀ ; VII, 1 ♂ 1 Stage V ♀

*Remarks* : The adults in our sample agree with the descriptions of Willey (1935) and Geddes (1968a) of *Phyllopodopsyllus armatus*. The juvenile female agrees completely with the female *L. armata* var. *indica* Sewell, 1940. Our male disagrees with the male of var. *indica* only in P.4 and P.5. Now that it is known that the "female" var. *indica* is a juvenile there can be no justification for the maintenance of this variety (or subspecies) as a separate taxon.

Examination of material from Mozambique identified by Wells (1967) as *L. armata* shows this also to be scarcely different from the Andaman specimens. In the Mozambique material is one juvenile male, probably Stage IV, which is very similar to the description of the female *L. typica* by Thompson & A. Scott (1903). The male nature of Thompson & Scott's specimen should have been suspected earlier from their illustration of P.5, and the juvenile nature of the abdomen is really rather obvious (at least in hindsight). In the Mozambique juvenile male the antennule is very similar to that illustrated by Thompson & Scott, except for the last segment being elongate. It is our firm belief that the original description of *L. typica* refers to a specimen that is a juvenile male of forms which have later been described as *Phyllopodopsyllus armatus*. Since *Laophontella typica* has priority in nomenclature, *Phyllopodopsyllus armatus* must become a junior subjective synonym of *Laophontella typica*.

103. *Laophontella horrida* (Por, 1964)

1964. *Willeyella horrida* F. D. Por, *Zool. Verh. Leiden*, 64 : 105.

*Material examined* : III, 1 ♀

*Remarks* : This single female differs only slightly from the females described by Por (1964) and Bodin (1964). The caudal ramus is intermediate in length between these two females and the antennule has the six-segmented structure described by Bodin rather than the eight-segments portrayed by Por. There is no doubt that this single female is referable to Por's species.

**Oniscopsis** Chappuis, 1954

Though expressing some doubt about his conclusions, Chappuis (1954) placed this genus in the Family Tetragonicipitidae. Lang (1965) transferred it to the Paramesochridae, but Becker & Kunz (1981) return it to the Tetragonicipitidae.

104. *Oniscopsis dimorphus* n. sp.  
(Figs. 113-114)

*Material examined* : III, 1 ♀ 1 ♂ 3 copepodids ; X, 1 ♀ 1 ♂ ; XII, 1 ♂ ; XV, 1 ♀ 1 ♂

*Holotype* female, III (C2863/2) and *Paratypes* (C2864/2) deposited with the Zoological Survey of India, Calcutta.

**Description**

*Female* : Length 625  $\mu\text{m}$ . Body almost linear, squat, about 3.8 times as long as broad, somewhat depressed dorsoventrally (Figs. 113c-d). Rostrum (Fig. 114a) very reduced, rounded anteriorly, not at all prominent, fused to cephalothorax. Cephalothorax rounded anteriorly; probably forming a burrowing shield since the antennules are held beneath the cephalothorax (Fig. 113d). Genital suture lateral and dorsolateral only, stemming from pronounced epimera (Fig. 113d). Genital field complex, with a pair of fused spine-like processes protruding ventrally; P.6 rudiment with three long setae (Fig. 113e). Anal operculum pronounced (Fig. 113f). Caudal ramus (Figs. 113g-h) most peculiar, with a complex topography with many accessory spines; without well developed terminal setae, although one is probably represented by a large broad-based spine.

*Somitic ornamentation* : Entire body punctate except for the caudal rami and four clear patches on the cephalothorax (Figs. 113c-d). All segments with epimera. Hyaline frill absent. Distal edge of all segments crenulate, as in Fig. 113f.

*Antennule* (Fig. 113k) short, eight-segmented but with, most unusually, the aesthete on the third segment. Third segment is by far the largest segment.

*Antenna* (Fig. 113l) with basis without setae. Exopod a single segment with two setae.

*Mandible* (Fig. 114b) : Pre-coxal cutting edge a simple, heavily chitinized rounded knob. Coxa-basis elongate, with three setae. Endopod a single elongate segment with one inner and seven terminal setae. Exopod of two segments.

*Maxillule* (Fig. 114c) : Pre-coxal arthrite with four broad, blunt teeth. Coxa with four setae. Basis with five setae. Exopod and endopod each of one segment.

*Maxilla* (Fig. 114d) : Syncoxa with four endites. Basis with a terminal claw and two basal setae. Endopod of two well defined segments.

*Maxilliped* (Fig. 114e) elongate, not prehensile. Basis with three basally directed setae. First endopod segment very elongate. Second endopod segment well developed; with two setae and a claw.

*P.1* (Fig. 114f) : Pre-coxa absent. Coxa transversely elongate, especially pronounced on the outer side, and freely articulated with the inter-costal plate. Inner distal corner with a few teeth. Basis small and originating on the anterior face of the coxa. Both rami two-segmented. Exopod segments small, equal. First endopod segment elongate, longer than the entire exopod. Second segment with two long geniculate setae.

*P.2-P.4* (Figs. 114g-i) : Pre-coxa absent. Coxa transversely elongate but, unlike the *P.1*, not extended to the external side. Inner distal corner with many sharp teeth. In *P.2* (Fig. 114g) this corner is "duplicated" It articulates with the inter-costal plate only at the proximal corner. The anterior "plate" of the inner edge almost meshes with that of its opposite partner. In *P.3* (Fig. 114h) the inner side of the coxa is not "duplicated"; it does not contact that of its opposite partner and is firmly fused to the inter-costal plate along the whole length of the plate. In *P.4* (Fig. 114i) the coxae of the pair of *P.4* are fused without suture to the intervening inter-costal plate. Basis of *P.2-P.4* complex in shape. Exopod three-segmented; all spines elongate and blunt. Endopod of *P.2* two-segmented, of *P.3* and *P.4* of one small segment. Setation as below.

*Setal formula*

	Exp.	Enp.
<i>P.1</i>	0. 0.2.2.	0. 0.2.0.
<i>P.2</i>	0. 0. 0.2.0.	1. 0.2.0.
<i>P.3-P.4</i>	0. 0. 0.2.0.	0.1.0.

*P.5* (Figs. 113d, 114j) modified as a large, domed brood pouch in which individual components cannot be recognized.

*Male* differs from the female in the following respects.

*Length* 428  $\mu\text{m}$ . *Abdomen* with first two segments distinct.

*Caudal ramus* (Figs. 113i-j) quite different in shape and topography; with one terminal seta, which is short, broad at the base and terminating in a fine lash.

*Antennule* (Fig. 114a) sub-chirocerate. Penultimate segment with a large hook. In all specimens the antennule has a right-angled bend as depicted in Fig. 114a.

*P.2* endopod (Fig. 114k) with second segment modified.

*P.5* (Fig. 114l) of both sides confluent. Basendopod with three, exopod with six setae. Outer side of exopod with a notch, which is not the articulation point of a missing seta.

P.6 (Fig. 114m) of each side a small lappet with two setae.

*Etymology* : The specific name is chosen to reflect the sexual dimorphism of the caudal ramus.

*Remarks* : Only two species have been described in this bizarre genus, and both are known only from their type-locality—*O. pauliani* Chappuis, 1954 (Madagascar) and *O. robinsoni* Chappuis & Delamare Deboutteville, 1956 (Bimini, Bahamas).

These two species are distinguished from each other on differences in the complex caudal rami and in the number of segments in the P.3 endopod. In both characters our specimens more closely resemble *O. pauliani*, but there are a number of differences:

1. Caudal ramus : There are some differences in the female but the overall similarity is close. Of more importance is the dimorphism in our specimens. Chappuis (1954) states positively that the male “branches furcales comme chez la femelle” The male of *O. robinsoni* is unknown.
2. P.5 female appears to be more complex at its distal end, but with less small setae.
3. Mandible : Endopod with seven terminal setae (vs. four), exopod with three terminal setae (vs. two).
4. P.3 : First exopod segment has a massive unguiform projection of the outer distal corner.
5. Male P.2 endopod has the outer spine firmly fused to the segment.
6. Anal operculum has more teeth.
7. Male antennule : The form of the penultimate segment appears to be quite different.

Unfortunately a comparison could only be made with the published description and it is possible that some of the differences could be due to errors in that description. However, given the major difference in the male caudal ramus we believe that it is more plausible that at least some of the other differences are real and that our specimens are not conspecific with *O. pauliani*.

#### Family CANTHOCAMPTIDAE

#### 105. *Mesochra pygmaea* (Claus, 1863)

1863. *Dactylopus pygmaea* C. Claus, *Die freilebenden Copepoden mit besonderer Berücksichtigung der Fauna Deutschlands, der Nordsee und des Mittelmeers* : 127.

*Material examined* : IV, 1 ♀ 1 ♂ ; XIII, 2 ♀ ♀ 1 ♂

*Remarks* : These specimens agree well with Hamond's (1971) redescription except that the anal operculum is clothed with fine setules rather than spines. *M. pygmaea* almost certainly is a cosmopolitan species, its relative rarity in the Indo-Pacific region probably reflecting lack of collecting. Its known distribution is—Arctic Ocean, Atlantic shores from Norway to Angola (including the British Isles and the outer parts of the Baltic Sea) in the east and from the St Lawrence River to the Caribbean Sea in the west, throughout the Mediterranean and Black Seas, Suez Canal, Mozambique, Bay of Bengal, Australia.

#### 106. *Orthopsyllus linearis* (Claus, 1866)

1866. *Liljeborgia linearis* C. Claus, *Schr. Ges. Beford. ges. Naturw. Marburg, Supplement 1* : 22.

*Material examined* : VII, 4 ♀ ♀ 3 ♂ ♂ ; VIII, 3 ♀ ♀ ; IX, 2 ♀ ♀ 3 ♂ ♂

*Remarks* : These specimens have been determined according to the argument of Boer (1971), which places them in that part of this variable species that Boer calls the “*linearis*-group” of records. No variability is displayed among this small sample.

#### Family CYLINDROPSYLLIDAE

#### 107. *Psammastacus spinicaudatus* Rao & Ganapati, 1969 (Figs. 128-129)

1969. *Psammastacus spinicaudatus* G. C. Rao & P. N. Ganapati, *Proc. Indian Acad. Sci.*, **69** : 7

*Material examined* : I, 1 ♀ ; 25 ♀ ♀ 8 ♂ ♂ ; XII, 6 ♀ ♀ ; XIV, 14 ♀ ♀ 2 ♂ ♂

We have identified our specimens by direct comparison with material from the type-locality. We use this opportunity to redescribe the species in rather more detail than was the case in the original description.

#### Amended description

*Female* : Length 560-660  $\mu\text{m}$ . Body cylindrical, vermiform, about ten times as long as broad, segments well demarcated from each other (Fig. 128a). Rostrum small, triangular, articulated with the cephalothorax (Fig. 128h). Genital suture represented by a pair of ventrolateral bars of chitin. Genital field with a pair of prominent lappets, each with one seta, representing the P.6 overlying a set of simple chitinous structures (Fig. 128e). Anal operculum pronounced, asetose. Caudal ramus (Figs. 128 f-g) large, terminating in a massive acuminate process (or spine?) whose apex is bifid, with a leaf-like structure ventrally; inner side a tapered curve with large spinules. Caudal and anal glands present, coloured black in life.

*Somitic ornamentation* : Hyaline frill reduced to a small bar of chitin which is naked except on the second to fourth abdominal segments (Fig. 128d). Anal segment with a few large spinules on ventral distal edge (Figs. 128b-c).

*Antennule* (Fig. 128h) elongate, seven-segmented. First segment very small; second segment elongate. An aesthete on segments four and seven; that on the fourth segment annulate (a condition previously noticed only in *Psammastacus erasmusi* McLachlan & Moore, 1978; but see also *Arenotopa dyadacantha* n.sp., described herein).

*Antenna* (Figs. 128 i-j) with allobasis suture defined by a thin line on the chitin. Endopod with three geniculate setae, the outer with a spinous projection at the "knee". Exopod of one small segment with one long and one short seta. The long seta always with a single long accessory spinule.

*Mandible* (Fig. 128k) : Cutting edge of pre-coxa simple, dentate. Palp two-segmented, the second segment with one lateral and two terminal setae.

*Maxillule* (Fig. 128l) : Pre-coxal arthrite with five spines, three of them massive, and two setae. Coxa with two setae. Basis elongate, large, with three terminal setae; laterally with a proximal seta and a more distal endite with two setae (these may represent the exopod and endopod respectively, but if so, the basis has reversed its orientation).

*Maxilla* large (Fig. 128m) : Syncoxa with two distal endites. Basis with a claw and one small seta. Endopod of one large segment with one lateral and three terminal setae.

*Maxilliped* (Fig. 128n) very large, prehensile. Basis elongate, narrow; with one seta. First endopod segment without setae. Second segment a long plumose claw with one seta.

*P.1* (Fig. 129a) : Pre-coxa absent. Coxa with two rows of spinules. Basis without ornamentation or setae. Exopod of one elongate segment with an outer seta; terminating in two geniculate setae and a club-like spine, setose at its tip. Endopod two segmented, the first longer than the second and as long as the exopod. Second segment about 80% of the length of the first; with two geniculate terminal setae.

*P.2-P.4* (Figs. 129b-d) : Pre-coxa rudiment visible, firmly fused to the coxa. Coxa with one spinule row in P.2-P.3, naked in P.4. Basis with an outer seta in P.3-P.4, naked in P.2. P.4 much longer than P.2 or P.3. Exopods three, endopods two-segmented; elongate and slender. Setation as below.

*P.5* (Fig. 129e) reduced to a narrow plate with five setae.

#### *Setal formula*

	Exp.			Enp.	
P.1		1.2.1.		1.	0.2.0.
P.2	0.	0.	0.2.1.	0.	0.1.0.
P.3	0.	0.	1.2.1.	0.	0.1.0.
P.4	0.	1.	2.2.1.	0.	1.1.0.

Male differs from the female in the following respects:

*Abdomen* : First two segments distinct. *Antennule* (Fig. 128o) haplocerate.

*P.5* (Fig. 129f) : The pair of P.5 confluent ; each side with three setae. *P.6* (Fig. 129g) of each side a lappet with two setae.

*Variability* : The Waltair material differs from that from the Andaman-Nicobar Islands in the reduced spination of the anal segment (cf. Figs. 128b-c); in the latter the smaller lateral spines are variable in size. No other differences between the two sets of specimens was observed, neither was there any further variability within each set.

*Remarks* : There can be no doubt that this species closely resembles *P. spinicaudus* Wells, 1967, with which it is identical in P.1-P.4 and, except for the apical part of the terminal spine, in the caudal ramus. The mouth parts are very similar and there are only small differences in the antennule and antenna. Larger scale differences appear in the P.5-P.6 of both sexes. The ventral ornamentation of the anal segment of *P. spinicaudus* shows two distinct morphs, only one of which is similar to the condition seen in *P. spinicaudatus*.

#### ***Arenotopa* Chappuis & Rouch, 1960**

Subsequent to the publication of the senior author's opinion (Wells, 1967) that *Arenotopa* is a synonym of *Psammastacus* Nicholls, two species have been described in which the endopod of the male P.4 is extensively modified in a manner similar to that of *Arenotopa ghanai* Chappuis & Rouch, 1960; another is described in this paper. The demonstration that this phenomenon is relatively widespread causes us to reconsider and to formally propose that the genus be resurrected to include these species :

*Arenotopa ghanai* Chappuis & Rouch, 1960 (type-species by monotypy)

*Arenotopa rossii* Cottarelli, 1977a

*Psammastacus erasmusi* McLachlan & Moore, 1978

*Arenotopa dyadacantha* n.sp.

The two genera undoubtedly are closely related. In the present state of knowledge it is impossible to separate the females, though it is possible that more extensive knowledge of the female genital field, which appears to be simpler in *Arenotopa* than in *Psammastacus*, will enable this to be done.



108. *Arenotopa dyadacantha* n.sp.  
(Figs. 130-131)

*Material examined* : II, 10 ♀ ♀ 7 ♂ ♂ .

*Holotype* male, II (C2865/2) and *Paratypes* (C2866/2) deposited with the Zoological Survey of India, Calcutta.

### Description

*Female* : Length about 440  $\mu\text{m}$ . Body cylindrical, vermiform, about ten times as long as broad (Fig. 130a). Rostrum a small narrow triangle, articulated with the cephalothorax (Fig. 130j). Genital suture absent. Genital field extremely complex (Fig. 130b); P.6 represented by a single long seta. Anal operculum without setae or chitinous strengthening. Caudal ramus (Figs. 130c-e) about twice as long as the maximum breadth; ill-defined from the anal segment dorsally. With two well developed apical setae, a proximal anteriorly directed dorsal seta, an outer lateral seta and an inner lateral articulated seta. With two spinous processes projecting dorsad, the proximal with a row of spinules at its base extending proximally along the inner dorsolateral edge.

*Somitic ornamentation* : Body without sensilla or surface ornamentation. Distal edge of all somites, except the last, with a complete row of small setules (Fig. 130b). Anal segment with a few stout spinules ventrally.

*Antennule* (Fig. 130f) seven-segmented. First segment short, aetose. Second segment elongate, with a plumose seta. Aesthete on segment four is annulate.

*Antenna* (Figs. 130g-h) with allobasis without trace of suture. Exopod firmly fused to allobasis; of one segment with two setae. Second endopod segment short; with two prominent rows of spinules.

*Mandible* (Fig. 131j) very small. Palp of one segment with one lateral and three terminal setae.

*Maxillule* (Fig. 131l) : Arthrite of pre-coxa with two terminal and four sub-terminal spines. Coxa short, with one terminal seta. Basis with four terminal setae. Exopod and endopod each represented by one seta. In *Arenotopa* the maxillule is described only for *A. erasmusi*; the differences between Fig. 131l and Fig. 6G of McLachlan & Moore (1978) almost certainly are due only to a different orientation of view. When viewed from beneath, the maxillule of our specimen is essentially similar to that of *A. erasmusi*.

*Maxilla* (Fig. 131m) : Syncoxa with two endites. Basis demarcated from coxa, terminating in a large claw, without setae. Endopod large, of one segment fused to the basis, with three setae.

*Maxilliped* (Fig. 130i) very large. Basis and first endopod segment asetose. Second endopod segment a long plumose claw, with one seta at its base.

*P.1* (Fig. 131a) : Pre-coxa fused with coxa. Coxa elongate. Basis without setae or spines. Exopod of one elongate segment with an outer lateral spine and with a plumose spine and two geniculate setae terminally. Endopod two-segmented, short. First segment only slightly longer than the second; with an inner seta. Second segment with two terminal geniculate setae. Outer edge of both segments with long spinules.

*P.2-P.4* (Figs. 131b-d) : Pre-coxa fused with coxa. Coxa moderately elongate. Basis with an outer seta in P.3 and P.4; P.2 without a seta but with a few spinules. Exopods three, endopods two-segmented; outer edge of all segments with long spinules, particularly the exopods. Endopod of P.4 broad, lamellar and without obvious setae, though it is probable that the two distal spines represent the setae of this segment. Setation as below.

*P.5* (Fig. 131e) of each side widely separated and reduced to a small plate with four setae.

*Setal formula*

	Exp.			Enp.	
P.1			0.2.2.	1.	0.2.0.
P.2	0.	0.	0.2.1.	0.	0.1.0.
P.3	0.	0.	1.2.1.	0.	0.1.0.
P.4	0.	1.	2.2.1.	0.	(0.2.0.?)

*Male* differs from the female in the following respects.

*Abdomen* : First two segments distinct. *Antennule* (Fig. 130o) haplocerate.

*P.3 endopod* (Fig. 131f) : Second segment more slender than in the female; terminal setae much shorter.

*P.4* (Fig. 131g) : Exopod rather more slender than in the female. First endopod segment elongate and with less accessory spinules; second segment highly modified.

*P.5* (Fig. 131 h) similar to the female but with only three setae.

*P.6* (Fig. 131 i) of each side widely separated; represented by a small lappet with two setae.

*Etymology* : The trivial name alludes to the two thorn-like projections of the caudal ramus (Gk. *dyad*—two; *akantha*—thorn).

*Remarks* : This species is readily distinguishable from the rest of the genus in the nature of the male P.4 and P.3 and by the caudal ramus, with its pair of dorsally projecting "thorns". The female also can be distinguished from *A. erasmusi* by the endopod of P.4 and from *A. ghanai* by the presence of two inner setae on the distal exopod segment of P.4. It would seem to be very difficult to distinguish it from *A. rossii* by characters other than the caudal ramus.

109. *Arenopontia* (*Neoleptastacus*) *indica* Rao, 1967  
(Figs. 132-133)

1967. *Arenopontia indica* G. C. Rao, *Crustaceana*, 13:129.

*Material examined* : III, 4 ♀ ♀ 2 ♂ ♂ ; X, 13 ♀ ♀ 4 ♂ ♂ ; XI, 8 ♀ ♀ 4 ♂ ♂ ; XII, 11 ♀ ♀ 7 ♂ ♂

*Remarks* : It<sup>o</sup> (1978) has shown that *A. indica*, *A. gussoae* Cottarelli, 1973 and *A. sakagamii* It<sup>o</sup>, 1978 form a discrete sub-group within the genus. He admits that they are very similar to each other but maintains that they can be distinguished on the balance of a number of points of fine, but important, detail.

Analysis of our present material showed that it was closely similar to the published description of *A. indica*, but with some differences and much variability. The chief difference was the absence of a pronounced lateral spur on the caudal ramus. Consequently, we examined *A. indica* from the type-locality. This investigation showed that this population was variable, and with the exception of the caudal ramus spur, had the same range of variation as the Andaman-Nicobar material. Thus we have no hesitation in assigning our present specimens to *A. indica*. However, the variability now apparent raises doubts on the validity of *A. sakagamii* and reduces the distinctiveness of *A. gussoae*. Similarities and differences between the species are summarised in Table 9. According to Cottarelli (1973) and It<sup>o</sup> (1978) variability in *A. gussoae* and *A. sakagamii* is very limited and confined to small differences in shape of the caudal ramus and last segment, whereas we have found that no two specimens of *A. indica* are exactly similar in respect of the sum of characters listed in Table 9 (47 specimens were examined, 22 from the type-locality).

From Table 9 it is apparent that, given the variability of *A. indica*, the sole diagnostic difference between this species and *A. sakagamii* is the reduction of setation in the antenna exopod to just one seta in the latter. The validity of *A. sakagamii* must be questionable and we propose that it sink as a junior subjective synonym of *A. indica*.

It<sup>o</sup> (1978) proposed that *A. gussoae* could be maintained as a distinct species because of its spinulose spur to P.5. Our studies remove this distinctiveness, but we argue that *A. gussoae* is sufficiently different in caudal ramus and, possibly, P.5 for it to warrant separate species status.

We take this opportunity to provide an expanded, more detailed description of *A. indica* and to draw attention to a basic error in the original description of the caudal ramus.

### Supplementary description

*Female* : Length 380-600  $\mu\text{m}$ . Body linear, elongate, cylindrical, about six times as long as the widest portion, the genital somite (Fig. 132a). Rostrum small, triangular, articulated with the cephalothorax. All segments well demarcated from each other with wide arthrodial membranes. Body without ornamentation. Hyaline frill of cephalothorax and thoracic segments narrow and fully incised obtusidigitate (in the terminology of Moore, 1976b). Hyaline frill of the abdominal segments wide and "broad rectangular-lappeted" (Moore, 1976b). Genital suture restricted to a very small ventrolateral bar of chitin. Genital field with a complex internal structure but without prominent receptacula or any trace of P.6 (Fig. 132b). Anal operculum prominent, asetose. Distal dorsolateral corner of anal segment produced into an acuminate process which curves dorsad.

*Caudal ramus* (Figs. 132c-h) terminating in a long acuminate process approximately as long as the basal portion. Principal terminal seta originates ventral to this process and is accompanied by two very short, fine setae and has a bunch of long hairs about its mid-point. Four dorsal setae; one very small and hair-like. *Inner* side with or without a small spur or its rudiment (*note* that the original description would indicate this spur to be on the *outer* side; see Rao, 1967, Fig. 1.1).

*Antennule* (Fig. 132i) six-segmented, the first very short the second elongate with a sparsely plumose lateral seta; aesthete on segment four.

*Antenna* (Fig. 132j) with a small coxal rudiment. Allobasis with partial suture. Second endopod segment with the inner part of the distal edge expanded as a thin shelf. Exopod of one elongate segment; terminally with one long seta and one weak setule of variable length.

*Mandible* (Fig. 132h), *maxillule* (Fig. 132l), *maxilla* (Fig. 132m) and *maxilliped* (Fig. 132n) of the form typical of the genus.

*P.1* (Fig. 133a) : Pre-coxa absent. Coxa without ornamentation. Basis with an inner seta. Exopod of three sub-equal segments, the median without an outer spine. Endopod two-segmented, the first almost as long as the entire exopod and about 1.75 times as long as the second segment.

*P.2-P.4* (Figs. 133b-d) : Pre-coxa fused to coxa, but recognisable. Coxa without ornamentation; elongate. Basis short, with a few spinules on the outer side; outer seta present in P.3 and P.4 only. Exopods three, endopods two-segmented, setation as below. Outer edge of first two exopod segments with exceedingly long spinules.

*P.5* (Figs. 133 e-g) of each side a single plate with four setae and spines. Inner distal corner a mucroniform process variously plain or dentate.

*Setal formula*

	Exp.			Enp.	
P.1	0.	0.	0.2.2.	1.	0.2.1.
P.2	0.	0.	0.2.1.	0.	1.2.0.
P.3	0.	0.	0.2.1.	0.	0.1.0.
P.4	0.	0.	1.2.1.	0.	0.2.0.

*Male* differs from the female in the following respects. *Abdomen* : First two segments distinct. *Antennule* haplocerate (Fig. 132o). *P.6* of each side a square lappet with two setae, the inner of varying length (Figs 133i-l).

*Variability* : The main sources of variability are identified in Table 9. Other, minor, sources are total length, and the number and size of accessory spinules on P.1-P.4. Probably of greater significance is variability in the caudal ramus, including the ratio of length of the terminal process against the basal portion of the ramus (1.88-2.21 : 1) and degree of curvature of the terminal claw. Additionally, in a few specimens the acuminate processes of the anal segment are almost straight, not curved dorsad. This may have real significance with regard to the relationship of *A. indica* sens. nov. and *A. gussoae* to the *acantha*-group of species (see It<sup>o</sup>, 1978, p. 54).

Family LOURINIIDAE

110. *Lourinia armata* (Claus, 1866)

1866. *Jurinia armata* C. Claus, *Schr. Ges. Beford ges. Naturw. Marburg*, Supplement 1:30

*Material examined* ; III, 1 ♀ 1 ♂ ; IV, 6 ♀ ♀ 5 ♂ ♂ ; VII, 11 ♀ ♀ 9 ♂ ♂ ; VIII, 5 ♀ ♀ 2 ♂ ♂

*Remarks* : Vervoort (1964) reviewed the data on variability in this species, which is distributed throughout the warm waters of the world. He concluded that, in the face of this variability, the forms and varieties proposed by Brian (1923) and Sewell (1940) and the subspecies *sulamericana* Jakobi, 1954b have no raison d'être, and that *L. nicobarica* Sewell, 1940 was separated on "not particularly impressive" grounds.

These present specimens from the Andaman Islands fall completely within the range of variation accepted by Vervoort for *L. armata* s. str. and surely confirm his opinion that *L. nicobarica* cannot be maintained as a separate species. Variability in *L. armata* shows no correlation with geographical distribution and our material has features in common with specimens from many parts of the species range. They

also show that features such as the form of the caudal setae are both variable within a population (even within the very small samples we dealt with) and depend upon orientation of view—the basal flattening can be either in the dorsoventral plane, when it is obvious, or in the lateral plane, where it can be misinterpreted as a normal seta when the animal is viewed from dorsum or ventrum. Placement of setae on particular borders of the P.2-P.4 endopods is similarly variable, as is the degree and extent of accessory setal spinulation, relative length of setae, and even their absolute number. Vervoort (1964) documents some of this variability. Our material serves to show that it does occur within a population. It can only be concluded that intra-specific variability must be considered to be a real phenomenon in *L. armata* until breeding experiments confirm or reject this hypothesis. Since Vervoort did not formally propose that *L. nicobarica* sink as a junior subjective synonym of *L. armata* we now do so, even though we have failed to trace Sewell's material or find in our samples from the Nicobar Islands any specimens of *Lourinia*.

#### Family CLETODIDAE

#### 111. *Cletodes dentatus* n.sp. (Figs. 134-135)

*Material examined* : IV, 1 ♂ ; VI 2 ♀ ♀ 6 ♂ ♂ ; VII, 1 ♂ ; XIII 2 ♀ ♀ 9 ♂ ♂

*Holotype* female, VI (C2867/2) and *Paratypes* (C2868/2) deposited with the Zoological Survey of India, Calcutta.

#### Description

*Female* : Length about 780-790  $\mu$ m. Body relatively linear with a slight taper in the abdomen; about five times as long as broad (Figs. 134a-b). Rostrum large, broad, triangular, with a slightly bifid tip with sensilla. Genital suture well marked and similar in structure to the distal edge of other segments. Genital field complex, with P.6 represented by a single short seta (Fig. 134d). Anal operculum distinct (Fig. 134i); a smooth flap of chitin with minute teeth let into the edge and flanked on either side by a sensillum on a pedestal. Caudal ramus (Figs. 134c-d) about three times as long as broad, sub-cylindrical, tapering in distal part of the inner side; with a distinct dorsal ridge at the base of which is an articulated seta. Outer side with two small setae; terminally with one moderately well developed seta and two small setae.

*Somitic ornamentation* : Entire body covered with minute spinules of a variety of sizes and shapes. In places these are arranged in rows but over most of the surface they appear to be scattered without definite pattern, although as all specimens were covered with fine debris, presumably embedded in mucus, this cannot be verified. Distal edge of all somites except the last marked by a row of fine setules but without a hyaline frill. Above this spinule row is a ridge of strengthened chitin which either is set with minute rounded spinules (thoracic segments and parts of

some abdominal segments, as in Figs. 134e-f), or with larger, stouter, sharp spinules (parts of some abdominal segments, as in Figs. 134g-h), or is naked, or is a mixture of these types (all abdominal segments). Springing from this ridge at intervals are sensillate pedestals. Anal operculum set with minute teeth (or spinules ?).

*Antennule* (Fig. 134j) short, stout, four-segmented with a weakly defined line of fusion on segment three. Second segment with a prominent knob. Heavily plumose spines on all segments except the first.

*Antenna* (Fig. 134h) with allobasis with one small distal seta. Second endopod segment with massive lateral spines and spinules; terminally with two geniculate setae and three spines, the outermost pectinate and geniculate. Exopod represented by a single plumose seta.

*Mandible* (Fig. 134l) : Cutting edge complex. Palp one-segmented with six setae.

*Maxillule* (Fig. 134m) : Pre-coxal arthrite with four complexly-toothed spines, a plain spine and a plumose seta, and with two plain setae on the surface. Coxa short, with four setae. Basis with six terminal setae and spines. Endopod represented by a plumose spine and two setae. Exopod represented by two curiously-shaped heavily plumose setae.

*Maxilla* (Fig. 134n) : Syncoxa with two endites, the distal with three spines, one of which is claw-like, the proximal with three spines and four stout spinules; spines of both endites with teeth and accessory spinules. Basis terminating in a short bifid claw, with an accessory seta and claw-like spine. Endopod represented by one seta.

*Maxilliped* (Fig. 134o) very small, prehensile. Basis without a seta. First endopod segment with stout spinules along inner edge. Second segment a plumose claw, with one seta.

*P.1-P.4* (Figs. 135a-d) are all of essentially similar construction. Pre-coxa large, fused to coxa. Coxa with spinules at outer distal corner and, except in P.1, near the inner distal corner. Basis with a stout, plumose outer seta and in P.1 only a long plumose inner seta. Exopods three, endopods two-segmented; outer edge of all segments with stout spinules, except for the first endopod segment of P.2-P.4 where these are replaced by fine setules. Posterior surface of P.4 exopod segments with blunt teeth projecting posteriorly (Fig. 135d). Setation as below.

*P.5* (Fig. 135e) : Rami distinct. Inner expansion of basendopod with three setae; outer expansion long and tubular. Exopod large, elongate, rectangular, about 4.3 times as long as broad; with five setae—one inner, two terminal and two outer.

*Setal formula*

	Exp.			Enp.	
P.1	0.	0.	0.2.2.	0.	1.2.0.
P.2	0.	1.	0.2.2.	0.	0.2.0.
P.3-P.4	0.	1.	0.2.2.	0.	1.2.1.

*Male* differs from the female in the following respects :

*Abdomen* : First two segments distinct. Distal edge of first segment as that of second, and identical to second female segment.

*Antennule* (Fig. 135g) sub-chirocerate.

*P.5* (Fig. 135f) very small. Basendopod without inner expansion or setae; outer expansion elongate, tubular. Exopod distinct, small, longer than broad; with three setae.

*P.6* absent.

*Variability* : In one male the endopod of the left P.3 had only three setae, the outermost being absent; the right P.3 was normal.

*Etymology* : The trivial name refers to the rows of teeth on the posterior surface of the exopod of P.4 (*L. dentatus*—toothed).

*Remarks* : This species is unique in the combination of setation of P.1-P.4 and lack of modification to the male P.3 endopod. In leg setation it is identical with *C. yotabis* Por, 1967 but differs in the male P.3, the caudal ramus, anal operculum and maxillule endopod. In many respects it is similar to *C. spinulipes* Por, 1967 (male P.3, caudal ramus, P.5, antenna exopod and, possibly, maxillule) but differs in the leg setation and the anal operculum. It is also unique, as far as can be ascertained from published descriptions, in the posterior ornamentation of P.4. Comparison with the detailed analysis of the genus by Hamond (1973d) emphasizes the uniqueness of the combination of this setation pattern and the lack of sexual dimorphism in the P.1-P.4. Hamond believes that the form and setation of the maxillule rami may prove to be important in *Cletodes* taxonomy. In this respect *C. dentatus* would appear to resemble only *C. milleorum* Hamond, 1973d, though lack of detail in most other descriptions makes this a comparison of limited value at the moment. The complexity of the form of the setae and spines of both maxillule and maxilla in *C. dentatus* also appears to be unique, but such detail is given for few species.

#### 112. *Enhydrosoma pectinatum* n.sp.

(Figs. 136-137)

*Material examined* : IV, 2 ♀ ♀ 1 ♂ ; VI, 6 ♀ ♀ 2 ♂ ♂ ; VIII 1 ♀ 1 ♂ ; XIII, 3 ♀ ♀ 2 ♂ ♂

*Holotype* female, VI (C2769/2) and *Paratypes* (C2870/2) deposited with the Zoological Survey of India, Calcutta.



## Description

*Female* : Length 630  $\mu\text{m}$ . Body almost linear, slightly tapering in abdomen, above five times as long as broad (Figs. 136a-b). Rostrum (Fig. 136f) large, broad basally tapering to a prominent rounded apex with a sensillum either side. Genital suture showing structure of the distal edge of a normal segment. Genital field simple (Fig. 136e). Anal operculum simple, naked, flanked on either side by a sensillate pedestal. Caudal ramus (Fig. 136d) almost cylindrical, 4.9-5.6 times as long as broad, about twice as long as the anal segment, longer than the last two segments; only one well developed terminal seta.

*Somitic ornamentation* (Figs. 136a-c) : Entire body densely clothed with minute hairs. Hyaline frill absent, distal edge of all segments without setae. All segments with a pattern of chitinous struts; distal edge with sensillate pedestals. Anal region with long hairs (Fig. 136c). A few setules above the origin of P.5 (Fig. 137h).

*Antennule* (Fig. 136g) short, five-segmented, the fourth very small. Pectinate spines present on the last segment only.

*Antenna* (Fig. 136i) of normal genus pattern. Exopod large, with two well developed setae.

*Mandible* (Fig. 137a) of normal genus pattern.

*Maxillule* (Fig. 137b) small and simple. Pre-coxal arthrite terminally with four plain spines and a plumose seta, and with a simple seta on the surface. Coxa, basis and rami fused together, with separate parts indistinguishable, with a total of five setae.

*Maxilla* (Fig. 137c) small. Syncoxa apparently with one endite only. Another endite-like structure originates on the inner side of the basis. Endopod represented by two setae only.

*Maxilliped* (Fig. 137d) of the form typical of the genus, except that the basis lacks a seta. Second endopod segment does not bear the usual long claw, but has a stout seta with a very fine and flexible terminal portion which in all specimens examined is partially or completely coiled.

*P.1* (Fig. 137e) : Coxa with fine setules near inner and outer distal corners. Basis with a stout outer seta and a plumose inner spine and with an almost continuous row of fine setules along the distal edge. Exopod of three subequal segments; the two terminal setae long and with a terminal tuft of long hairs. Endopod two-segmented, the first very small; slightly shorter than the exopod. Outer edge of all segments with very long spinules.

*P.2-P.4* (Figs. 137f-g) : Coxa and basis complexly ornamented with long hairs. Exopods three, endopods two-segmented. *P.3* identical to *P.4*. Outer edge of all segments with very long spinules. Setation as below.

*P.5* (Fig. 137h) : Rami confluent. Basendopod with a long tubular outer expansion; the small inner expansion with a plumose seta and two massive pectinate spines. Exopod portion with four setae, each of which has a broad base rapidly tapering to a thin lash; inner seta less modified than the others. Whole appendage with a complex ornamentation of stout spinules.

*Setal formula*

	Exp.			Enp.	
P.1	0.	0.	0.2.2.	0.	0.1.1.
P.2	0.	0.	0.2.2.	0.	0.2.0.
P.3-P.4	0.	0.	1.2.2.	0.	0.2.1.

*Male* differs from the female in the following respects.

*Abdomen* (Fig. 136d) : First two segments distinct; dorsal and lateral distal edge of first segment as other segments. Second segment with a row of fine spinules ventrally.

*Antennule* (Fig. 136h) sub-chirocerate.

*P.5* (Fig. 137i) : Rami confluent. Basendopod with a seta and one pectinate spine. Exopod with two setae.

*P.6* (Fig. 136d) apparently represented by a crescentic row of fine spinules.

*Variability* : Except for the length of the caudal ramus, no variability was noted.

*Etymology* : The trivial name refers to the massive pectinate setae of the *P.5*

*Remarks* : This species is unique in the exact form of the *P.5* in both sexes. The form of the maxilla as described here has only previously been noted in *E. variabile* Wells, Hicks & Coull, 1982, but it seems most probable that other authors have failed to observe the correct line of articulation between syncoxa and basis.

Although we have not attempted a thorough analysis, we believe that in view of the relative stability of setation of *P.1-P.4* and the considerable intra-specific variability of the caudal ramus in the genus, the *P.5* is the best key to understanding the phylogeny of *Enhydrosoma*. It is in this light that we offer the following opinions on the relationships of *E. pectinatum*.

*E. pectinatum* shows a clear affinity in the P.5 with the *sordidum*-group of species (*E. sordidum* Monard, 1926b, *gariensis* Gurney, 1930, *tunisensis* Monard, 1935b, *pontica* Jakubisiak, 1938, *caeni* Raibaut, 1965; the precise status of these species is a matter of debate—see Thistle (1980) for a review). It seems probable that *E. radhakrishnai* Reddy, 1979 is derived from this group. It is possible that *E. littorale* Wells, 1967 shows a condition of P.5 that is ancestral to that of the *sordidum*-group on the one hand and to the species *E. variabile* and *E. woodini* Thistle, 1980 on the other.

#### Family LAOPHONTIDAE

### 113. *Laophonte cornuta* Philippi, 1840 (Fig. 138)

1840. *Laophonte cornuta* A. Philippi, *Arch. Naturgesch.*, **5** : 195.

*Material examined* : II, 1 ♀ 2 ♂ ♂ ; IV, 15 ♀ ♀ 7 ♂ ♂ ; V, 1 ♀ ; VI, 1 ♂ ; VII, 9 ♀ ♀ 3 ♂ ♂ ; VIII, 2 ♀ ♀ 4 ♂ ♂ ; IX 1 ♀

*Remarks* : This material proved to be fully as variable in the anal operculum as that from California described by Lang (1965). Lang reported intense variation within a single population. Our material confirms this; in the largest sample (Stn IV) no two specimens were alike. The total range of variation was from an almost plain operculum to a large spiniform projection, with all manner of types in between. There is little point in giving illustrations of such diversity, which seems to be almost infinite in the species.

Lang (1965) also found the crenulation of the posterior edge of all somites to be very variable. This is not the case with our material. In all our specimens the cephalothorax has a plain edge, and with one exception, the posterior edge of all other somites (except the last) is regularly crenulate with a distinct difference between the thorax and first two abdominal segments (Fig. 138a), and abdomen segments three and four (Fig. 138b). In the one exception (the female from Stn IX) there is a degree of irregularity (Figs. 138c-d).

In addition to these two sources of variation our material exhibits three others :—

- (a) *Caudal ramus* : Variations in length/width ratio and in the point of origin of the proximal lateral seta (Figs. 138e-h). In general the ramus is much longer in our material than has been previously reported; only the single female from Stn IX is an exception (Fig. 138c).
- (b) *P.1* : There is variability in the relative length of the endopod claw (Figs. 138i-j).
- (c) *Female antennule* : In the majority of specimens the antennule is like that reported in all earlier literature (Fig. 138k), but in about one third the third

segment is relatively longer and has a number of transverse rows of spinules (Fig. 138l).

There appears to be no correlation between these sources of variation. Lang (1965) believes that such variable populations must be "in an intense evolution process" compared to the apparently stable, non-variable populations of Scandinavia. He may be correct but some experimentation is needed before the relative importance of genetic and environmental effects on such variability is understood.

114. **Laophonte dinocerata** Monard, 1926  
(Fig. 138)

1926. *Laophonte dinocerata* A. Monard, *Revue suisse Zool.*, 33 : 619.

*Material examined* : VIII, 1 ♀

*Remarks* : In all respects except the P.5 our female agrees with the various descriptions of this species (Monard, 1926b, 1928, Vervoort, 1964, Pallares, 1975b). These authors record some variability in P.5 in the degree to which the exopod extends beyond the basendopod; shape of the distal part of the basendopod; length/width ratio of the exopod, and spatial relationship between the two outer setae on the exopod. Our female extends the variability of the exopod in being longer (2.3 : 1 cf. 1.5-1.9 : 1) and in having six setae (Fig. 138m). The two outermost setae arise close together in a manner similar to that described by Monard (1926b, 1928).

This rare species has now been recorded from the English Channel, several localities in the Mediterranean, the Andaman Islands, Caroline Islands, and Tierra del Fuego.

115. **Laophonte spinicauda** (Vervoort, 1964)  
(Figs. 138-139)

1964. *Paralaophonte spinicauda* W. Vervoort, *Bull. U. S. natn. Mus.*, 236 : 335.

*Material examined* : I, 1 ♀ ; II, 18 ♀ ♀ 14 ♂ ♂ ; III, 1 ♀ 2 ♂ ♂ ; V, 2 ♂ ♂ ; VI, 2 ♀ ♀ ; X, 1 ♀ ; XII, 2 ♀ ♀ ; XV, 3 ♀ ♀ 12 ♂ ♂

*Remarks* : Describing this species from the female only, Vervoort (1964) placed it in *Paralaophonte* Lang, whose generic diagnosis (Lang, 1944, 1948) it follows. It would seem that Vervoort also was influenced by the similarity to *P. taurina* (Monard, 1928) in the 5-setose basendopod of P.5, a condition then unique in the genus. With the discovery of the male (Coull, 1971a) the systematic position of *P. spinicauda*

must be reassessed since it is now known that it lacks the modified seta on the male P.2 endopod, the cardinal point of Lang's generic diagnosis, and that the male P.3 exopod is not modified. With this new knowledge it becomes quite clear that the similarity to *P. taurina* is very superficial, resting solely on the female P.5 basendopod. Significant differences exist between the species in (a) the shape of the female P.5 exopod, (b) the form of the first segment of the female antennule, and the shape of the hook and place of origin of the three outer setae of the second segment, and (c) the male P.2 endopod and P.3 exopod. With the description of *P. majae* Petkovski, 1964 even the uniqueness of the female basendopod has disappeared. There can be no doubt that *Paralaophonte spinicauda* does not belong in that genus and must be transferred to *Laophonte* Philippi (sensu Lang, 1944, 1948), where it has similarities with some species of the *inornata*-group, and particularly with *L. dinocerata* (Monard) in the P.5 female.

Our specimens agree well with Vervoort (1964) and Coull (1971a) but there are a few differences :

- (a) at 360  $\mu\text{m}$  they are slightly smaller;
- (b) the "externally directed spine" (Vervoort, 1964) on the first antennule segment, described also by Coull for the male, is in our material a hirsute rounded knob (Fig. 139d);
- (c) the basendopod of the female P.5 has rows of long spinules and the inner expansion is relatively longer; the exopod is shorter, only as long as broad, and is minutely pubescent (Fig. 139e);
- (d) the whole body is minutely pubescent;
- (e) the abdominal epimeral plates are clothed with long hairs, and the abdominal segments are ornamented with a more complex pattern of spinules than shown by Vervoort (Figs. 138n-o, 139a-b).

We have examined the type material and find it identical with our material in respect of characters (d) and (e). Characters (a), (b) and (c) are real differences but in our opinion do not warrant the erection of a separate taxon for our specimens.

It is also evident that *Laophonte spinifer* Kunz, 1975 is synonymous with *L. spinicauda*. Kunz's female is identical to Vervoort's except in the antennule, which is identical with our females, and in minor details of the antenna exopod. Kunz's male differs from Coull's and ours (which are identical) in the shorter exopod of P.5 and the presence of a seta on the basendopod. We propose that *Laophonte spinifer* Kunz, 1975 sink as a junior subjective synonym of *Paralaophonte spinicauda* Vervoort, 1964. which species must be transferred to *Laophonte* Philippi.

116. *Esola longicauda* Edwards, 1891  
(Fig. 139)

1891. *Esola longicauda* C. L. Edwards, *Arch. Naturgesch.*, **57** : 81.

*Material examined* : VII, 1 ♀

*Remarks* : There can be no doubt that our female belongs to this highly distinctive pan-temperate/tropical species. Lang (1948) considered *E. longicauda* to be a highly variable species, a concept with which Vervoort (1964) is not wholly satisfied. With only one specimen at our disposal we cannot profitably enter this debate, except to state that we are not impressed with the criteria used by Mielke (1981a) to justify his new subspecies *galapagoensis*. In the characters known to be variable in *E. longicauda* our female has a relatively long antennule with two processes on the first segment (Fig. 139h); a slender P.1 endopod (Fig. 139i); lacks an inner seta on the first endopod segment of P.4 (it is present on P.2-P.3) ; has a moderately well developed outermost seta of P.5 basendopod (Fig. 139j).

117. *Echinolaophonte armiger* (Gurney, 1927)

1927. *Laophonte armiger* R. Gurney, *Trans. zool. Soc. Lond.*, **22** : 554.

*Material examined* : IV, 1 ♀ 1 ♂ ; VII, 3 ♀ ♀ 2 ♂ ♂ ; VIII, 1 ♀ ; IX, 1 ♀

*Remarks* : Lang's (1965) superb illustrations reveal the extreme complexity of ornamentation in this species. Lang also described variability in this ornamentation, a feature that had been suspected independently by Vervoort (1964). Lang went so far as to describe his Californian material as forma *briani* nov., it being rather different in detail of ornamentation to other specimens that he describes as "forma *typica* (Gurney)"; this latter material presumably being from the central Mediterranean since it was provided by Professor Brian of Genoa. Our present material is very close to Lang's illustrations of forma *typica*, and certainly quite different to forma *briani*. It would appear from his illustrations that Vervoort's Caroline Islands female also resembles *typica* more closely than *briani*. Other published descriptions do not have enough detail for comment, but we can state that Wells' (1978) Fijian material is rather different to both forms.

118. *Echinolaophonte mirabilis* (Gurney, 1927)  
(Figs. 140-142)

1927. *Laophonte mirabilis* R. Gurney, *Trans. zool. Soc. Lond.*, **22** : 558.

*Material examined* : II, 1 ♀ ; IX, 1 ♂

*Remarks* : This species has been recorded twice only. The original record is of a single female from the Suez Canal; this Holotype is a whole animal preserved in

spirit and now deposited in the British Museum (Natural History). The other record is from the Xisha Islands, Guangdong Province, China by Zhang & Li (1976), who give no details of numbers or sex taken; we failed to obtain a loan of this material, or get any further details of it.

We have made the best comparison that we can between our specimens and the Holotype, bearing in mind that it is a female and that its status prevented us from dissecting it.

Gurney's description is brief and generally accurate, but does contain four important errors :

- (i) The antennule has six segments, not five (Fig. 140d). In fact Gurney's illustration (1927a, Fig. 162G) clearly shows six segments.
- (ii) The small, fourth seta of the P.5 basendopod is not an articulated seta but a hyaline tube (Fig. 141i). Mielke (1981a) describes a similar structure in *E. tetracheir*.
- (iii) The distal segment of P.4 exopod (Fig. 141j) has only six setae and spines (distributed as 2.2.2.); Gurney states that there are seven, distributed as 2.2.3.
- (iv) The dorsal distal edge of the penultimate segment has four digitate projections forming a pseudoperculum (Fig. 140c). Such a structure is found in several other species of the genus. Gurney's illustration (1927a, Fig. 162B) clearly represents the ventral edge of this segment (cf. Fig. 140h).

As the result of this comparison we are positive that our *male* is of this species, since it is identical to the Holotype in the body armature, maxilliped, P.1, pseudoperculum and caudal ramus. It is also identical in the P.2-P.4, that is, there is no sexual dimorphism in the P.3-P.4 exopods and P.3 endopod. The only differences from the female are the chirocerate antennule and the P.5-P.6 (Figs. 140k-1). The mandible, maxillule and maxilla of both sexes differ only insignificantly from those described by Lang (1965) for *E. armiger* and by Mielke (1981a) for *E. tetracheir*.

We are not so certain of the identity of our *female*. There are a number of differences from the Holotype of *E. mirabilis* :

- (i) Rostrum (cf. Figs. 140e-f), which is identical to that of *E. tetracheir*.
- (ii) Cephalic, thoracic, and abdominal armature has the appearance of being less completely formed, as though there was a further moult to come. The anterior two cephalic protuberances are not hook-shaped (Fig. 141b); the lateral cephalic projections are less acute (Fig. 141a); the thoracic spines

are shorter, blunter, and there is variation both between segments and between right and left sides (Fig. 141a); the projections of abdomen segments one and two are hardly formed at all (Fig. 141a); that of the third abdomen segment is less detailed (cf. Figs. 140b, i); the pseudoperculum projections have less "fingers" (cf. Figs. 140c, g).

- (iii) The distal segment of P.4 exopod is shorter and broader (cf. Figs. 141f, j).
- (iv) The P.5 exopod is fused to the basendopod and the hyaline tube is smaller (cf. Figs. 141h-i).

The similarity to *E. mirabilis* in other species specific characters (e.g. maxilliped, P.1) is so exact that if our female is not this species then it must be closely related. The specimen is mature, with a well developed genital field and P.6 rudiment. With only a single specimen at our disposal it is difficult to interpret these differences and we have decided to place it in *E. mirabilis*. The "unformed" nature of the body armature and the fusion of the P.5 rami could indicate a simple developmental abnormality. It is possible that they indicate a regional genetic differentiation, though we consider it unlikely that such differences would be so strongly sex-linked.

With these corrections to the description of the female and with the new knowledge of the male it is obvious that *E. mirabilis* is most closely similar to *E. tetracheir* Mielke, 1981a, from which it can be distinguished on precise details of body armature, relative length of the caudal ramus, exopod of P.1, and on the male P.3-P.4. The total absence of male modifications to P.3-P.4 exopods shows *E. mirabilis* to be a more derived species than *E. tetracheir*. Many differences from *E. tropica* Ummerkuty, 1970, the only other species with a total lack of sexual dimorphism in P.2-P.4, show that this condition has evolved at least twice within the genus.

#### 119. *Echinolaophonte tropica* Ummerkuty, 1970 (Figs. 142-145)

1970. *Echinolaophonte tropica* A. N. P. Ummerkuty, *Rec. Zool. Survey India*, **64** : 159.

*Material examined* : IV, 3 ♀ ♀ 1 ♂ ; VII, 1 ♀ 2 ♂ ♂

*Remarks* : We have compared the present material with the holotype and we are convinced that our specimens belong to this species. Despite the deficiencies of the original description it is obvious that *E. tropica* is very distinctive in its P.1 and P.5. We take this opportunity to supplement the original description.

#### Supplementary description

*Female* : Length 650-660  $\mu\text{m}$ . Body broad, rather squat, slightly dorsoventrally compressed, about five times as long as the width of the thorax (Figs. 142c-d).



Cephalothorax with two dorsal furrows and prominent lateral and ventrolateral projections; without dorsal spinous projection (Figs. 142e-f). Rostrum very broad, truncate, fused with cephalothorax (Fig. 144a). Genital suture complete dorsally. Genital field simple, without trace of P.6 (Fig. 143c). Caudal ramus slightly less than twice as long as broad; two principal terminal setae fused at their base, inner much longer than outer (Fig. 143i).

*Somitic ornamentation* : Entire body and the basal parts of all appendages minutely punctate. Cephalothorax with acutely pointed lateral "wings" and with distal ventrolateral corners drawn out to a slightly bifid projection; mid-dorsal ridge not pronounced and only slightly hairy (Figs. 142c-f). Thoracic segments without dorsal ornamentation. Abdominal segments with pronounced epimera clothed with fine setules; distal ventral edge of segments three to five with fine setules, segment two naked. Mid-dorsum of abdominal segments without prominent armature, though slightly produced in segments two and three (Figs. 143d-e). Segment four with an expanded hyaline frill which in mid-dorsum forms a finely denticulate pseudopericulum (Figs. 143f-g).

*Antennule* (Fig. 144a) relatively short, six-segmented. Last three segments very small, together only about one-quarter of the combined length of the first three segments. Aesthete on segment four.

*Antenna* (Fig. 143j) relatively large. Coxa clearly distinct. Exopod well developed, with four long setae.

*Mandible* (Fig. 142g), *maxillule* (Fig. 142h) and *maxilla* (Fig. 142i) all of the typical genus construction.

*Maxilliped* (Fig. 143k) large, robust; terminal claw massive.

*P.1* (Fig. 144c) considerably more robust than in other species. Coxa and basis elongate, sub-equal. Basis with outer seta originating in distal half of the segment and with a very well developed inner seta. Exopod two-segmented, appearing elongate because of the extreme robustness of the first endopod segment.

*P.2-P.4* (Figs. 144d-f) typical of the genus, though the last endopod segment and the last two exopod segments are comparatively much shorter than in other species, giving the impression of a very elongate first exopod segment.

*P.5* (Fig. 145a) densely clothed in fine setules. Inner expansion of basendopod narrow; with four stout setae, the inner two sparsely plumose, the outer two plumose around the whole circumference. Exopod elongate, with three setae, the inner densely plumose. Exopod more or less fused to basendopod; the line of articulation being either absent entirely or weak and partial, or, if relatively well developed, present only on anterior surface.

*Setal formula*

	Exp.			Enp.	
P.2	0.	1.	1.2.2.	0.	1.2.0.
P.3	0.	1.	2.2.2.	0.	2.2.0.
P.4	0.	1.	2.2.2.	0.	1.2.0.

*Male* : Similar in length to the female. Ornamentation of cephalothorax, thorax and dorsal abdomen exactly as in the female. P.1-P.4 exactly as in the female. Differs from the female only in the following respects.

*Abdomen* : First two segments distinct. Ventral ornamentation more copious than in the female (Fig. 143h).

*Antennule chirocerate* (Fig. 144b).

*P.5* (Fig. 145b) : Basendopod firmly fused to segment; without inner expansion and with outer expansion unusually small. Exopod with a spine and two setae.

*P.6* (Fig. 145c) of each side reduced to a hairy lappet with a small seta and a massive spine.

*Variability* : Variation was found only in the female P.5 (see above) and in the form of the pseudoperculum (Figs. 143 f-g).

**120. *Quinquelaophonte quinquispinosa* (Sewell, 1924)**  
(Fig. 145)

1924. *Laophonte quinquispinosa* R. B. S. Sewell, *Mem. Indian Mus.*, **5** : 832.

*Material examined* : II, 2 ♀ ♀ 2 ♂ ♂ ; V, 1 ♀

*Remarks* : Variability in this species has been discussed by Wells & McKenzie (1973, as *Heterolaophonte*) and Wells, Hicks & Coull (1982, where it is cited as the type-species of their new genus *Quinquelaophonte*). Our specimens agree with Sewell's original description in respect of the characters assessed by Wells & McKenzie and also seem closest to Sewell's specimens in the shape of the female P.5 (Fig. 145 d).

**121. *Paralaophonte brevirostris* (Claus, 1863)**  
(Fig. 145)

1863. *Cleta brevirostris* C. Claus, *Die freilebenden Copepoden mit besonderer Berücksichtigung der Fauna Deutschlands, der Nordsee und des Mittelmeers* : 124

*Material examined* : IV, 6 ♀ ♀ 2 ♂ ♂ ; VI, 1 ♀ 1 ♂ ; VII, 6 ♀ ♀ 3 ♂ ♂ ; VIII, 1 ♀ ; XIII, 7 ♀ ♀ 10 ♂ ♂

*Remarks* : While typical of *P. brevis* (i.e. as described by Sars, 1908) in the shape and relative size of the cephalothorax and rostrum and in details of antenna, mouthparts and P.1-P.4, these specimens resemble only the female reported by Sewell (1940) in the elongate caudal ramus which, in all except one female, is nearly twice as long as broad (Figs. 145o-p). They are also similar to this female in the shape of the P.5 (Fig. 145q). Sewell's is the only previous record of this species in the Andaman or Nicobar Islands.

Our specimens are very variable in the female antennule, where the second segment may be naked or bear a small conical spur ; where there may be a genuinely distinct seventh segment or where the two distal segments are coalescent with a variably developed trace of the suture (Figs. 145e-n). The seven-segmented condition of the antennule has been observed before (Hamond, 1972) and creates an obvious confusion with *P. congenera* (Sars, 1908). It leaves the different shape and size of the rostrum and cephalothorax as the only reliable criterion of distinction between the two species.

122. **Klieonychocamptus ponticus** (Serban & Plesa, 1957)  
(Fig. 145)

1957. *Onychocamptus ponticus* M. Serban & Plesa. C., *Izd. Zav. Ribarst. N. R. Maked.*, 1 : 229

*Material examined* : XV, 2 ♂ ♂

*Remarks* : This very distinctive species has been recorded twice only—from Rumania (Serban & Plesa, 1957) and the Canary Islands (Noodt, 1958 as *K. diarticulatus*). Our specimens are readily identified with *K. ponticus* but differ in the two-segmented P.1 exopod (Fig. 145r) and the more spinulose P.5 (Fig. 145u). We also note the variation in segmentation of the P.4 exopod between the two specimens (Figs. 145s-t).

**Apolaophonte** n.gen.

The diagnosis of this genus coincides at present with the description of its sole and type species. The generic name is derived by the addition of the prefix *apo*—(Gk.—separate from) to the existing genus, *Laophonte*; the gender is feminine.

123. **Apolaophonte hispida** n.sp.  
(Figs. 146-147)

*Material examined* : II, 11 ♀ ♀ 4 ♂ ♂ ; V, 1 ♀ ; VI, 7 ♀ ♀ 3 ♂ ♂ ; X, 1 ♀

*Holotype* female, II (C2871/2) and *Paratypes* (C2872/2) deposited with the Zoological Survey of India, Calcutta.

## Description

*Female* : Length 510-530  $\mu\text{m}$ . Body almost linear, about four times as long as broad; slightly dorsoventrally depressed, segments well differentiated (Figs. 146a-b). Rostrum short and broad, slightly bifid (Fig. 146c). Genital suture differing little from a normal segment border (Figs. 146a-b). Genital field simple, P.6 represented by two setae (Fig. 146c). Anal operculum finely setose. Caudal ramus (Figs. 146a-c) less than twice as long as broad, tapering towards, apex; two well developed terminal setae.

*Somitic ornamentation* (Figs. 146a-d) : Entire body covered with minute spinules; sensilla present on cephalothorax and on the distal edge of all segments except the last two. Hyaline frill absent. Distal edge of cephalothorax with minute setules, slightly longer at the rounded distal corners. Distal edge of thoracic segments moulded into large teeth, becoming finer on the lateral epimera (Fig. 146d). Dorsal and lateral distal edge of abdominal segments similar to that of the thorax; with well developed epimera on segments one to three covered with a mixture of long and short spinules. Epimera of segment four not so distinct, but marked by a dense patch of spinules. Ventral distal edge of abdominal segments (except the last) with long, fine spinules. Anal operculum with small setules; flanked by sensilla and coarse spines. Caudal ramus with a transverse row of long spinules proximally.

*Antennule* (Fig. 146f) six-segmented, aesthete on segment four. Second segment with a small conical spur. Segments one to four densely hirsute.

*Antenna* (Fig. 147a) of normal construction. Exopod well developed, with three large plumose setae and one small plain seta.

*Mandible* (Fig. 146g), *maxillule* (Fig. 146h), *maxilla* (Fig. 147b) and *maxilliped* (Fig. 147c) of typical laophontid form. Mandible palp of one segment. Maxilliped relatively large; angle between basis and first endopod segment always as illustrated.

*P.1* (Fig. 147d) comparatively large; of normal form. Exopod of three well developed segments.

*P.2-P.4* (Figs. 147e-h): Coxa and basis short; with copious cover of long setules on outer edge of coxa. Exopods three-, endopods two-segmented. Exopod with a copious cover of long spinules. Exopods totally without setae on inner edge. Seta-tion as below. Distal segment of P.4 exopod very variable in shape (Figs. 147f-h), but always with very reduced seta and spines.

*P.5* (Fig. 147k) : Basendopod very broad and with a dense cover of spinules. Inner expansion relatively short, not reaching to the end of the exopod; with five stout, plumose setae. Exopod very densely covered in long, fine setules; sub-circular in shape; with five slender setae, the origin of the outermost anterior to, and somewhat obscuring the origin of, the penultimate seta.

*Setal formula*

	Exp.			Enp.	
P.1	0.	0.	0.2.2.	0.	2.
P.2-P.3	0.	0.	0.2.3.	0.	1.2.0.
P.4	0.	0.	0.2.2.	0.	1.2.0.

*Male* without sexual dimorphism in P.2-P.3; differs from the female in the following respects. Length 420-430  $\mu$ m. First two segments of the abdomen distinct; distal edge as in segment two. Antennule sub-chirocerate (Fig. 147n). Mandible palp as Fig. 146h.

*P.4* (Figs. 147i-j) : Both rami comparatively shorter and stouter, especially the distal segment of endopod. Setae and spines of the distal exopod segment differ from those of P.2-P.3 only in the shorter seta and thus are fundamentally different from the female. Shape of distal exopod segment not variable. One male has two setae on the P.4 of one side (Fig. 147j).

*P.5* (Fig. 147l) : Basendopod barely distinguishable from the segment edge; without an inner expansion, or setae. Exopod distinct, with four setae.

*P.6* (Fig. 147m) of each side a small protrusion with two setae.

*Variability* : No variability was noted other than that described in the P.4.

*Etymology* : The trivial name reflects the extreme hairyness of the body (*L. hispidus*—hairy, bristly).

*Remarks* : In addition to that in the very highly derived *Pseudolaophonte* group of genera (discussed later in this paper) a trend towards reduction of setation by elimination of inner setae from the P.2-P.4 exopod has occurred independently in several lineages in the Laophontidae. Similarly, several independent trends to reduction of male characters in P.2-P.4 have occurred. *Apolaophonte* is unusual in that both trends have gone to completion together, a situation otherwise seen only in *Hemilaophonte* Jakubisiak, 1932 and *Laophonte foxi* Harding 1956. The only other example of total elimination of male modifications to P.2-P.4 is in *Tapholeon* Wells, 1967. *Apolaophonte* seems to be unique in that it is the female P.4 that shows apomorphic tendencies.

But most remarkable is that although it is derived in respect of these characters, *A. hispida* remains very primitive in antenna exopod and in segmentation of P.1-P.4. All other taxa that have reduced setation or male characters in P.2-P.4 also show a derived condition in at least one of antenna exopod, P.1 exopod or one or more ramus of P.2-P.4. It is very difficult, therefore, to postulate relationships for *Apolaophonte*.

In general terms *Apolaophonte* has similarities with a number of taxa, some of which are themselves enigmatic. Resemblances in P.2-P.5 general shape, form and number of segments exists with several species of *Heterolaophonte* Lang, 1944, but this genus is thought to be united (at least at a 'supergenous' level) by the reduced antenna exopod, and in all species the male P.2-P.4 exopods are extensively modified. It is intriguing, however, that the most similar species is *H. furcata* Noodt, 1958, whose male is unknown. There are strong resemblances with some species of *Pseudonychocamptus* Lang, 1944 (notably *P. spinifer* Lang, 1965), but wide differences in the male preclude a close relationship. *Apolaophonte* has a more derived state of leg setation than either of these genera. The similarity of the female *A. hispida* to all species of *Loureiophonte* Jakobi, 1953 is striking, and includes a reduced leg setation, but, again, the male of this genus is extensively modified. In *Arenolaophonte* Lang, 1965 P.2-P.4 endopods are reduced beyond the condition seen in *Apolaophonte* while the exopods retain relict inner setae and the male still shows some modifications to P.3-P.4 endopods. *Stygolaophonte* Lang, 1965 is more derived than *Apolaophonte* in almost all respects, but retains well marked sexual dimorphism in P.3. Finally to *Coullia* Hamond, 1973e; here it is possible to consider *Apolaophonte* ancestral in all female respects. Unfortunately the male of both species of *Coullia* is unknown. Given this final uncertainty we can only describe our specimens as a new genus.

#### **Langia n.gen.**

The diagnosis of this new genus coincides at present with the description of its sole and type species. We name the genus in honour of the late Dr. Karl Lang, but for reasons of euphony declare the gender to be feminine.

#### 124. **Langia maculata** n.sp. (Figs. 148-149)

*Material examined* : II, 1 ♀ ; X, 1 ♀ ; XII, 1 ♂ ; XIII, 1 ♀ ; XIV, 6 ♀ ♀ 8 ♂ ♂ .

*Holotype* female, XIV (C2873/2) and *Paratypes* (C2874/2) deposited with the Zoological Survey of India, Calcutta.

#### **Description**

*Female* : Length 357µm. Body linear, dorsoventrally depressed, slightly more than four times as long as broad (Figs. 148a-b). Cephalothorax rounded anteriorly; rostrum minute (Fig. 148c). Genital suture complete dorsally and laterally, with the structure of a normal segment edge. Genital field simple, P.6 represented by one seta (Fig. 148f). Abdominal epimera not well developed. Anal operculum prominent, dentate (Fig. 148d). Caudal ramus longer than broad, tapering to a sharp, dorsally directed terminal unguiform projection; none of the setae well developed (Figs. 148a-b, d-g).

*Somitic ornamentation* : Large punctae on dorsal and lateral surfaces of cephalothorax, thorax and abdomen, and on the basal segments of the antennule. These punctae give the organism a spotted appearance. Cephalothorax with a few sensilla; distal edge finely setose. Distal edge of thoracic segments, and dorsal and lateral distal edge of all abdominal segments except the last, dentate; without a hyaline frill. Abdominal segments ventrally with long fine setules. Weakly developed epimera clothed with long hairs. Anal segment with strong spinules ventrally. Anal operculum strongly dentate. Outer side of caudal ramus with long hairs.

*Antennule* (Fig. 148h) five-segmented; aesthete on fourth segment. Second segment with a very long unguiform projection. First segment with a small pointed or rounded projection and a row of strong spinules. First three segments punctate.

*Antenna* (Fig. 148j) : Coxa distinct ; allobasis with one small plumose seta. Exopod well developed, one-segmented with three well developed plumose setae and a small plain seta.

*Mandible* (Fig. 148k) : Cutting edge a simple, heavily chitinized, rounded knob. Palp of one segment with three setae.

*Maxillule* (Fig. 148l) : Pre-coxal arthrite with five spines and a row of long spinules. Coxa with two setae. Basis elongate with two setae. Exopod and endopod each represented by three setae.

*Maxilla* (Fig. 148m) : Syncoxa with two endites. Basis with an unguiform projection with three setae at its base. Endopod represented by two setae.

*Maxilliped* (Fig. 148n) small but well developed, prehensile. Basis with a single seta at the inner distal corner. First endopod segment bare. Second segment a claw.

*P.1* (Fig. 149a) : Pre-coxa recognizable but firmly fused to the elongate coxa. Elongate basis articulates with coxa at their inner junction only; in our preserved specimens articulation angle between coxa and basis varies between 90° and 180°. Exopod two-segmented, the second with four setae. Endopod two-segmented, prehensile; second segment with a claw and a minute seta.

*P.2* (Fig. 149b) : Coxa recognizable but firmly fused to the segment edge. Basis with an outer lobe with a long seta; inner side a rounded lobe with long hairs. Exopod of two segments, distal segment with three setae. Endopod absent.

*P.3-P.4* (Figs. 149c-d) : Coxa as P.2. Outer side of basis as P.2; inner side straight and not pilose. Exopod of three weakly demarcated segments; distal segment with five setae and spines. Endopod of one very small segment with two long setae.

*P.5* (Fig. 149e) large. Inner proximal part of basendopod rounded, setose; inner expansion with four setae. Exopod elongate, with five setae.

*Male* : Length 310  $\mu\text{m}$ . Without sexual dimorphism in P.2-P.4 Differs from the female in the following respects.

*Abdomen* (Fig. 148g) : First two segments distinct. Lateral and dorsal posterior edge of the first segment dentate and with a finely incised hyaline frill. Ventrally the second segment has one row of long spinules, with others scattered ventrolaterally. Third and fourth segments with a few long spinules ventrolaterally.

*Antennule* (Fig. 148i) sub-chirocerate.

*P.5* (Fig. 149f) : Basendopod without inner expansion; with one seta. Exopod with five setae.

*P.6* (Fig. 148g) of each side a small lappet with two setae.

*Variability* : None was noted.

*Etymology* : The trivial name alludes to the body ornamentation, which gives a spotted appearance to the animal. (*L. macula*—a spot).

*Remarks* : In the reduction of P.2-P.4, the two-segmented P.1 exopod, and in the antennule *Langia maculata* resembles species of *Pseudolaophonte*. The absence of sexual dimorphism in P.2-P.4 clearly distinguishes the two genera. We believe that the similarities probably are convergent; this is discussed later in this paper (p. 192).

### 125. *Laophontina sensillata* n.sp.

(Figs. 149-150)

*Material examined* : II, 7 ♀ ♀ 6 ♂ ♂ ; III, 3 ♀ ♀ 4 ♂ ♂ ; V, 1 ♂ ; X, 4 ♀ ♀ 9 ♂ ♂ ; XII, 1 ♂ ; XV 3 ♀ ♀ 2 ♂ ♂

*Holotype* female, II (C2875/2) and *Paratypes* (C2876/2) deposited with the Zoological Survey of India, Calcutta.

#### Description

*Female* : Length 470-520  $\mu\text{m}$ . Body cylindrical, squat, about four times as long as broad (Figs. 150a-b). Rostrum fused to cephalothorax, minute. Epimeral plate present only on the first free thoracic segment. Dorsally and laterally the genital suture is complete and marked externally by teeth; ventrally it is represented by some patches of chitin. Genital field very simple ; without trace of P.6 (Fig. 150c). Anal operculum prominent, dentate. Caudal ramus (Figs. 150d-f) small, complex. Inner distal corner a long blunt unguiform process. Two small dorsal processes in proximal half of ramus. All setae weak.



*Somitic ornamentation* (Figs. 150a-c) : Entire body minutely pubescent. Cephalothorax with many rows of sensilla. All somities except the cephalothorax and the last segment, with a wide hyaline frill which either is finely striated or is very finely and totally divided—we are not able to say which is the correct interpretation. Distal edge of all somites, except the last, weakly dentate. Last segment with spinules which increase in size from ventral to dorsal. Anal operculum strongly dentate.

*Antennule* (Fig. 149g) six-segmented, the last three small. First segment slightly sigmoid and with a small pointed projection on the outer side. Second segment with a large unguiform projection.

*Antenna* (Fig. 149h) allobasis without setae. Exopod well developed; one-segmented with four plumose setae.

*Mandible* (Fig. 149i) : with cutting edge seemingly consisting of a broad plate from which spring a pair of strong teeth, a seta and a movable spine. This arrangement is unusual, though a similar condition has been reported in *L. distincta* Wells, 1967. Palp of one segment with three setae.

*Maxillule* (Fig. 149j) : Pre-coxal arthrite with two large spines and four slender setae. Coxa distinct, with two setae. Basis with three long, geniculate setae. Exopod a distinct segment with two setae. Endopod represented by three setae.

*Maxilla* (Fig. 149k) : Syncoxa with two endites. Basis with a terminal unguiform projection and two setae. Endopod represented by two setae.

*Maxilliped* (Fig. 149l) : Basis with a seta at the inner distal corner. First endopod segment bare. Second segment a claw; prehensile upon the first segment.

*P.1* (Fig. 150g) : Coxa elongate and bare. Basis with the inner part longer than the outer ; with weak inner and outer setae. Exopod of one segment with two terminal and four outer setae. Endopod two-segmented, prehensile. First segment elongate, five times as long as broad and four times as long as the second segment. Second segment with a long claw.

*P.2-P.4* very reduced. Coxa not apparent and endopods either absent or represented by a seta.

*P.2* (Fig. 150h) reduced to a single plate with a massive spine and three setae, the outermost on a separate tubular lobe, which presumably springs from the basis. No trace of an endopod.

*P.3* (Fig. 150i) : Coxa-basis with an external seta on a long tubular lobe, and with a seta on the inner side which presumably is the rudiment of the endopod. Exopod of one small segment with two massive plumose spines and two setae.

*P.4* (Fig. 150j) : Coxa-basis as in *P.3*. Exopod two-segmented. First segment with a single, massive outer plumose spine. Second segment with one massive plumose spine and three setae.

*P.5* (Figs. 150k-l) small, reaching only halfway along the first abdominal segment. Basendopod not produced, usually with two setae (three setae were found on the right *P.5* of one female from Stn. III). Inner side of basendopod rounded and with long setules. Exopod with three setae; both edges setose.

*Male* : Length 375-470  $\mu\text{m}$ . Differs from the female in the following respects.

*Abdomen* : First two segments distinct. Posterior edge of the first segment with hyaline frill and ornamentation as in the second segment of the male and female. *Antennule* chirocerate.

*P.5* (Figs. 150m-n) : Basendopod very reduced; inner expansion vestigial, with two small setules. Exopod with three setae. In one male from Stn. V the basendopod supports a single, weak seta.

*P.6* (Fig 150o) : One of the pair of *P.6* is always a small rectangular protuberance fused to the segment edge, bearing two setae, while in the other this protuberance is extended medially as a plate apparently articulated with the segment edge. Of the 23 males recorded, 14 have the right *P.6* bearing the plate and 9 the left.

*Variability* : None was noticed apart from that already described in the male *P.6*, and the presumed abnormalities in the *P.5* of both sexes.

*Etymology* : The trivial name refers to the extremely dense distribution of sensilla on the cephalothorax.

*Remarks* : It is quite clear from Table 10 that the affinities of this species lie with *Laophontina* as we define it (p. 191). It differs from all other species of the genus in the caudal ramus, in which the dorsal spur is weakly developed and probably not homologous with that of these species. In the absence of a pedunculate terminal seta it is similar to *L. distincta*. In the presence of a setal rudiment of the endopod of *P.3-P.4* it is similar to *L. reducta*. Whereas *L. distincta* can be seen as possibly ancestral to *L. dubia* and *L. acantha* it cannot so stand for *L. reducta* and *L. sensillata*. Neither can either of those species be ancestral to *L. distincta*, with its *P.2-P.4* in which the coxae are distinct. It seems likely, therefore, that *Laophontina*, as we presently constitute the genus, contains two closely related lines of descent from an unknown ancestor.

126. *Klieonychocamptoides arganoi* Cottarelli & Mura, 1980

(Fig. 151)

1980. V. Cottarelli & G. Mura, *Cah. biol. Mar.* 12 : 366

*Material examined* : II, 1 ♀ 2 ♂ ♂ ; III, 1 ♀

*Remarks* : We place these specimens in *K. arganoi* despite the occurrence of both *K. remanei* and *K. arenicola* in beach sands at Waltair (Rao & Ganapati, 1968, 1969b) and of *K. remanei* on the Orissa coast (Nagabhushanan & Rao, 1969, Rao, 1969).

The only significant difference to *K. arganoi* is in the male P.5, where the exopod portion bears only three setae and spines. The body and appendages lack the profuse ornamentation of small spinules that are seen in *K. itoi*, the only species of this genus totally adequately described.

Cottarelli & Mura's (1980) illustration of the male P.5 makes it appear that the exopod is fused with the outer expansion of the basendopod and this complex structure articulates with the basendopod proper. We cannot believe this to be an accurate observation. In our males (Fig. 151h) the exopod is firmly fused to the basendopod, but projects out over the segment edge so that the edge can be seen through the P.5. We suspect that Cottarelli & Mura have misinterpreted as a real phenomenon what they have seen only in optical section.

#### 127. *Afrolaophonte ensiger* n.sp.

(Figs. 151-154)

*Material examined* : II, 1 ♀ 3 ♂ ♂ ; V, 1 ♀ ; VI, 9 ♀ ♀ 1 ♂ ; XIII, 1 ♀ 3 ♂ ♂ ; XIV, 2 ♀ ♀

*Holotype* ovigerous female, VI (C2877/2) and *Paratypes* (C2878/2) deposited with the Zoological Survey of India, Calcutta.

#### **Description**

*Female* : Length 470-480  $\mu$ m. Body almost cylindrical, with a slight antero-posterior taper; about six times as long as the width of the cephalothorax (Figs. 152a-b). Rostrum of the curious form typical of this genus (Fig. 152i). Genital suture lateral and dorsal, prominent; dentate, with sensilla. Genital field simple (Figs. 152e). Anal operculum distinct. Caudal ramus (Figs. 152c-h) sub-conical, about 1.5 times as long as broad. Distal ventral edge drawn out into one to three hyaline tubes, open at their tip. Terminal setae moderately well developed, without peduncle; inner seta geniculate.

*Somitic ornamentation* (Figs. 152a-e) : Cephalothorax and distal edge of all segments except the last two with sensilla. Segments ornamented with faint, naked striae. Epimera well developed on thorax and first three abdomen segments; densely clothed with a mixture of long fine hairs and short stout spinules. Long fine hairs clothing the ventral and ventrolateral of abdomen segments three and four and the whole of the anal segment. Distal edge of cephalothorax with fine setules; of thoracic segments dentate; of abdomen segments dentate dorsal and lateral, with

fine setules ventrally. Caudal rami with long fine hairs all over, but with a few stout spinules dorsally.

*Antennule* (Fig. 151i) six-segmented, aesthete on segment four; last three segments small. First segment with a prominent setose rounded lobe. Second segment with a large unguiform process. Third segment with a setose outer edge. Without a dense cover of small hairs.

*Antenna* (Fig. 151k) of the type normal in the family. Exopod well developed, of one segment with four plumose setae.

*Mandible* (Fig. 151l), *maxillule* (Fig. 151m), *maxilla* (Fig. 151n) and *maxilliped* (Fig. 151o) all of normal genus pattern.

*P.1* (Fig. 153a) : Coxa not elongate ; densely hirsute. Basis moderately elongate, inner seta well developed. Exopod of one stout segment with four poorly developed setae. Endopod two-segmented, prehensile, claw of the second segment very long.

*P.2* (Fig. 153b) : Coxae, bases and intercostal plate indistinguishably fused to form a single plate for the pair of P.2, from which springs a tubular extension of the basis, bearing a long seta. Exopod of one very small segment with a slender seta and three alate spines. Endopod absent.

*P.3* (Figs. 153d-g) : Coxae and intercostal plate indistinguishably fused to form a single plate for the pair of P.3. Basis fused to this plate but with the line of fusion still visible ; with a tubular outer expansion bearing a long seta, and with a small inner lobe. This lobe may be small and (except for a few small spinules) naked and the endopod absent. (Fig. 153e), or it may be fused to an endopod rudiment, which itself is variously ornamented (Figs. 153d, f, g). Exopod of one small segment, 2.5-3 times as long as broad, with one weak inner seta and with five strong alate spines on the outer and apical edges.

*P.4* (Fig. 153h) very large compared to P.2-P.3 and overlapping the P.5. Coxae and intercostal plate indistinguishably fused to form a single plate for the pair of P.4. Basis fused to this plate but with the line of fusion still visible; with a tubular outer expansion bearing a long seta. Inner part of basis fused with the endopod; bearing two terminal setae. Exopod a single elongate segment, probably fused to the basis, though the line of fusion is still apparent. Exopod without trace of inter-podomere sutures, though the setation shows that it is derived by such fusion; with six setae, distributed as 1.2.3.

*P.5* (Figs. 154a-c) large. Basis deep and with a rounded inner proximal portion. Inner expansion of the basendopod well developed, with four setae and a small tubular "pore" Exopod usually with five, occasionally with four setae; origin of inner seta variable.

*Male* differs from the female in the following respects. Length 430  $\mu\text{m}$ . First two abdominal segments distinct.

*Antennule* sub-chirocerate (Fig. 151j).

*P.3* (Figs. 153i-j) : Exopod of three small, distinct segments, with setation as 0.0.1.2.1. Endopod possibly two- or three-segmented, though lines of demarcation are not always clear. In the best developed specimen (Fig. 153j) there are undoubtedly three segments, the second with an apophysis. In others (Fig. 153i) this distinction is less clear. Distal segment with a terminal unguiform process.

*P.4* (Fig. 153k) : Coxa distinct. Basis without an inner expansion; endopod probably represented by a single small seta, which often is very difficult to see. Exopod of three distinct segments, with outer spines modified in the normal genus pattern.

*P.5* (Fig. 154d) : Basendopod reduced to a tubular outer expansion with a long seta. Exopod reduced to a minute segment with three spines and a seta.

*P.6* (Fig. 154e) of each side represented by two setae.

*Variability* : In one female the left *P.2* clearly is abnormal (Fig. 153c). In two females the exopod of one of the pair of *P.5* bears only four setae. In the majority of females (8 of 14) both *P.3* are identical and as in Fig. 153d. In one female the endopod is absent in both *P.3* (as in Fig. 153e), and in three others the right *P.3* is of this type while the left is normal (i.e. as Fig. 153d). One female has the pair of *P.3* as in Fig. 153f. One female has the pair of *P.3* as in Fig. 153g.

*Etymology* : The trivial name refers to the broad, sword-like shape of the female *P.4* exopod (*L. ensiger*—sword bearing).

*Remarks* : *A. ensiger* is remarkably different to all others in two female characters—the *P.4*, with its unified exopod, and the variability of the *P.3*, which in its most fully developed state is quite unique, being approached only by *A. pori*. The male is very similar to all other species, though it would appear to be unique in having four setae on the *P.2* exopod.

There are considerable similarities to *A. schmidti*, particularly in the ornamentation of the body and in the presence of a hyaline tube on the caudal ramus. However, since none of the other species have been described in such detail as *A. schmidti* it remains to be seen if these similarities are notable, or simply are generic characters.

#### **Pseudolaophonte and the Laophontina group of genera**

The genera *Laophontina*, *Klieonychocamptoides*, *Afrolaophonte* and *Mexicolao-phonte* have in common a considerably reduced level of segmentation of *P.2-P.4*;

reduced, indeed, to the extent that endopods may be quite redundant, exopods one-segmented or represented only by setae, and setation correspondingly diminished. Even where three segments remain in a particular ramus, generally they are of small size, or of peculiar shape. Usually the coxa is not recognizable and often the ramus vestige is fused to the reduced basis. P.1 exopod always is one-segmented. Sexual dimorphism in P.2-P.4 sometimes is present, but where it affects the exopods, they are never modified by being strengthened in the classic laophontid manner.

There are other laophontid genera with reduced segmentation of P.2-P.4, but none exhibit such radical departures from the normal family pattern; except, that is, for *Pseudolaophonte*. Tracing relationships of these genera, therefore, is difficult. Lang (1948), having to deal only with *Pseudolaophonte* and *Laophontina*, places them as descendants of a common ancestor and as a "sister-group" to *Paronychocamptus* and *Onychocamptus* (this latter then containing *Klieonychocamptus* Noodt, 1958). Noodt (1958), who also had to consider *Klieonychocamptoides*, makes *Laophontina* a direct descendant of *Pseudolaophonte*, and *Klieonychocamptoides* a direct descendant of *Klieonychocamptus*, with the two pairs forming "sister-groups" derived from a common hypothetical ancestor, which also gave rise to *Onychocamptus* sens. nov.

Lang (1965) doubts the validity of *Klieonychocamptus* as a natural assemblage. We agree, and also are unconvinced by Noodt's argument on the direct relationship between *Klieonychocamptoides* and *Klieonychocamptus*. Neither can we accept unequivocally that *Pseudolaophonte* is a direct ancestor of *Laophontina*. However, we do believe that *Klieonychocamptoides* cannot be directly related to *Laophontina* and accept Lang's (1965) argument that *Afroloaophonte* is a distinct line of evolution from both genera.

Since Lang's (1965) review one new genus and several new species have been described. We add three new species in this paper, one of which we believe to represent a new genus. The species to be considered in this discussion thus are as follows (see Table 10 for a summary of salient morphology).

*Pseudolaophonte* A. Scott, 1896

*spinosa* (I. C. Thompson, 1893)

*proteus* Klie, 1950

*glemareci* Bodin, 1977.

*Laophontina* Norman & T. Scott, 1905

*dubia* Norman & T. Scott, 1905 (redescribed by Geddes, 1982)

*acantha* Noodt, 1955c (♀ described by Wells & Clark, 1965; this amended by Wells, 1967)

*distincta* Wells, 1967

*reducta* Coull & Zo, 1980

*sensillata* n.sp.

*triarticulata* Coull & Zo, 1980 (*Galapalaophonte pacifica* Meilke, 1981a is considered a synonym by Mielke, 1982)

*variabilis* Coull & Zo, 1980

*Laophontina* sp. Mielke, 1982.

*Klieonychocamptoides* Noodt, 1958

*remanei* Noodt, 1958

*arenicola* (Chappuis & Delamare Deboutteville, 1956)

*arganoi* Cottarelli & Mura, 1980

*itoi* Mielke, 1981a.

*Afrolaophonte* Chappuis, 1960

*monodi* Chappuis, 1960

*brevipes* (Chappuis, 1954)

*renaudi* (Chappuis & Delamare Deboutteville, 1956) (♂ unknown)

*pori* Masry, 1970

*schmidti* Mielke, 1981a

*ensiger* n.sp.

*Mexicolaophonte* Cottarelli, 1977b

*arganoi* Cottarelli, 1977b.

*Langia* n.gen.

*maculata* n.sp.

We make these observations and recommendations :

1. *Laophontina* represents a lineage in which the major trend is towards the total elimination of sexual dimorphism in P.2-P.4. This state is seen fully developed only in *L. sensillata*, but no species has marked male modifications of either ramus. This trend is accompanied by a marked tendency to loss of endopods and to reduction of exopods, processes that have proceeded furthest in P.2 and least far in P.4. Lack of setae on the male P.5 basendopod and a dorsal spur on the caudal ramus also characterise this genus. *Laophontina* should be restricted to *dubia*, *acantha*, *distincta*, *reducta* and *sensillata*.
2. *Galapalaophonte* must be resurrected to contain the species *pacifica* and *triarticulata*, which for the moment should be kept separate. These species are unique in the P.2 of both sexes, which differs so widely from all others considered here that any relationship must be very distant. In the absence of a male for confirmation, the female of *Laophontina variabilis* seems most similar to these two species and should be placed *incertae sedis* in *Galapalaophonte*.
3. *Afrolaophonte* stands isolated from the other genera by virtue of the female P.4, whose exopod is more primitive in its proportions than any ramus of any leg in any of these genera. On the other hand its male P.4 shows some similarity with *Pseudolaophonte*. The male P.3 endopod is highly modified, and is very

like that in *Klieonychocamptoides* and *Mexicolaophonte*. This condition could be derived from *Pseudolaophonte* but since in this respect *Pseudolaophonte* is a typical laophontid, this is not significant.

4. *Klieonychocamptoides* is unified by the form of reduction of P.2-P.4 and by the presence of spines on the male P.5 basendopod. The form of the male P.4 could be derivable from *Pseudolaophonte*. There is also a resemblance to this genus in the female P.5, where the basendopod/segment articulation is broad, giving the appendage a triangular shape. This condition, otherwise seen only in *Mexicolaophonte*, contrasts with that in all other genera, where the articulation is at the outer corner only and the inner corner is rounded and hirsute.
5. *Mexicolaophonte* has similarities to *Pseudolaophonte* in the female P.5 and in the male P.4, where it particularly resembles *P. glemareci*. It is probable that *Laophontina* sp. ♂ Mielke belongs here.
6. *Pseudolaophonte* and *Langia* are the most primitive of these genera but have little to indicate close affinity, though the form of the first segment of female antennule could indicate some relationship. *Langia* is derived with respect to sexual dimorphism and the endopods of P.2-P.4 but remains ancestral in the form of the exopods. The P.5 is fundamentally different from *Pseudolaophonte*. It is possible that *Langia* is relatively closely related to *Laophontina*, but not directly ancestral. It is possible that *Pseudolaophonte* is ancestral to *Mexicolaophonte* and *Klieonychocamptoides*.

#### Family ANCORABOLIDAE

#### 128. *Paralaophontodes echinatus* (Willey, 1930)

1930. *Laophonte echinata* A. Willey, *Ann. Mag. nat. Hist.*, 10 (6) : 109

*Material examined* : IX, 1 ♂

*Remarks* : Three species of *Paralaophontodes* have been described. Of these, *P. exopoditus* Mielke, 1981a is comparatively primitive and can be distinguished easily from *P. echinatus* and *P. robustus* (Božić, 1964). However, as Lang (1965) points out, the differences that can be observed between the original descriptions of these last two species are very small. Lang refrains from bringing them into synonymy only because of the great distance between their then known limited distribution (*echinatus*—Bermuda; *robustus*—Réunion Island). Since then specimens from the western Mediterranean have been attributed to *robustus* (Bodin, 1964, 1968, Dinet, 1971, 1972). In fact Willey's illustrations are not of good quality and a comparison of them with those of Božić (1964) and Bodin (1964) almost certainly over-emphasizes any real differences that may exist. Thus we formally propose that *P. robustus* sink as a junior subjective synonym of *P. echinatus*.



