FOUR NEW COPEPODS (CRUSTACEA: HARPACTICOIDA, CANUELLIDAE) SIMULTANEOUSLY OCCURRING WITH *DIOGENES SENEX* (CRUSTACEA: PAGURIDEA) NEAR SYDNEY

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Synopsis

Sunaristes tranteri nov. sp. is described and compared with the other four undoubted species of this genus, all of which are associated with hermit-crabs. In north-west Europe the only species is the type of the genus, *S. paguri* Hesse ; *Pagurus cuanensis* and *Diogenes pugilator* are recorded for the first time as hosts for this species in this area, where the usual host is *P. bernhardus* (the record of *P. prideauxi* as a host for *S. paguri* in British waters is shown to be doubtful). It is shown that variously poorly described canuellids, placed from time to time in *Sunaristes*, are ineligible for generic placement in the basis of existing descriptions ; however, the five species here referred to *Sunaristes* form an extremely close-knit group.

Brianola sydneyensis, *B. pori* and *B. elegans* nov. spp. are described ; the setal formulae of all six known species of *Brianola* are compared. The taxonomic differences between corresponding swimming-feet in different species are most marked in the first pair of swimming-feet, less so in the second pair, and least of all in the third and fourth pairs. *B. reichi* (Por) is the most aberrant species, but is best left in *Brianola* pending a major revision of the family.

Keys are given to the accepted species of both these genera.

Introduction

The family Canuellidae (for diagnosis see Lang, 1948) comprises harpacticoid copepods of moderate to large size, occurring intertidally or in small depths among benthos. None have yet been recorded in Australian territorial waters, although the " Siboga " took *Canuella curticaudata* off the Aru Islands and *Sunaristes paguri* off New Guinea (Scott, 1909, but see below). The nearest other records of canuellids are from Ceylon (Thompson and Scott, 1903), Mozambique (Wells, 1967), Madagascar (Humes and Ho, 1969), and the Red Sea (Por, 1967) ; records outside the Indo-West Pacific area are summarized by Lang (1948) and Bodin (1967, list only).

Material and Methods

The four new species described below were collected in two localities, both in the coastal suburbs of metropolitan Sydney.

(1) In Narrabeen Lagoon (approximately 33° 43′ S., 151° 17′ E.), among weeds at the water's edge on 4.x.1969 ; a single female (the holotype) of *Brianola pori* nov. sp. As far as I can ascertain (see Acknowledgements) no pagurid has ever been found in this lagoon.

(2) In the swimming pool of the C.S.I.R.O. Division of Fisheries and Oceanography (approximately 34° 04′ 30″ S., 151° 08′ 53″ E.). The pool empties directly into Gunnamatta Bay during low tide (although the drainpipe can be

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shut off to keep the pool full to any desired level for as long as needed), and is filled during high tide by a centrifugal pump whose inlet is under the boat jetty, just below ELWST and about 20 m. from the pool. The pool is about 30 m. long, 13 m. wide and 3 m. deep, rectangular in shape, and can be filled to the brim ; the common Sydney rock-oyster (*Crassostrea commercialis* Roughley and Iredale) is found on the concrete walls, and various small fish (up to about 12 cm. in length) and invertebrates live on the limestone bottom. One of the most conspicuous invertebrates is the small hermit-crab *Diogenes senex* Heller, inhabiting empty shells almost exclusively of the gastropod *Pyrazus ebeninus* Bruguière, although a small percentage live in shells of *Bellastraea* sp. or *Austrocochlea* sp. ; no other species of hermit-crab has yet been found in the pool. The following two samples of *D. senex* in their shells were soaked overnight in formalinized seawater, which was then filtered through plankton gauze of pore size 0·3 mm., and were then rinsed with several lots of tapwater, which was also filtered through the same gauze, the filtrate being examined under the binocular microscope.

(*a*) About 200 *D. senex*, collected on 20.xi.1970, yielded 6, 1, 5, 2 *Sunaristes tranteri* nov. sp. (*i.e.* six females of which one was ovigerous, five males, and two copepodites whose sex was not determined ; *cf.* Hamond, 1971*a*, 1971*b*), as well as harpacticoids of other families (preserved) and other organisms such as small polychaetes (discarded).

(*b*) About 1,000 *D. senex*, collected on 28.ii.1971, yielded 5, 3, 9, 24 *S. tranteri*, 20, 11, 30, 33 *Brianola pori* nov. sp., 9, 3, 9, 105 *Brianola sydneyensis* nov. sp., and 13, 2, 12, 0 *Brianola elegans* nov. sp., as well as many other harpacticoids (preserved), hydroid polyps apparently rubbed off the *Pyrazus* shells (*Hydractinia* sp. and ? *Campalecium* sp., both preserved), and other invertebrates as before (discarded).

The copepods were dissected and mounted as previously (Hamond, 1969, 1971*b*); the terminology employed and all abbreviations are those in normal use by workers on harpacticoids. Special attention was paid to making drawings of uncompressed entire animals from various aspects, in order to record the somitic ornamentation as exactly as possible ; it was also found that the male antennule of *Sunaristes* could not be drawn satisfactorily except in the uncompressed state (Figs 9–11). All figures of females are from the holotypes, and of males from the allotypes, unless otherwise indicated ; dissected paratypes are labelled 1, 2, 3, . . . for females and A, B, C, . . . for males, undissected paratypes being without individual designations. Type specimens have been deposited in the Australian Museum, Sydney, under the following registration numbers :

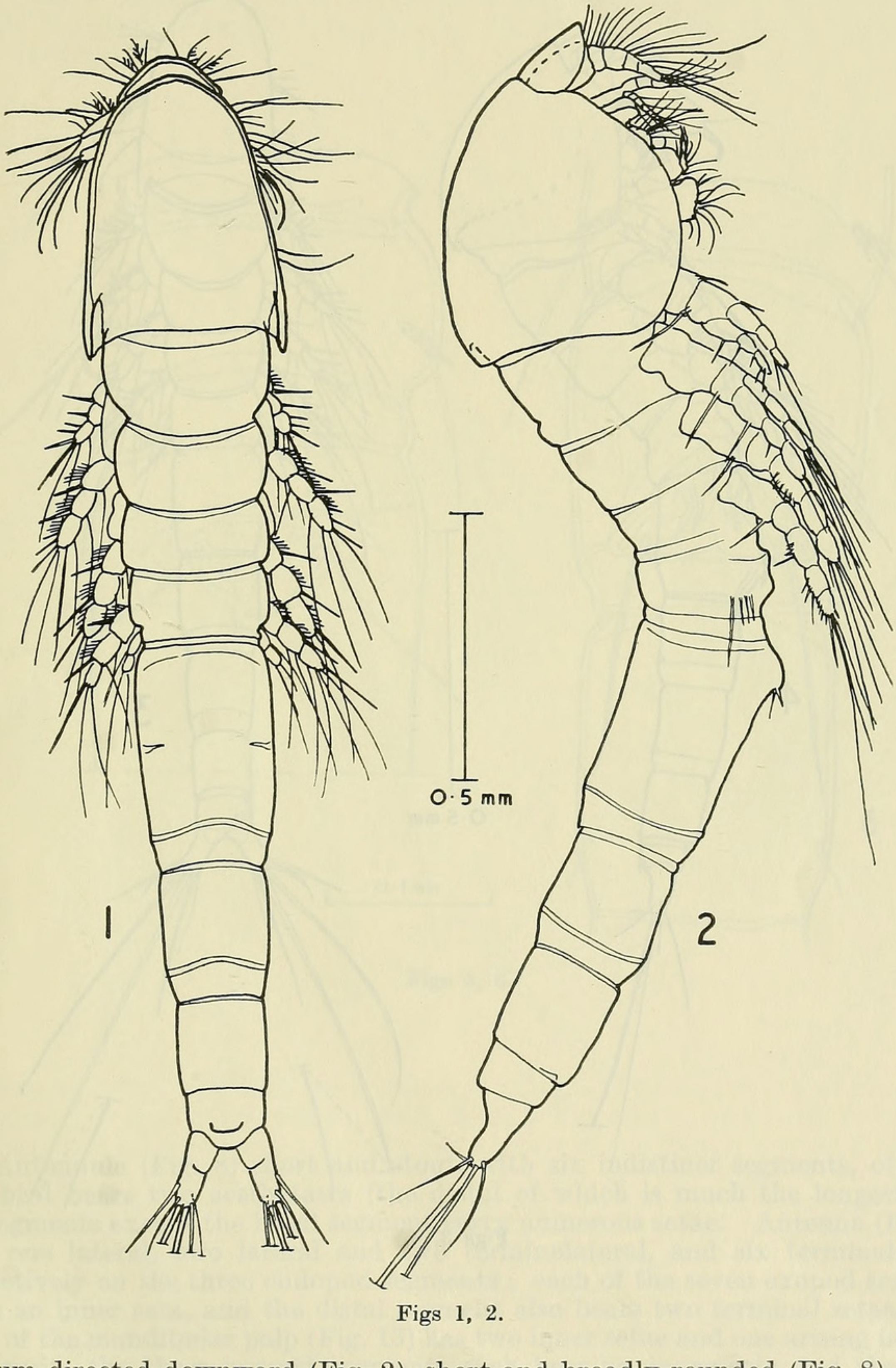
P.18678	*Brianola elegans*, nov. sp.	Holotype, female.
P.18679	*B. elegans*	Allotype, male.
P.18680	*B. sydneyensis*, nov. sp.	Holotype, female.
P.18681	*B. sydneyensis*	Allotype, male.
P.18682	*B. pori*, nov. sp.	Holotype, female.
P.18683	*B. pori*	Allotype, male.
P.18684	*Sunaristes tranteri*, nov. sp.	Holotype, female.
P.18685	*S. tranteri*	Allotype, male.

All the paratypes are being kept in my own collection for comparison with canuellids to be found in future.

Sunaristes tranteri nov. sp.