## HABITAT AND DISTRIBUTION

The present collection of Copepoda was made mostly from clean and detritus sands, with a few samples from mud and algae. Based on the qualitative investigations made, little can be said of their population densities, habitat preference and species dominance. The distribution of copepods in the habitat was similar to that known in other regions. The number of species and individuals collected on these islands varied considerably from beach to beach. About half of the total species recorded in the present study are widely distributed on the archipelago. Quantitatively, an average of 50 to 400 copepods in 100cm<sup>3</sup> sediment could be collected. Sheltered situations having detritus sands with adequate coarse particles generally supported the richest populations of the fauna. Thus, several species were well represented in detritus sands. Maximum densities of copepods occurred between the low and mid-tide levels of the intertidal zone.

A majority of the copepod species occurred in small to very small numbers of individuals. The dominant species noted in the four littoral substrates are indicated in Table 11. Many species were not confined to a particular habitat and exhibited considerable overlapping.

## ZOOGEOGRAPHY

Since we have no knowledge to date of the harpacticoid fauna of the east coast of the Bay of Bengal and very little from the entire Indo-Malay area, it is not surprising that the degree of endemism among the species we recorded on these island is so high. Of the total 128 species identified in the present study, 48 species and 1 subspecies (38.3%) are endemic to the Andaman-Nicobar archipelago and a further 17 species (13.3%) have only previously been recorded from the area between Kerala and Calcutta (including the Maldive Islands and Sri Lanka). Thus, about half of the species that we recorded here have a distribution limited to the Bay of Bengal and its immediate approaches (Table 12).

Of the species remaining, the likeliest probability is that 10 (7.8%) are cosmopolitan and 6 (4.7%) are sub-cosmopolitan (i.e. worldwide except for polar latitudes). Twenty three species (18.0%) possibly are pantropical-warm temperate; of these, 10 extend their distribution northward into the Atlantic cool temperate. Several of these species may originally have had a purely Tethyan distribution (e.g. *Amphiascus parvus*, *A. propinquus*, *Eudactylopus robustus*, *Robertsonia knoxi*, *Robertgurneya rostrata*, *Scottolana longipes*). Twelve species (9.4%) appear to be confined to the Indo-West Pacific region, some having extremely restricted distributions. Of these, only *Longipedia weberi*, *L. kikuchii*, *Peltidium ovale* and *Eudactylopus andrewi* have previously been recorded in the Bay of Bengal. It is notable that some of these Indo-West Pacific species and the endemic species are the only purely tropical species in the present collections.

Ignoring the three species of uncertain or confused taxonomy, the remaining species all have a restricted distribution far from the Bay of Bengal; some have been recorded only from a very few widely scattered localities. A rational discussion of their geographical distribution is hardly possible but it could be that *Laophontella horrida*, *Paralaophontodes echinatus*, *Klieonychocamptus ponticus* and *Ectinosoma reductum* are rare Tethyan species. The most puzzling record on these islands is that of *Halectinosoma tenuireme*, which is relatively common on beaches from Norway to the English Channel but has never even been recorded in the Mediterranean.

### SUMMARY

The present study deals with a collection of littoral harpacticoid copepods made from the Andaman and the Nicobar Islands, Bay of Bengal, during the years 1969, 1973 and 1974. The material was collected from intertidal sand, mud and algae at 15 sites throughout the Archipelago. In a total of 128 species identified, 2 new genera, 43 new species and 1 new subspecies are described. Fifty more species are redescribed partially or completely. The systematic position of different taxa has been discussed.

Until the present three faunistic surveys, the meiobenthic Copepoda of these Islands is almost unknown except for the work of R.B.S. Sewell (1940). Further collecting in these areas will doubtless reveal the existence of more species than now known.

Detailed ecological investigations of the fauna could not be carried out due to shortage of time. The limited data collected showed that the distribution of Copepoda in the habitat was similar to that known in other regions. Many species recorded are widely distributed on the Archipelago. Quantitatively, an average of 50 to 400 individuals in 100 cm<sup>3</sup> sediment was recorded. Detritus sands with adequate coarse particles supported the richest population densities. Dominant species noted in the four littoral substrates are indicated.

A brief account of the zoogeography of the species is also given. Of the total 128 species, 48 species and 1 subspecies (38.3%) are endemic to the Andaman and Nicobar Islands, while 17 species (13.3%) have only been recorded in their vicinity. Ten species (7.8%) are most probably cosmopolitan and 6 species (4.0%) sub-cosmopolitan. About 12 species (7.4%) are confined to the Indo-West Pacific region. The remaining species showed a restricted distribution if widely scattered global areas.

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Table 1. Types of spine on P. 1 in *Scottolana* species in these samples (see Fig. 19 for illustration)

	Basis inner	Exp.						Enp.		
		Exp. seg. 1	Exp. seg. 2	seg. 3				seg. 3		
				No. 1*	No. 2*	No. 3*	No. 4*	No. 1*	No. 2*	No. 3*
<i>S. oleosa</i>	B	A	B	C	B	B	D	B	B	E
<i>S. tumidiseta</i>	E	A	B	C	C	E	D	E	E	E
<i>S. rostrata</i>	B	A	B	C	C	F	D	F	E	F
<i>S. longipes</i>	B	A	C	C	C	C	D	C	B	**

\* Number counting from proximal end

\*\* See Fig. 12g.

Table 2. Setation of P. 1—P. 4 in *Noodtiella* Wells, 1965a (as revised by Kunz, 1974).

	P. 1		P. 2		P. 3		P. 4	
	Exp.	Enp.	Exp.	Enp.	Exp.	Enp.	Exp.	Enp.
<i>N. ornamentalis</i> n. sp.	0. 1. 022	1. 121	1. 1. 022	1. 221	1. 1. 022	1. 221	1. 1. 022	1. 221
<i>N. wellsii</i> Apostolov, 1974	0. 1. 022	1. 121	1. 1. 022	1. 221	1. 1. 022	1. 221	1. 1. 022	1. 221
<i>N. arenosetelloides</i> (Noodt, 1958)	0. 1. 022	1. 121	0. 1. 022	1. 121	1. 1. 022	1. 121	1. 1. 022	1. 121
<i>N. lusitanica</i> Wells, 1965a	0. 1. 022	1. 121	0. 1. 021	1. 221	0. 1. 021	1. 221	0. 1. 021	1. 221
<i>N. hoodensis</i> Mielke, 1979	0. 1. 022	1. 120	1. 1. 021	1. 220	1. 1. 021	1. 220	1. 1. 021	1. 220
<i>N. tabogensis</i> Mielke, 1981b	0. 1. 022	1. 120	1. 1. 021	1. 220	1. 1. 021	1. 220	1. 0. 021	1. 220
<i>N. problematicum</i> (Rouch, 1962)	0. 1. 022	1. 120	0. 1. 021	1. 120	0. 1. 021	1. 121	0. 1. 021	1. 121
<i>N. mielkei</i> n. sp.	0. 1. 022	1. 120	1. 1. 022	1. 121	1. 1. 022	1. 121	1. 122	1. 120
<i>N. frequentior</i> Mielke, 1979	0. 0. 022	1. 120	1. 0. 021	1. 220	1. 0. 021	1. 220	1. 021	1. 220
<i>N. gracile</i> Mielke, 1975	0. 1. 021	1. 120	1. 1. 021	1. 121	1. 1. 021	1. 121	1. 121	1. 120

**Table 3.** Variability among specimens attributed here to *Diarthrodes cystoecus*.

	♀ A	♀ B	♀ C	♀ D	♂
Abdomen ; ornamentation on	segs. 4-5	segs. 4-5	segs. 4-5	seg. 5	segs. 2-5
A. 2 Exp., no of segs.	3	3	2	2	2
P. 1 Basis, spinule type	short, broad	small, fine	short, broad	small fine	long, broad
P. 1 Exp. 2, no. of setae	6	6	5	5	5
P. 1 Enp. 3, ratio outer/ inner claw	1:2	1:2	1:3	1:3	1:3
P. 1-P. 3 coxa, spinule type	few and broad	many and fine	few and broad	many and fine	many and fine
Station found	IV, VII	VIII	VII, VIII, IX	IV	IX

**Table 4.** Reported setation of P. 2—P. 4 in *Parastenhelia hornelli*

Authority	P. 2		P. 3		P. 4	
	Exp.	Enp.	Exp.	Enp.	Exp.	Enp.
Thompson & A. Scott, 1903 ( <i>P. hornelli</i> & <i>P. similis</i> )	?	?	?	?	1. 1. 223	1. 1. 221
Noodt, 1955b	1. 1. 0-123	1. 1. 121	1. 1. 223	1. 1. 221	1. 1. 223	1. 1. 221
Apostolov, 1973	1. 1. 123	0. 1. 121	1. 1. 223	1. 1. 221	1. 1. 223	1. 1. 221
Wells, 1967	1. 1. 123	1. 1. 121	1. 1. 323	1. 1. 221	1. 1. 323	1. 1. 221
this paper	1. 1. 123	1. 1. 121	1. 1. 323	1. 1. 221	1. 1. 323	1. 1. 221
Vervoort, 1964 (♀ <i>P. spinosa</i> , loc 589)	1. 1. 123	1. 1. 121	0. 1. 323	1. 1. 221	0. 1. 323	1. 1. 221
Vervoort, 1964 (♂ <i>P. spinosa</i> , loc 590)	1. 1. 123	modified	1. 1. 223	modified	1. 1. 2-323	1. 1. 221

Table 5. Distribution of *Stenhelia* species in the Andaman and Nicobar Islands.

SPECIES	NICOBAR IS.		SOUTH ANDAMAN IS.			MIDDLE ANDAMAN IS.	NORTH ANDAMAN IS.
	Nankauri	Kamorta	Neil	Havelock	Portblair	Long	Mayabandar
<i>polluta</i>	+		+	+		+	
<i>ovalis</i>		+	+	+		+	
<i>breviseta</i>		+		+		+	
<i>mixta</i>		+				+	
<i>oblonga</i>			+	+	+	+	
<i>fustiger</i>			+	+			
<i>clavus</i>			+				+
<i>paraclavus</i>			+				
<i>valens</i>			+				
<i>hirtipes</i>					+		
<i>madrasensis</i>						+	



Table 6. Differences between *Stenhelia caulerpae*, *S. bisetosa* and *S. ovalis*

	<i>S. caulerpae</i>	<i>S. bisetosa</i>	<i>S. ovalis</i>
Location	Israel (Por, 1964)	North Carolina, U.S.A. (Coull, 1971b)	Andaman and Nicobar Islands
♀ length	390-400 $\mu\text{m}$	470-490 $\mu\text{m}$	420 $\mu\text{m}$
Caudal ramus	spinules confined to inner distal corner (Fig. 76g)	spinules extend across dorsal apex (Fig. 76h)	without spinules; with an additional seta (Fig. 76f)
Mandible; coxa-basis	without surface spinulation; exopod with 5 setae	with surface spinule row plus a patch of hairs; exopod with 5-6 setae, sometimes variable on a single individual (Fig. 77h)	with surface spinule row; without hairs; exopod with 5 setae (Fig. 77c)
Maxillule; pre-coxal arthrite	with 1 simple seta and 6 claws (Fig. 77j)	without simple setae; 6 claws only (Fig. 77i)	with 2 simple setae and 5 claws (Fig. 77e)
P. 1 Enp. 1	elliptical (Fig. 78d)	rectangular (Fig. 78g)	ovoid (Fig. 78a)
P. 2-P. 4 coxa	lightly ornamented (Figs. 78e-f, 79b)	highly ornamented (Figs. 78h-i, 79c)	lightly ornamented (Figs. 78a-b, 79a)
P. 2-P. 3 rami segs.	relatively slender	robust	very robust
Setal formula			
P. 2 Exp.	1. 1. 0.2.2.	1. 1. 1.2.2.	0. 1. 0.2.2.
Enp.	1. 1. 0.2.1.	1. 1. 0.2.1.	1. 1. 0.2.1.
P. 3 Exp.	1. 1. 1.2.2.	1. 1. 3.2.2.	1. 1. 2.2.2.
Enp.	1. 1. 2.2.1.	1. 1. 2.2.1.	1. 1. 2.2.1.
P. 4 Exp.	1. 1. 3.2.2.	1. 1. 3.2.2.	1. 1. 3.2.2.
Enp.	1. 1. 2.2.1.	1. 1. 2.2.1.	1. 1. 2.2.1.



**Table 9.** Differences between *Arenopontia indica*, *A. gussoae* and *A. sakagamii* (see text for further details of variability in *A. indica*)

	<i>indica</i> *	<i>gussoae</i>	<i>sakagamii</i>
Caudal ramus with a spinule ?	Yes or No or intermediate Figs. 132c-f)	No	No
Caudal ramus— proximal inner dorsal seta	tubular	lanceolate	tubular
A. 2 Exp.	1 seta + 1 setule of variable size	1 seta + 1 stout setule	1 seta only
Mandible; coxa-basis	naked	1 seta	naked
P. 5 spur spinulose ?	Yes or No or intermediate (Figs. 133e-h)	Yes	No
♂ P. 6 with 2 sub-equal setae ?	Yes (Fig. 133j)		Yes
1 seta + 1 long spine ?	Yes (Figs. 133i, k)		
1 seta + 1 short spine ?	Yes (Fig. 133l)	Yes	

(\*) Data from this collection and from material from the type-locality (Rao, 1967).

Table 10. Salient morphological features of *Pseudolaophonte* and the *Laophontina* group of genera.

	Exp. ♀			Exp. ♂			Enp. ♀			Enp. ♂			P.5 ♀		P.5 ♂		P.1 Exp. segs	CuR
	P.2 segs	P.3 segs	P.4 segs	P.2 segs	P.3 segs	P.4 segs	P.2 segs	P.3 segs	P.4 segs	P.2 segs	P.3 segs	P.4 segs	Benp. setae	Exp. setae	Benp. setae	Exp. setae		
<i>Laophontina</i>																		
<i>dubia</i>	2s <sup>2)</sup>	1	3	2s	1	3	0	0	1	0	0	1v <sup>3)</sup>	4	5	0	3	1	+
<i>acantha</i>	2s	1	2	2s	1	2	0	0	1	0	0	0	3	5	0	3	1	+
<i>distincta</i>	1	1	2	1	1	2	0	0	1	0	0	0	4	5	0	3	1	+
<i>reducta</i>	3s	1	3	3s	1	3	0	1s	1s	0	1s	1s	3	5	0	3	1	+
<i>sensil- lata</i>	4s	1	2	4s	1	2	0	1s	1s	0	1s	1s	2-3	3	0-1	3	1	+
<i>triarti- culata</i>	2-3s	3	3	3s	3	3	2	2	1	2 <sup>4)</sup>	1 <sup>4)</sup>	0	4	5	0	3	1	+
<i>varia- bilis</i>	2s	2	3	—	—	—	1	1-2	1	—	—	—	4	5	—	—	1	+
<i>Laophon- tina</i> sp Mielke, 1982	—	—	—	1	2	3	—	—	—	0	1 <sup>4)</sup>	2	—	—	0	4	1	+
<i>Klieonychocamptoides</i>																		
<i>remanei</i>	1	1	1	1	1	1 <sup>4)</sup>	0	0	0	0	1 <sup>4)</sup>	0	3	4	2	3	1	a
<i>arenicola</i>	1	1	1	1	1	1 <sup>4)</sup>	0	0	0	0	1 <sup>4)</sup>	0	3	4	2	3	1	a
<i>arganoi</i>	1	1	1	1	1	1 <sup>4)</sup>	0	0	0	0	1 <sup>4)</sup>	0	3	4	2	3-4	1	a
<i>itoi</i>	1	1	1	1	1	1 <sup>4)</sup>	0	0	0	0	1 <sup>4)</sup>	0	3	4	2	4	1	a
<i>Afroloaophonte</i>																		
<i>monodi</i>	3s	2	3	1	3	3 <sup>4)</sup>	0	1s	2s	0	1 <sup>4)</sup>	0	4	4	0	3	1	a
<i>brevipes</i>	1	2	2	1	3	3 <sup>4)</sup>	0	1s	1	0	1 <sup>4)</sup>	1v	4	4	0	3	1	a
<i>renaudi</i>	3s	5s	3	—	—	—	0	1	2s	—	—	—	4	4	—	—	1	a
<i>pori</i>	1	3	3	1	3	3 <sup>4)</sup>	0	2	1	0	2 <sup>4)</sup>	1	4	4	0	3	1	a
<i>schmidti</i>	1	3	3	1	3	3 <sup>4)</sup>	0	1	1	0	2 <sup>4)</sup>	1s	3-4	4-5	0	3	1	a
<i>ensiger</i>	1	1	1	1	3	3 <sup>4)</sup>	0	0-1	2s	0	2 <sup>4)</sup>	1s	4	4-5	0	3	1	a
<i>Mexicolaophonte</i>																		
<i>arganoi</i>	2	2	2	2s	1s	2 <sup>4)</sup>	0	2	2	0	2 <sup>4)</sup>	1	5	5	0	4	1	+
<i>Langia</i>																		
<i>maculata</i>	2	3	3	2	3	3	0	1	1	0	1	1	4	5	1	5	2	+
<i>Pseudolaophonte</i>																		
<i>spinosa</i>	1	2	3	1	2	3 <sup>4)</sup>	0	2	2	0	2 <sup>4)</sup>	2	5	5	2	3	2	+
<i>proteus</i>	3	3	3	3	3	3 <sup>4)</sup>	0	2	2	0	3 <sup>4)</sup>	2	5	6	2	4	2	+
<i>glema- reci</i>	1	2	2	1	2	2 <sup>4)</sup>	0	1	1	0	2 <sup>4)</sup>	1 <sup>4)</sup>	5	5	2	3	2	+

## Notes :

1. Caudal Ramus—presence (+) or absence (a) of a dorsal spur.
2. 's' means the ramus is represented by setae ; the number preceding 's' is the number of setae, and includes any seta that could be interpreted as the outer seta of the basis.
3. The symbol "v" indicates "vestigial".
4. These rami show considerable sexual dimorphism.

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**Table 11.** Dominant species of Copepoda in the four littoral substrates of Andaman and Nicobar Islands.

## 1. Clean sand

*Phyllopodopsyllus stigmatosus*  
*P. gracilipes*  
*Apodopsyllus camptus*  
*Tisbisoma triarticulatum*  
*Tetragoniceps unguis*  
*Psammastacus spinicaudatus*  
*Arenopontia (N.) indica*  
*Kliopsyllus holsaticus*  
*Hastigerella leptoderma*

## 2. Detritus sand

*Phyllopodopsyllus gracilipes*  
*P. stigmatosus*  
*Balucopsylla triarticulata*  
*Amphiascoides subdebilis*  
*Ectinosoma dentatum*  
*Stenhelia (D.) breviseta*  
*Parasthenelia hornelli*  
*Amphiascopsis cinctus*  
*Paramphiascella robinsoni*  
*Hastigerella leptoderma*  
*Tisbisoma triarticulatum*

## 3. Mud

*Amphiascopsis cinctus*  
*Brianola hamondi*  
*Cletodes dentatus*  
*Metis holothuriae*  
*Stenhelia (D.) breviseta*  
*Paralaophonte brevisetris*

## 4. Algae

*Parasthenelia hornelli*  
*Robertgurneya rostrata*  
*Amphiascoides subdebilis*  
*Stenhelia (D.) madrasensis*  
*Paramphiascella robinsoni*  
*Diosaccus monardi*

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Table 12. The most probable zoogeography of the species recorded in this paper.

## 1. Cosmopolitan species

*Ectinosoma melaniceps*  
*Dactylopodia tisboides*  
*Paradactylopodia brevicornis*  
*Parastenhelia spinosa*  
*Bulbamphiascus imus*  
*Amphiascoides subdebilis*  
*Ameira longipes*  
*Ameira parvula*  
*Mesochra pygmaea*  
*Laophonte cornuta*

## 2. Sub-cosmopolitan species

*Hastigerella leptoderma*  
*Arenosetella germanica*  
*Rhynchothalestris rufocincta*  
*Diarthrodes cystoecus*  
*Amphiascopsis cinctus*  
*Nitocra spinipes*

## 3. Pan Tropical-Warm Temperate

*Scottolana longipes*  
 \**Ectinosoma dentatum*  
 \**Phyllothalestris mysis*  
*Eudactylopus robustus*  
*Parastenhelia hornelli*  
*Stenhelia polluta*  
*Robertsonia propinqua*  
*Robertsonia knoxi*  
 \**Amphiascus propinquus*  
 \**Amphiascus parvus*  
*Metamphiascopsis hirsutus*  
*Robertgurneya rostrata*  
*Paramphiascella robinsoni*  
 \**Metis holothuriae*  
 \**Psyllocamptus minutus*  
*Praepleptomesochra africana*  
*Laophontella typica*  
*Lourinia armata*  
 \**Laophonte dinocerata*  
 \**Esola longicauda*  
*Echinolaophonte armiger*  
 \**Quinquelaophonte quinquespinosa*  
 \**Paralaophonte brevirostris*

## 4. Indo-West Pacific (with previously known distribution)

*Longipedia weberi* (Suez Canal, Mozambique, Maldives Is., Madras, Aru Is., Japan)  
*Longipedia kikuchii* (Madras, Singapore, Aru Is.?, Japan)  
*Sunaristes tranteri* (Moluccas, Sydney)  
*Brianola sydneyensis* (Sydney)  
*Lineosoma intermedia* (Mozambique)  
 \**Peltidium ovale* (Maldives Is., Manar, Nicobar Is., South Australia, China, Japan)  
*Eudactylopus andrewi* (Maldives Is., Manar, Nicobar Is., Aru Is., Caroline Is., China, Japan).  
 \**Parialysus robustus* (Red Sea, South and Western Australia, Caroline Is.)  
*Paraleptomesochra minima* (Mozambique)  
*Tisbisoma triarticulatum* (Mozambique)  
*Phyllopodopsyllus aegypticus* (Red Sea)  
*Echinolaophonte mirabilis* (Suez Canal, China)  
 \*these species include in their distribution record a location (South Australia) in the southern cool temperate.

## 5. Bay of Bengal region only

*Porcellidium ravanae*  
*Peltidium angulatum*  
*Idomene maldivae*  
*Stenhelia indica*  
*Stenhelia madrasensis*  
*Diosaccus hamiltoni*  
*Diosaccus monardi*  
*Robertsonia adduensis*  
*Metamphiascopsis nicobaricus*  
*Sicameira langi*  
*Parapseudoleptomesochra trisetosa*  
*Apodopsyllus madrasensis*  
*Apodopsyllus camptus*  
*Arenopontia indica*  
*Psammastacus spinicaudatus*  
*Echinolaophonte tropica*  
*Klieonychocamptoides arganoi*

\*these species have a range extended north wards into the Atlantic cool temperate.

## 6. Endemic

43 new species and 1 new subspecies  
(see Fauna List, p. 000)

*Longipedia andamanica*

*Peltidium* sp. A

*Peltidium* sp. B

*Eoschizopera reducta*

*Kliopsyllus spiniger*

## 7. Peculiar or restricted distribution (with previously known distribution)

*Ectinosoma reductum* (Germany, English Channel, western Mediterranean)

*Halectinosoma tenuireme* (Norway to English Channel)

*Stenhelia oblonga* (California)

*Phyllopodopsyllus longipalpatus* (Italy, Madagascar)

*Laophontella horrida* (Mediterranean)

*Laophonte spinicauda* (Caroline Is., Virgin Is.)

*Klieonychocamptus ponticus* (Rumania, Canary Is.)

*Paralaophontodes echinatus* (Bermuda)

## 8. Not included due to confused taxonomy

*Paramesochra helgolandica*

*Kliopsyllus holsaticus*

*Orthopsyllus linearis*

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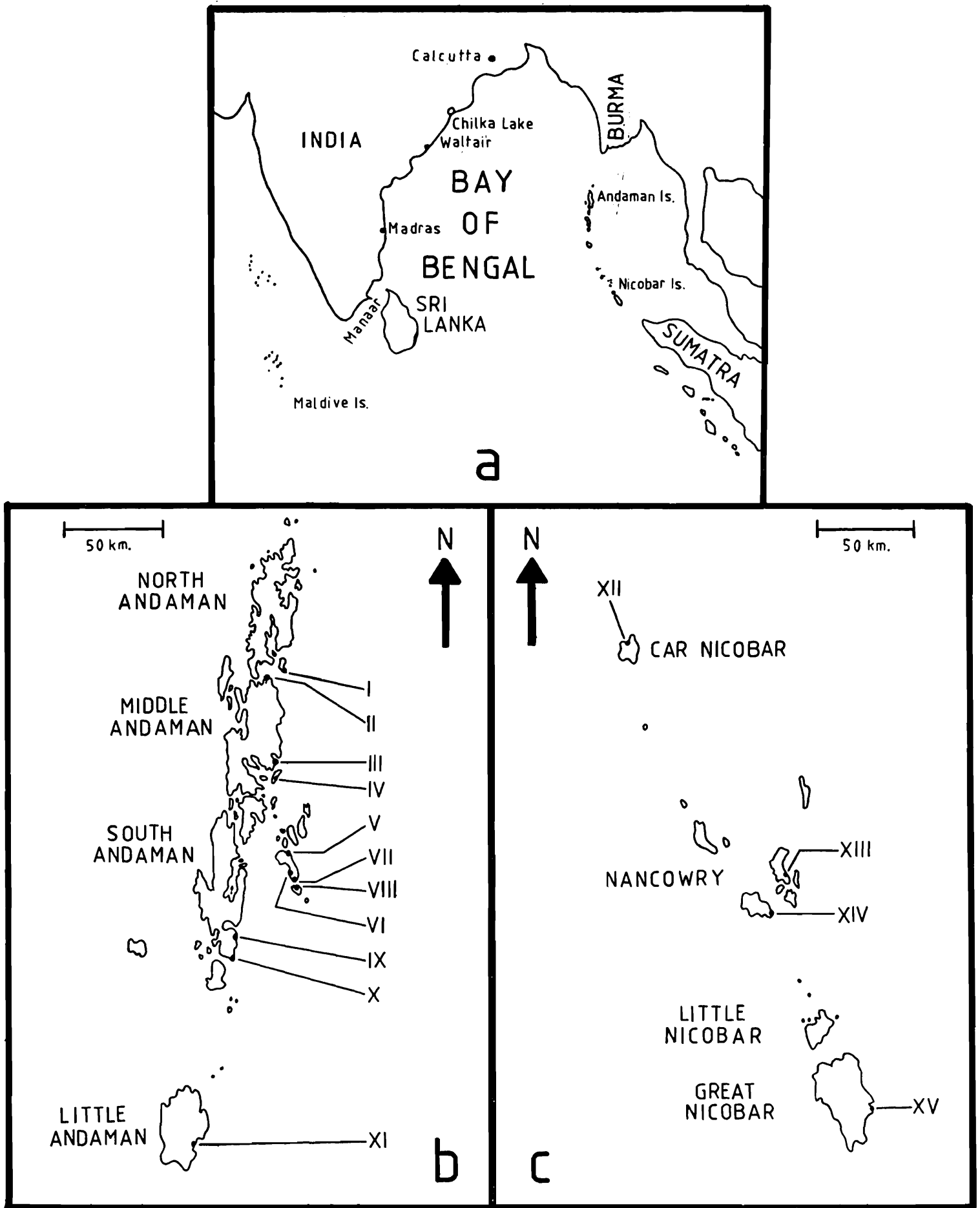


Fig. 1. a, The Bay of Bengal, showing the relative position of the Andaman and Nicobar Islands to other locations frequently referred to in the text. b-c, The sampling locations in the Andaman and Nicobar Islands.

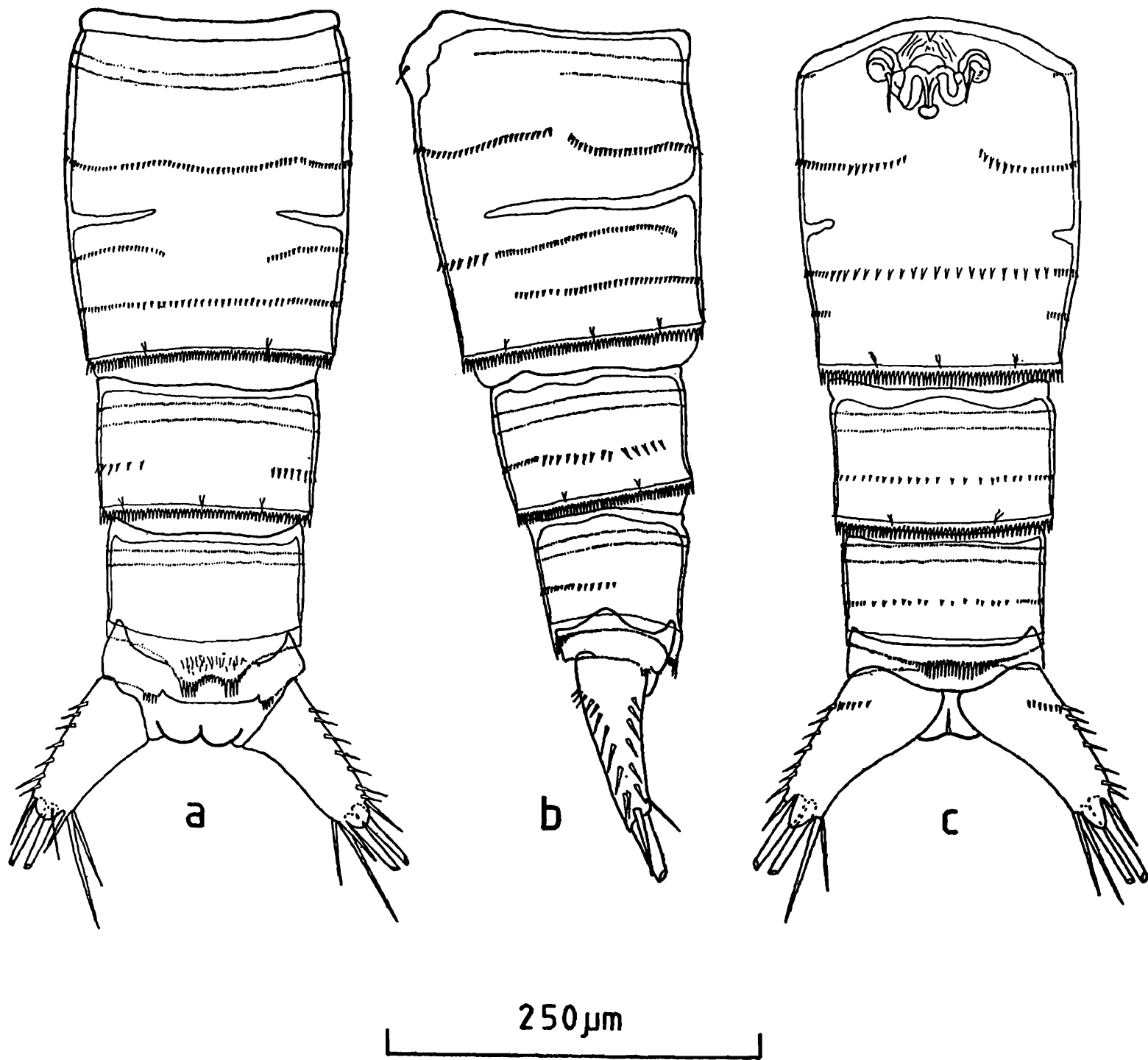


Fig. 2. *Brianola sydneyensis* ♀ a-c, abdomen, dorsal, lateral and ventral.

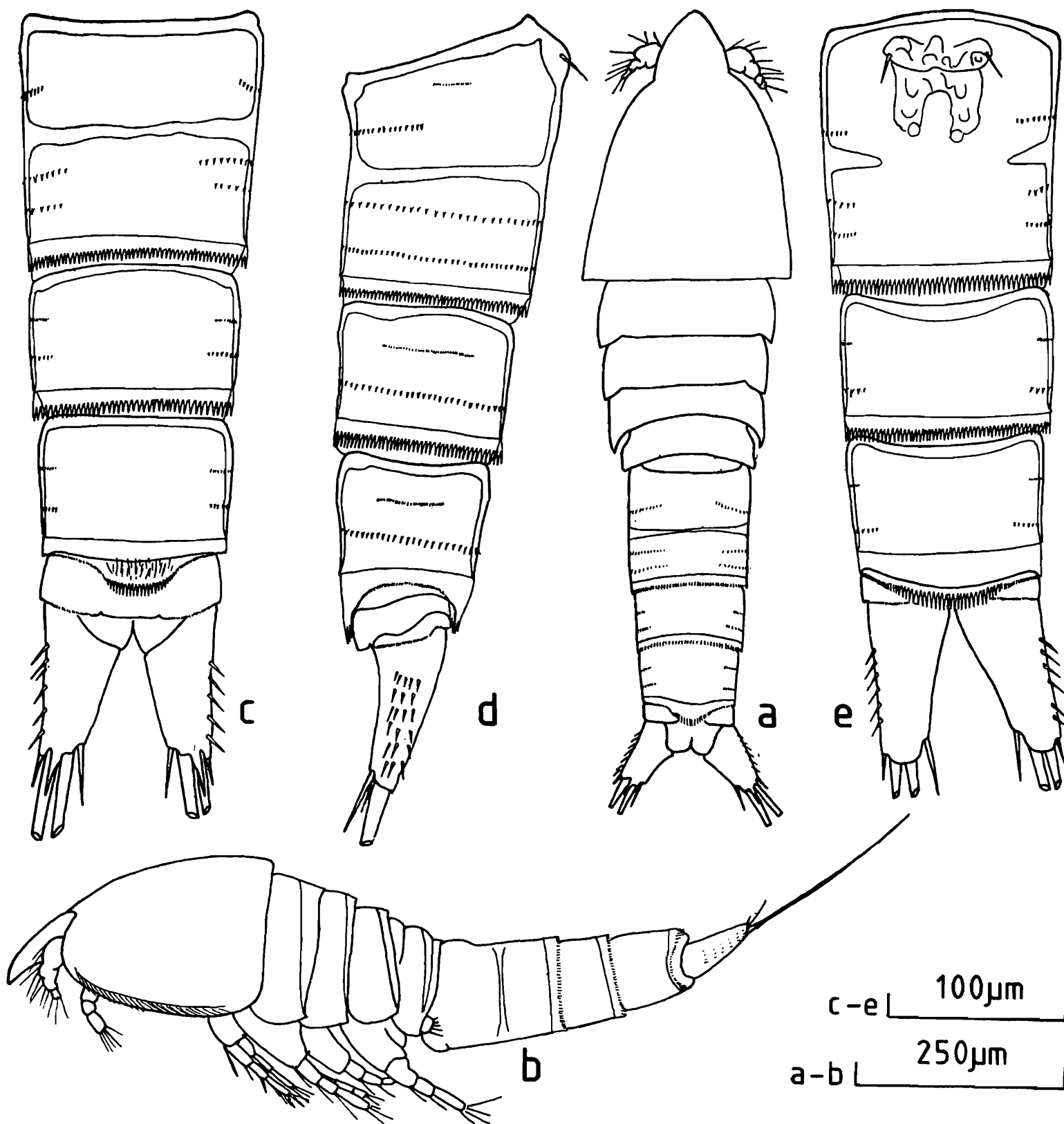


Fig. 3. *Brianola hamondi* ♀ a-b, dorsal and lateral. c-e, abdomen, dorsal, lateral and ventral.

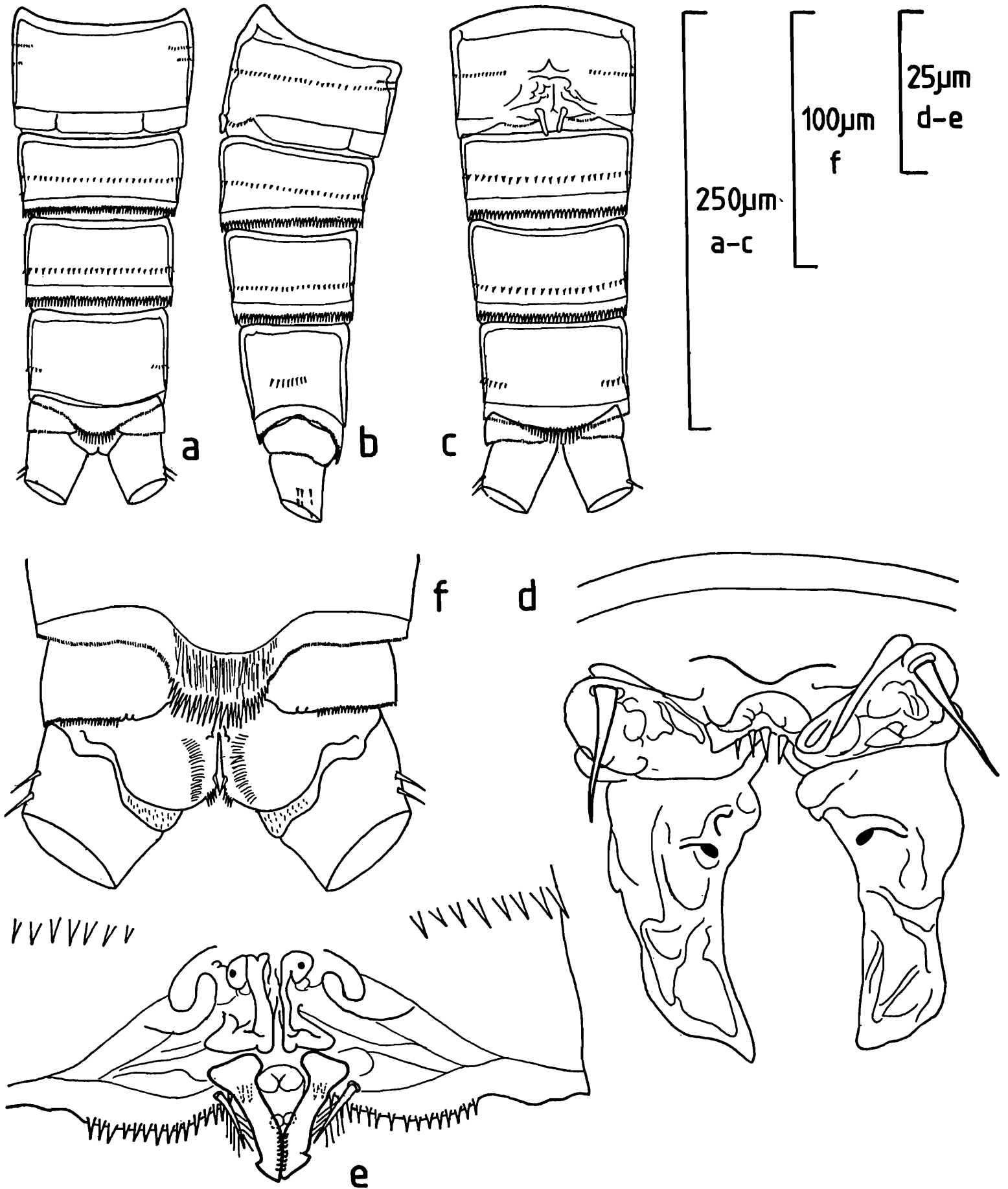


Fig. 4. *Brianola hamondi*. a-c, ♂ abdomen, dorsal, lateral and ventral. d-e, genital field of ♀ and ♂ f, posterior abdomen, dorsal.

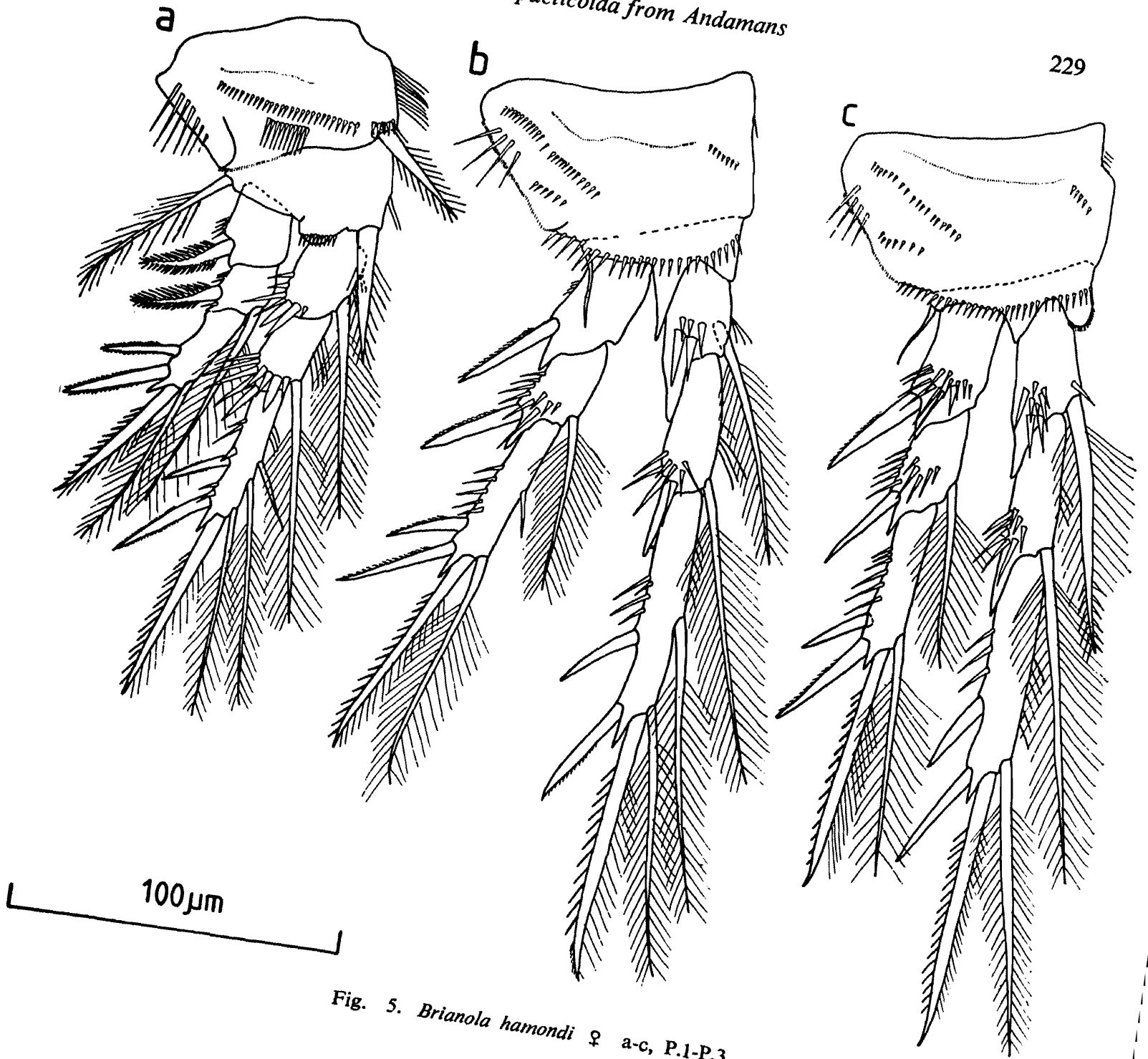


Fig. 5. *Brianola hamondi* ♀ a-c, P.1-P.3.

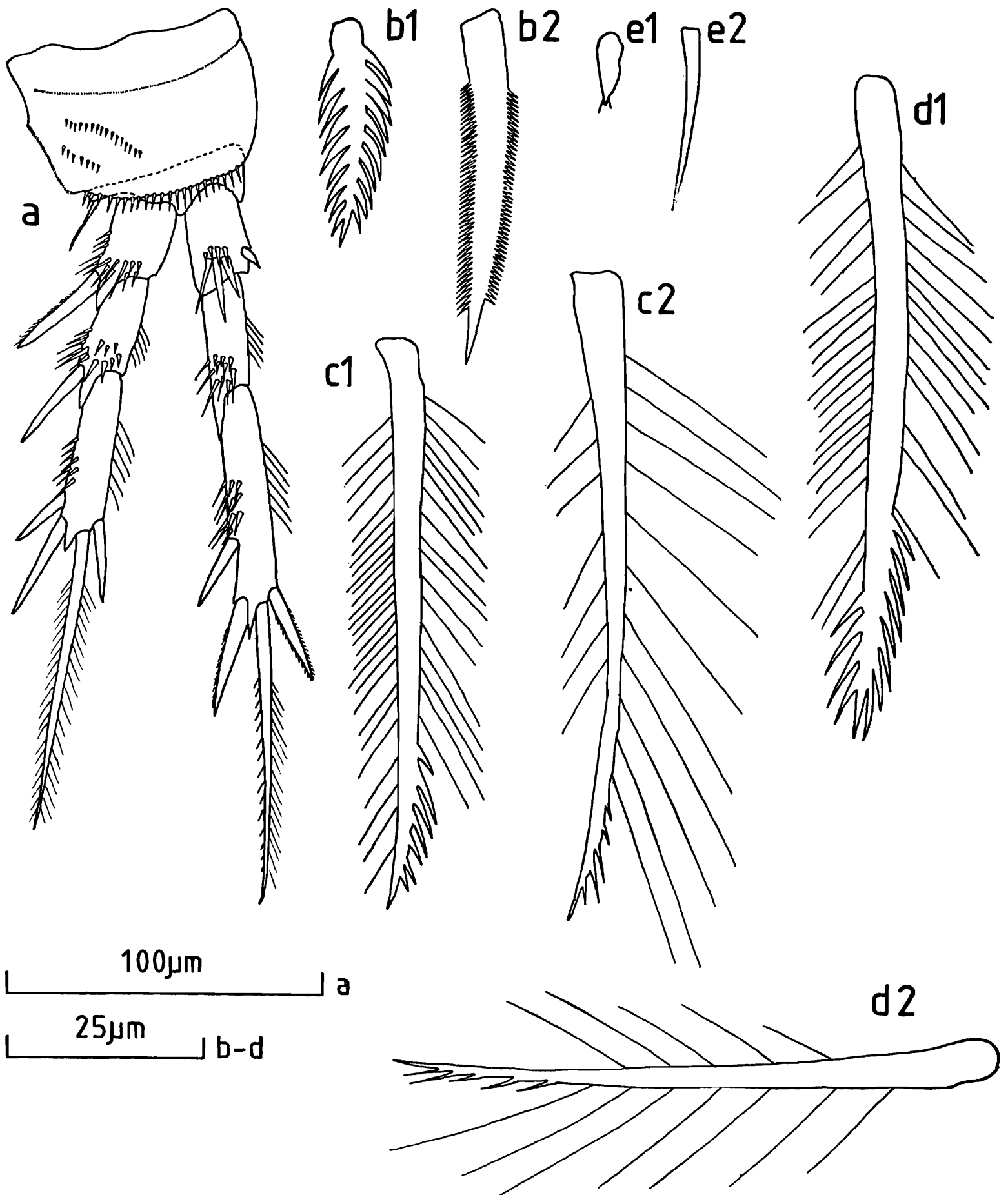


Fig. 6. a, *Brianola hamondi* P.4 ♀ b-e, form of certain spines and setae in *B. hamondi* (b1-e1) and *B. sydneyensis* (b2-e2)—b, P.1 Exp. 1 outer spine ; c, P.2 Enp. 1 inner seta ; e, P.4 Enp. 1 inner seta.

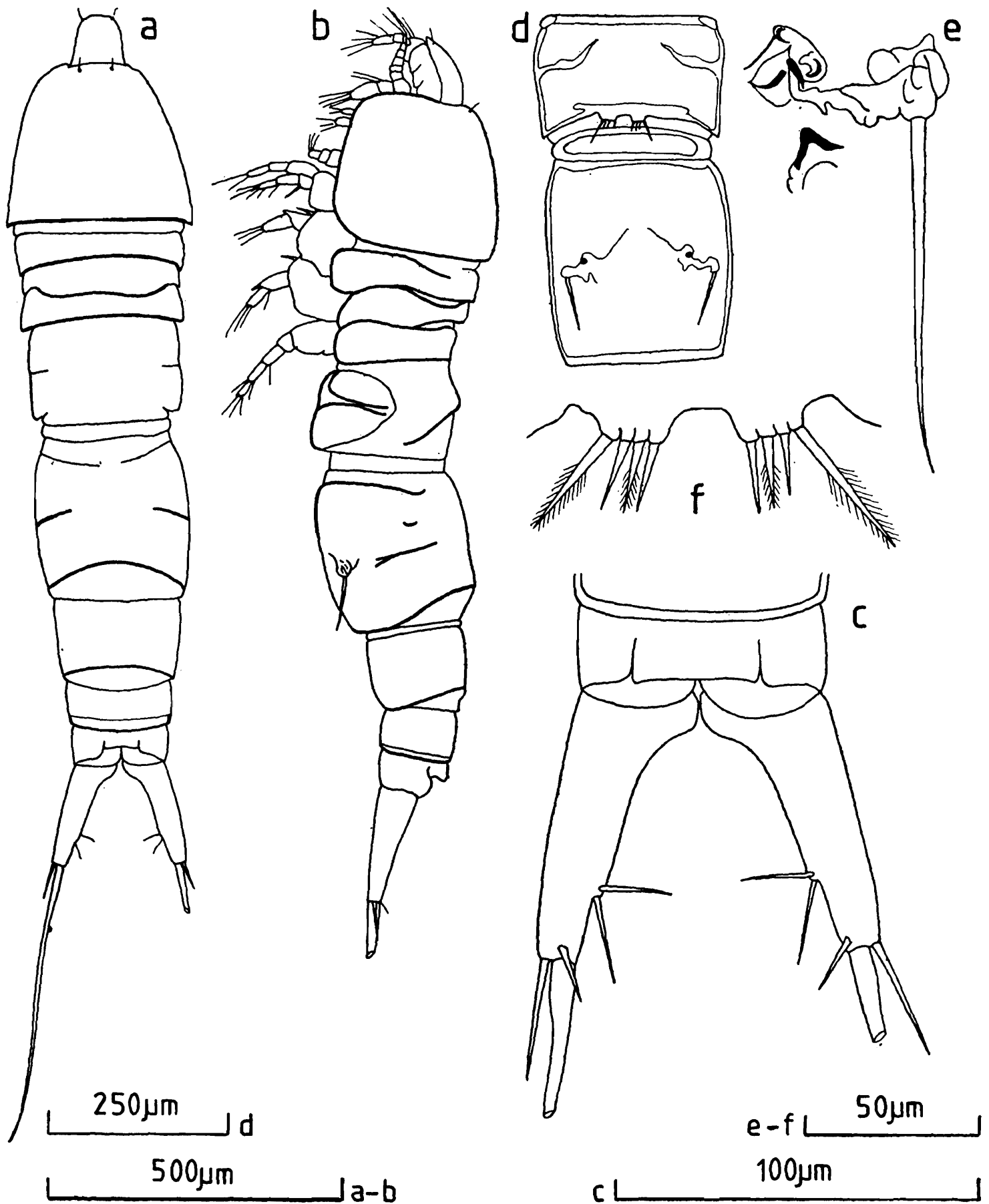


Fig. 7. *Canuellina nicobaris* ♀ a-b, dorsal and lateral. c, posterior abdomen, dorsal. d, P.5 and genital field. e, left half of genital field. f, P.5

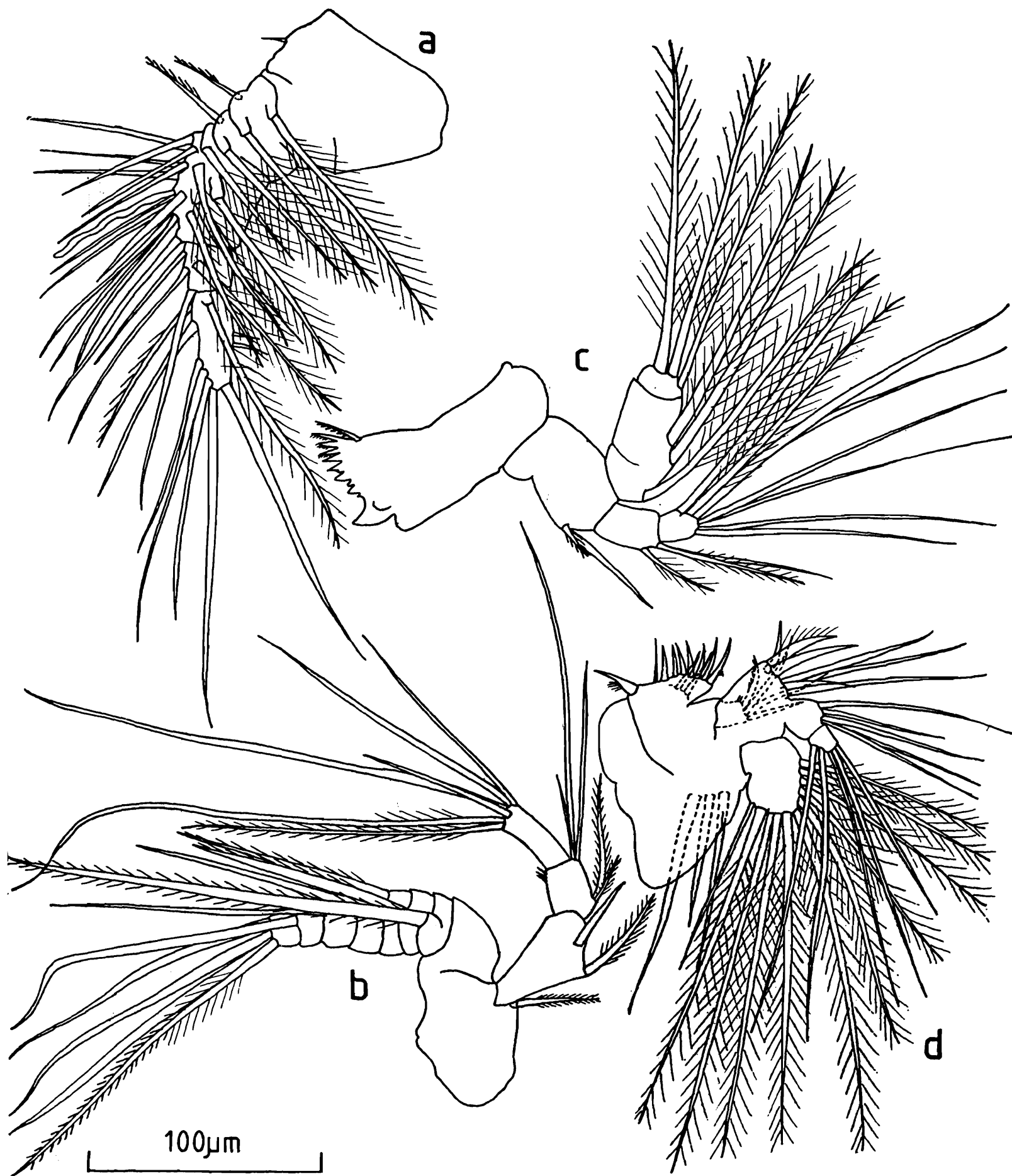


Fig. 8. *Canuellina nicobaris* ♀ a, antennule, b, antenna. c, mandible. d, maxillule.



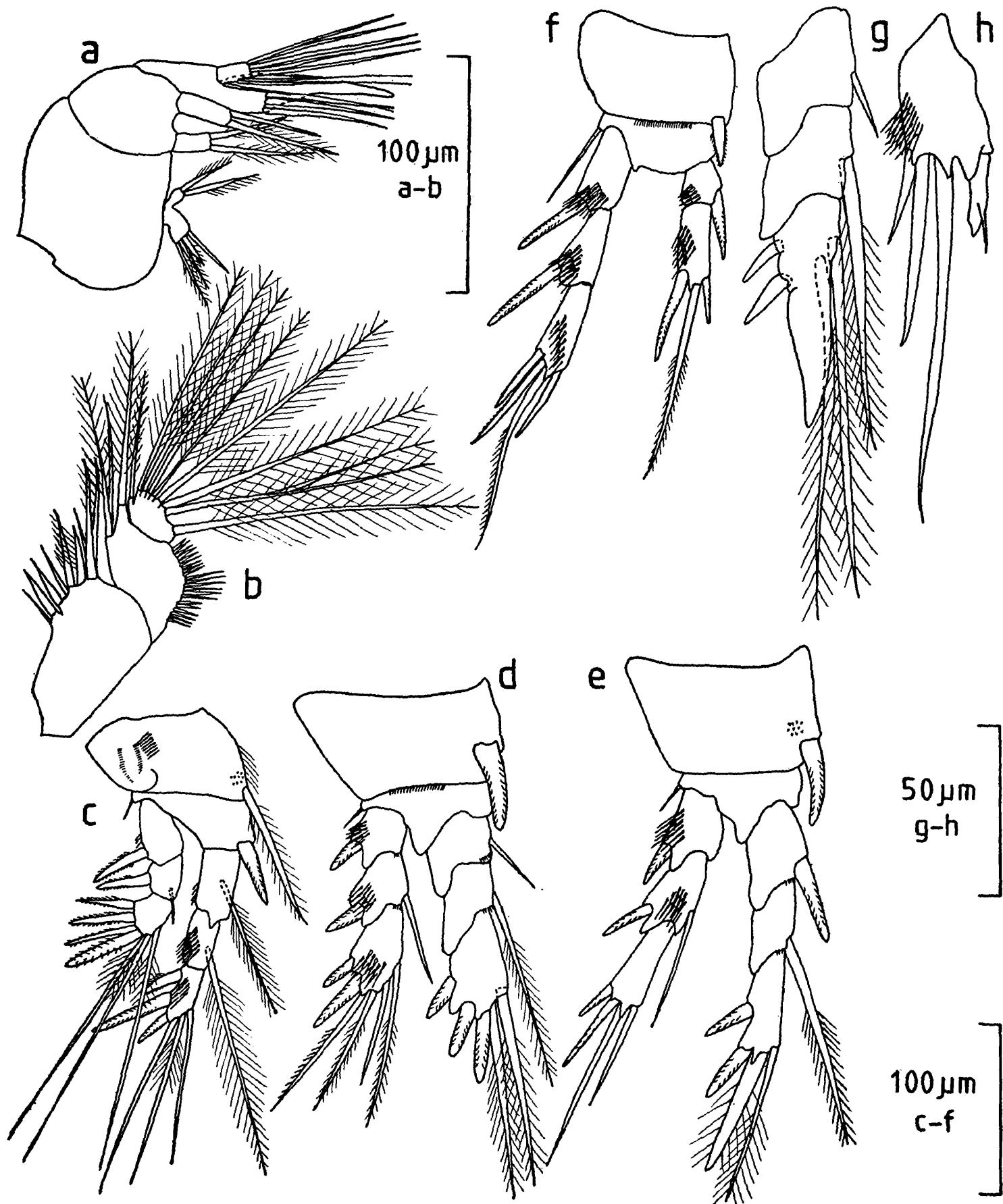


Fig. 9. *Canuellina nicobaris*. a, ♀ maxilla. b, ♀ maxilliped. c-f, ♀ P.1-P.4. g, ♂ P.2 Enp. h, ♂ P.4 Exp.3.

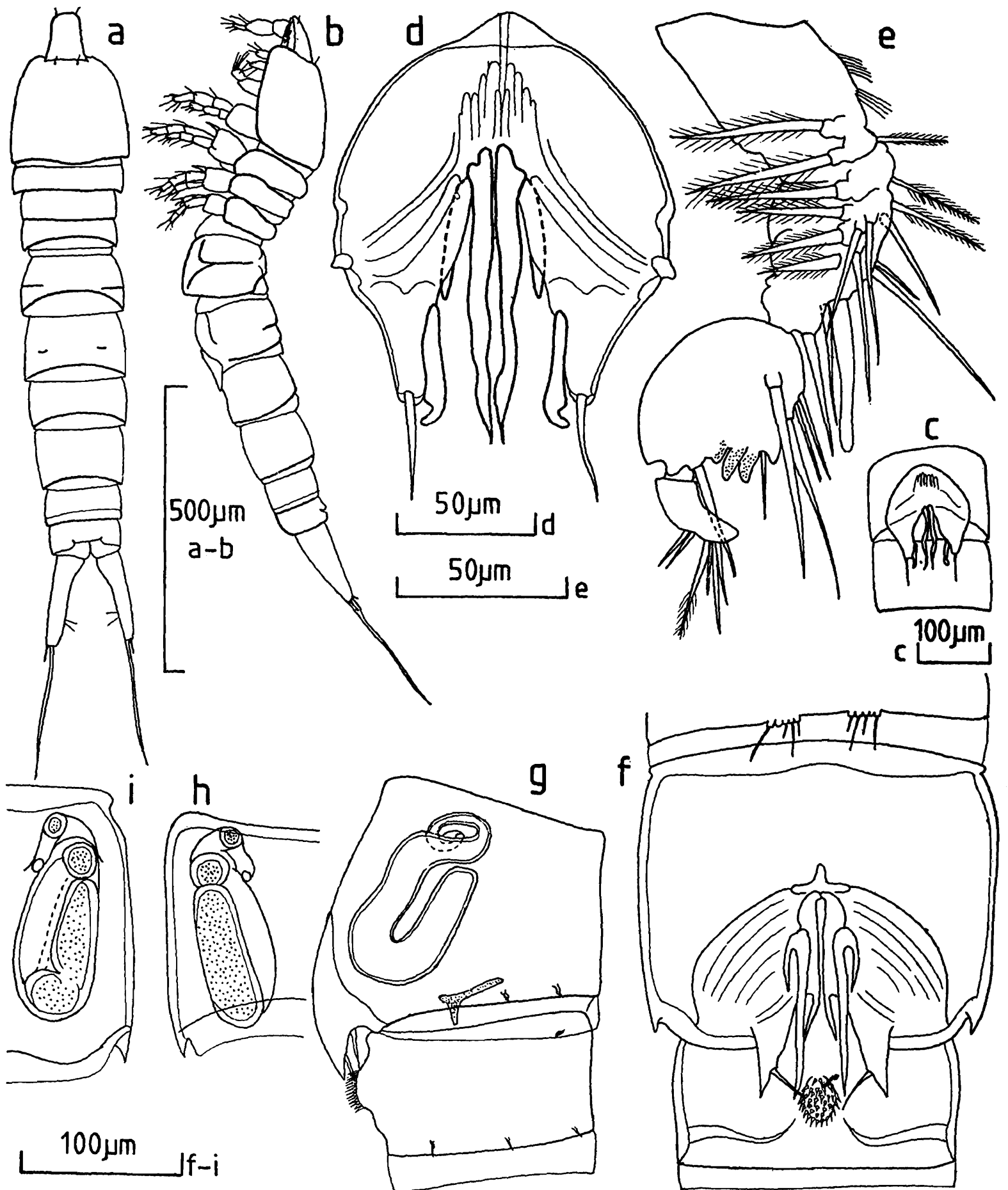


Fig. 10. a-e, *Canuellini nicobaris* ♂ a-b, dorsal and lateral. c-e, genital field. e, antennule. f-i, *Scottonala longipes* ♂ f, P.5 and genital field. g, genital segment and left receptaculum seminis, lateral. h-i, receptacula seminis, dorsal and ventral.

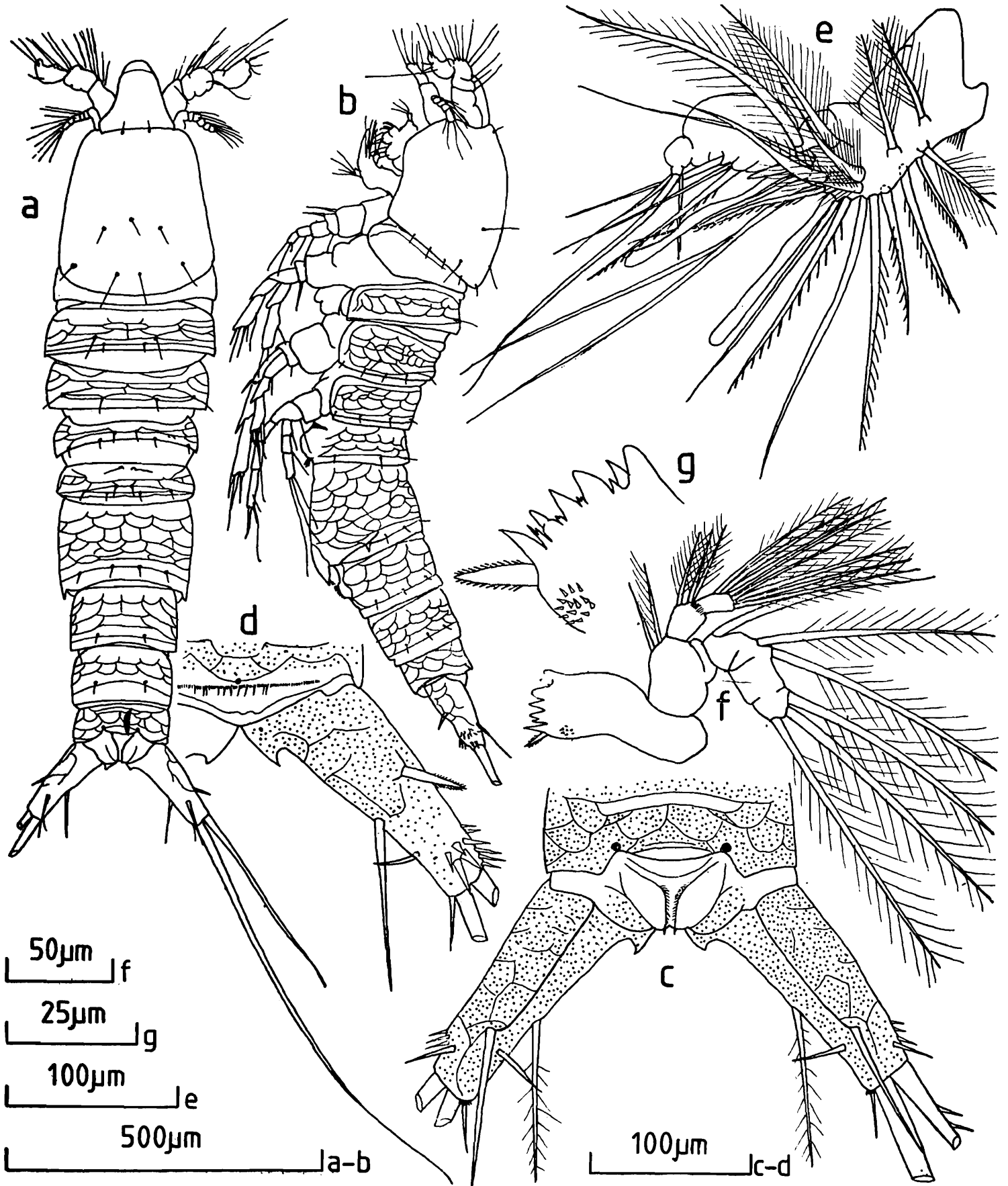


Fig. 11. *Scottolana longipes*. a-b, dorsal and lateral. c-d, posterior abdomen, dorsal and ventral. e, antennule. f, mandible. g, mandible cutting edge.

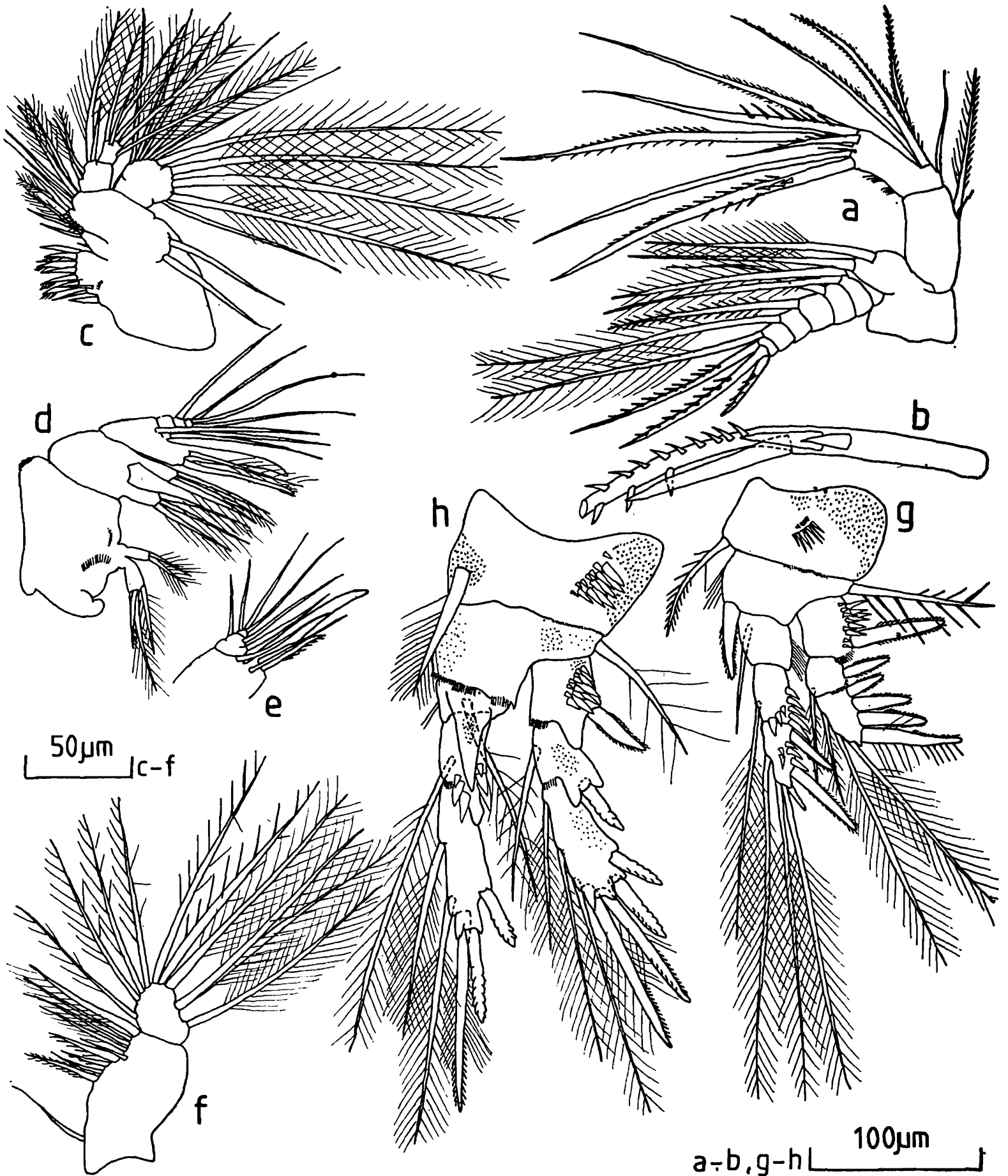


Fig. 12. *Scottolana longipes* ♂ a, antenna, b, detail of the outermost seta of antenna endopod. c, maxillule. d, maxilla. e, maxilla endopod from other side. f, maxilliped. g-h, P.1-P.2.

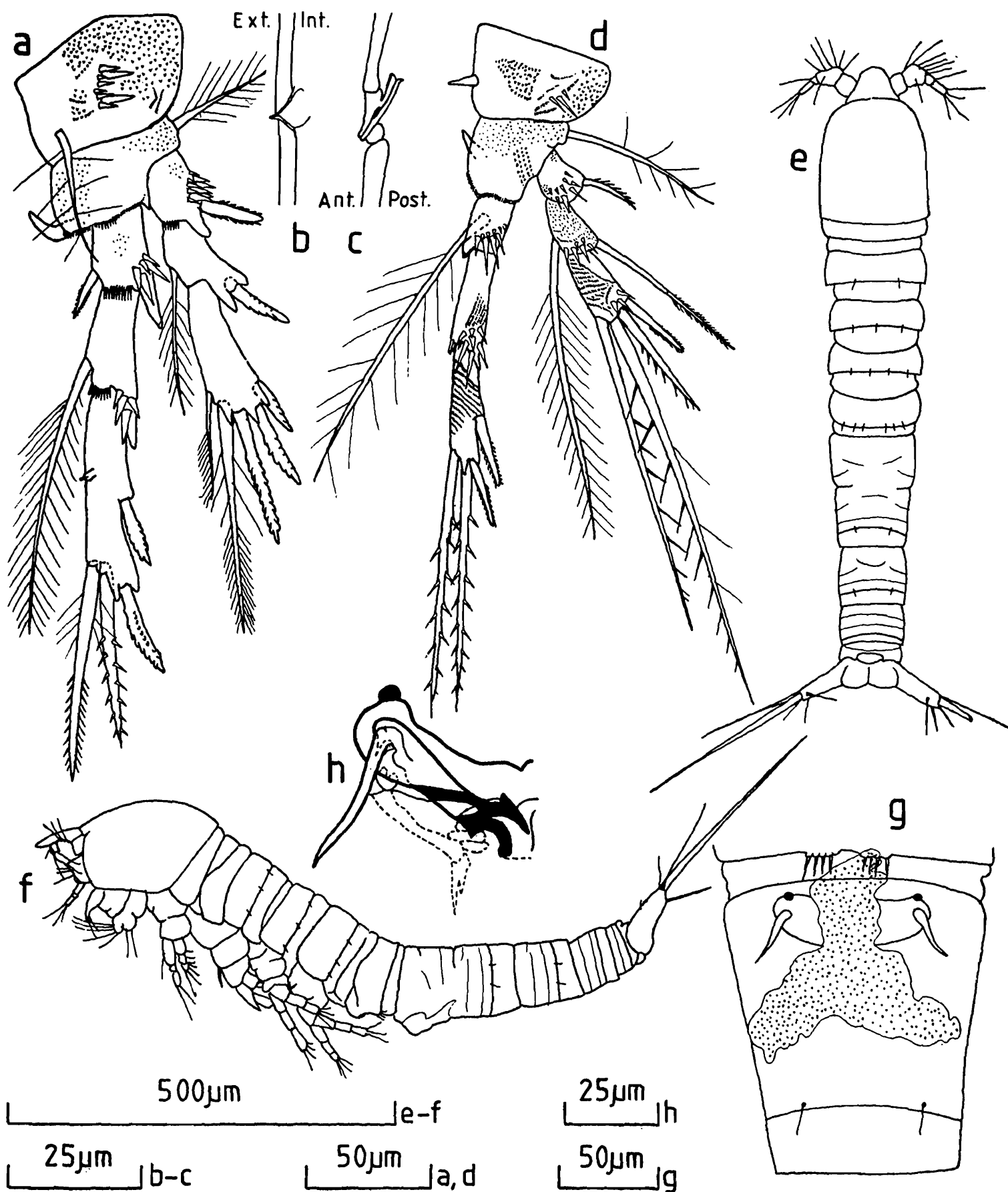


Fig. 13. a-d, *Scottolana longipes* ♂. a, P.3. b-c, the 'slit' on P.3 Enp.3, anterior and lateral. d, P.4. e-h, *Scottolana oleosa* ♀. e-f, dorsal and lateral. g, P.5 and genital somite (oil store stippled). h, right half of genital field.

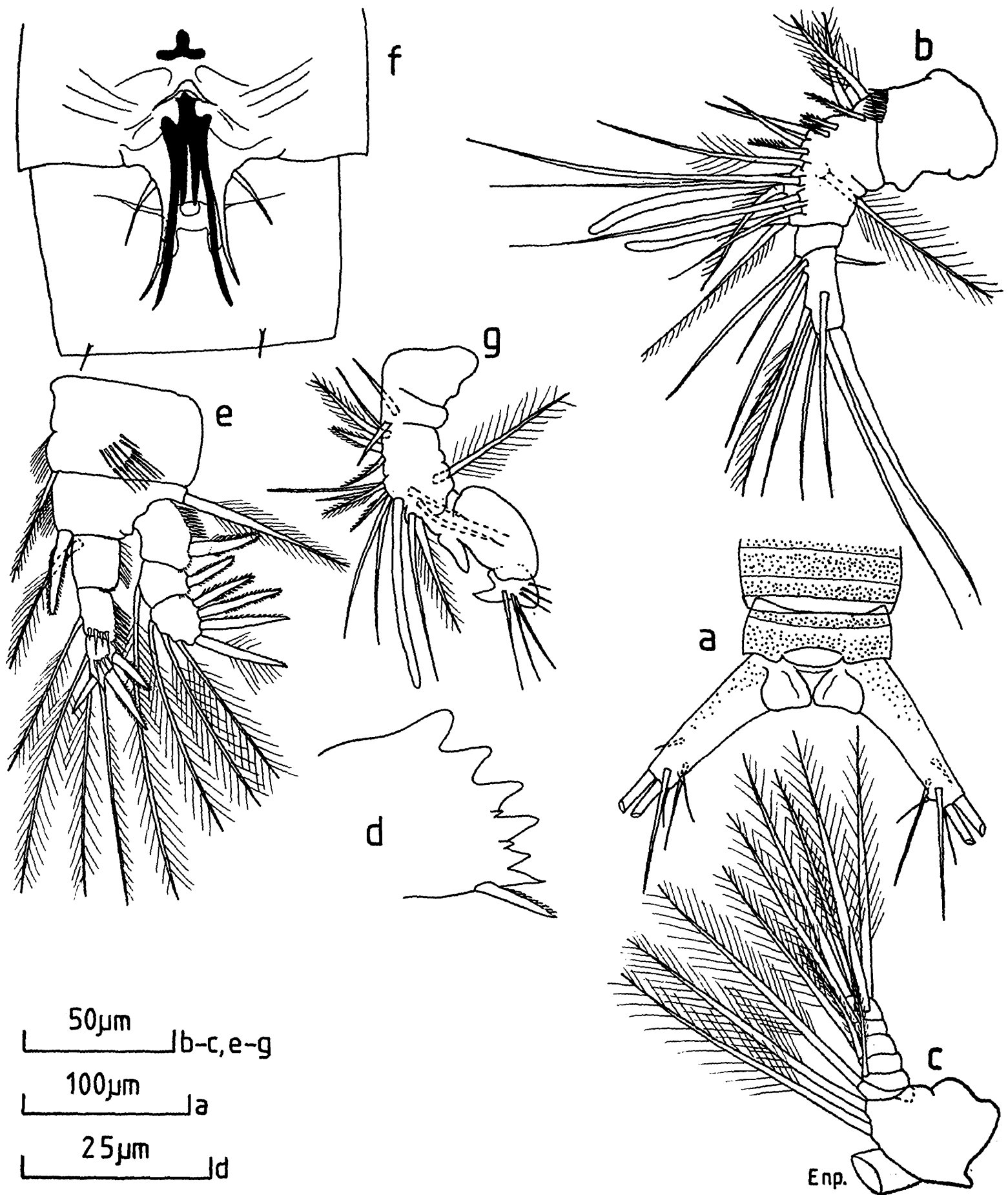


Fig. 14. *Scottolana oleosa*. a, posterior of ♀, dorsal. b, ♀ antennule. c, ♀ antenna exopod. d, ♀ mandible cutting edge. e, ♀ P.I. f, ♂ genital field. g, ♂ antennule.

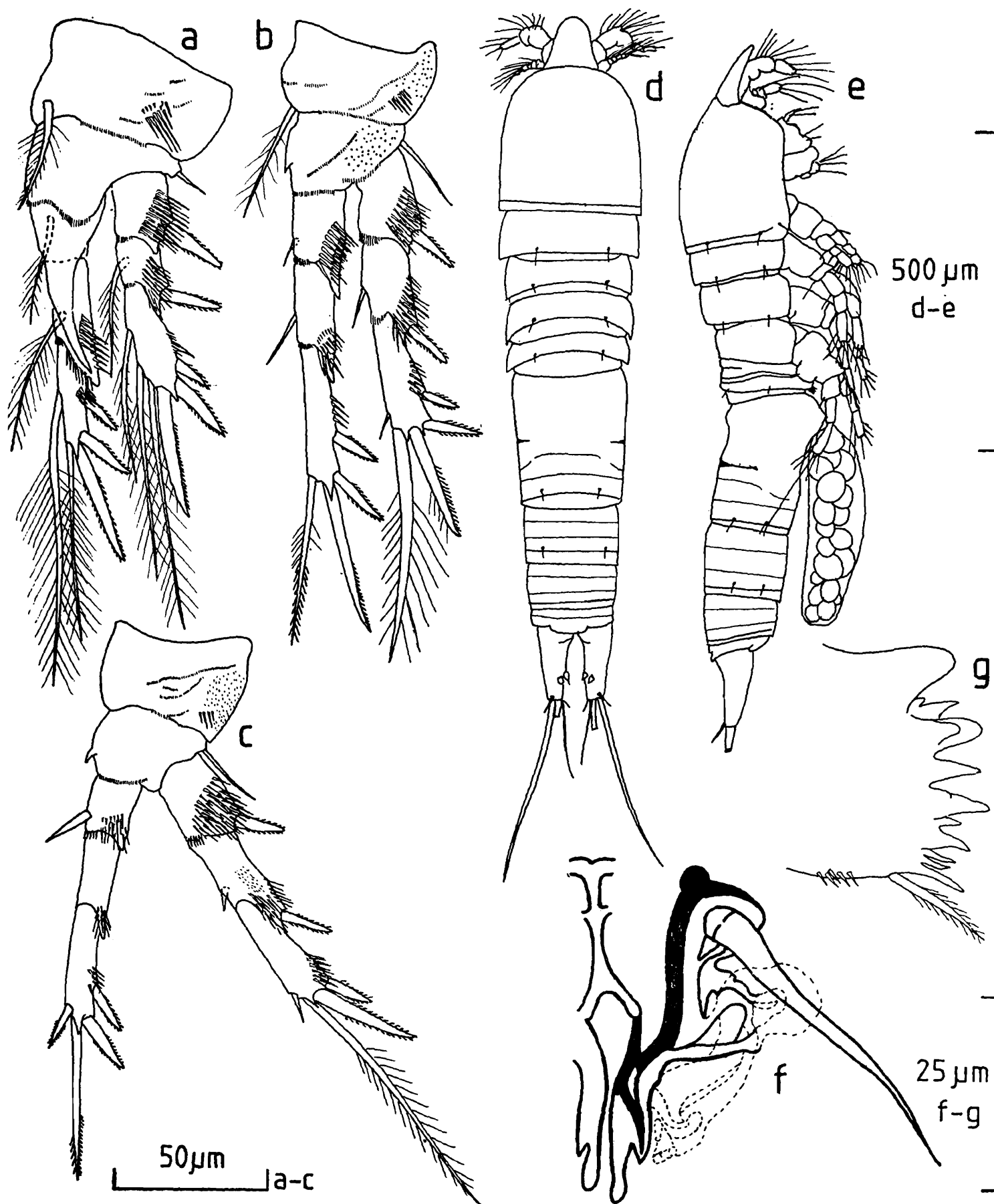


Fig. 15. a-c, *Scottolana oleosa* ♀ P.2.-P.4 d-g, *Scottolana tumidiseta* ♀ d-e, dorsal and lateral. f, left half of genital field. g, mandible cutting edge.

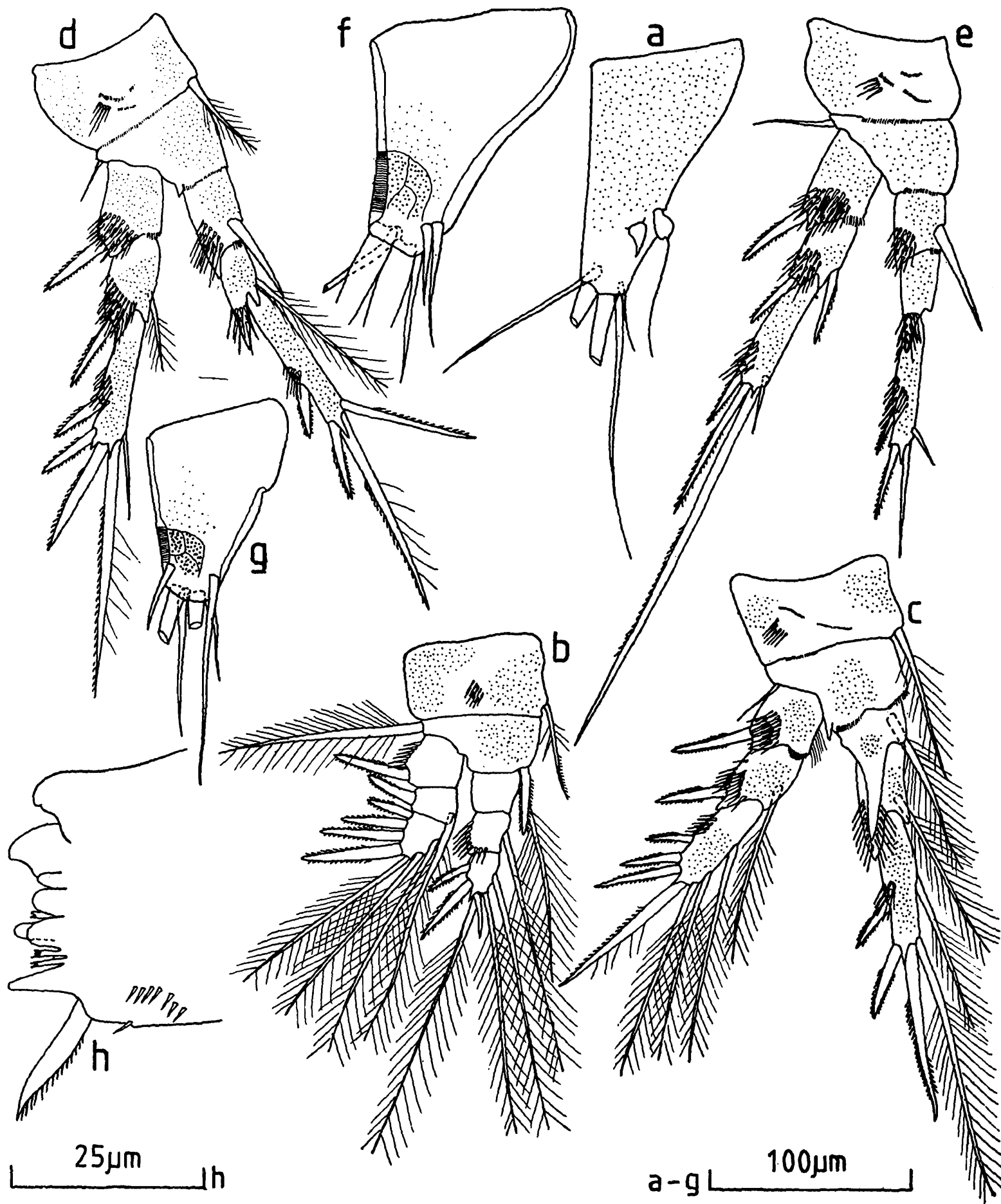


Fig. 16. a-e, *Scottolana tumidiseta* ♀ a, right caudal ramus, ventral. b-e, P.1-P.4. f-h, *Scottolana rostrata*. f-g, right caudal ramus, ventral, ♀ and ♂, h, ♀ mandible cutting edge.



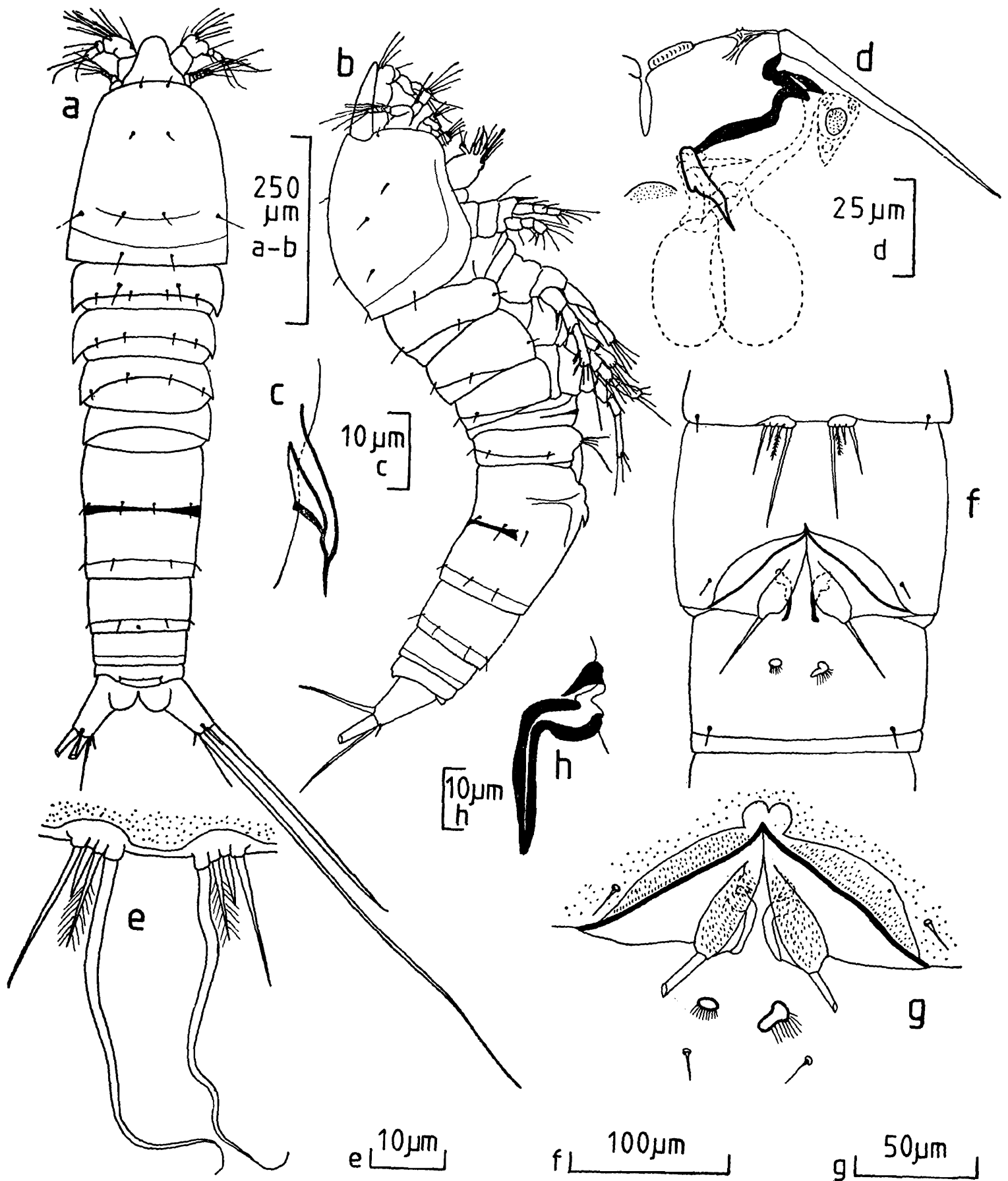


Fig. 17. *Scottolana rostrata*. a-b, ♀, dorsal and lateral. c, ♀ median hook of genital field, lateral. d, ♀ left half of genital field. e, the pair of ♀ P.5. f, ♂ P.5 and genital segments. g, genital field. h, ♂ chitinous ridge and hook of genitalia.