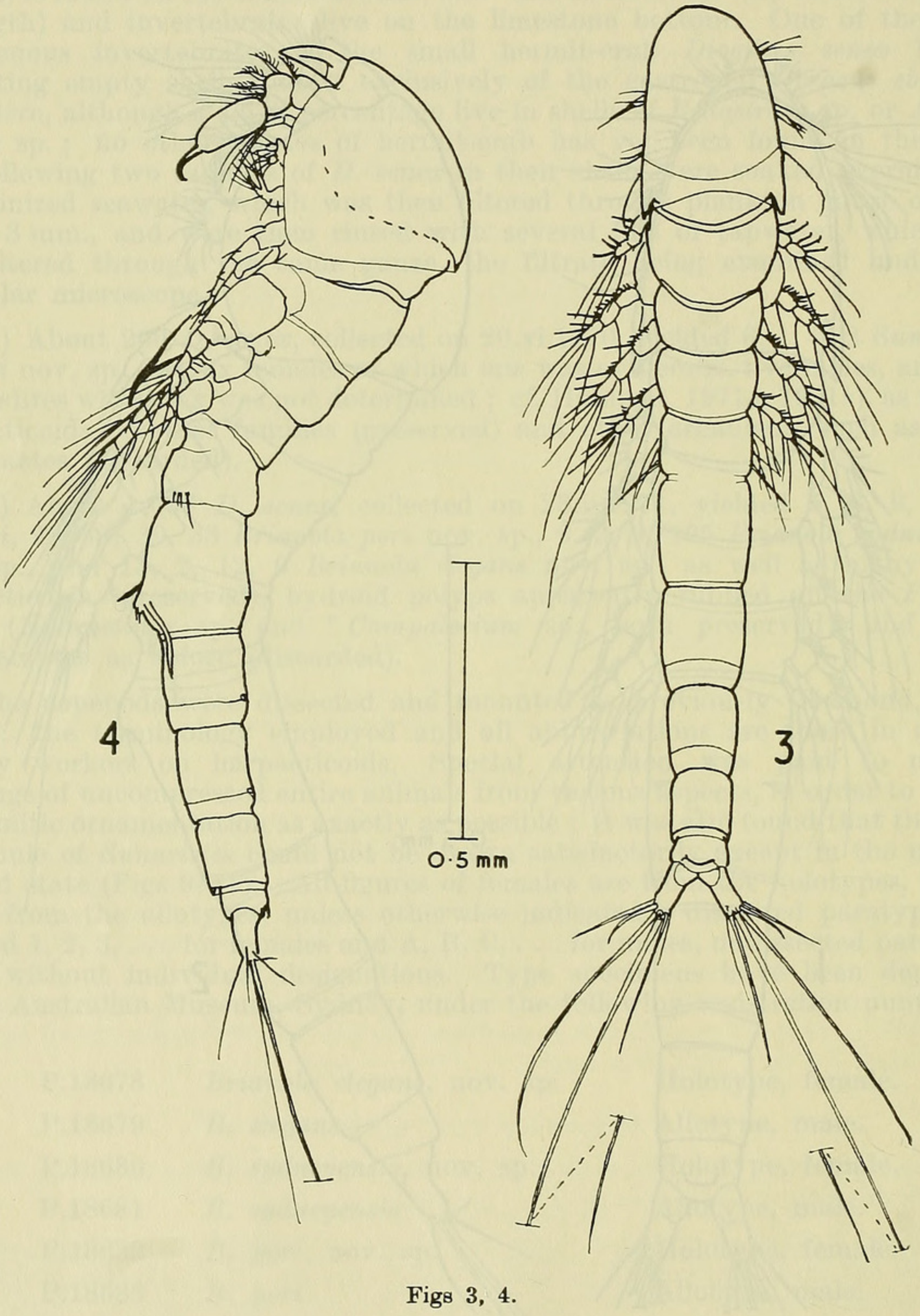
(Figs 1–21)

Female (*holotype*). Length 2·3 mm., measured in side view round the curves, along the axis of each section of the body. Body long and slender, with a high, vaulted prosome which is somewhat compressed laterally (Figs 1, 2).



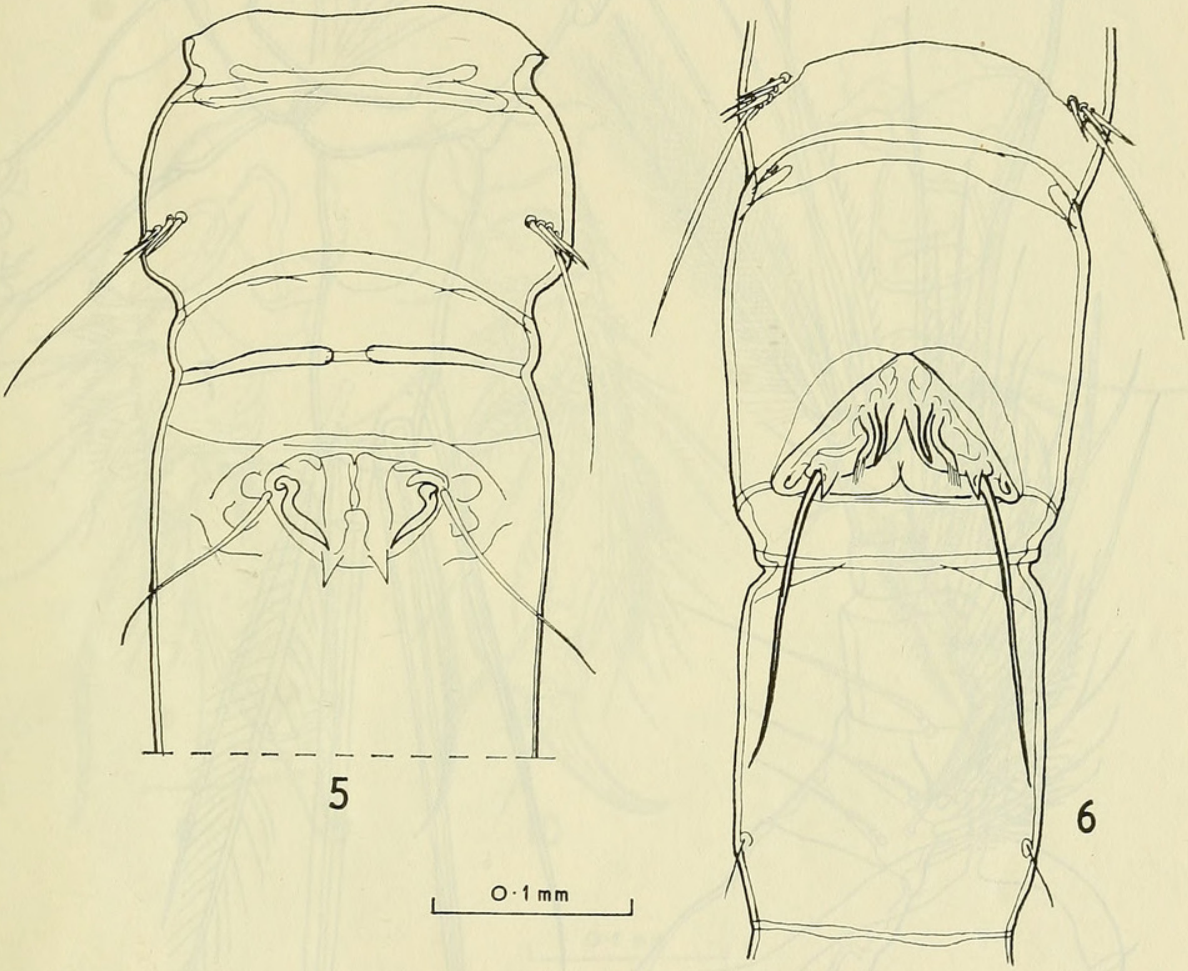
Figs 1, 2.

Rostrum directed downward (Fig. 2), short and broadly rounded (Fig. 8). The rear margin of each abdominal somite bears a few sensillae, but there is no other somitic ornamentation anywhere. Abdominal somites longer than broad (except



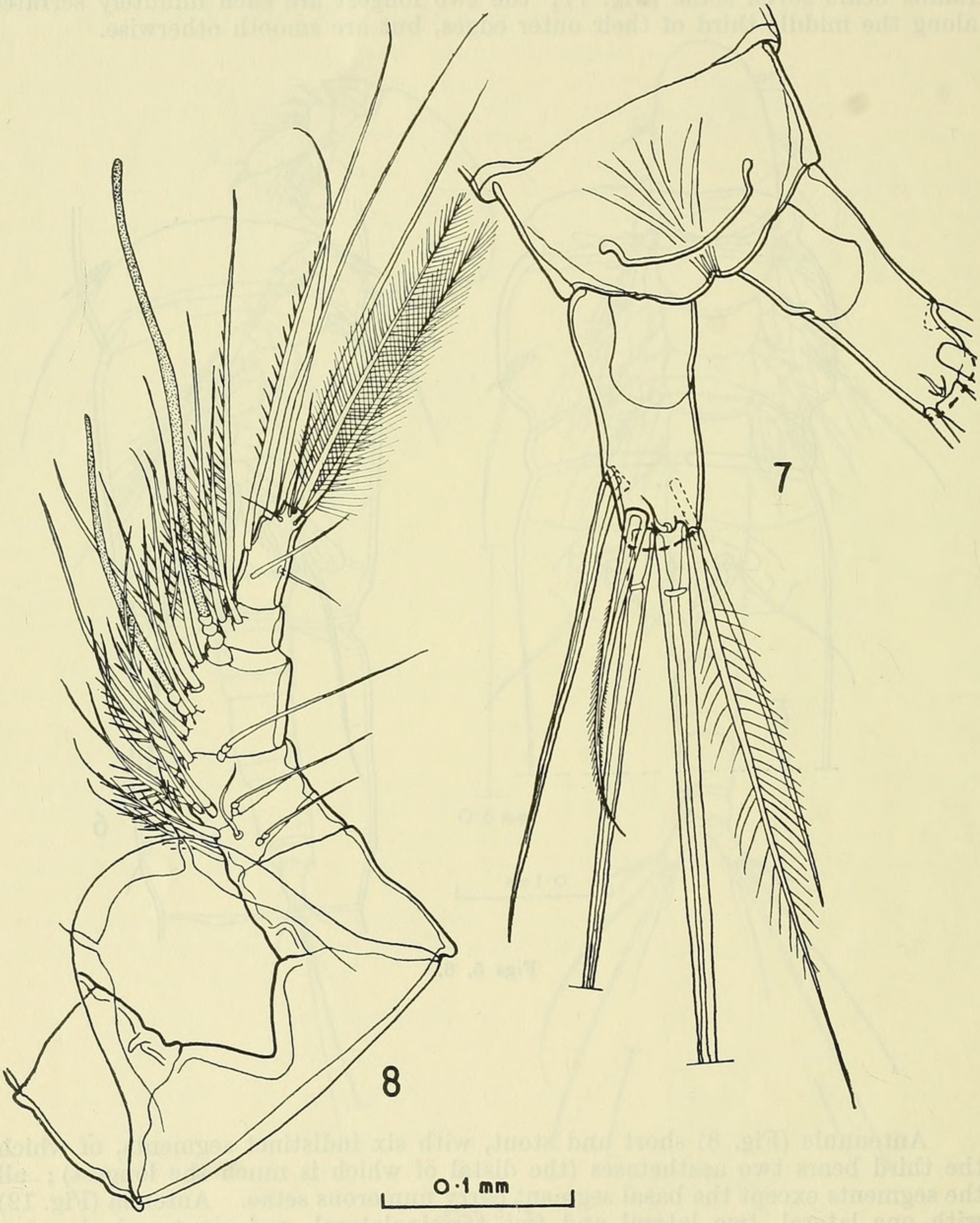
Figs 3, 4.

the anal somite) and cylindrical, separated by conically tapering intersomitic membranes ; genital double-somite not divided, genital area as in Fig. 5. Operculum shallowly curved, with a smooth edge. Furcal rami slightly divergent (Fig. 7), the inner wall of each ramus distinctly shorter than the outer. Each ramus bears seven setae (Fig. 7) ; the two longest are each minutely serrated along the middle third of their outer edges, but are smooth otherwise.



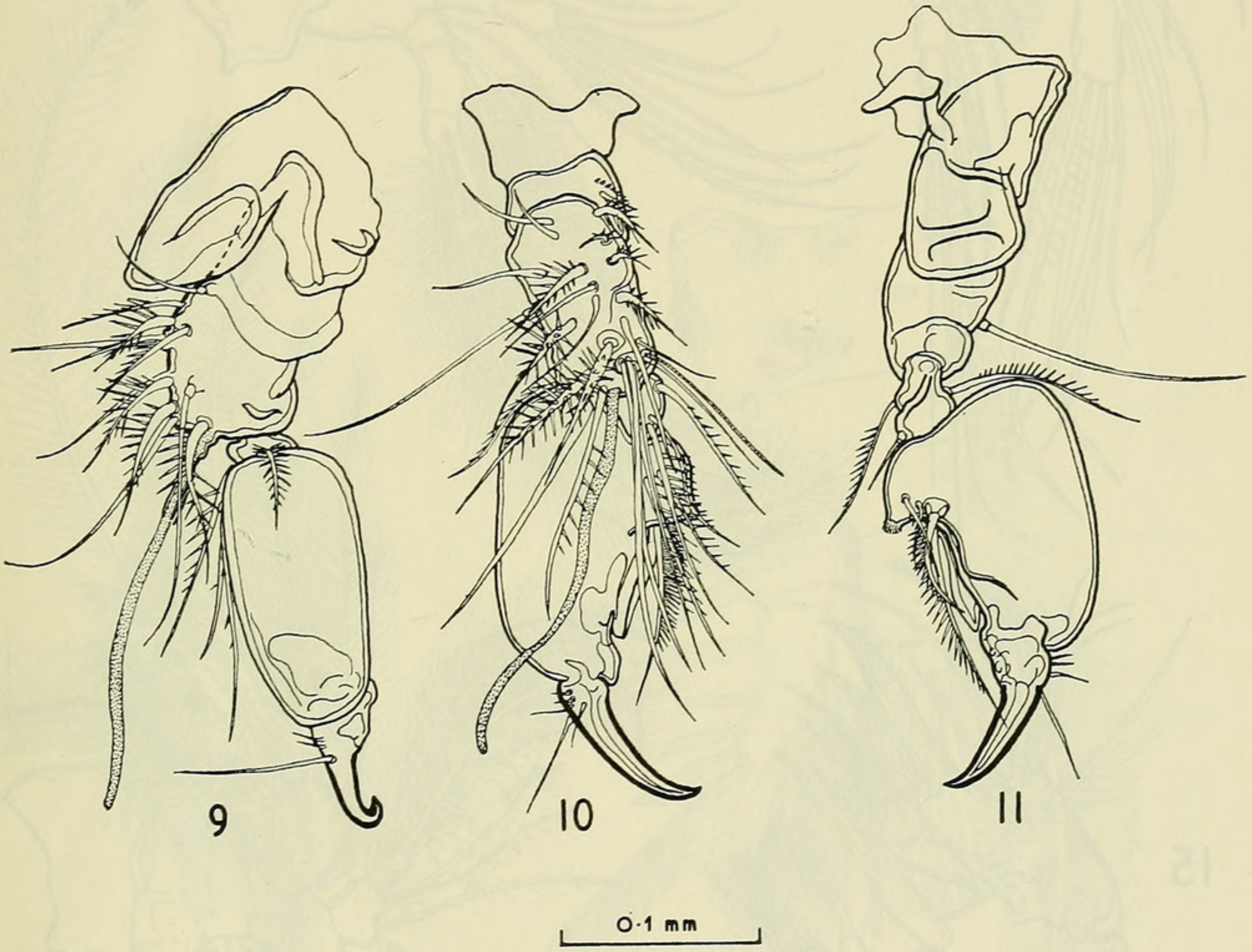
Figs 5, 6.

Antennule (Fig. 8) short and stout, with six indistinct segments, of which the third bears two aesthetascs (the distal of which is much the longest) ; all the segments except the basal segment carry numerous setae. Antenna (Fig. 12) with one lateral, two lateral and two terminolateral, and six terminal, setae respectively on the three endopod segments ; each of the seven exopod segments bears an inner seta, and the distal segment also bears two terminal setae. The basis of the mandibular palp (Fig. 13) has two inner setae and one arising between the rami ; the three exopod segments each bear an inner seta and the distal segment also has two terminal setae, while the two endopod segments carry three inner and eight terminal setae respectively.



Figs 7, 8.

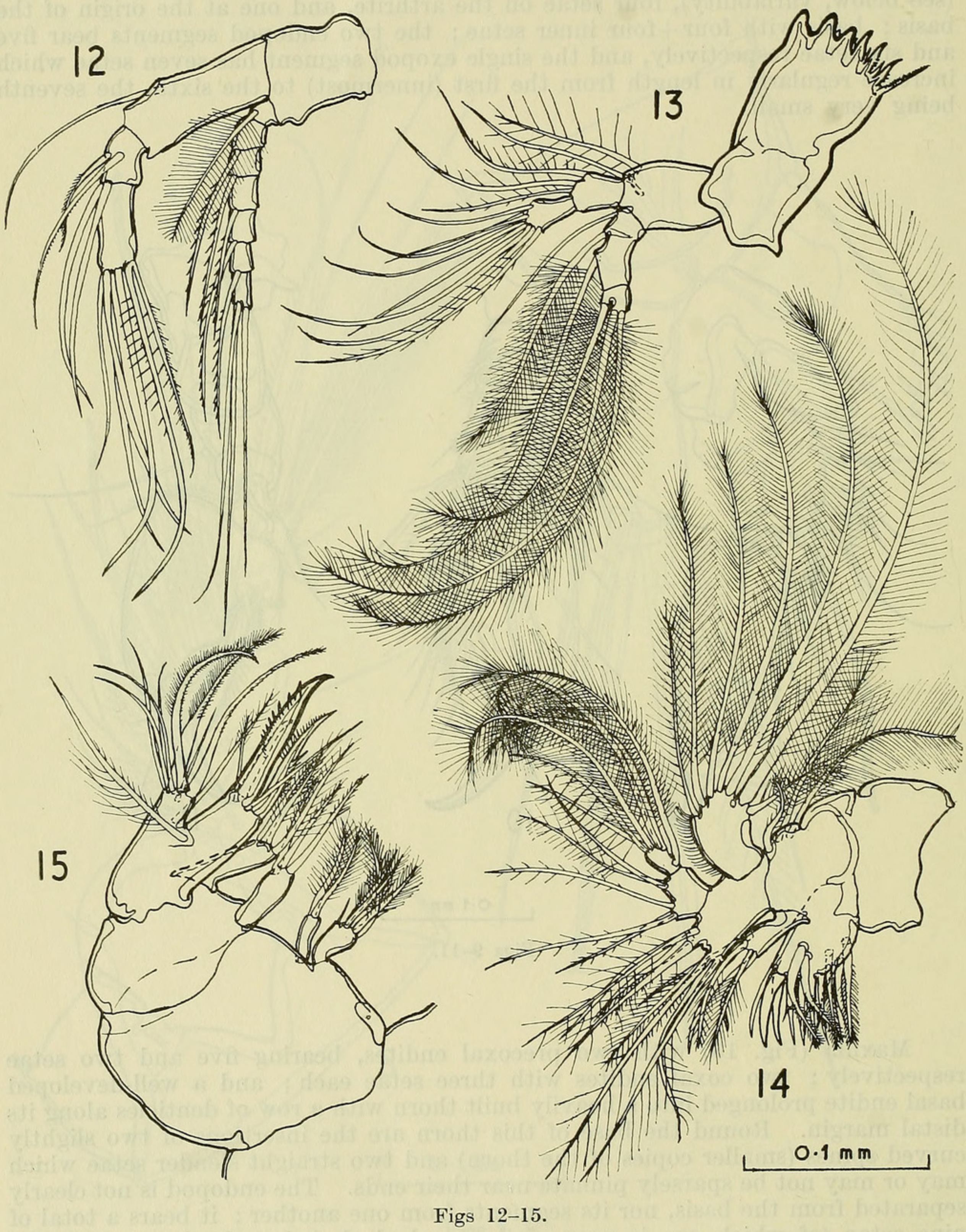
Precoxal arthrite of maxillule (Fig. 14) with a total of ten teeth, smooth setae, and plumose setae (these structures appear to intergrade) along its cutting edge, as well as three palmar setae (two frontal and one abfrontal), all of which are sparsely set with coarse short pinnules. Coxa with three epipodal setae (see below, variability), four setae on the arthrite, and one at the origin of the basis ; basis with four + four inner setae ; the two endopod segments bear five and six setae respectively, and the single exopod segment has seven setae which increase regularly in length from the first (innermost) to the sixth, the seventh being very small.



Figs 9–11.

Maxilla (Fig. 15) with two precoxal endites, bearing five and two setae respectively ; two coxal endites with three setae each ; and a well-developed basal endite prolonged into a heavily built thorn with a row of denticles along its distal margin. Round the base of this thorn are the insertions of two slightly curved spines (smaller copies of the thorn) and two straight slender setae which may or may not be sparsely pinnate near their ends. The endopod is not clearly separated from the basis, nor its segments from one another ; it bears a total of nine setae (of which one is very easily overlooked, being slender and hidden among the others) and the basis has a seta near the insertion of the endopod.

Maxillipede (Fig. 16) with fused coxa and precoxa, but with distinct basis and endopod. The setae are arranged as follows : precoxa, 1 ; coxa, 2 + 4 + 3 ; basis, 2 ; endopod, 11.