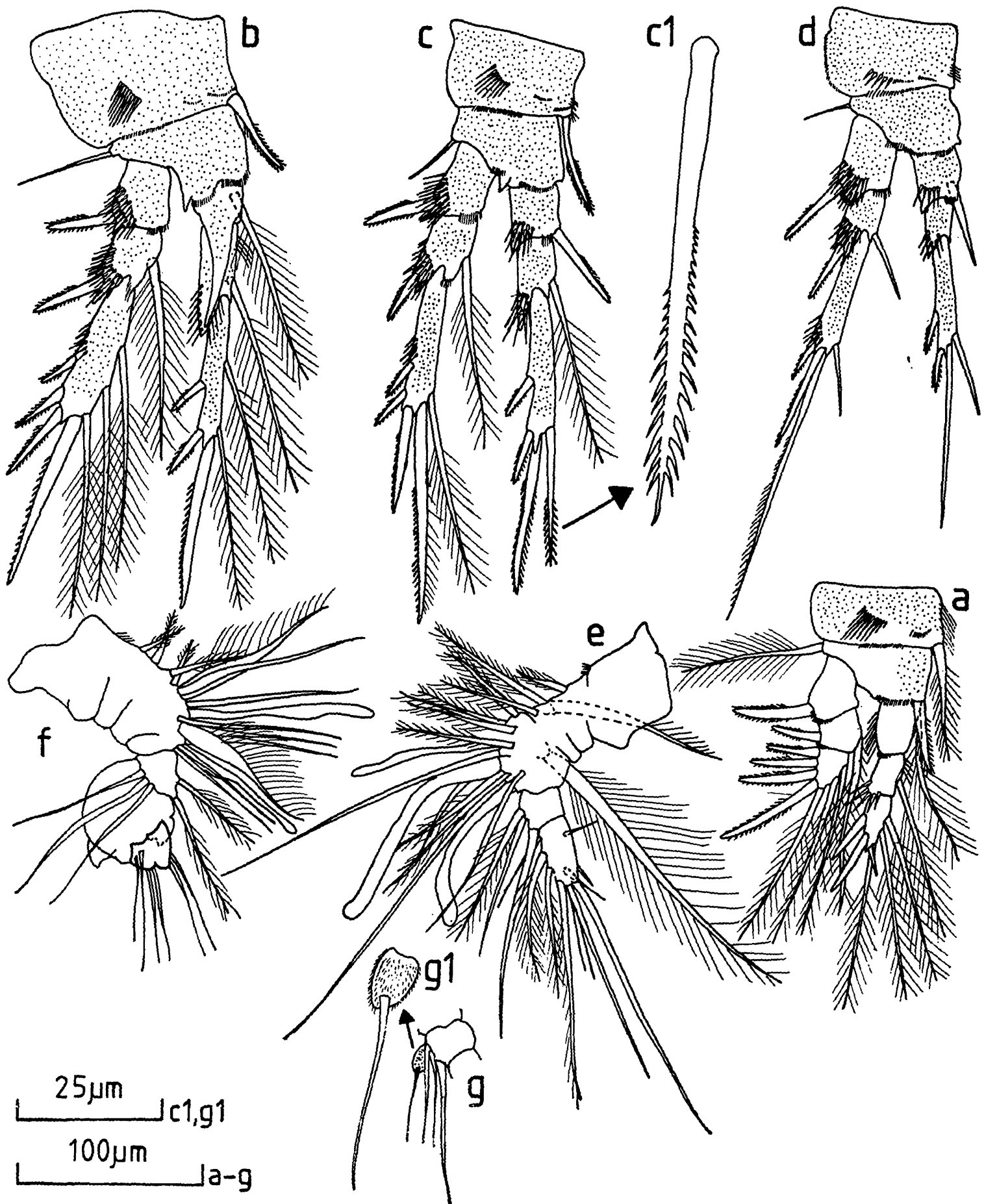


Fig. 18. *Scottolana rostrata*. a-d, ♀ P.1-P.4. e, ♀ antennule. f, ♂ antennule. g, juvenile ♂ antennule. g1, penultimate segment.

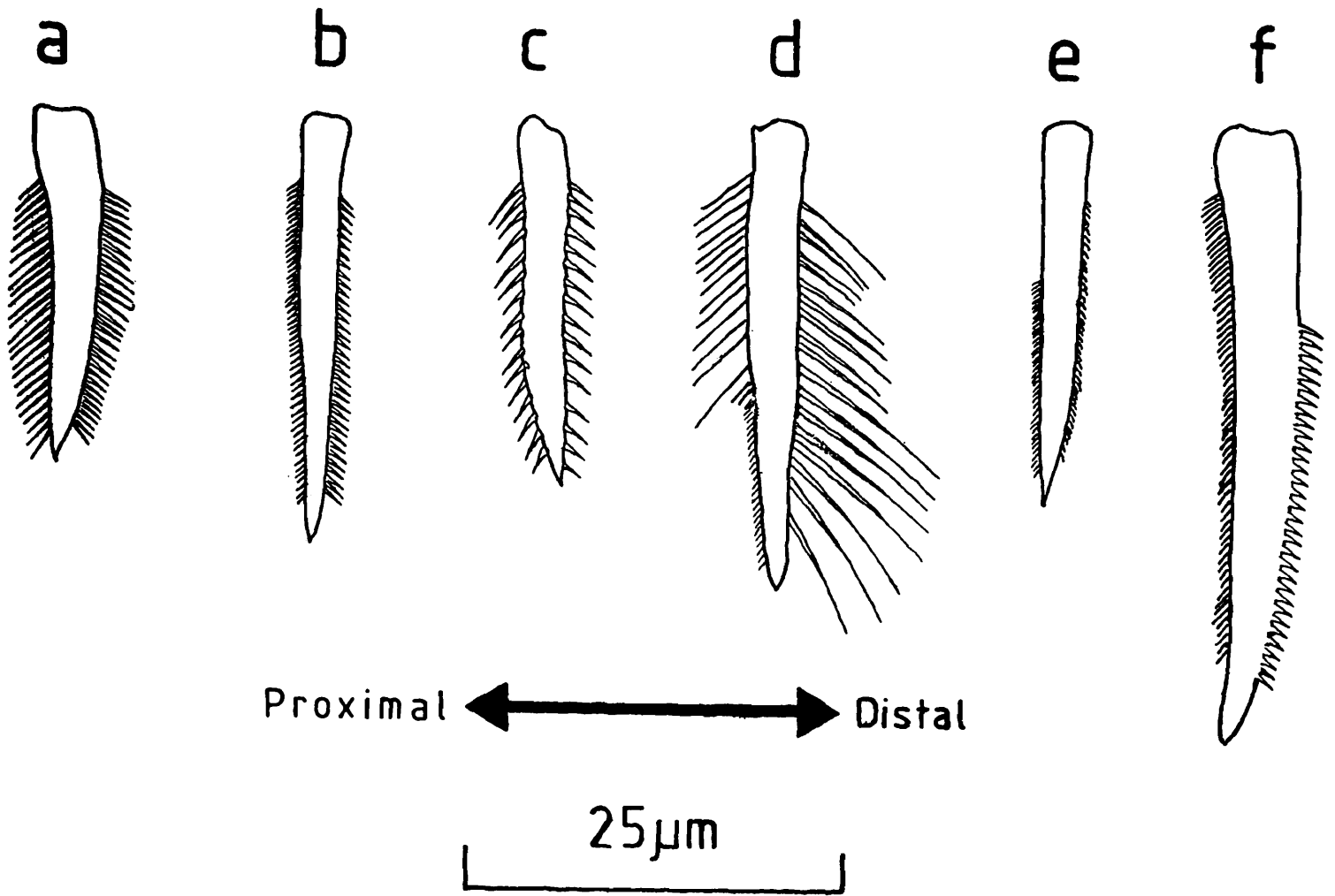


Fig. 19. Spines on the P.1 in the four species of *Scottolana* found in our samples (see also Table 1).

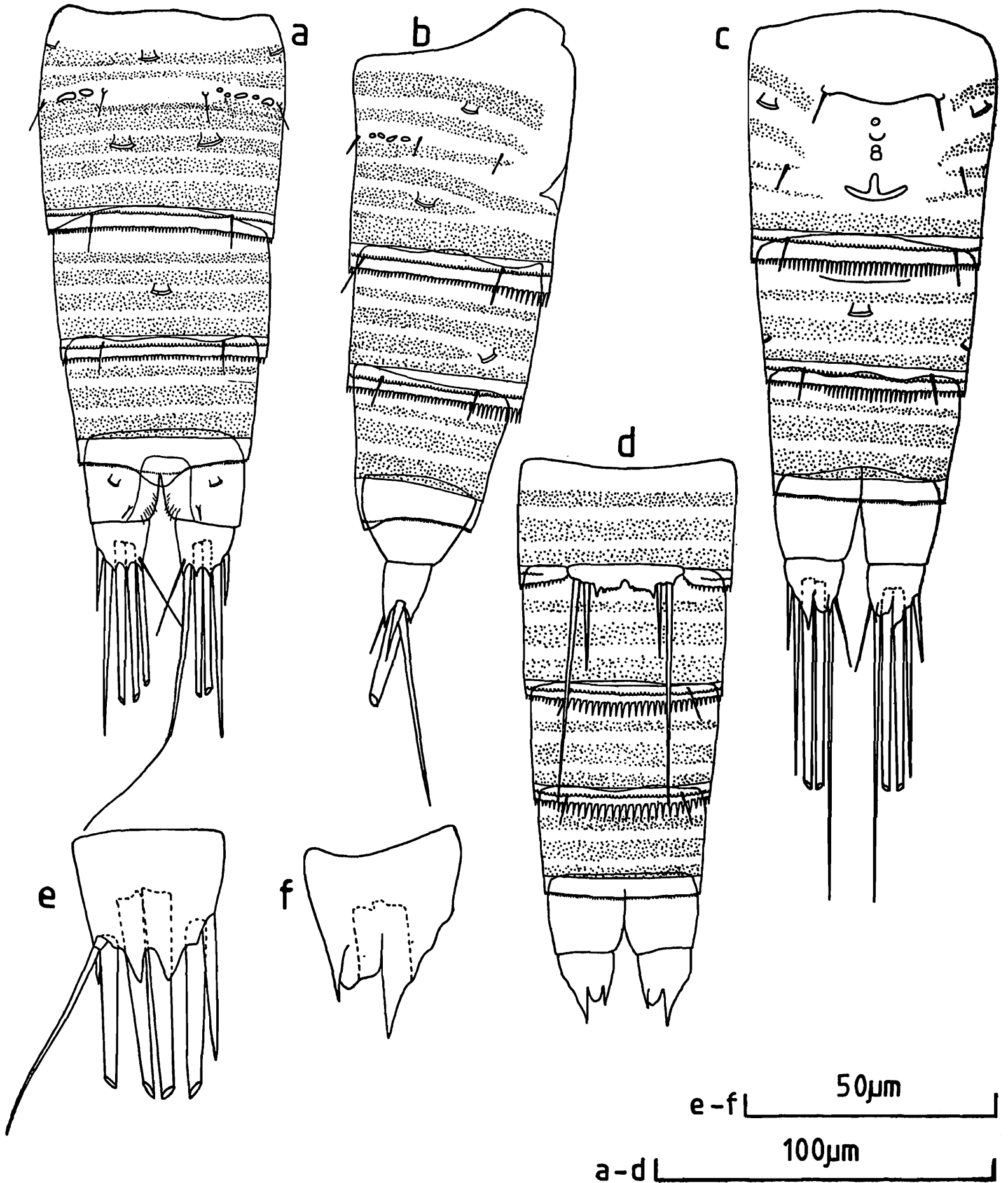


Fig. 20. *Ectinosoma dentatum*. a-c, ♀ abdomen, dorsal, lateral and ventral. d, ♂ abdomen, ventral. e-f, right caudal ramus, dorsal and ventral.

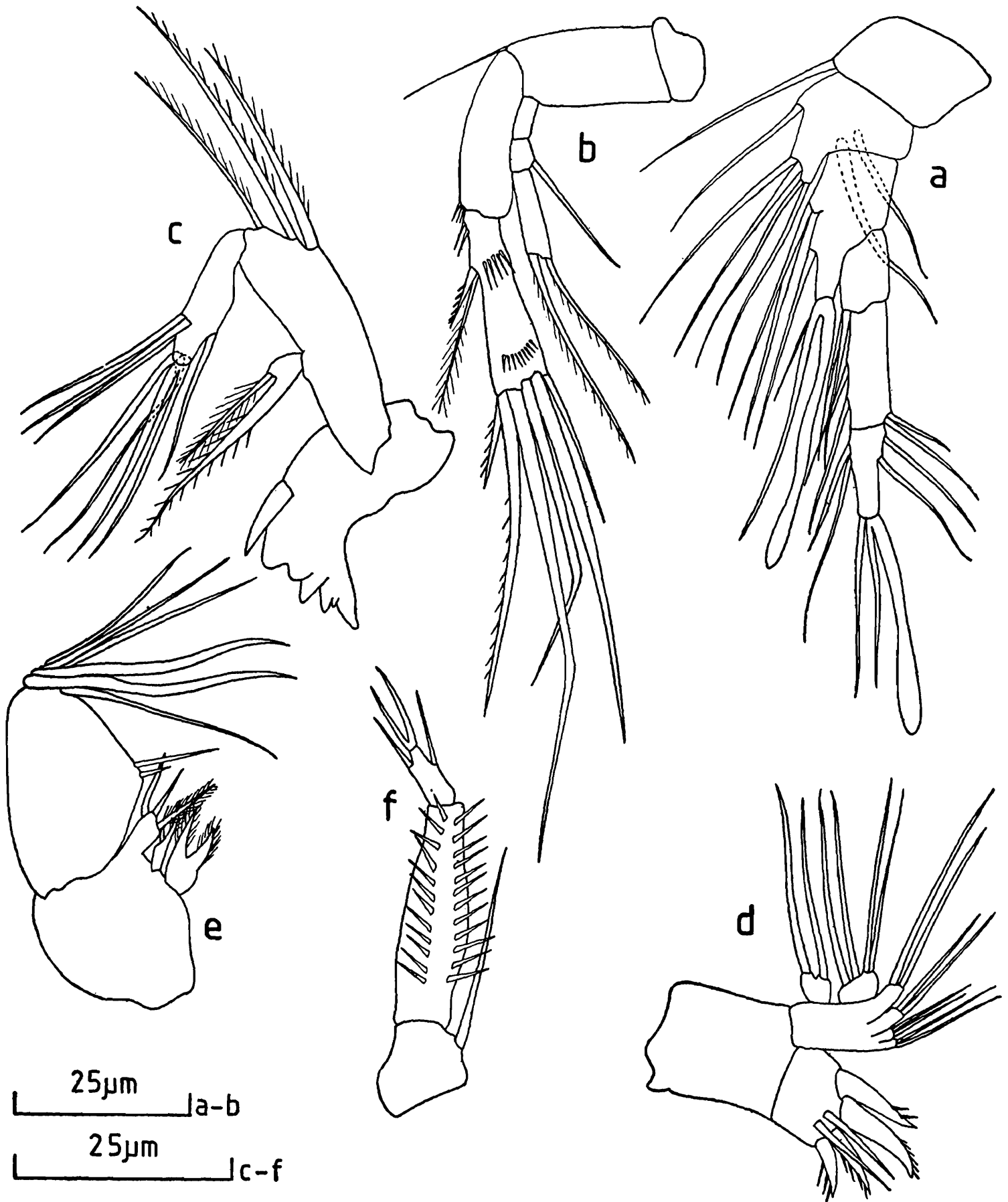


Fig. 21. *Ectinosoma dentatum* ♀ a, antennule. b, antenna. c, mandible. d, maxillule. e, maxilla. f, maxilliped.

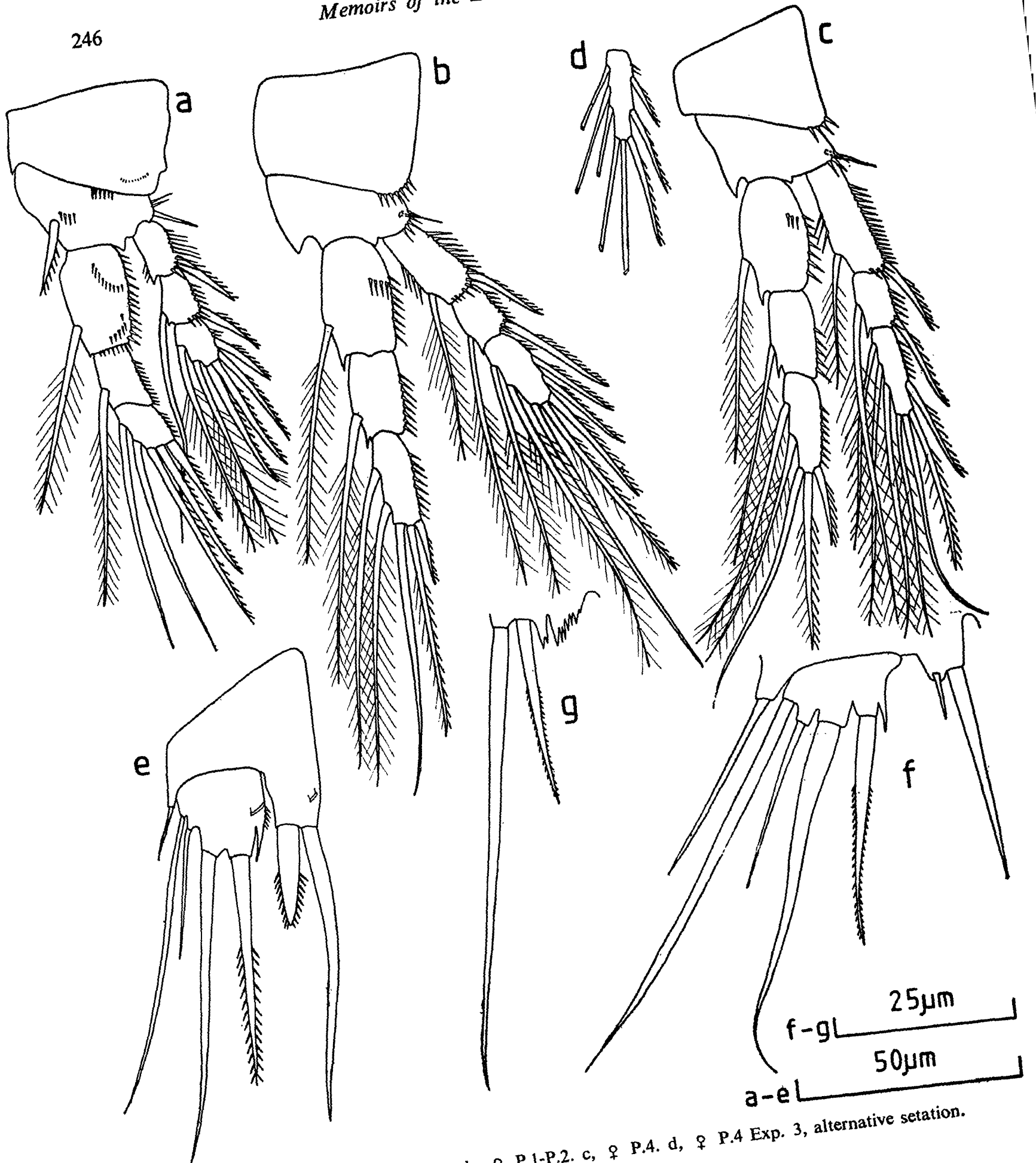


Fig. 22. *Ectinosoma dentatum*. a-b, ♀ P.1-P.2. c, ♀ P.4. d, ♀ P.4 Exp. 3, alternative setation. e, ♀ P.5. f-g, ♂ P.5-P.6.

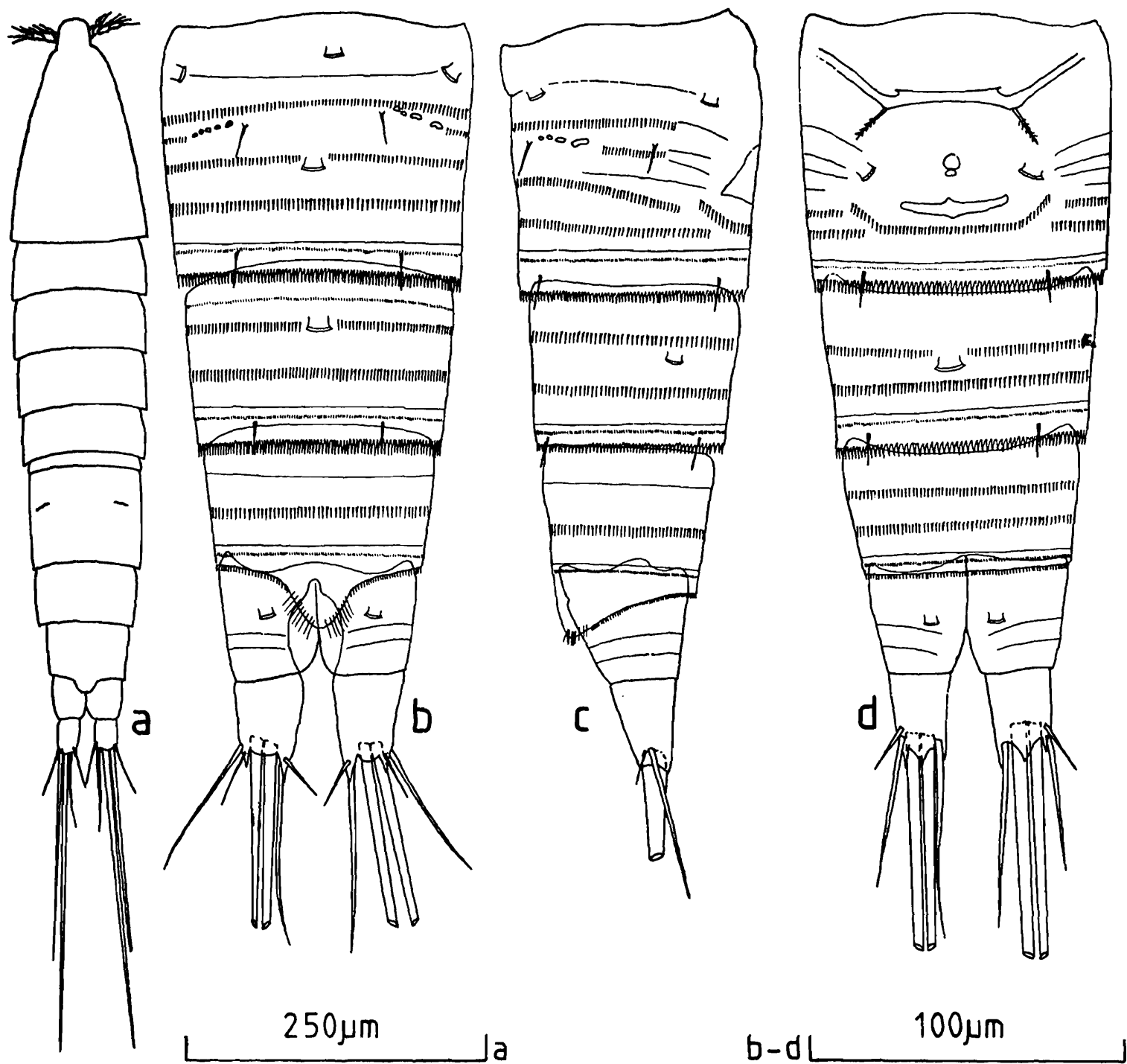


Fig. 23. *Ectinosoma reductum* ♀ a, dorsal. b-d, abdomen, dorsal, lateral and ventral.

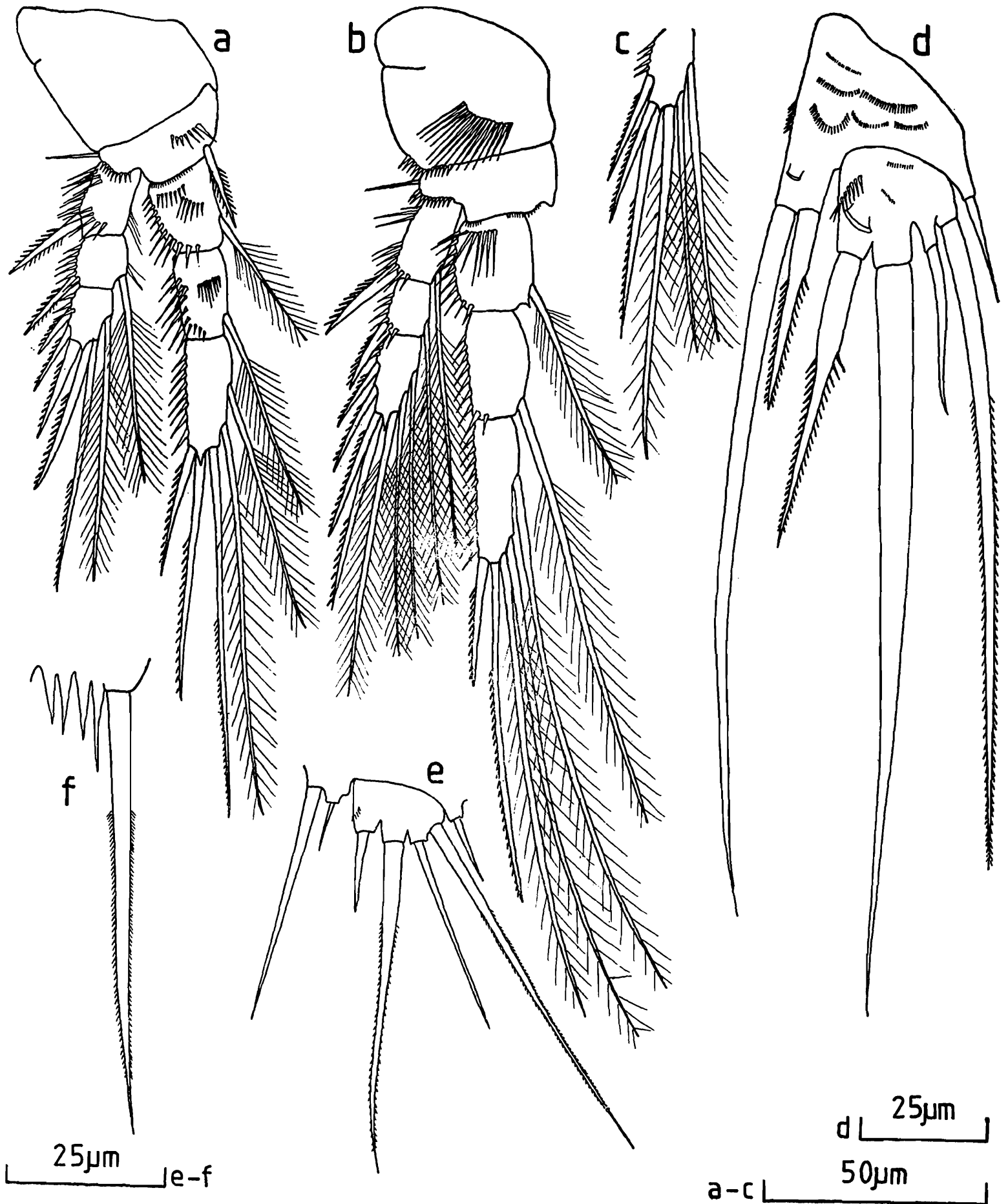


Fig. 24. *Ectinosoma reductum*. a-b, ♀ P.1-P.2. c, ♀ P.3 Exp. 3. d, ♀ P.5. e-f, ♀ P.5-P.6.



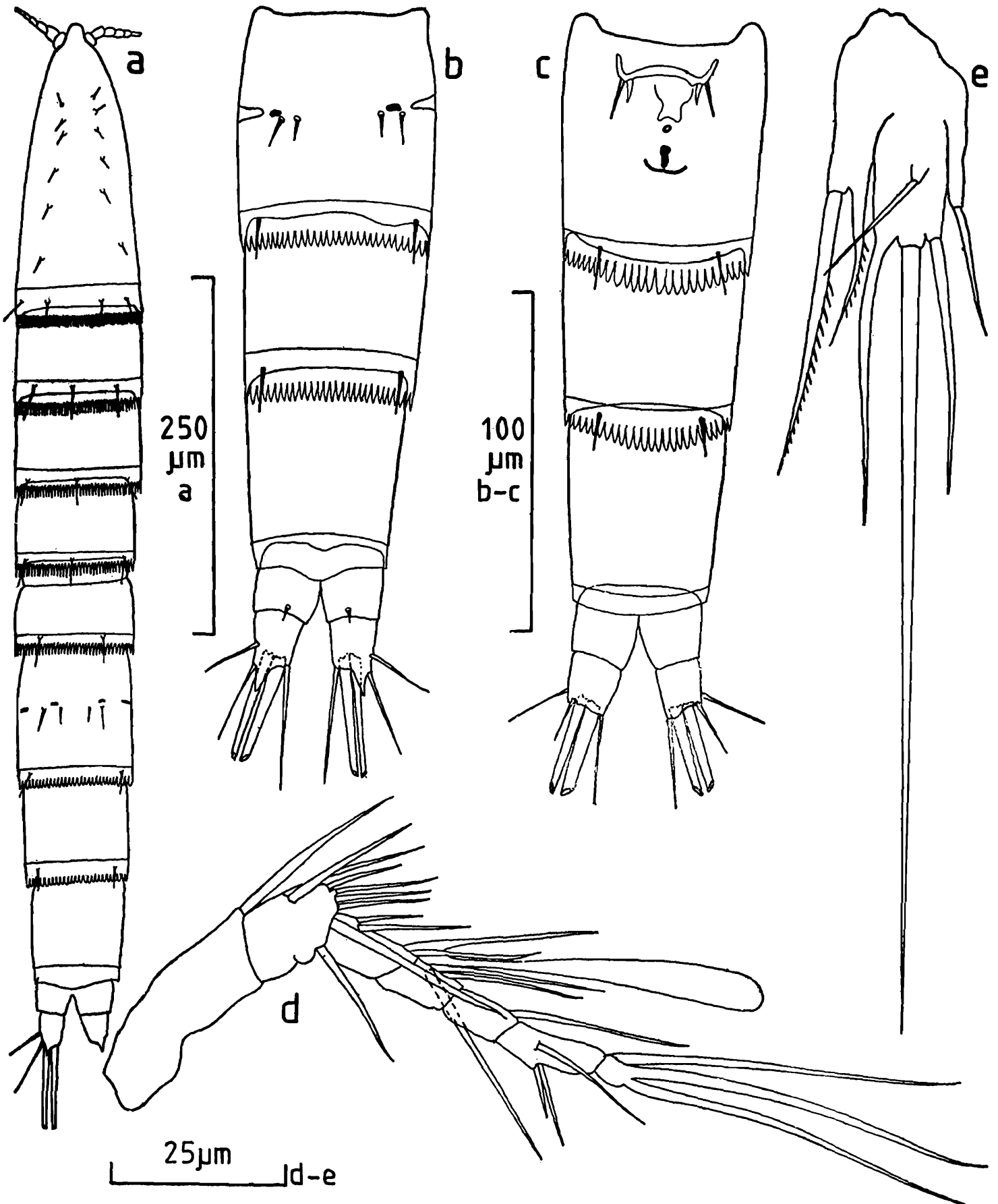


Fig. 25. *Halectinosoma tenuireme* ♀ a, dorsal. b-c, abdomen, dorsal and ventral. d, antennule. e, P.5.

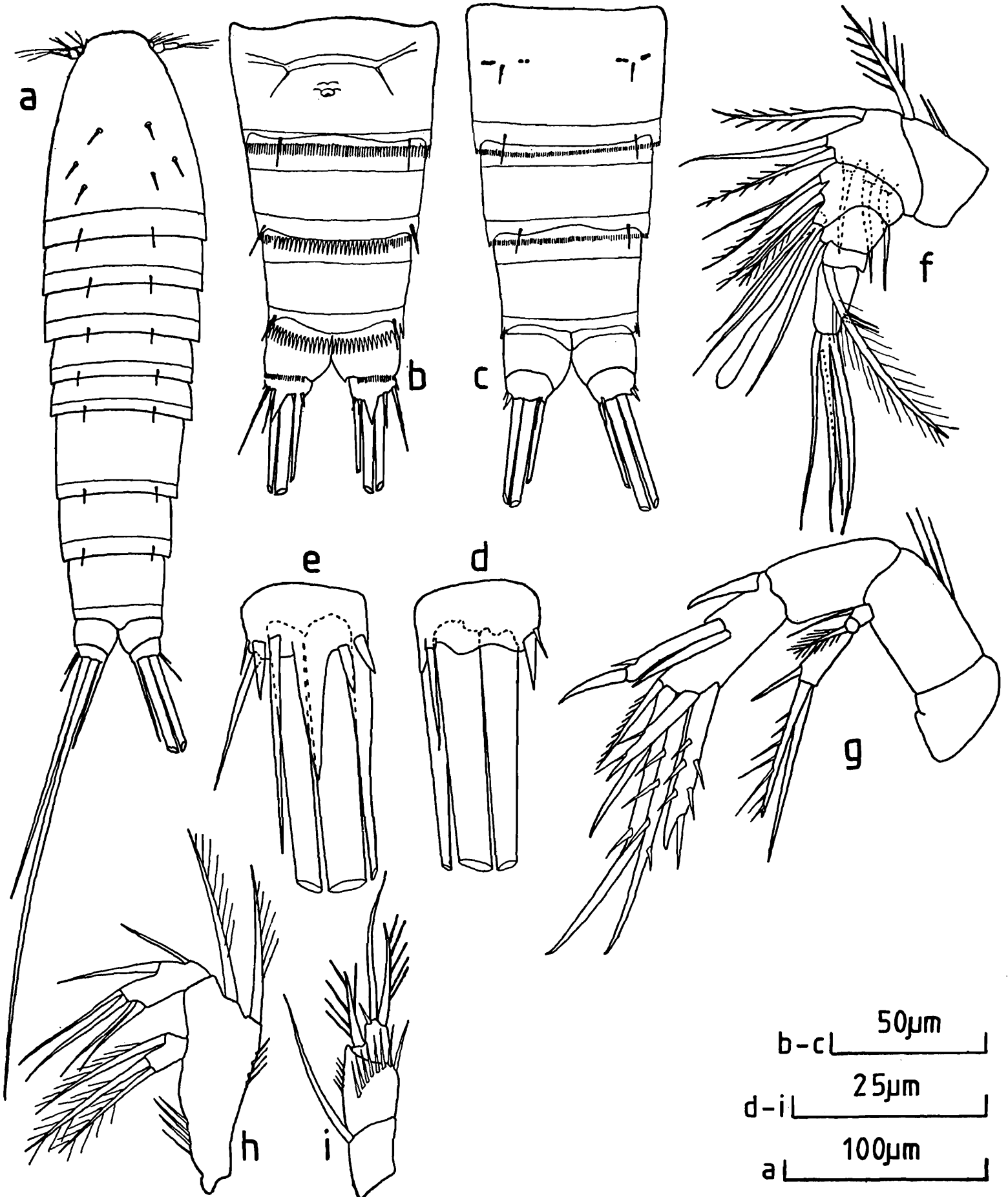


Fig. 26. *Halophytophilus simplex* ♀ a, dorsal. b-c, abdomen ventral and dorsal. d-e, right caudal ramus, dorsal and ventral. f, antennule. g, antenna. h, mandible palp. i, maxilliped.

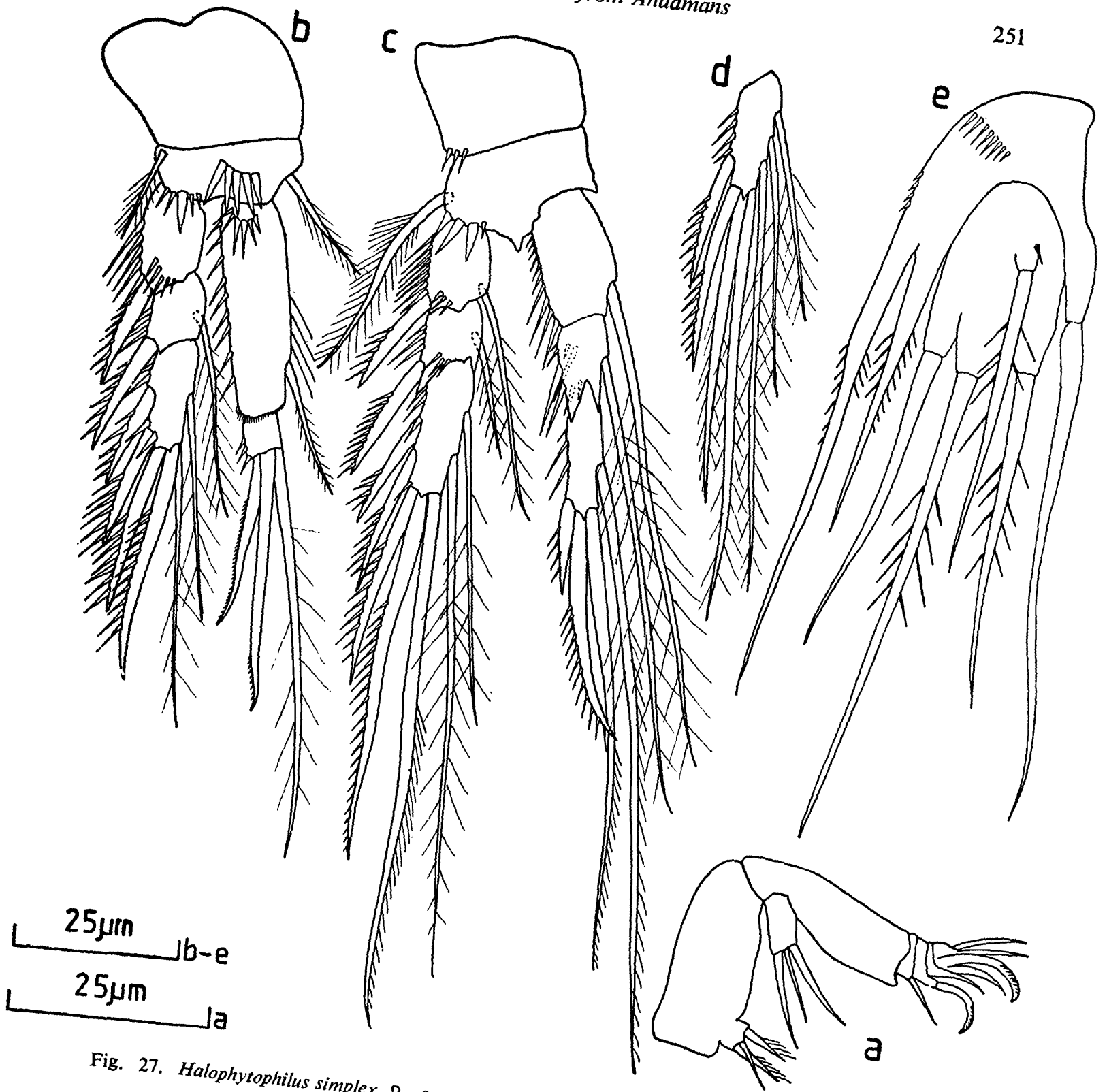


Fig. 27. *Halophytophilus simplex* ♀ a, maxilla. b-c, P.1-P.2. d, P.4 Exp.3. e, P.5.

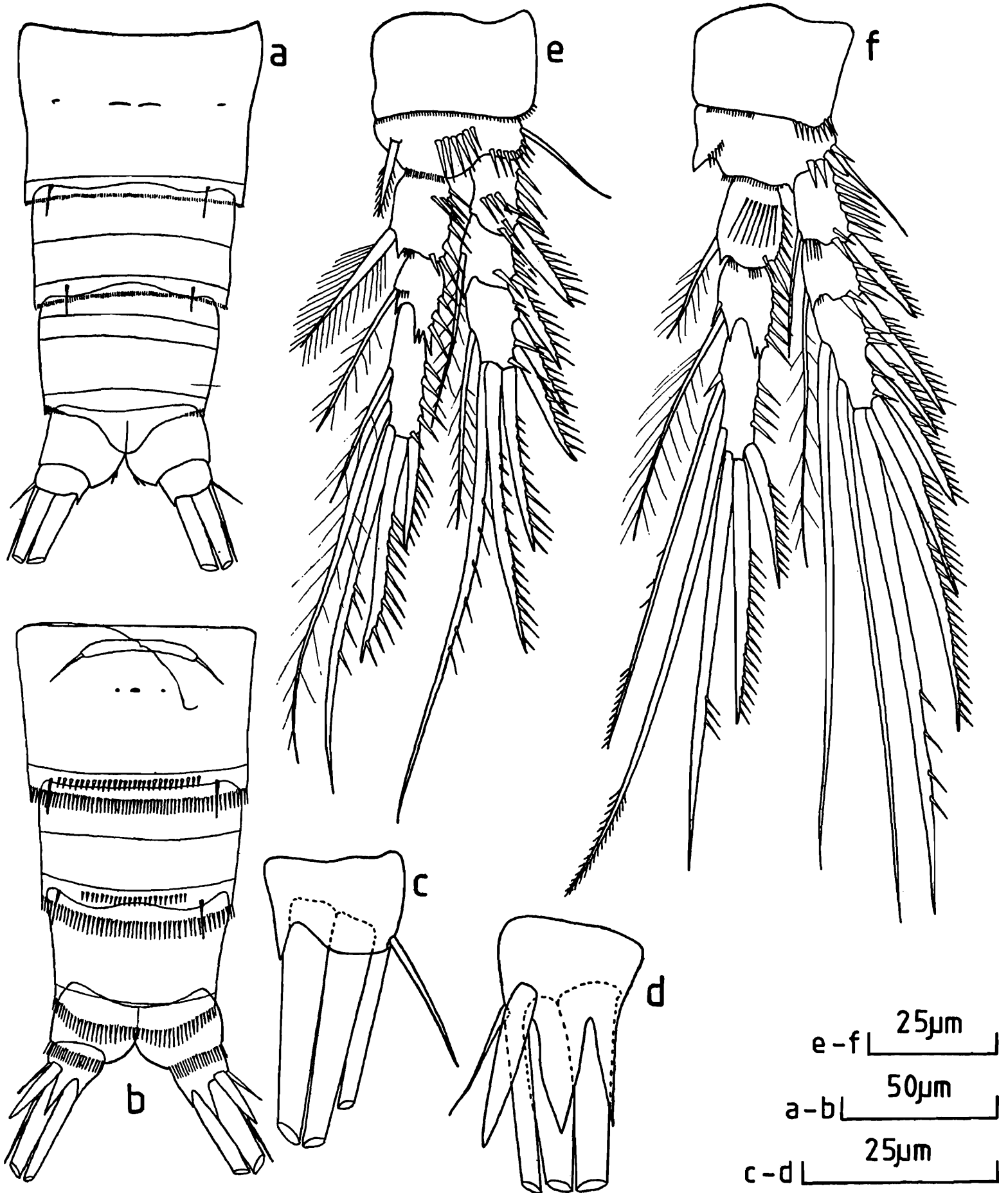


Fig. 28. *Halophytophilus aberrans* ♀ a-b, abdomen, dorsal and ventral. c-d, right caudal ramus, dorsal and ventral. e, P.1. f, P.4.

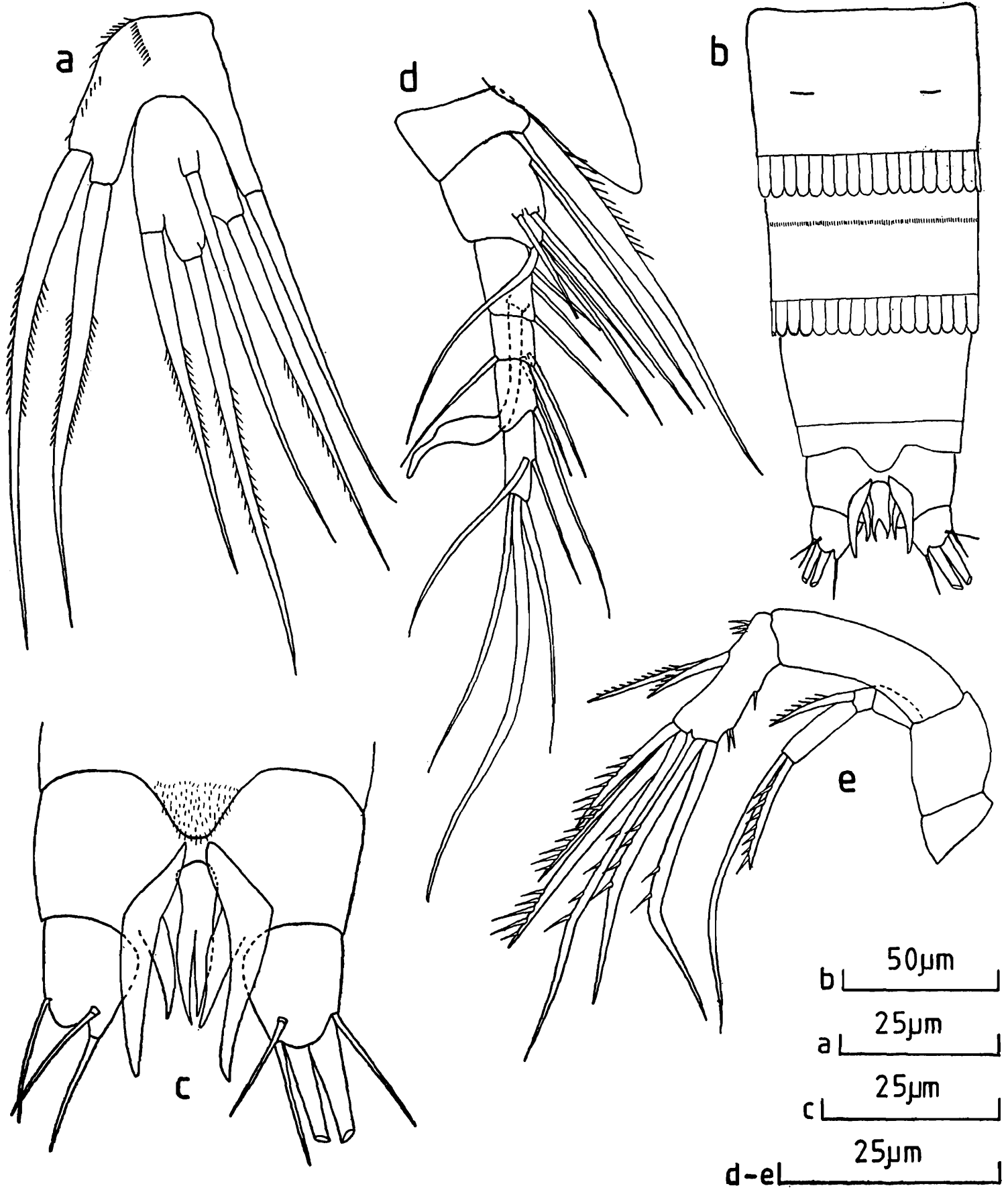


Fig. 29. a, *Halophytophilus aberrans* ♀ P.5. b-e, *Arenosetella tricornis* ♀ b, abdomen, dorsal c, last abdominal seg., dorsal. d, rostrum and antennule. e, antenna.

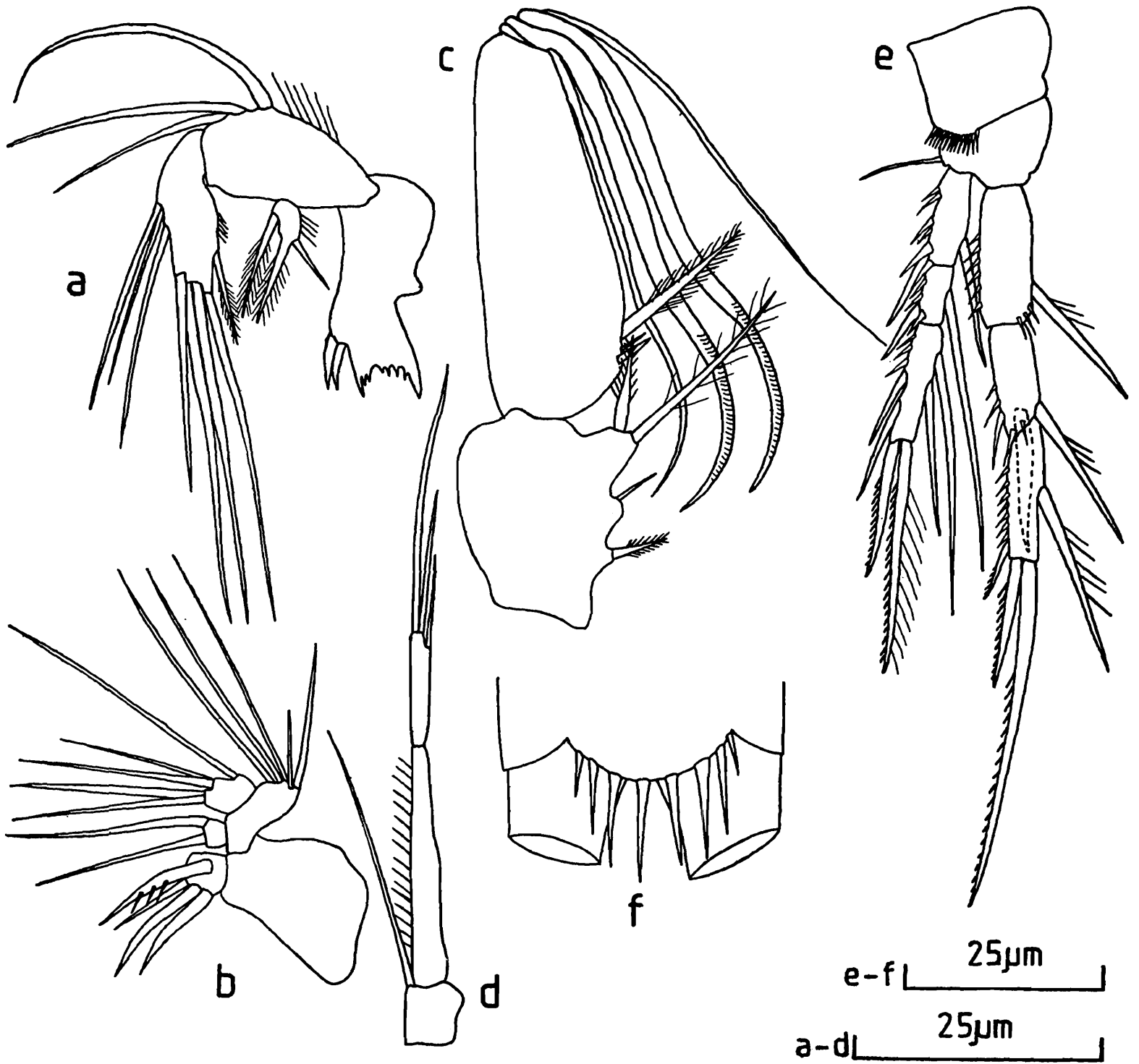


Fig. 30. *Arenosetella tricornis*. a, ♀ mandible. b, ♀ maxillule. c, ♀ maxilla. d, ♀ maxilliped. e, ♀ P.4. f, pseudoperculum of Stage V copepod.

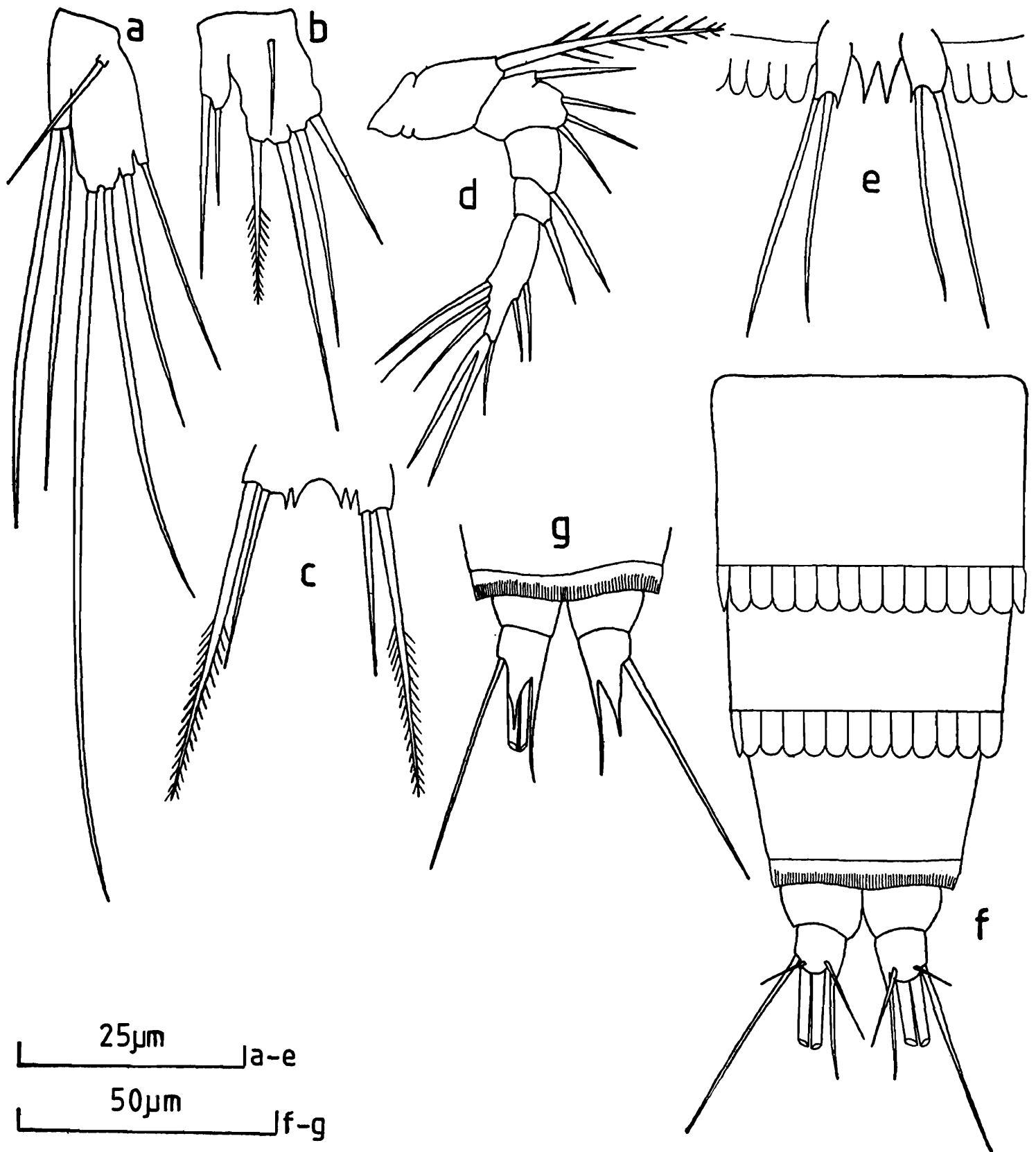


Fig. 31. a-c, *Arenosetella tricornis*. a, ♀ P.5. b-c, ♂ P.5-P.6. d-e, *Hastigerella leptoderma*. d, antennule, Mozambique ♀ e, ♂ P.6. f-g, *Noodtiella mielkei* ♀ f, abdomen, dorsal. g, posterior abdomen, ventral.

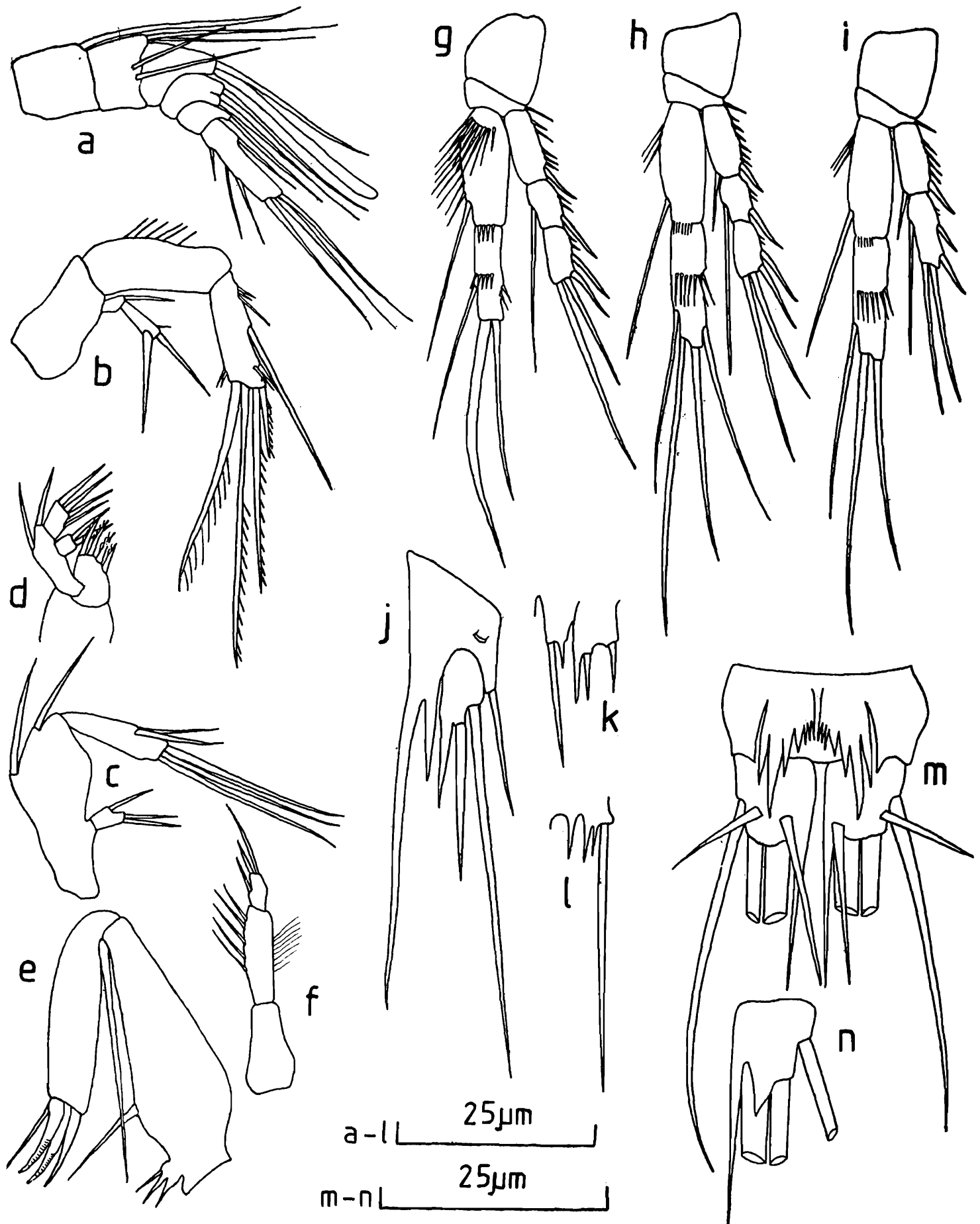


Fig. 32. a-l, *Noodtiella mielkei*. a, ♀ antennule. b, ♀ antenna. c, ♀ mandible palp. d, ♀ maxillule. e, ♀ maxilla. f, ♀ maxilliped. g-h, ♀ P.1-P.2. i, ♀ P.4. j, ♀ P.5. k-l, ♂ P.5-P.6. m-n, *Noodtiella ornamentalis* ♀ m, posterior abdomen, dorsal. n, left caudal ramus, ventral.



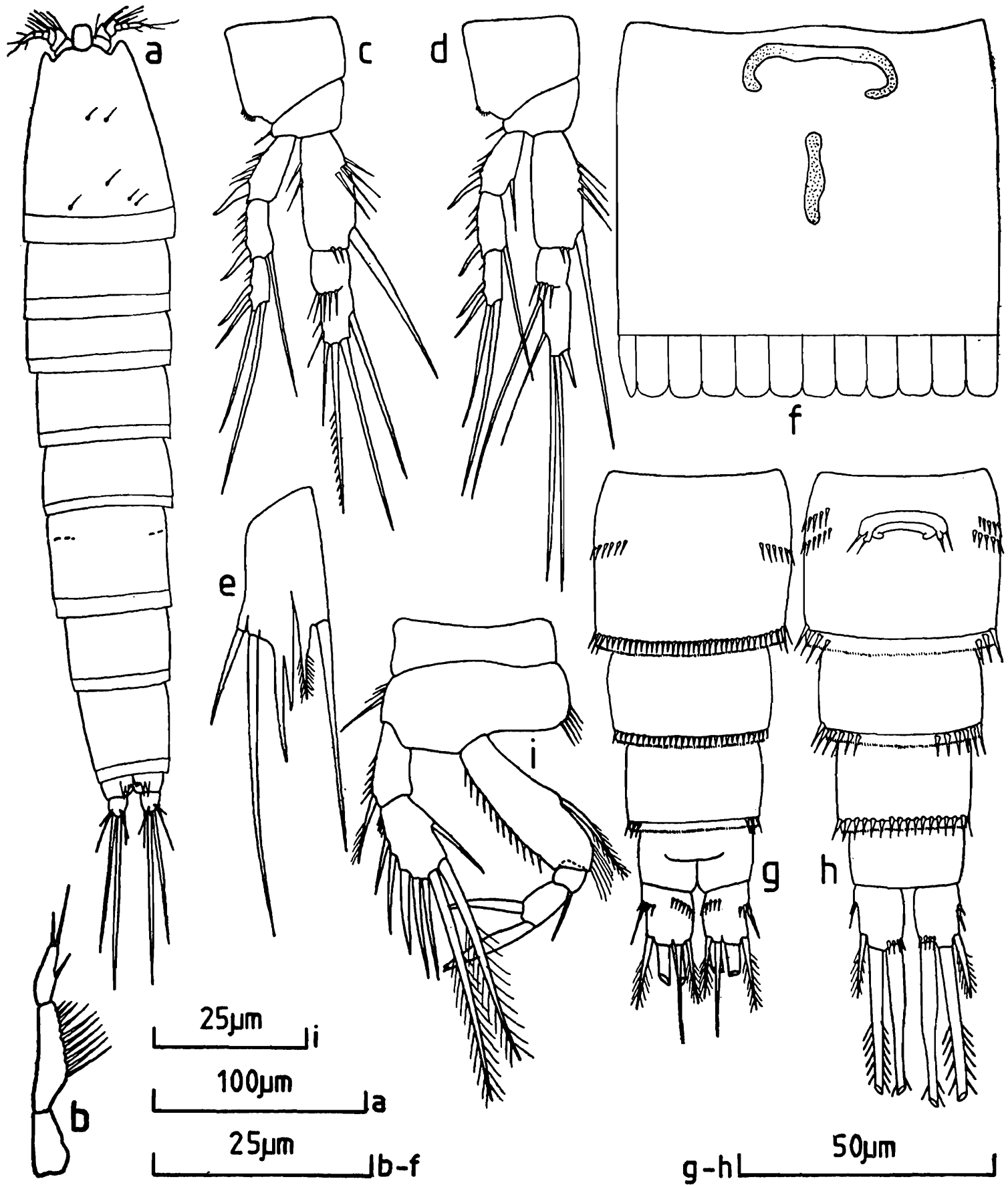


Fig. 33. a-f, *Noodtiella ornamentalis* ♀ a, dorsal. b, maxilliped. c-d, P.1-P.2. e, P.5. f, genital somite, ventral. g-i, *Tisbisoma triarticulatum* ♀ g-h, abdomen, dorsal and ventral. i, P.1.

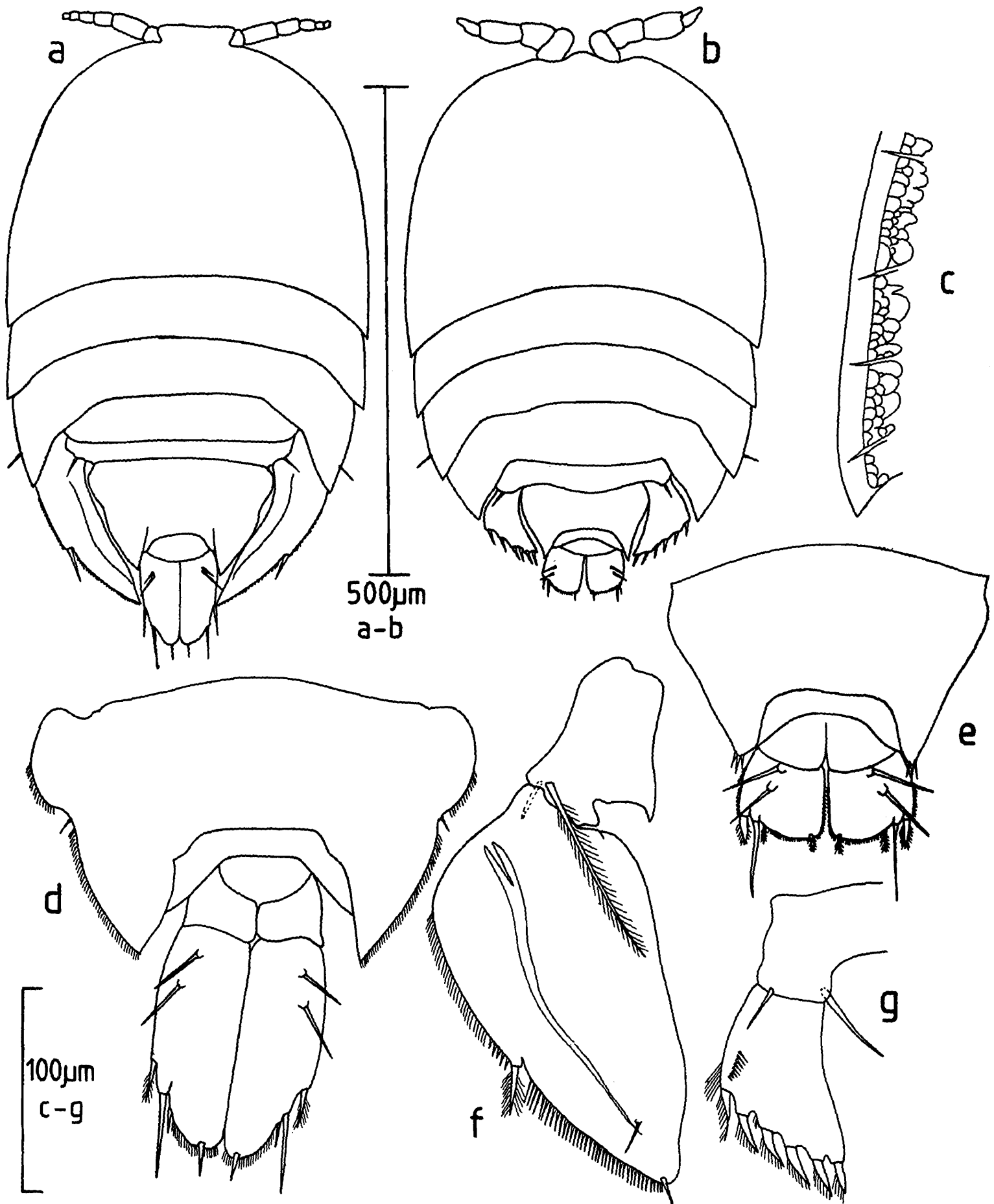


Fig. 34. *Porcellidium ravanae*. a-b, ♀ and ♂, dorsal. c, detail of ornamentation of cephalothorax, near left distal corner. d-e, ♀ and ♂ abdomen, dorsal. f-g, P.5 ♀ and ♂

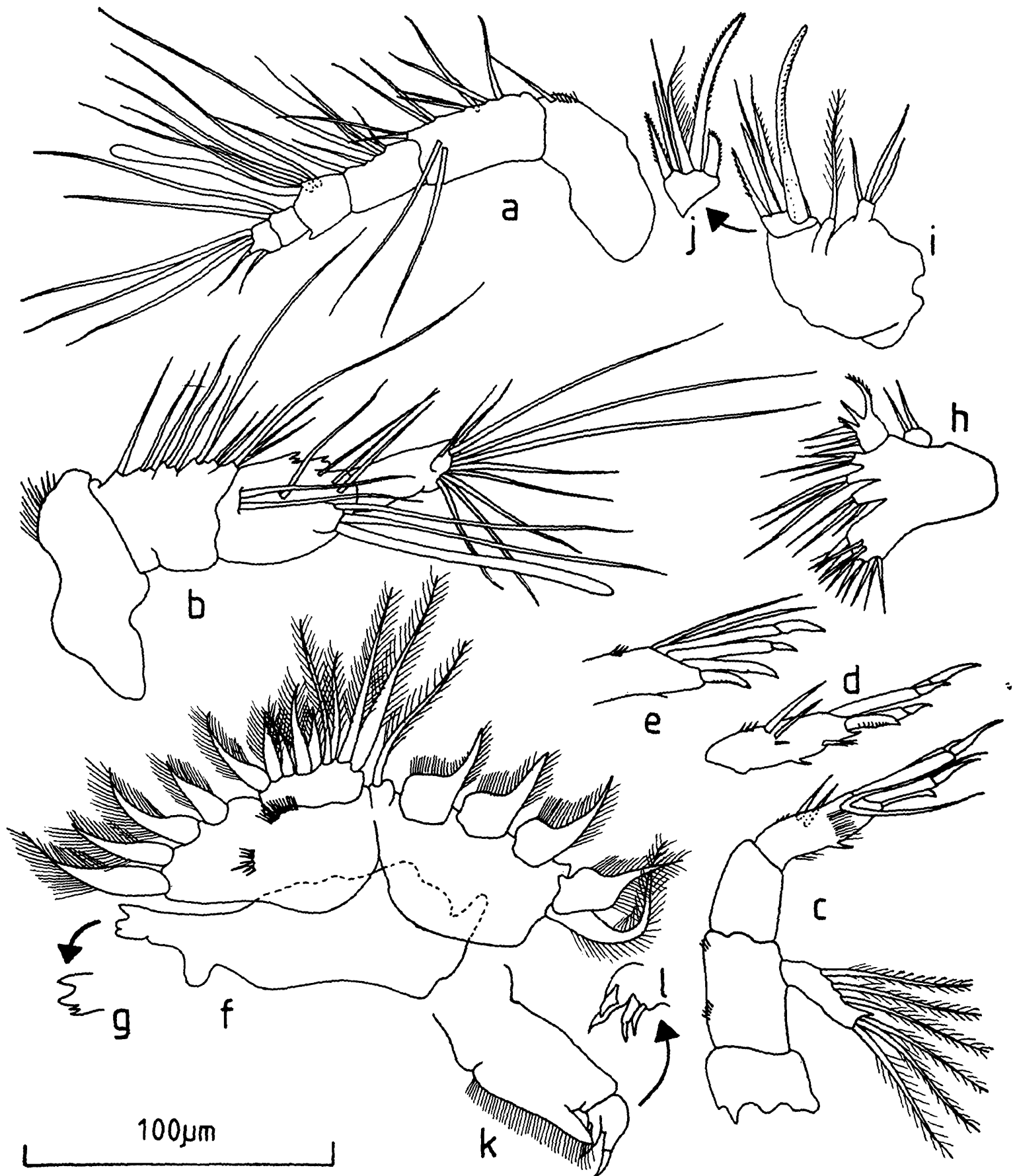


Fig. 35. *Porcellidium ravanae*. a-b, ♀ and ♂ antennule. c, ♀ antenna. d-e, antenna Enp. 2 in different orientations. f, ♀ mandible. g, mandible cutting edge in another orientation. h, ♀ maxillule. i, ♀ maxilla. j, maxilla endopod in another orientation. k, ♀ maxilliped. l, maxilliped endopod.

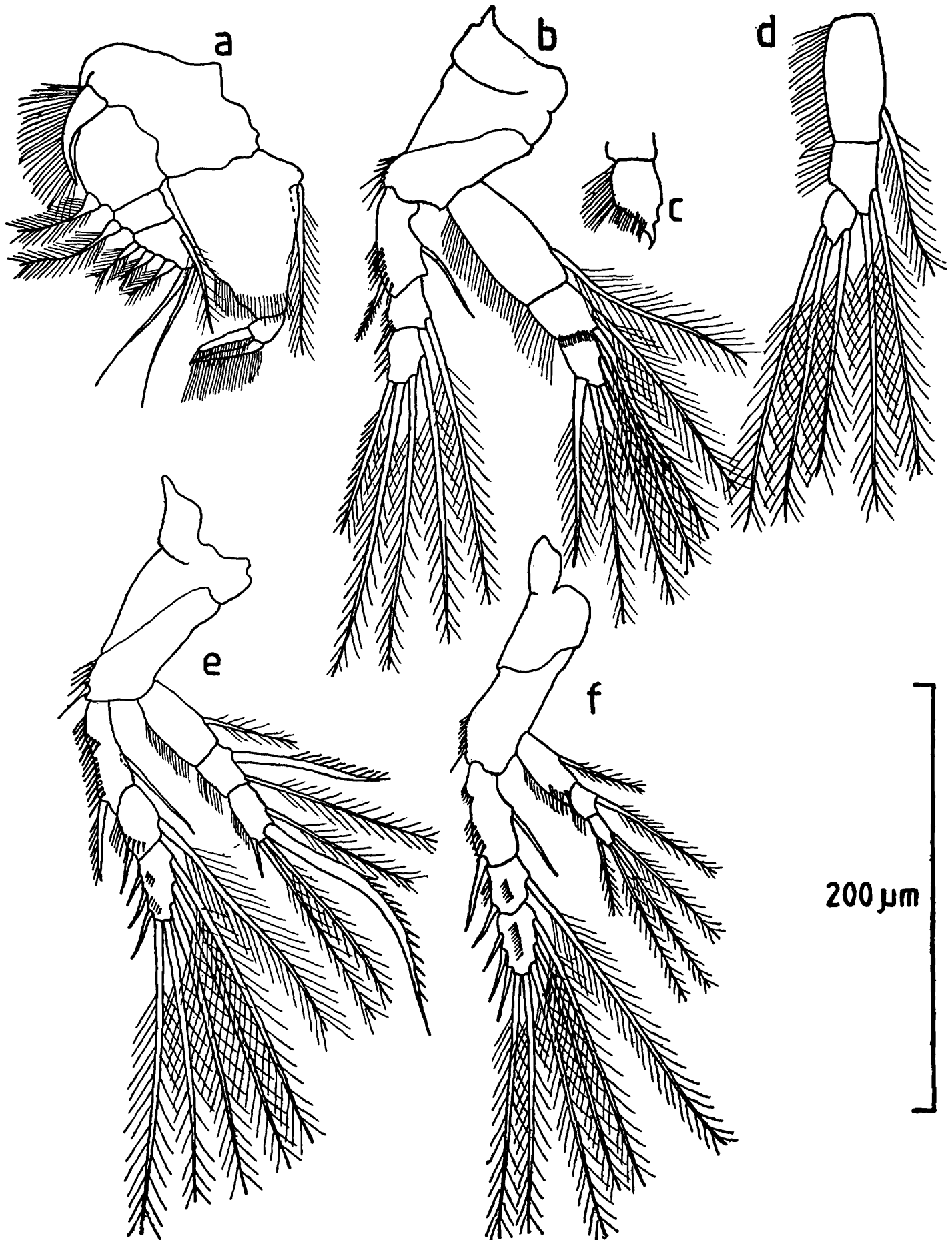


Fig. 36. *Porcellidium ravanae*. a-b, ♀ P.1-P.2. c, ♀ P.2 Enp.2, posterior. d, ♂ P.2 Enp. e-f, ♀ P.3-P.4.

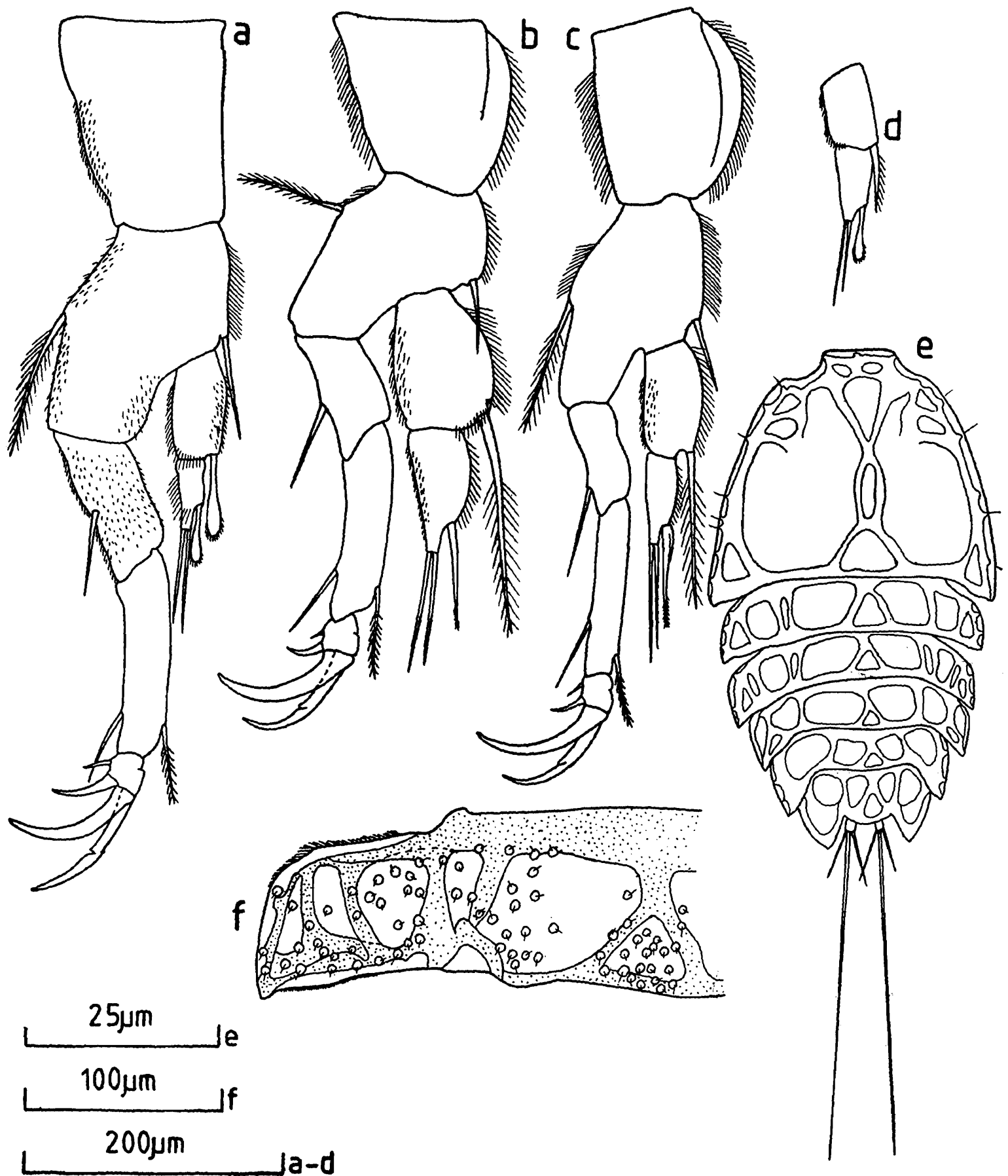


Fig. 37. a-d, *Peltidium ovale*. a, ♂ P.I. b, adult ♀ P.I. c, Stage V ♀ P.I. d, Stage IV P.I. Enp. e-f, *Peltidium angulatum* ♀ e, dorsal. f, pleurotergite of second free thoracic segment, (chitinous struts lightly stippled).

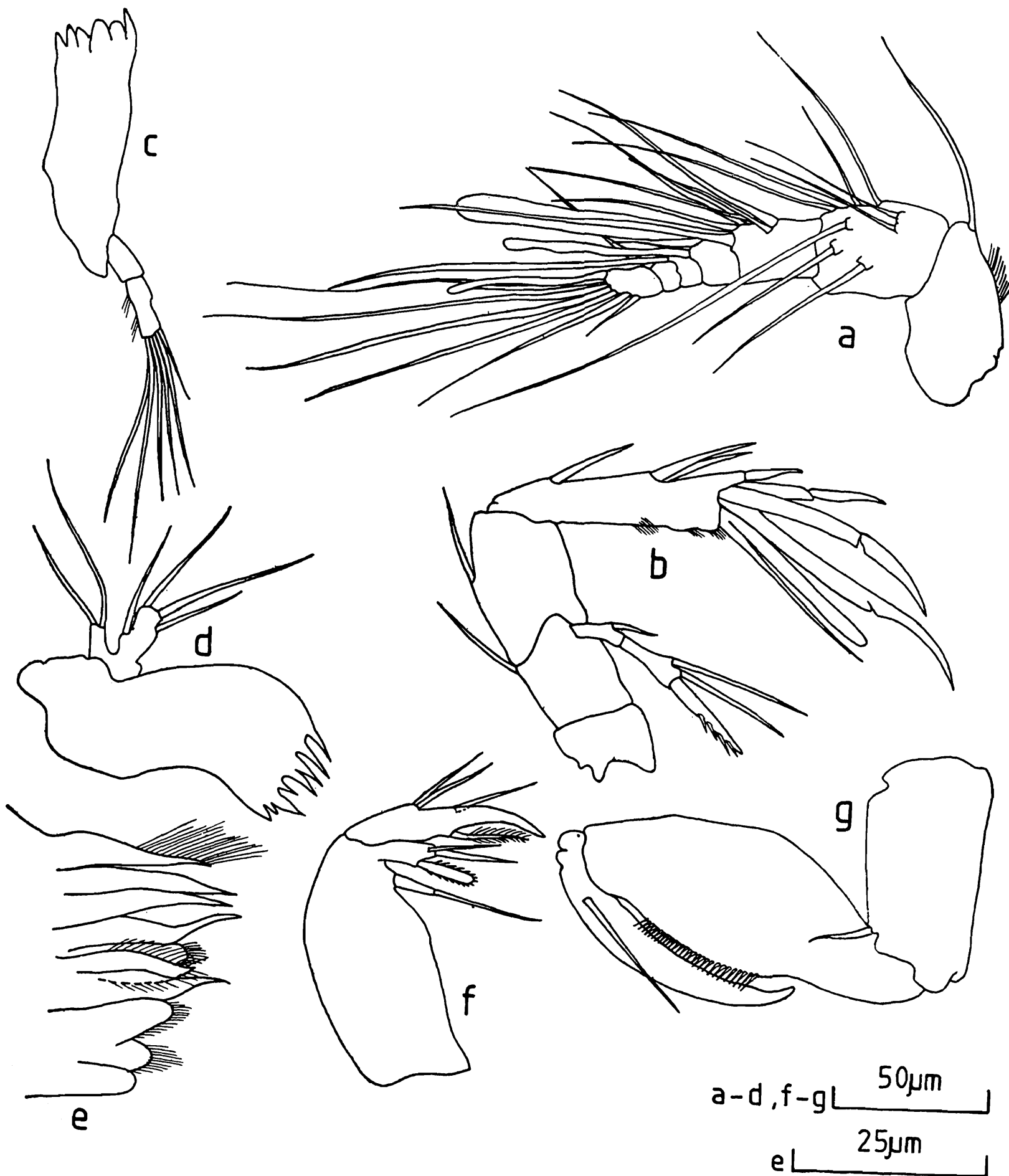


Fig. 38. *Peltidium angulatum* ♀. a, antennule. b, antenna. c, mandible. d, maxillule. e, maxillule, precoxal arthrite. f, maxilla. g, maxilliped.

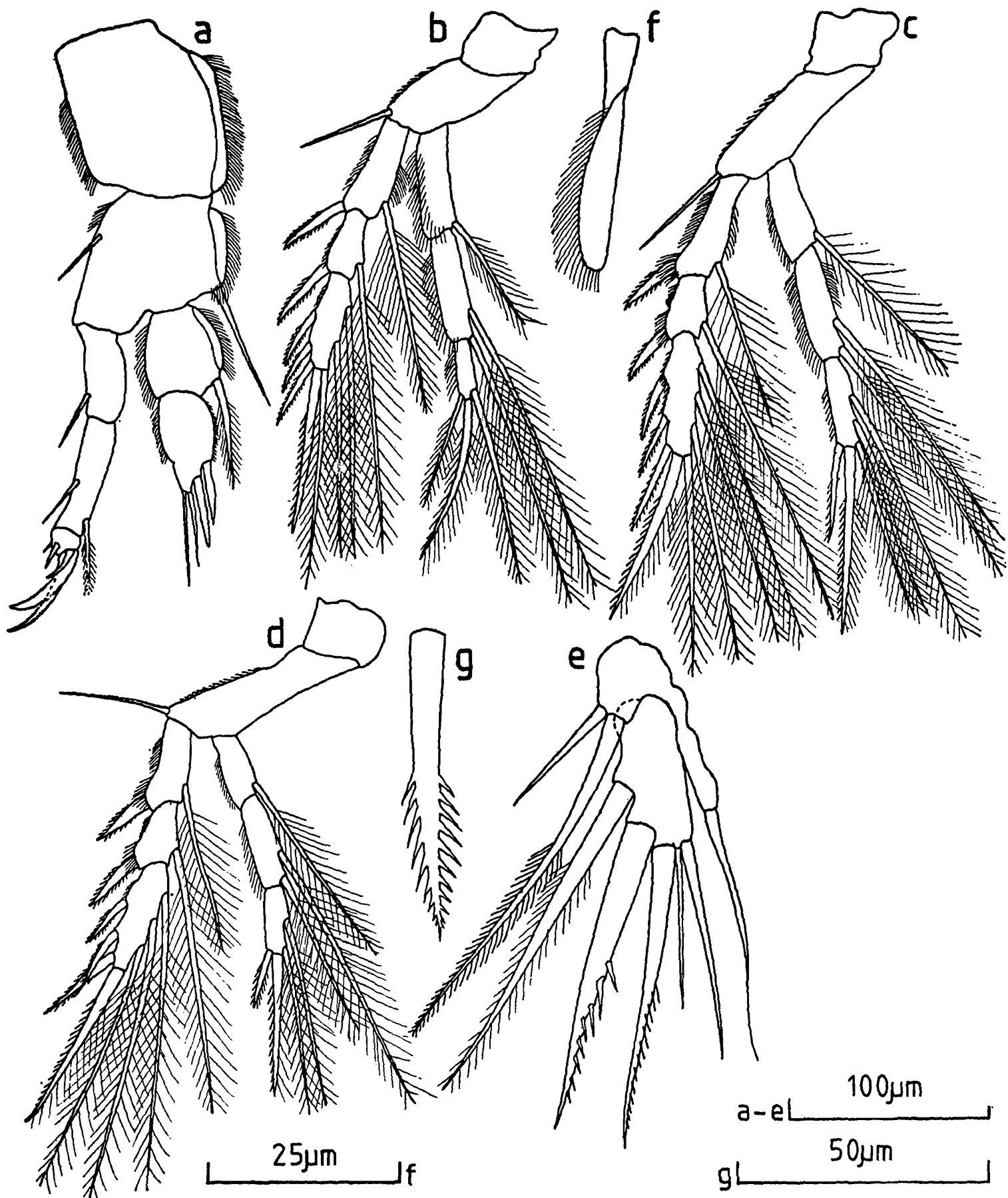


Fig. 39. *Peltidium angulatum* ♀ a-e, P.1-P.5. f, P.1 Enp.2, inner seta. g, second inner seta of P.5 exopod in another orientation.

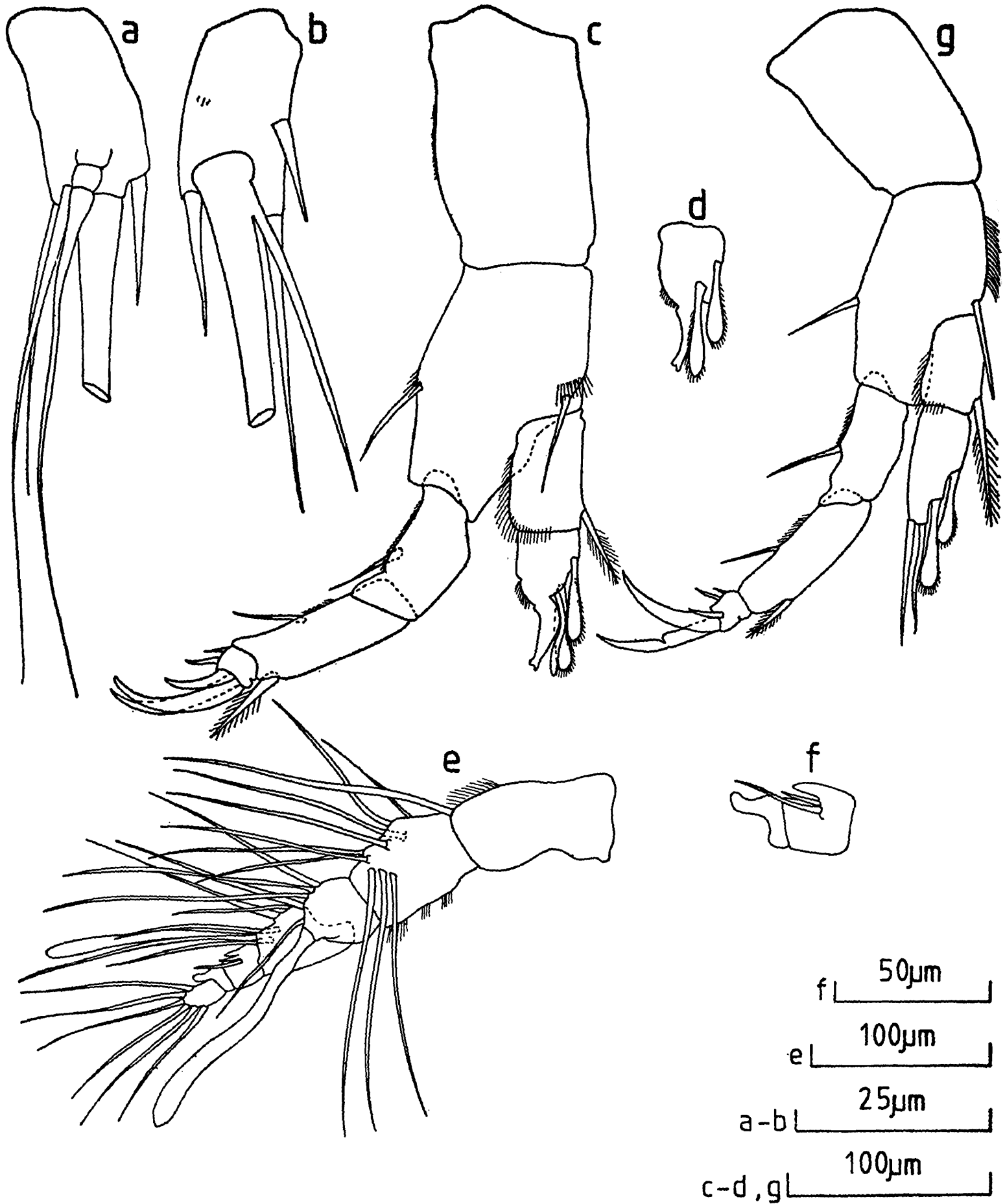


Fig. 40. a-b *Peltidium angulatum* ♀, left caudal ramus, dorsal and ventral. c-d, *Peltidium* sp. A. c, P.1. d, P.1 Enp.2, posterior. e-g, *Peltidium* sp. B ♂ e, antennule. f, antennule, segs, 5-6. g, P.1.