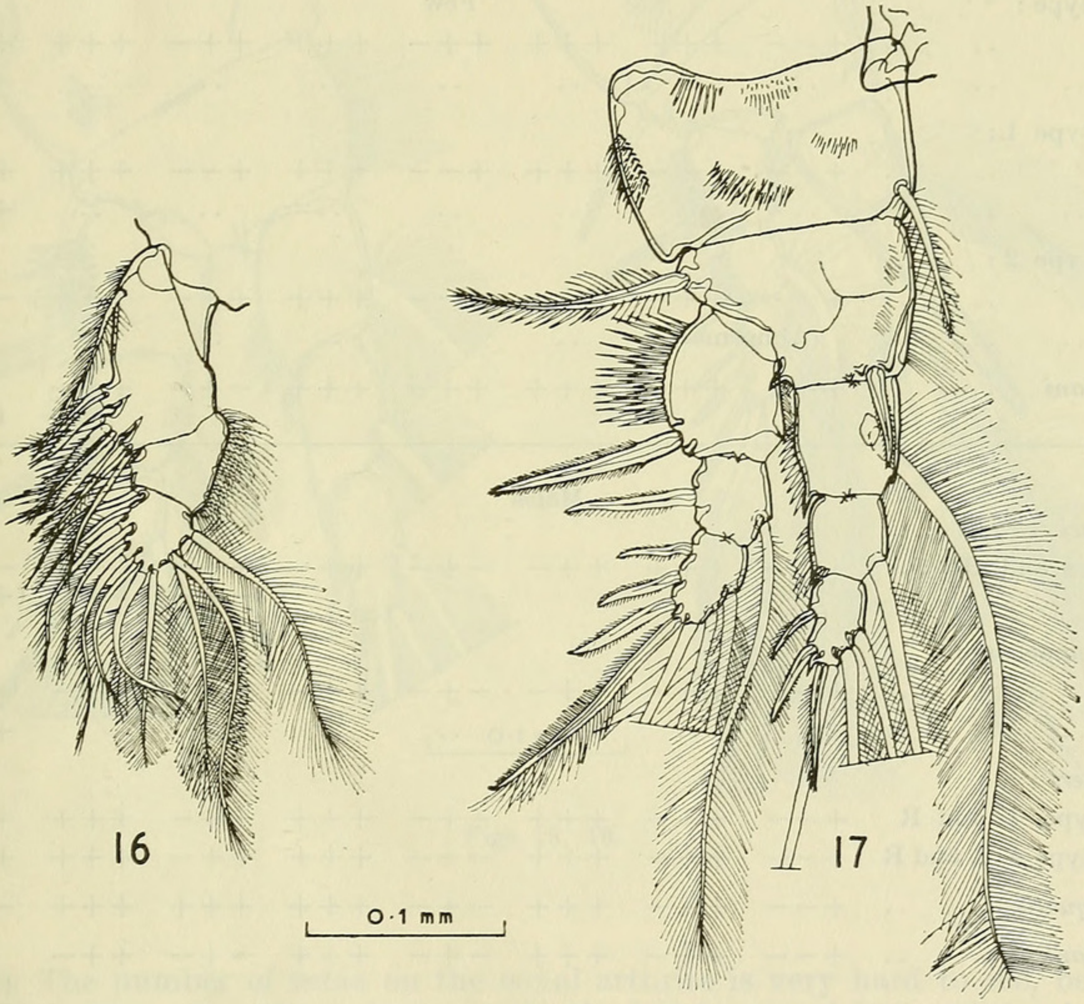


Figs 12–15.

All rami of swimming legs have three segments each ; the endopod is longer than the exopod in P1 and P2, about equally long in P3, and much shorter and slimmer in P4. The inner seta of the first endopod segment in P4 is slightly longer than the entire endopod. Setal formula (*cf.* Por. 1967, p. 109) :

P1 (Fig. 17)		P2 (Fig. 18)		P3 (Fig. 20)		P4 (Fig. 21)	
exp	enp	exp	enp	exp	enp	exp	enp
0.1.7	1.1.6	0.1.7	1.1.5	0.1.5	1.1.3	0.1.4	1.0.3

exactly as in *S. paguri* Hesse (Sars, 1911 ; Humes and Ho, 1969 ; Codreanu and Mack-Fira, 1961 ; own observations) ; the formula 1.1.4, 0.1.3, given by Por (1967, p. 109) for P4 of *S. paguri* is clearly erroneous.



Figs 16, 17.

On every segment of both rami of the swimming legs a comb of spines is either present (+) or absent (−) on the outer surface (as in Humes and Ho, 1969, table II) ; Table 1 of the present paper consists of Humes and Ho's table II together with my own observations.

Table 1

Spinulation of Sunaristes *spp.* (*as in Humes and Ho, 1969, table II*)

R = right, L = left, foot of the same pair, of a specimen examined by me ; L is left blank except where it differs from R. Variants are placed in brackets

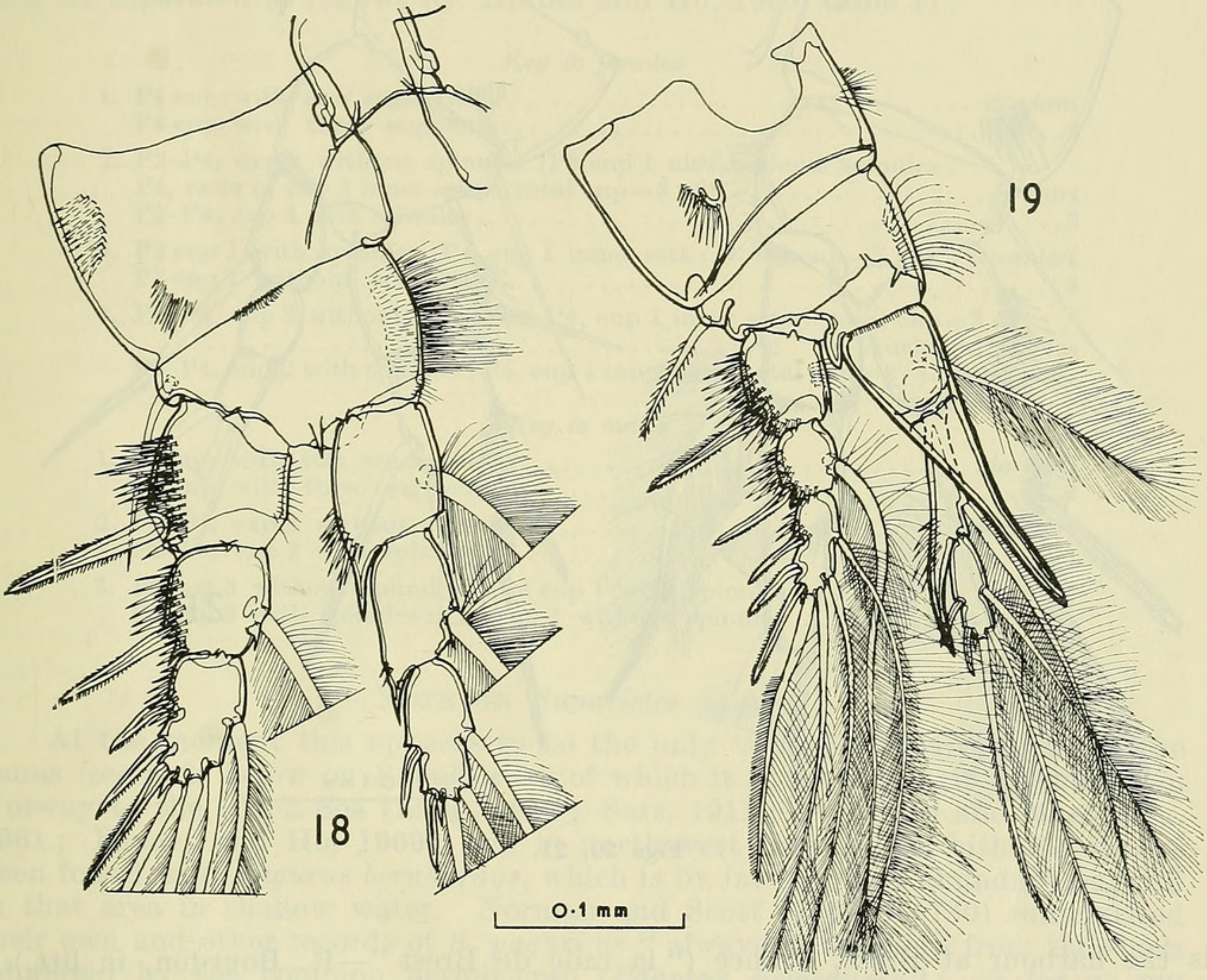
	P1		P2		P3		P4	
	exp	enp	exp	enp	exp	enp	exp	enp
Females								
S. paguri	+−−	++−	++−	−−−	++−	−−−	++−	−−−
Sunaristes sp. from Auckland.. ..	+−−	++−	+++	+−−	+++	−−−	+++	−−−
S. inaequalis	+−−	++−	+++	++−	+++	−+−	+++	−++ (−+−)
S. tranteri :								
Holotype :				Few				
R	+−−	++−	+++	++−	+++	++−	+++	+−−
L	..	..	..	..	..	..	..	−+−
Paratype 1 :								
R	+−−	++−	+++	+−−	+++	+−−	+++	+−−
L	..	..	..	..	..	..	..	++−
Paratype 2 :								
R	+−−	++−	+++	+−−	+++	++−	+++	−−−
L	(Abnormal)		..	..	..	..	..	..
S. dardani	+−−	++−	+++	++−	+++	−+−	++−	−− (−+)
Males								
S. paguri :								
Humes and Ho ..	+−−	++−	++−	−+−	++−	++− (−+−) (−−−)	++−	−+− (++−)
Own material :								
R	+−−	++−	++−	−+−	++−	++−	++−	+−−
L	..	..	..	..	..	..	..	++−
S. tranteri :								
Allotype, L and R	+−−	++−	+++	−+−	+++	++−	+++	++−
Paratype A, L and R	+−−	++−	+++	−+−	+++	++−	+++	++−
S. inaequalis	+−−	++−	+++	−+−	+++	+++	+++	−++
S. dardani	+−−	++−	+++	−+−	+++	−+−	++−	−− (−+)

P5 (Fig. 5) consisting of a minute thickening of the chitinous rear margin of the fifth pediger, bearing four setae of approximately equal thickness, of which the outermost is long, the other three all being very short.

Male (*allotype*). Length 1·9 mm., measured as in the female (Figs 3, 4). Very like the female but shorter, and slimmer in proportion to its length ; also distinguishable from the female at sight by the dark brown sclerotization of the hooks (*a*) on the end of the antennule (Figs 9–11), (*b*) on the end of the first endopod segment of P2 (Fig. 19), and (*c*) of the coupling apparatus on the genital area (Fig. 6) ; all these sclerotized hooks are also visible in Fig. 4.

Variability. The holotype, the allotype, and three paratypes (2♀, 1♂) have been dissected ; the following variations were found :

(*a*) The third (smallest and most distal) epipodal seta in Fig. 14 was not found on the other maxillule of the holotype, nor on either maxillule of any other dissected specimen.



Figs 18, 19.

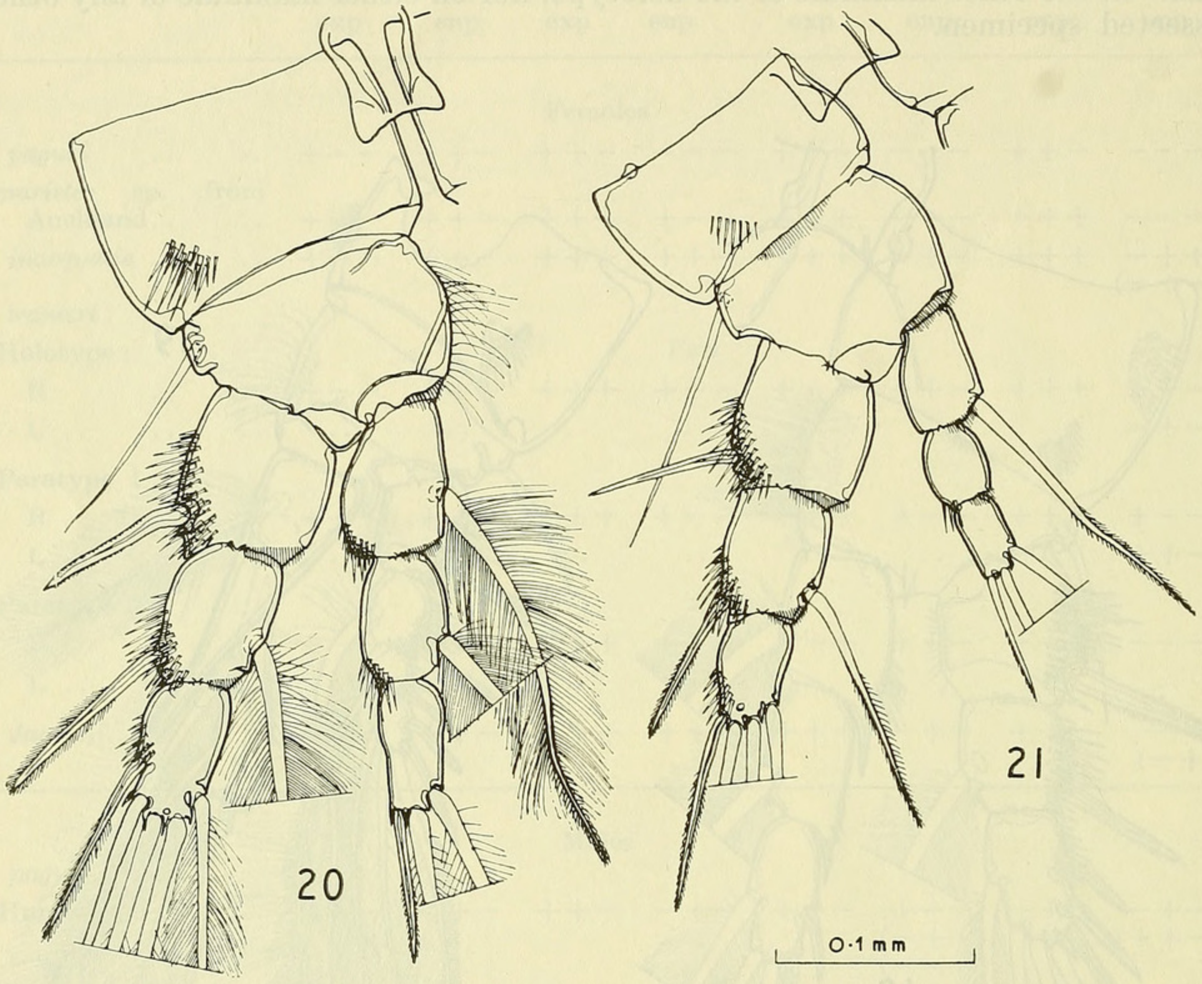
(*b*) The number of setae on the coxal arthrite is very hard to see, because setae lie over one another ; however, in the holotype and in paratype A there appeared to be four on one maxillule and five on the other, whereas the other dissected specimens each had five setae on both maxillules.

(*c*) The seta arising between the rami from the mandibular basis is lacking on both mandibles of paratype 1, but is present on both mandibles of all the other dissected specimens.

(*d*) The antennal exopod is normal in all the dissected specimens except that, on one side only of paratype 2, it consists of only one segment with a lateral and two terminal setae.

(*e*) For variability in the spinulation, see Table 1.

Remarks. This species (named in honour of my colleague, the Australian planktologist and copepodologist D. J. Tranter) is so close to *S. paguri* that a redescription of the latter does not seem to be warranted at present (see Codreanu and Mack-Fira, 1961 ; Humes and Ho, 1969). The type-locality for *S. paguri*



Figs 20, 21.

is the harbour at Brest, France (" la rade de Brest "—R. Bourdon, in litt.), from which it would be highly desirable to collect further specimens since the type material (Hesse, 1867) appears to be lost. However, specimens of *S. paguri* from Roscoff, kindly sent by Dr. Bourdon (see below), agreed entirely with *S. tranteri* except for :

(1) the spinulation (Table 1) ; in this respect the Roscoff specimens agreed exactly with material from Holland (Humes and Ho, 1969) and the single female from near Oslo studied by Sars (1911). Unfortunately, Codreanu and Mack-Fira give no details of the spinulation of their material (but see below) ;

(2) the ratio, in the female, of the total length of the fourth endopod to the length of the inner seta on the first segment thereof. In another species, *S. inaequalis* Humes and Ho, this seta is longer than this endopod in the male (Humes and Ho, fig. 42), but is shown as shorter than the endopod in the female (Humes and Ho, fig. 38), although in their text these authors explicitly state that this seta is shorter than this endopod in both sexes of *S. inaequalis*.

Keys to the Species of *Sunaristes*

Four named species, *S. paguri* Hesse 1867, *S. dardani* Humes and Ho 1969, *S. inaequalis* Humes and Ho 1969, and *S. tranteri* nov. sp., are defined well enough to make it quite certain that they belong to this genus. A fifth species comprises at present a dissected and an undissected female kindly sent by Dr. Maureen Lewis (*née* Barclay) from the harbour at Auckland, New Zealand, where they were associated with *Pagurus novaezealandiae* Filhol ; although they cannot be identified with any of the other species, it would be inadvisable to describe them until more specimens (including males) are available. The five species may be separated as follows (*cf.* Humes and Ho, 1969, table 1) :

Key to females

1. P4 enp with two segments . . . . *dardani*
   P4 enp with three segments 2
2. P2–P4, exp 3 without spinules (P3 enp 1 also without spinules ; P4, ratio of enp 1 inner seta : total enp = 3 : 2) . . . . *paguri*
   P2–P4, exp 3 with spinules 3
3. P3 enp 1 with spinules (P4, enp 1 inner seta : total enp = 7 : 6) . . . . *tranteri*
   P3 enp 1 without spinules 4
4. P2–P4, enp 2 without spinules ; P4, enp 1 inner seta : total enp = 3 : 2 . . . . the Auckland species
   P2–P4, enp 2 with spinules; P4, enp 1 inner seta: total enp = 3: 4. . *inaequalis*

Key to males

1. P4 enp with two segments . . . . *dardani*
   P4 enp with three segments 2
2. P2–P4, exp 3 without spinules . . . . *paguri*
   P2–P4, exp 3 with spinules 3
3. P3 enp 3 without spinules ; P4 enp 1 with spinules . . . . *tranteri*
   P3 enp 3 with spinules ; P4 enp 1 without spinules . . . . *inaequalis*

Note on *Sunaristes paguri*

At the moment this appears to be the only valid European species of the genus (see note below on *S. bulbosus*), of which it is the type ; it extends from Norway to the Black Sea (Lang, 1948 ; Sars, 1911 ; Codreanu and Mack-Fira, 1961 ; Humes and Ho, 1969), and in north-west Europe has hitherto always been found with *Pagurus bernhardus*, which is by far the most abundant pagurid in that area in shallow water. Norman and Scott (1906, p. 130) summarized their own and other records of *S. paguri* as " always in washings from the shells inhabited by the common hermit-crab (*Pagurus prideauxi*) " ; as far as my experience goes, the term " common " has never been applied in British waters to any hermit-crab other than *P. bernhardus*, and it appears therefore that Norman and Scott's record of *prideauxi* (accepted by Codreanu and Mack-Fira) is a slip of the pen. However, Dr. Bourdon's specimens of *S. paguri* were taken with *P. cuanensis* at a depth of 30 m. on the dredging-ground Paradis, near Roscoff, in shells of *Turritella communis*, and intertidally at Saint-Efflam with *Diogenes pugilator* ; these are the first indisputable records of hosts other than *P. bernhardus* in north-west Europe, although in the Mediterranean *S. paguri* has several species of host (Codreanu and Mack-Fira). I can find no record that anyone has deliberately examined a large number of any British species of hermit-crab other than *P. bernhardus*, for *S. paguri* ; this is surprising, because some British pagurids are locally abundant offshore (Pike and Williamson, 1959).

As recently indicated (Hamond, 1971*a*), *S. paguri* has not been found on the coast of Norfolk, even though *P. bernhardus* is abundant there ; this may have been, however, because the two collections made with a view to securing it were both in the first week of August, and were therefore just too late for the mass death of the adults which follows immediately after the breeding season (Codreanu and Mack-Fira). If it is genuinely absent from Norfolk waters, its presence under very similar conditions on the coast of Holland (*cf.* Humes and Ho, 1969) must be due to recruitment from the English Channel.

Notes on Other Species of *Sunaristes* sens. lat.

The literature on the canuellids is full of instances where species have been transferred to *Sunaristes* for a longer or shorter period, as if this name was a sort of repository for any large species bearing a vague resemblance to *S. paguri*. The result has been a state of the greatest possible confusion, due almost entirely to insufficient descriptions and figures ; for instance, Thompson and Scott (1903) succeeded in squeezing the descriptions of three allegedly new species (*S. inopinata*, *S. longipes* and *S. curticaudata*) on to a single page (their p. 256, and a short passage at the top of p. 257) and all the figures on to a single plate (their Plate III, figs 1–17) ; there is not a single drawing of a mouth-part, or of somitic ornamentation, or of the animal in dorsal view, while of the 17 figures only one is of a male (their fig. 7). It is hardly surprising that at least one character which was accepted as a generic criterion by Lang (1948), namely the degree to which the first pediger is fused with the prosome, has been shown to vary within a single species (*S. paguri*) by Codreanu and Mack-Fira (1961) ; in these circumstances a revision of the family in depth, though urgently required, is simply not possible, although the outline revision by Por (1967) contains some useful concepts.