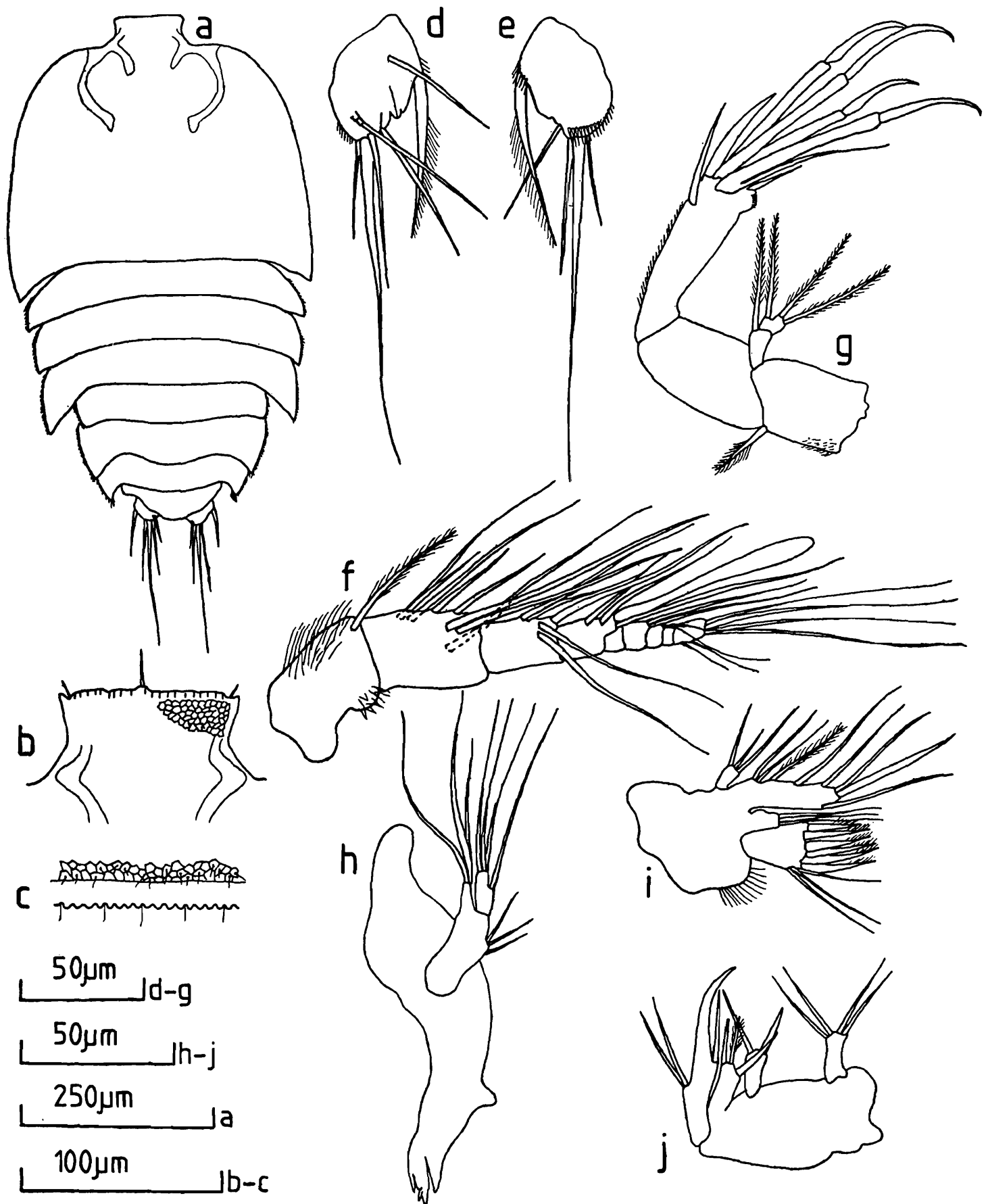


Fig. 41. *Eupelte aurulenta* ♀ a, dorsal. b, rostrum. c, posterior edge of cephalothorax. d-e, right caudal ramus, dorsal and ventral. f, antennule. g, antenna. h, mandible. i, maxillule. j, maxilla.

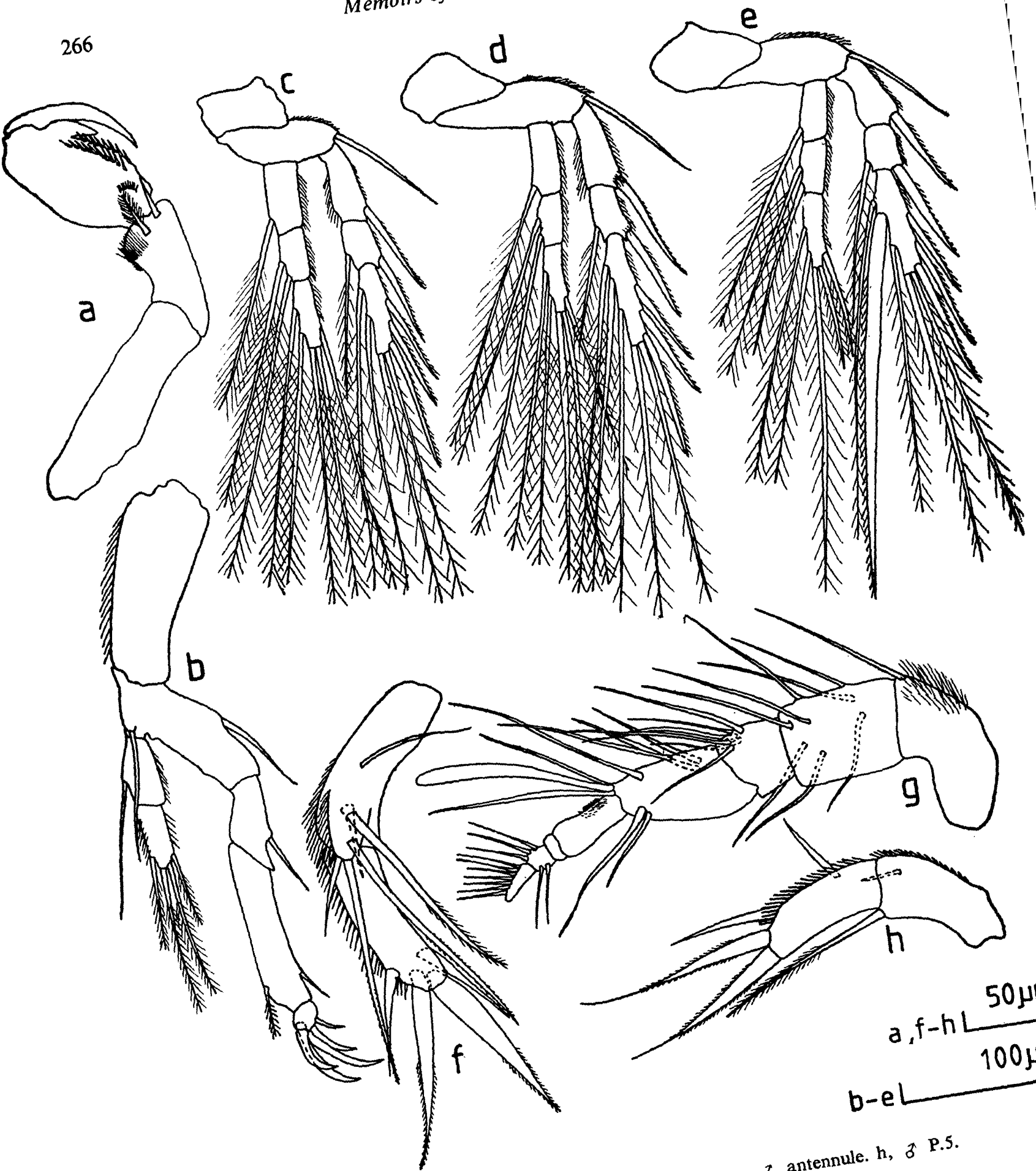


Fig. 42. *Eupelte aurulenta*. a, ♀ maxilliped. b-f, ♀ P.1-P.5. g, ♂ antennule. h, ♂ P.5.

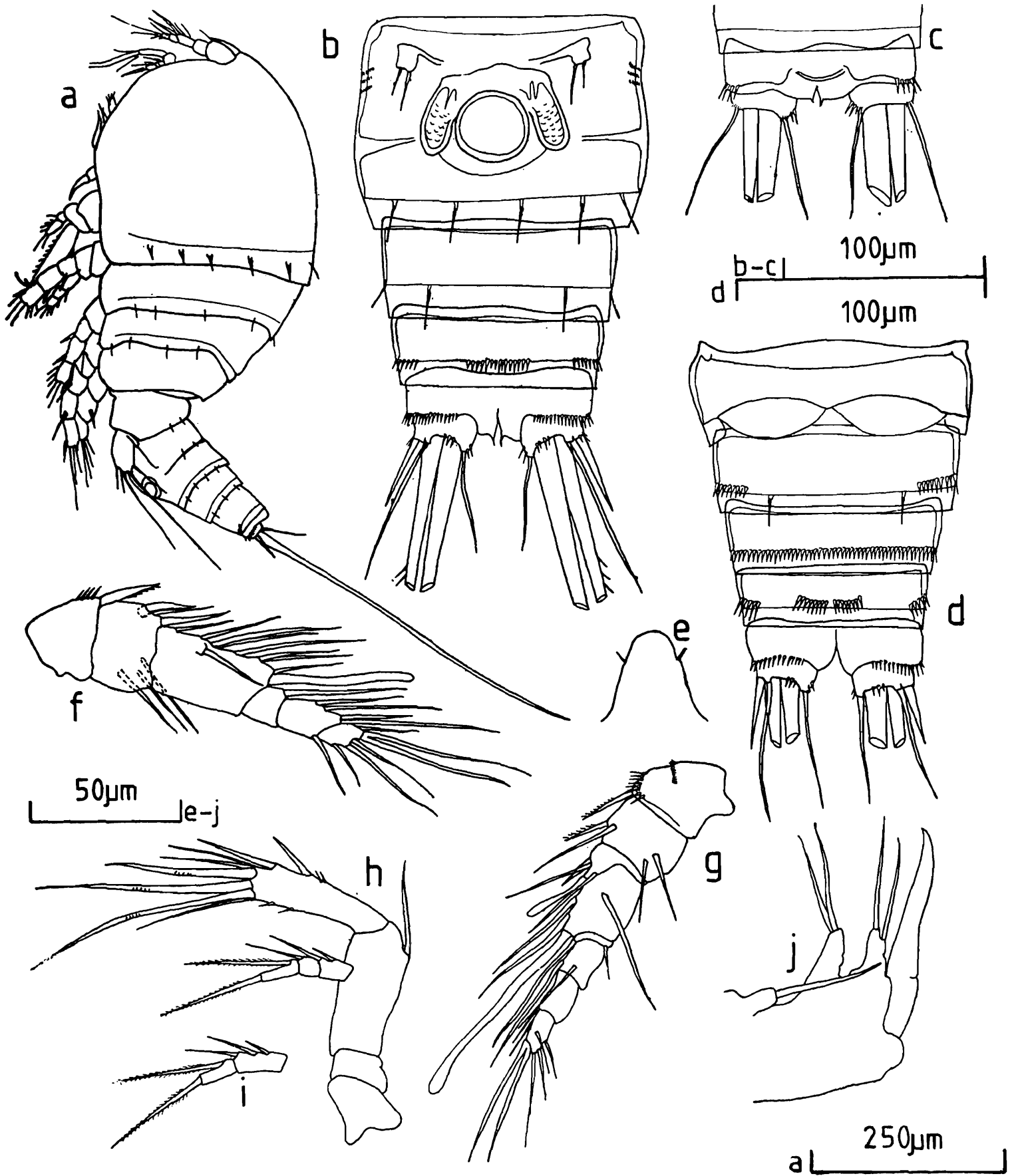


Fig. 43. *Diarthrodes cystoecus*. a, ♀ lateral. b, ♀ abdomen, ventral. c, ♀ posterior abdomen, dorsal. d, ♂ abdomen, ventral. e, ♀ rostrum. f-g, antennule ♀ and ♂ h, type A ♀ antenna. i, type C ♀ antenna exopod. j, ♀ maxilla.

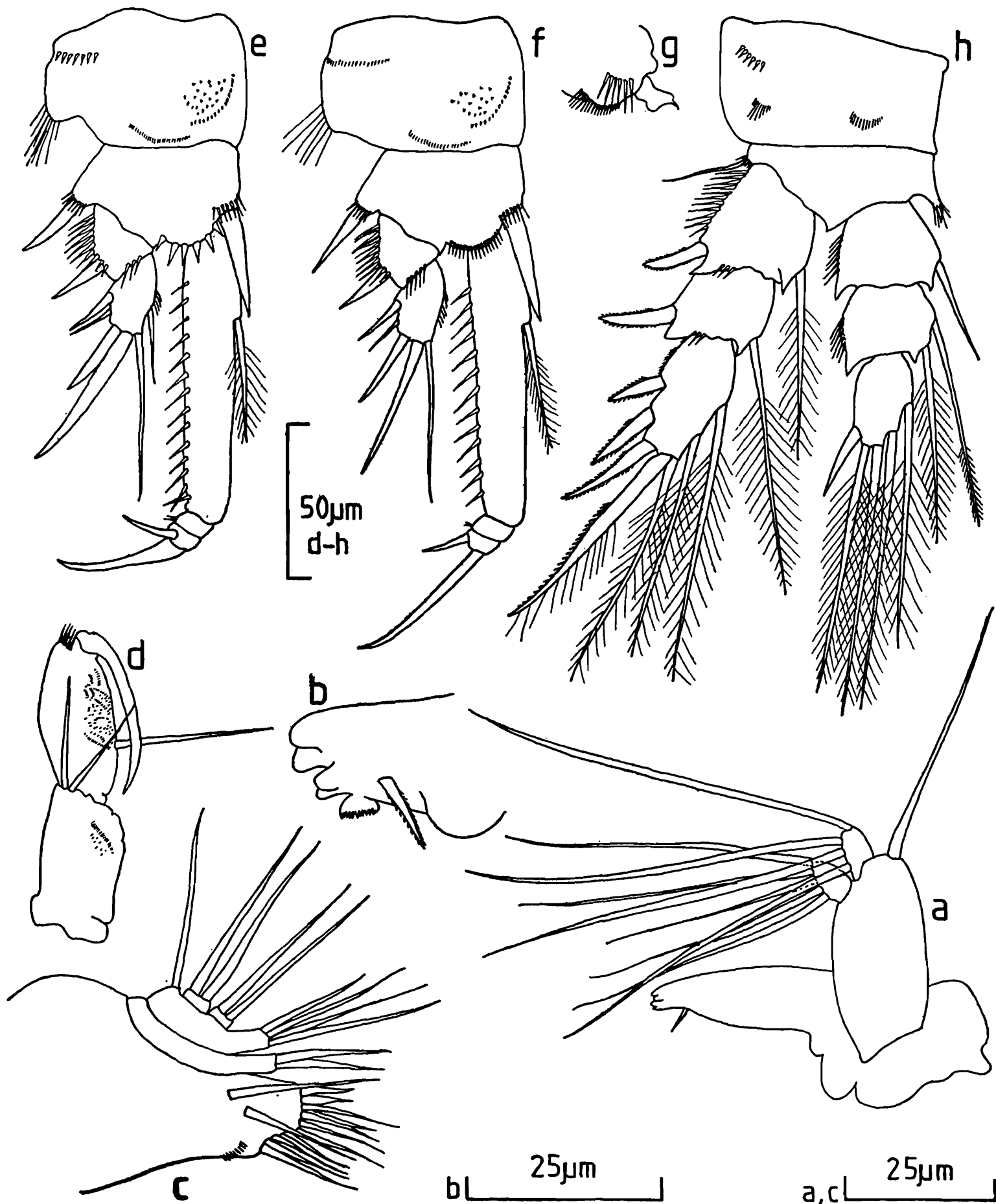


Fig. 44. *Diarthrodes cystoecus*. a, ♀ mandible. b, ♀ mandible cutting edge. c, ♀ maxillule. d, ♀ maxilliped. e-f, ♀ P.1, type A and type D. g, ♂ P.1 basis, inner spine. h, ♀ type C P.2.

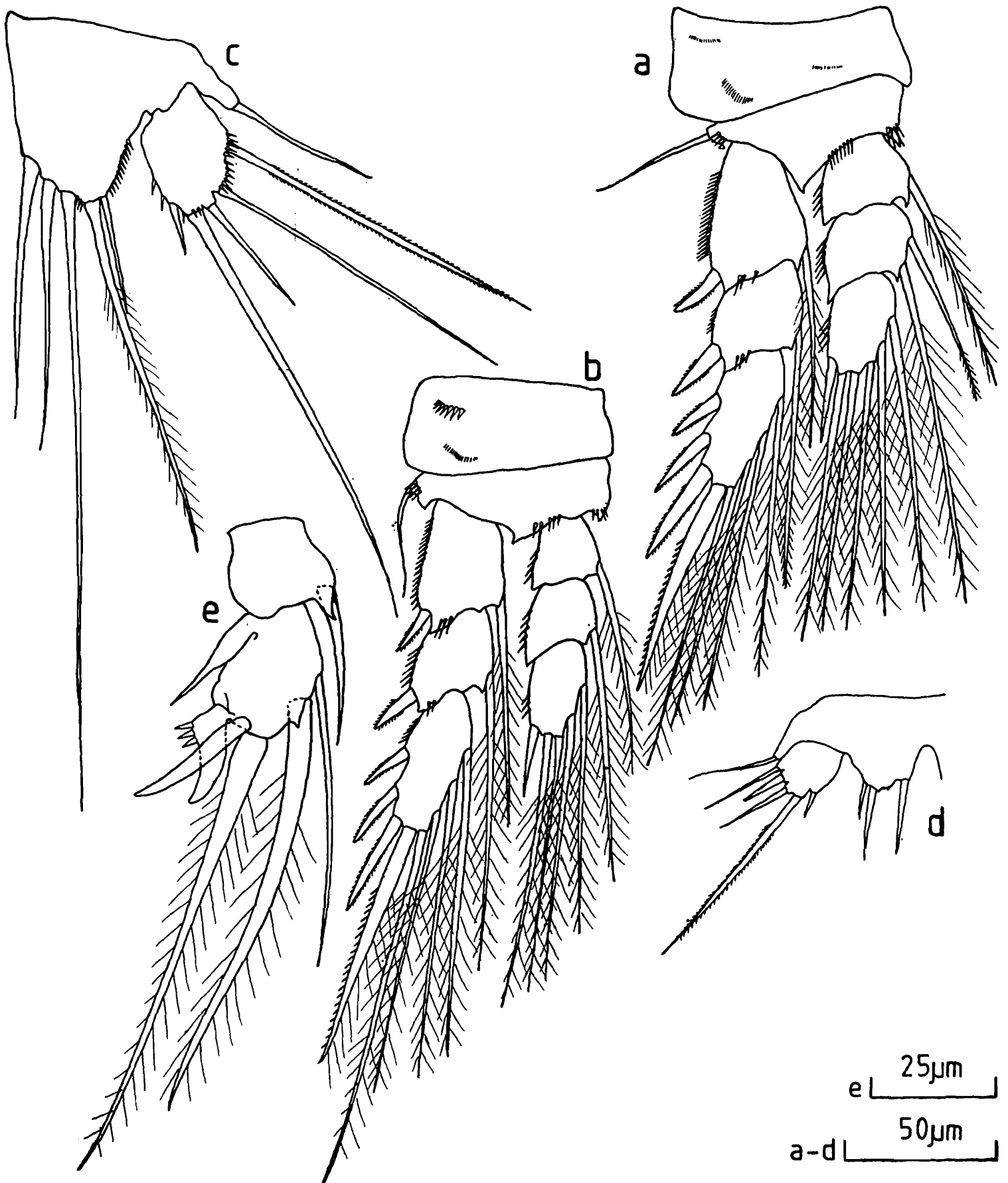


Fig. 45. *Diarthrodes cystoecus*. a, ♀ type B P.3. b, ♀ P.4. c-d, P.5 ♀ and ♂ ♀ e, ♂ P.2 endopod.

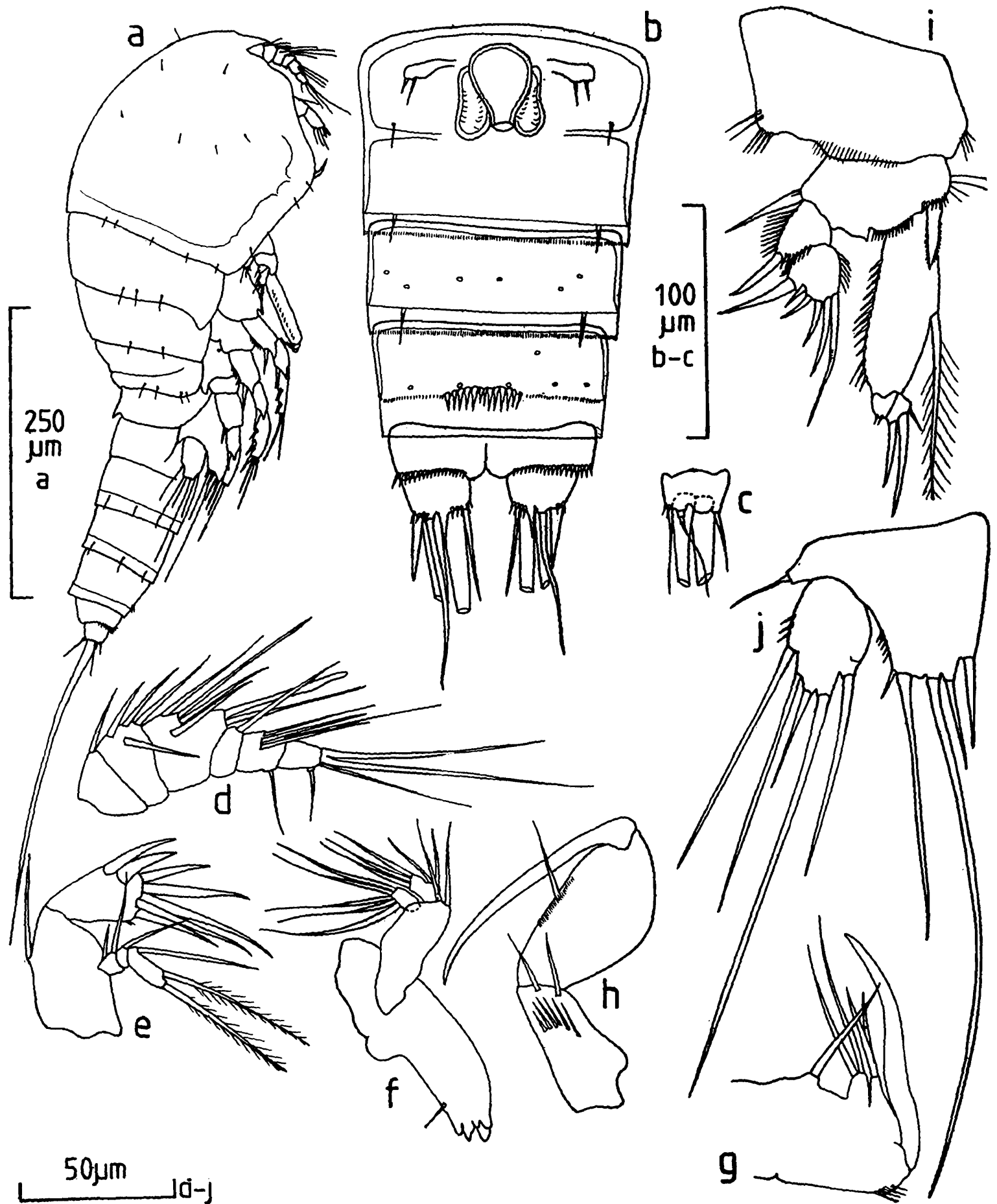


Fig. 46. *Diarthrodes brevipes* ♀ a, lateral. b, abdomen, ventral. c, right caudal ramus, dorsal, d, antenna. e, antenna. f, mandible. g, maxilla. h, maxilliped. i, P.1. j, P.5.

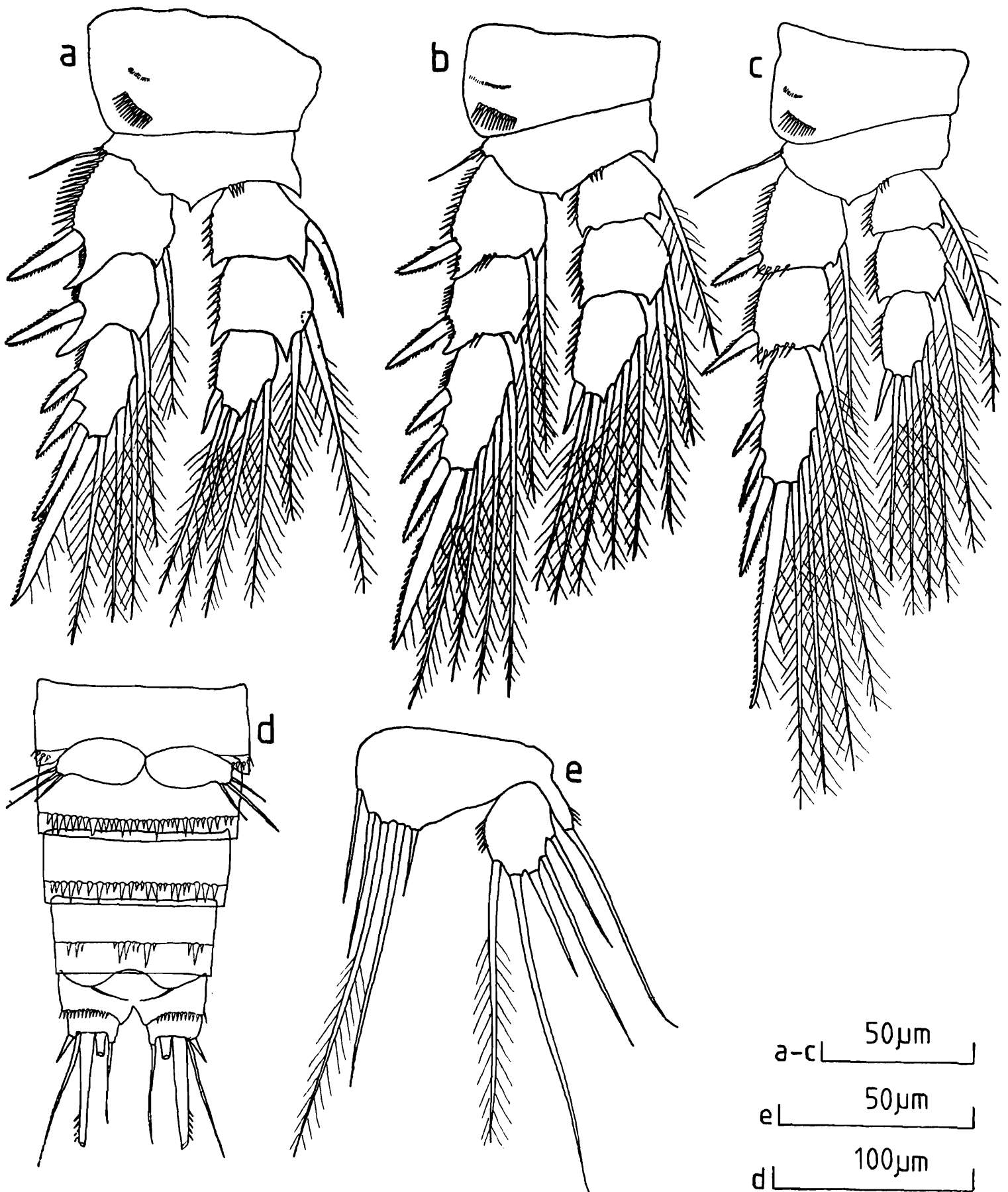


Fig. 47. a-c, *Diarthrodes brevipes* ♀, P.2-P.4. d, *Dactylopodia tisdoides* ♂, abdomen, ventral. e, *Paradactylopodia brevicornis* ♀ P.5.

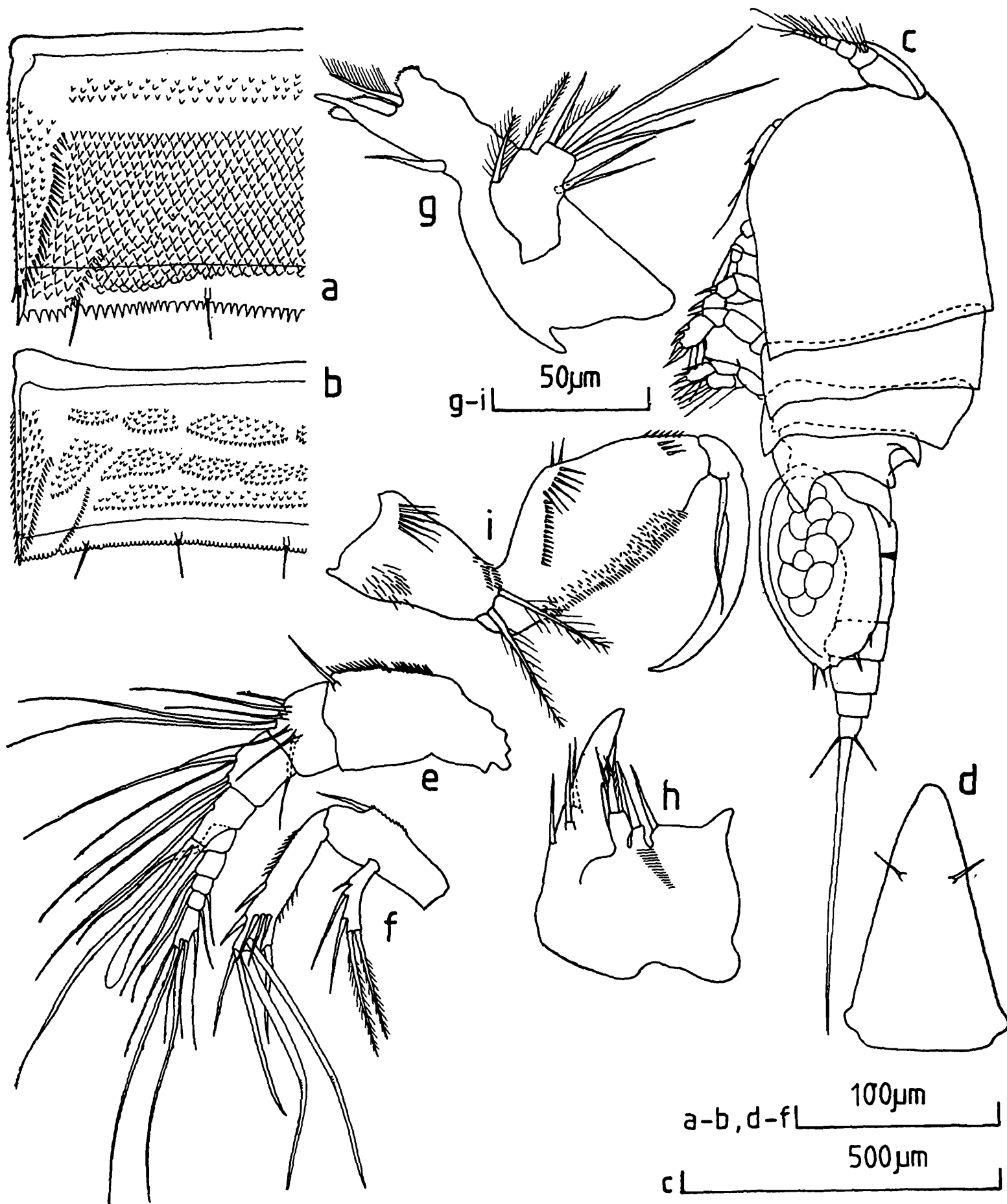


Fig. 48. a-b, dorsal ornamentation of third abdominal seg. of (a) *Eudactylopus robustus* ♀ and (b) *E. andrewi* ♀ c-i, *Neodactylopus trichodes* ♀ c, lateral. d, rostrum. e, antennule. f, antenna. g, mandible. h, maxilla. i, maxilliped.



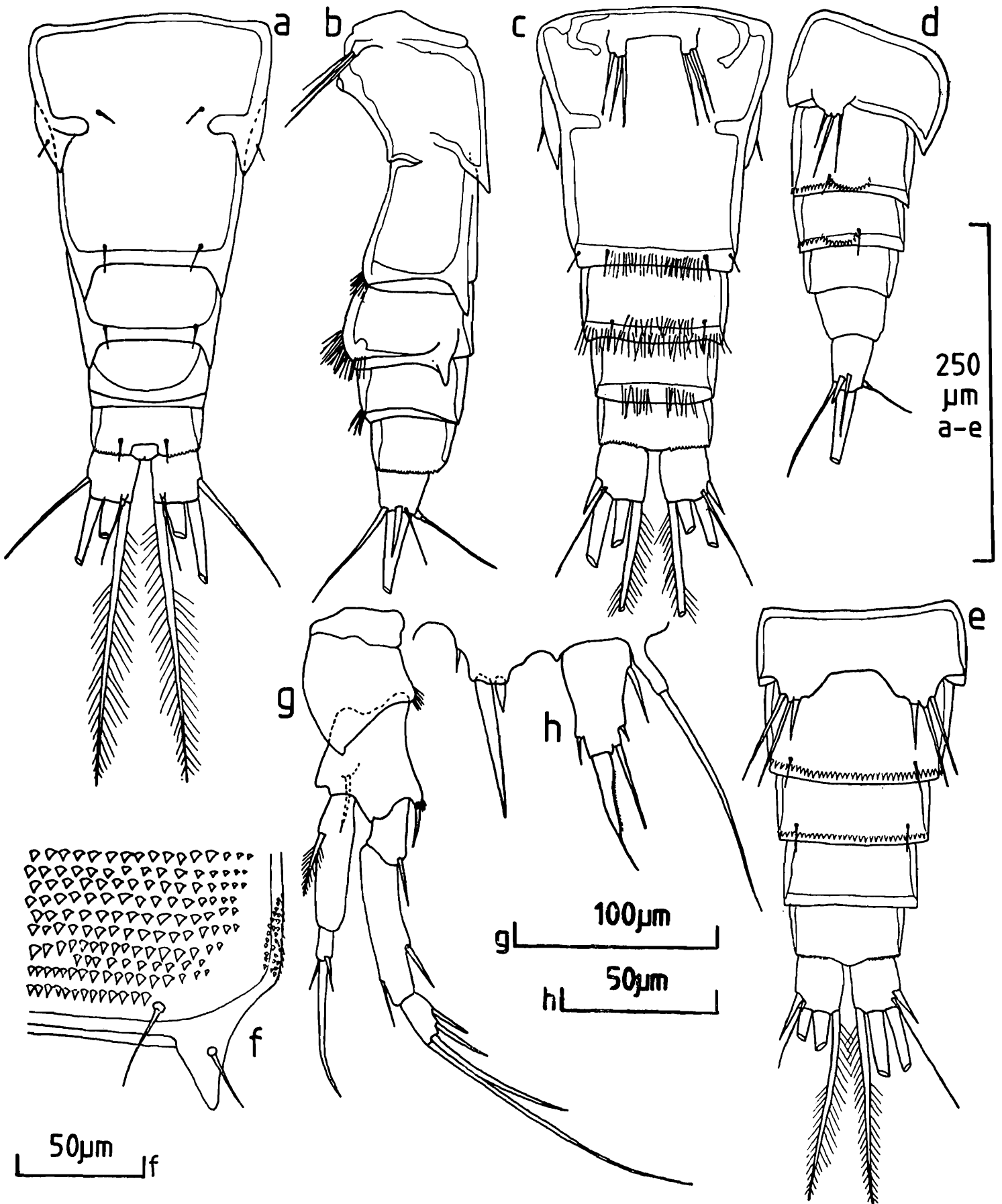


Fig. 49. *Neodactylopus trichodes*. a-c, ♀ abdomen, dorsal, lateral and ventral. d-e, ♂ abdomen, lateral and ventral. f, ♀ ornamentation of distal dorsal corner of second abdominal seg. g, ♀ P.1. h, ♂ P.5.

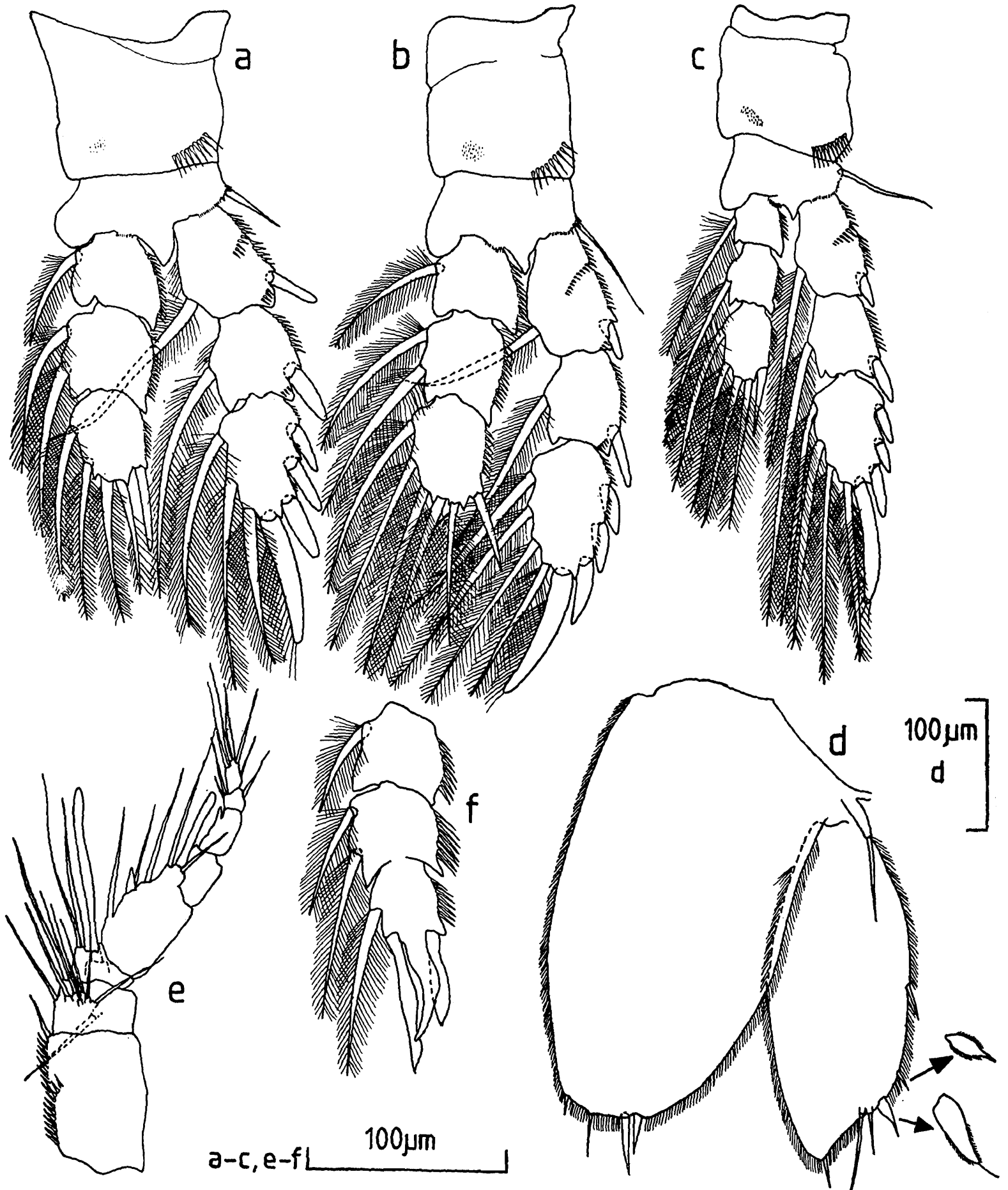


Fig. 50. *Neodactylopus trichodes*. a-d, ♀ P.2-P.5. e, ♂ antennule. f, ♂ P.2 Enp.

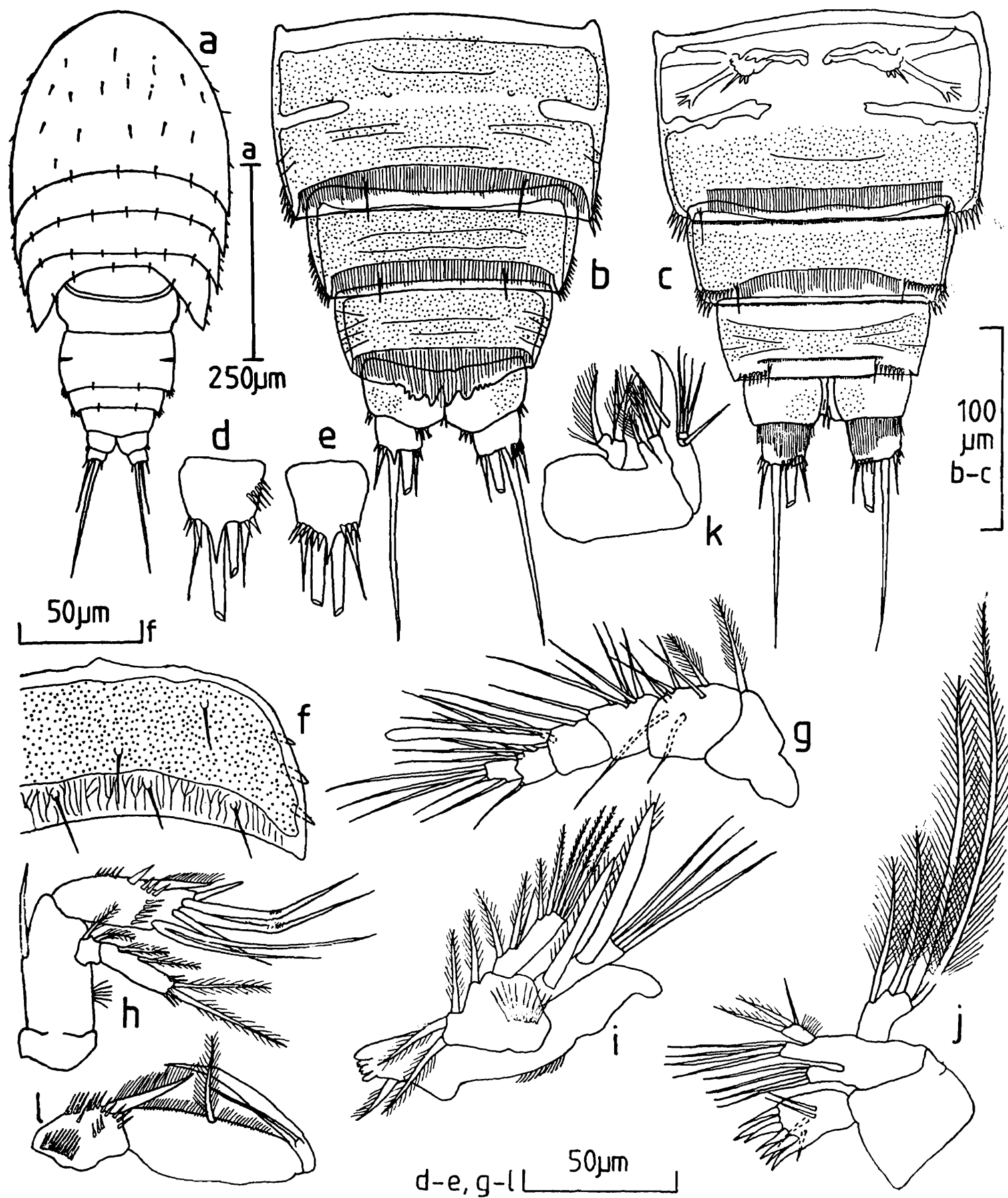


Fig. 51. *Idomene maldivae* ♀ a, dorsal. b-c, abdomen, dorsal and ventral. d-e, right caudal ramus, dorsal and ventral. f, pleurotergite of second free thoracic segment. g, antennule. h, antenna. i, mandible. j, maxillule. k, maxilla. l, maxilliped.

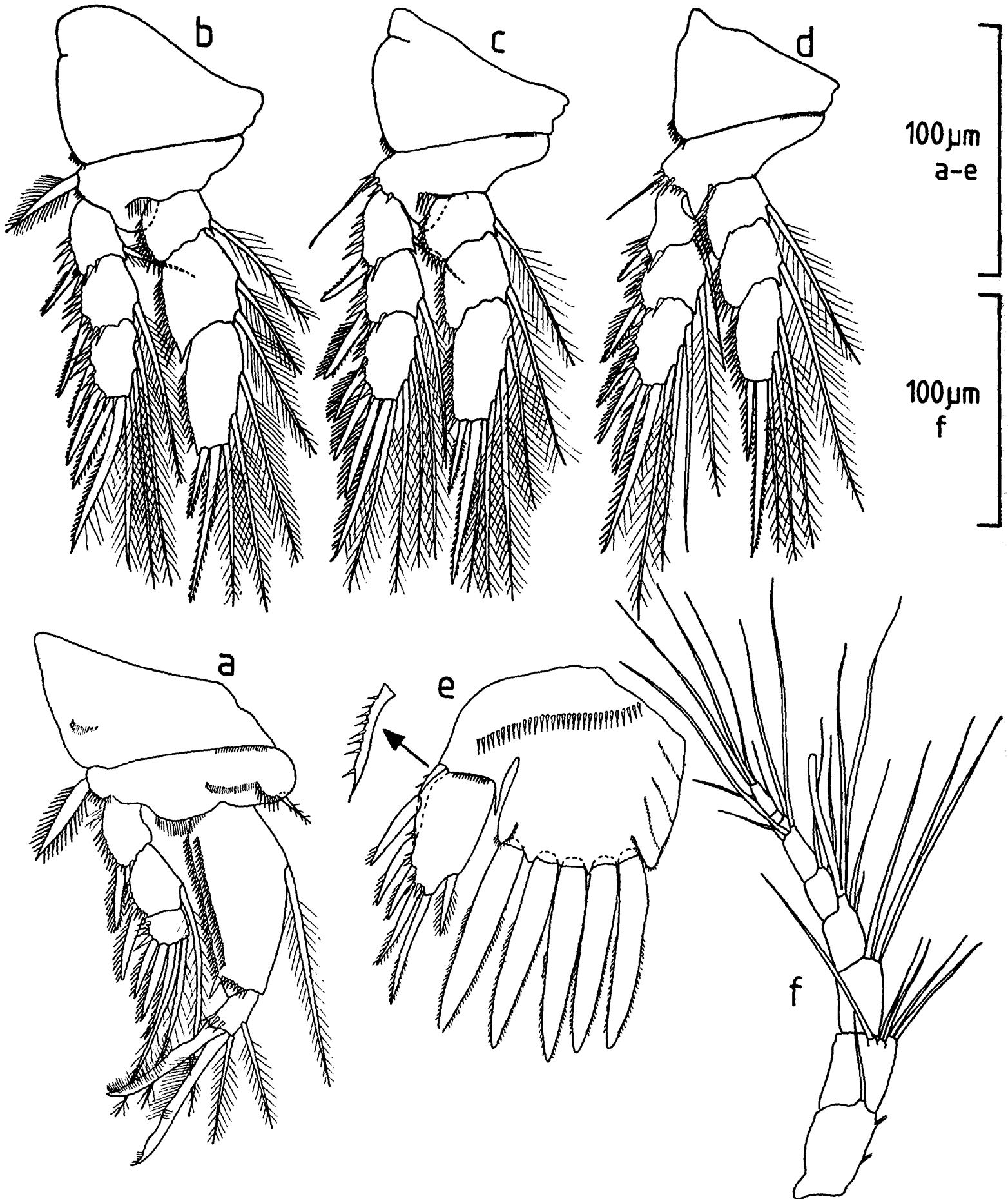


Fig. 52. a-e, *Idomene maldivae* ♀, P.1-P.5. f, *Parastenhelia hornelli* ♀, antennule.

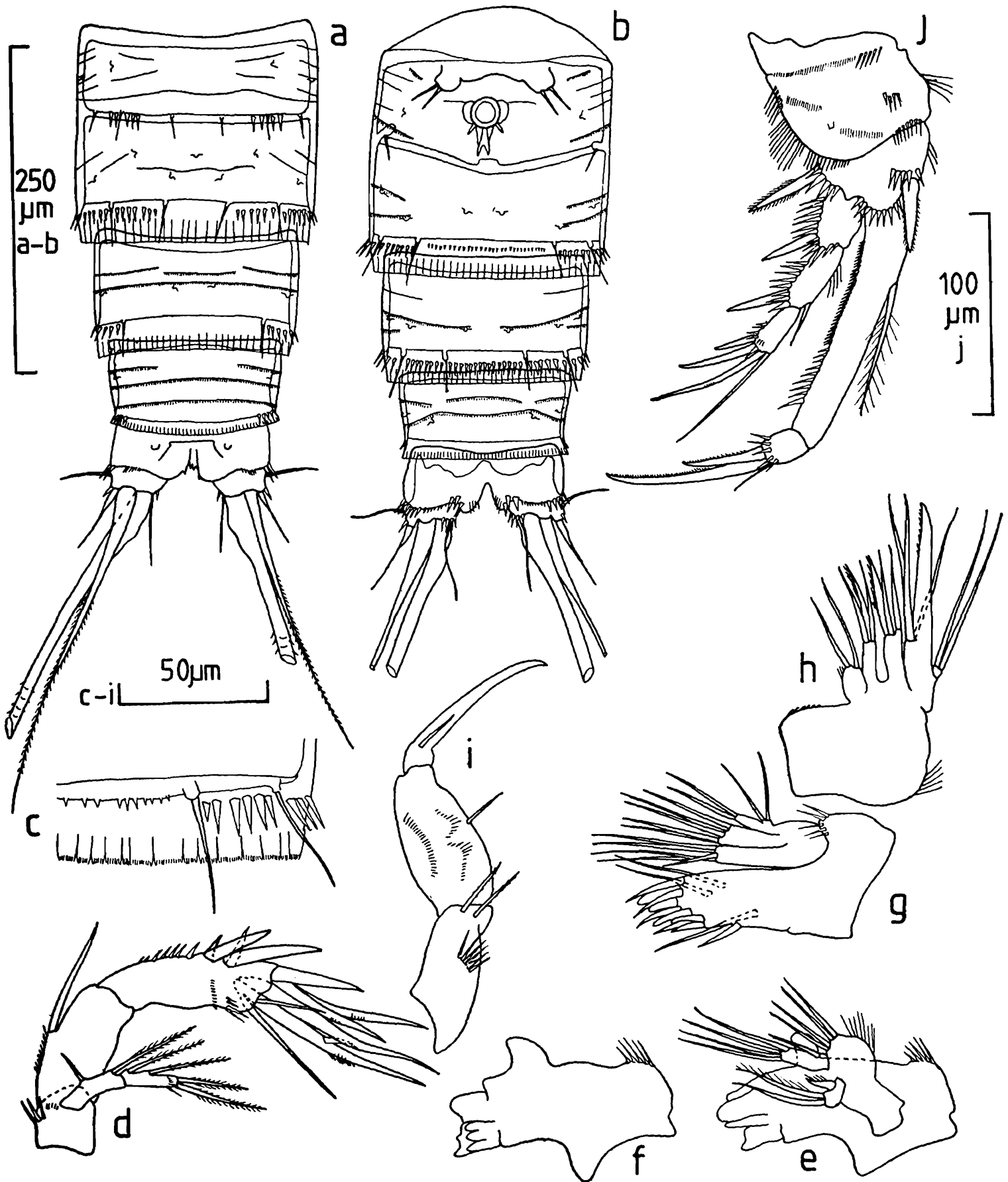


Fig. 53. *Parastenhelia hornelli* ♀ a-b, abdomen, dorsal and ventral. c, ventral distal corner of genital somite. d, antenna. e, mandible. f, mandible pre-coxa in another orientation. g, maxillule. h, maxilla. i, maxilliped. j, P.1.

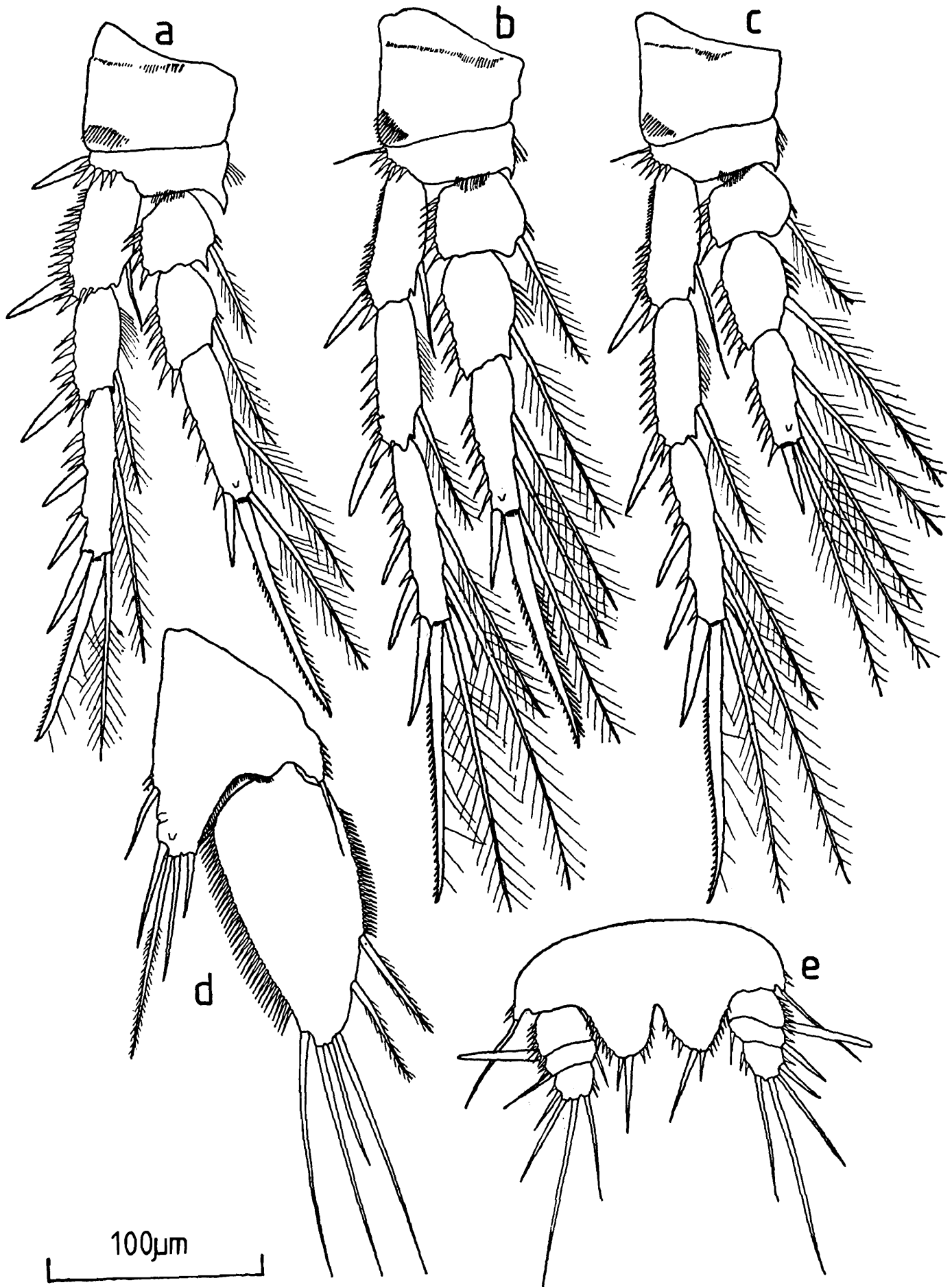


Fig. 54. *Parastenelia hornelli*. a-d, ♀ P.2-P.5. e, ♂ pair of P.5.

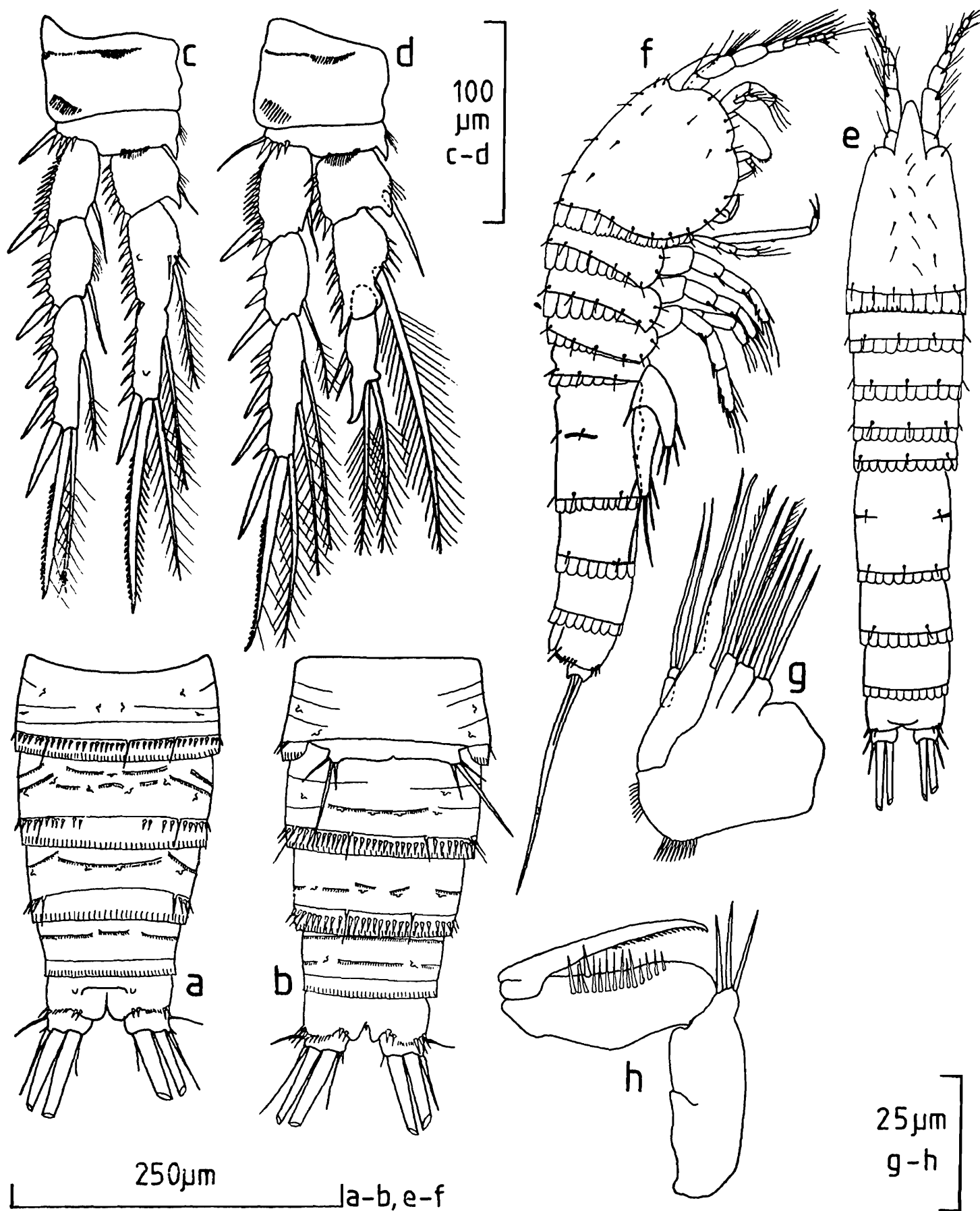


Fig. 55. a-d, *Parastenhelia hornelli* ♂ a-b, abdomen, dorsal and ventral. c-d, P.2-P.3. e-h, *P. oligochaeta* ♀ e-f, dorsal and lateral. g, maxilla. h, maxilliped.

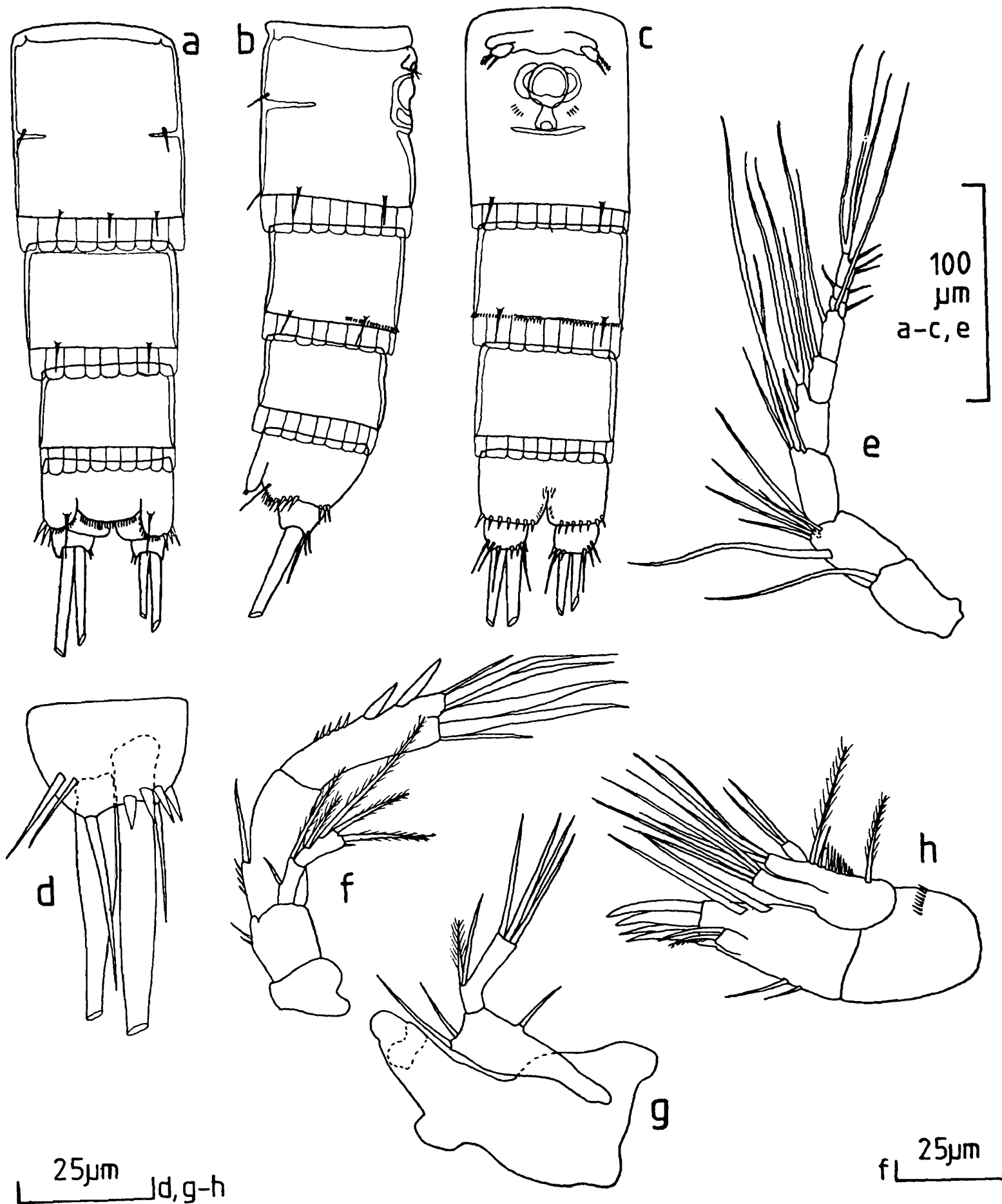


Fig. 56. *Parastenhelia oligochaeta* ♀ a-c, abdomen, dorsal, lateral and ventral. d, right caudal ramus, ventral. e, antennule. f, antenna. g, mandible. h, maxillule.



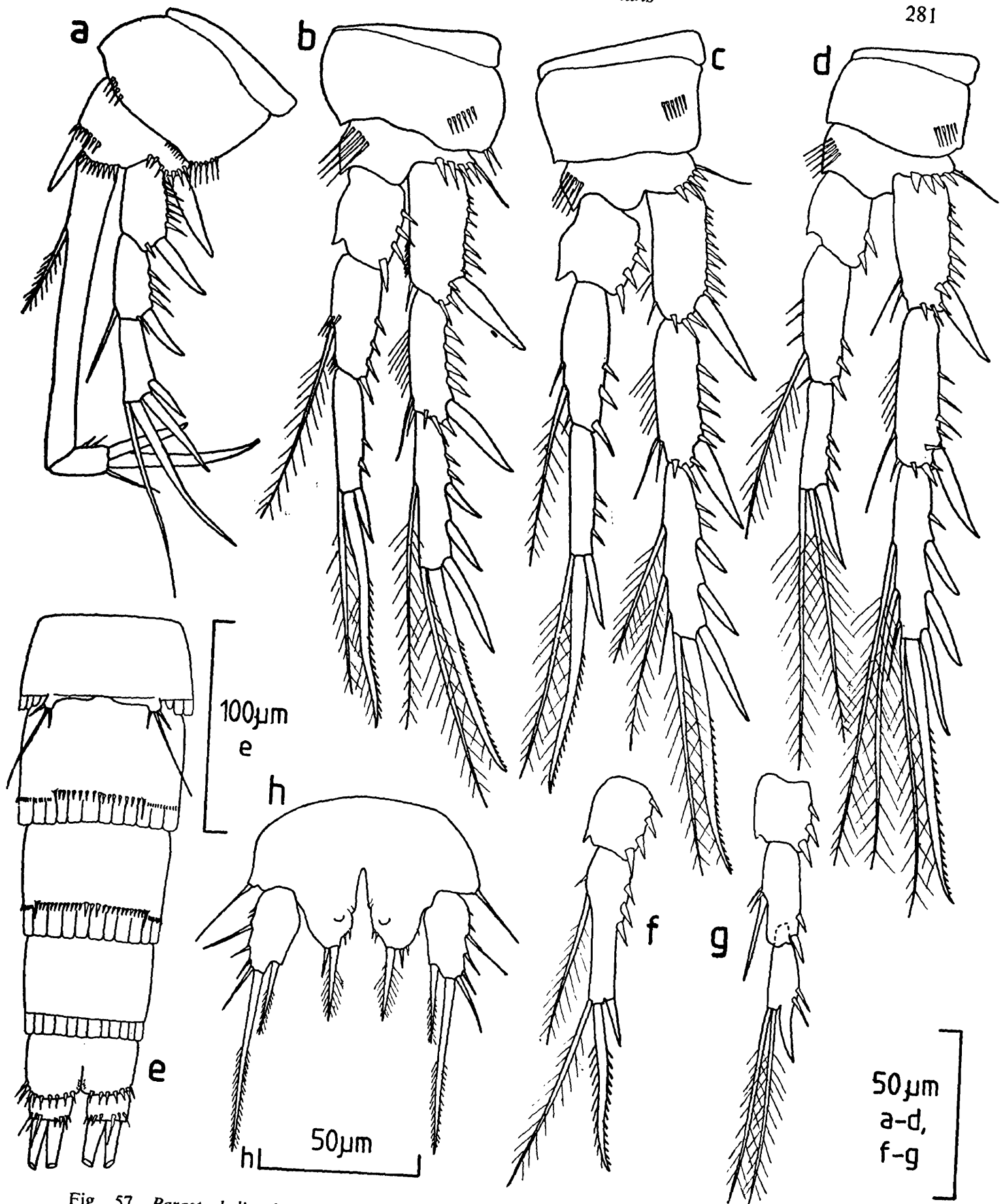


Fig. 57. *Parastenhelia oligochaeta*. a-d, ♀ P.1-P.4. e, ♂ abdomen, ventral. f-g, ♂ P.2-P.3 Enp. h, ♂ pair of P.5.

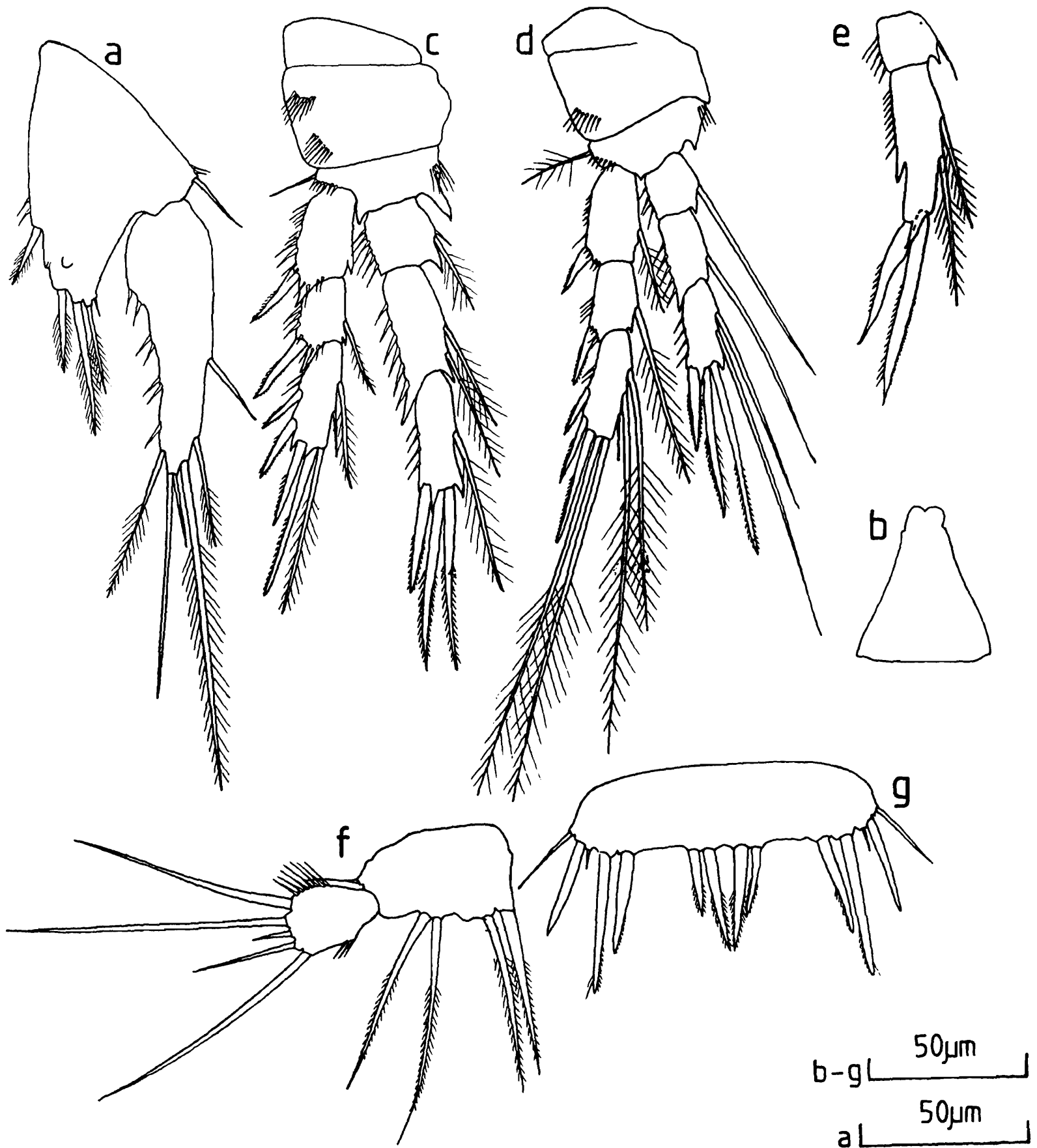


Fig. 58. a, *Parastenheia oligochaeta* ♀, P.5. b-g, *Stenhelia (Delavalia) polluta*. b, ♀ rostrum. c, ♀ P.2. d, ♀ P.4. e, ♂ P.2 Enp. f-g, P.5 ♀ and ♂

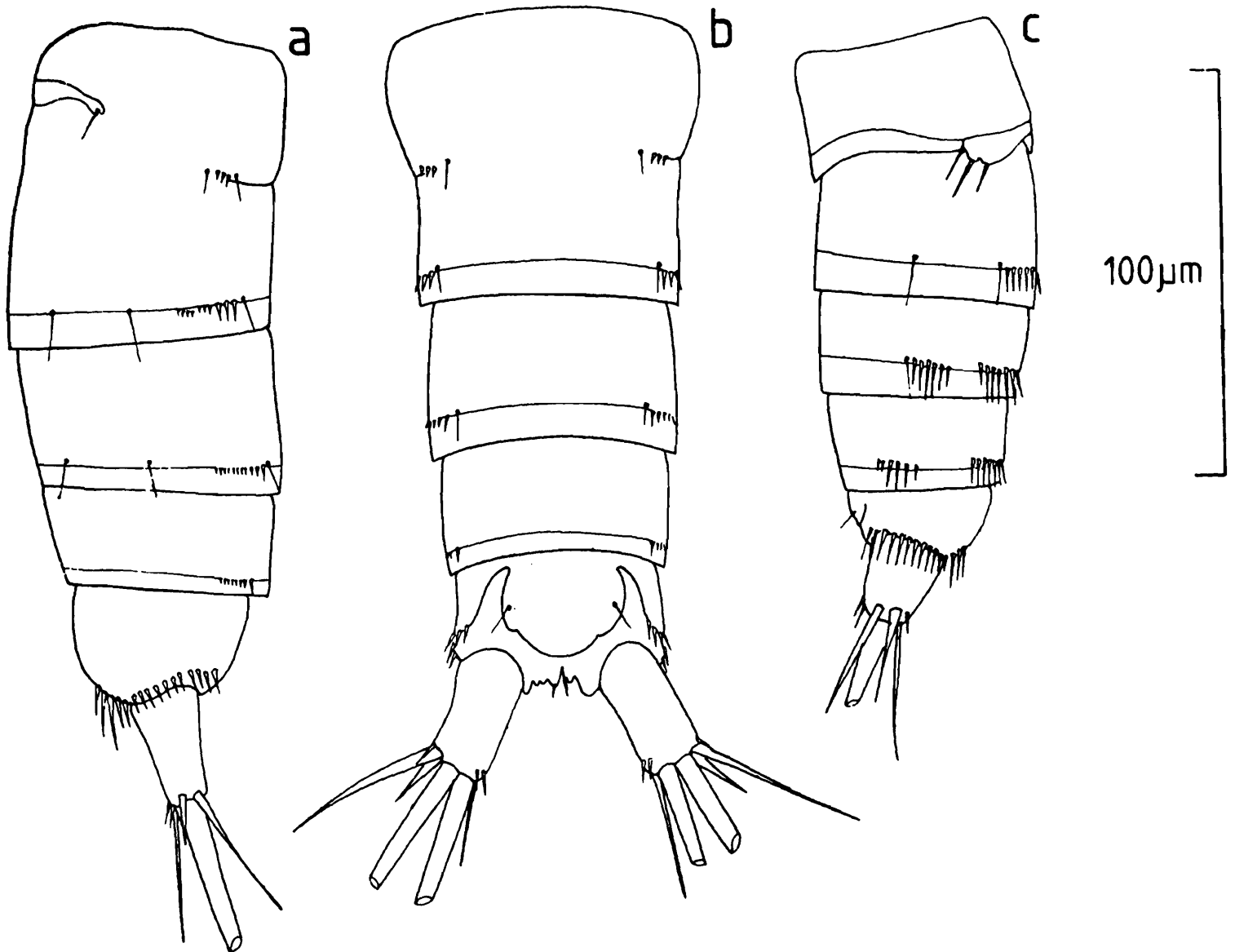


Fig. 59. *Stenhelia (Delavalia) polluta*. a-b, ♀ abdomen, lateral and dorsal. c, ♂ abdomen, lateral.

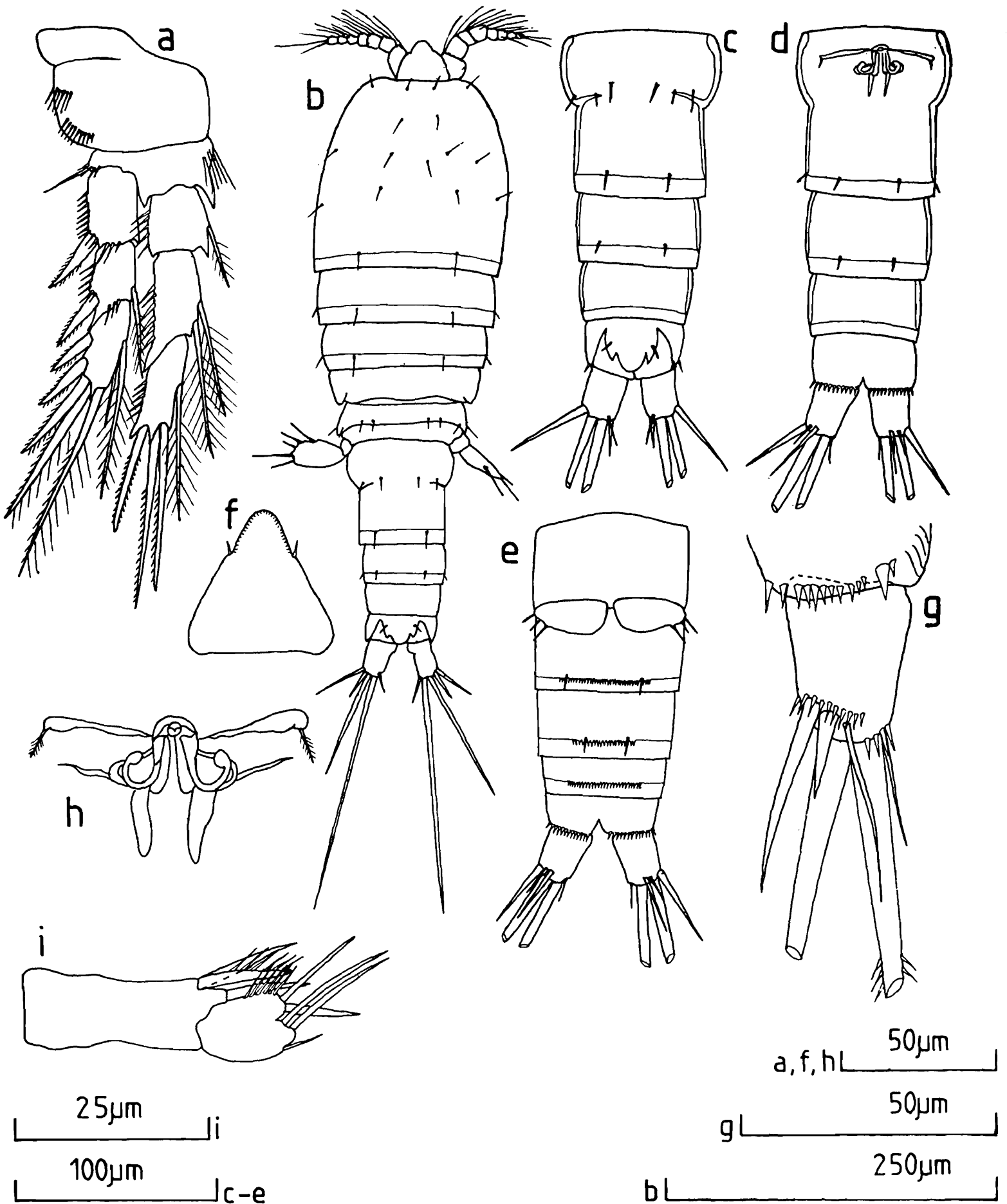


Fig. 60. a, *Stenhelia (Delavalia) oblonga* ♀, P.2. b-i, *Stenhelia (D.) breviseta*. b, ♀, dorsal. c-d, ♀ abdomen, dorsal and ventral. e, ♂ abdomen, ventral. f, ♀ rostrum. g, ♀ right caudal ramus, ventral. h, ♀ genital field. i, ♀ maxilliped.

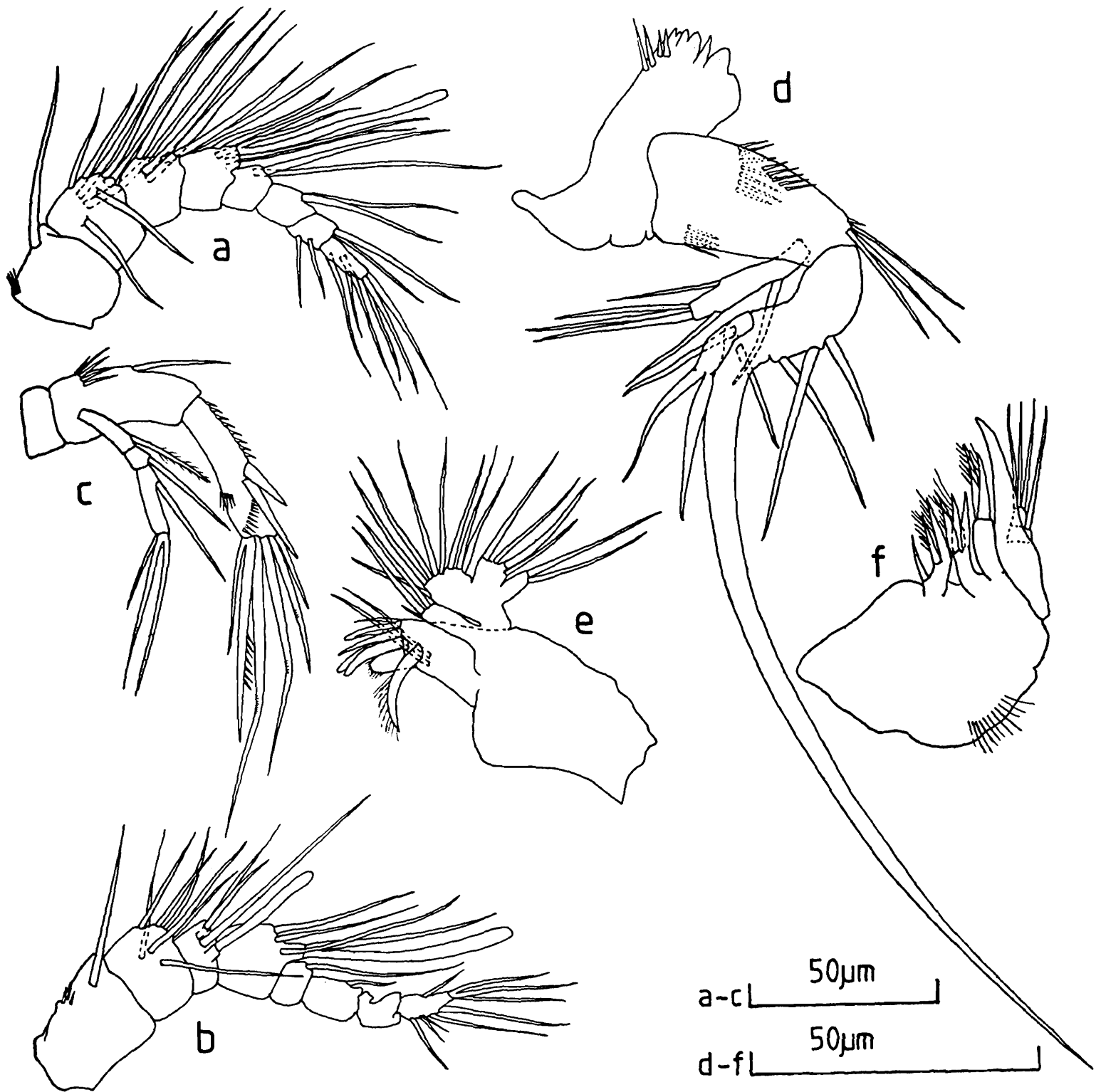


Fig. 61. *Stenhelia (Delavalia) breviseta*. a-b, antennule ♀ and ♂ c, ♀ antenna. d, ♀ mandible. e, ♀ maxillule. f, ♀ maxilla.

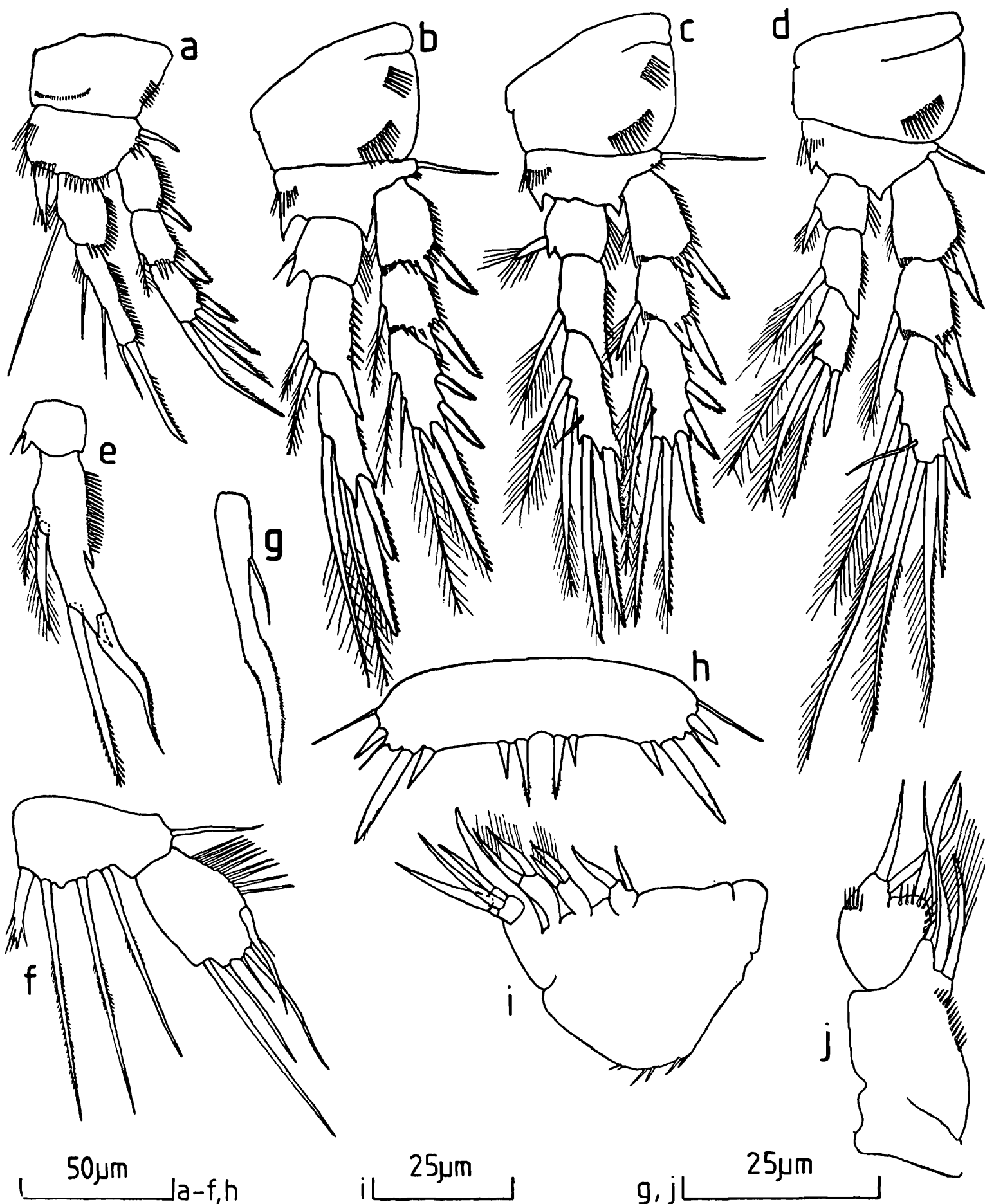


Fig. 62. a-h, *Stenhela (Delavalia) breviseta*. a-d, ♀ P.1-P.4. e, ♂ P.2 Enp. f, ♀ P.5. g, ♀ P.5 Exp., outer seta. h, ♂ pair of P.5. i-j, *Stenhela (D.) mixta* ♀ i, maxilla. j, maxilliped.