Thompson and Scott's *curticaudata* is probably indeterminable ; however, Scott's opinion (1909) that the alleged *Canuella curticaudata* taken by the " Siboga " is identical with the former, is clearly mistaken (Sewell, 1940). On the other hand, the " Siboga " species is possibly identical with *Sunaristes bulbosus* Por (1964) ; the corresponding figures show a very close resemblance. Sewell was himself mistaken in assuming that his own *Canuella scotti* was identical with the " Siboga " species ; the former lacks an inner seta on P1 enp 1 (present in the latter) but has a peculiar small inner seta on P1 enp 3 (not shown in the admittedly rudimentary figures either of Scott (1909) or of Por (1964)). Pending adequate redescription, I suggest the following synonymy :

A. *Sunaristes curticaudatus* Thompson and Scott (1903). No synonyms.

B. *Sunaristes bulbosus* Por (1964), syn. *Canuella curticaudata* Scott (1909).

C. *Canuella scotti* Sewell (1940). No synonyms.

These are all Indo-Pacific species, and all, especially *S. bulbosus*, are therefore likely to occur in Australian waters. None of them can be placed in a given genus with certainty, and they are therefore left in the genera to which they were originally assigned, purely for convenience.

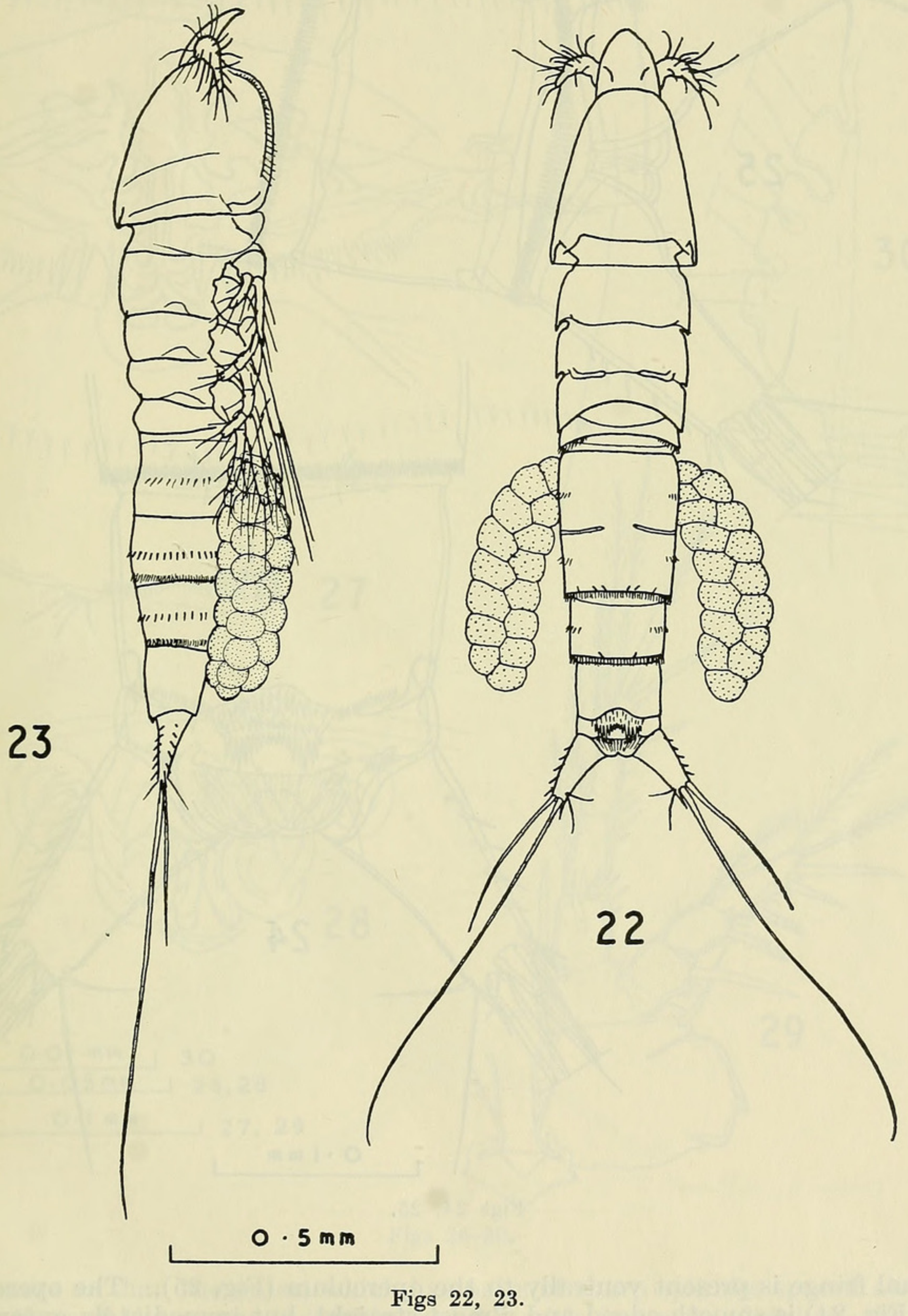
The finds of alleged *S. paguri* in New Guinea (Scott, 1909) and Ceylon (Thompson and Scott, 1903), regarded as doubtful by Humes and Ho, are almost certainly of some other species, perhaps *S. tranteri* or an indeterminable canuellid. They are probably not of *S. bulbosus*, which shows two characters that appear to exclude it from *Sunaristes* as defined here :

(1) The type of sexual dimorphism found in P2 (Por, 1964, figs 19 and 21) appears to be different ; and

(2) the rami of P4 each have a very short middle segment and a very long distal segment, the junction between them being sharply angulate (Por, 1964, fig. 20 ; *cf.* Scott, 1909, pl. LXIV, fig. 4), very different from P4 of *Sunaristes* spp. as understood here.

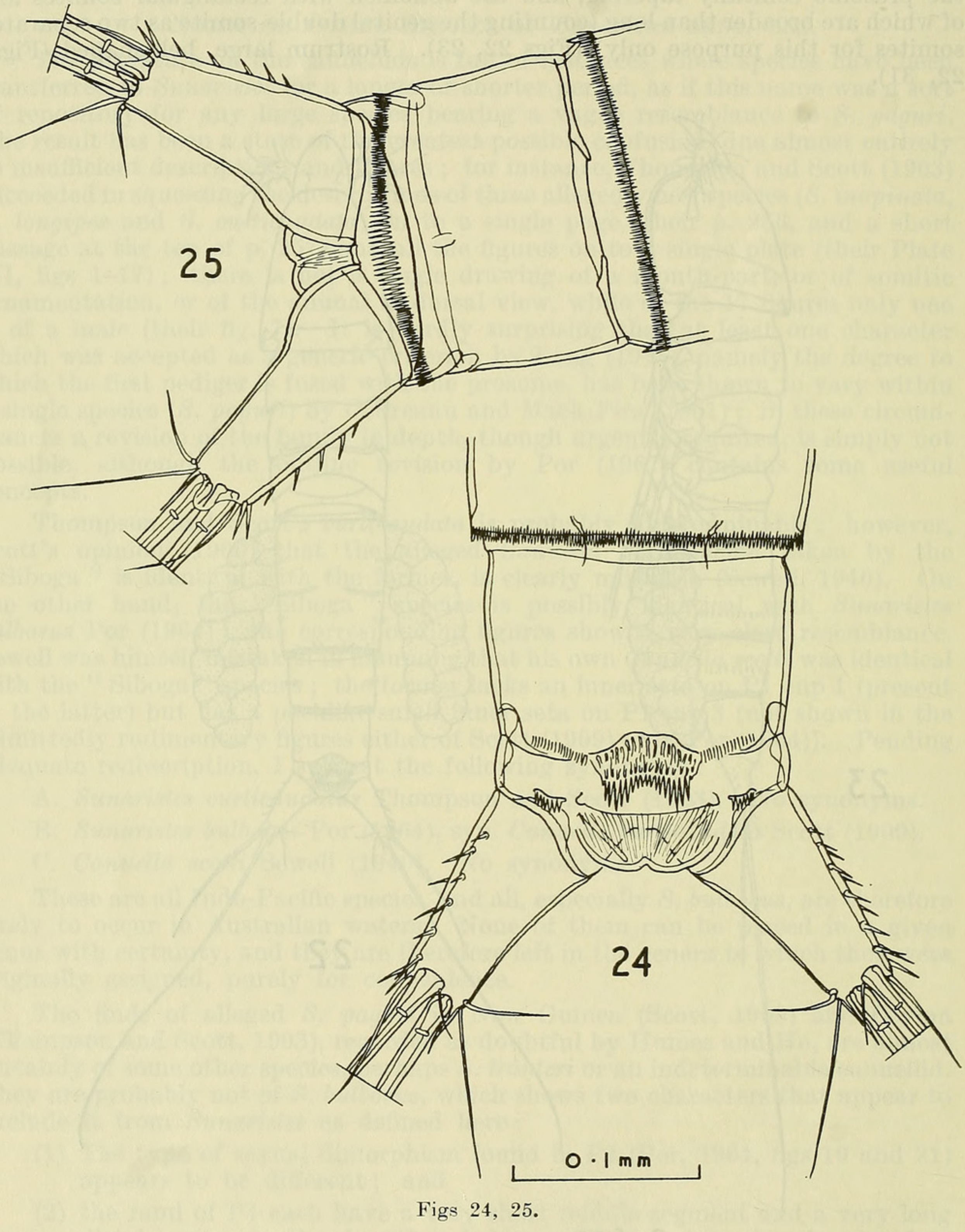
Brianola sydneyensis nov. sp.
(Figs 22–40)

Female (*holotype*). Length 1·43 mm. ; body without a noticeable " waist ", the prosome conically tapering, and the abdomen with rectangular somites all of which are broader than long (counting the genital double-somite as two separate somites for this purpose only) (Figs 22, 23). Rostrum large, bell-shaped (Figs 22, 31).



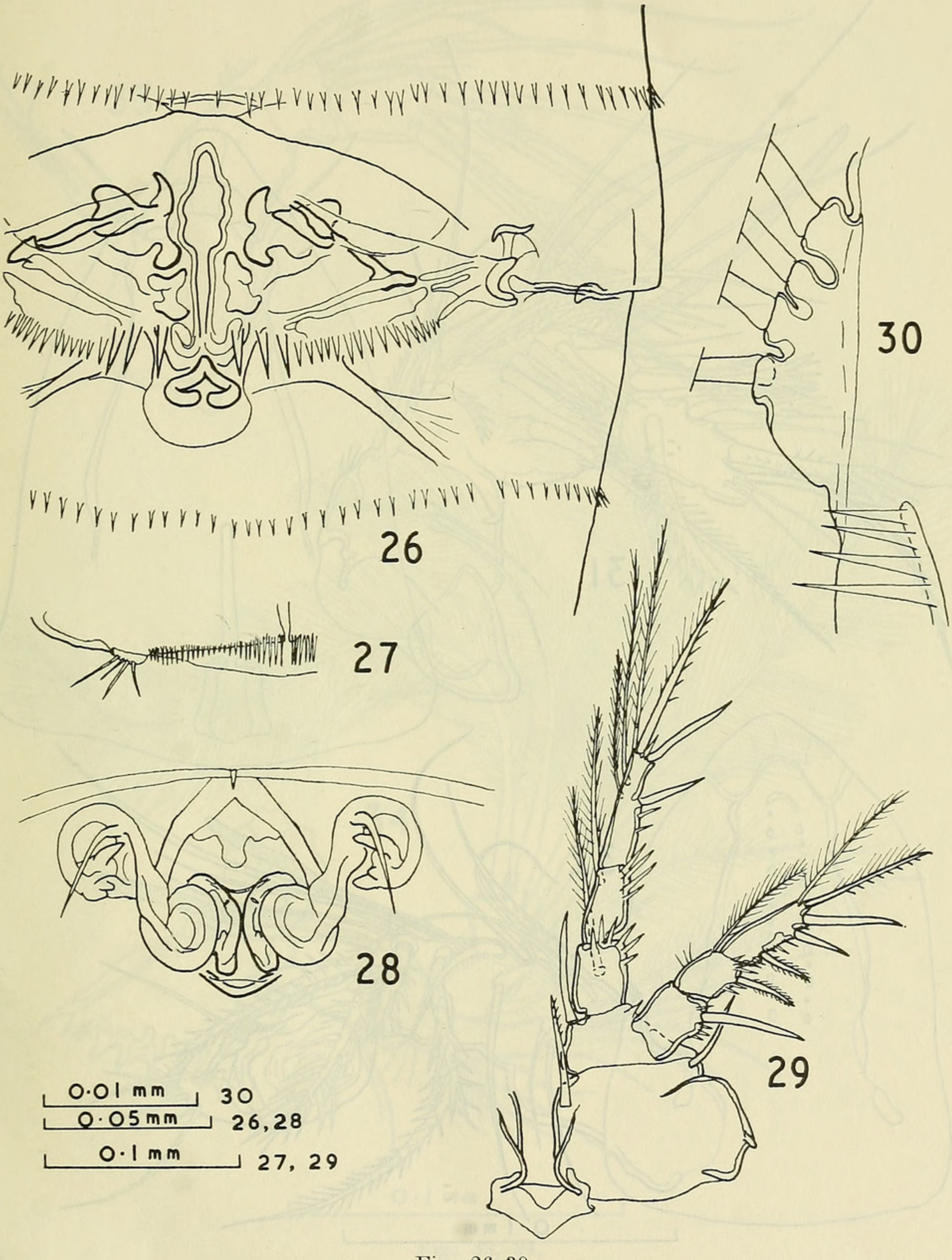
Figs 22, 23.

The genital double-somite has a lateral comb of spinules on each of its halves, and there is a similar comb on the somite behind it ; this somite, and the rear half of the genital double-somite, each have a fringe of spinules completely circling the body and forming the rear margin of the somite, and a similar rear-



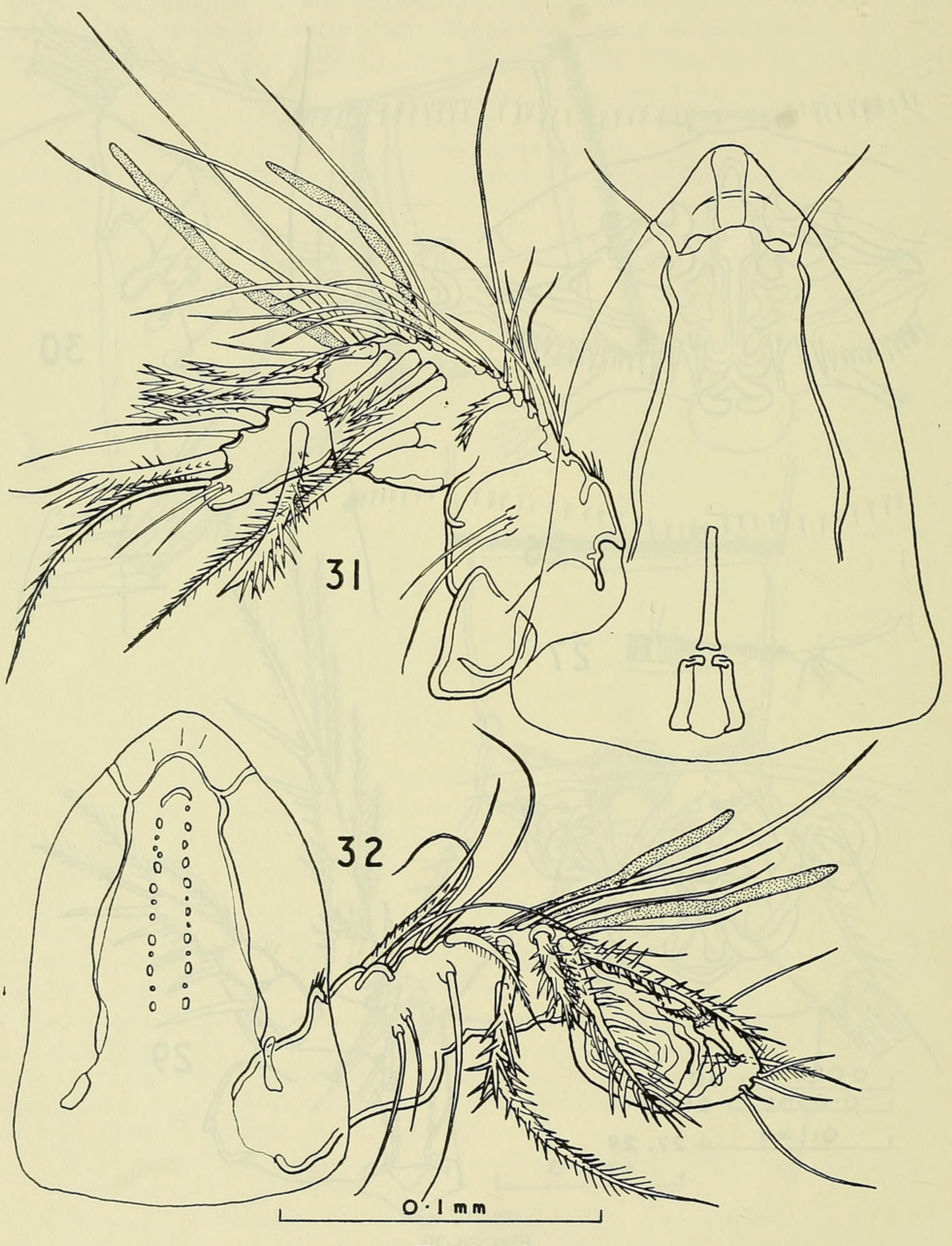
Figs 24, 25.

marginal fringe is present ventrally to the operculum (Fig. 25). The operculum itself (Fig. 24) is smooth-edged and almost straight, but immediately anterior to it is a median pseudoperculum whose dorsal surface is cut into grooves parallel to the long axis, and whose rear margin is drawn out into a comb of long sharp teeth ; these teeth are shortest in the middle and longer towards the ends of the comb. Lateral to the pseudoperculum is a row of tiny spinules, and lateral to the operculum is a short row of about six sharp and thick-walled teeth. Furcal rami short, broad, and divergent at about 80°, both margins curving inwards but the



Figs 26–30.

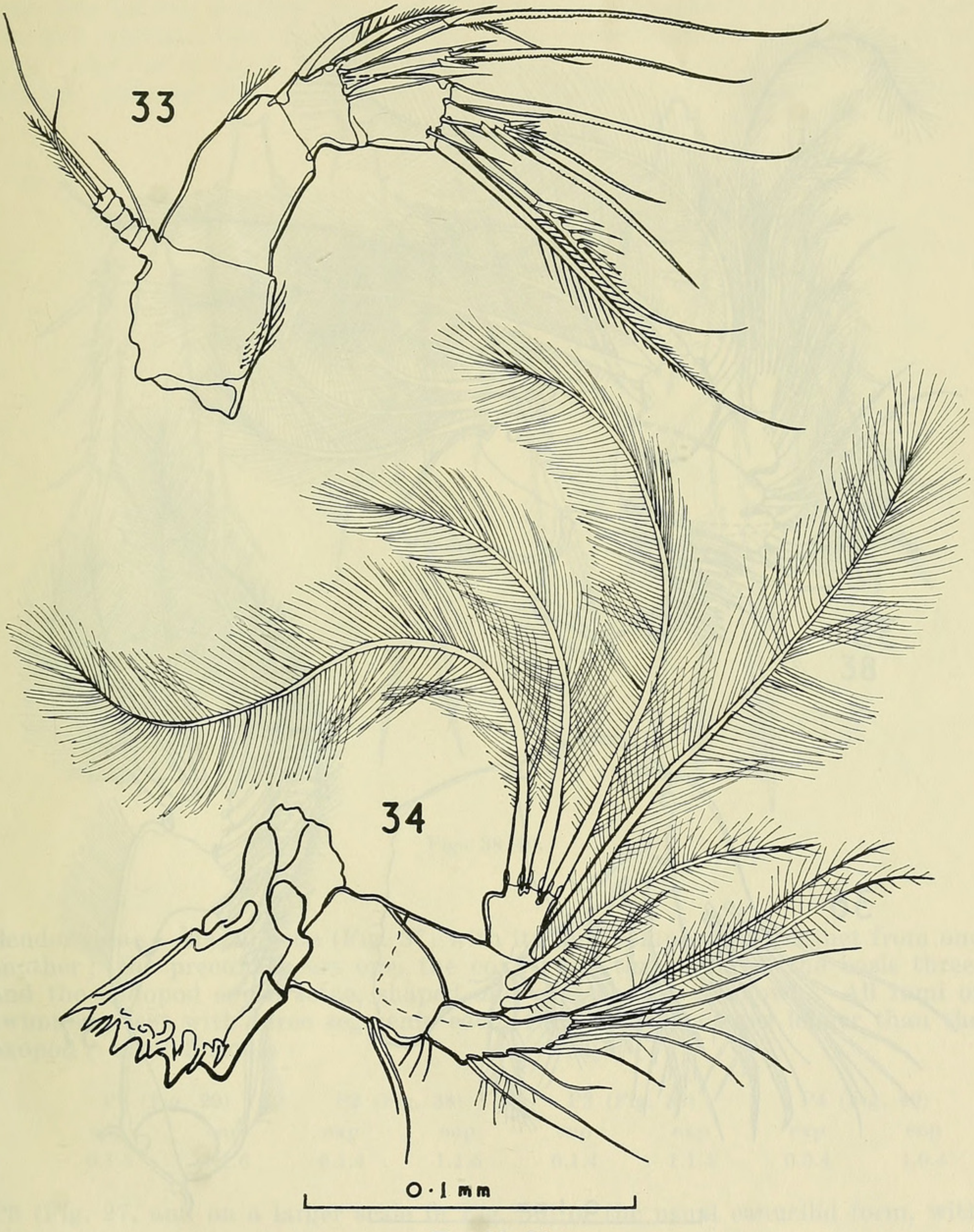
inner more so than the outer, which has pairs of sharp spinules spaced along it. The surface of the ramus is thickly covered with fine pointed spines, flattened rather like the scales of a butterfly's wing, which are very difficult to see *in situ* but are easily detached ; they appear to be present also in *B. stebleri* (*cf.* Monard, 1937, p. 21, " formations en triangle allongé "), and are about the same size and shape as the outer marginal spines of the furcal ramus. Ventrally, the tip of the ramus is drawn out into a rounded projection (Fig. 25), and there is a slender thorn-like projection on the adaxial side of the tip ; there are two large furcal