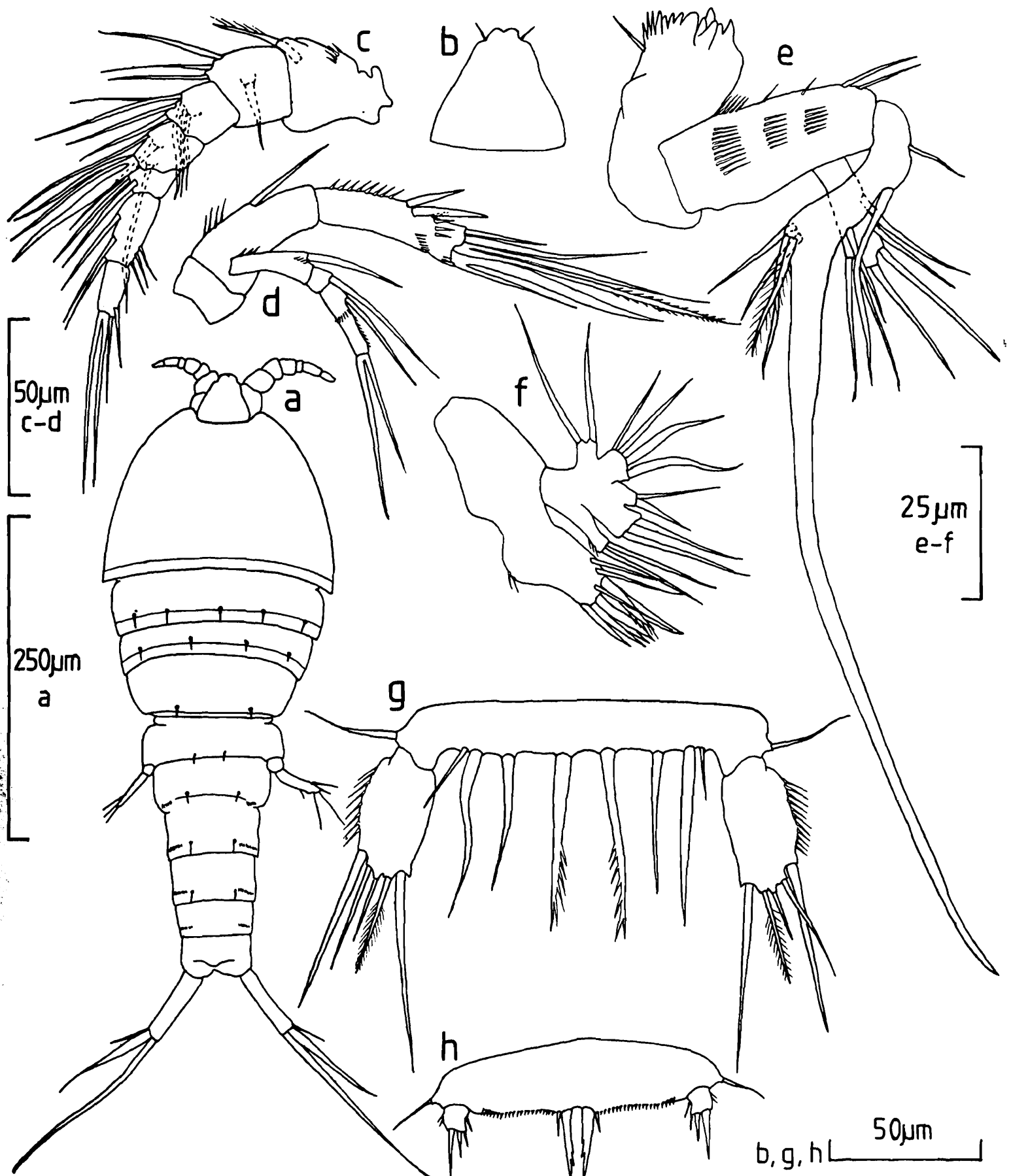


Fig. 63. *Stenhelius (Delavalia) mixta*. a, ♀ dorsal. b, ♀ rostrum. c, ♀ antennule. d, ♀ antenna. e, ♀ mandible. f, ♀ maxillule. g-h, pair of P.5, ♀ and ♂

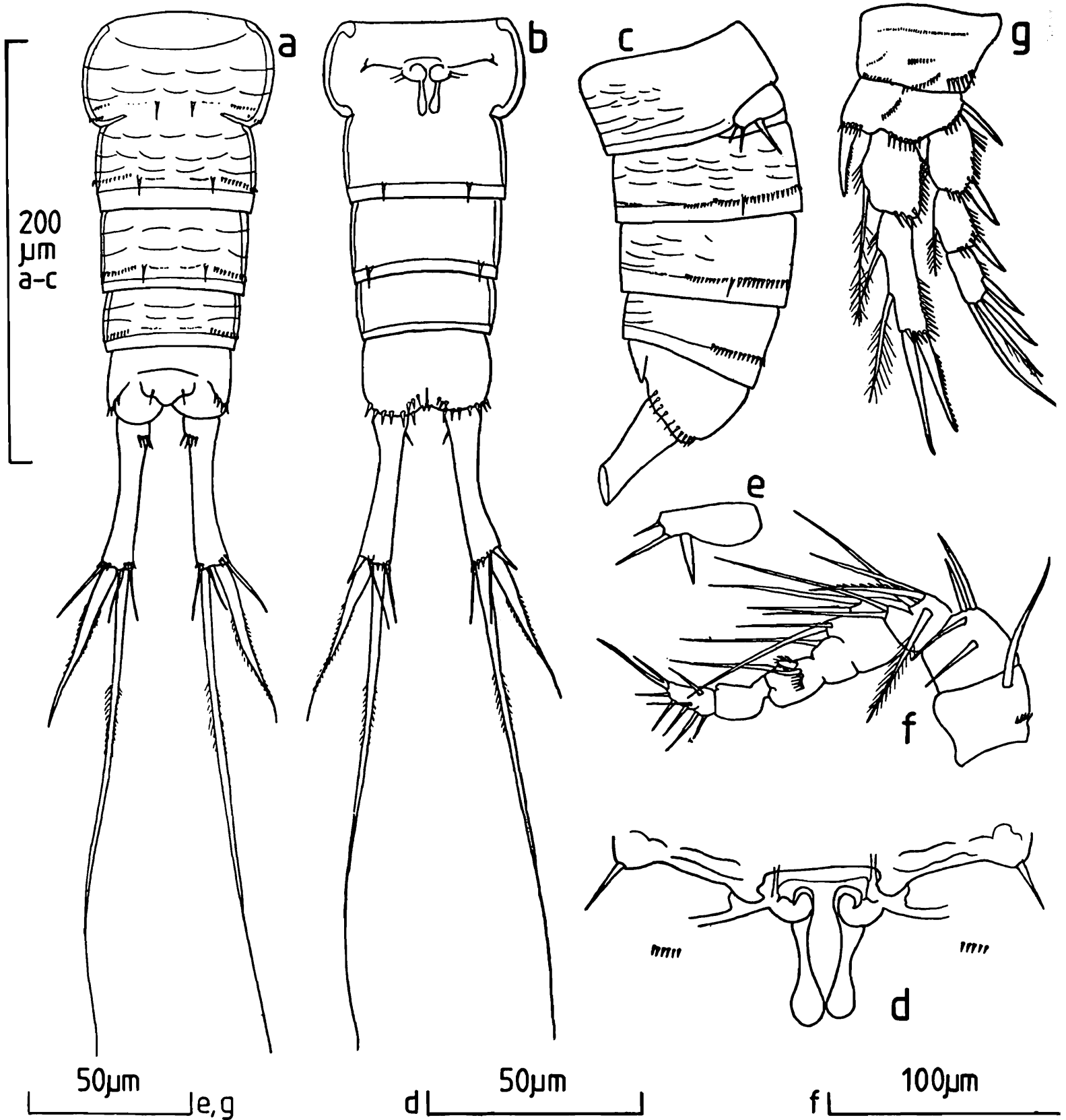


Fig. 64. *Stenhelia (Delavalia) mixta*. a-b, ♀ abdomen, dorsal and ventral. c, ♂ abdomen, lateral. d, ♀ genital field. e, ♂ right P.6. f, ♂ antennule. g, ♀ P.1.



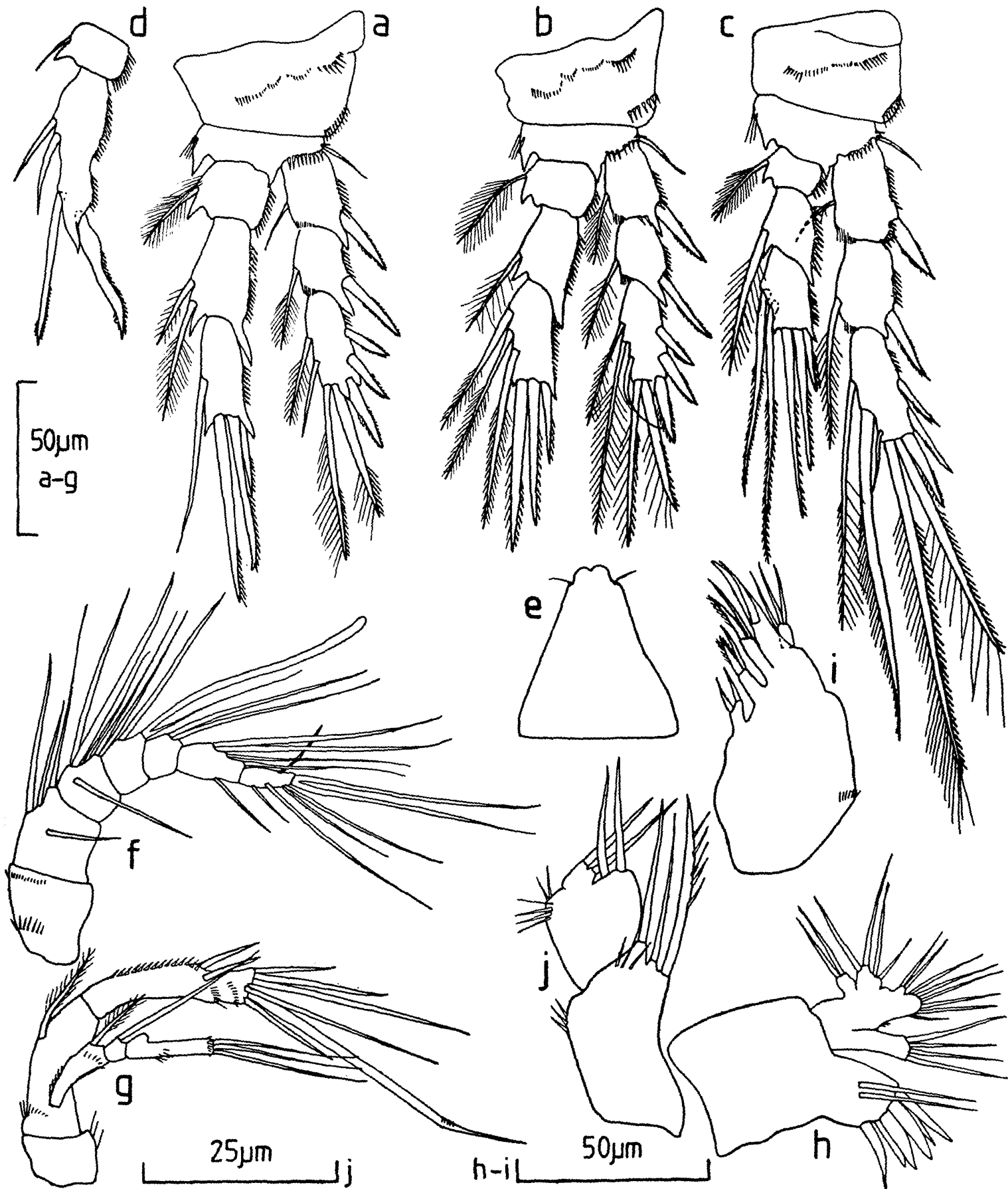


Fig. 65. a-d, *Stenhelia (Delavalia) mixta*. a-c, ♀ P.2-P.4. d, ♂ P.2. Enp. e-j, *Stenhelia (D.) hirtipes* ♀ e, rostrum. f, antennule. g, antenna. h, maxillule. i, maxilla. j, maxilliped.

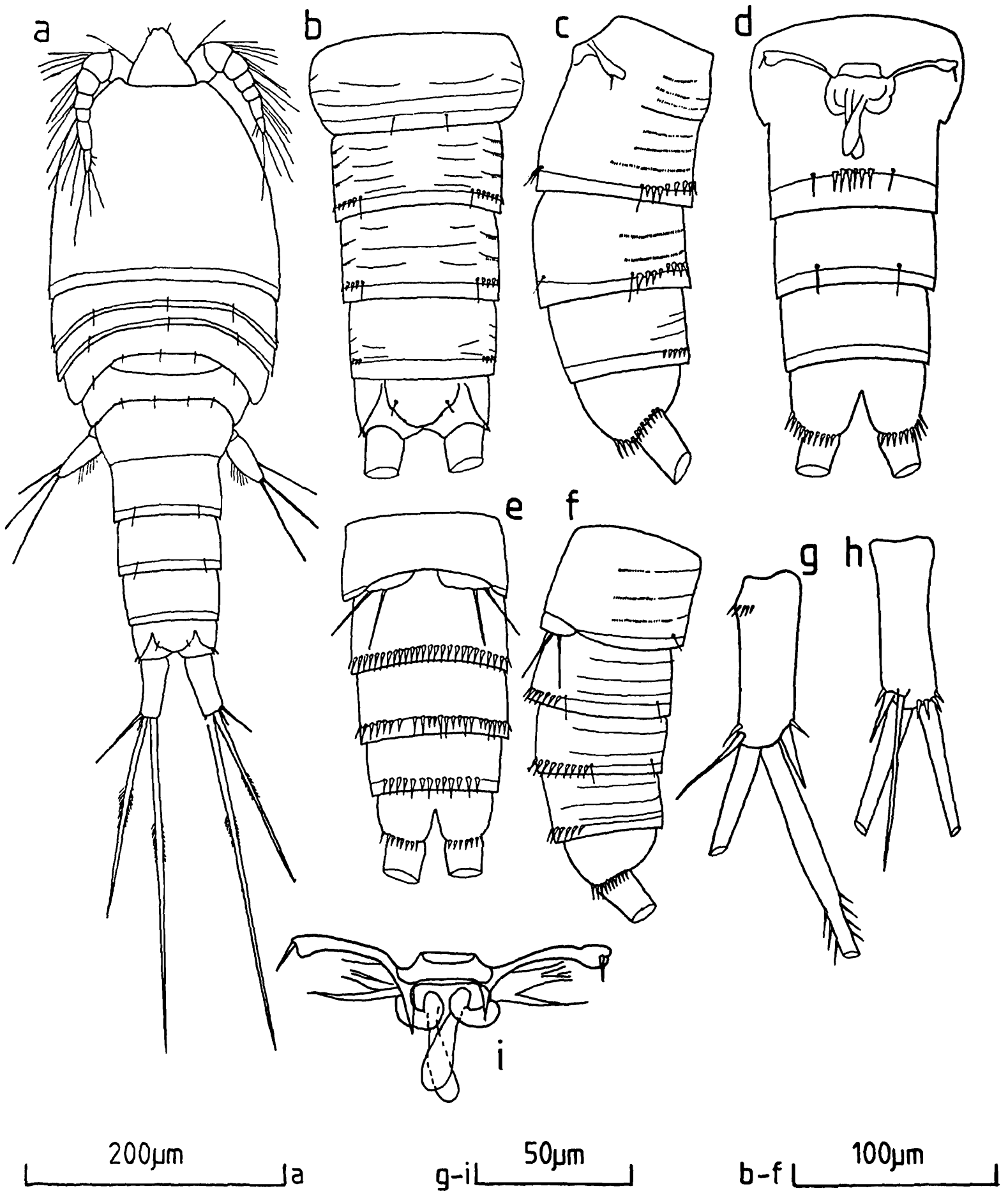


Fig. 66. *Stenhelia (Delavalia) hirtipes*. a, ♀ dorsal. b-d, ♀ abdomen, dorsal, lateral and ventral. e-f, ♂ abdomen, ventral and lateral. g-h, ♀ right caudal ramus, dorsal and ventral. i, ♀ genital field.

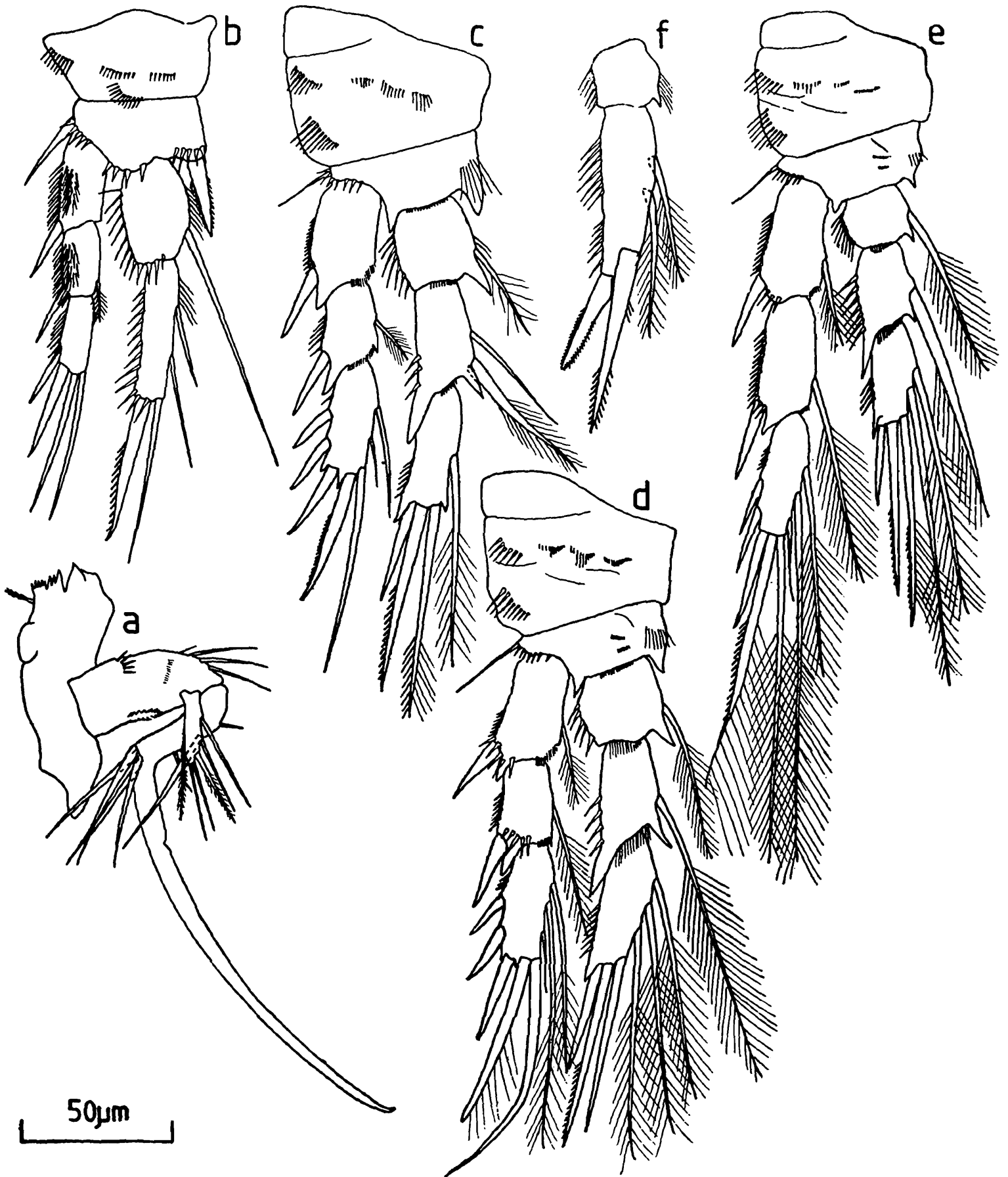


Fig. 67. *Stenhelia (Delavalia) hirtipes*. a, ♀ mandible. b-e, ♀ P.1-P.4. f, ♂ P.2 Enp.

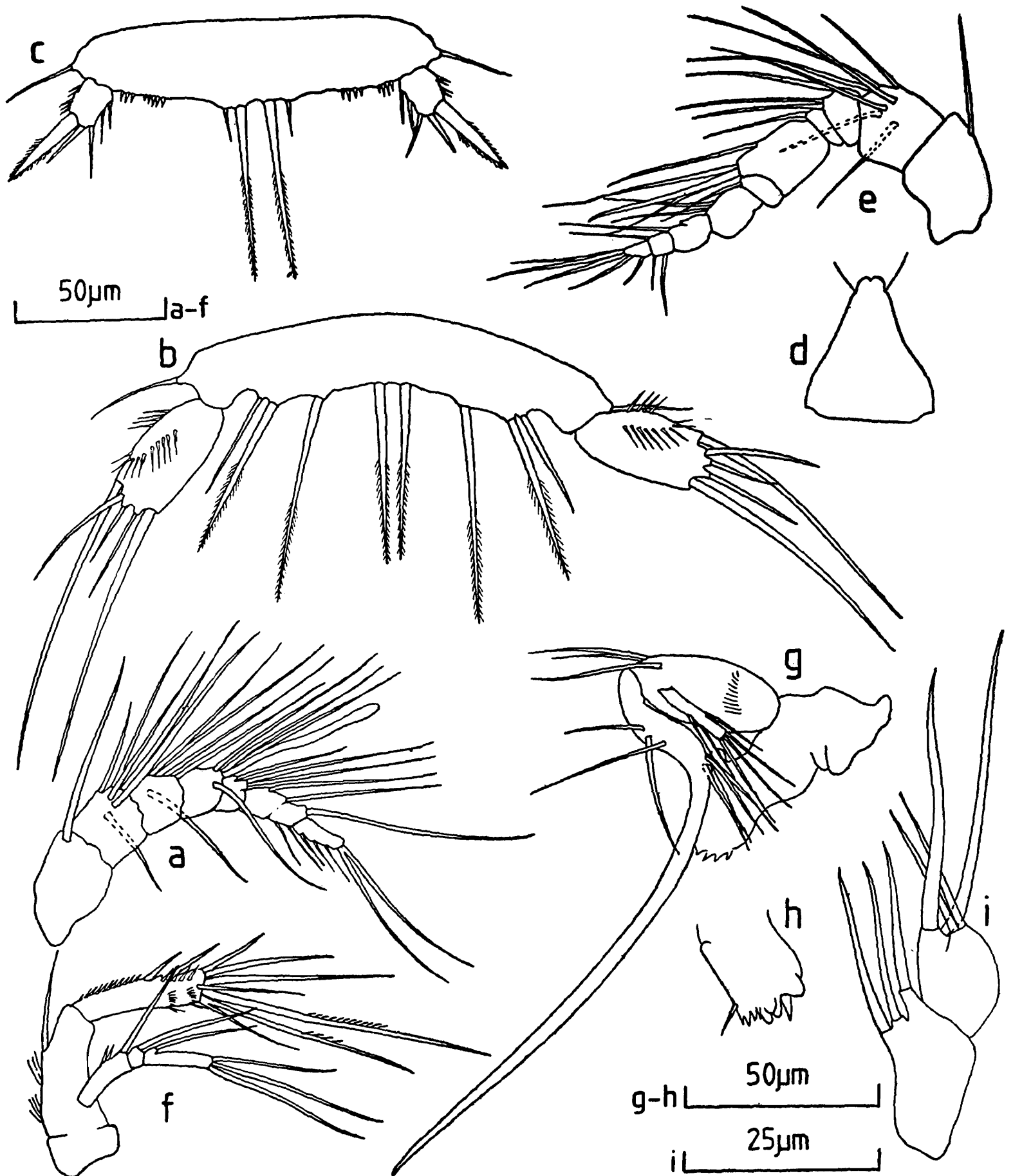


Fig. 68. a-c, *Stenhelia (Delavalia) hirtipes*. a, antennule. b-c, P.5 ♀ and ♂ d-i, *Stenhelia (D.) clavus* ♀ d, rostrum. e, antennule. f, antenna. g, mandible. h, cutting edge of mandible. i, maxilliped.

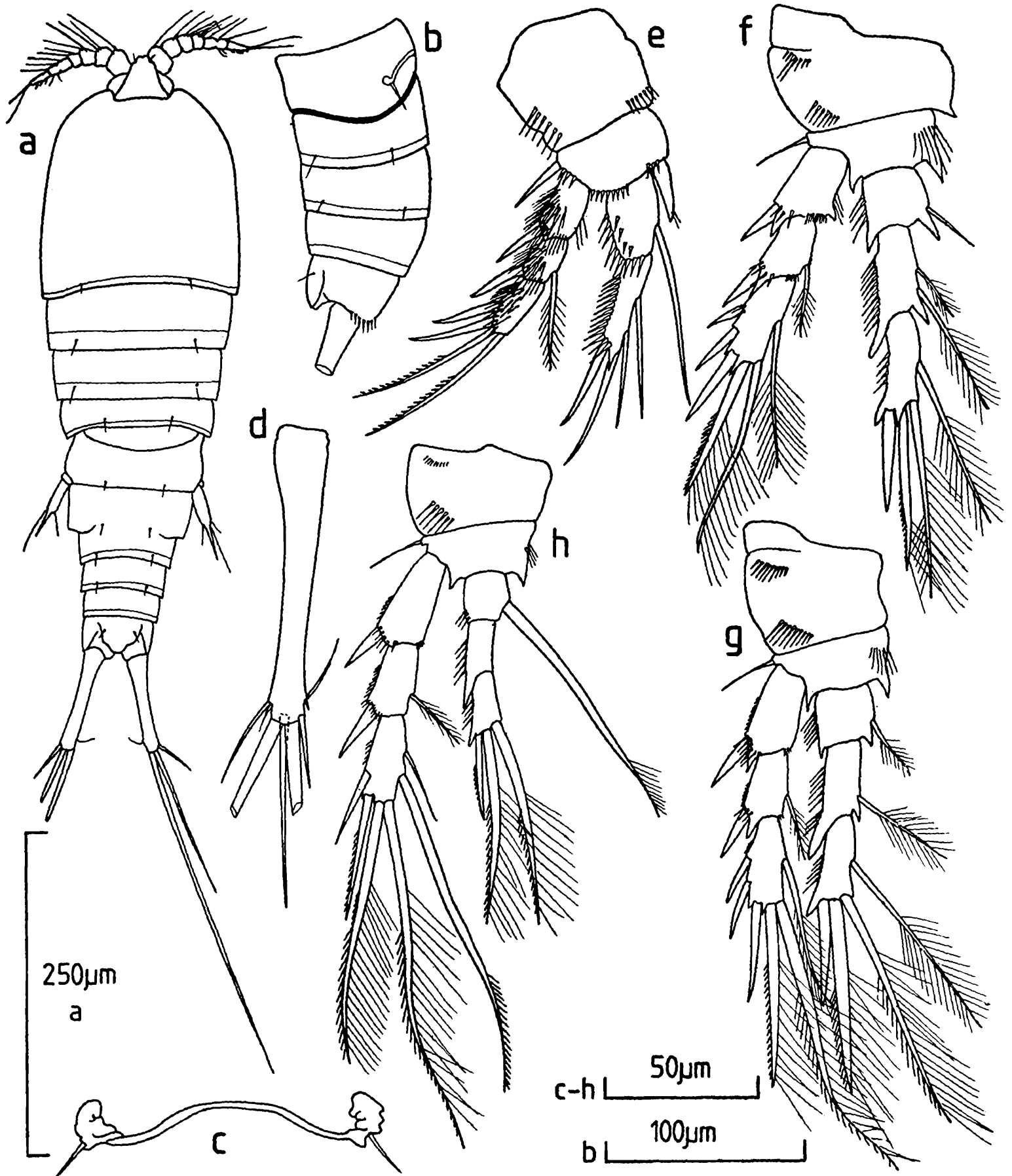


Fig. 69. *Stenhelia (Delavalia) clavus* ♀ a, dorsal. b, abdomen, lateral. c, genital field. d, left caudal ramus, dorsal. e-h, P.1-P.4.

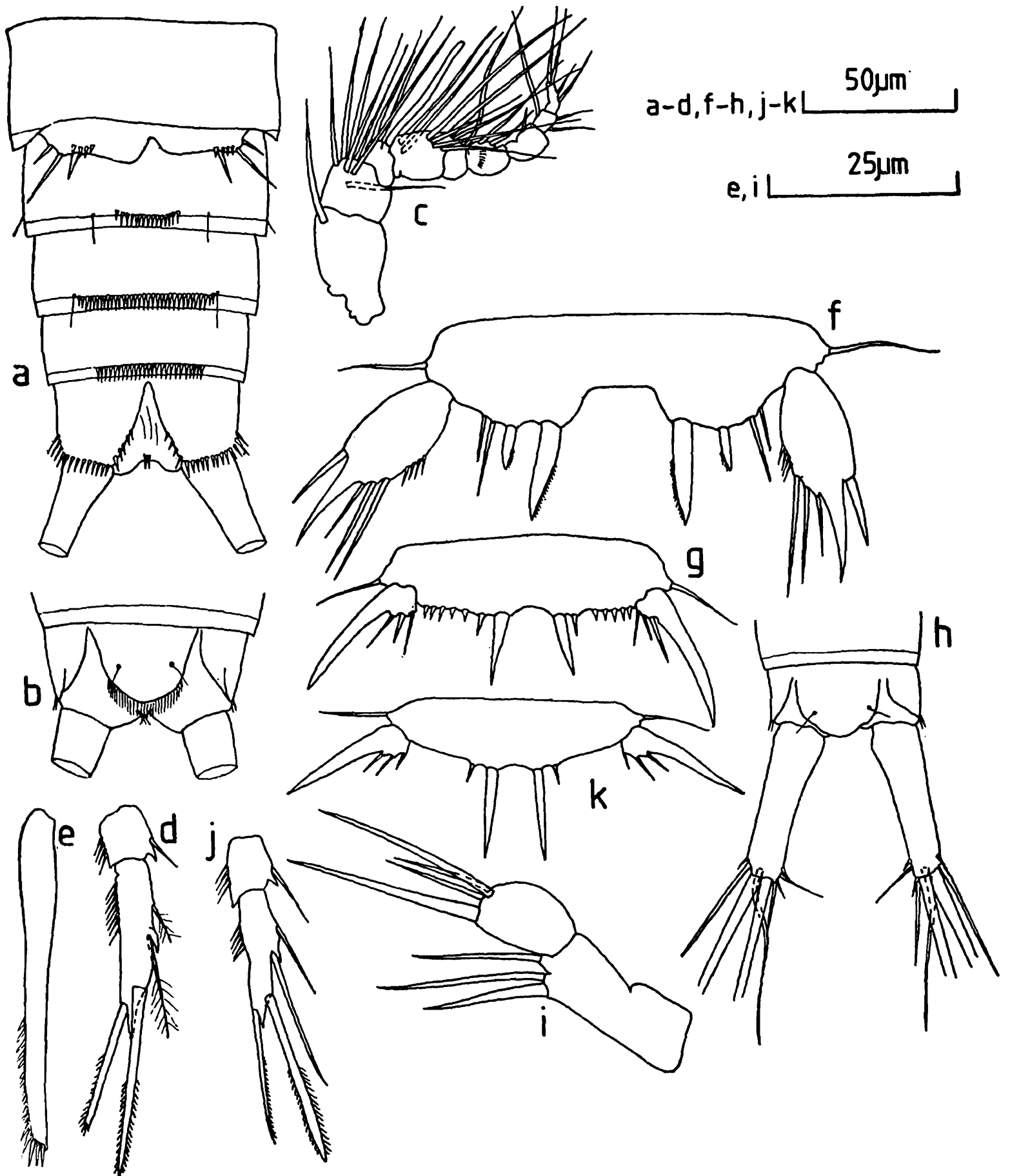


Fig. 70. a-g, *Stenhelia (Delavalia) clavus*. a, ♂ abdomen, ventral. b, ♂ anal operculum. c, ♂ antennule. d, ♂ P.2 Enp. e, ♂ Enp., outer setae. f-g, P.5 of ♀ and ♂ h-k, *Stenhelia (D.) paraclavus* ♂ h, anal operculum and caudal rami. i, maxilliped. j, P.2 Enp. k, P.5.

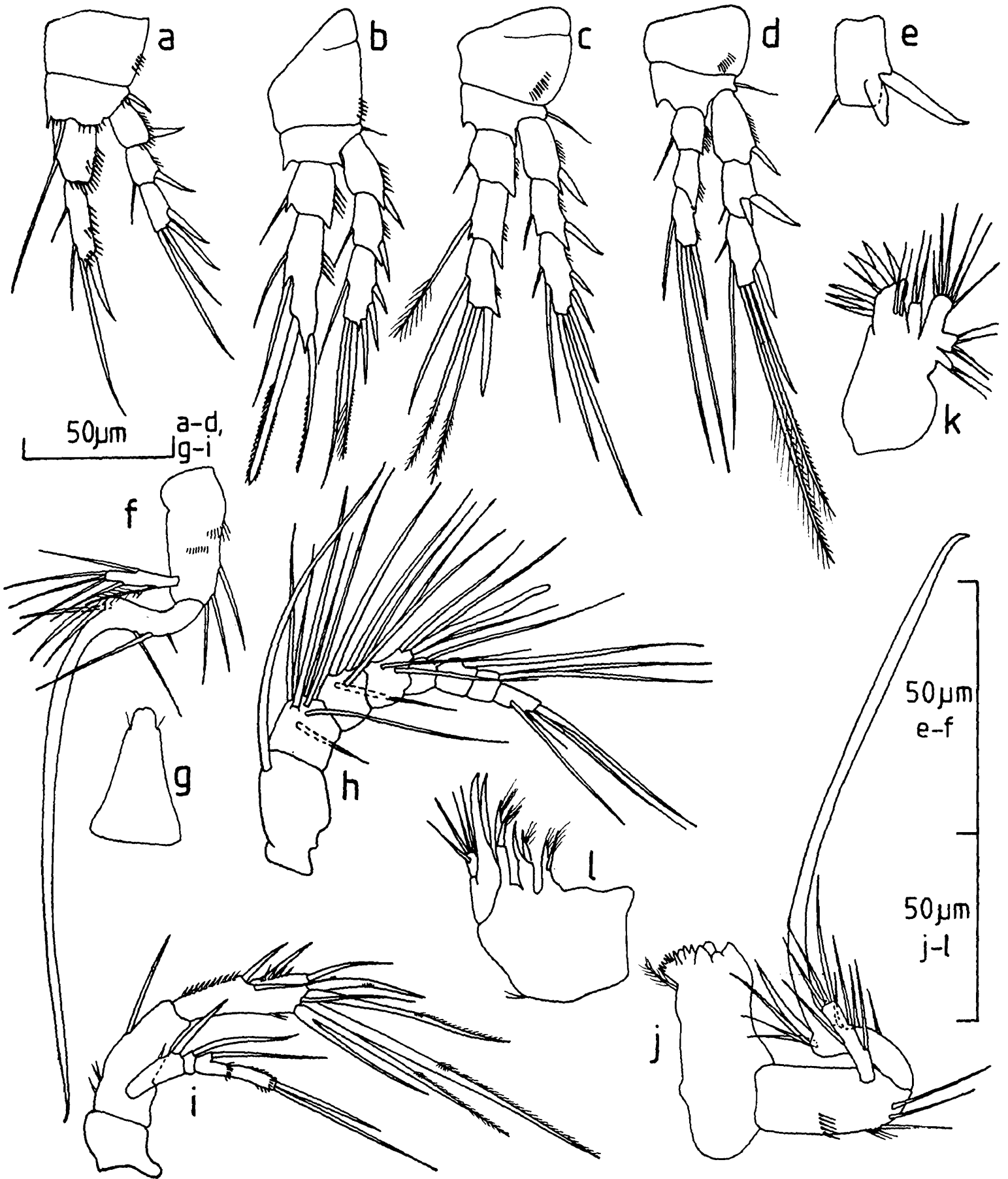


Fig. 71. a-f, *Stenhelia (Delavalia) paraclavus* ♂ a-d, P.1-P.4. e, P.4 Exp.2. f, mandible palp. g-l, *S. (D.) valens* ♀ g, rostrum. h, antennule. i, antenna. j, mandible. k, maxillule. l, maxilla.

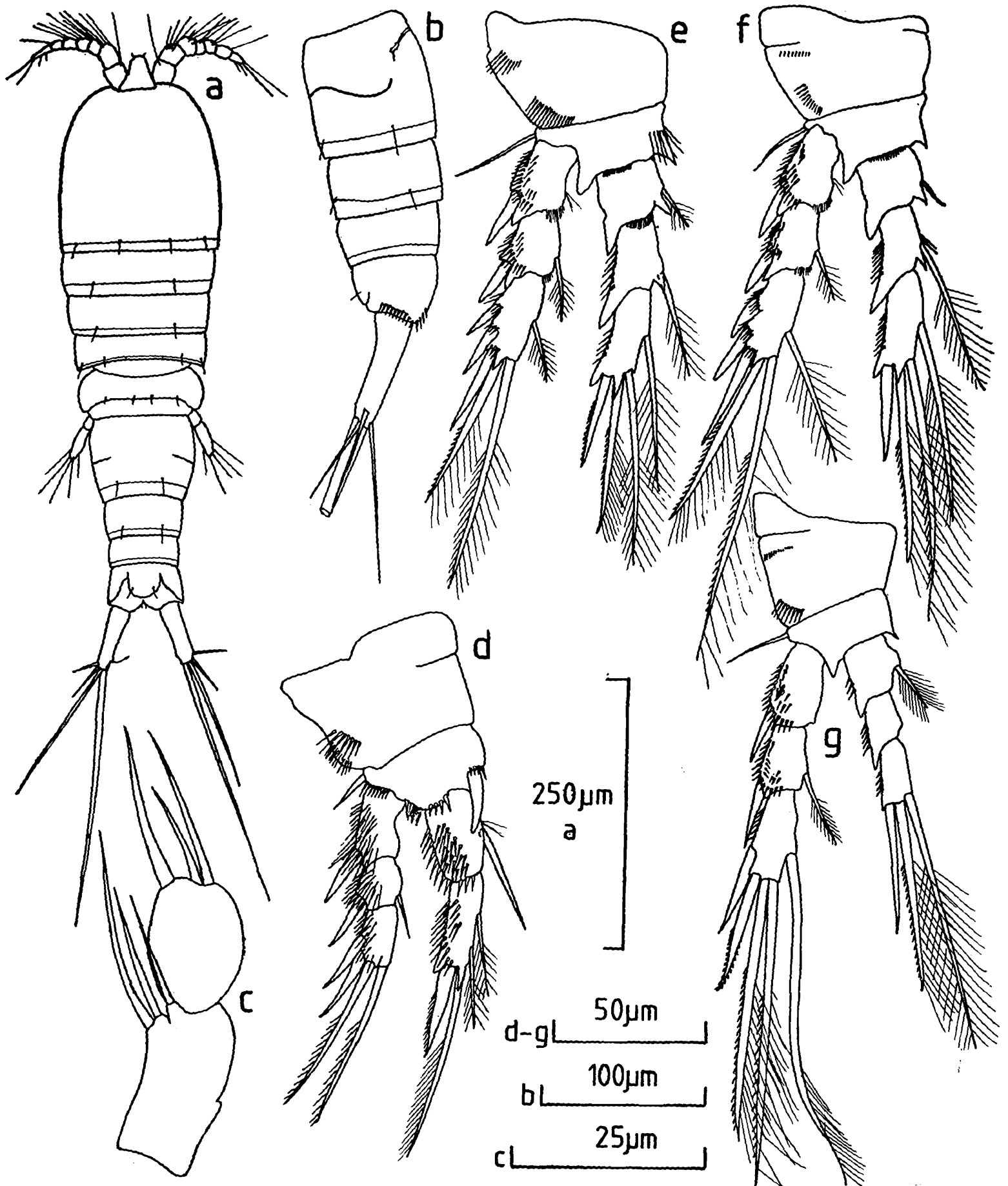


Fig. 72. *Stenhelium (Delavalium) valens* ♀ a, dorsal. b, abdomen, lateral. c, maxilliped. d-g, P.1-P.4.



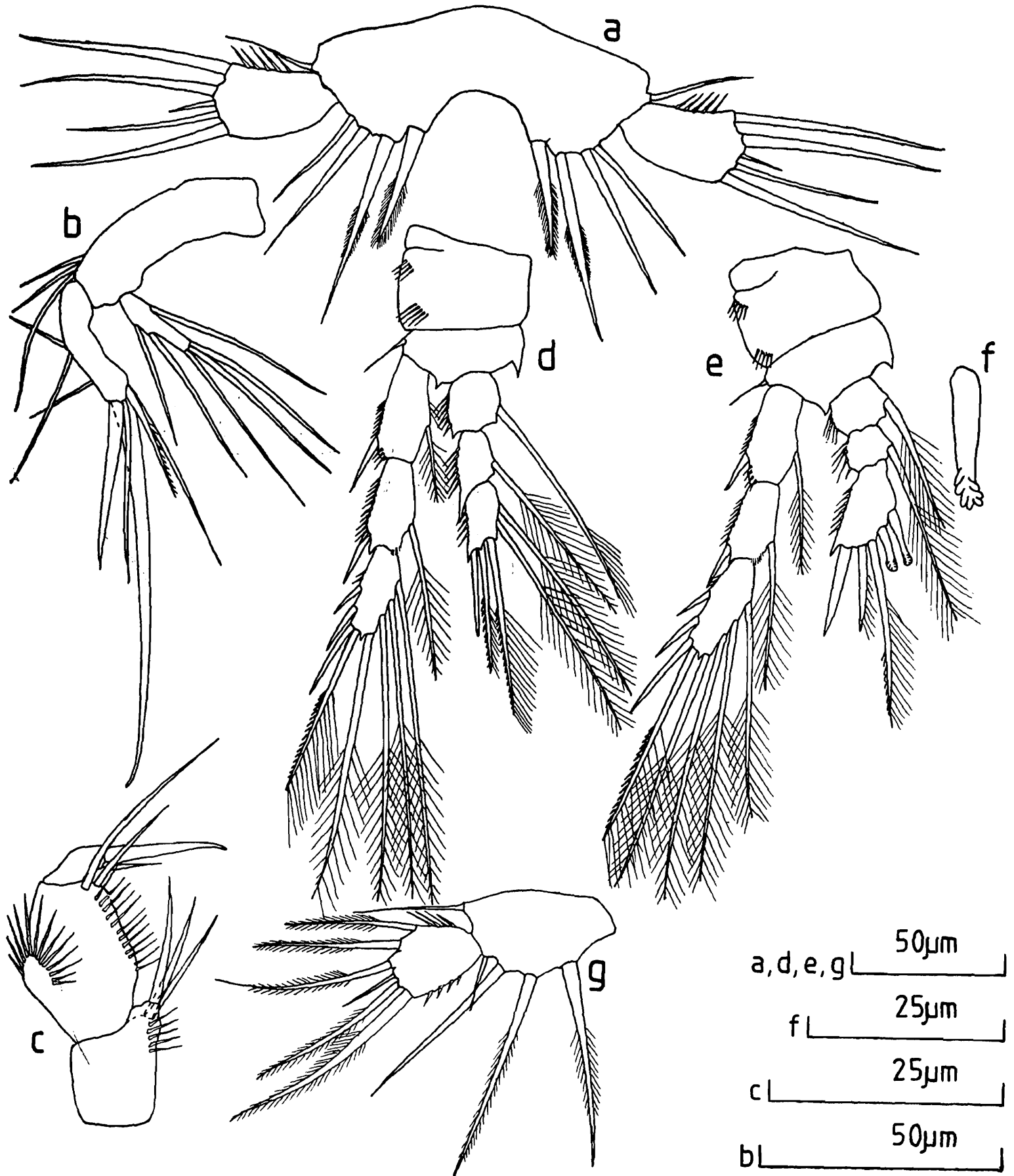


Fig. 73. a, *Stenhelia (Delavalia) valens* ♀ P.5. b-g, *Stenhelia (D.) fustiger*. b, ♀ mandible palp. c, ♀ maxilliped. d-e, P.4 ♀ and ♂ f, ♂ P.4 Enp.3, inner seta. g, ♀ P.5.

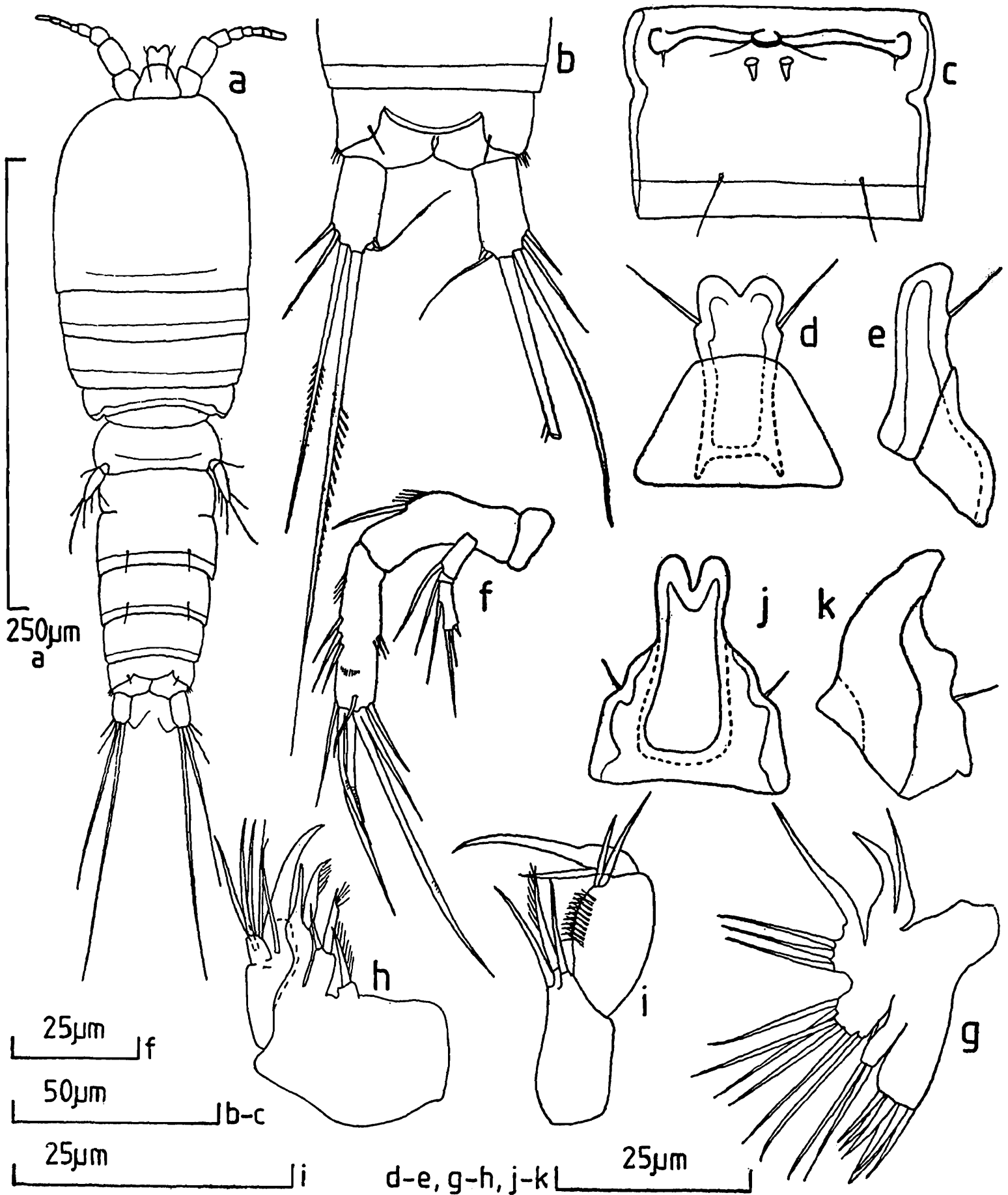


Fig. 74. a-i, *Stenhelia (Delavalia) indica*. ♀ a, dorsal. b, last seg. and caudal run field. d-e, rostrum, dorsal and lateral. f, antenna. g, maxillule. h, maxilla. i, maxilliped. j-k, *Stenhelia (D.) bifidia* ♀, rostrum, dorsal and lateral.

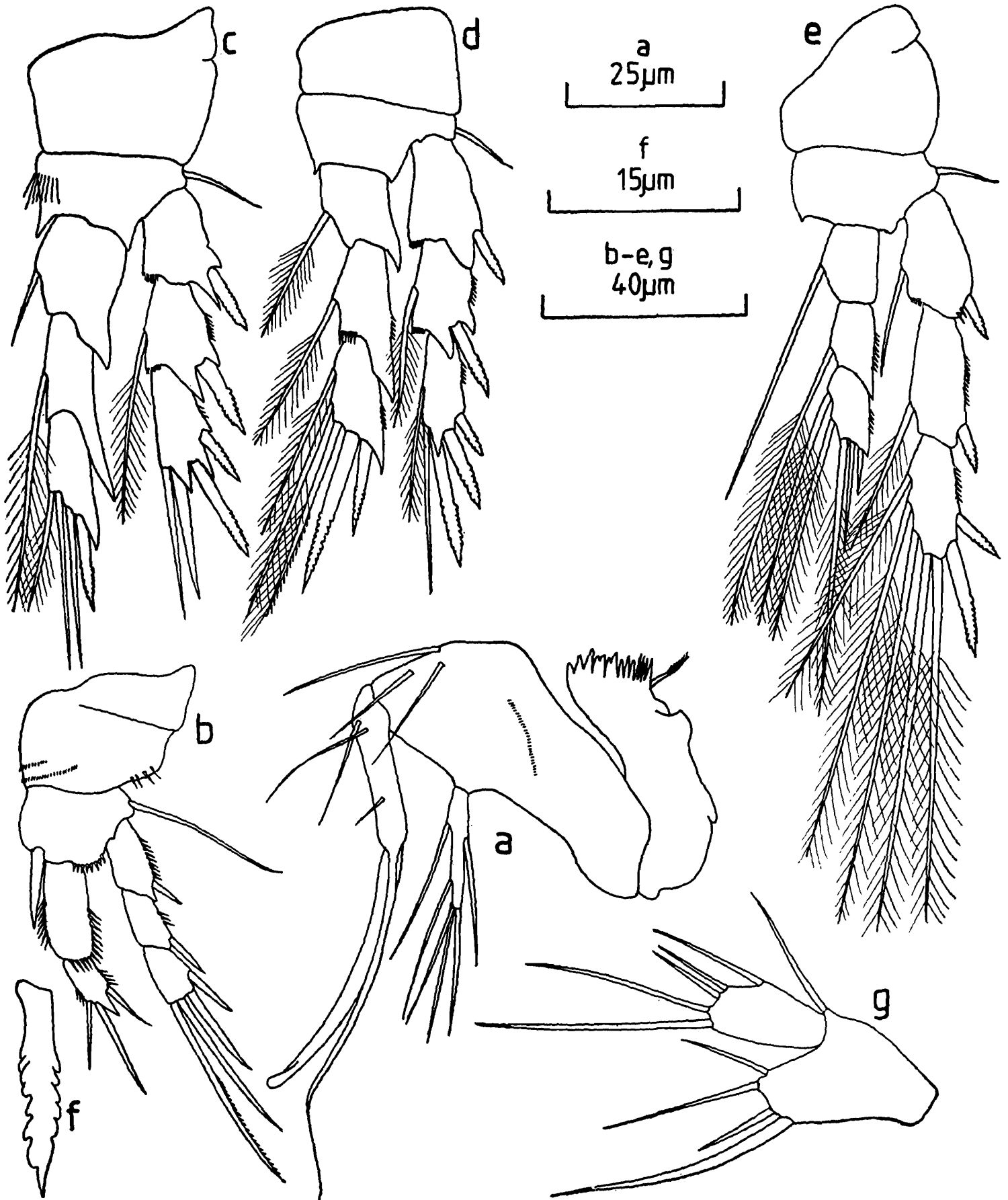


Fig. 75. *Stenhelia (Delavalia) indica* ♀ a, mandible. b-e, P.1-P.4. f, P.3 Exp., outer seta. g, P. 5.

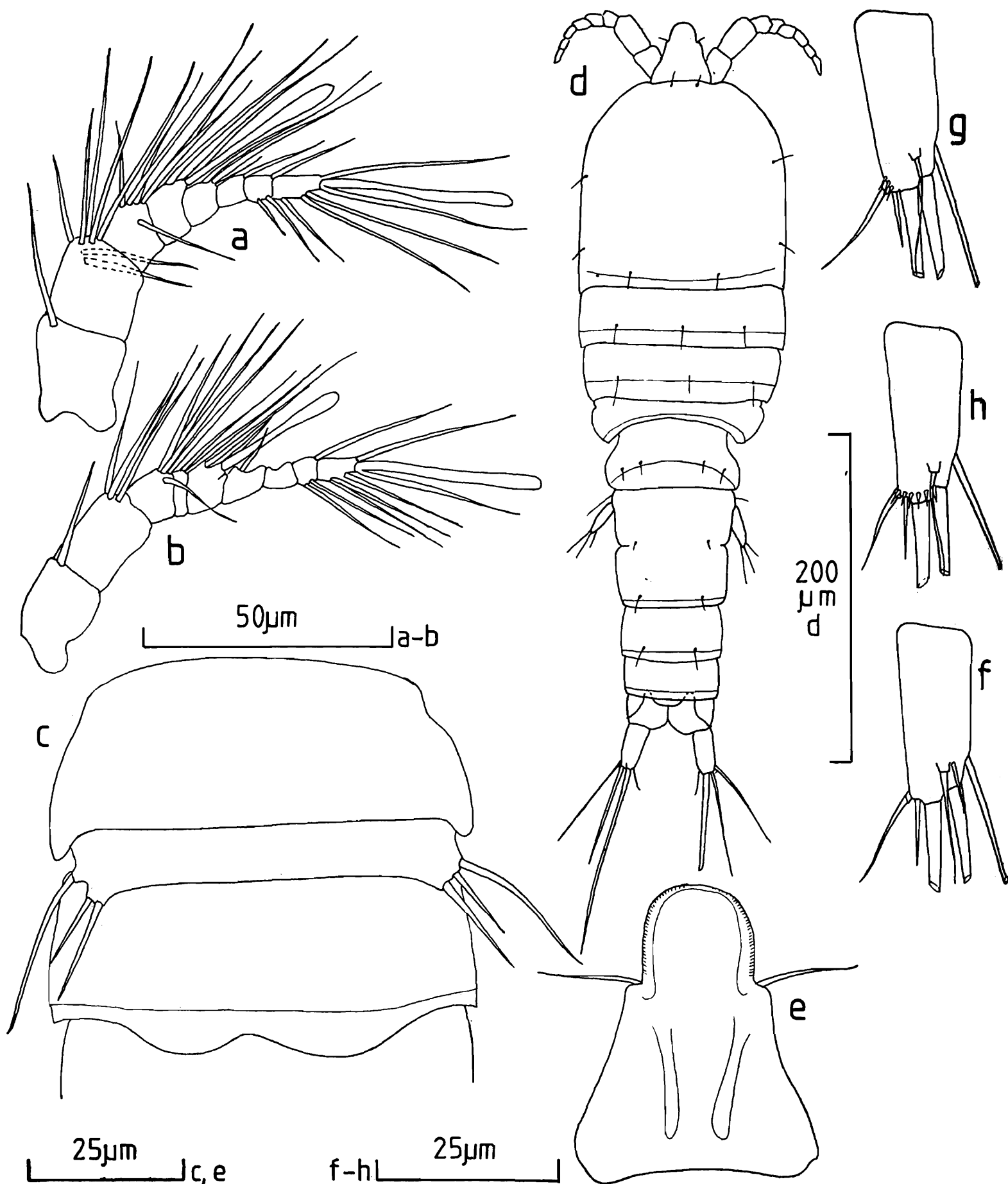


Fig. 76. a-c, *Stenhelia (Delavalia) indica*. a-b, antennule ♀ and ♂ c, P.5-P.6. d-f, *Stenhelia (D.) ovalis* ♀ d, dorsal. e, rostrum. f, right caudal ramus, dorsal. g-h, right caudal ramus, dorsal, of (g) *Stenhelia (D.) caulerpae* and (h) *Stenhelia (D.) bisetosa*.

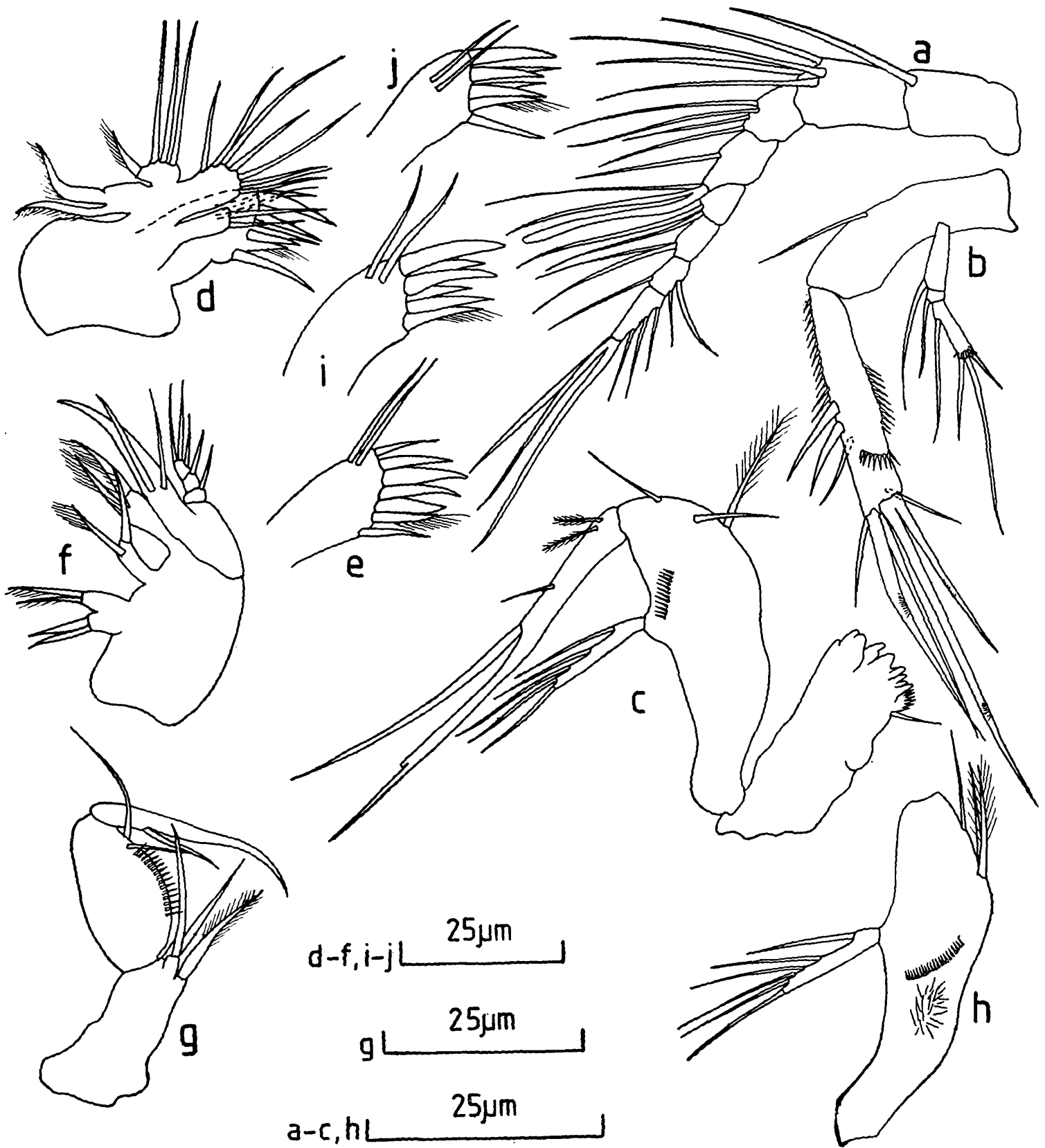


Fig. 77. a-g, *Stenhelia (Delavalia) ovalis* ♀ a, antennule. b, antenna. c, mandible. d, maxillule. e, pre-coxal arthrite of maxillule. f, maxilla. g, maxilliped. h-i, *Stenhelia (D.) bisetosa* ♀ h, mandible coxa-basis and exopod. i, maxillule, pre-coxal arthrite. j, *Stenhelia (D.) caulerpae* ♀ maxillule, pre-coxal arthrite.

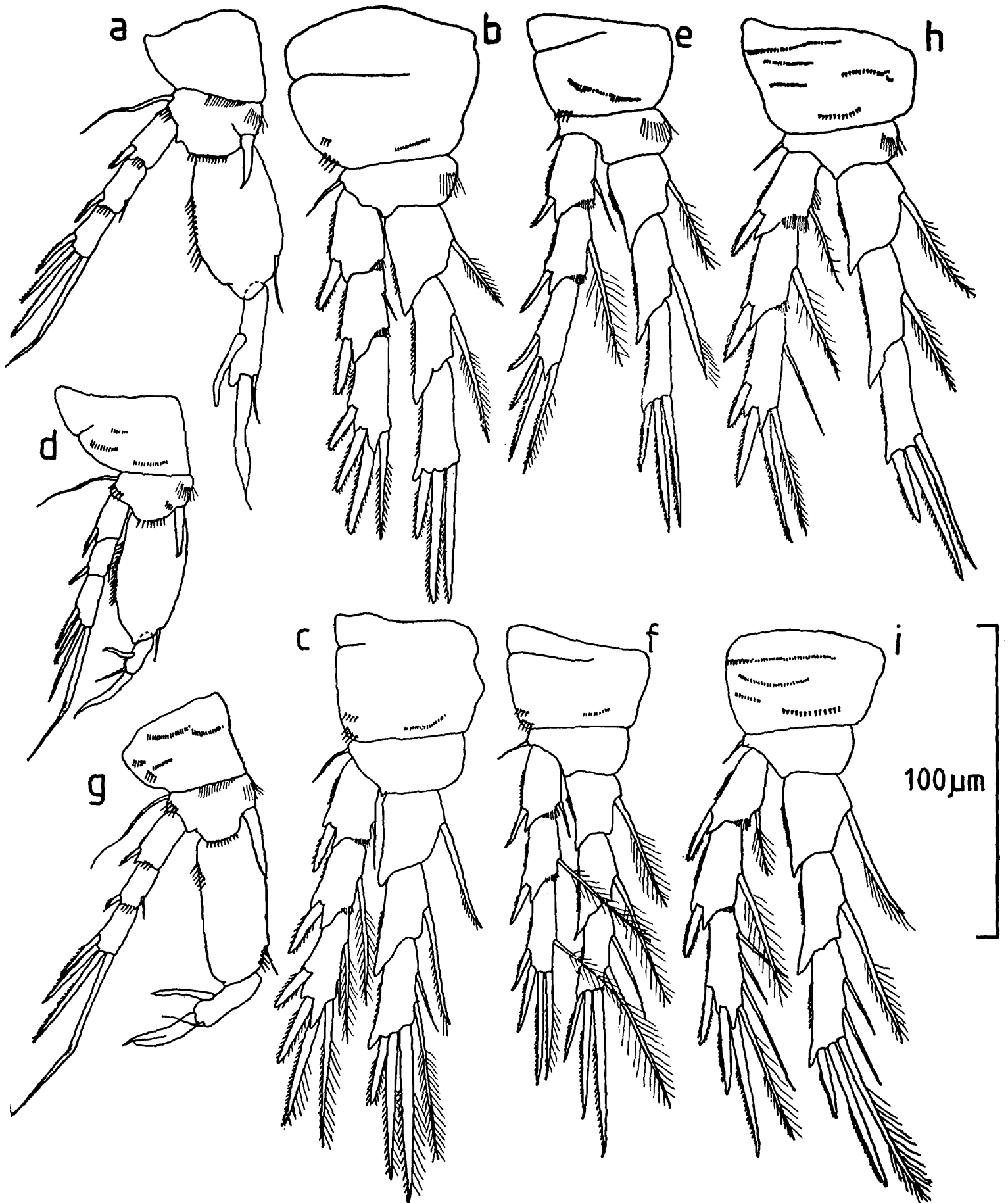


Fig. 78. P.1-P.3 of *Stenhelia (Delavalia) ovalis* ♀ (a-c), *Stenhelia (D.) caulerpae* ♀ (d-f) and *Stenhelia (D.) bisetosa* ♀ (g-i).

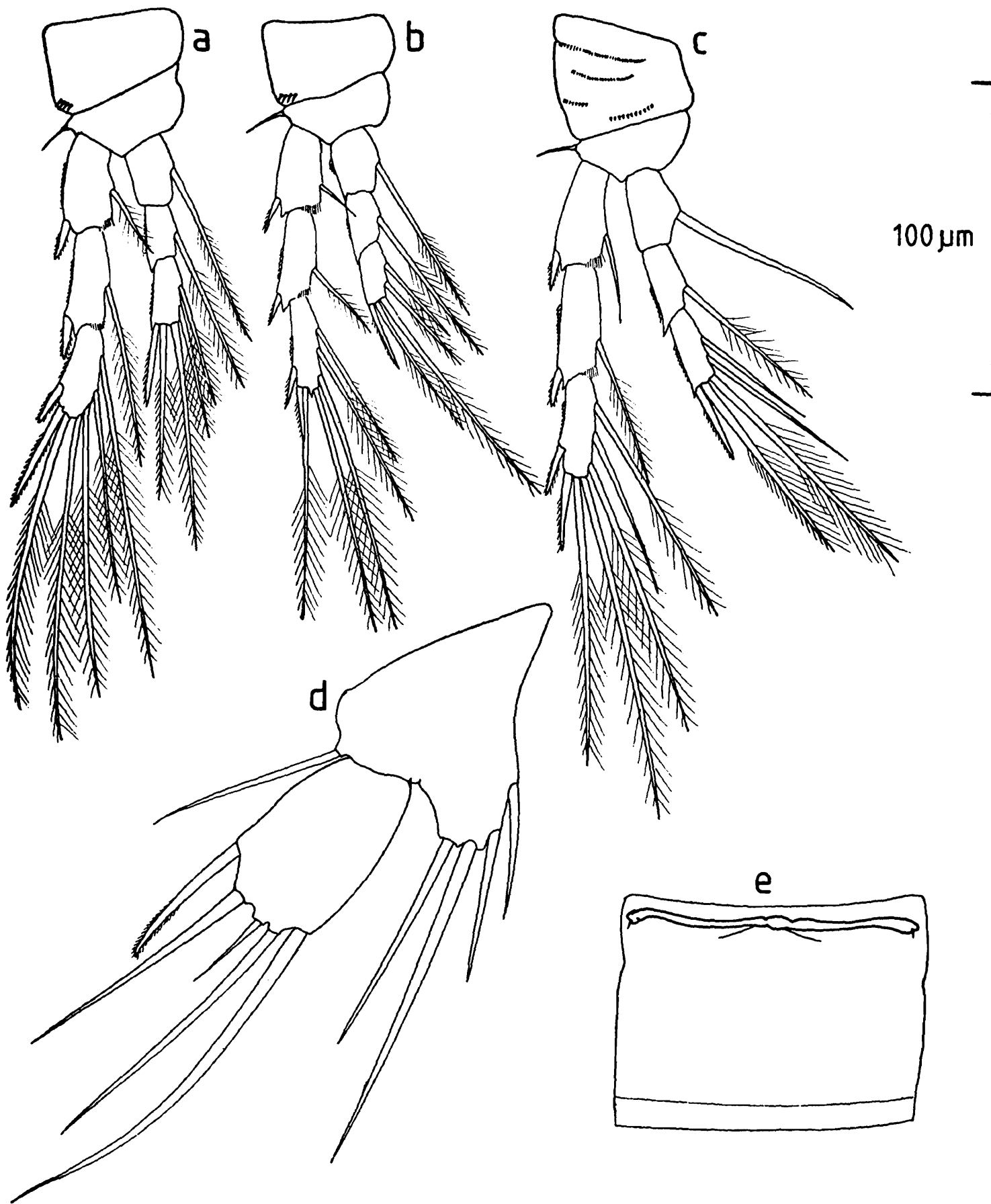


Fig. 79. a-c, P.4 in *Stenhelia (Delavalia) ovalis* ♀, *Stenhelia (D.) caulerpae* ♀ and *Stenhelia (D.) bisetosa* ♀ d-e, *Stenhelia (D.) ovalis* ♀ d, P.5. e, genital field.

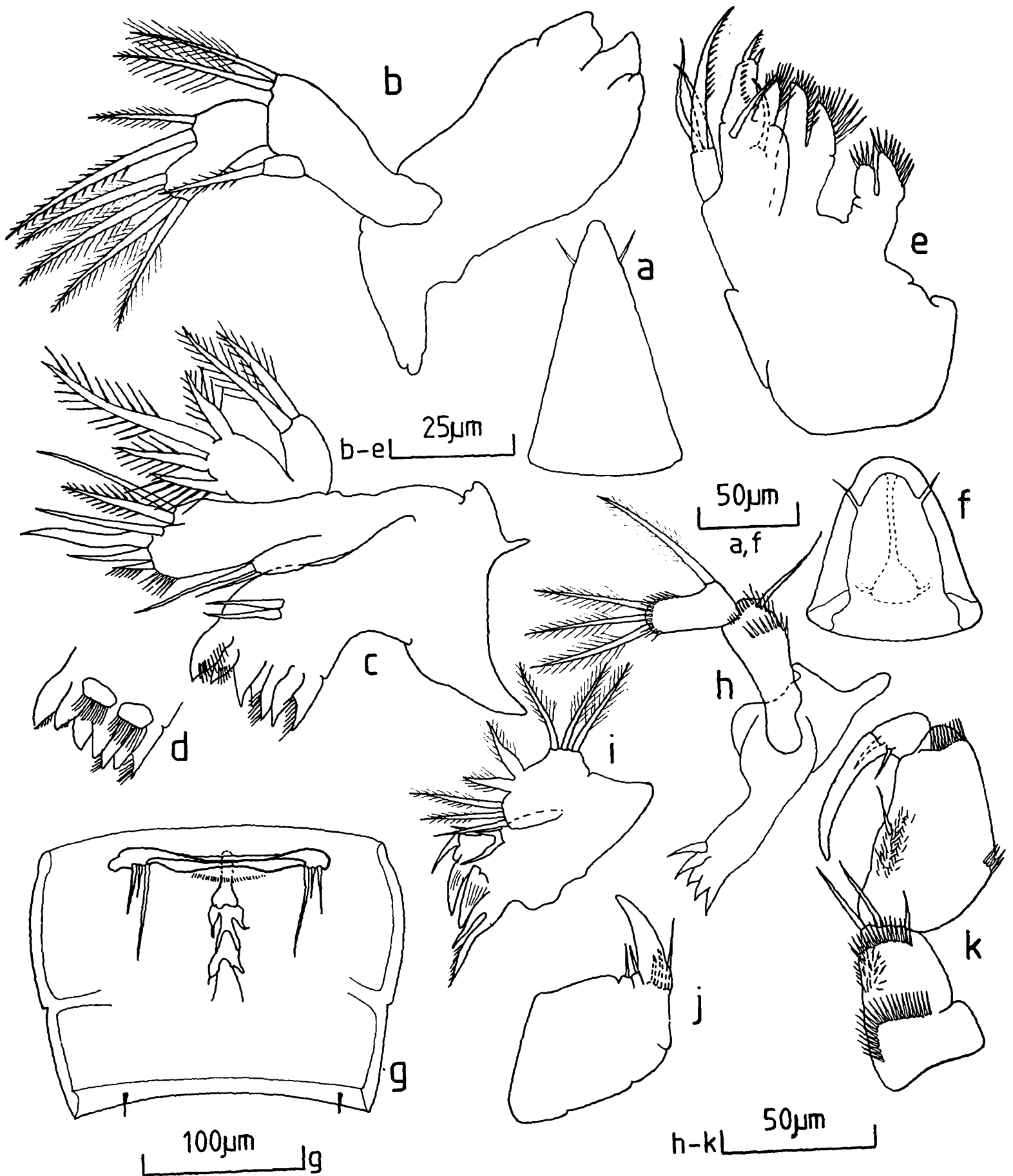


Fig. 80. a-e, *Diosaccus hamiltoni* ♀ a, rostrum. b, mandible. c, maxillule. d, maxillule, pre-coxal arthrite, reverse side. e, maxilla. f-k, *Diosaccus monardi* ♀. f, rostrum. g, genital field. h, mandible. i, maxillule. j, maxilla. k, maxilliped.



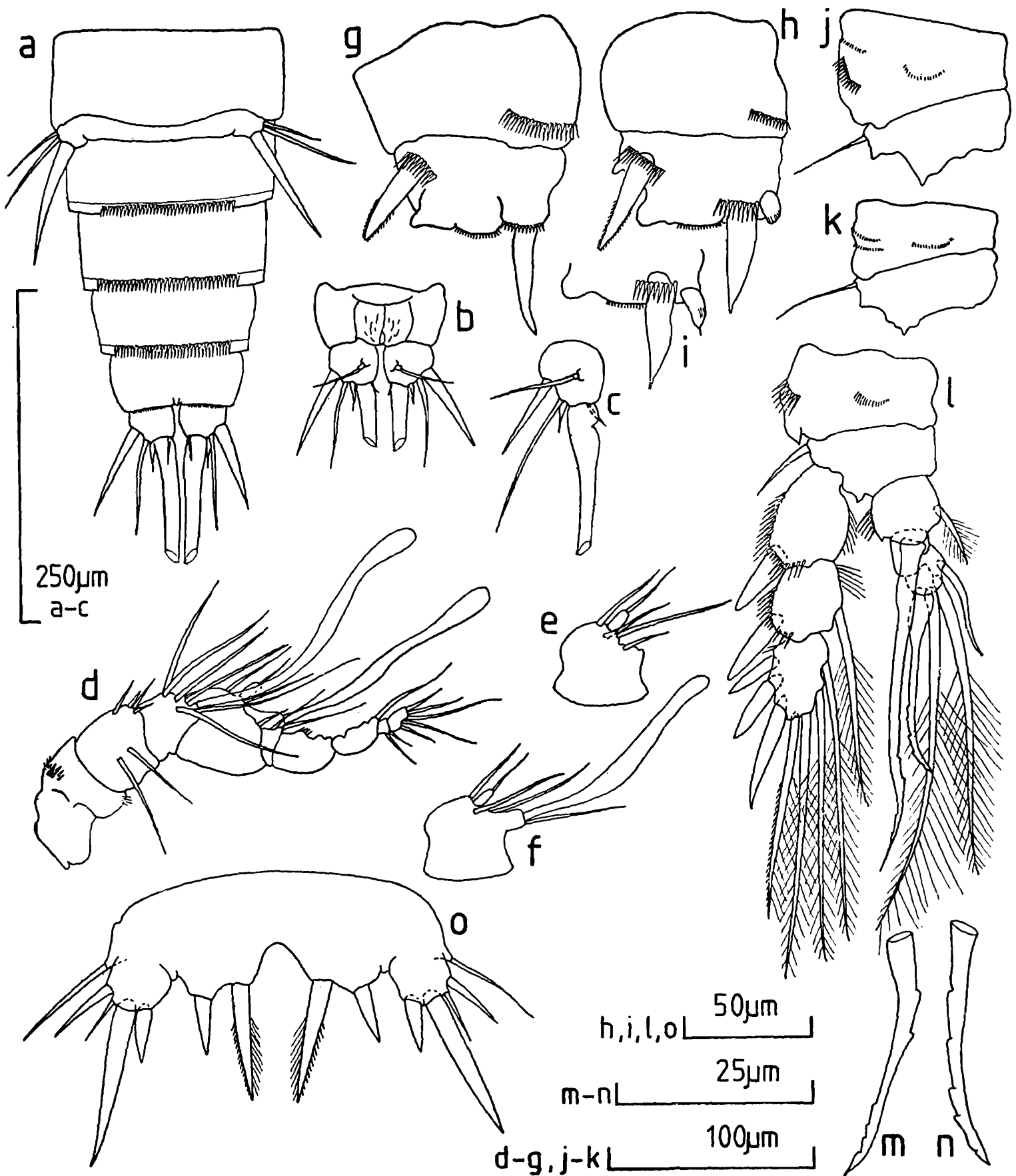


Fig. 81. *Diosaccus monardi*. a, ♂ abdomen, ventral. b, ♂ last seg. and caudal rami in dorsal view. c, ♀ left caudal ramus, dorsal. d, ♂ antennule. e-f, ♂ antennule, seg. 4, right and left side. g-h, P.1 ♀ and ♂ Coxa and Basis. i, ♂ P.1 Basis spine in another orientation. j-k, ♀ P.2 and P.4, Coxa and Basis. l, ♂ P.2. m-n, ♂ P.2 Enp., detail of setae. o, ♂ P.5.

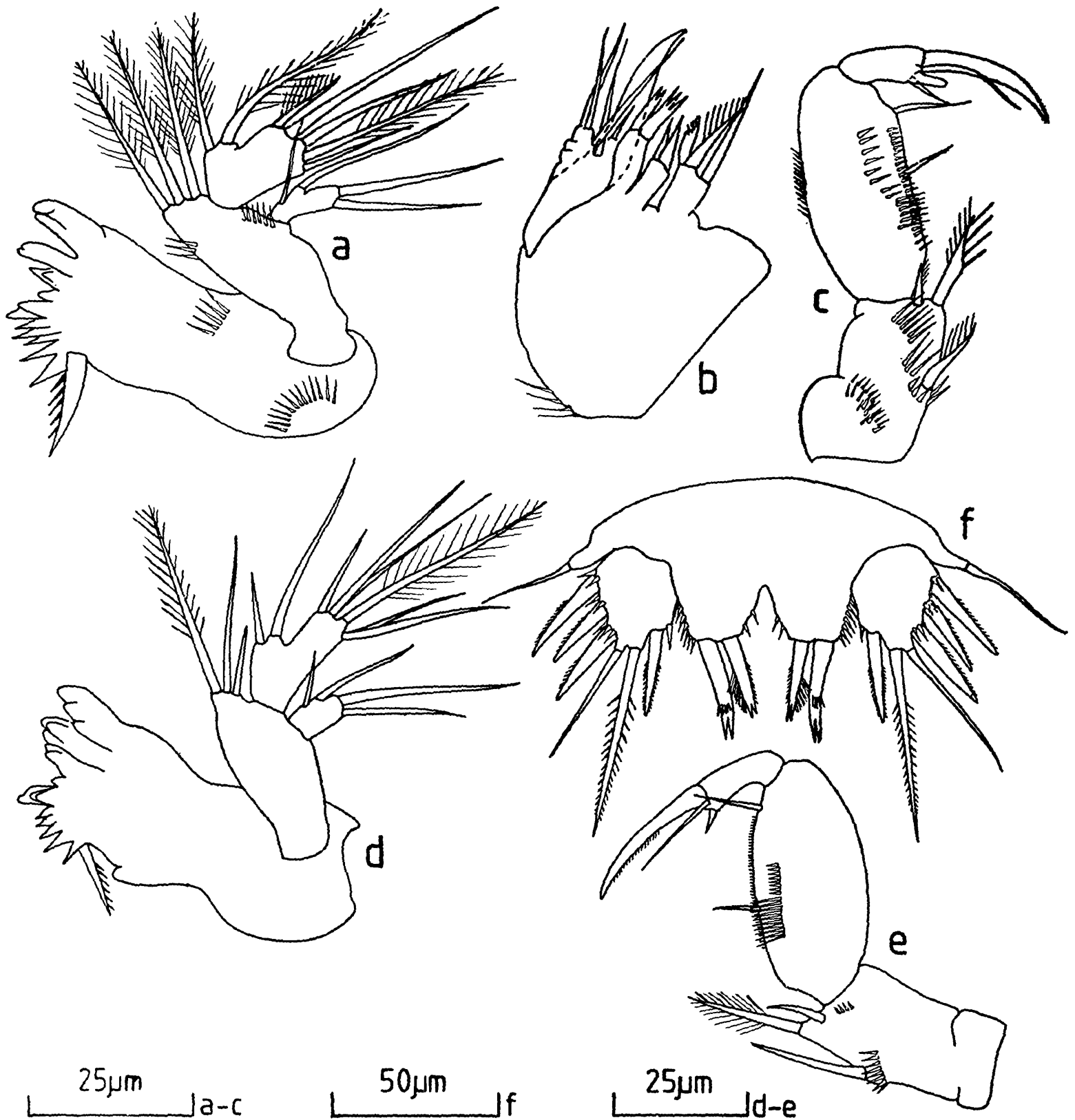


Fig. 82. a-c, *Robertsonia propinqua* ♀ a, mandible. b, maxilla. c, maxilliped. d-f, *Robertsonia adduensis*. d, ♀ mandible. e, ♀ maxilliped. f, ♂ P.5.

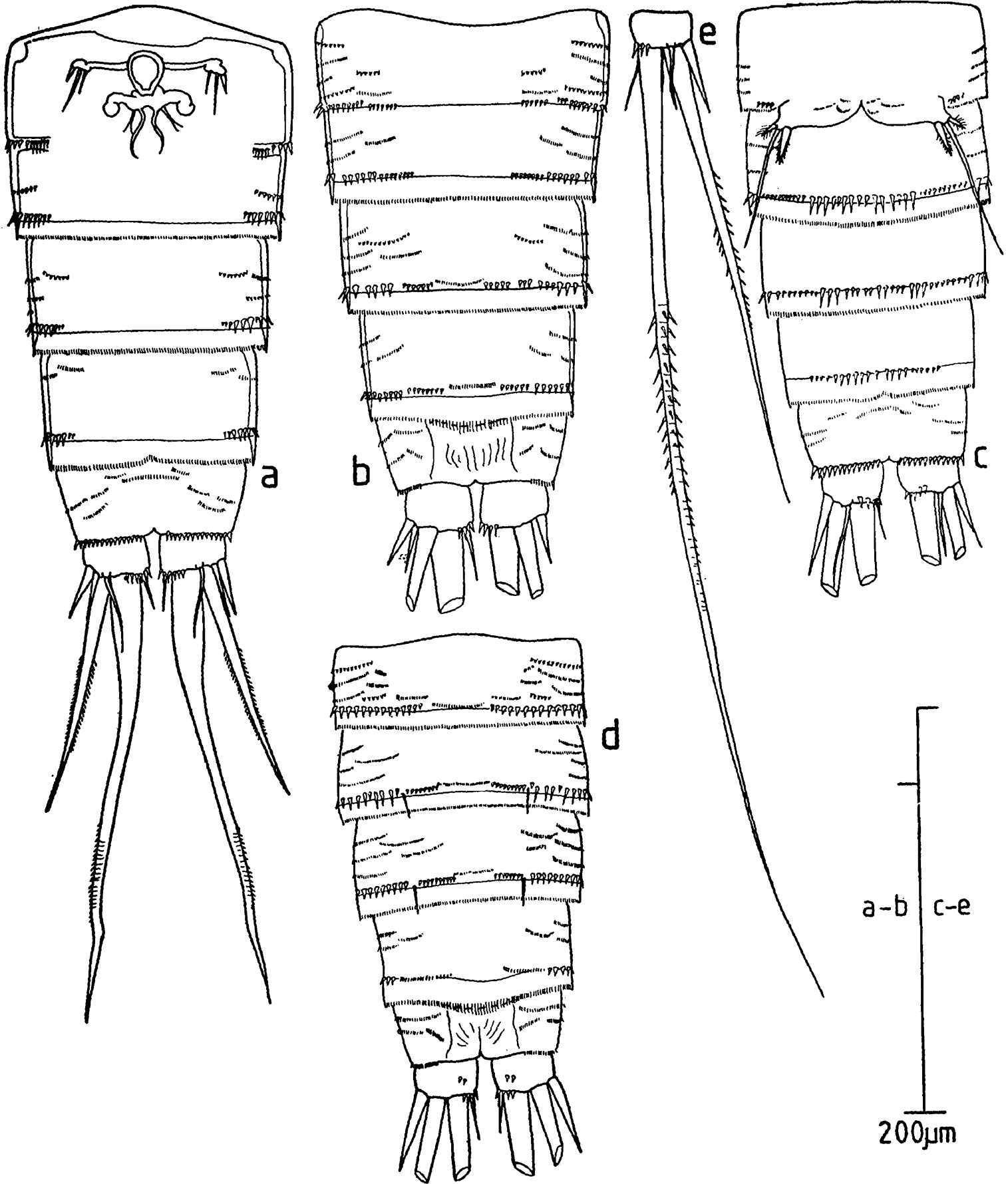


Fig. 83. *Robertsonia adduensis*. a-d, abdomen, ventral and dorsal, of ♀ (a-b) and ♂ (c-d). e, ♂ right caudal ramus, ventral.

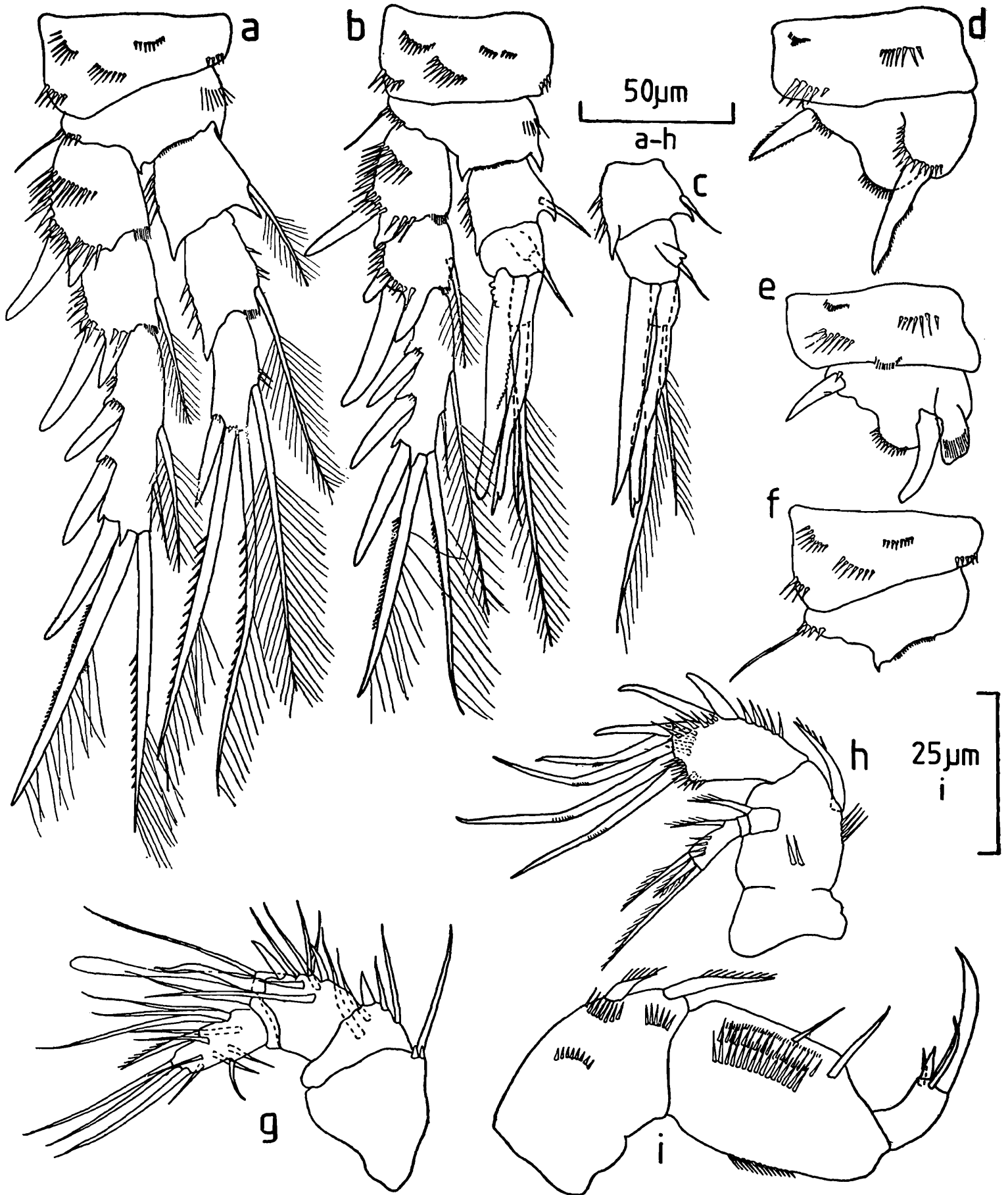


Fig. 84. a-f, *Robertsonia adduensis*. a-b, P.2, ♀ and ♂ c, ♂ P.2 Enp., another orientation. d-e, P.1 Coxa and Basis, ♀ and ♂ f, ♀ P.4 Coxa and Basis. g-i, *Robertsonia robusta* ♀ g, antennule. h, antenna. i, maxilliped.

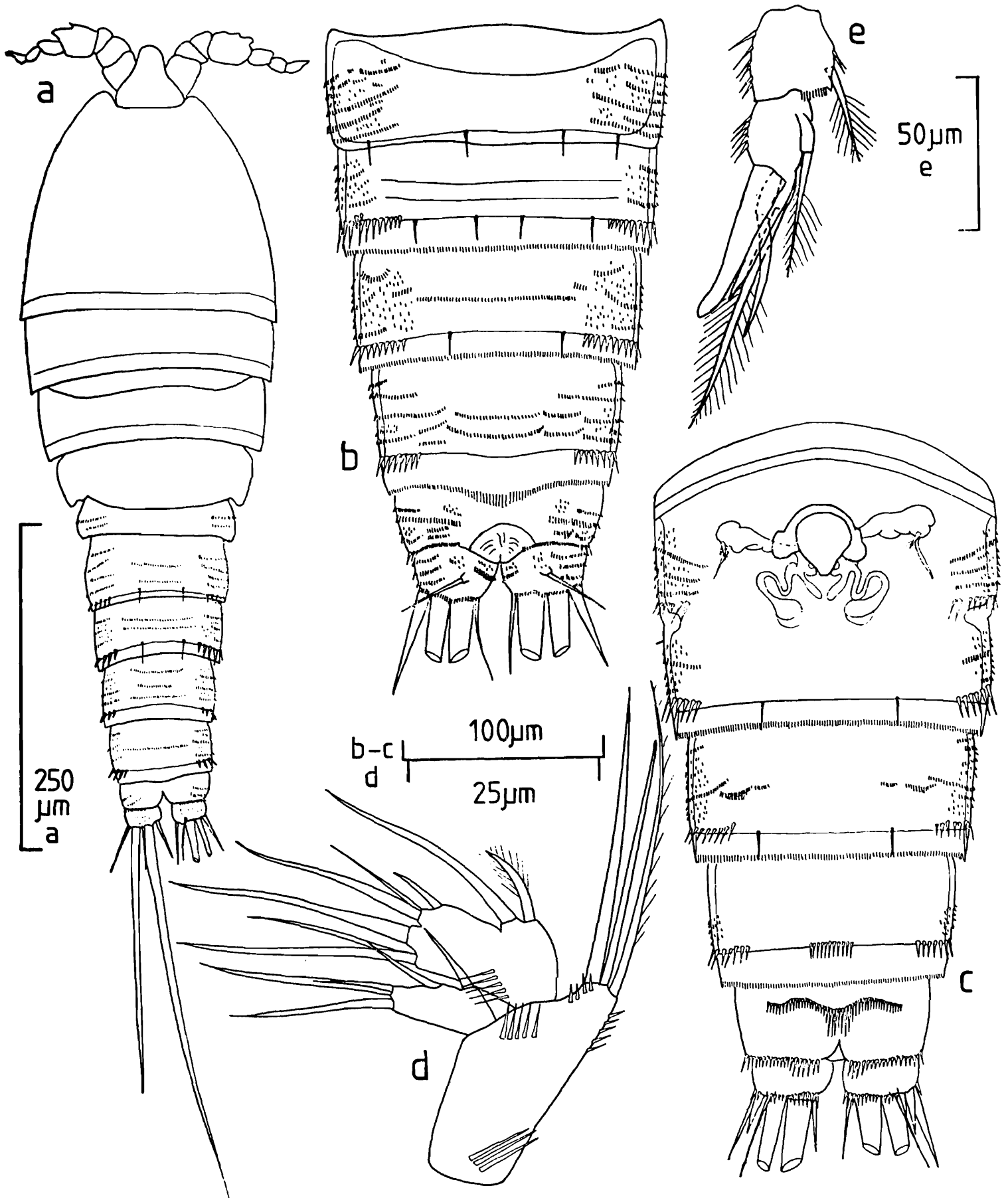


Fig. 85. *Robertsonia robusta*. a, ♂ dorsal. b-c, ♀ abdomen, dorsal and ventral. d, ♀ mandible palp. e, ♂ P.2 Enp.

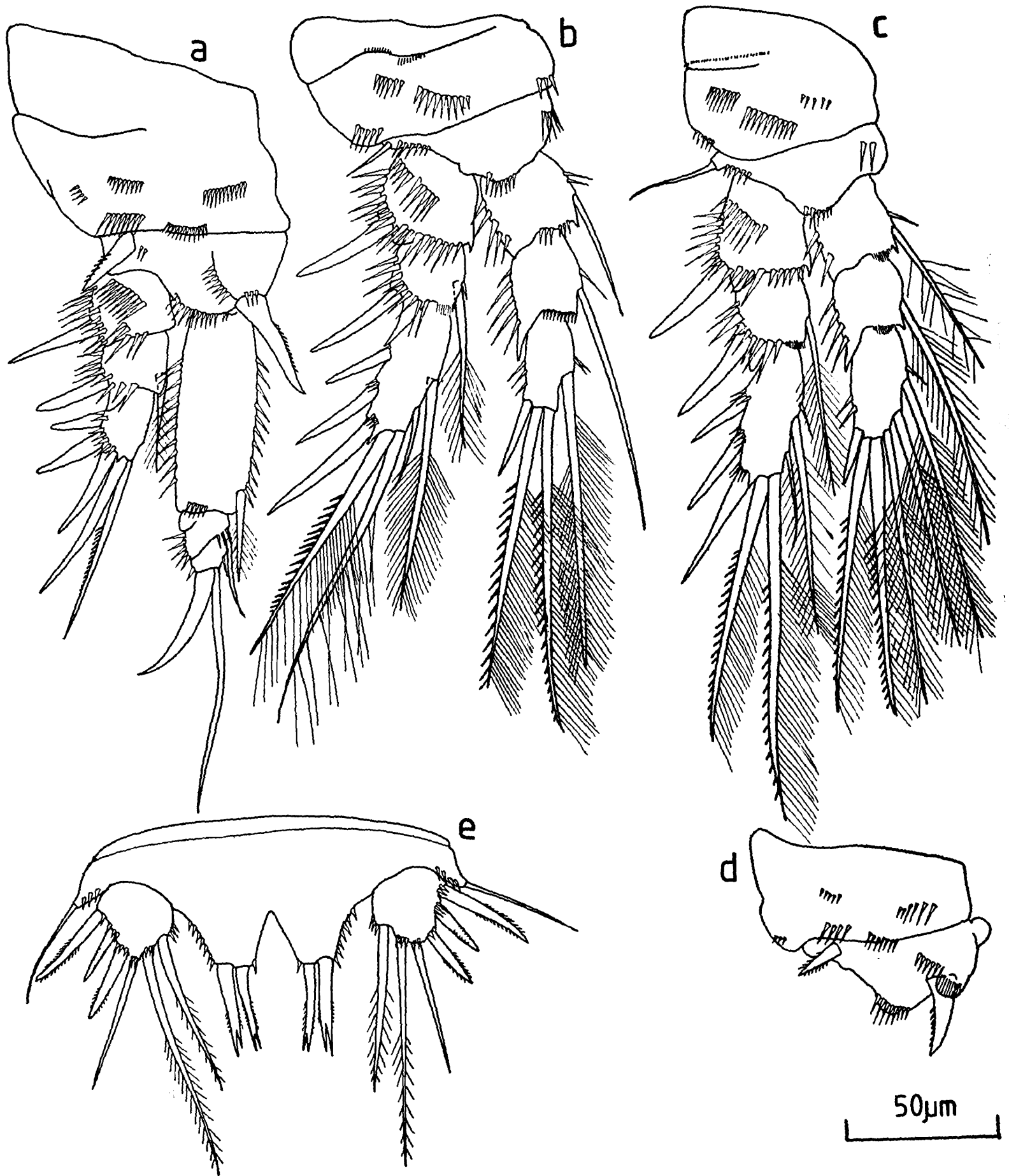


Fig. 86. *Robertsonia robusta*. a-c, ♀ P.1-P.3. d, ♂ P.1 Coxa and Basis. e, ♂ P.5.

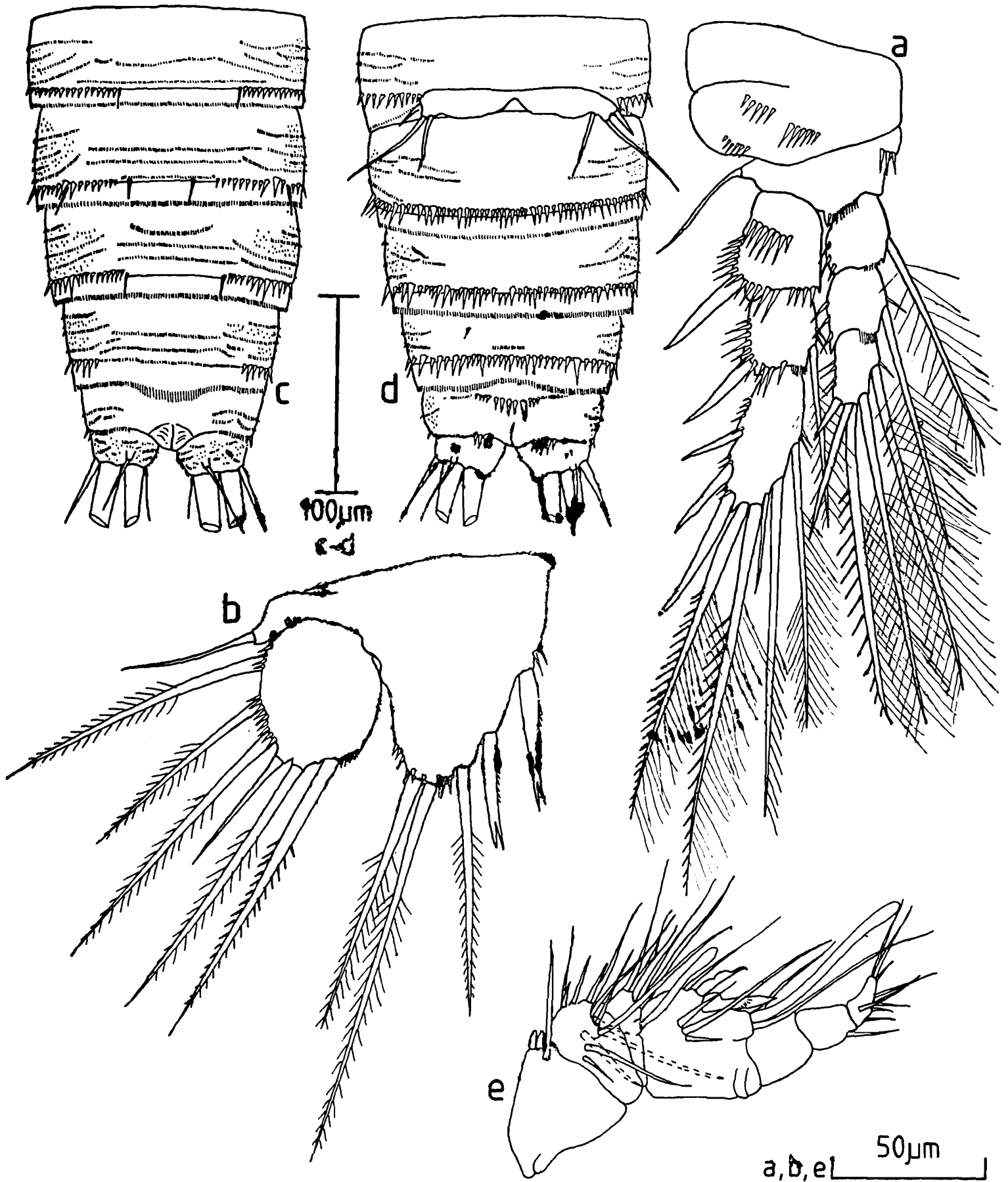


Fig. 87. *Robertsonia robusta*. a-b, ♀ P.4-P.5. c-d, ♂ abdomen, dorsal and ventral. e, ♂ antennule.

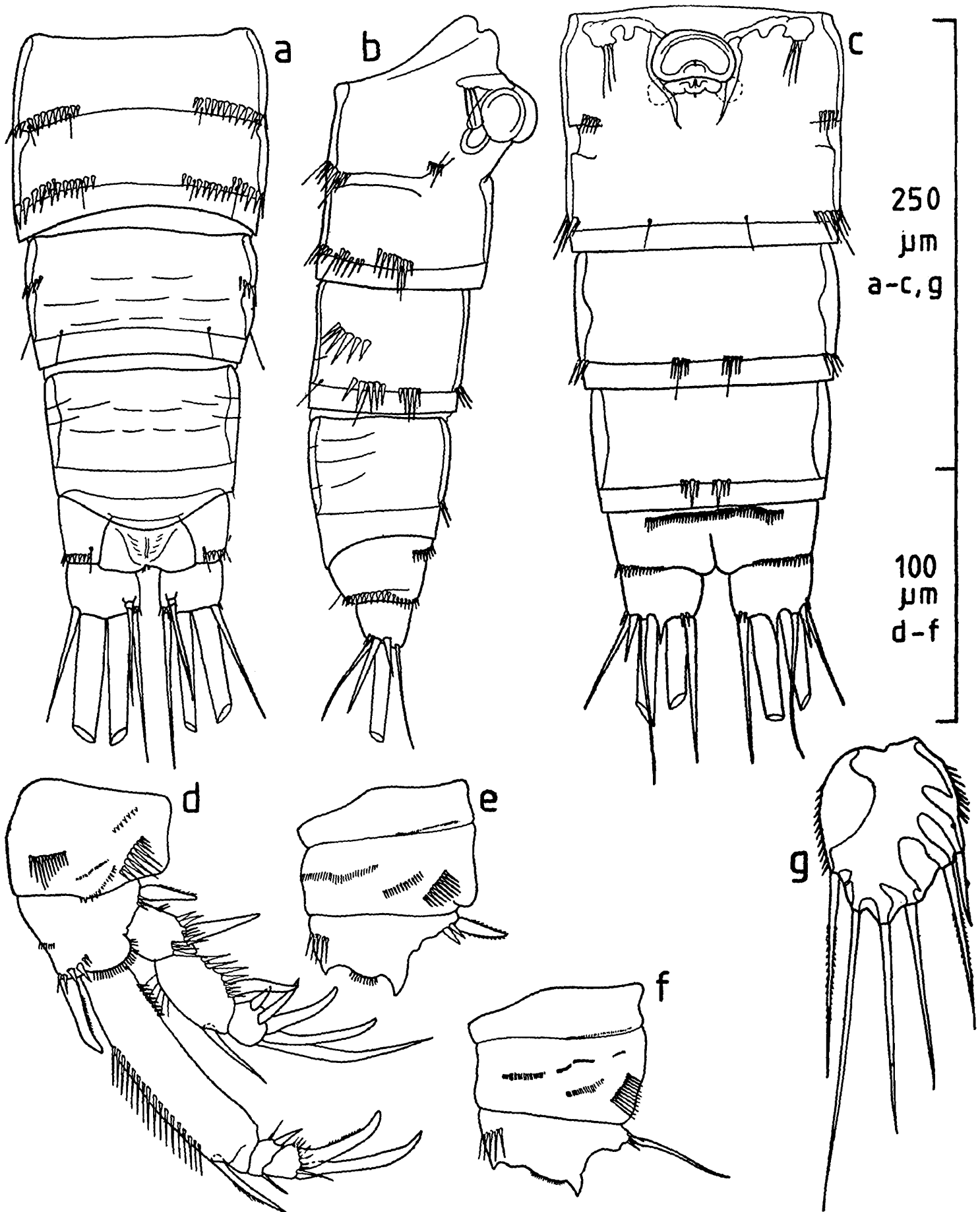


Fig. 88. *Amphasopsis cinctus*, type 1 ♀ a-c, abdomen, dorsal, lateral and ventral. d, P.1. e-f, P.2-P.3 Coxa and Basis (P.4 is identical to P.3). g, P.3 Exp.



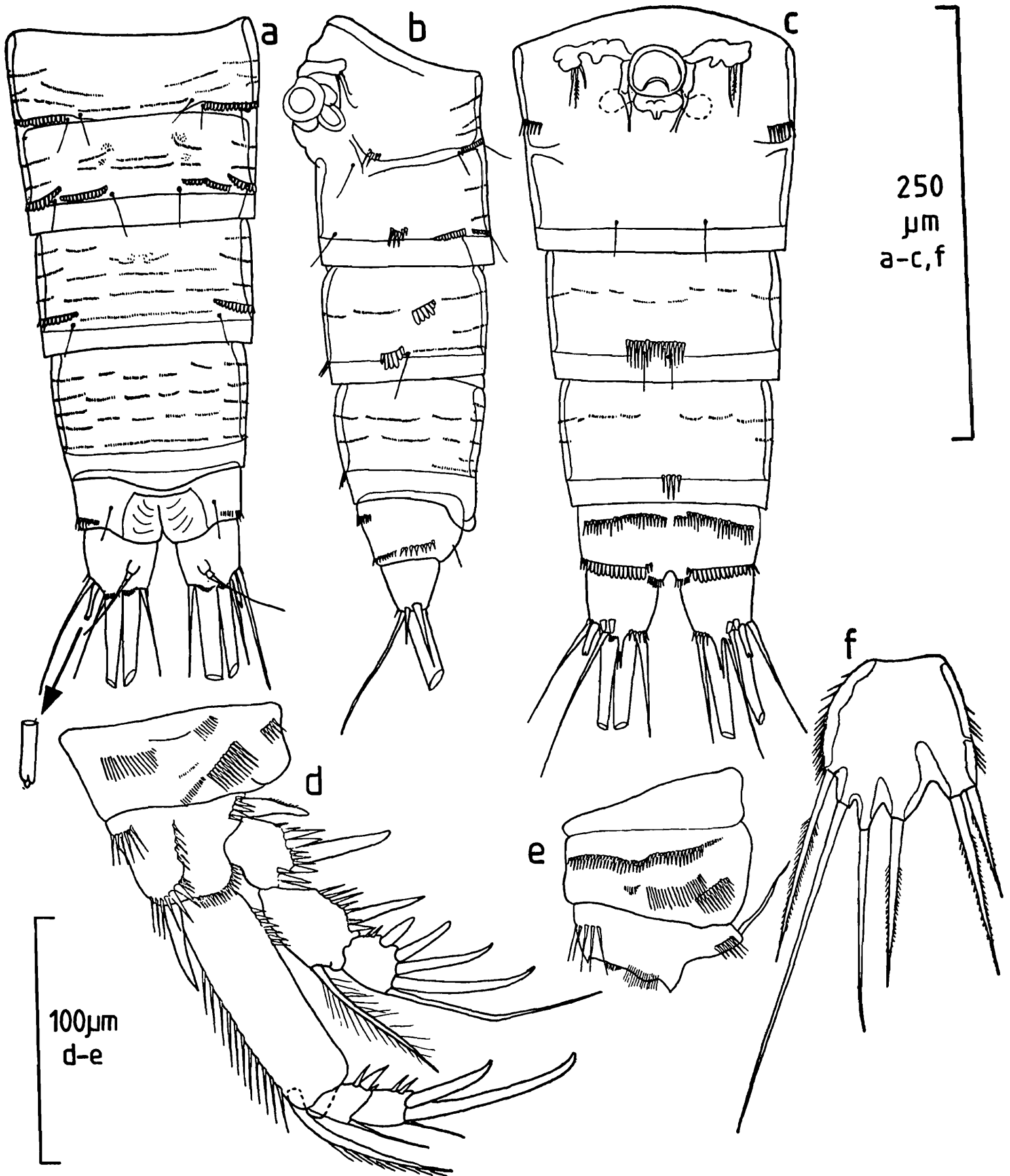


Fig. 89. *Amphiacopsis cinctus*, type 2 ♀ a-c, abdomen, dorsal, lateral and ventral. d, P.1. e, P.4 Coxa and Basis (P.2-P.3 are identical to P.4). f, P.5 Exp.

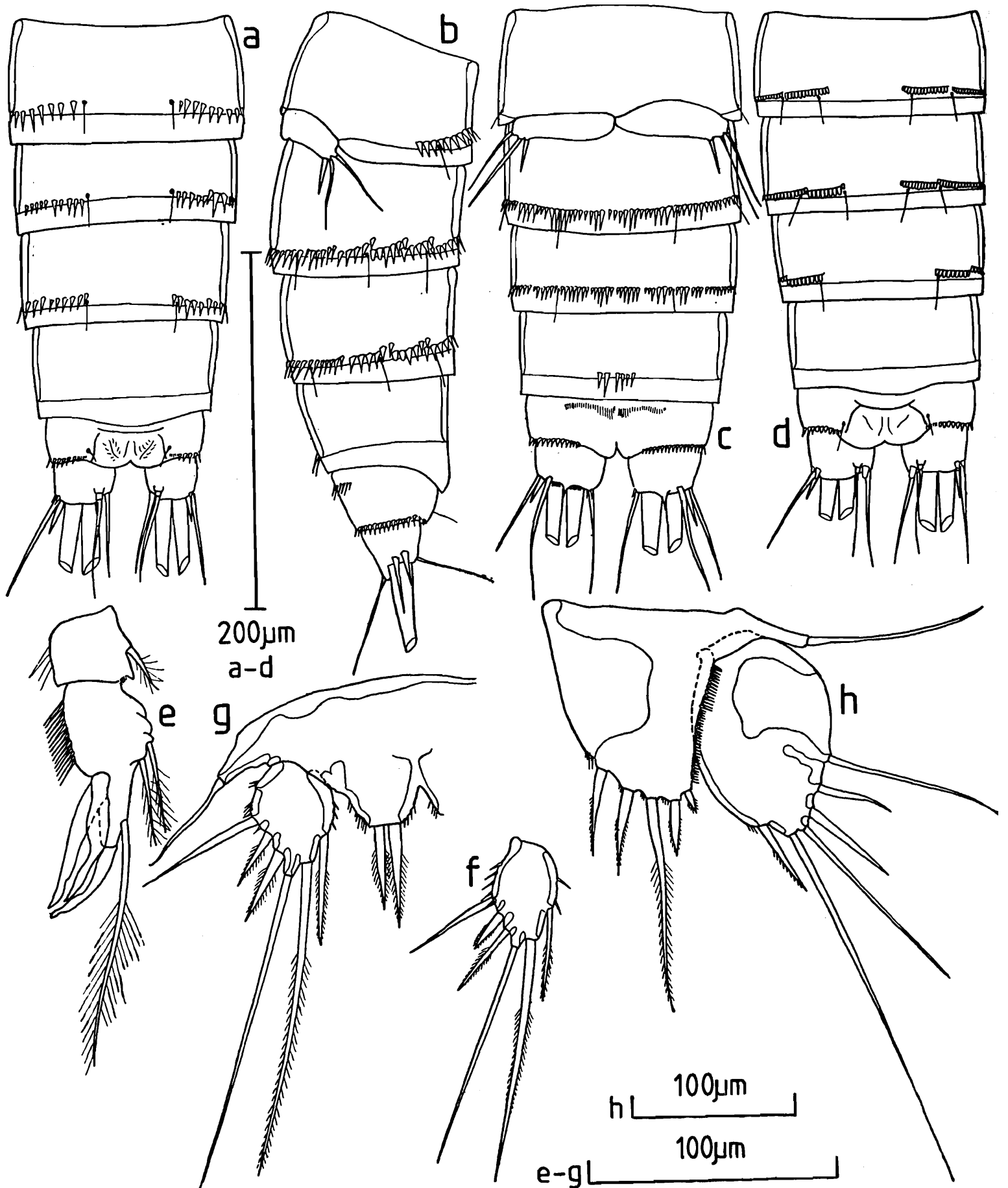


Fig. 90. a-g, *Amphascopepsis cinctus* ♂. a-c, type 1 abdomen, dorsal, lateral and ventral. d, type 2 abdomen, dorsal. e, P.2 Enp. f, P.5 Exp. type 1. g, P.5, type 2. h, *Metamphascopepsis hirsutus* ♀, P.5.

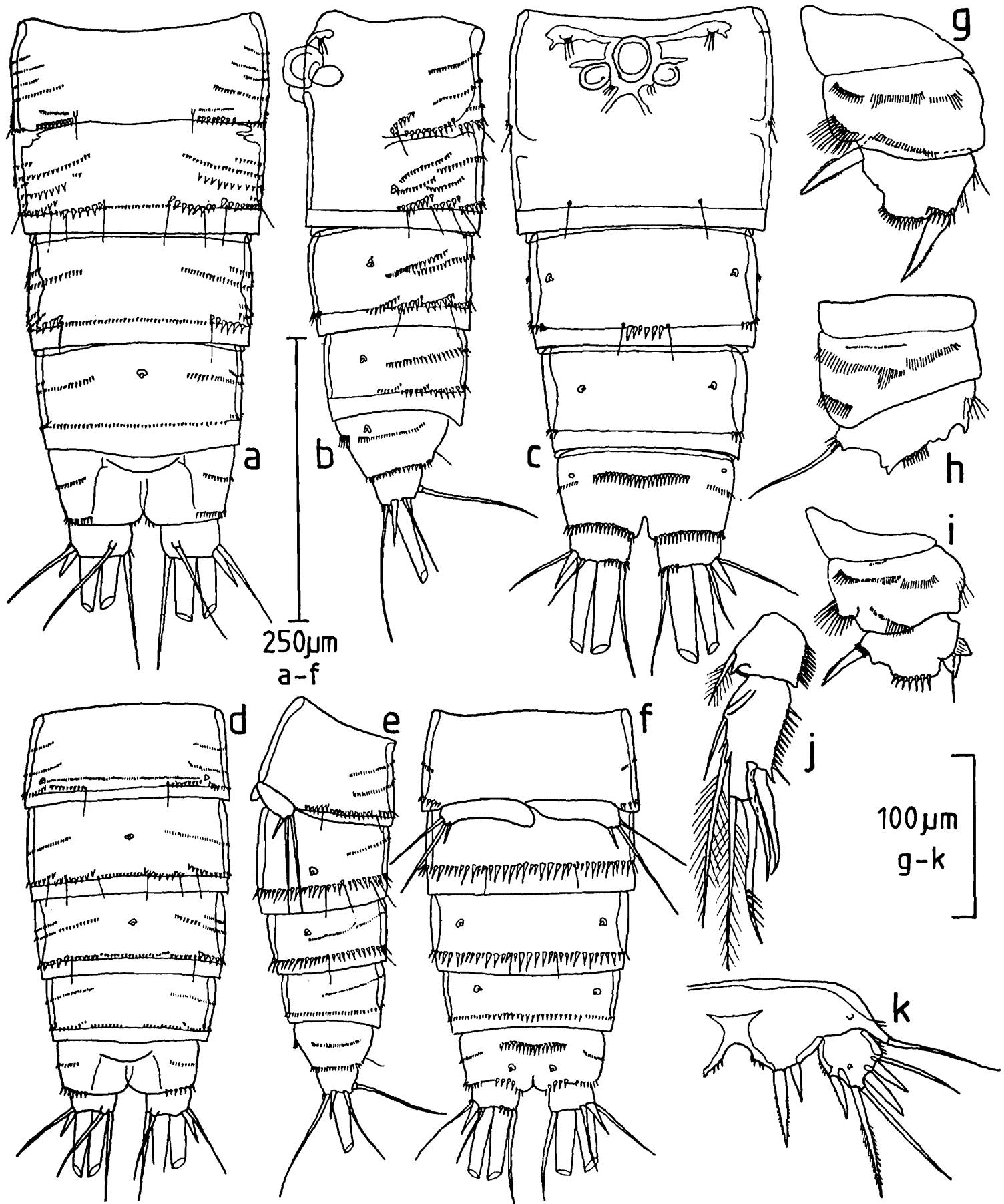


Fig. 91. *Metaphiascopsis hirsutus*. a-f, abdomen, dorsal, lateral and ventral of ♀ (a-c) and ♂ (d-f). g-i, P.1 ♀, P.4 ♀, P.1 ♂, Coxa and Basis. j, ♂ P.2 Enp. k, ♂ P.5.

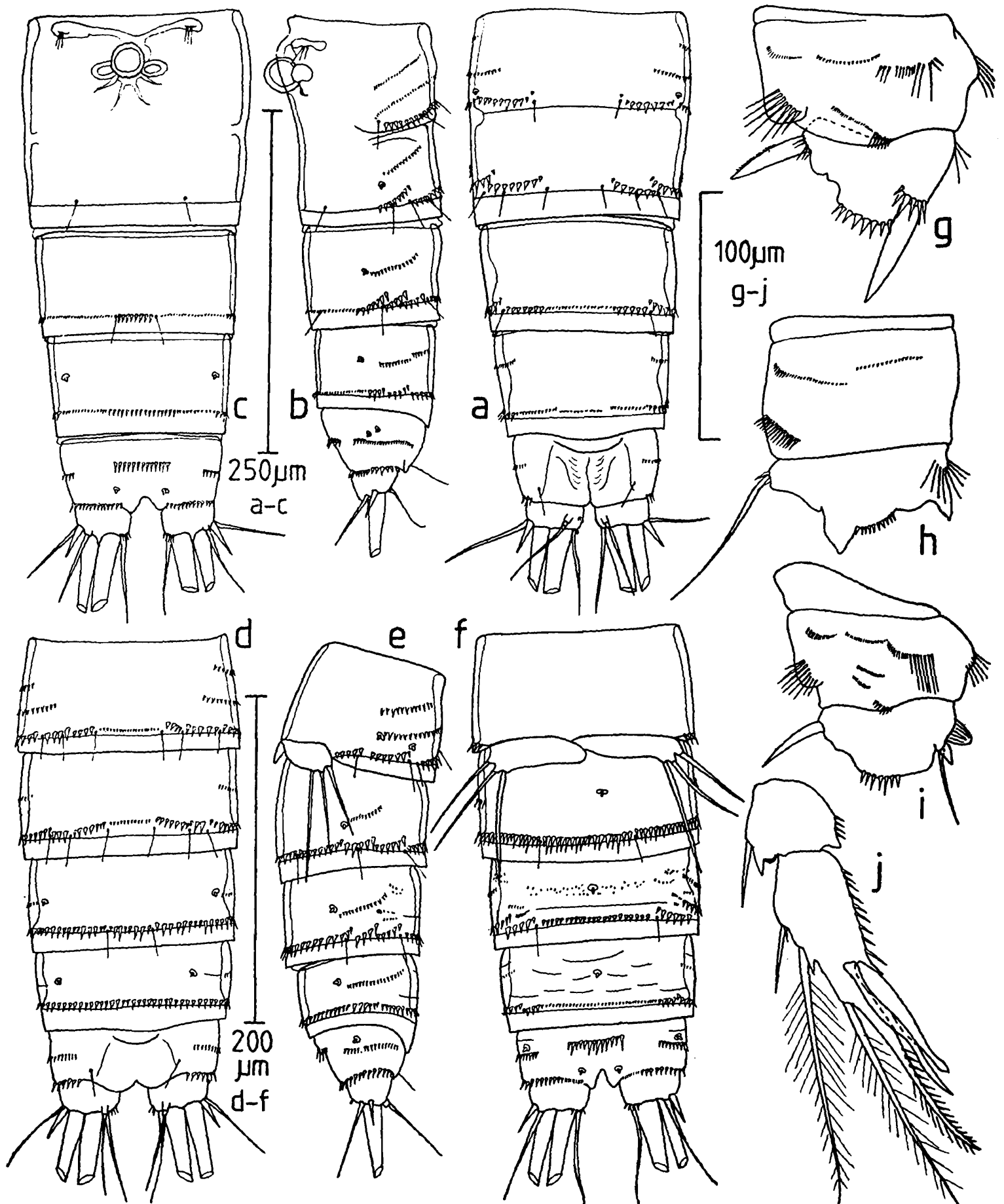


Fig. 92. *Metamphiascopsis nicobaricus*. a-f abdomen, dorsal, lateral and ventral of ♀ (a-c) and ♂ (d-f). g-i, P.1 ♀, P.4 ♀, P.1 ♂, Coxa and Basis. j, ♂ P.2 End.

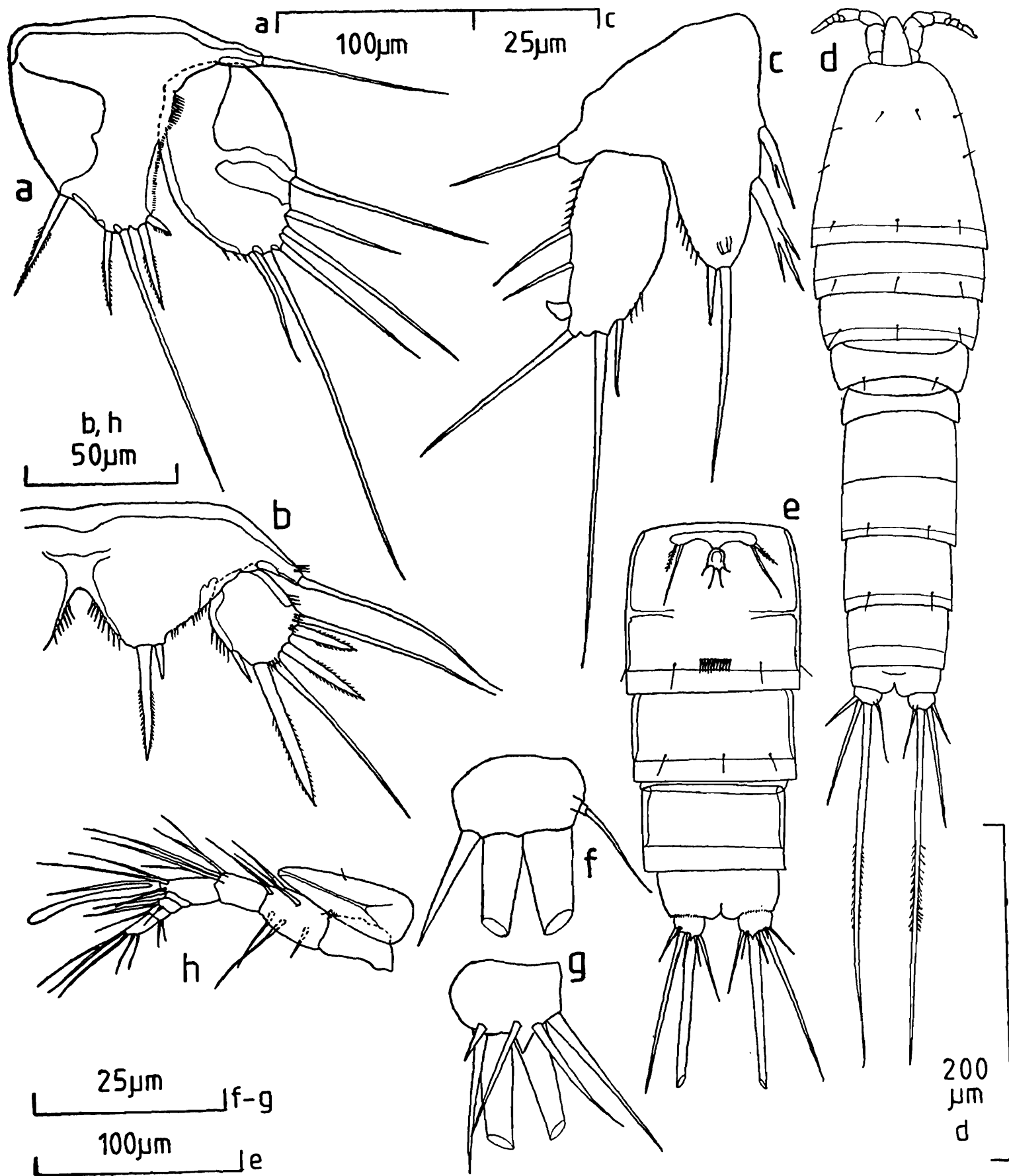


Fig. 93. a-b, *Metamphiascopsis nicobaricus*, P. 5 ♀ and ♂ c, *Bulbamphiascus imus* ♀, P.5. d-h, *Robertgurneya brevipes* ♀ d, dorsal. e, abdomen, ventral. f-g, left caudal ramus, dorsal and ventral. h, rostrum and antennule.

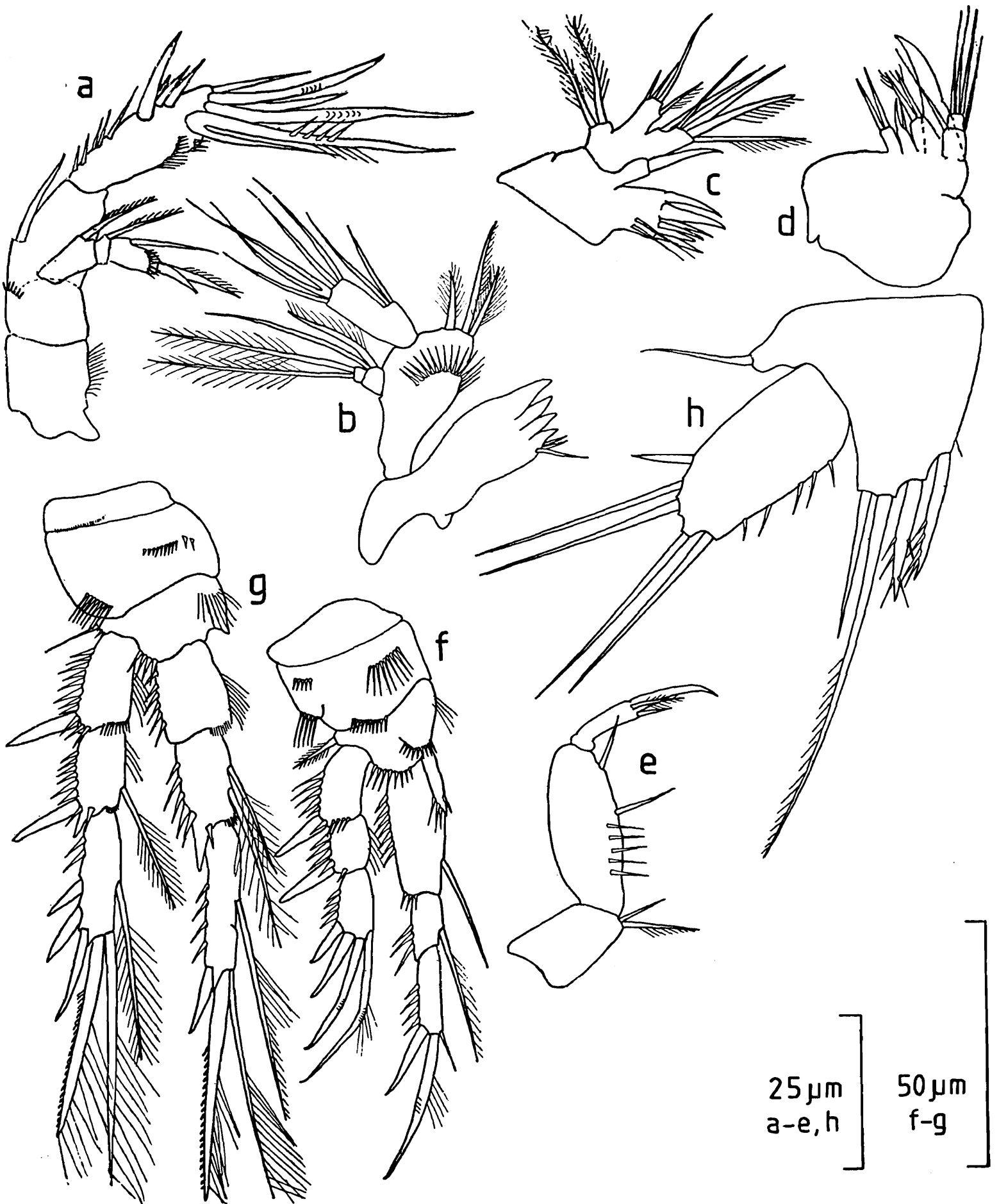


Fig. 94. *Robertgurneya brevipes* ♀. a, antenna. b, mandible. c, maxillule. d, maxilla. e, maxilliped. f-g, P.1-P.2. h, P.5.

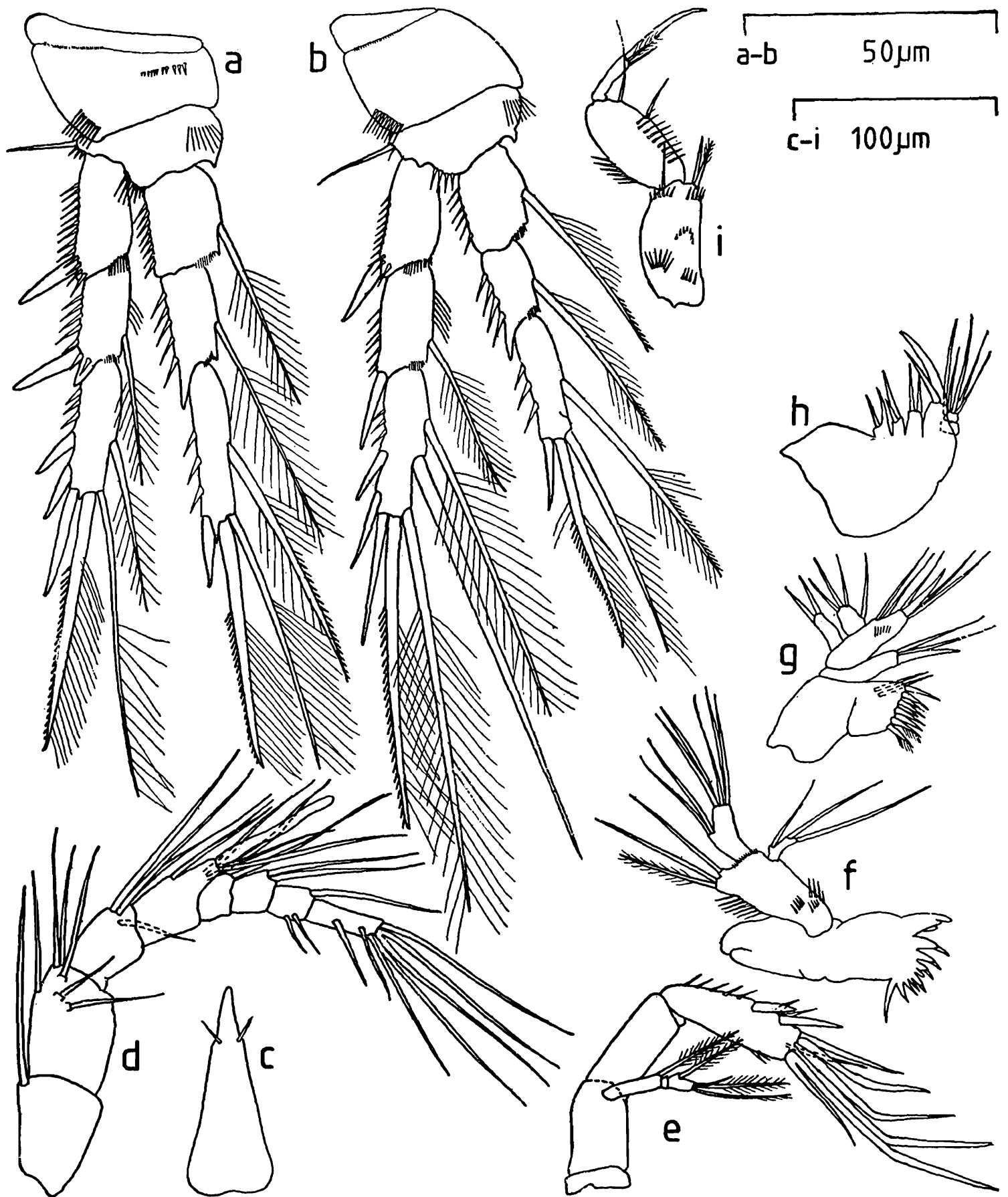


Fig. 95. a-b, *Robertgurneya brevipes* ♀ P.3-P.4. c-i, *Typhlamphiascus ovale* ♀ c, rostrum. d, antennule. e, antenna. f, mandible. g, maxillule. h, maxilla. i, maxilliped.

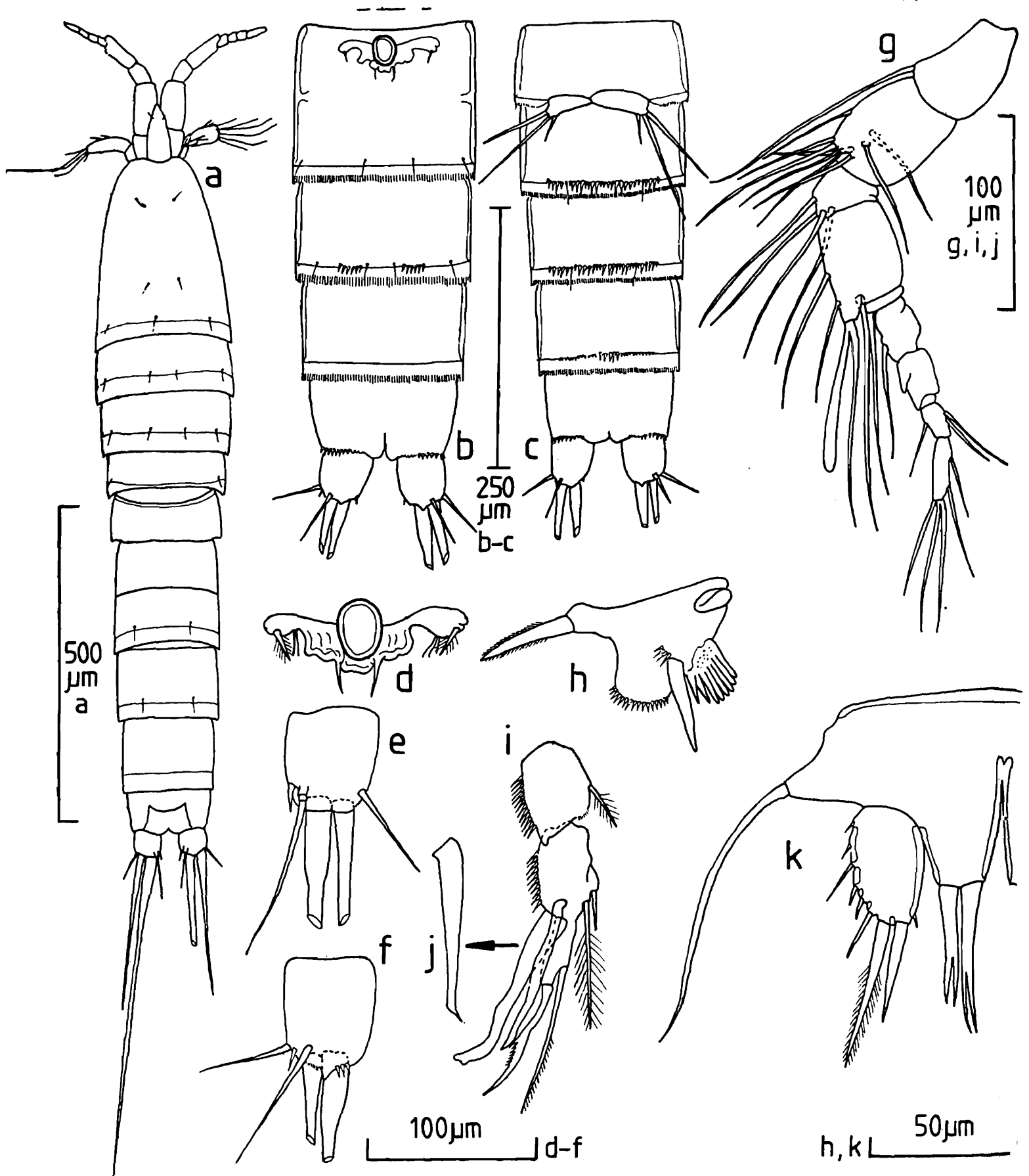


Fig. 96. *Typhlamphiascus ovale*. a, ♀, dorsal. b-c, ♀ and ♂ abdomen, ventral. d, ♀ genital field. e-f, right caudal ramus, dorsal and ventral. g, ♂ antennule. h, ♂ P.1 Basis. i, ♂ P.2 Enp. j, ♂ P.2 Enp. spine in another orientation. k, ♂ P.5.





Fig. 97. a-e, *Typhlamphiascus ovale* ♀, P.1-P.5. f-g, *Schizopera spinifer* ♀, f, rostrum, g, antennule.

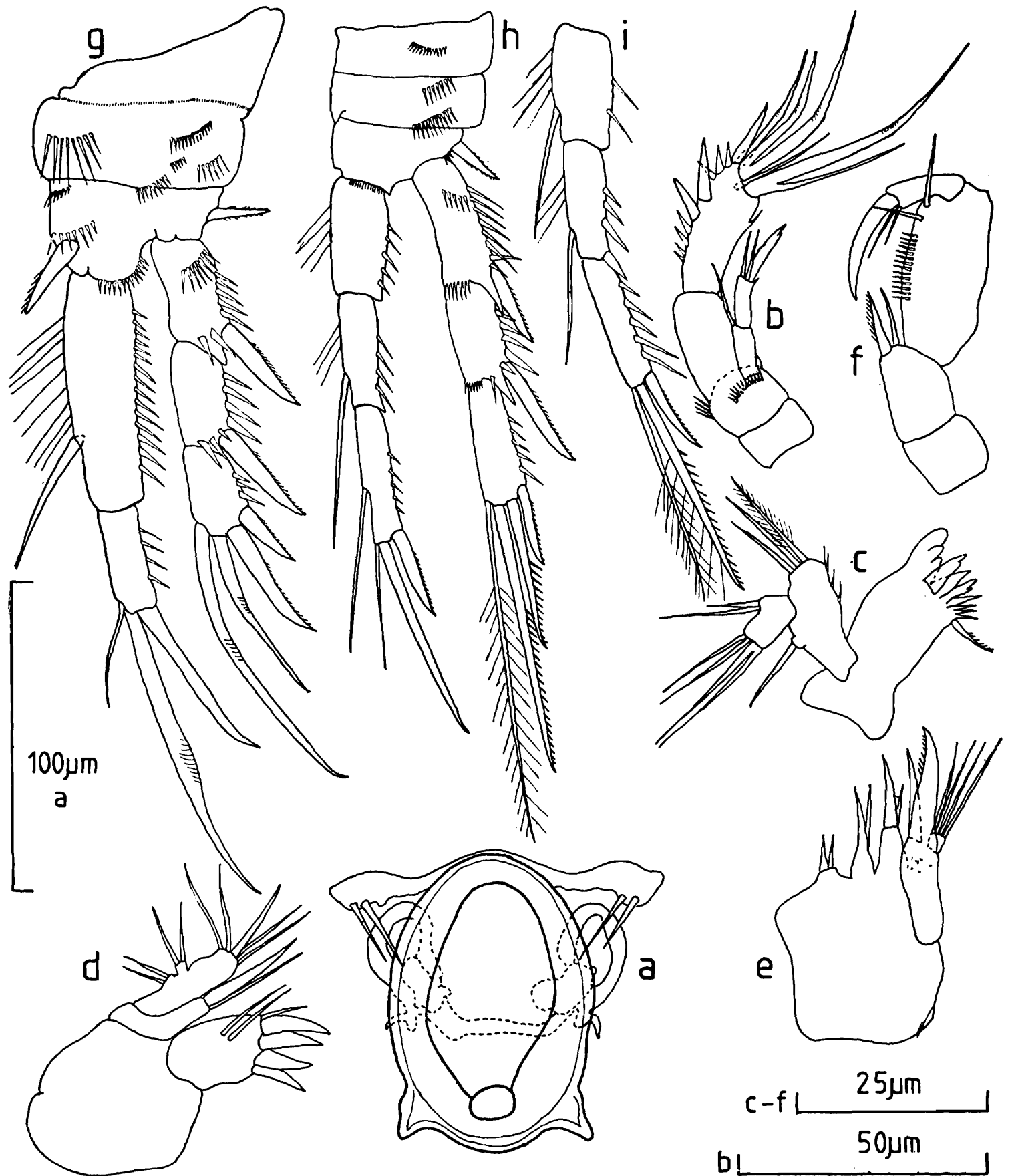


Fig. 98. *Schizopera spinifer* ♀ a, genital field. b, antenna. c, mandible. d, maxillule. e, maxilla. f, maxilliped. g, P.1. h, P.2. i, P.3 Enp.

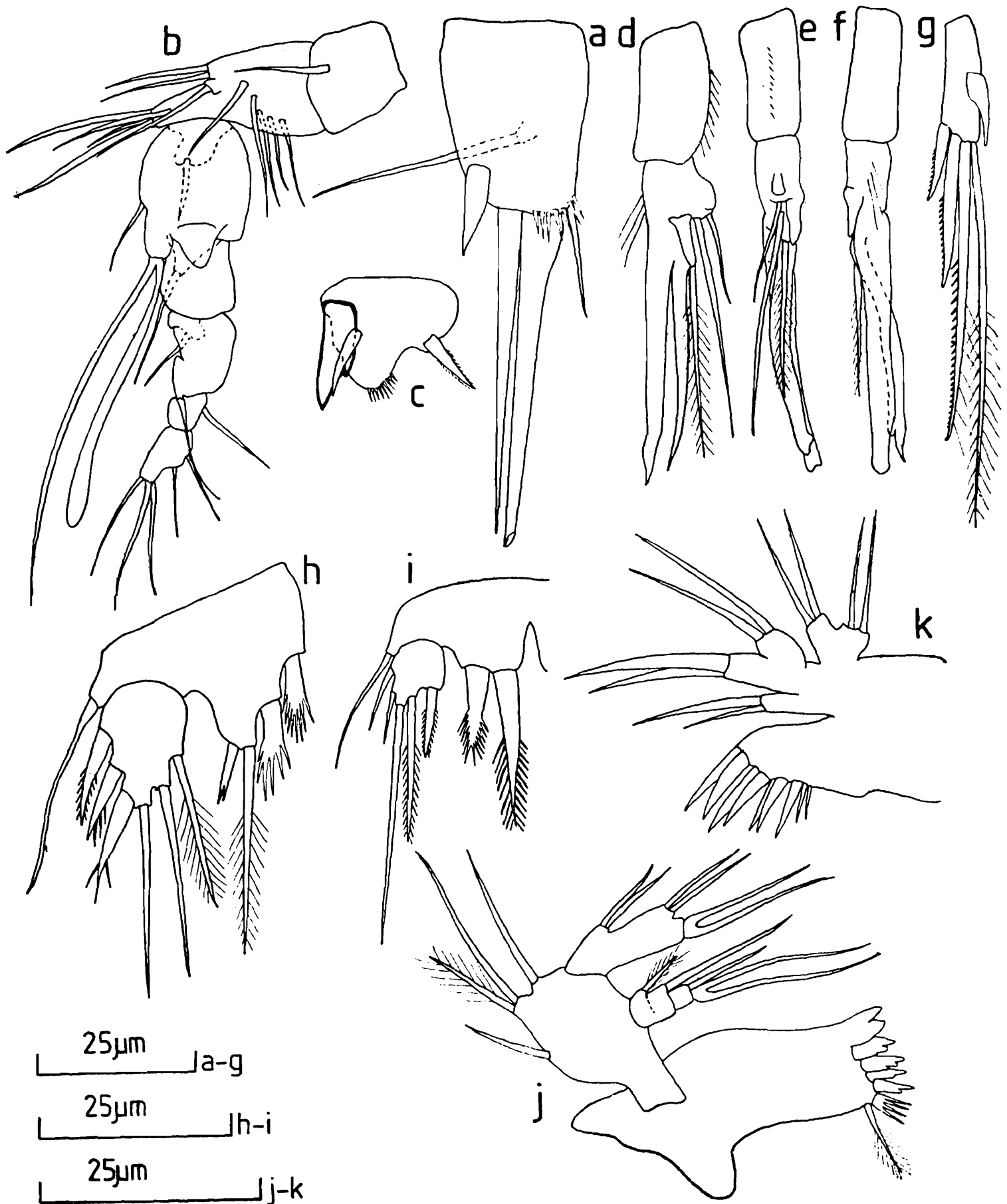


Fig. 99. a-i, *Schizopera spinifer*. a, ♀ right caudal ramus, ventral. b, ♂ antennule. c, ♂ P.1 Basis. d, ♂ P.2 Enp., anterior. e-f, ♂ P.2 Enp., other orientations. g, ♂ P.3 Exp. 3. h-i, P.5 ♀ and ♂ j-k, *Helmutkunzia variabilis* ♀ j, mandible. k, maxillule.

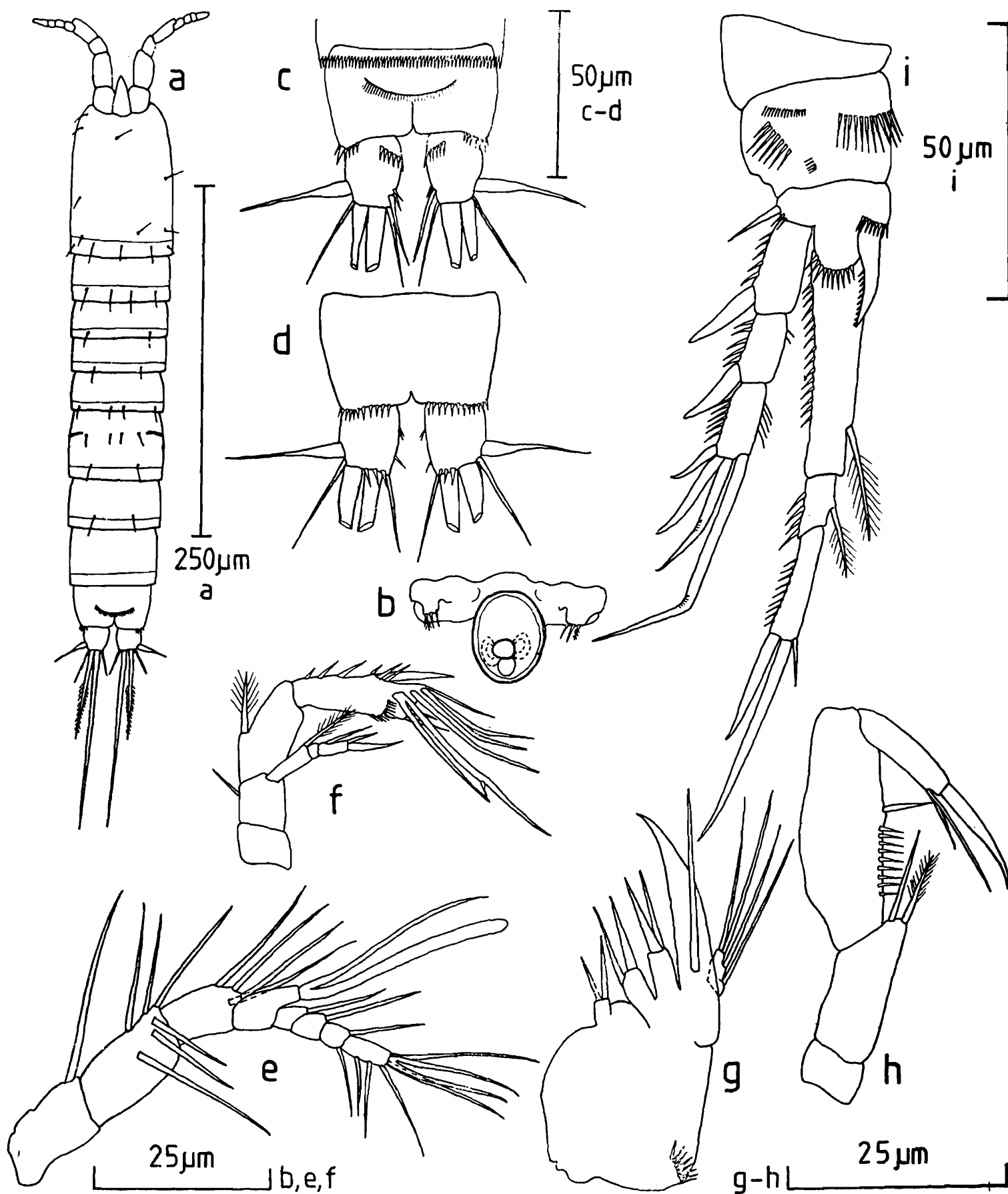


Fig. 100. *Helmutkunzia variabilis* ♀ a dorsal, b, genital field. c-d, last seg. and caudal rami, dorsal and ventral. e, antennule. f, antenna. g, maxilla. h, maxilliped. i, P.I.

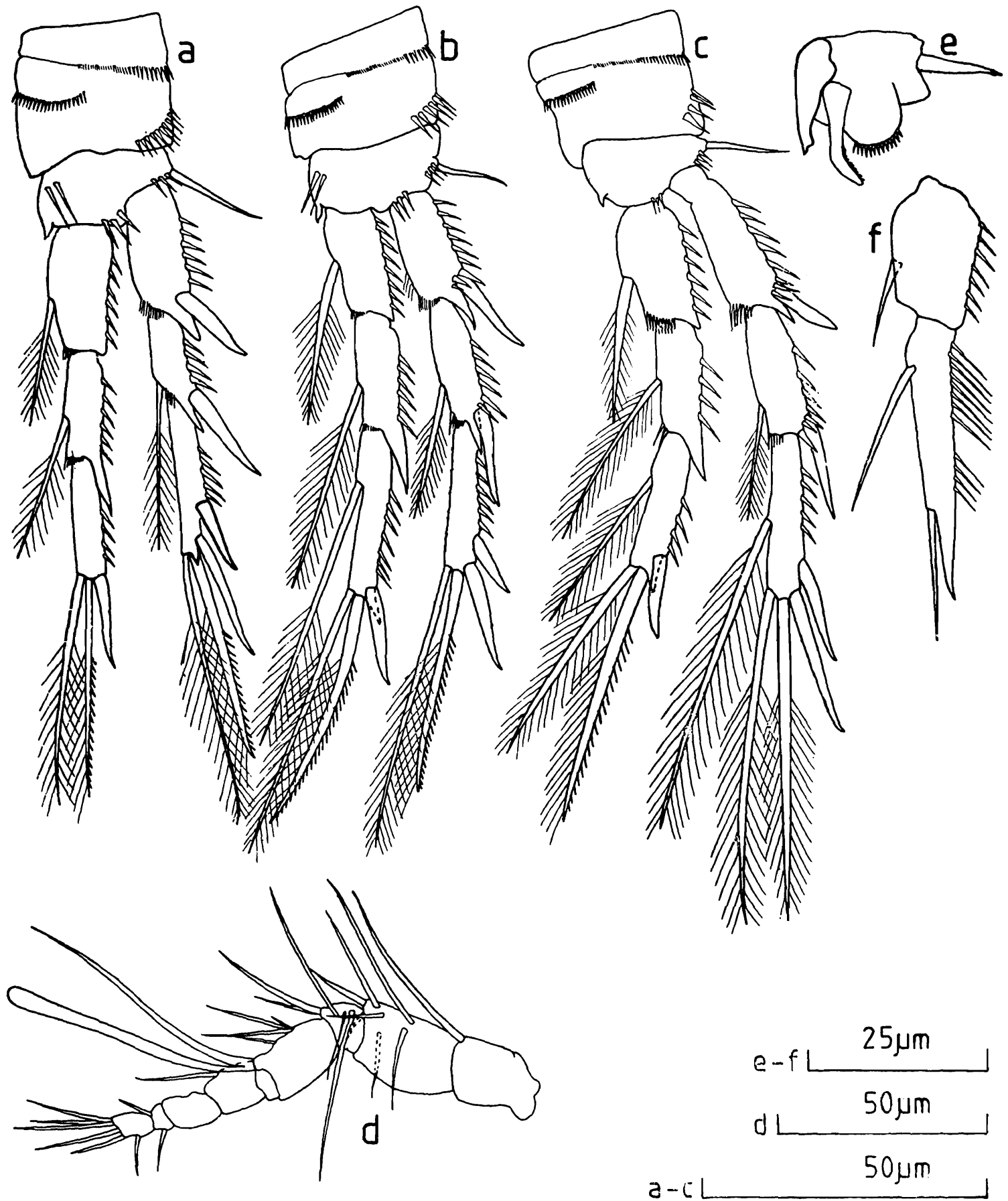


Fig. 101. *Helmutkunzia variabilis*. a-c, ♀ P.2-P.4. d, ♂ antennule. e, ♂ P.1 Basis. f, ♂ P.2 Enp.

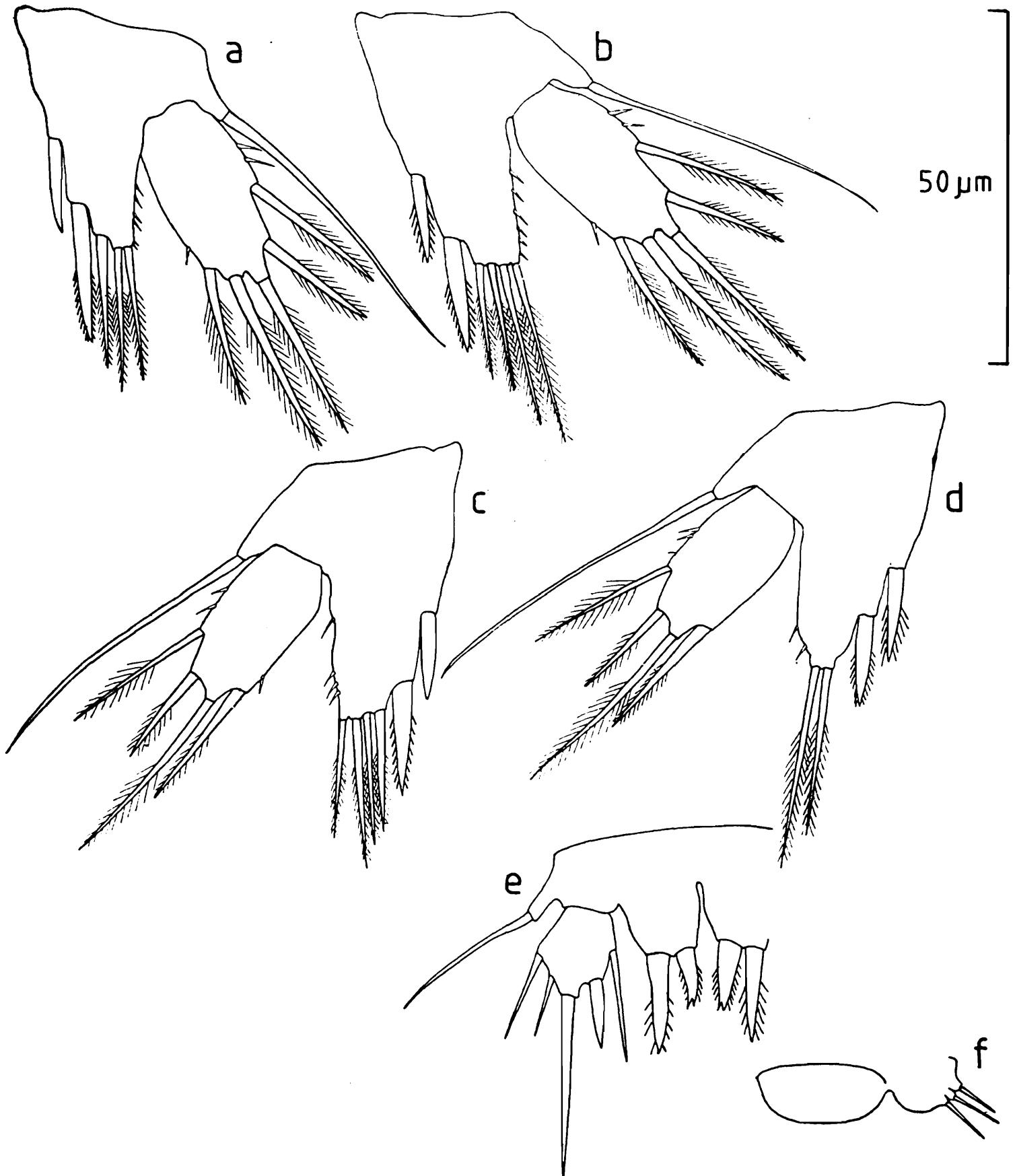


Fig. 102. *Helmutkunzia variabilis*. a-d ♀ P.5. e-f, ♂ P.5-P.6.

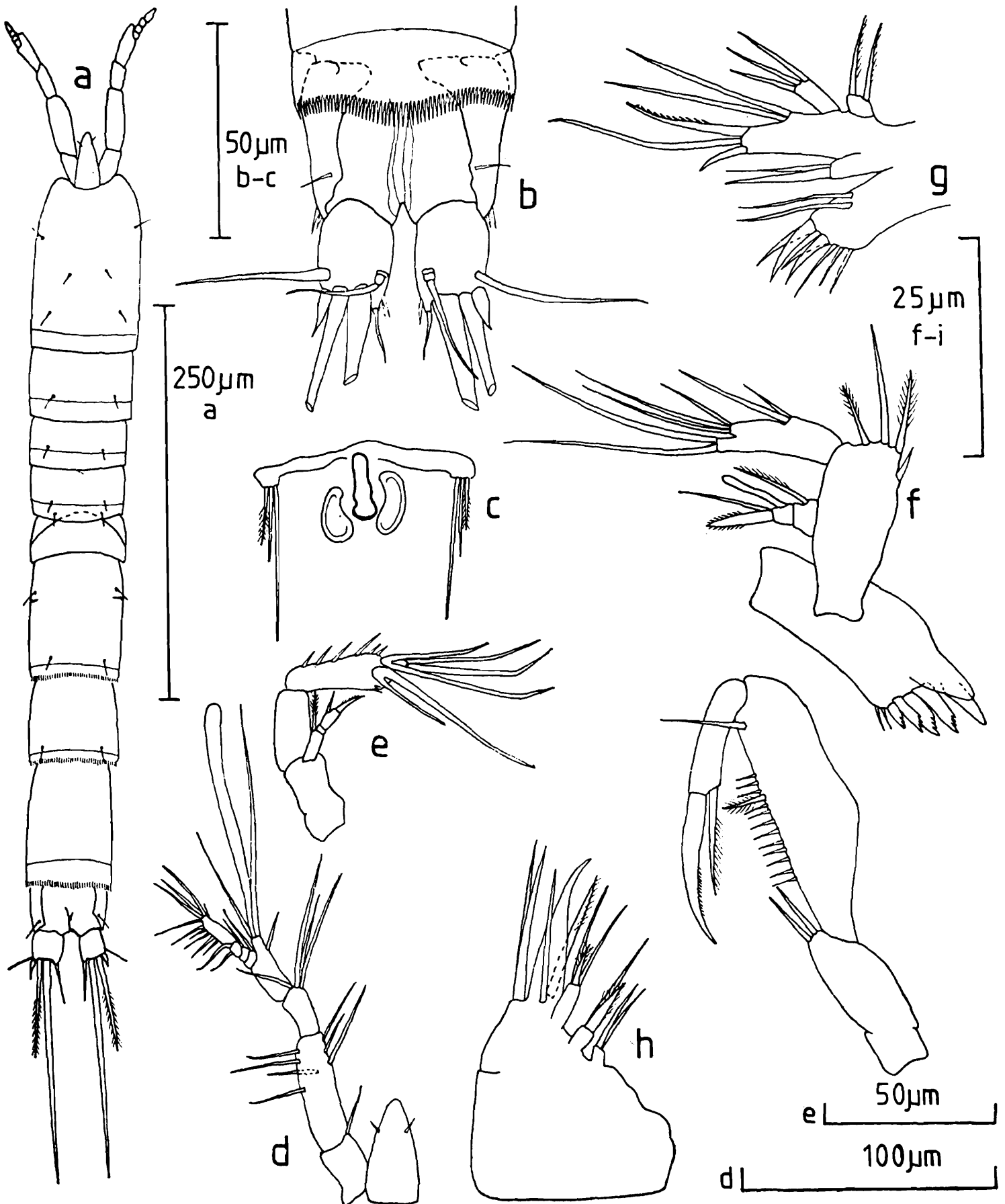


Fig. 103. *Balucopsylla triarticulata* ♀ a, dorsal. b, last seg. and caudal rami, dorsal. c, genital field. d, rostrum and antennule. e, antenna. f, mandible. g, maxillule. h, maxilla. i, maxiliped.

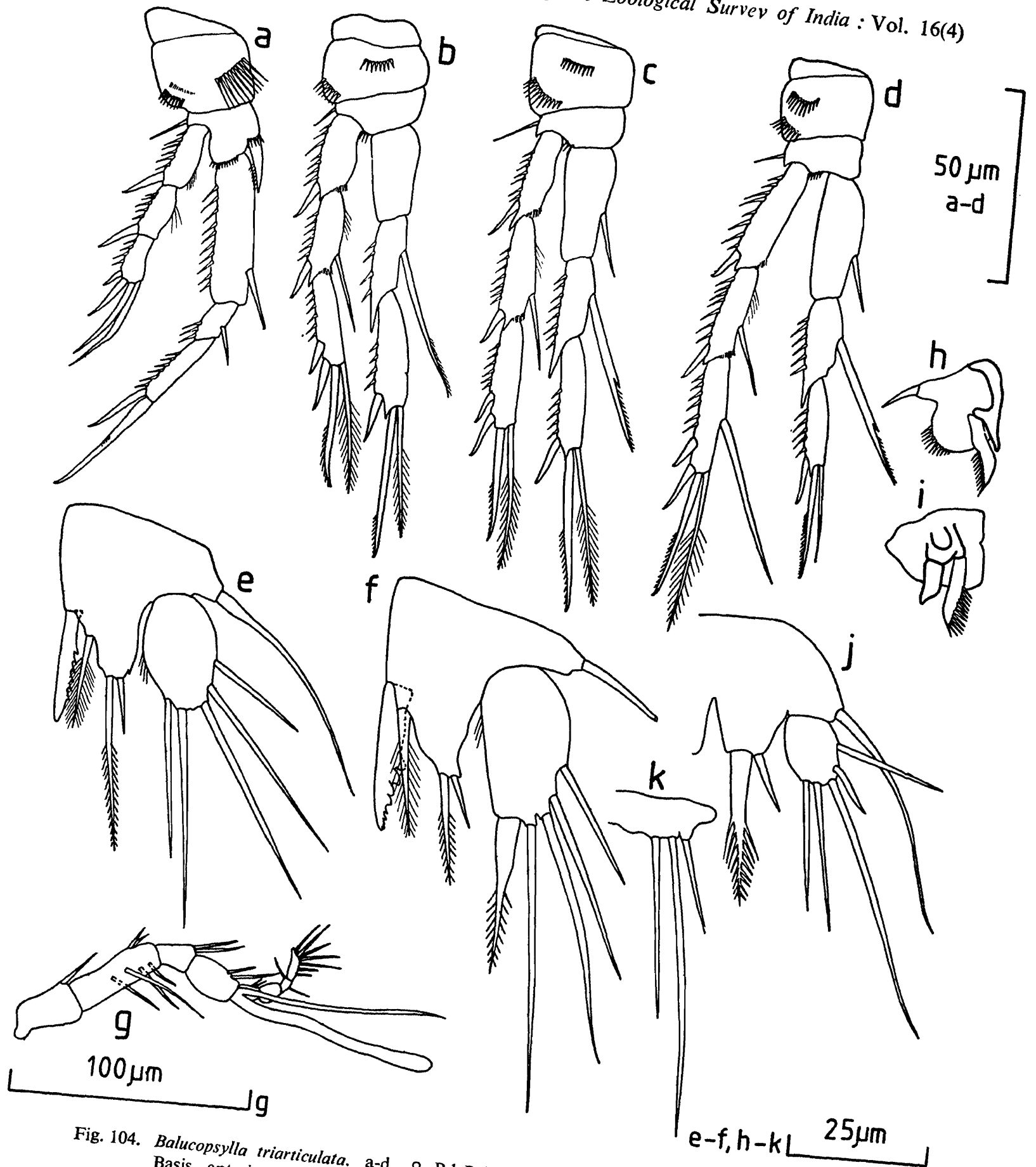


Fig. 104. *Balucopsylla triarticulata*. a-d, ♀ P.1-P.4. e-f, ♀ P.5. g, ♂ antennule. h-i, ♂ P.1 Basis, anterior and inner lateral. j-k, ♂ P.5-P.6.



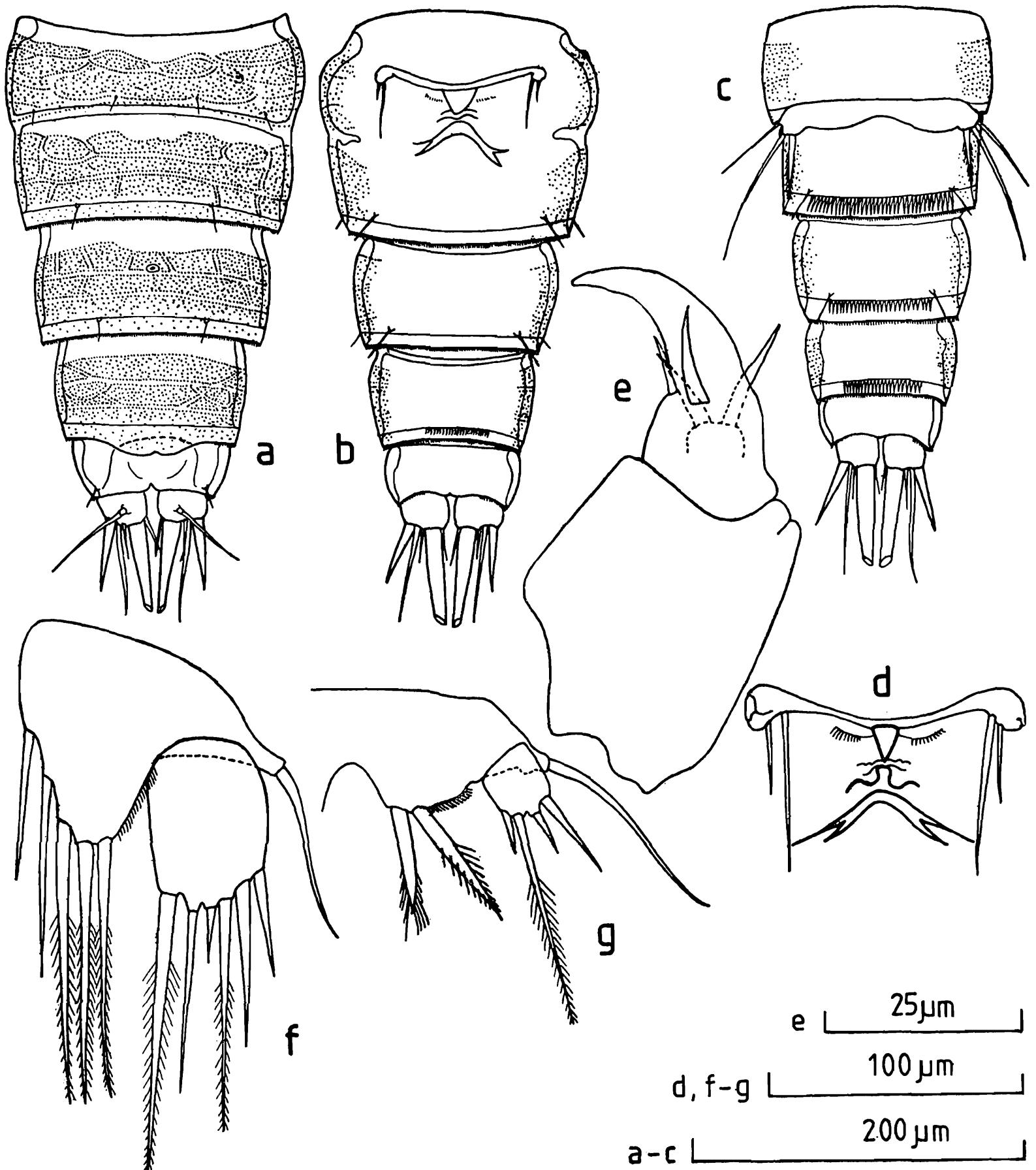


Fig. 105. *Parialysus robustus*. a-b, ♀ abdomen, dorsal and ventral. c ♂ abdomen, ventral. d, ♀ genital field. e, ♀ maxilla. f-g, P.5 ♀ and ♂

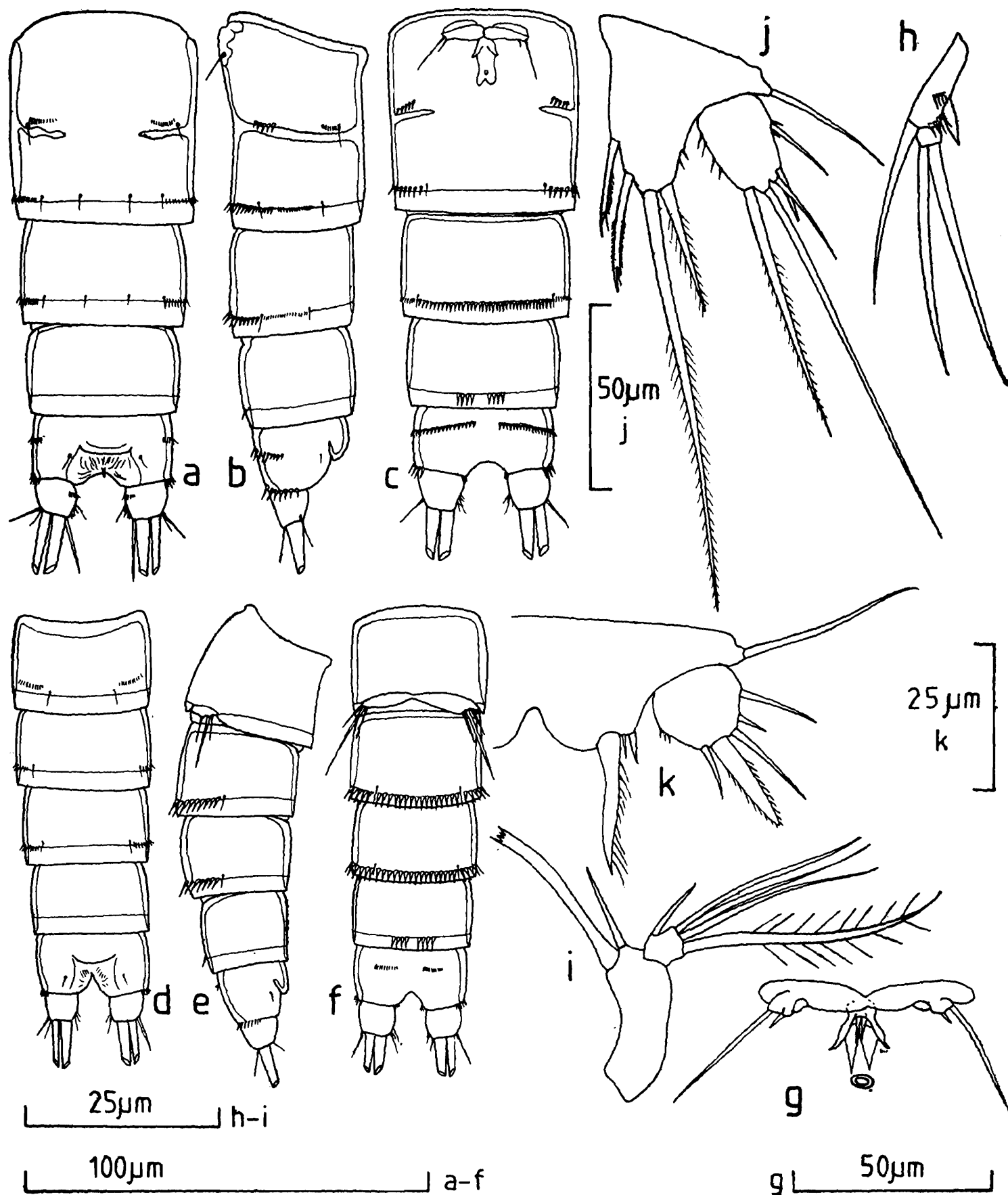


Fig. 106. *Ameira parvula*. a-f, abdomen, dorsal, lateral and ventral of ♀ (a-c) and ♂ (d-f). g. ♀ genital field. h, ♀ antenna. i, ♀ mandible palp. j-k, P.5 ♀ and ♂

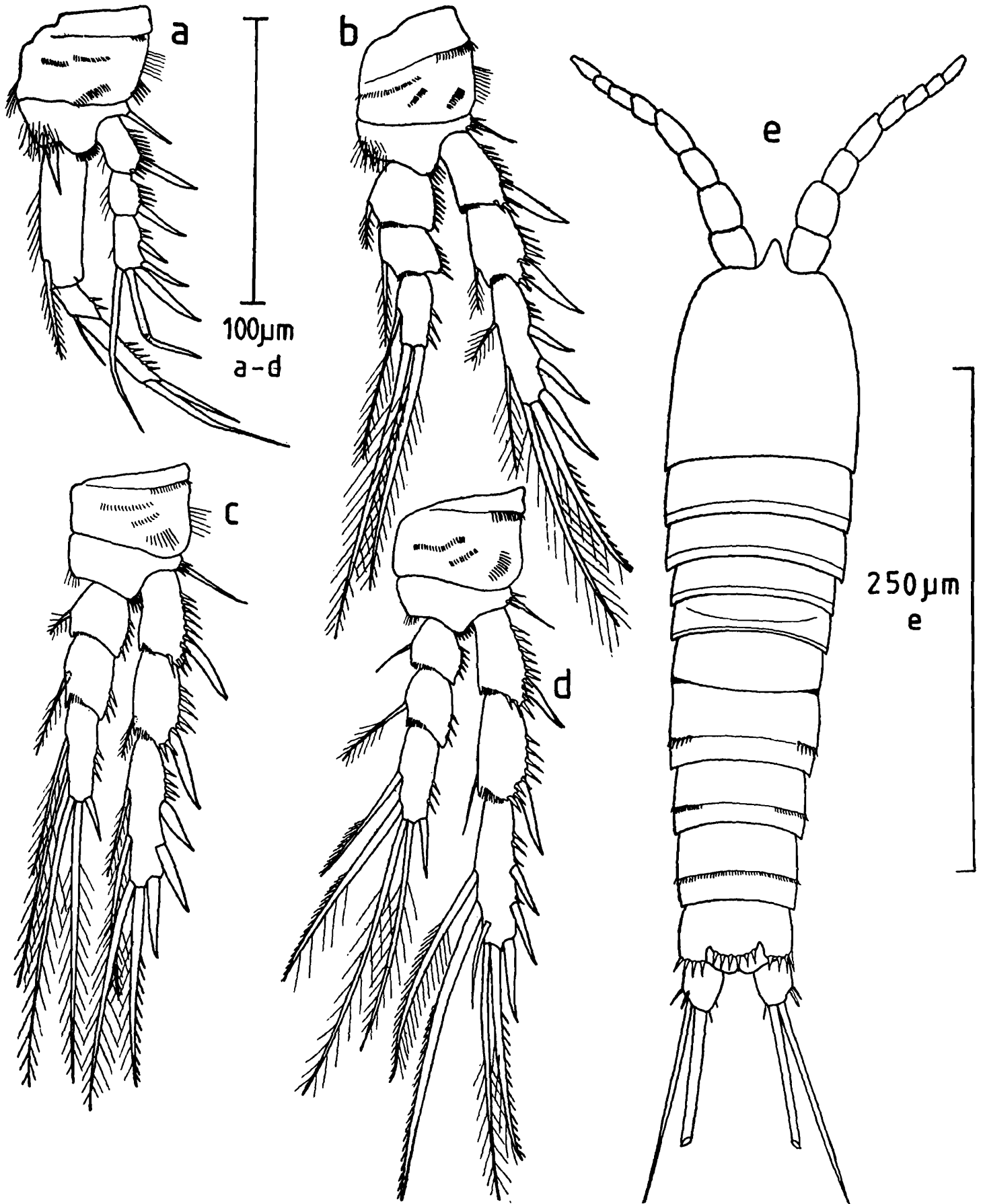


Fig. 107. a-d, *Ameira parvula* ♀, P.1-P.4. e, *Nitocra quadriseta* ♀, dorsal.

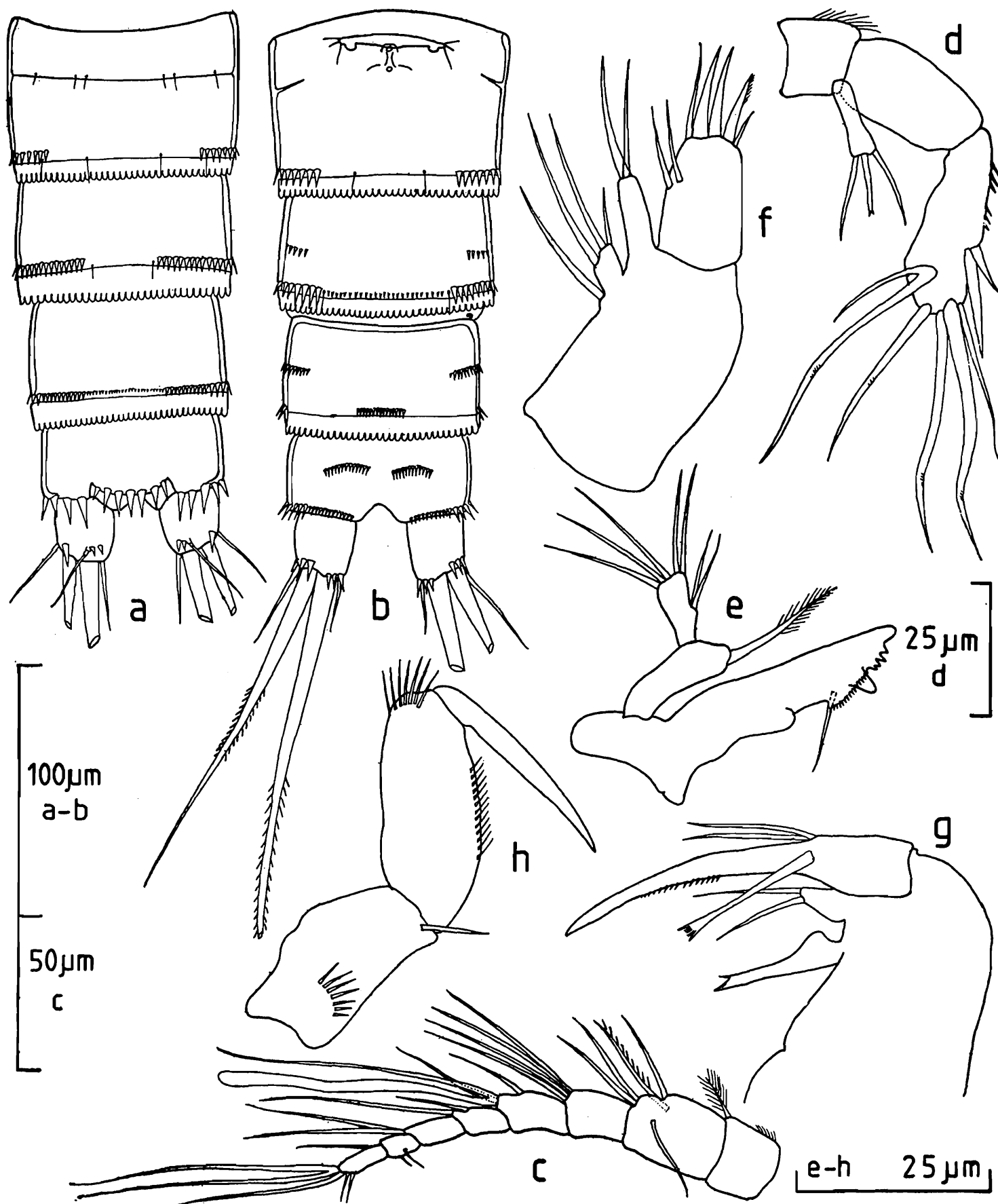


Fig. 108. *Nitocra quadriseta* ♀. a-b, abdomen, dorsal and ventral. c, antennule. d, antenna. e, mandible. f, maxillule. g, maxilla. h, maxilliped.

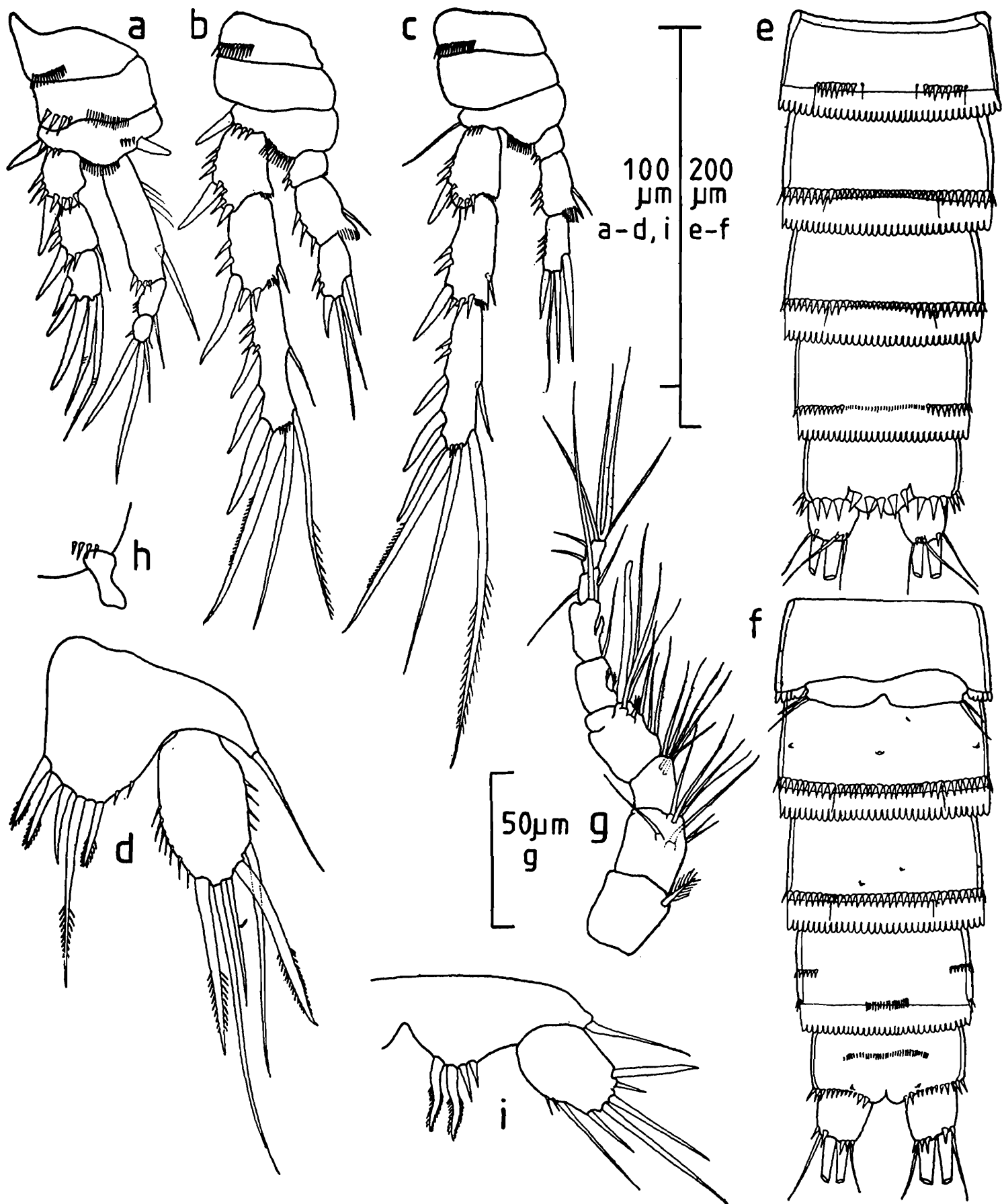


Fig. 109. *Nitocra quadriseta*. a-b, ♀ P.1-P.2. c-d, ♀ P.4-P.5. c-f, ♂ abdomen, dorsal and ventral. g, ♂ antennule. h, ♂ P.1 Basis, inner spine. i, ♂ P.5.

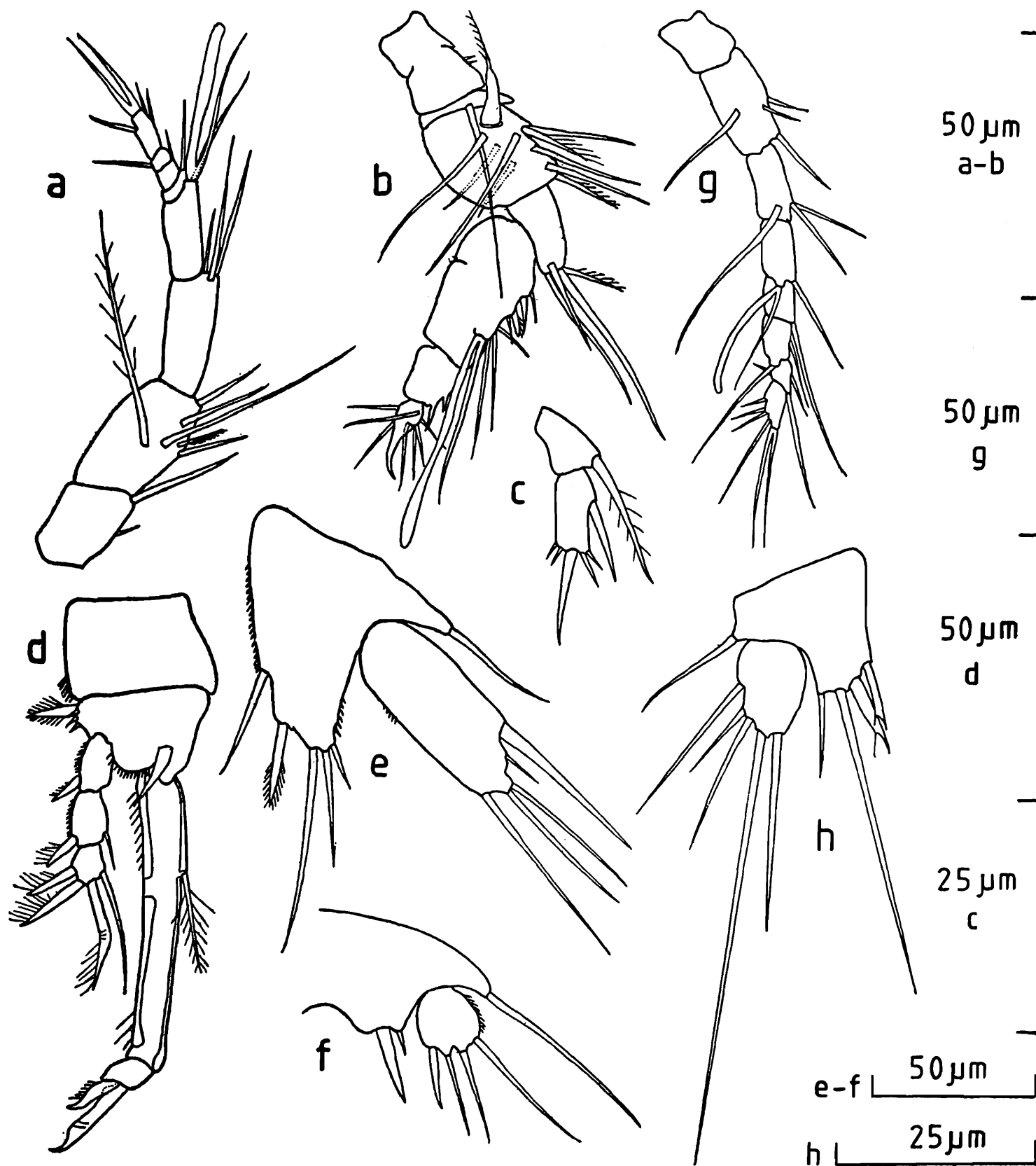


Fig. 110. a-f, *Karllangia arenicola bengalensis*. a-b, antennule, ♀ and ♂. c, ♀ antenna Exp. d, ♀ P.1. e-f, P.5, ♀ and ♂. g-h, *Parapseudoleptomesochra trisetosa* ♀. g, antennule. h, P.5.

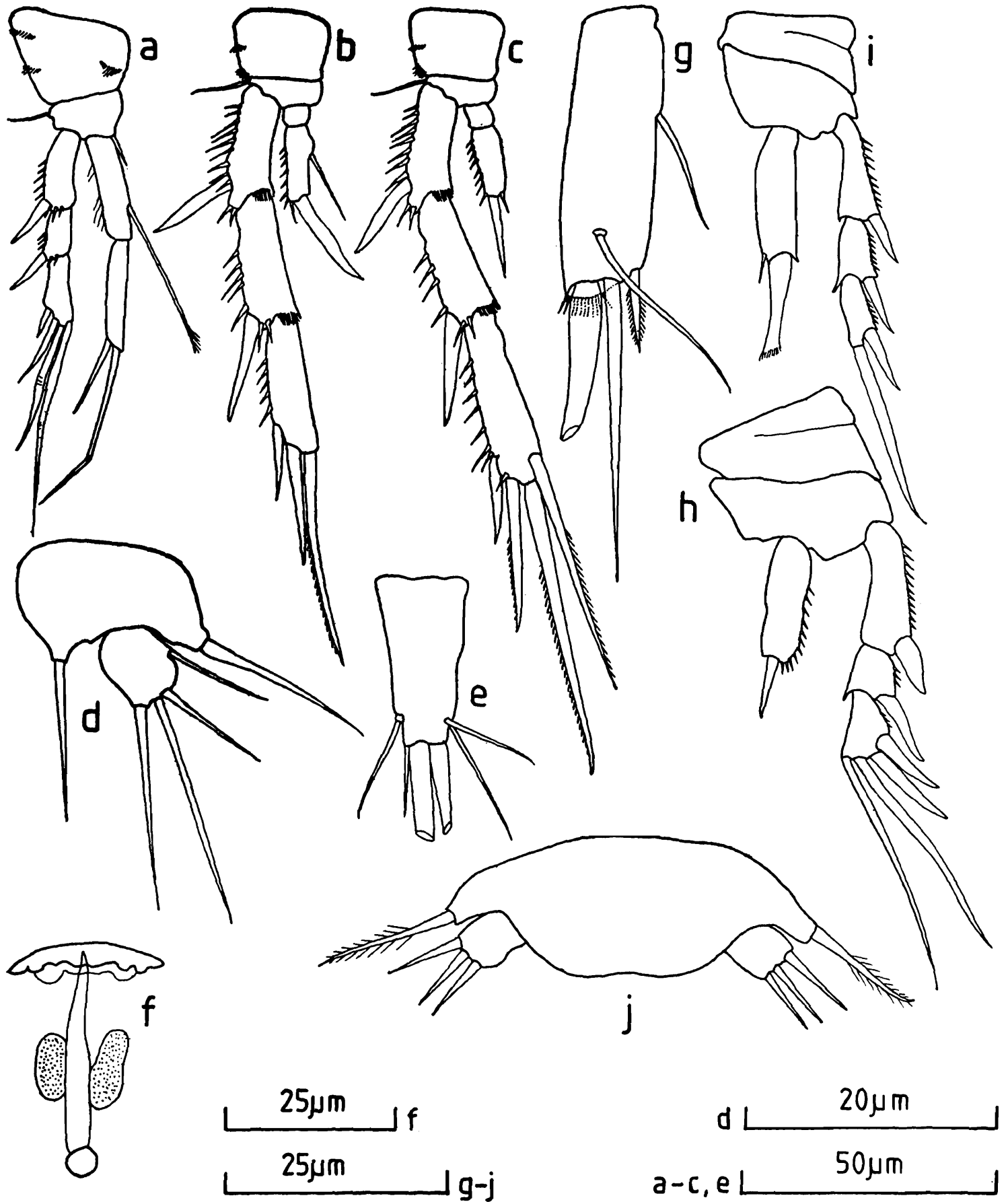


Fig. 111. a-f, *Parevansula elongatus* ♀ a-b, P.1-P.2. c-d, P.4-P.5. e, left caudal ramus, ventral f, genital field. g-j, *Kliopsyllus holsaticus*. g, ♀ right caudal ramus, dorsal. h, ♀ P.2 i, ♂ P.4. j, ♂ P.5.

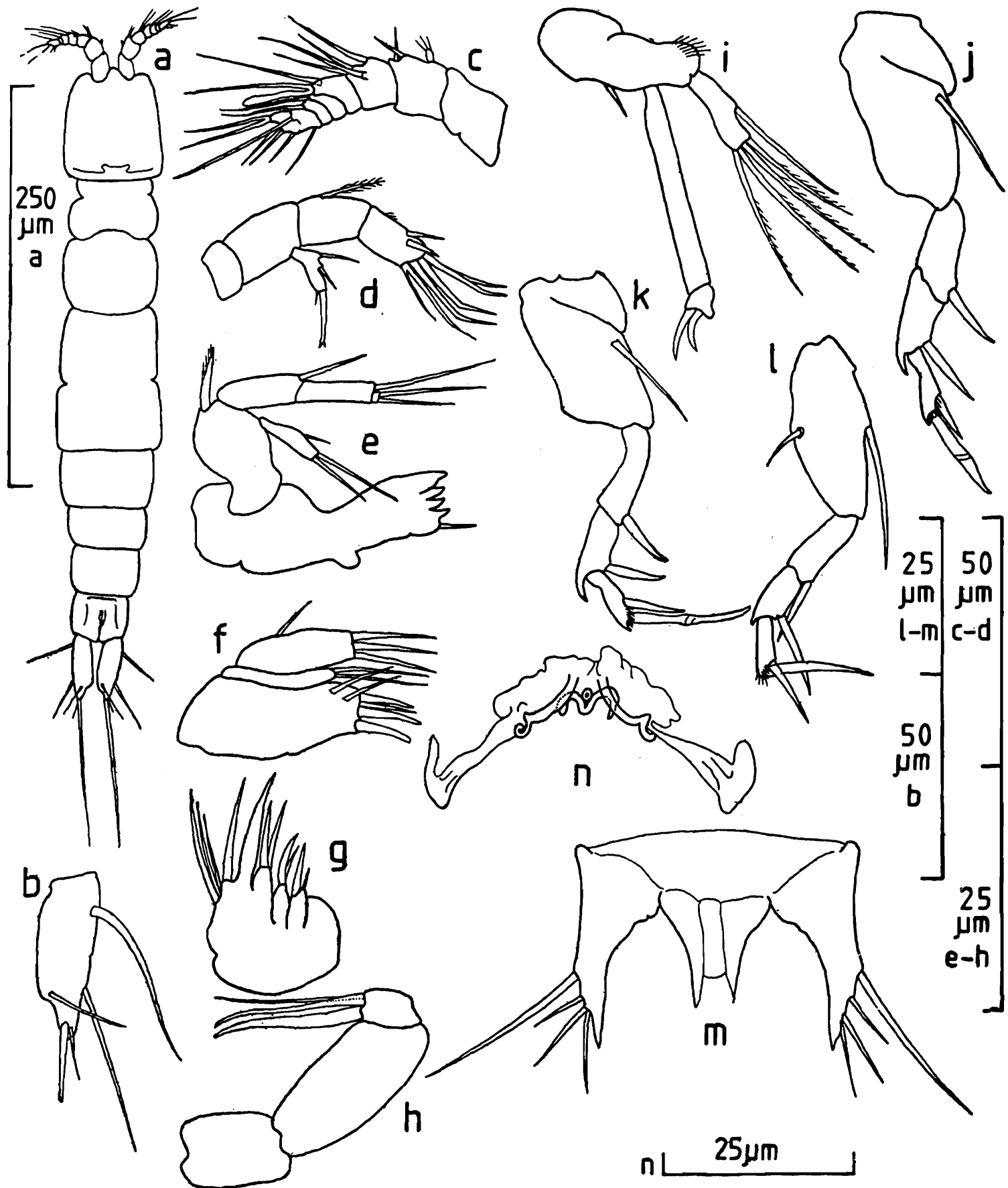


Fig. 112. *Apodopsyllus madrasensis* ♀. a, dorsal. b, right caudal ramus, dorsal. c, antennule. d, antenna. e, mandible. f, maxillule. g, maxilla. h, maxilliped, i-m, P.1-P.5. n, genital field.



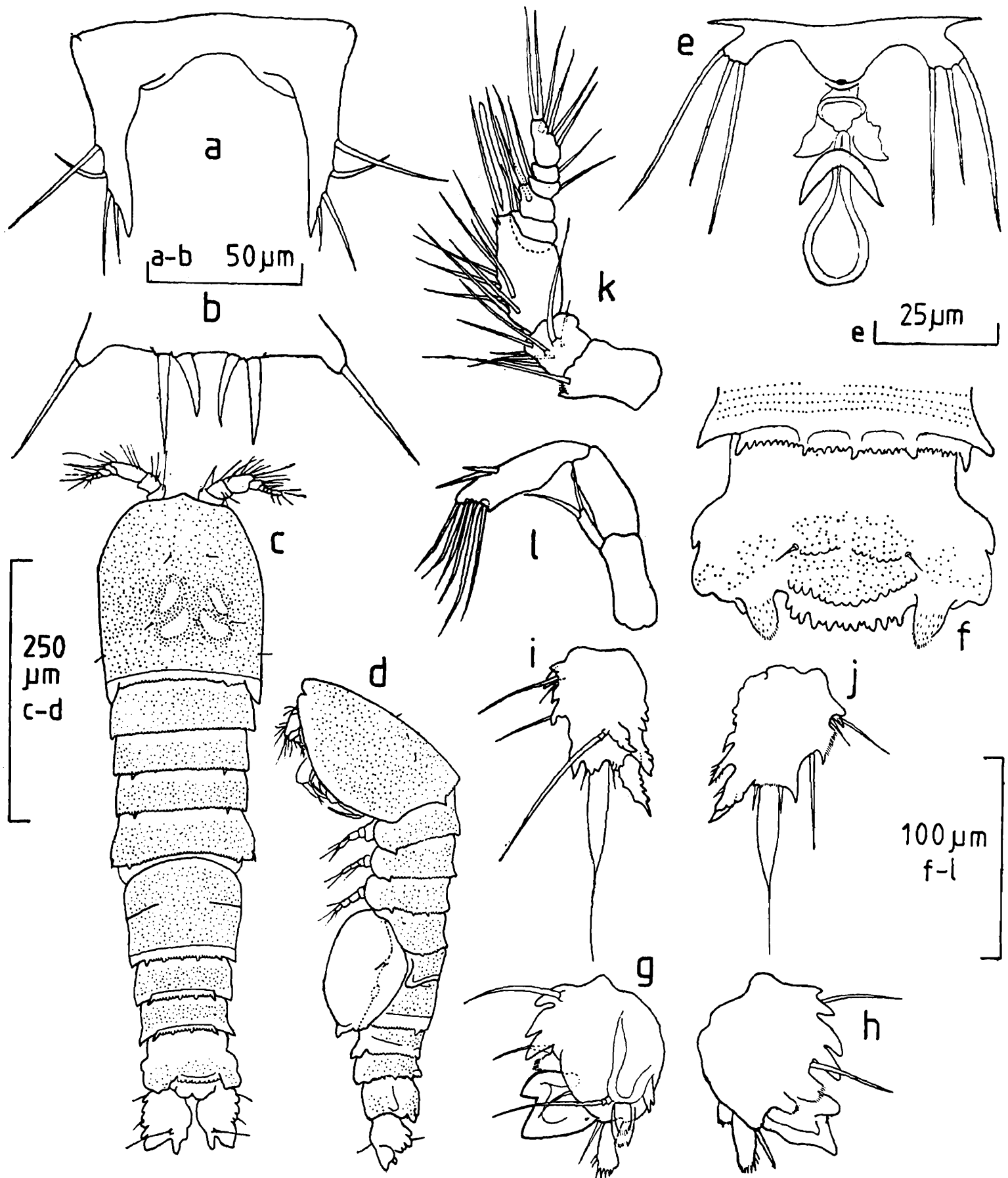


Fig. 113. a-b, *Apodopsyllus madrasensis*, ♂ P.5-P.6. c-l, *Oniscopsis dimorphus*. c-d, ♀ dorsal and lateral. e, ♀ genital field. f, ♀ anal seg., dorsal. g-j, left caudal ramus, dorsal and ventral of ♀ (g-h) and ♂ (i-j). k, ♀ antennule. l, ♀ antenna.

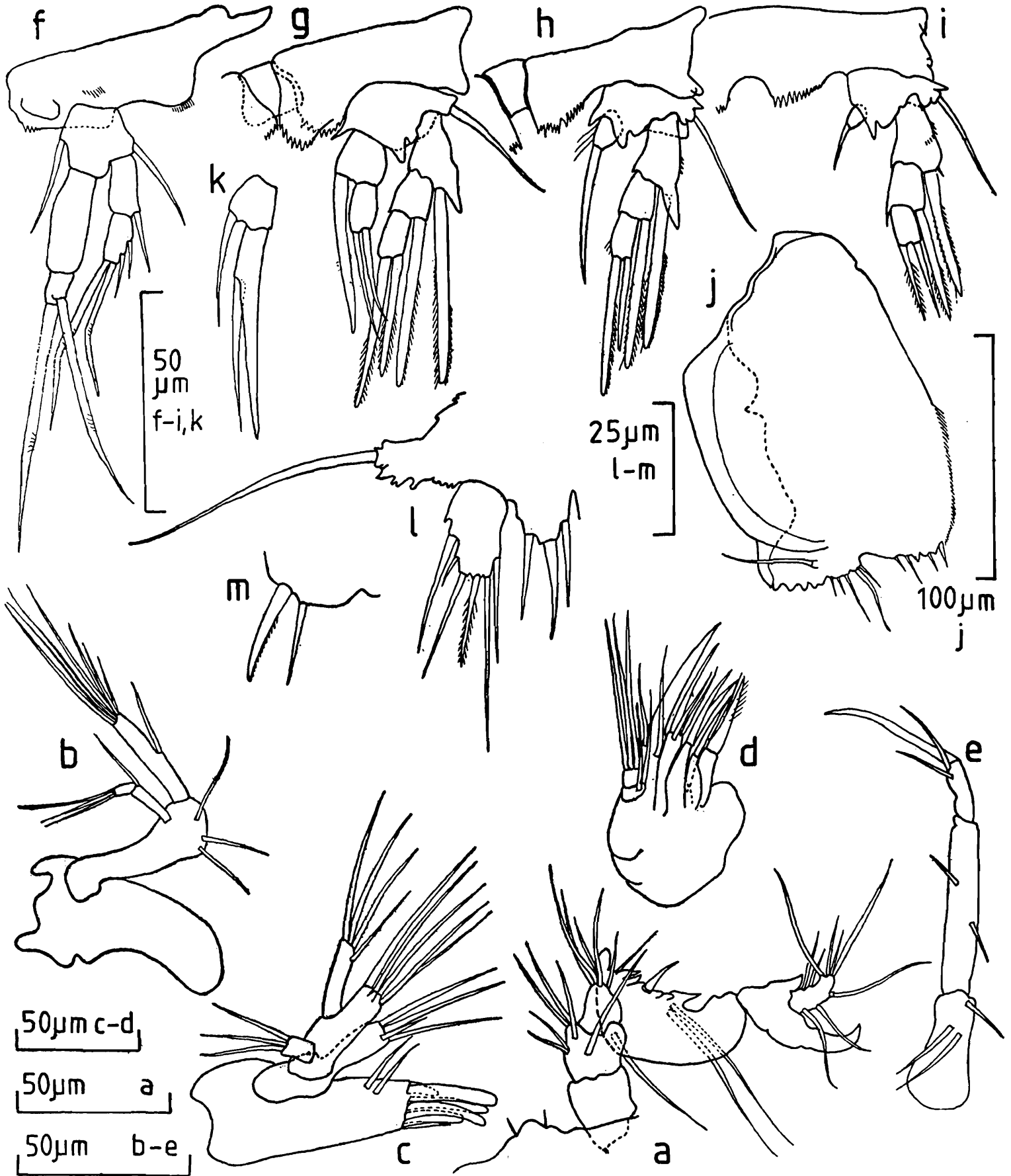


Fig. 114. *Oniscopsis dimorphus*. a, ♂ rostrum and antennule. b, ♀ mandible. c, ♀ maxillule. d, ♀ maxilla. e, ♀ maxilliped. f-j, ♀ P.1-P.5. k, ♂ P.2 Enp. l-m, ♂ P.5-P.6.

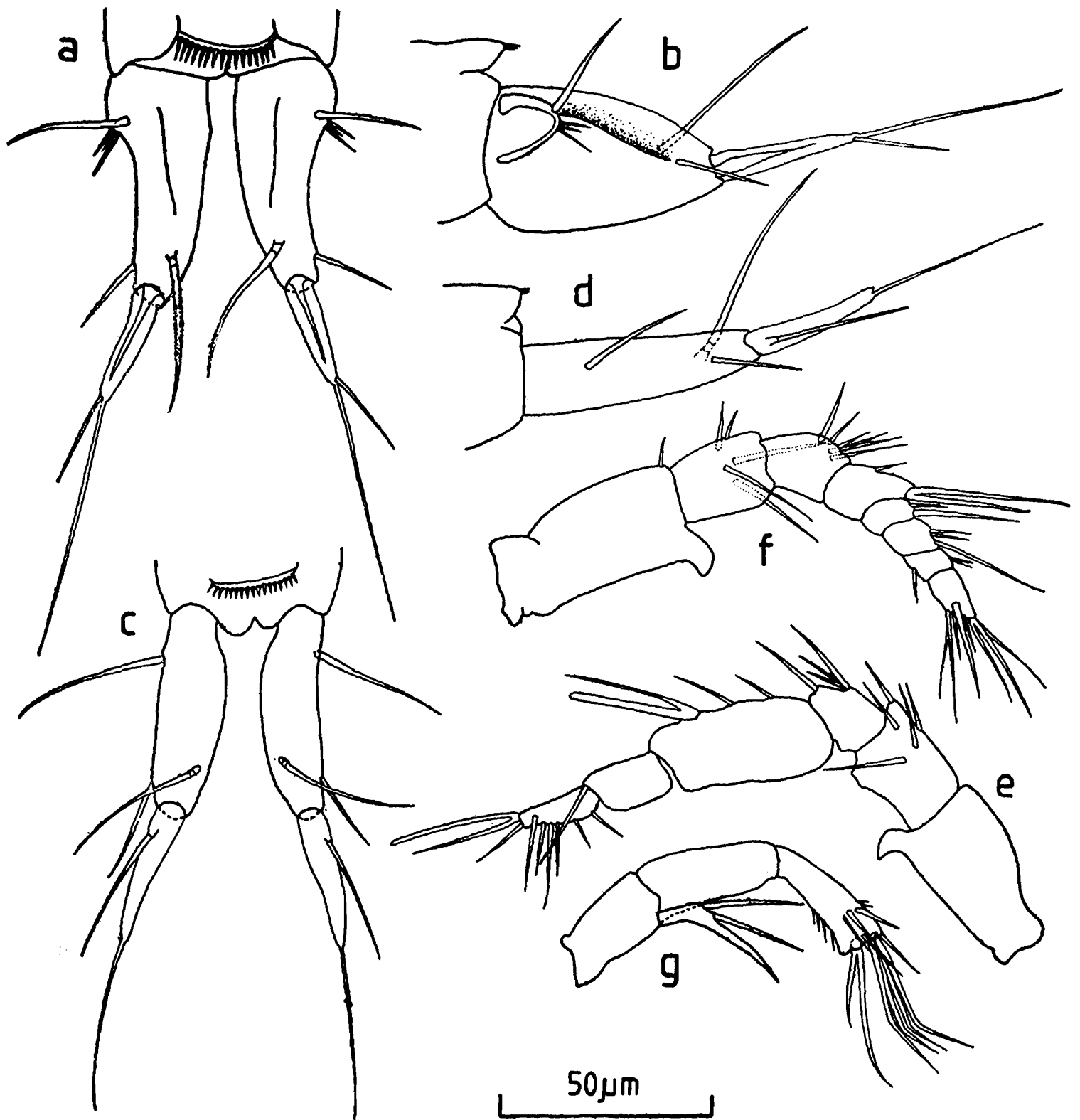


Fig. 115. *Tetragoniceps unguis*. a, ♀ last seg. and caudal rami, dorsal. b, ♀ left caudal ramus, outer lateral. c, ♂ last seg. and caudal rami, dorsal. d, ♂ left caudal ramus, outer lateral. e-f, antennule ♀ and ♂ g, ♀ antenna.

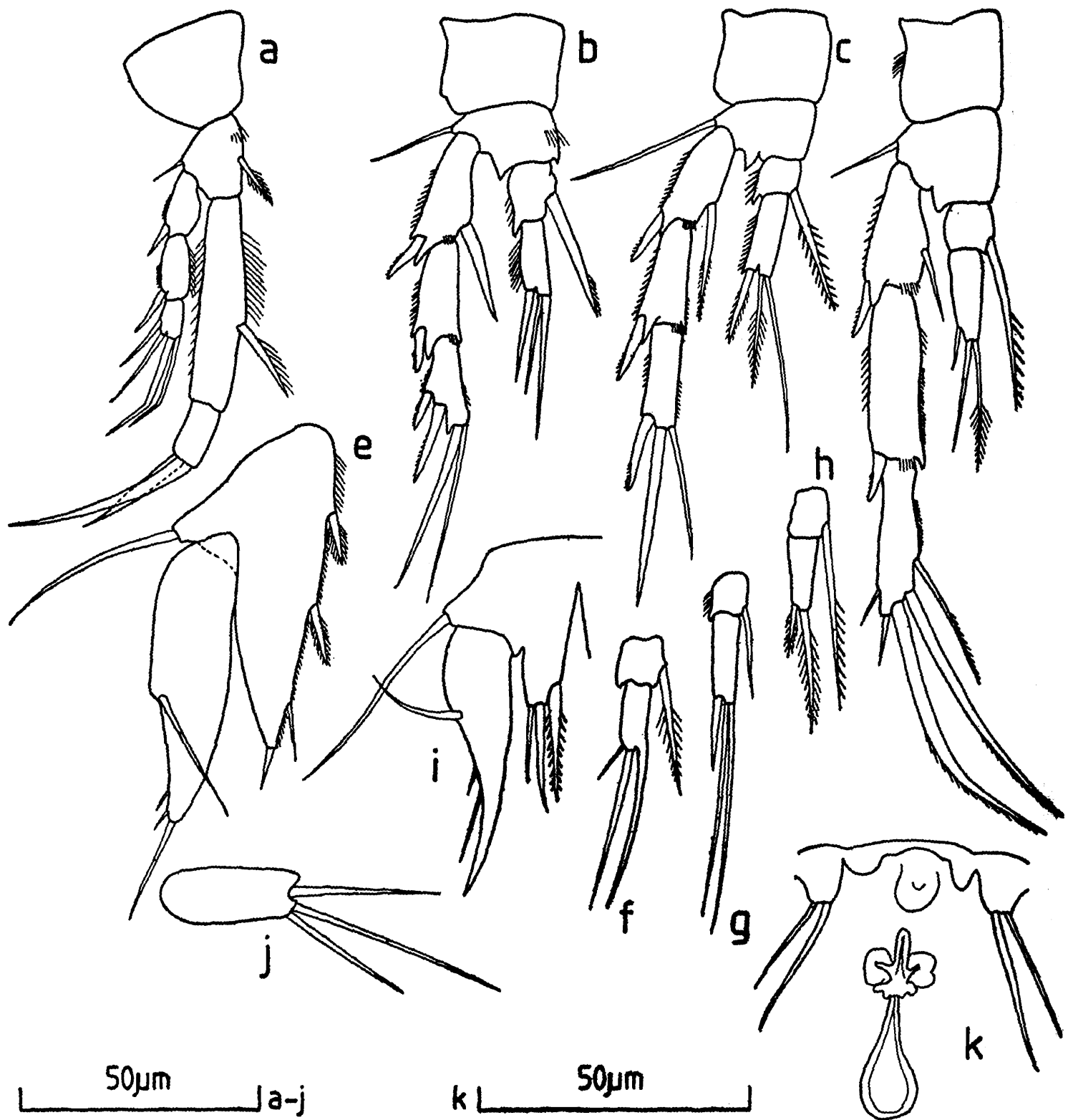


Fig. 116. *Tetragniceps unguis*. a-e, ♀ P.1-P.5. f-h, ♂ P.2-P.4. Enp. i-j, ♂ P.5-P.6. k, ♀ genital field.

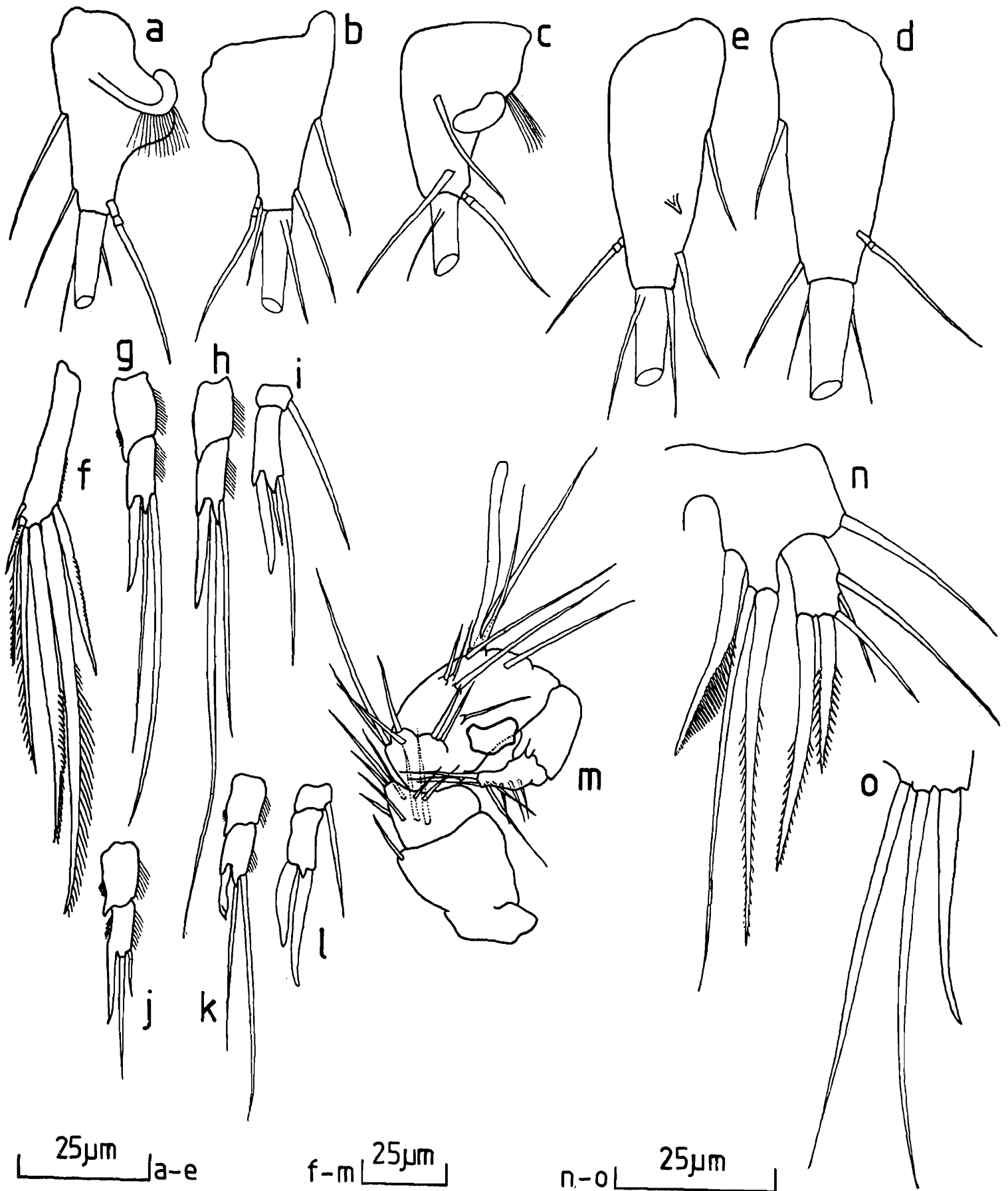


Fig. 117. *Phyllopodopsyllus aegypticus*. a-c, ♀ caudal ramus, dorsal, ventral and outer lateral. d-e, ♂ caudal ramus, dorsal and ventral. f, ♀ P.4 Exp.3. g-i, ♀ P.2-P.4 Enp. j-l, ♂ P.2-P.4 Enp. m, ♂ antennule. n-o, ♂ P.5-P.6.

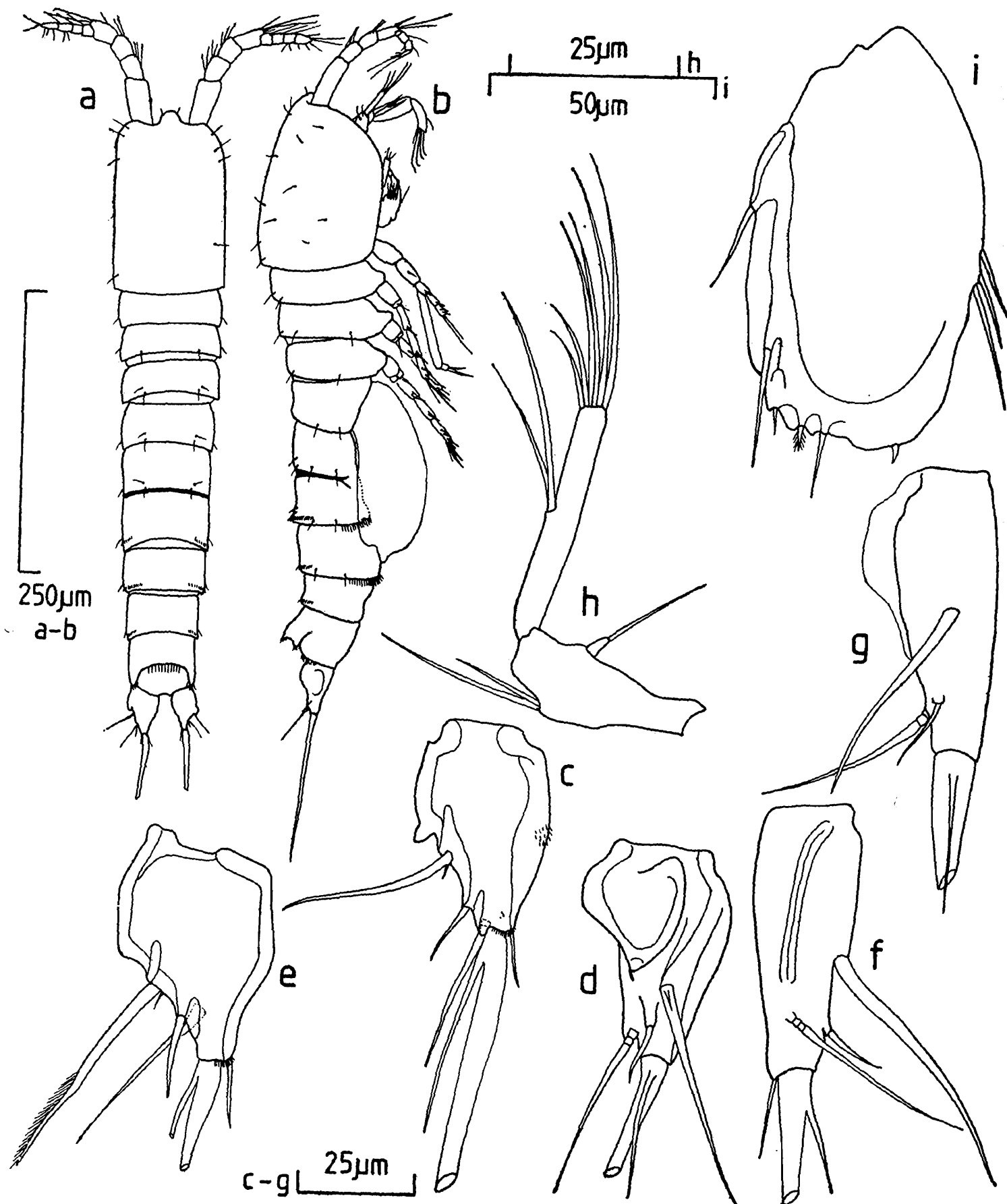


Fig. 118. *Phyllopodopsyllus longipalpus*. a-b, ♀ dorsal and lateral. c-d, ♀ right caudal ramus, ventral and outer lateral. e, ♀ right caudal ramus, ventral, of another ♀ f-g, ♂ right caudal ramus, dorsal and outer lateral. h, ♀ mandible palp. i, ♀ P.5.

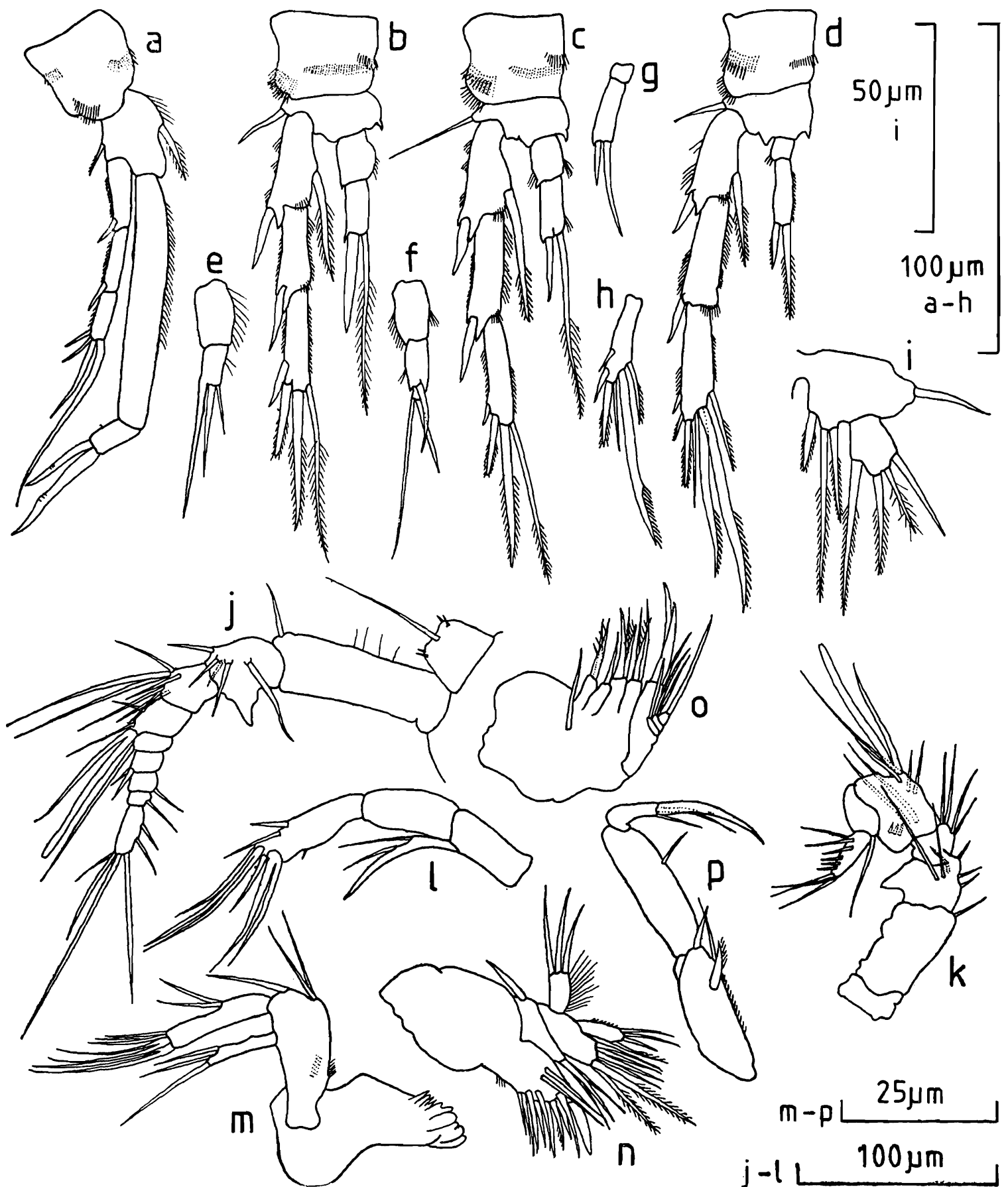


Fig. 119. a-i, *Phyllopodopsyllus longipalpatus*. a-d, ♀ P.1-P.4. e-g, ♂ P.2-P.4 Enp. h, ♂ P.4 Exp.3. i, ♂ P.5. j-p, *Phyllopodopsyllus crenulatus*. j, ♀ rostrum and antennule. k, ♂ antennule. l, ♀ antenna. m, ♀ mandible. n, ♀ maxillule. o, ♀ maxilla. p, ♀ maxilliped.

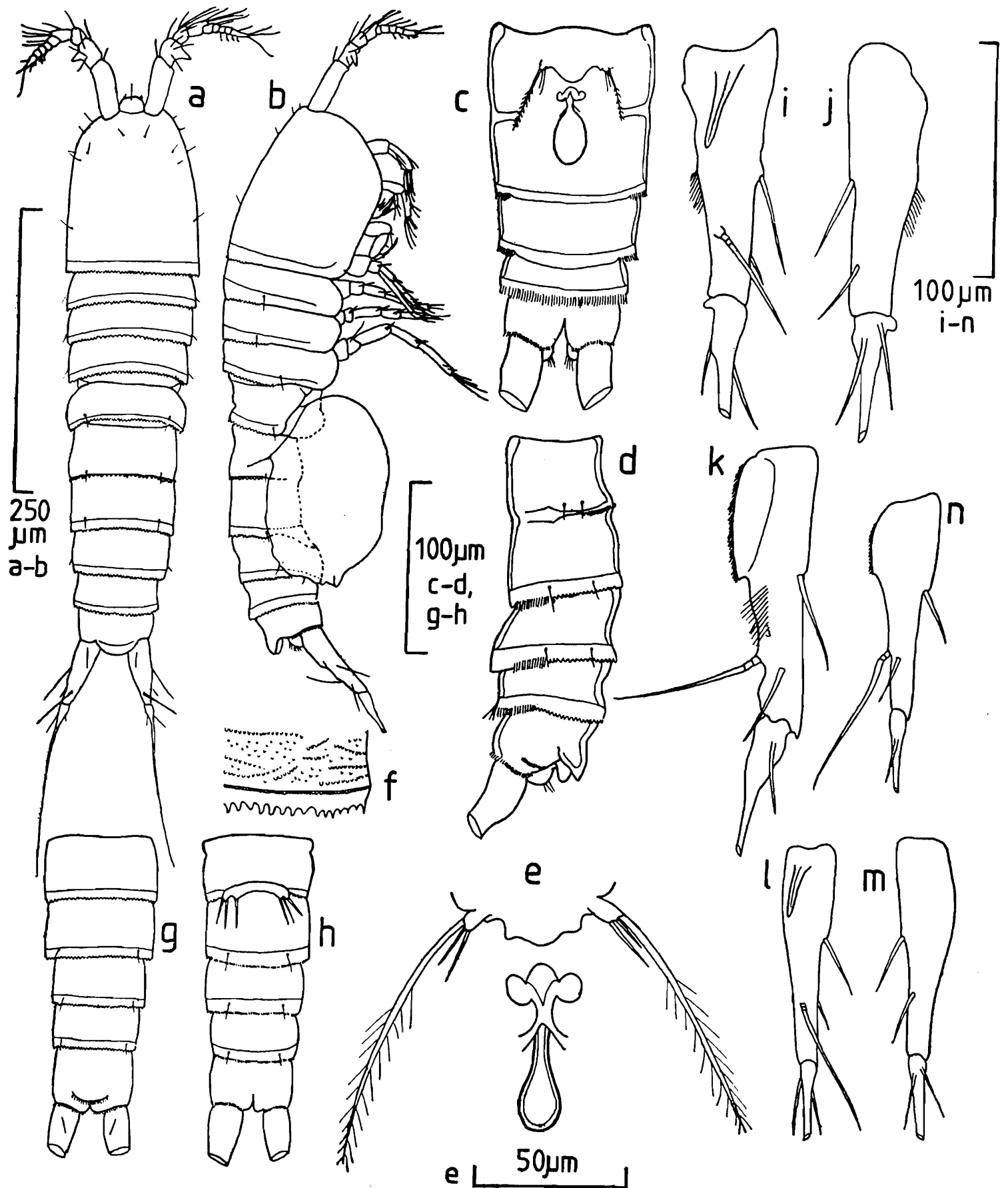


Fig. 120. *Phyllopodopsyllus crenulatus*. a-b, ♀ dorsal and lateral. c-d, ♀ abdomen, ventral and lateral. e, ♀ genital field. f, ♀ abdomen seg. 4, dorsolateral ornamentation. g-h, ♂ abdomen, dorsal and ventral. i-n, right caudal ramus, dorsal, ventral and outer lateral, of ♀ (i-k) and ♂ (l-n).



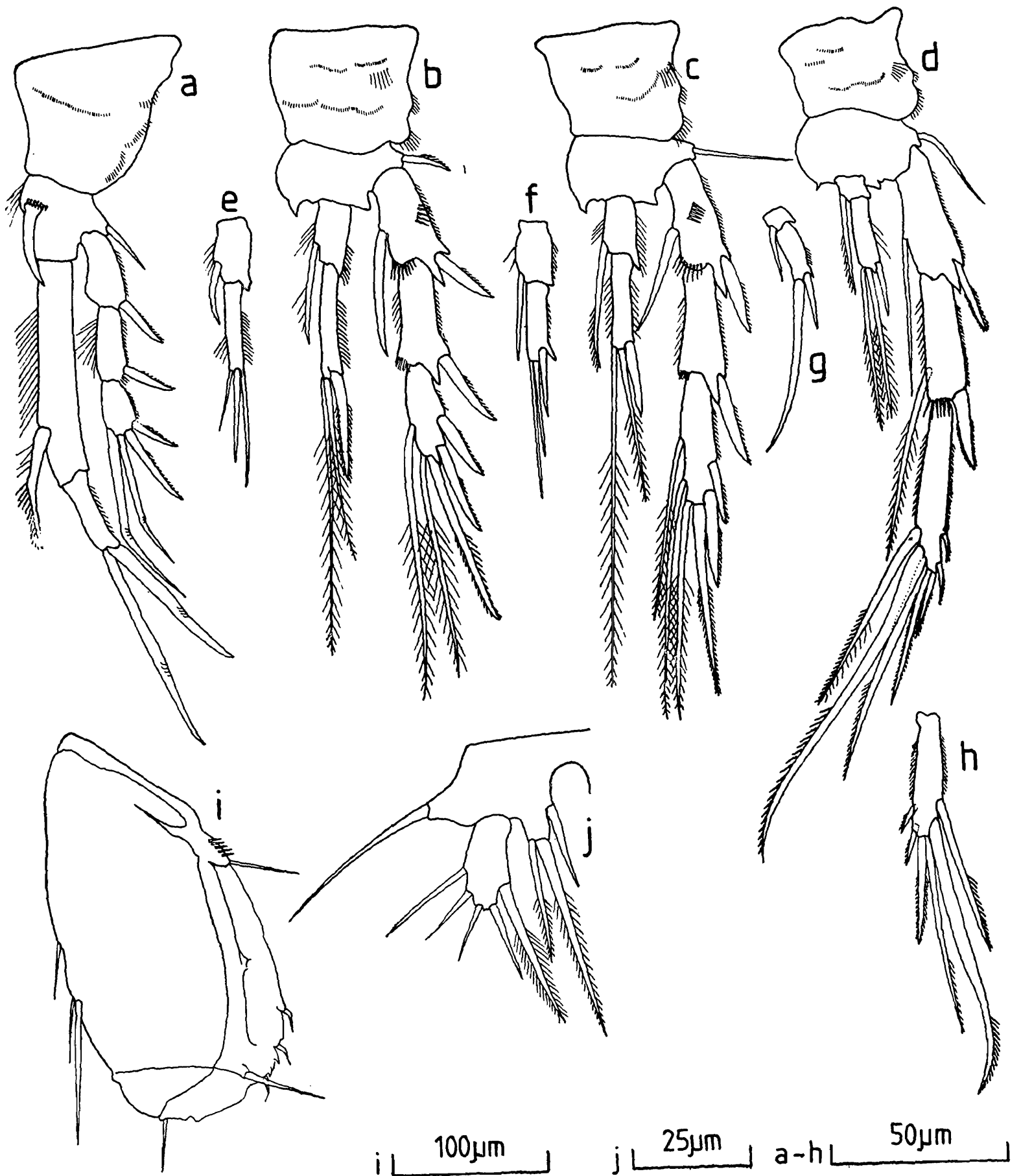


Fig. 121. *Phyllopodopsyllus cremulatus*. a-d, ♀ P.1-P.4. e-g, ♂ P.2-P.4. h, ♂ P.4. Exp. 3, i-j, P.5 ♀ and ♂

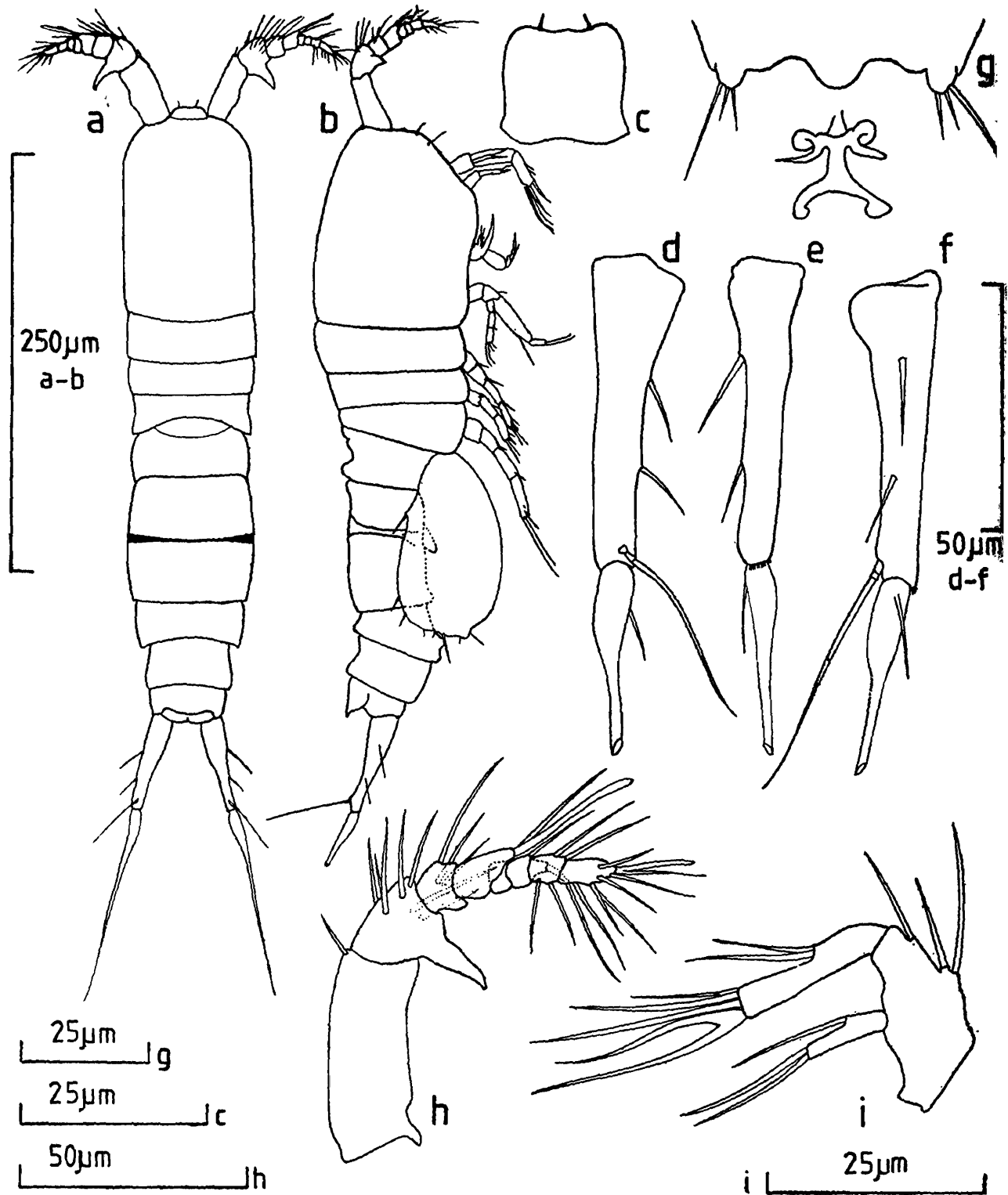


Fig. 122. *Phyllopodopsyllus stigmatosus* ♀ a-b, dorsal and lateral. c, rostrum. d-f, right caudal ramus, dorsal, ventral and outer lateral. g, genital field. h, antennule. i, mandible palp.

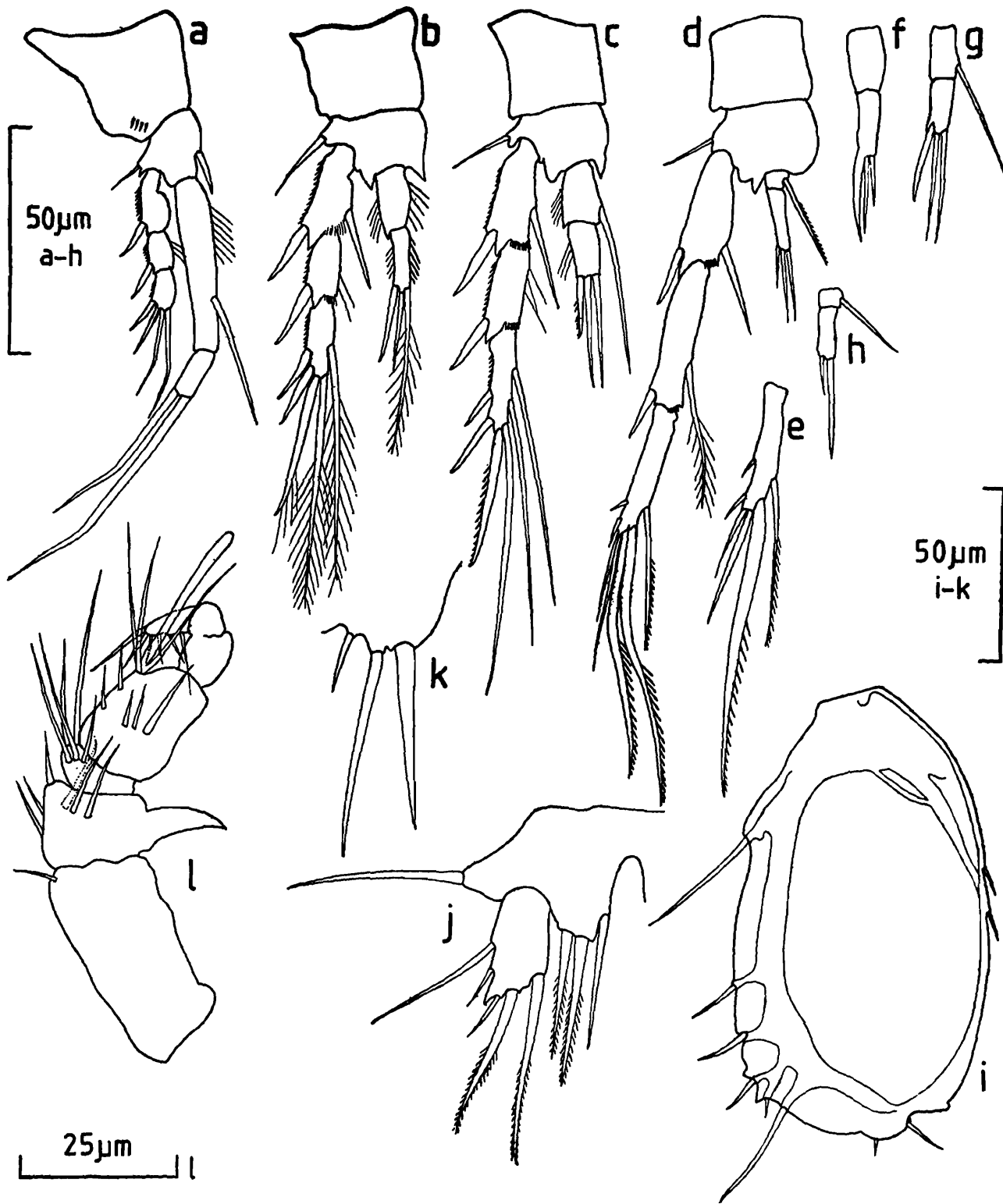


Fig. 123. *Phyllopodopsyllus stigmatosus*. a-d, ♀ P.1-P.4. e, ♂ P.4 Exp.3. f-h, ♂ P.2-P.4 Enp. i-j, P.5 ♀ and ♂ k, ♂ P.6. l, ♂ antennule.

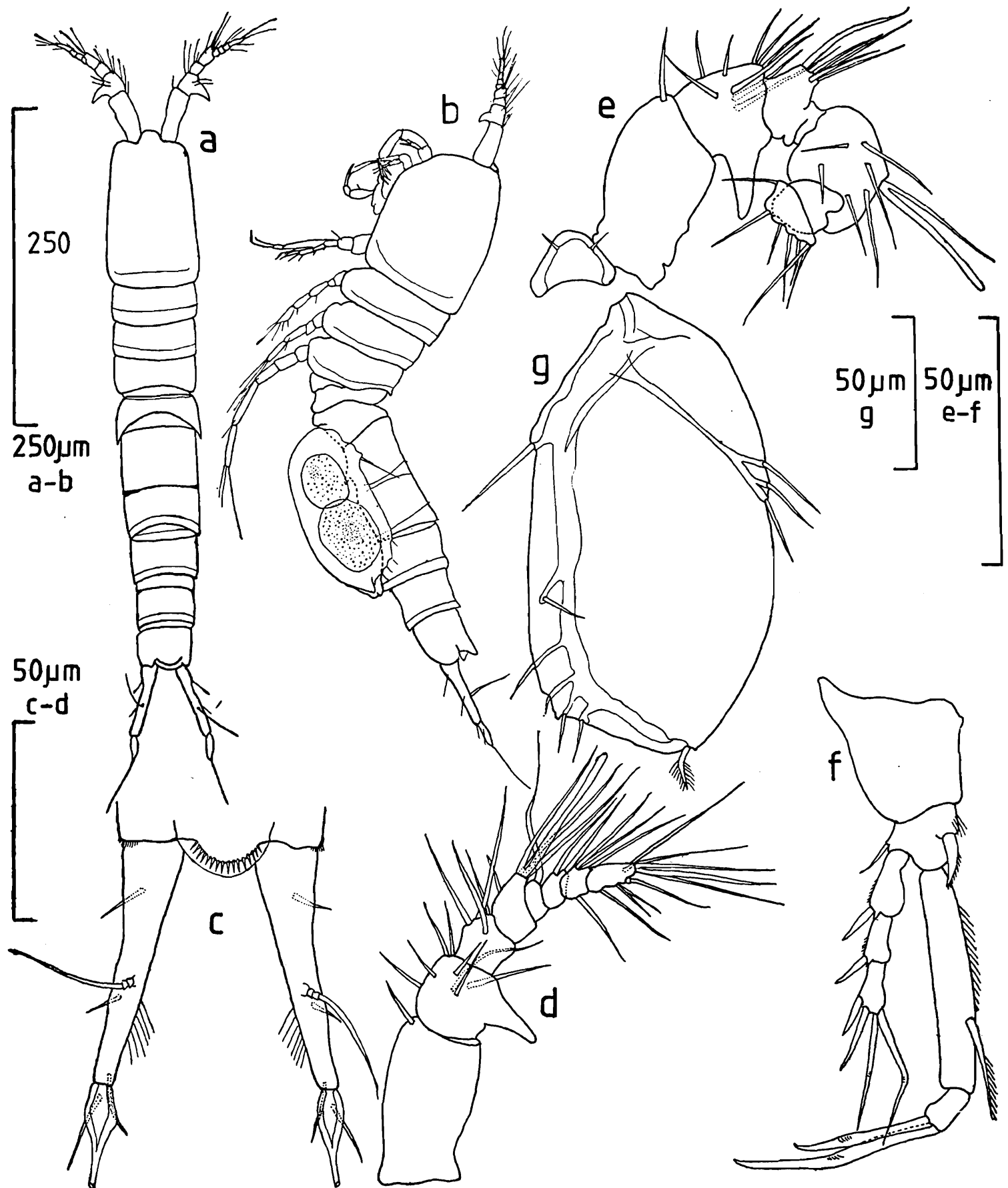


Fig. 124. *Phyllopodopsyllus tenuis*. a-b, ♀ dorsal and lateral. c, ♀ last seg. and caudal rami, dorsal. d, ♀ antennule. e, ♂ rostrum and antennule. f, ♀ P.1. g, ♀ P.5.

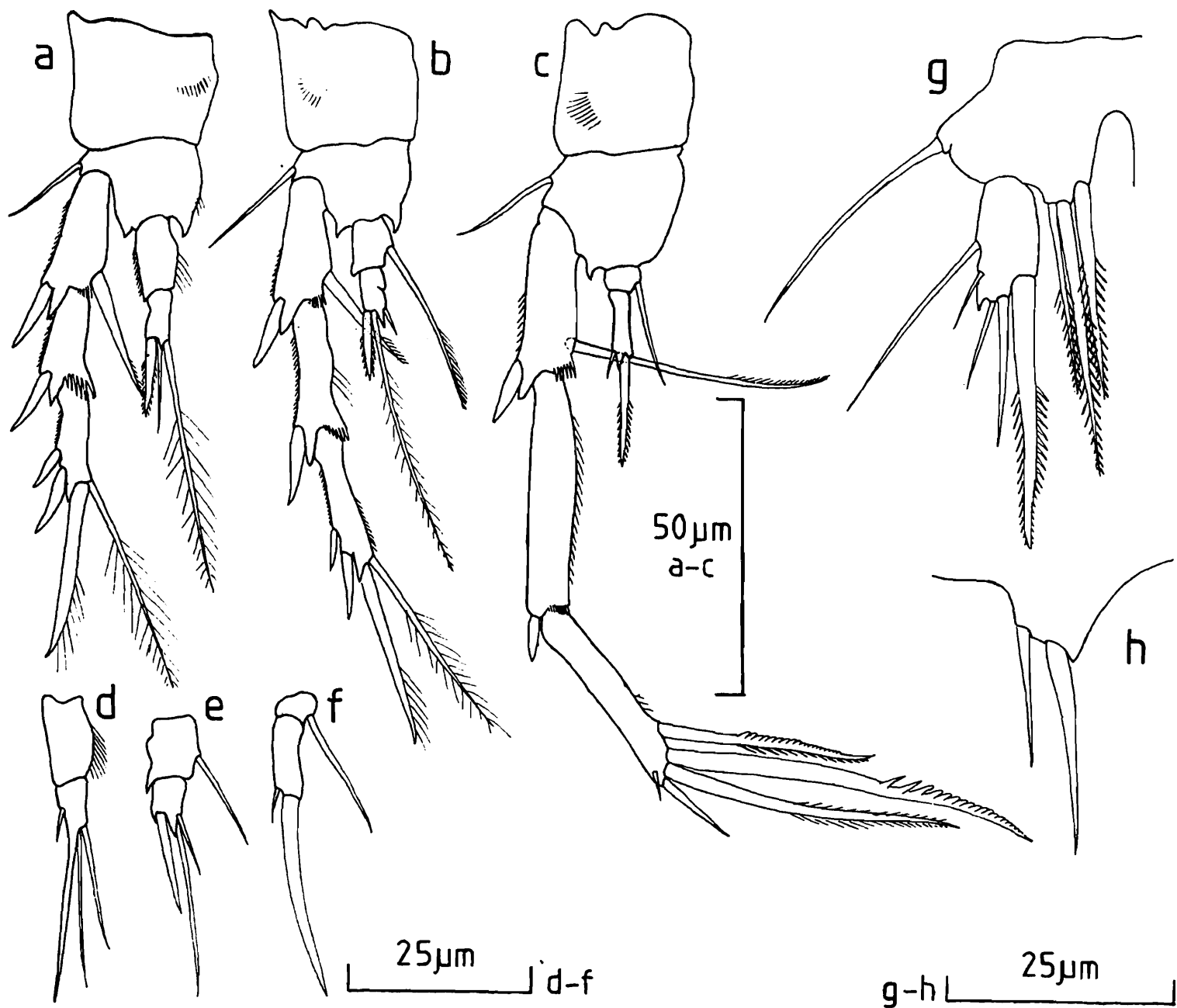


Fig. 125. *Phyllopodopsyllus tenuis*. a-c, ♀ P.2-P.4. d-f, ♂ P.2-P.4 Enp. g-h, ♂ P.5-P.6.

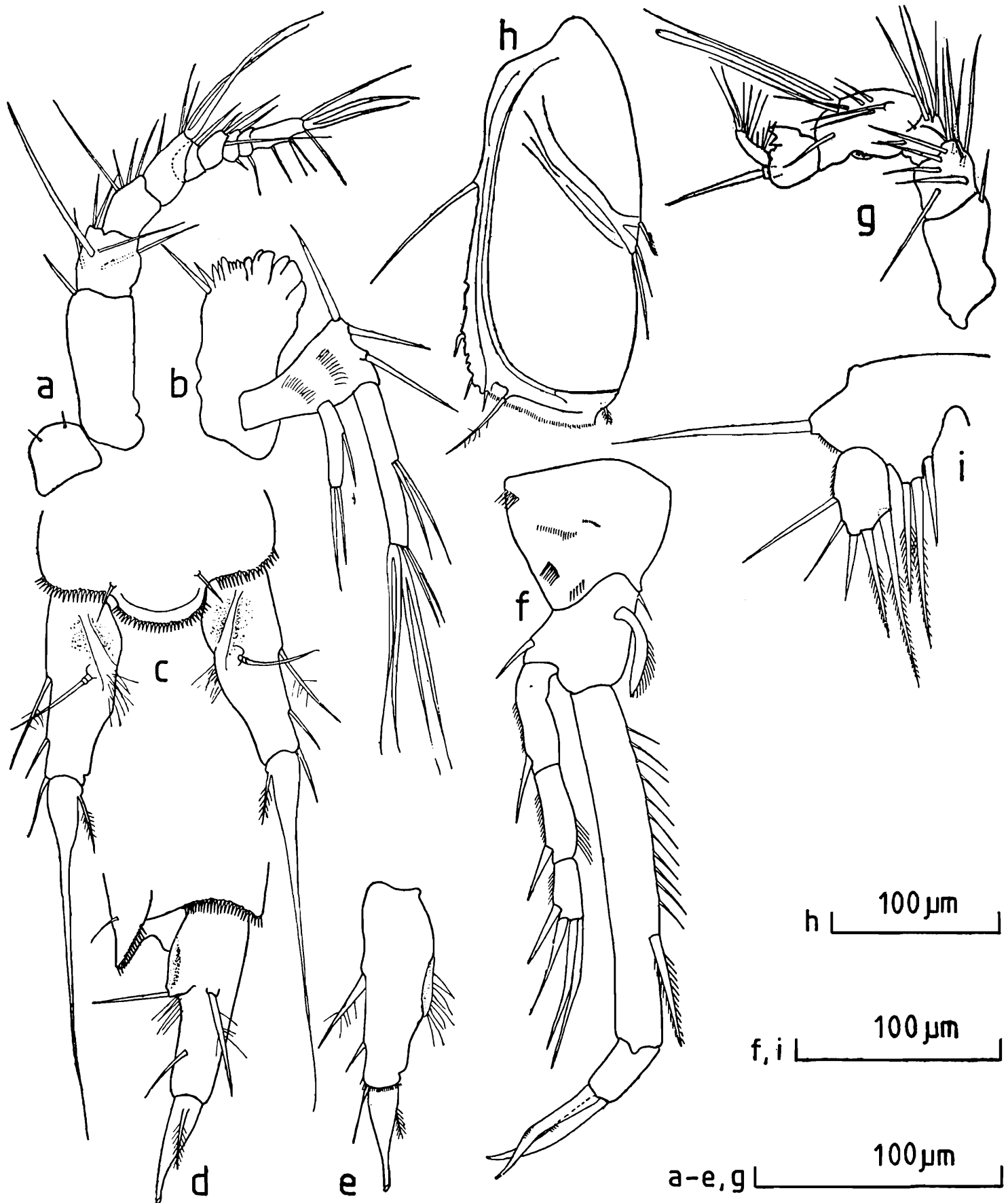


Fig. 126. *Phyllopodopsyllus gracilipes*. a, ♀ rostrum and antennule. b, ♀ mandible. c-d, ♀ last seg. and caudal rami, dorsal and lateral. e, ♀ left caudal ramus, ventral. f, ♀ P.1. g, ♂ antennule. h-i, P.5 ♀ and ♂.

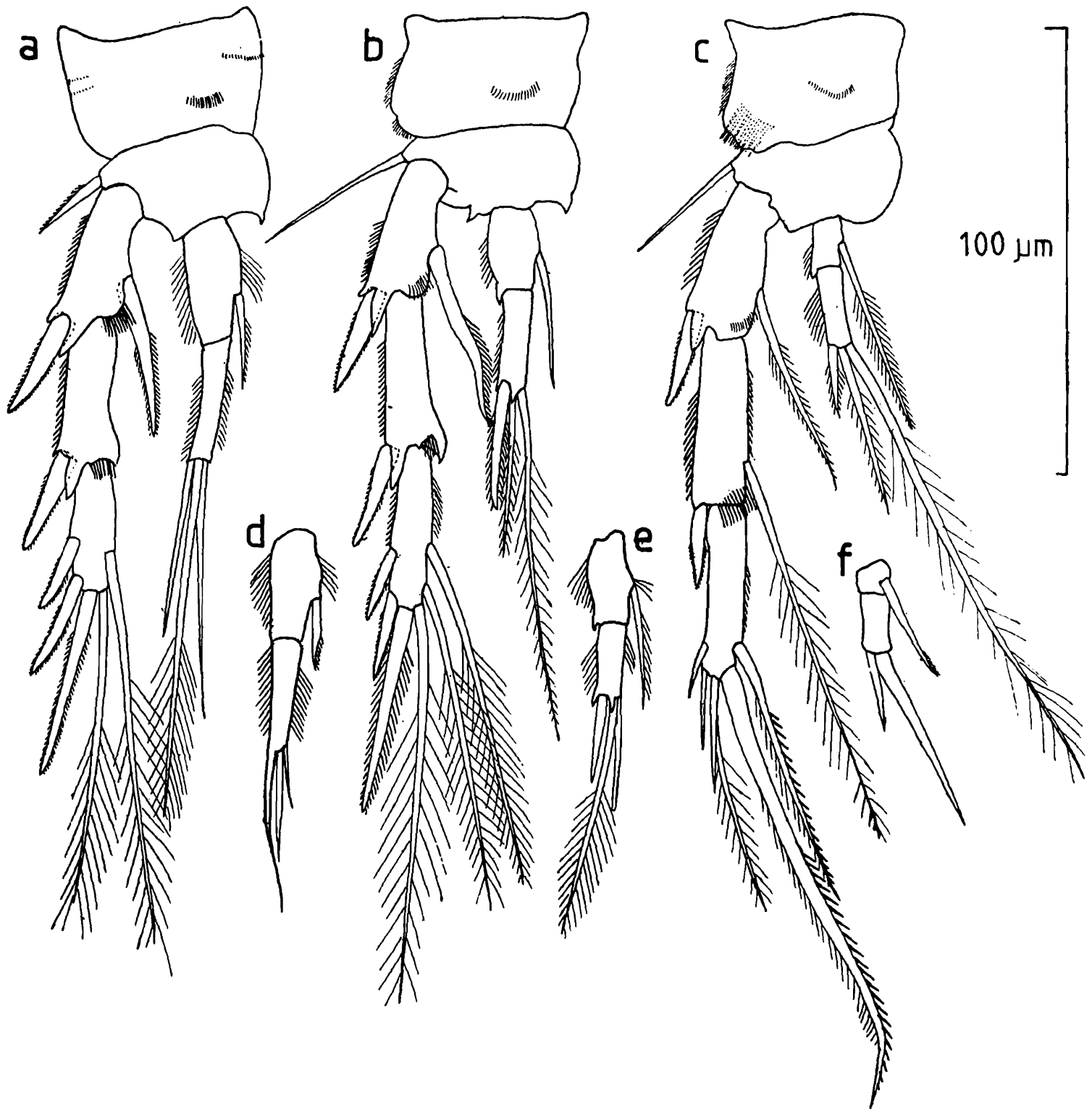


Fig. 127. *Phyllopodopsyllus gracilipes*. a-c, ♀ P.2-P.4. d-f, ♂ P.2-P.4 Enp.

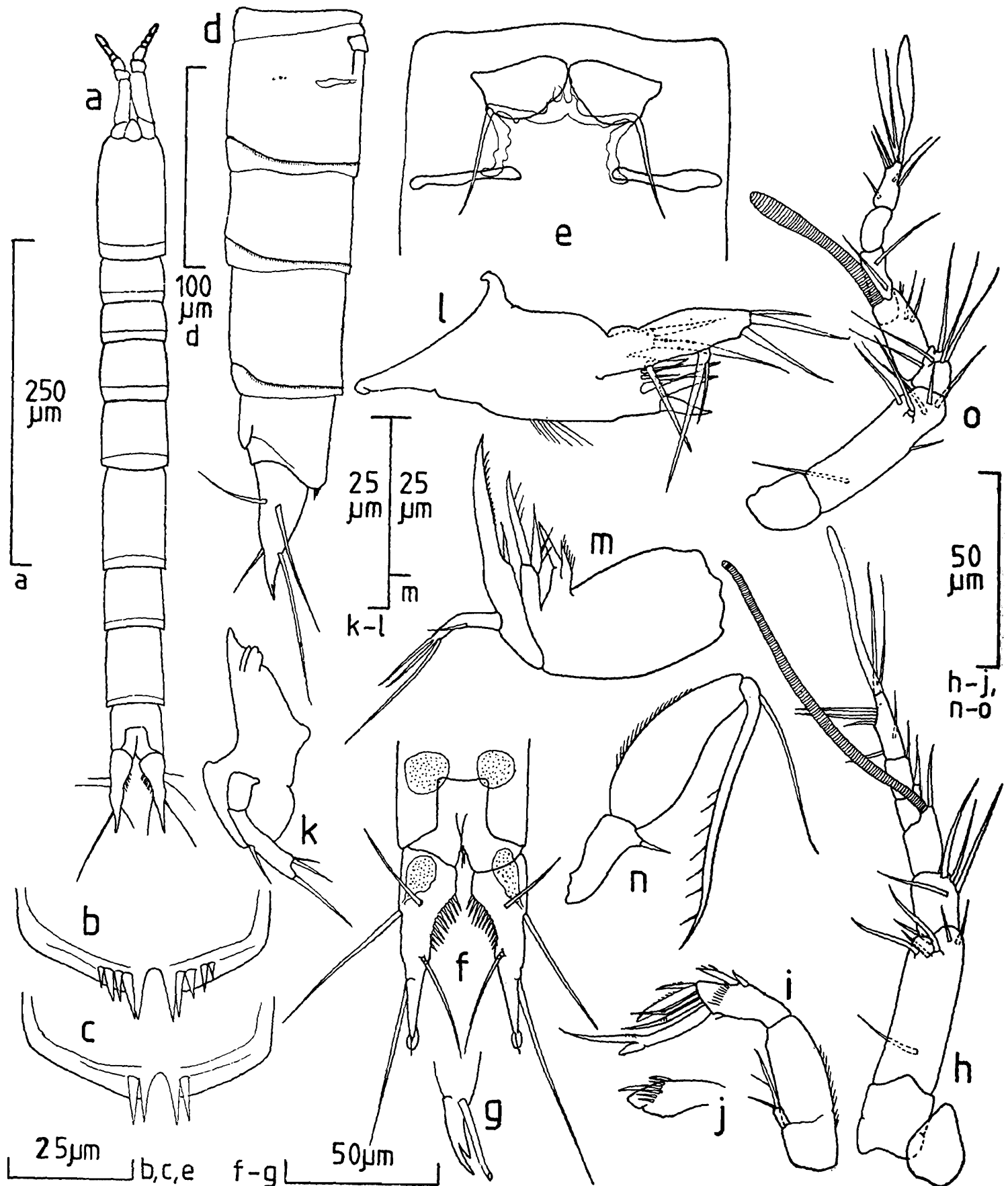


Fig. 128. *Psammastacus spinicaudatus*. a, ♀ dorsal. b-c, last seg., ventral, Andaman and Waltair females. d, ♀ abdomen, lateral. e, ♀ genital field. f, ♀ last seg. and caudal ramus, dorsal. g, ♀ caudal ramus, apical spine, lateral. h, ♀ rostrum and antennule. i, ♀ antenna. j, ♀ antenna Enp. 2 from other side. k, ♀ mandible. l, ♀ maxillule. m, ♀ maxilla. n, ♀ maxilliped. o, ♂ antennule.



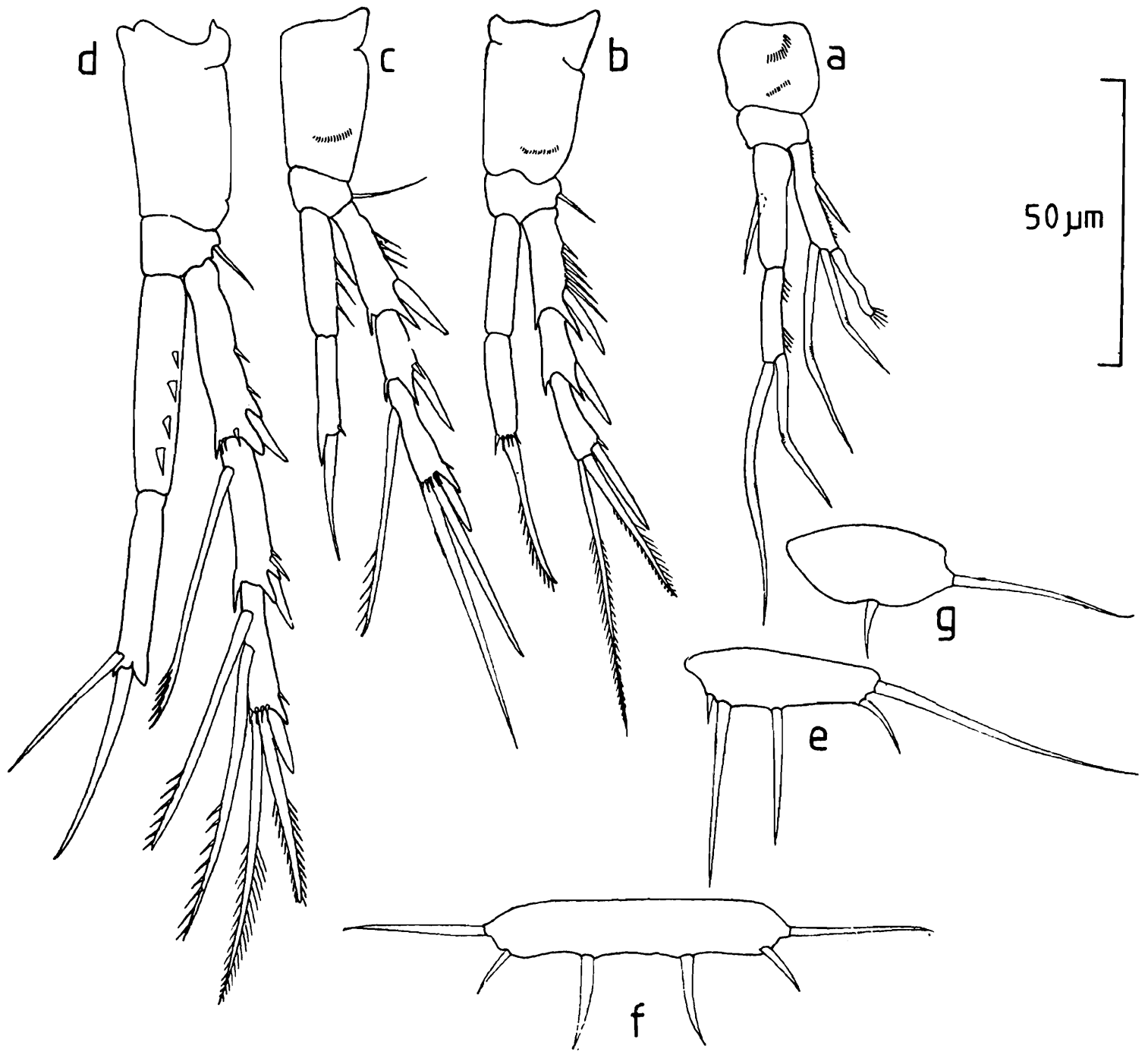


Fig. 129. *Psammastacus spinicaudatus*. a-e, ♀ P.1-P.5. f, ♂ pair of P.5. g, ♂ P.6.

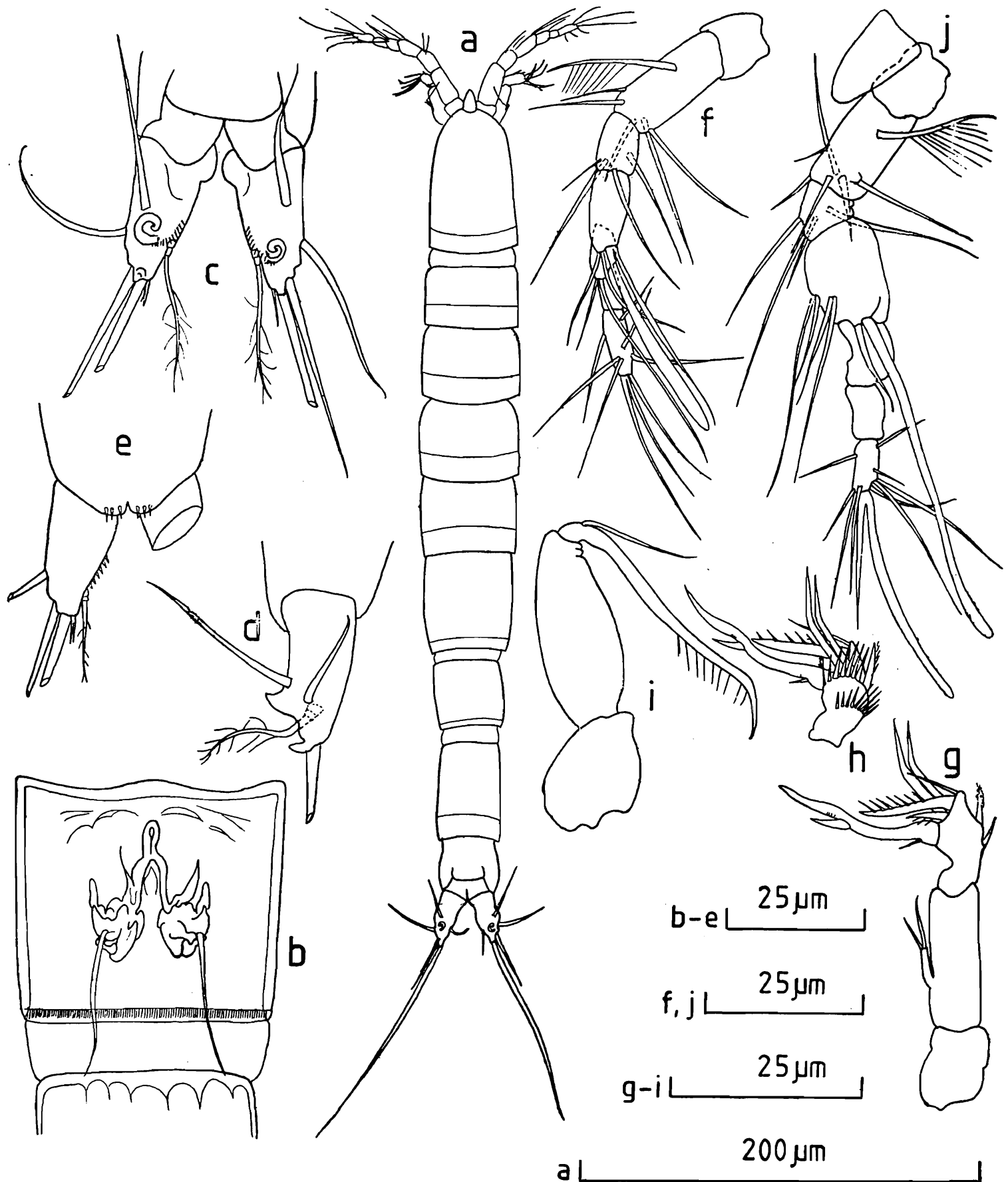


Fig. 130. *Arenotopa dyadacantha*. a, ♀ dorsal. b, ♀ genital somite, ventral. c-e, ♀ last seg. and caudal rami, dorsal, outer lateral and ventral. f, ♀ antennule. g, ♀ antenna. h, ♀ antenna Enp. 2 from other side. i, ♀ maxilliped. j, ♂ rostrum and antennule.

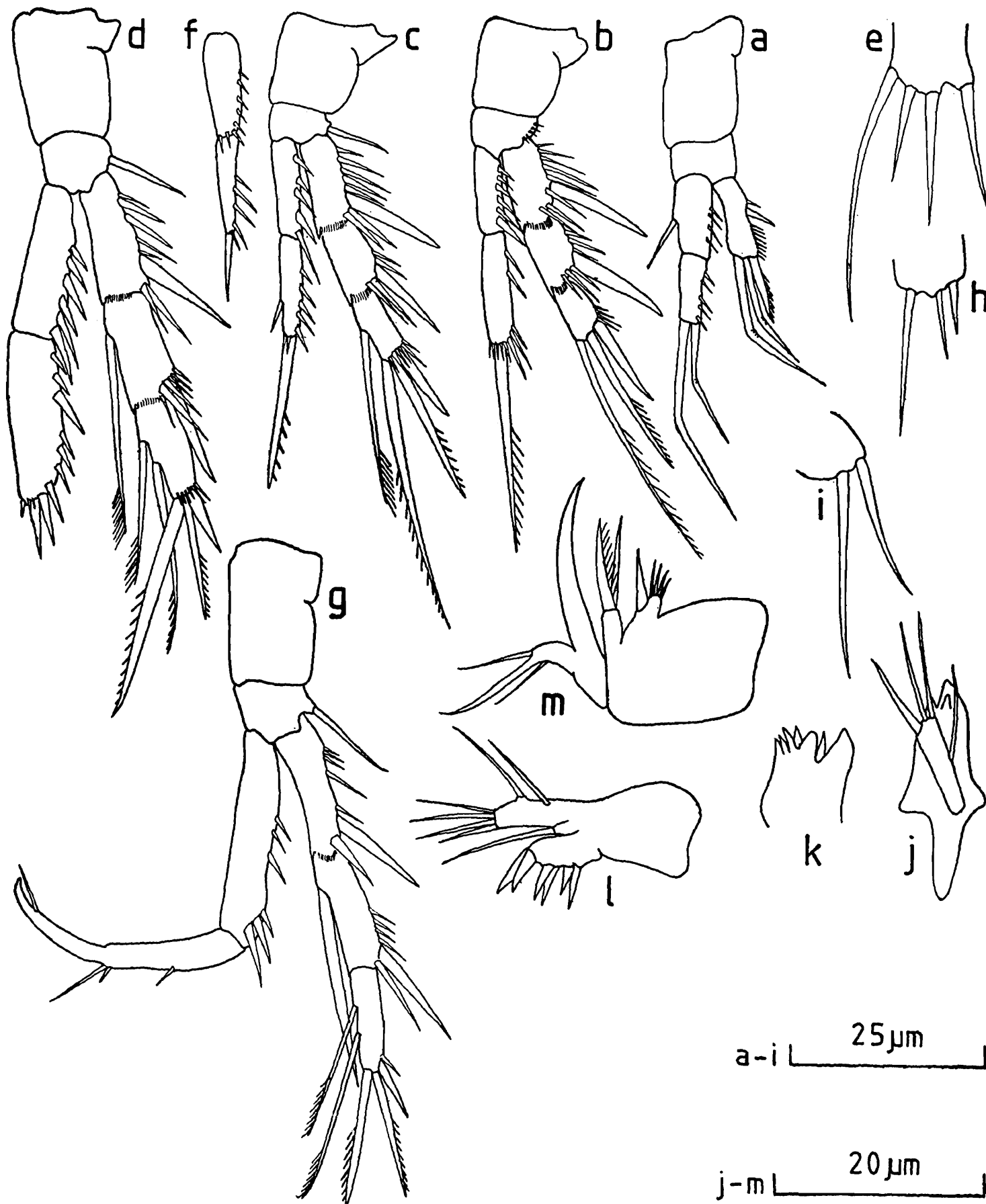


Fig. 131. *Arenotopa dyadacantha*. a-e, ♀ P.1-P.5. f, ♂ P.3 Enp. g-i, ♂ P.4-P.6. j, ♀ mandible. k, ♀ mandible cutting edge. l, ♀ maxillule. m, ♀ maxilla.

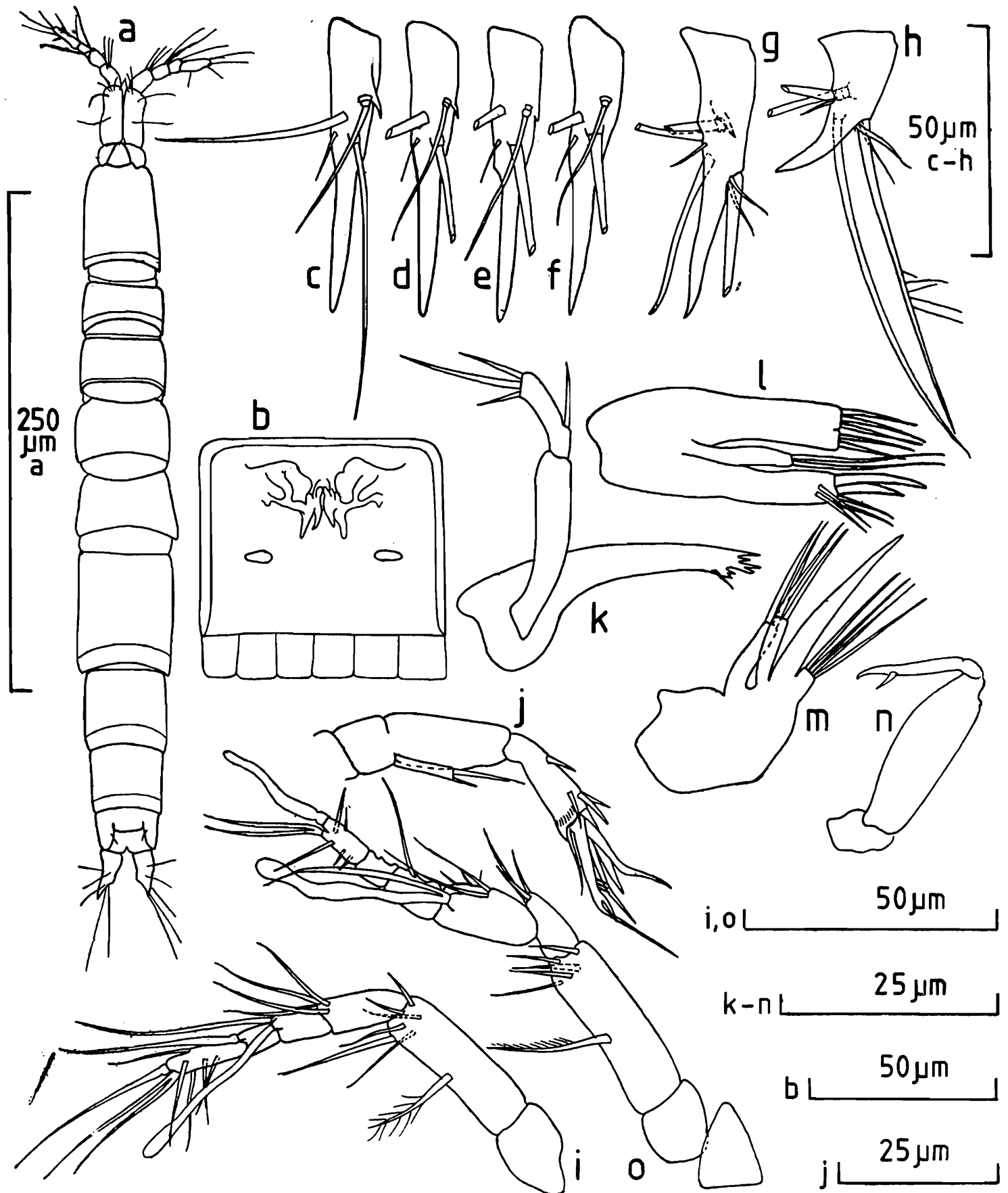


Fig. 132. *Arenopontia (Neoleptastacus) indica*. a, ♀ dorsal. b, ♀ genital somite, ventral. c-f, ♀ caudal ramus, varying degrees of development of inner spur. g-h, ♀ caudal ramus, outer lateral, extremes of variability. i, ♀ antennule. j, ♀ antenna. k, ♀ mandible. l, ♀ maxillule. m, ♀ maxilla n, ♀ maxilliped. n, ♂ rostrum and antennule.

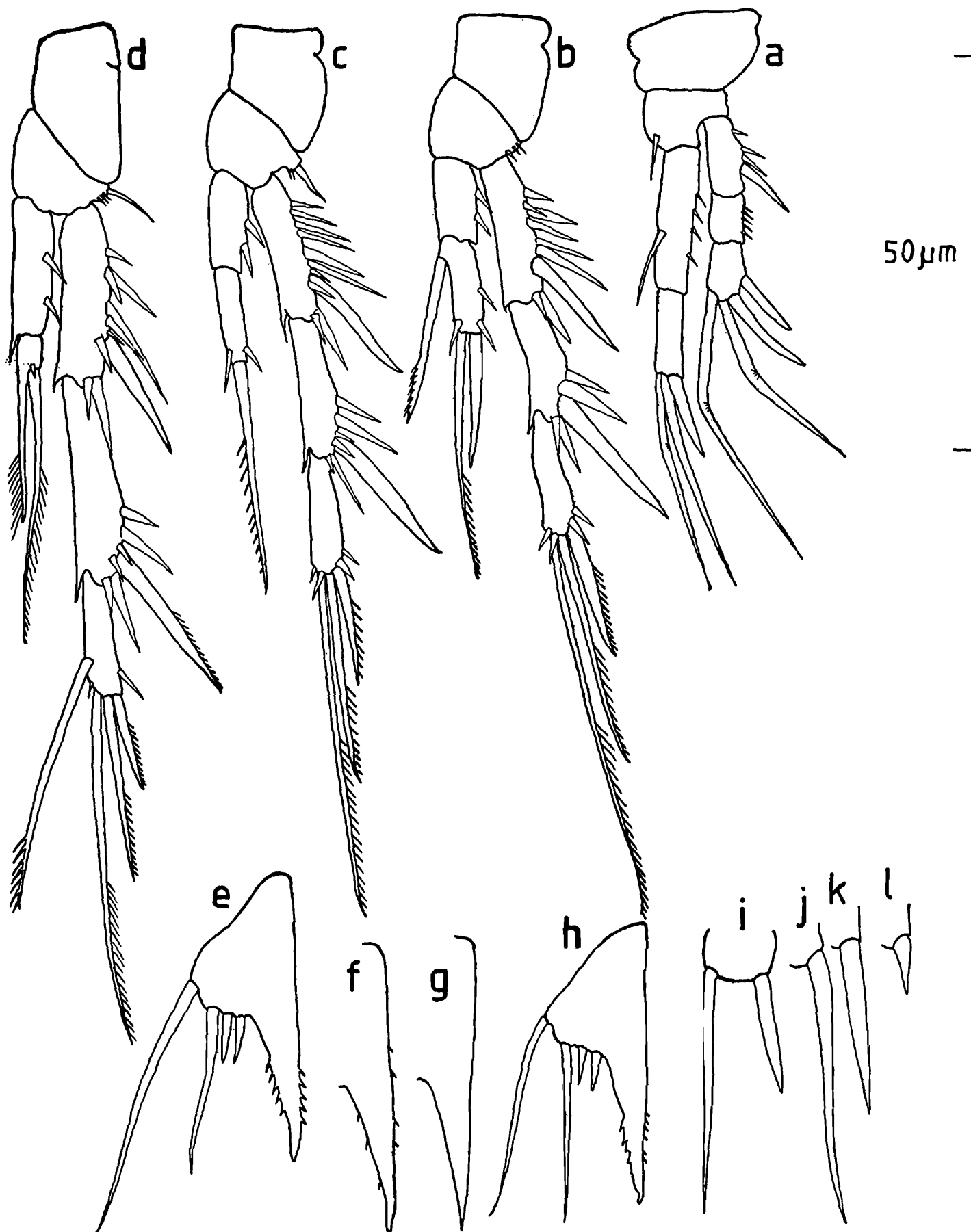


Fig. 133. *Arenopontia (Neoleptastacus) indica*. a-e, ♀ P.1-P.5. f-g, ♀ P.5, variability in spinulation of inner spur. h, ♂ P.5. i, ♂ P.6. j-l, ♂ P.6, variability in form of inner seta/spine.

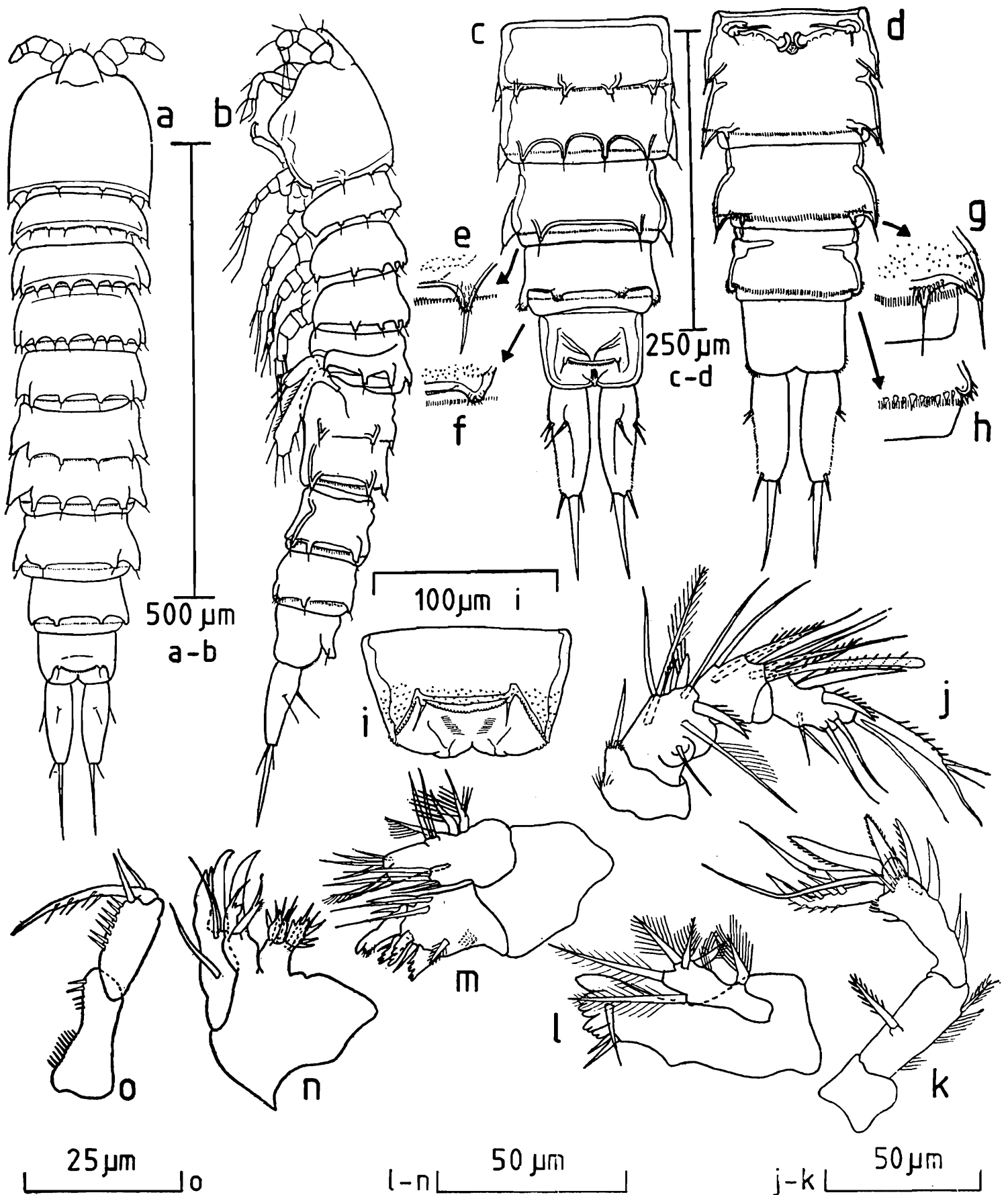


Fig. 134. *Cletodes dentatus* ♀. a-b, dorsal and lateral. c-d, abdomen, dorsal and ventral. e-h, ornamentation of abdomen segs. i, last seg., dorsal. j, antennule. k, antenna. l, mandible. m, maxillule. n, maxilla. o, maxilliped.

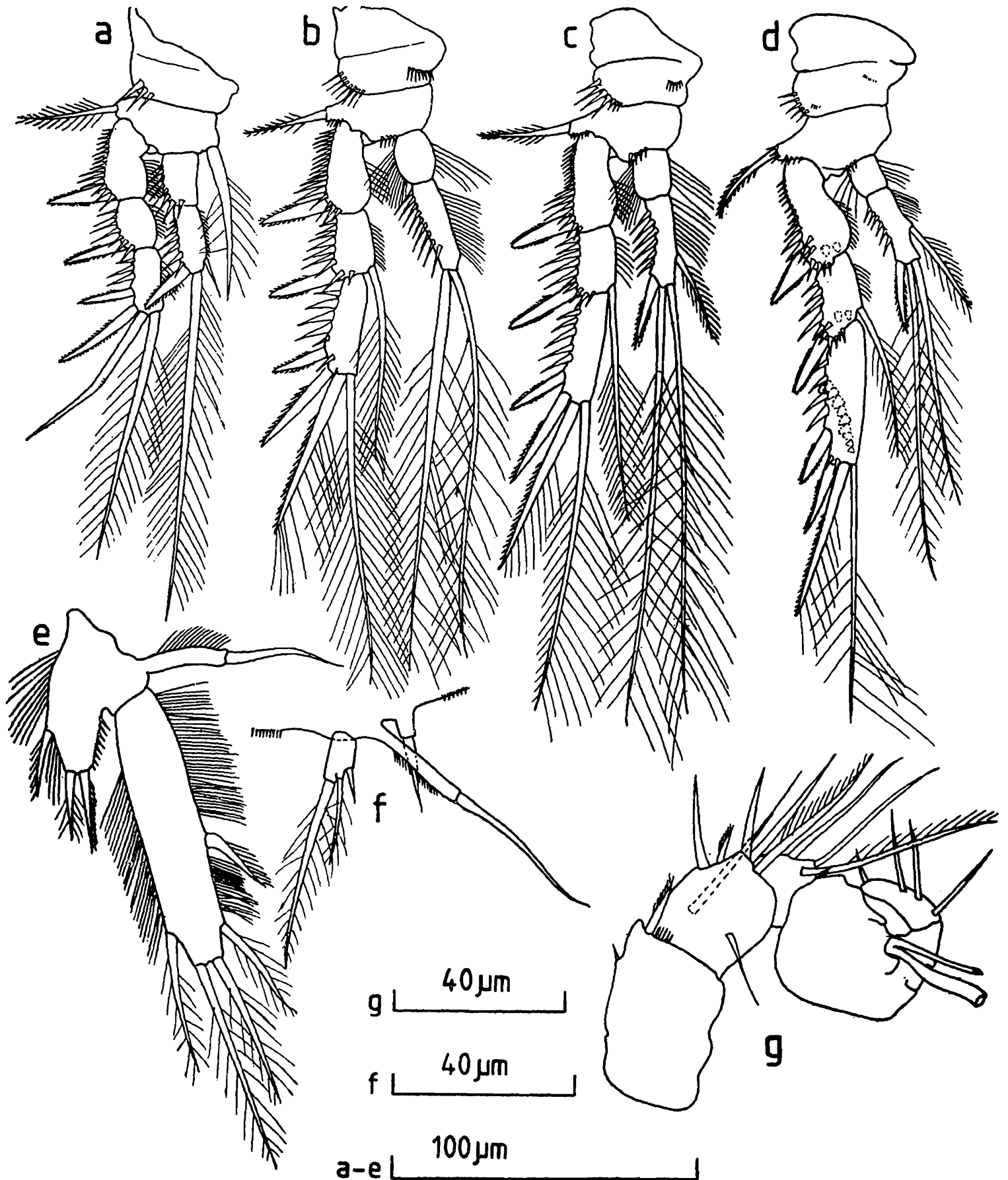


Fig. 135. *Cletodes dentatus*. a-e, ♀ P.1-P.5. f, ♂ P.5. g, ♂ antennule.

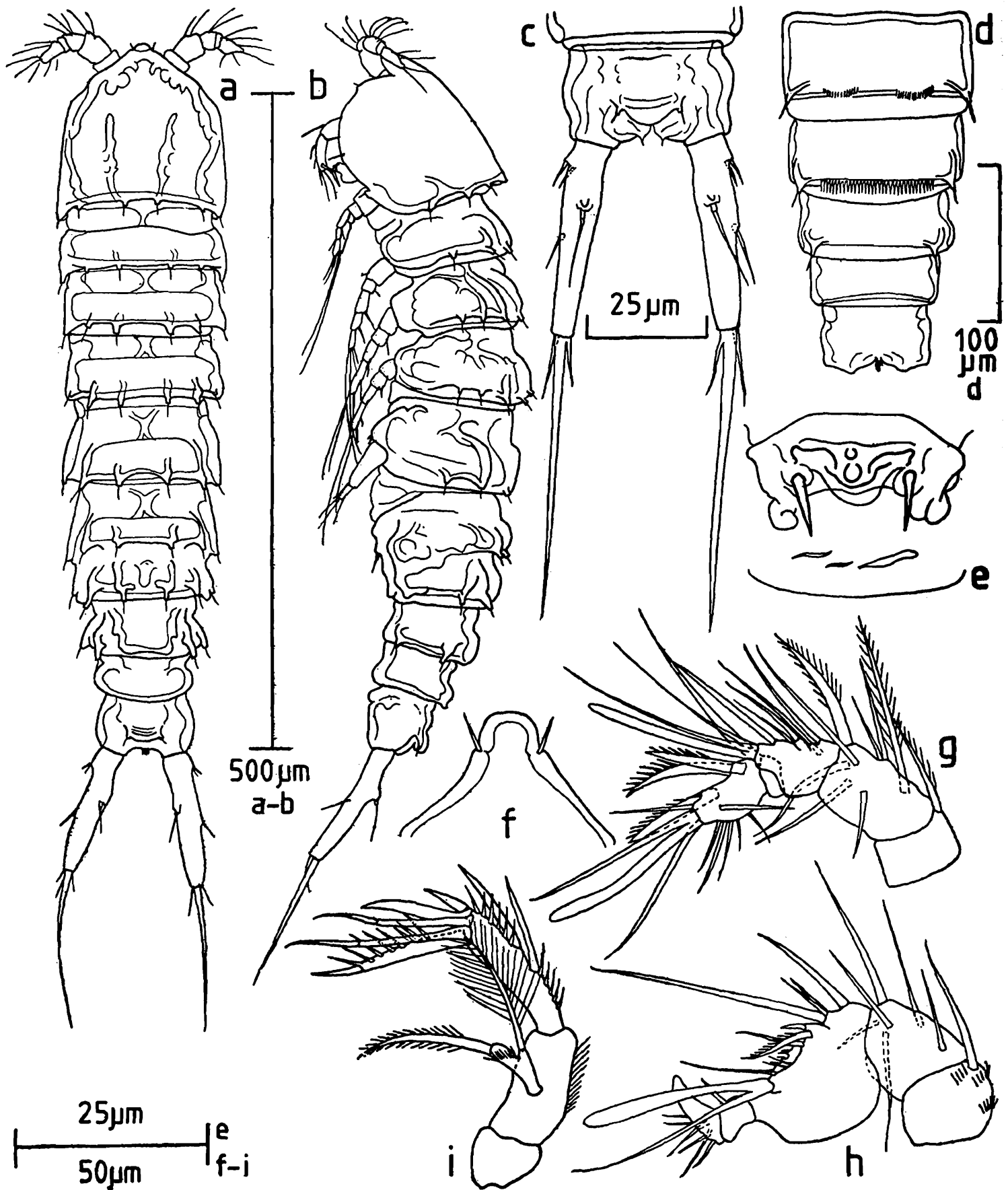


Fig. 136. *Enhydrosoma pectinatum*. a-b, ♀ dorsal and lateral. c, ♀ last seg. and caudal ramus, dorsal. d, ♂ abdomen, ventral. e, ♀ genital field. f, ♀ rostrum. g-h, antennule ♀ and ♂ i, ♀ antenna.



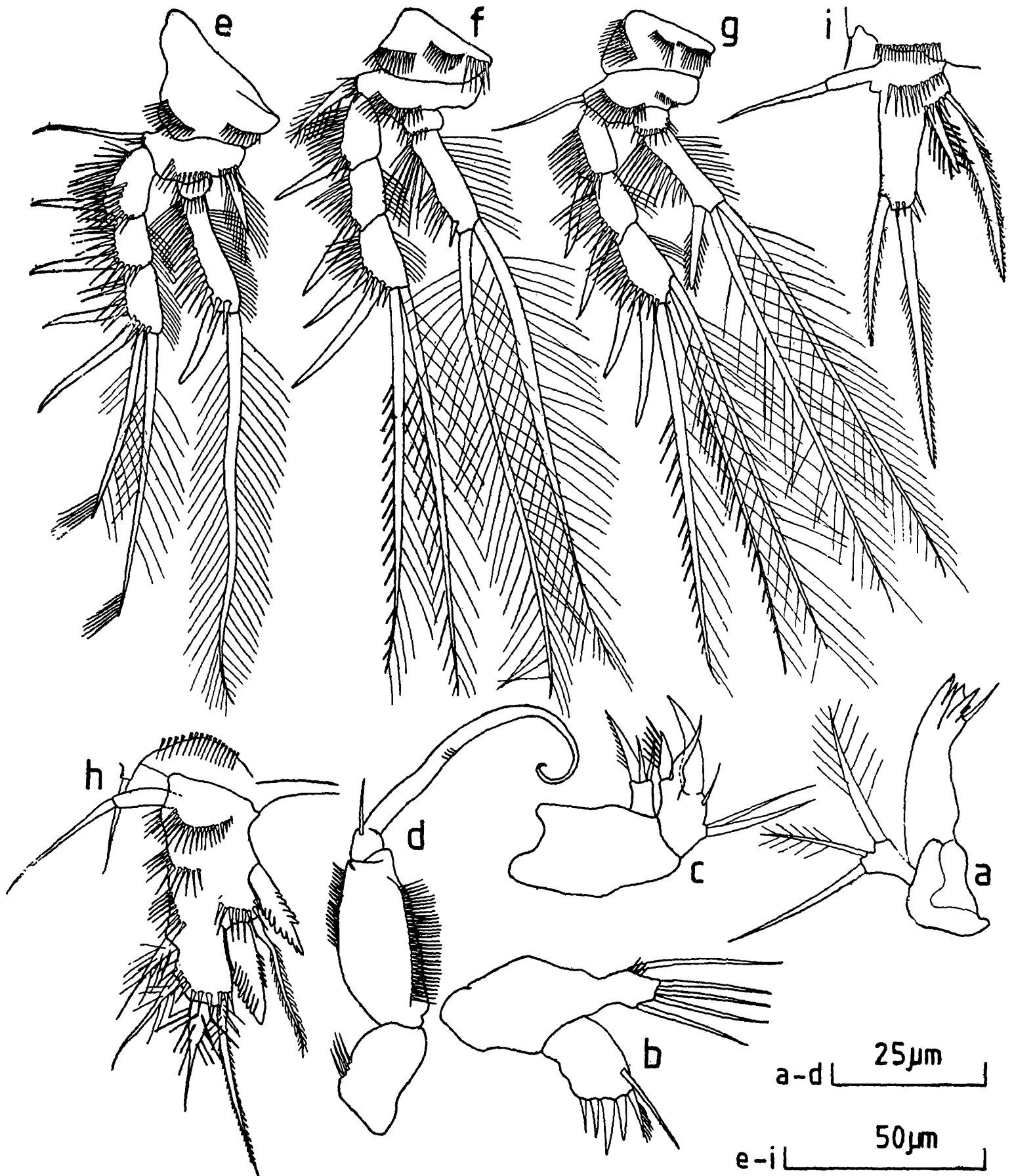


Fig. 137. *Enhydrosoma pectinatum*. a, ♀ mandible. b, ♀ maxillule. c, ♀ maxilla. d, ♀ maxilliped. e-g, ♀ P.1-P.3. h-i, P.5 ♀ and ♂

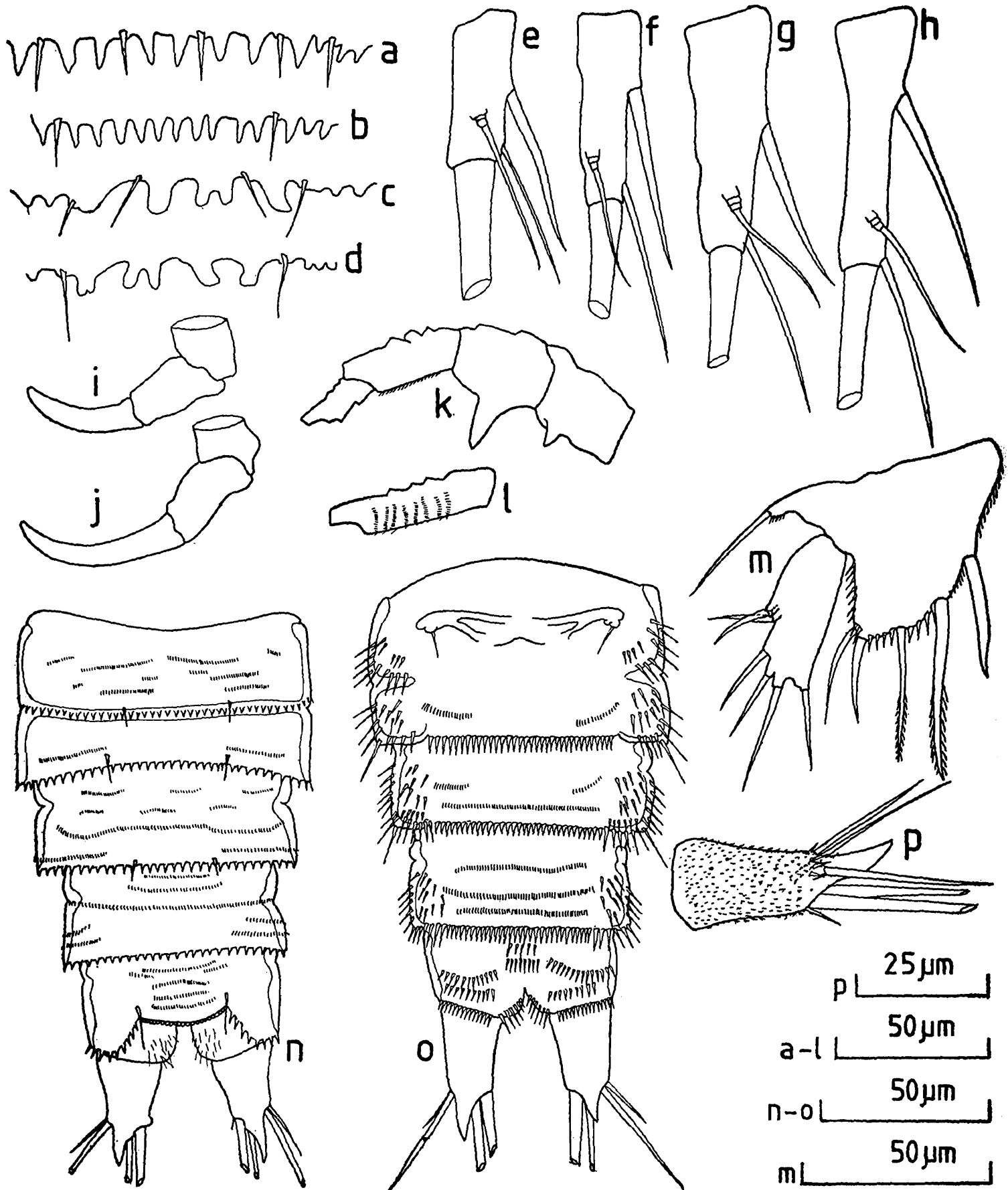


Fig. 138. a-l, *Laophonte cornuta* ♀ a-d, abdomen segs. 2-3, distal edge—normal condition (a-b), and in Stn IX ♀ (c-d). e-h, variation in caudal ramus—dorsal view of specimens from (e) Stn IX, (f) Stn II, (g-h) Stn VII. i-j, variation in P.1 Enp. claw. k-l, variation in antennule seg. 3. m, *Laophonte dinocerata* ♀, P.5. n-p, *Laophonte spinicauda* ♀ n-o, abdomen, dorsal and ventral. p, right caudal ramus, outer lateral.

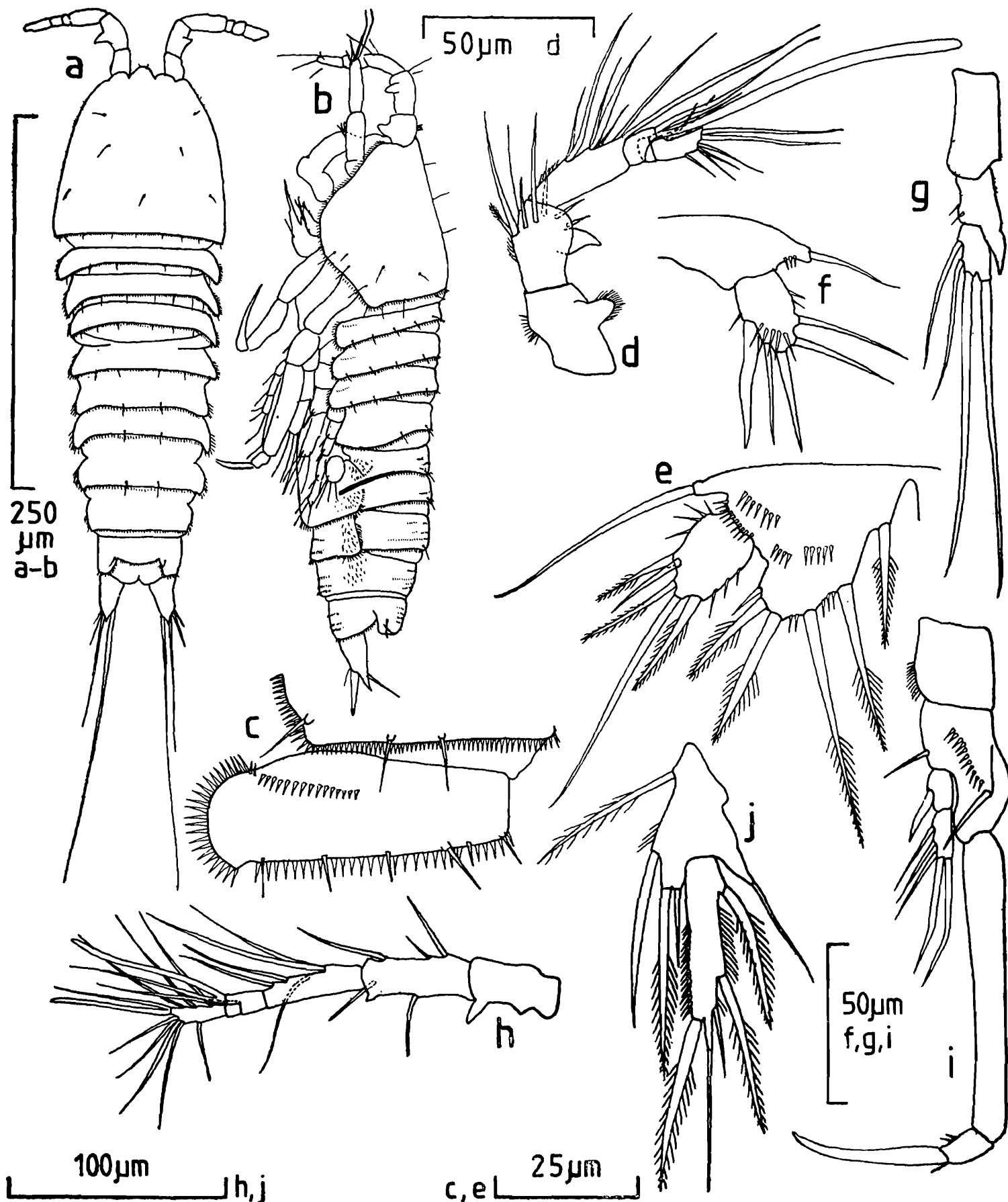


Fig. 139. a-g, *Laophonte spinicauda*. a-b, ♀ dorsal and lateral. c, ♀ ornamentation of edge of cephalothorax and 1st thorax seg. d, ♀ antennule. e-f, P.5 ♀ and ♂ g, ♂ P.3 Enp. h-j, *Esola longicauda* ♀ h, antennule. i, P.1. j, P.5.

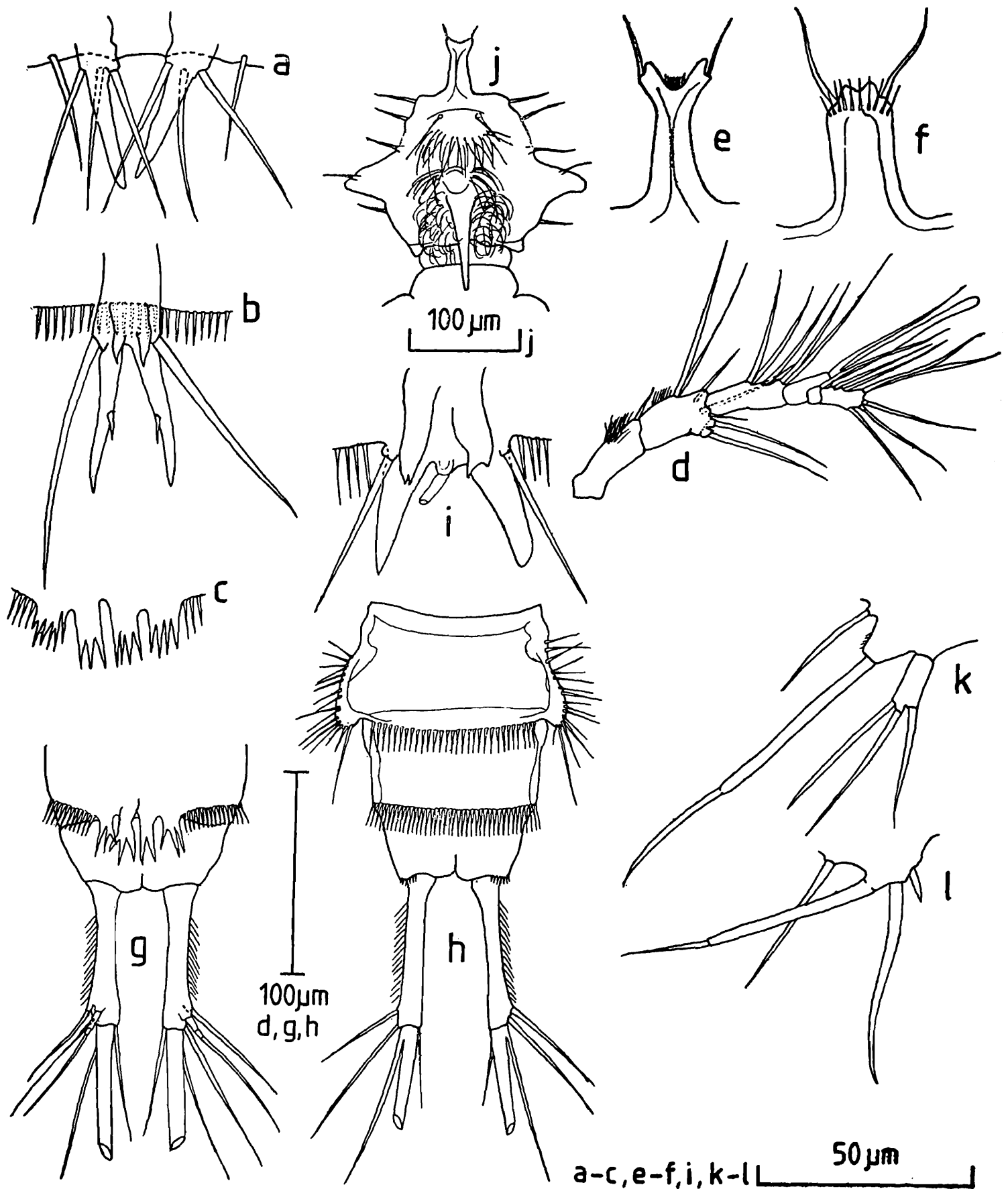


Fig. 140. *Echinolaophonte mirabilis*. a-c, Holotype ♀ dorsal armature of (a) thorax seg. 2, (b) abdomen seg. 3, (c) abdomen seg. 4. d, Holotype ♀ antennule. e-f, rostrum of male (e) and Andaman ♀ (f). g-h, Andaman ♀, posterior abdomen, dorsal and ventral. i, Andaman ♀ dorsal armature of abdomen seg. 3. j, ♂ cephalothorax, dorsal. k-l, ♀ P.5-P.6.

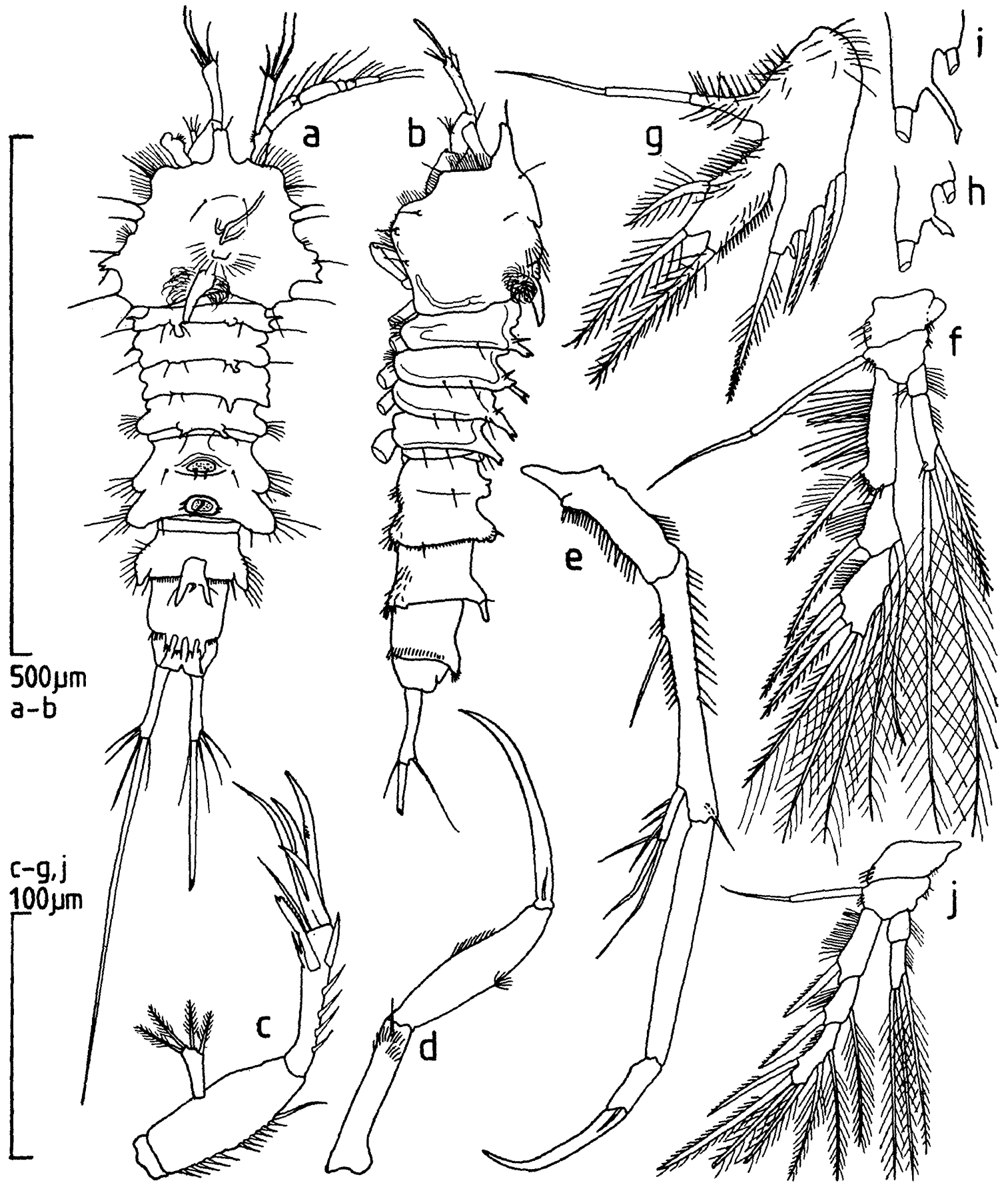


Fig. 141. *Echinolaophonte mirabilis*, a-h, Andaman ♀ ; i-j, Holotype ♀ a-b, dorsal and lateral. c, antenna. d, maxilliped. e, P.1. f-g, P.4-P.5. h-i, P.5 hyaline tube. j, P.4.

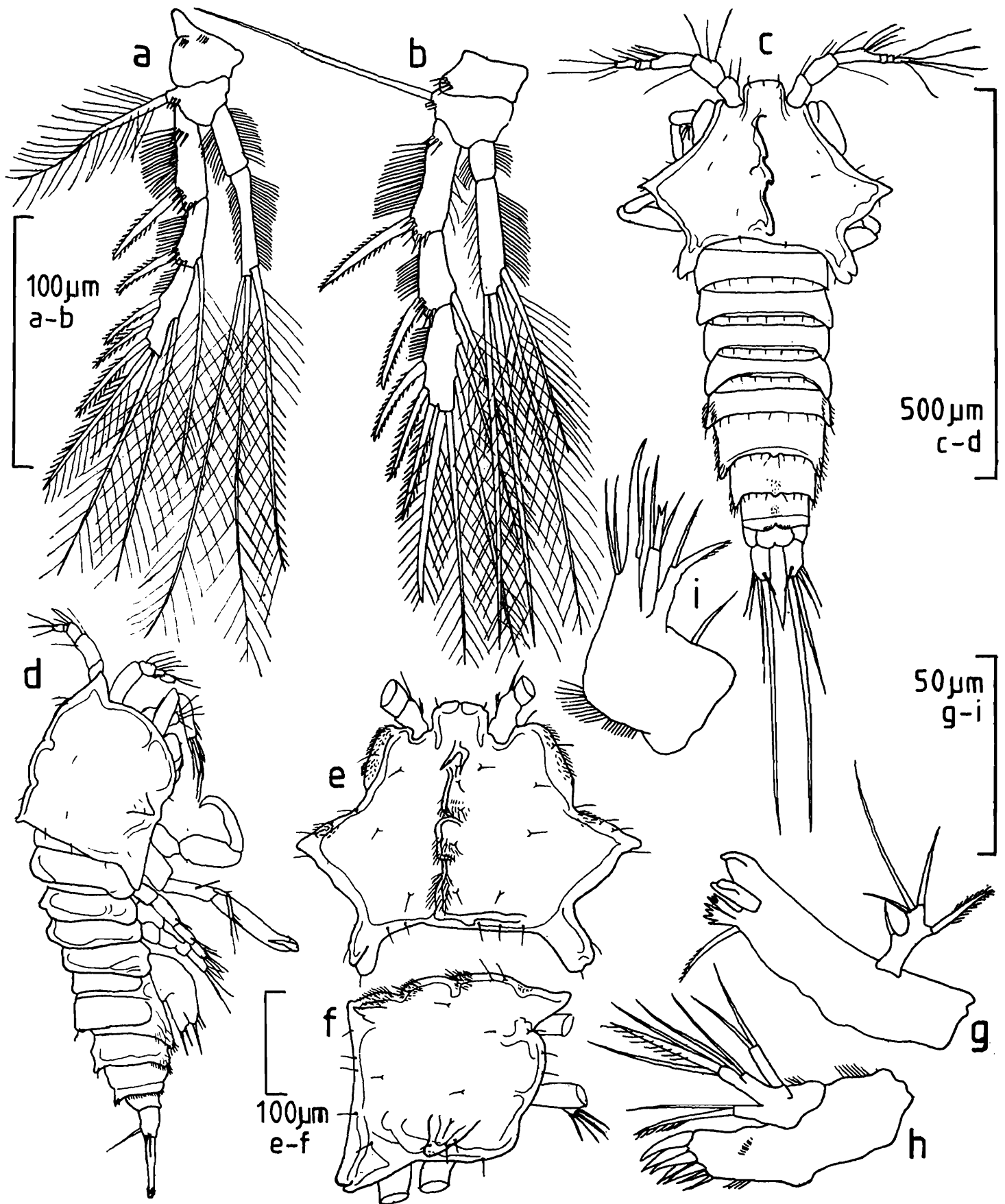


Fig. 142. a-b, *Echinolaophonte mirabilis*, Andaman ♀, P.2-P.3. c-i, *Echinolaophonte tropica* ♀ c-d, dorsal and lateral. c-f, cephalothorax, dorsal and right lateral. g, mandible. h, maxillule. i, maxilla.

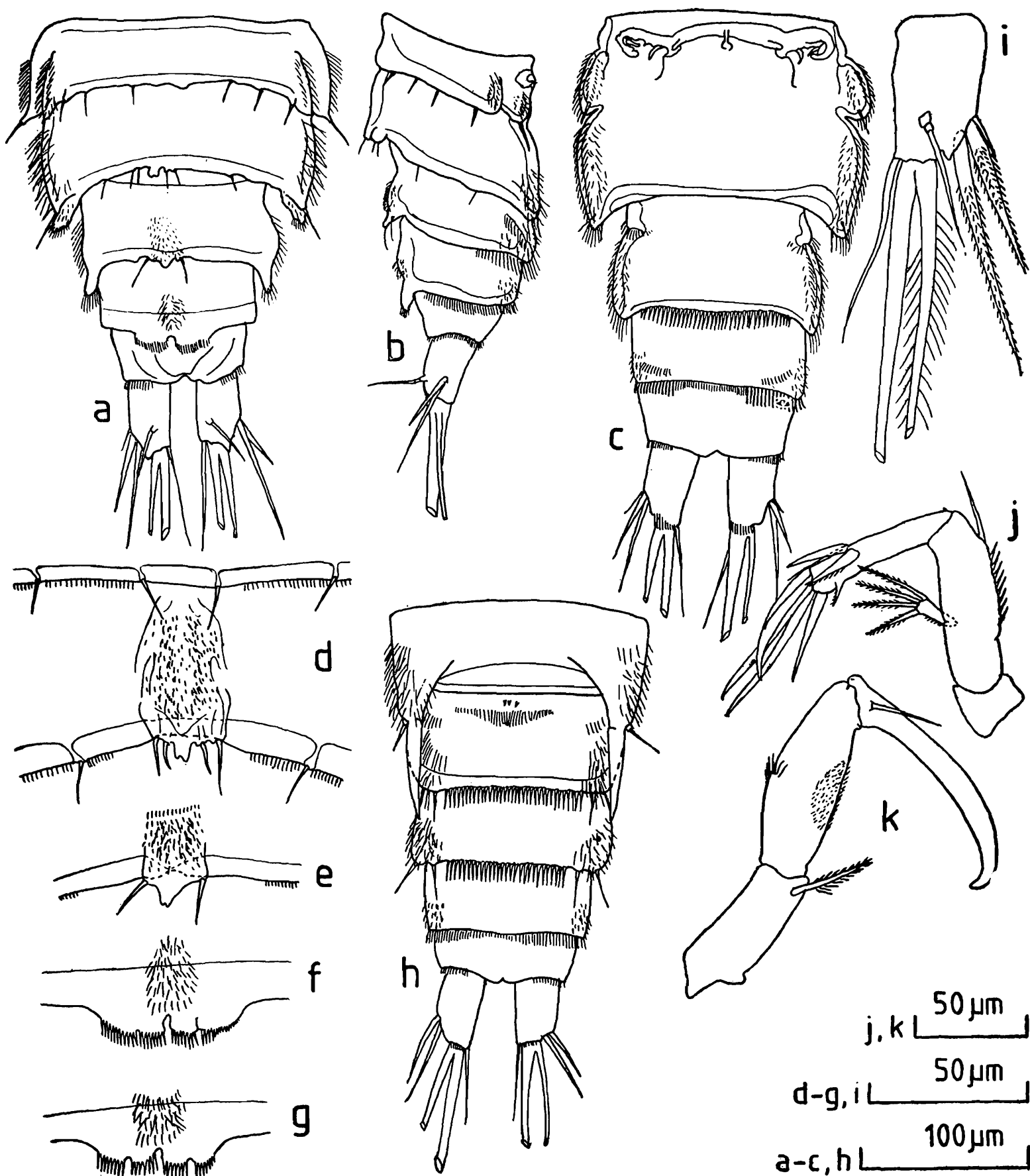


Fig. 143. *Echinolaophonte tropica*. a-c, ♀ abdomen, dorsal, lateral and ventral. d-e, ♀ abdomen, dorsal armature segs. 1-2, and 3. f-g, ♀ two variants of pseudoperculum. h, ♂ abdomen, ventral. i, ♀ right caudal ramus, dorsal. j, ♀ antenna. k, ♀ maxilliped.

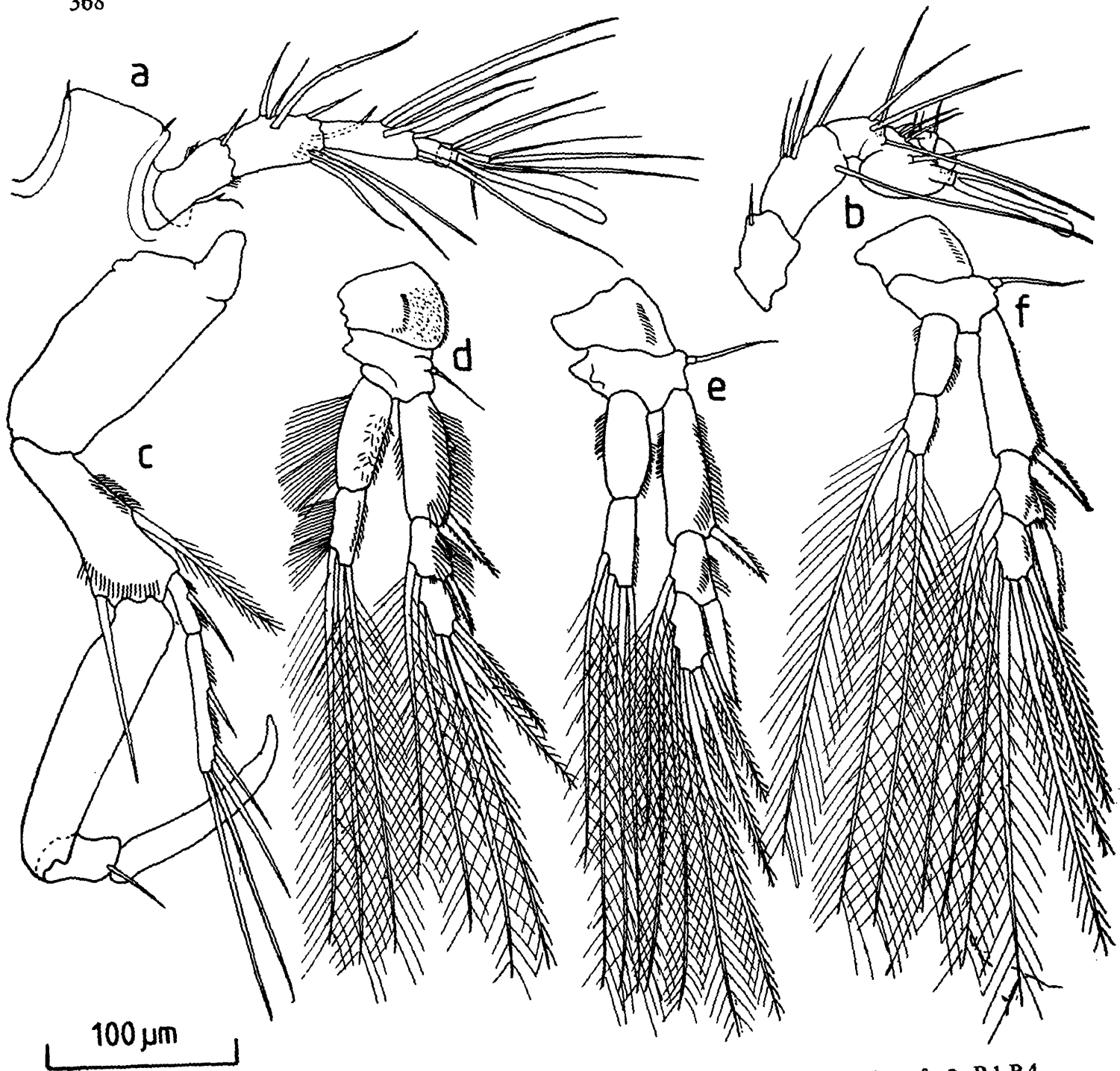


Fig. 144. *Echinolaophonte tropica*. a, ♀ rostrum and antennule. b, ♂ antennule. c-f, ♀ P.1-P.4.



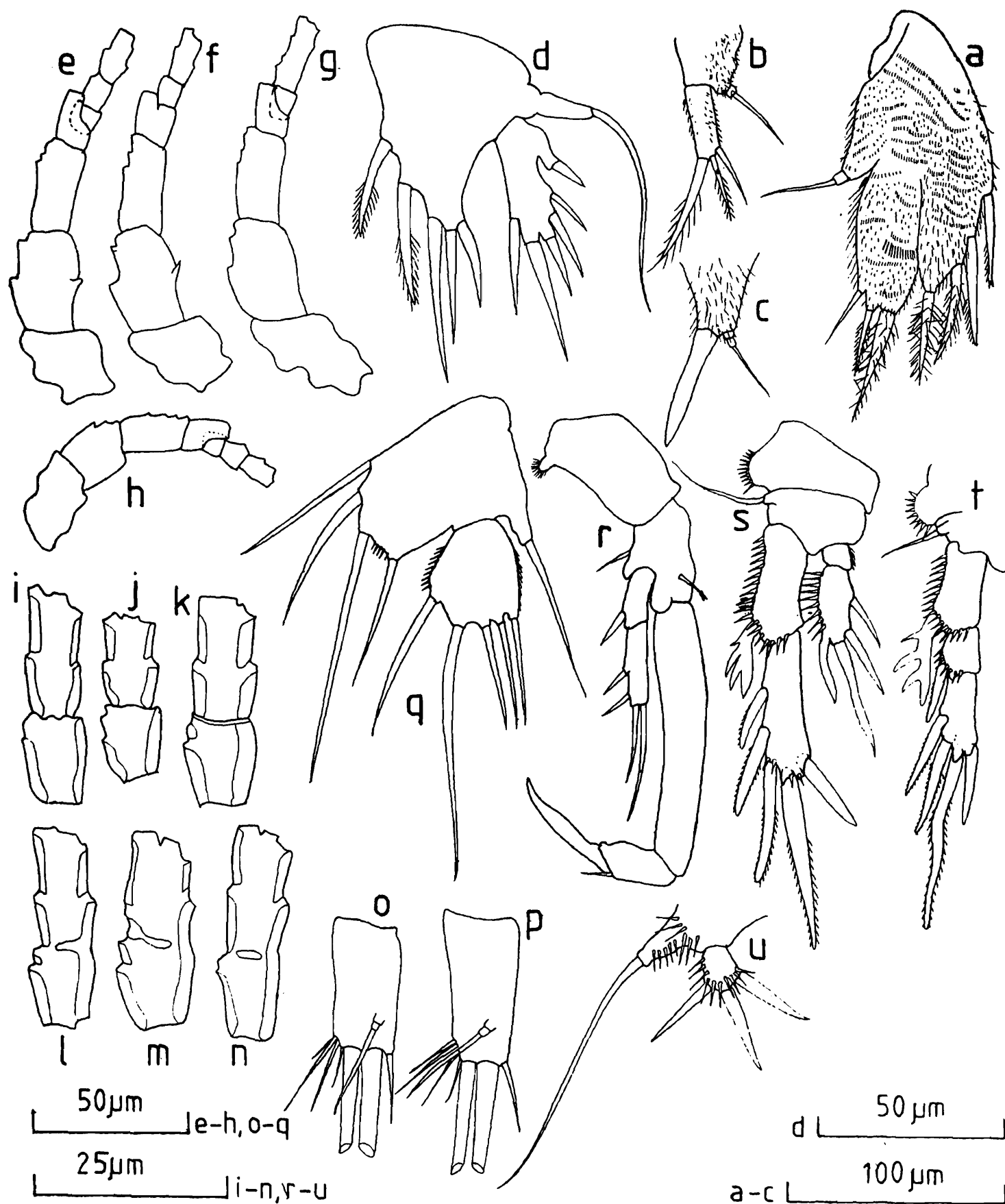


Fig. 145. a-c, *Echinolaophonte tropica*. a, ♀ P.5. b-c, ♂ P.5-P.6. d, *Quinquelaophonte quinquespinosa* ♀, P.5. e-q, *Paralaophonte brevisrostris* ♀ e-n, variation in antennule—in seg. number and in seg. 2 (e-h); in last 2 segs. in 7-seg. condition (i-k); in last seg. in 6-seg. condition (l-n). o-p, left caudal ramus, dorsal, of two females. q, P.5. r-u, *Klieonychocamptus ponticus* ♂ r, P.1. s, P.4. t, P.4 Exp. of another male. u, P.5.

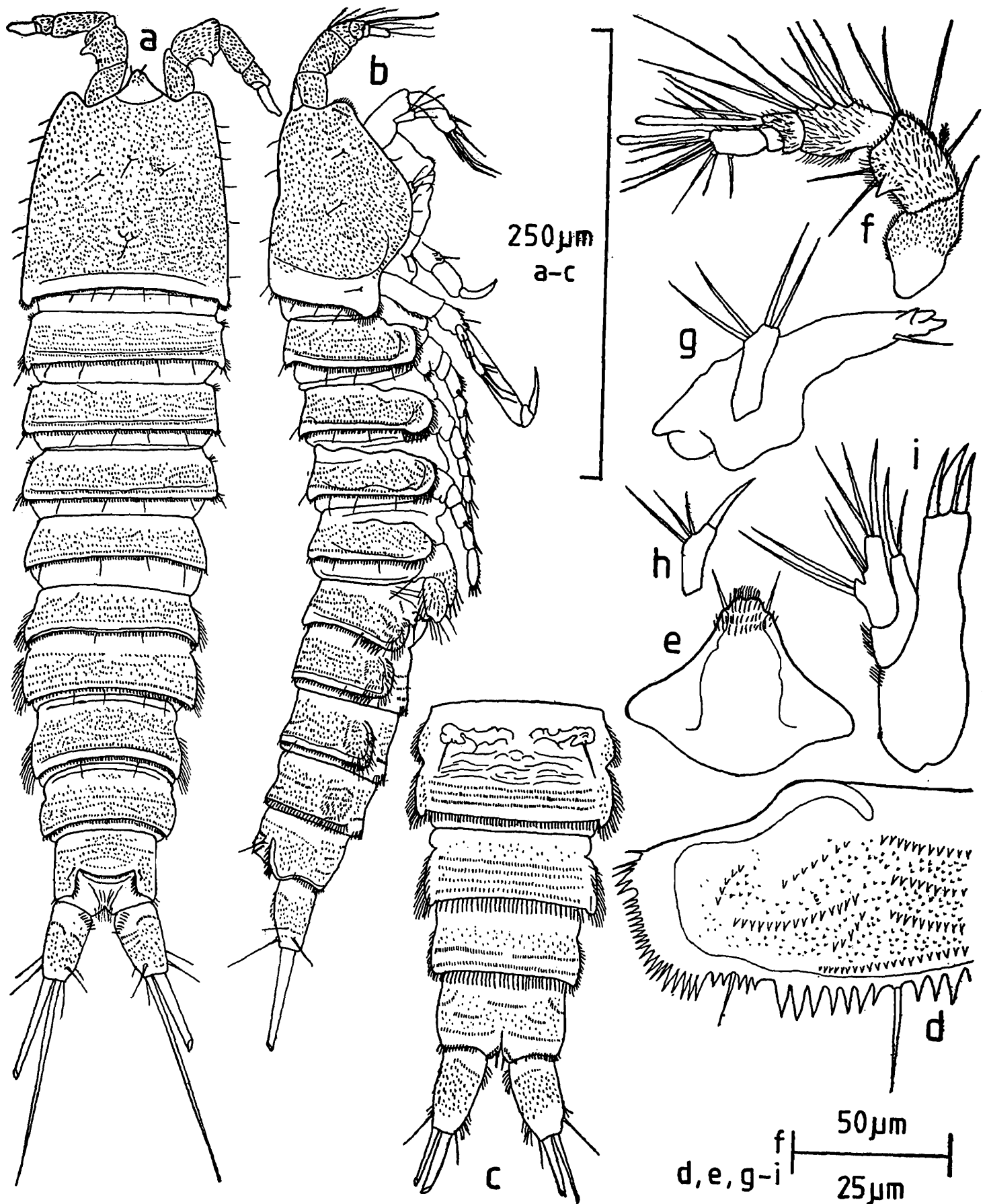


Fig. 146. *Apolaophonte hispida* ♀ a-b, dorsal and lateral. c, abdomen, ventral. d, ornamentation of thorax segs. e, rostrum. f, antennule. g, mandible. h, ♂ mandible palp. i, maxillule.

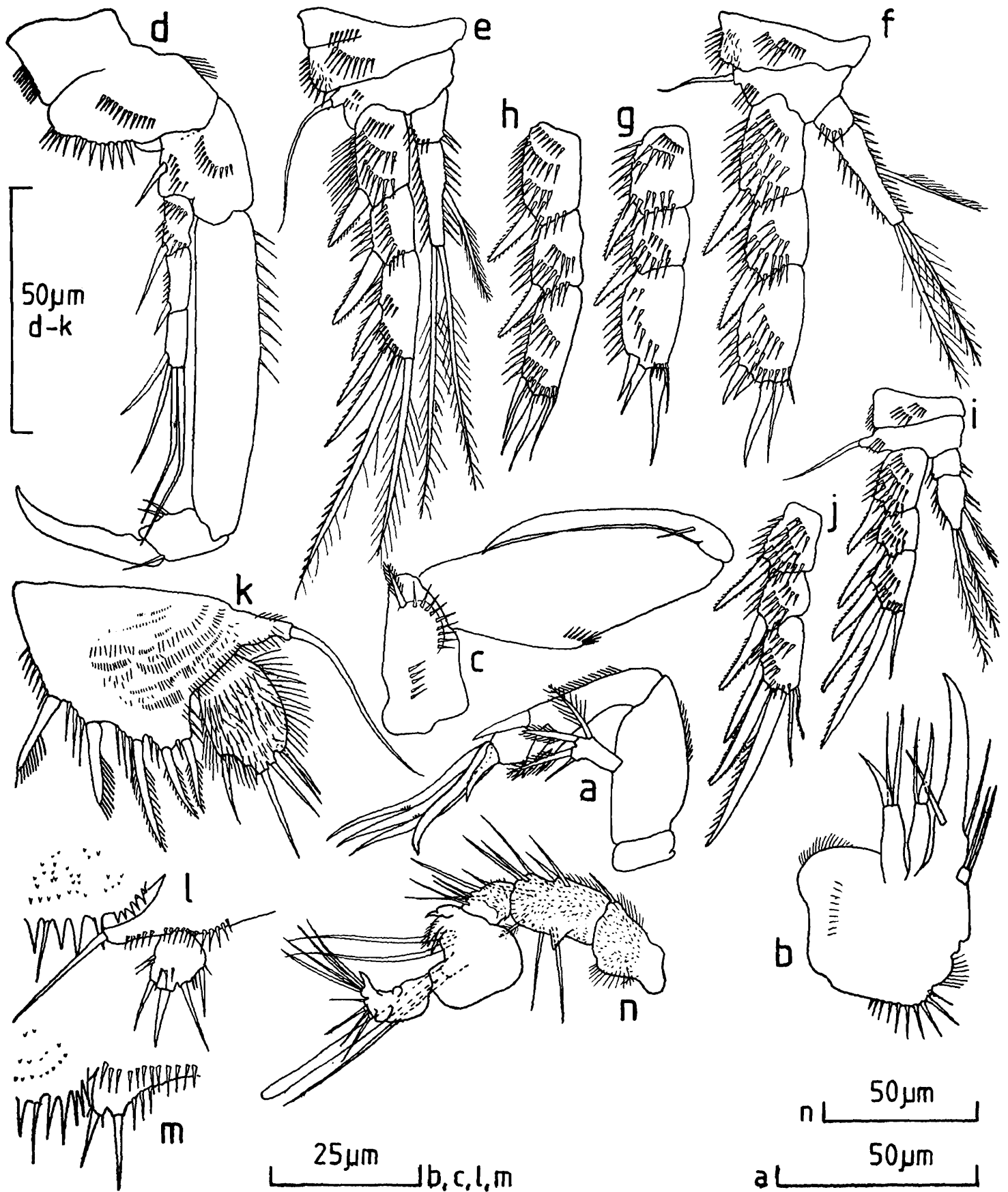


Fig. 147. *Apolaophonte hispida*. a, ♀ antenna. b, ♀ maxilla. c, ♀ maxilliped. d, ♀ P.1. e-f, ♀ P.3-P.4. g-h, ♀ P.4 Exp., two variants. i, ♂ P.4. j, ♂ P.4 Exp., variant. k, ♀ P.5-P.6. l-m, ♂ P.5-P.6. n, ♂ antennule.

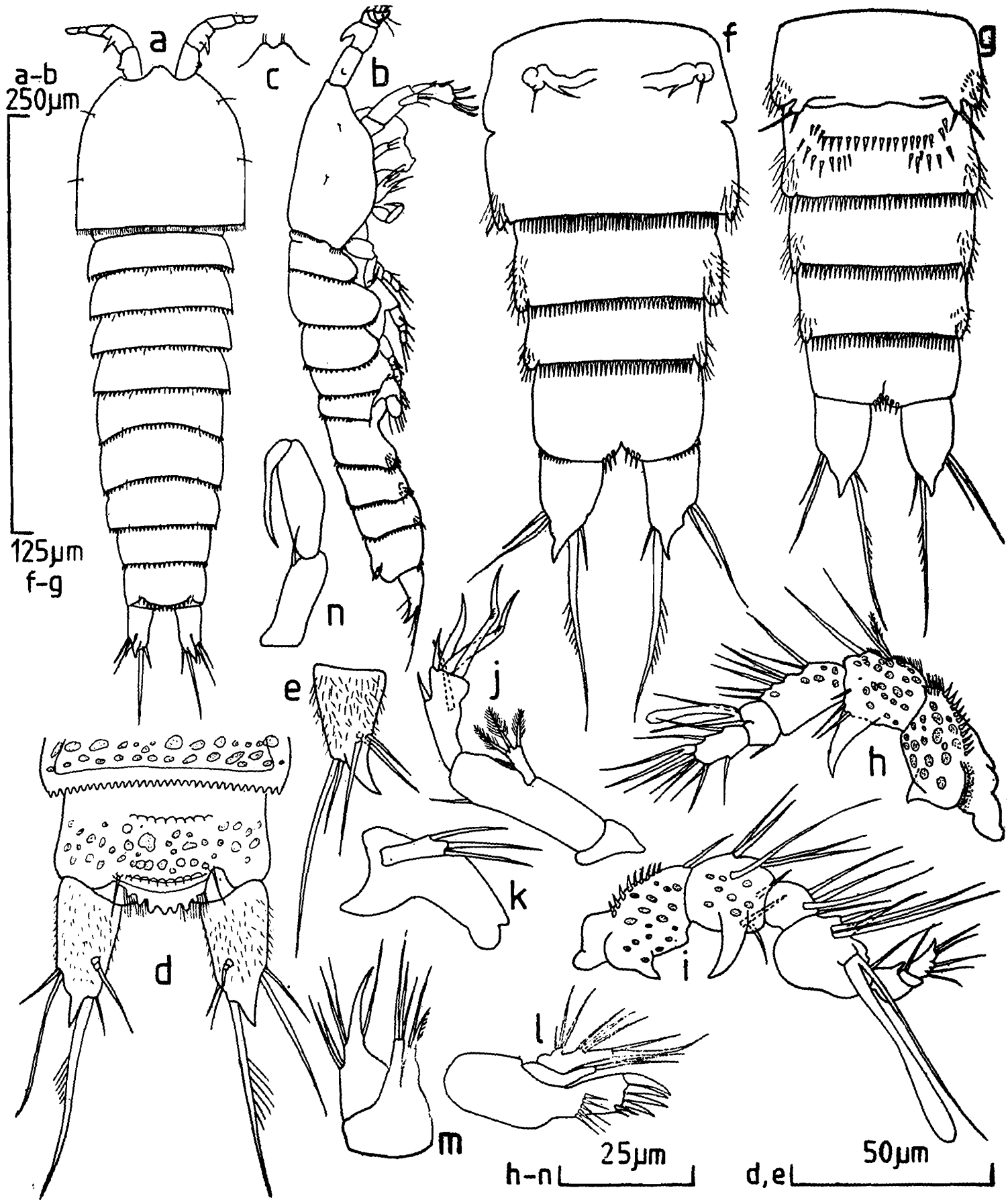


Fig. 148. *Langia maculata*. a-b, ♀ dorsal and lateral. c, ♀ rostrum. d, ♀ posterior abdomen, dorsal. e, ♀ left caudal ramus, outer lateral. f-g, abdomen ♀ and ♂, ventral. h-i, antennule ♀ and ♂ j, ♀ antenna. k, ♀ mandible. l, ♀ maxillule. m, ♀ maxilla. n, ♀ maxilliped.

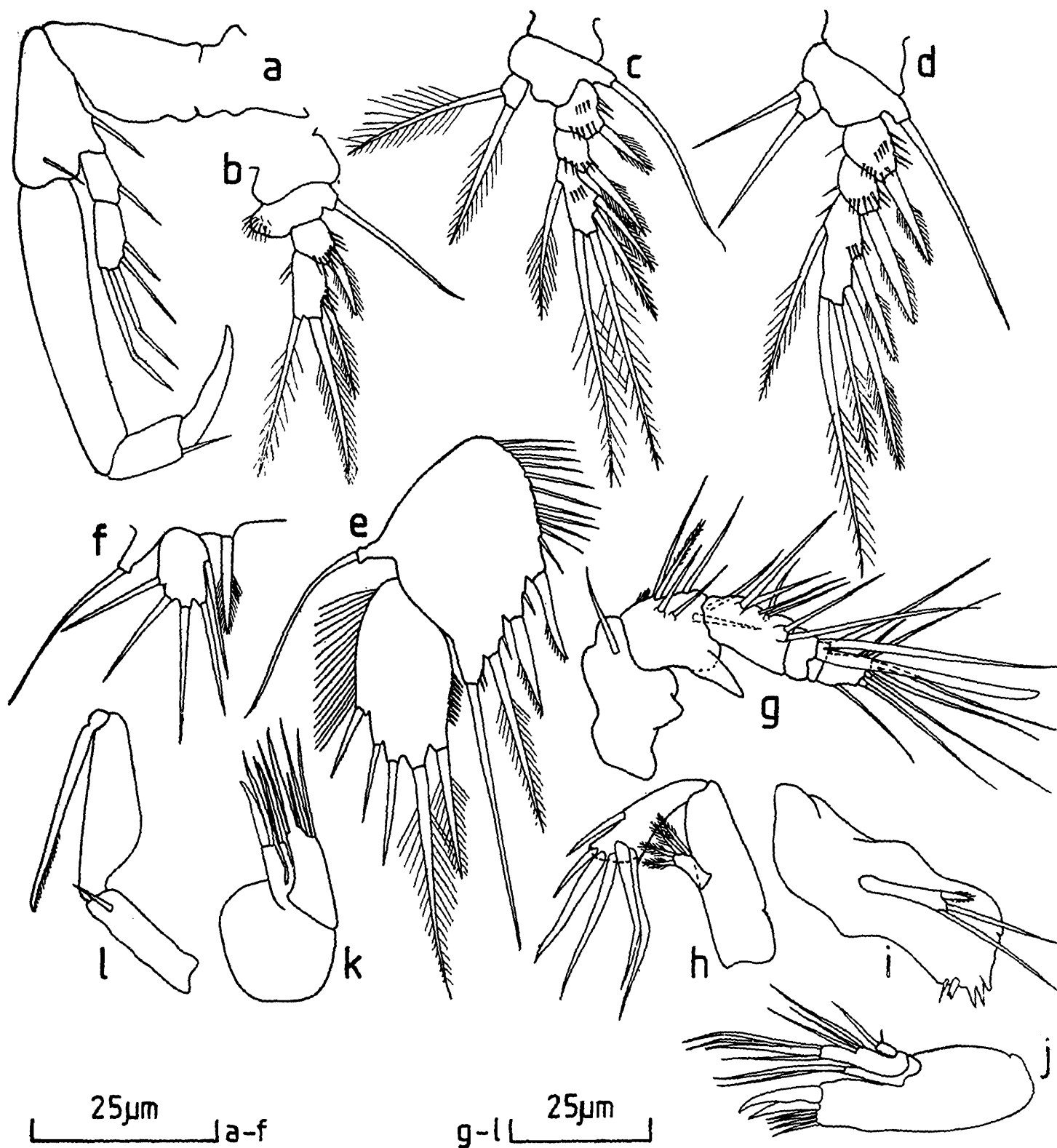


Fig. 149. a-f, *Langia maculata*. a-e, ♀ P.1-P.5. f, ♂ P.5. g-l, *Laophontina sensillata* ♀ g, antennule. h, antenna. i, mandible. j, maxillule. k, maxilla. l, maxilliped.

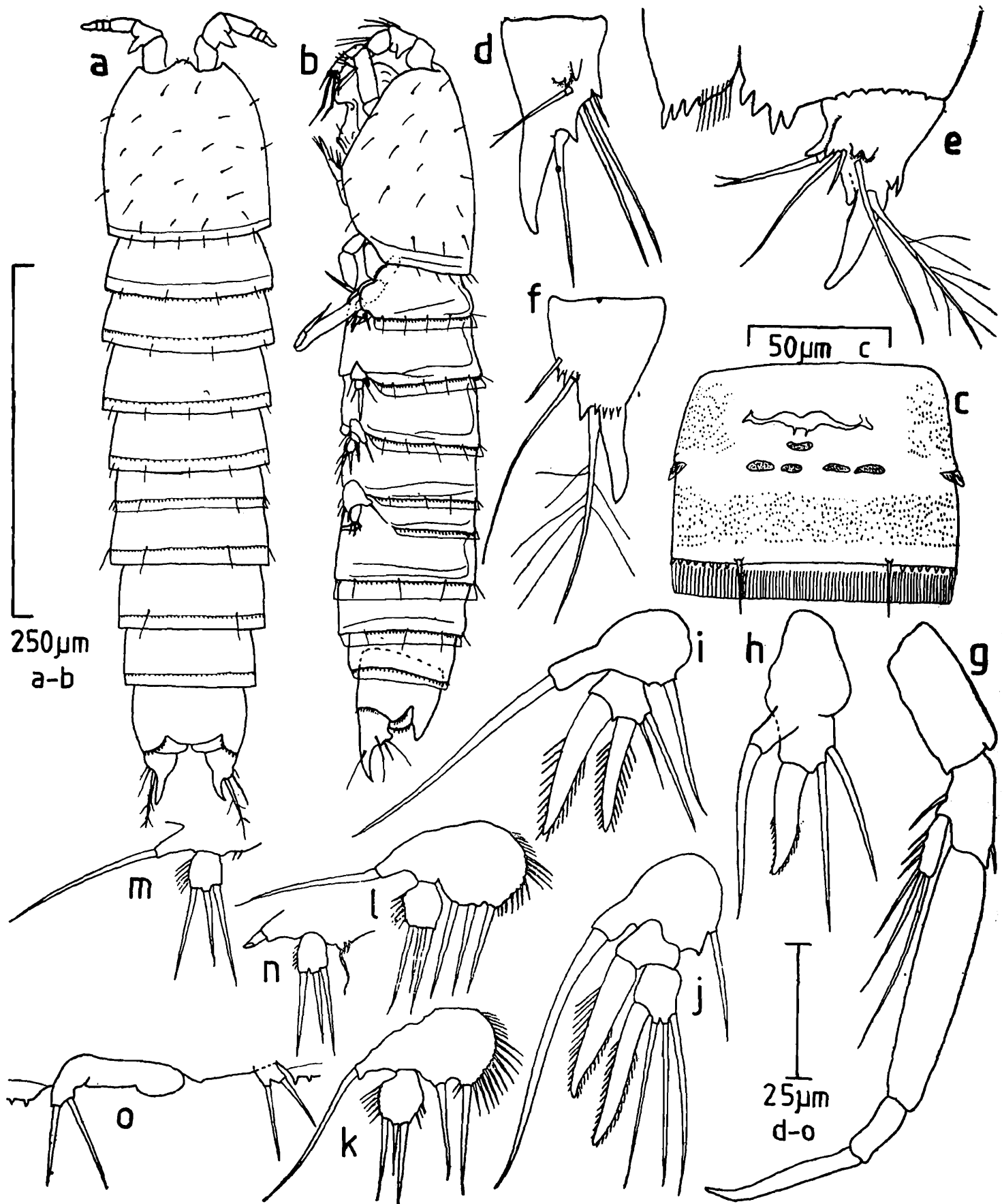


Fig. 150. *Laophontina sensillata*. a-b, ♀ dorsal and lateral. c, ♀ genital somite, ventral. d-f, ♀ right caudal ramus, dorsal, outer lateral and ventral. g-k, ♀ P.1-P.5. l, ♀ abnormal P.5. m, ♂ P.5. n, ♂ abnormal P.5. o, ♂ pair of P.6.

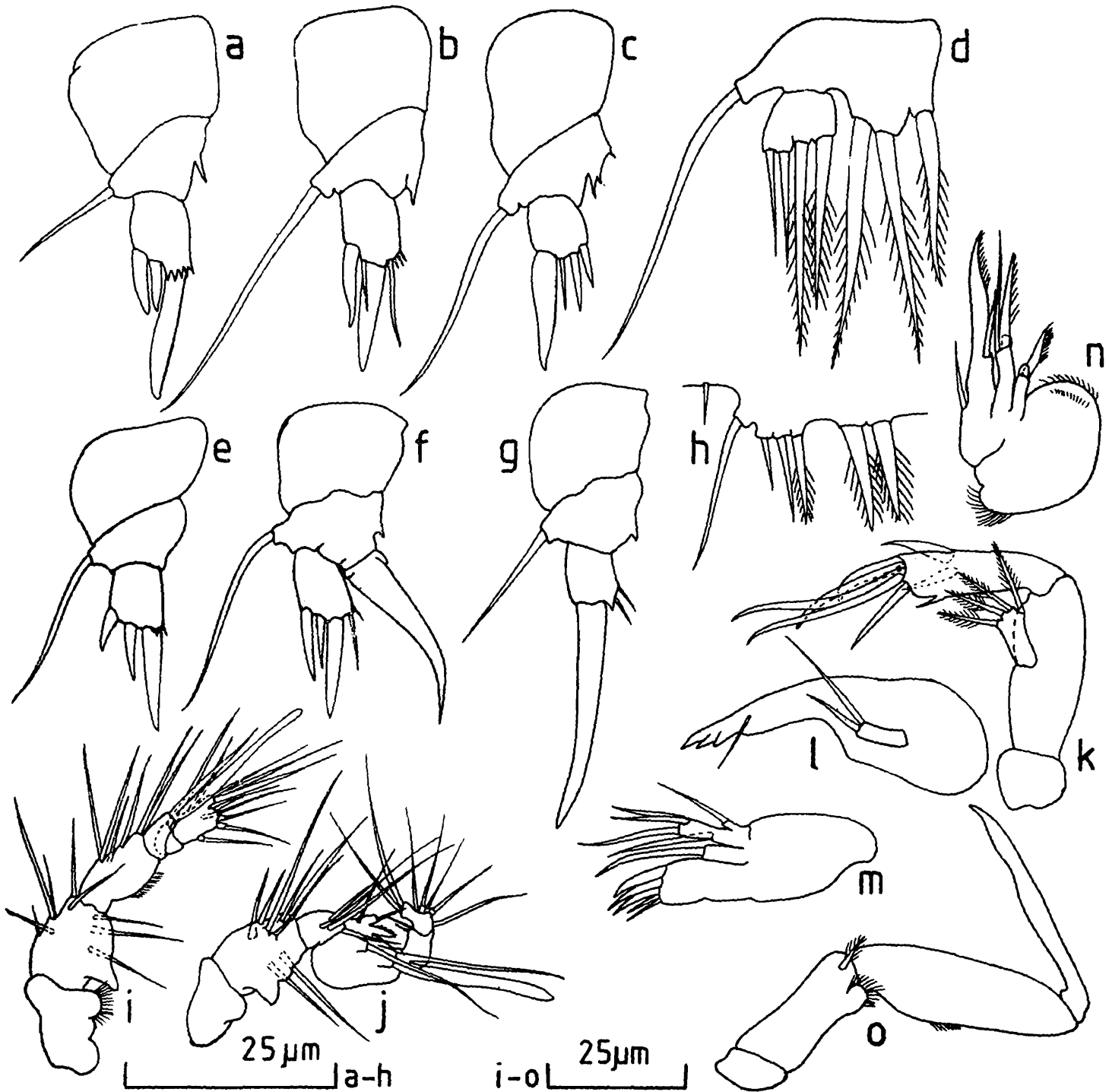


Fig. 151. a-h, *Klieonychocamptoides arganoi*. a-d, ♀ P.2-P.5. e-h, ♂ P.2-P.5. i-o, *Afrolaophonte ensiger*. i-j, antennule ♀ and ♂ k, ♀ antenna. l, ♀ mandible. m, ♀ maxillule. n, ♀ maxilla. o, ♀ maxilliped.

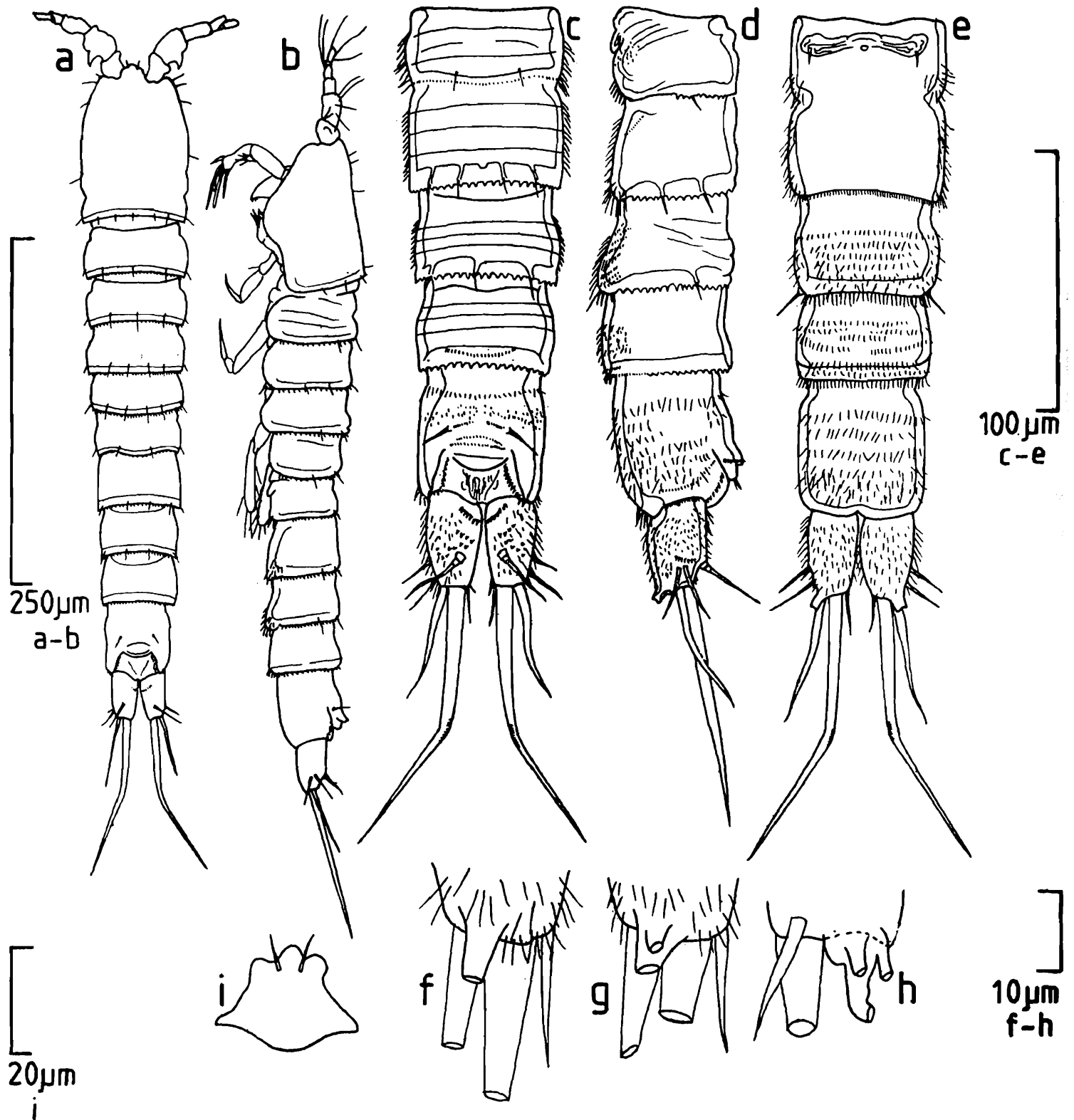


Fig. 152. *Afrolaophonte ensiger* ♀. a-b, dorsal and ventral. c-e, abdomen, dorsal, lateral and ventral. f-h, caudal ramus, hyaline tubes, variants. f-g, ventral. h, lateral.



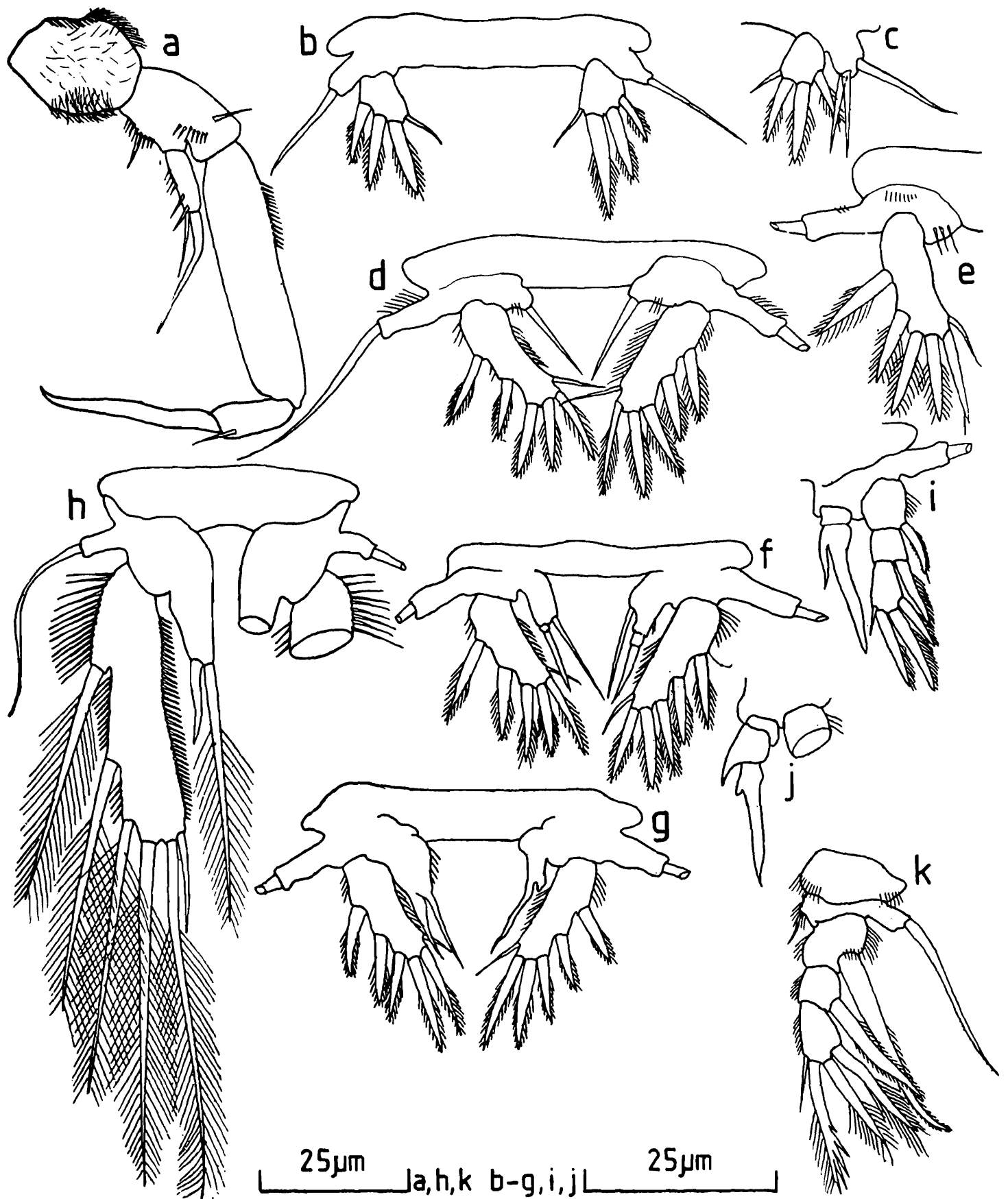


Fig. 153. *Afrolaophonte ensiger*. a, ♀ P.1. b, ♀ pair of P.2. c, ♀ abnormal P.2. d, ♀ pair of P.3. e-g, ♀ P.3, variants. h, ♀ P.4. i, ♂ P.3. j, ♂ P.3 endopod, variant. k, ♂ P.4.

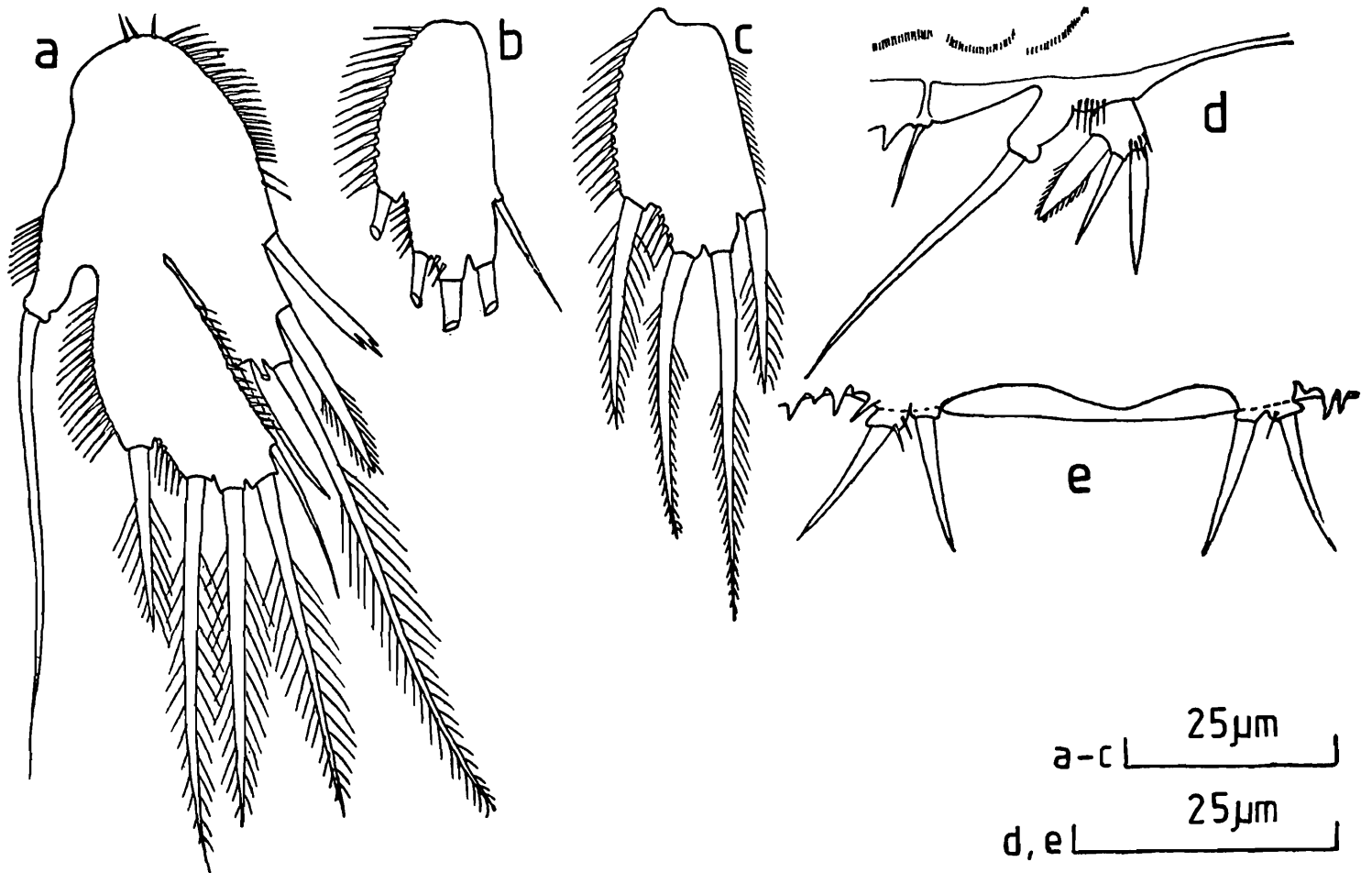


Fig. 154. *Afrolaophonte ensiger*. a, ♀ P.5. b-c, ♀ P.5 exopod, variants. d, ♀ P.5. e, ♂ pair of P.6.

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