Figs 31, 32.

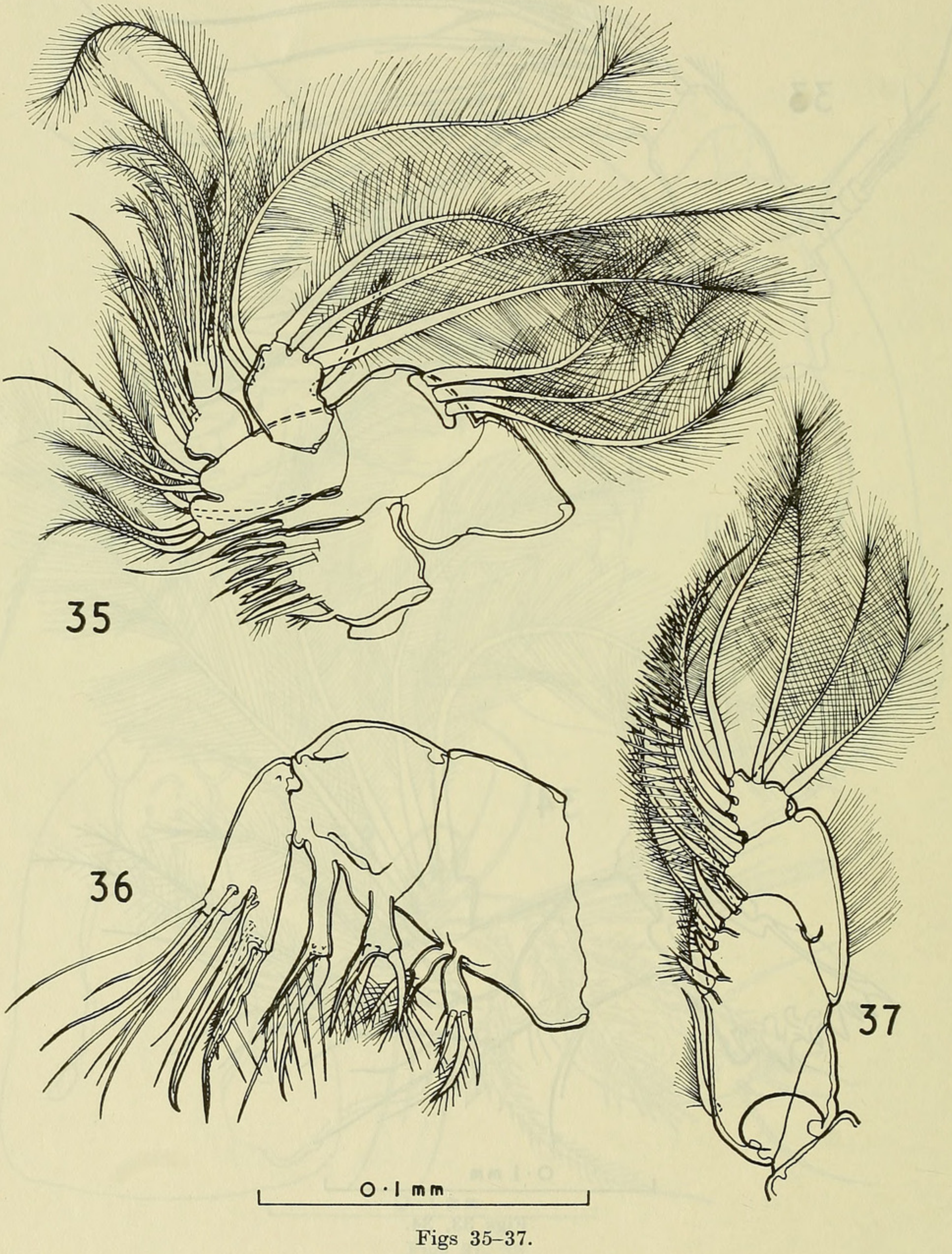
setae and four smaller ones. Genital field (Fig. 26) with a curved comb of spines, which are largest in the midline and become progressively smaller towards either side.

Antennule (Fig. 31) indistinctly segmented (four or five segments), with two aesthetascs on the leading edge of the penultimate segment, and with numerous setae of which the dorsalmost tend to be more heavily built, and provided with more lateral spines, than the others. Antenna (Fig. 33) with four



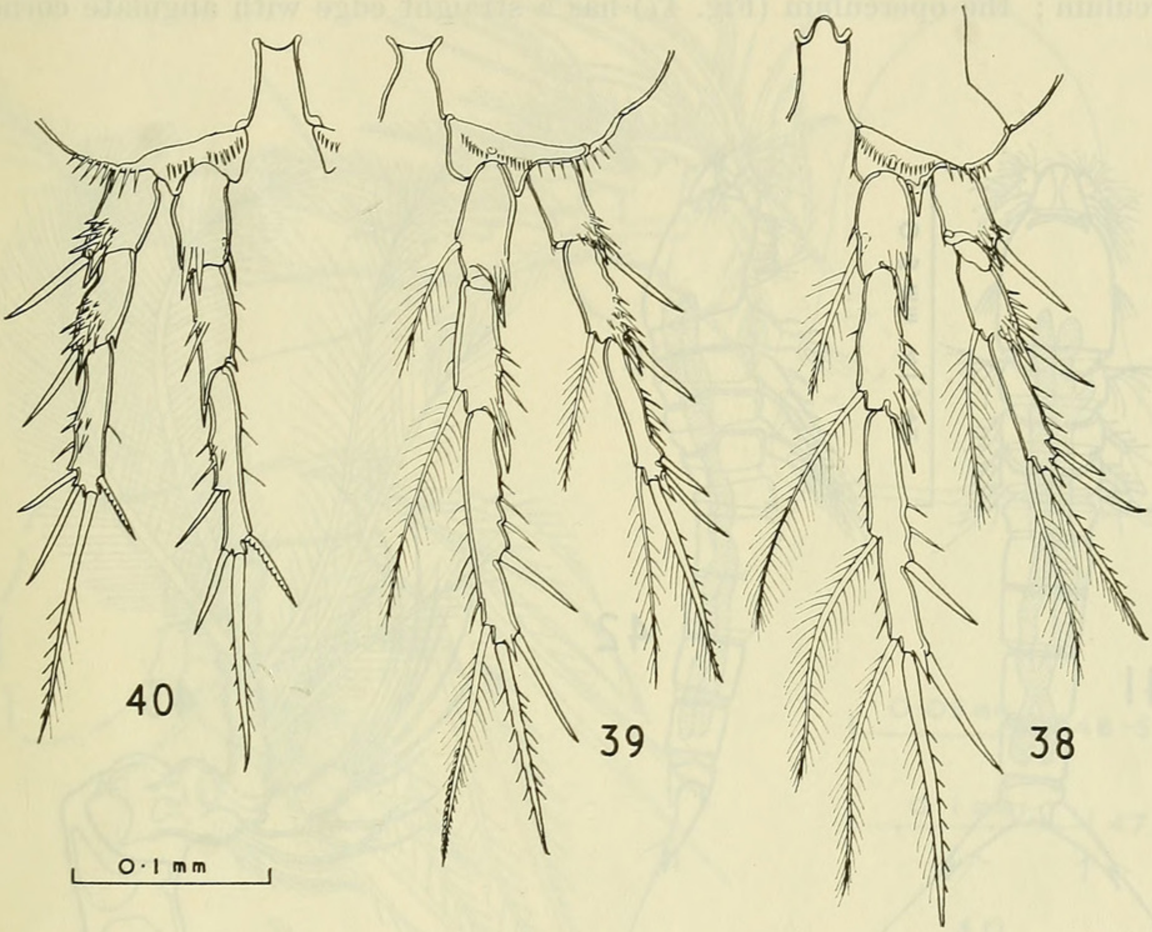
Figs 33, 34.

segments, of which the basal carries a six-segmented exopod. Mandible (Fig. 34) with a two-segmented exopod bearing two and four setae, and a one-segmented endopod bearing 11 setae; the basis has two inner setae. Maxillule (Fig. 35) with three epipodal setae on the coxa, two groups of three setae each on the



Figs 35–37.

basis, six setae on the single exopod segment, and four and five setae respectively on the two endopod segments. Maxilla (Fig. 36) with two precoxal and two coxal endites ; the endopod carries seven setae, and is not distinct from the basis, which is prolonged into a long hooked thorn surrounded by two stout and two



Figs 38–40.

slender setae. Maxillipede (Fig. 37) with its four components distinct from one another ; the precoxa bears one, the coxa two+three+three, the basis three, and the endopod seven setae, shaped and ornamented as shown. All rami of swimming feet with three segments each, the endopod always longer than the exopod ; setal formula :

P1 (Fig. 29)		P2 (Fig. 38)		P3 (Fig. 39)		P4 (Fig. 40)	
exp	enp	exp	enp	enp	exp	exp	enp
0.1.5	1.1.6	0.1.4	1.1.5	0.1.4	1.1.4	0.0.4	1.0.4

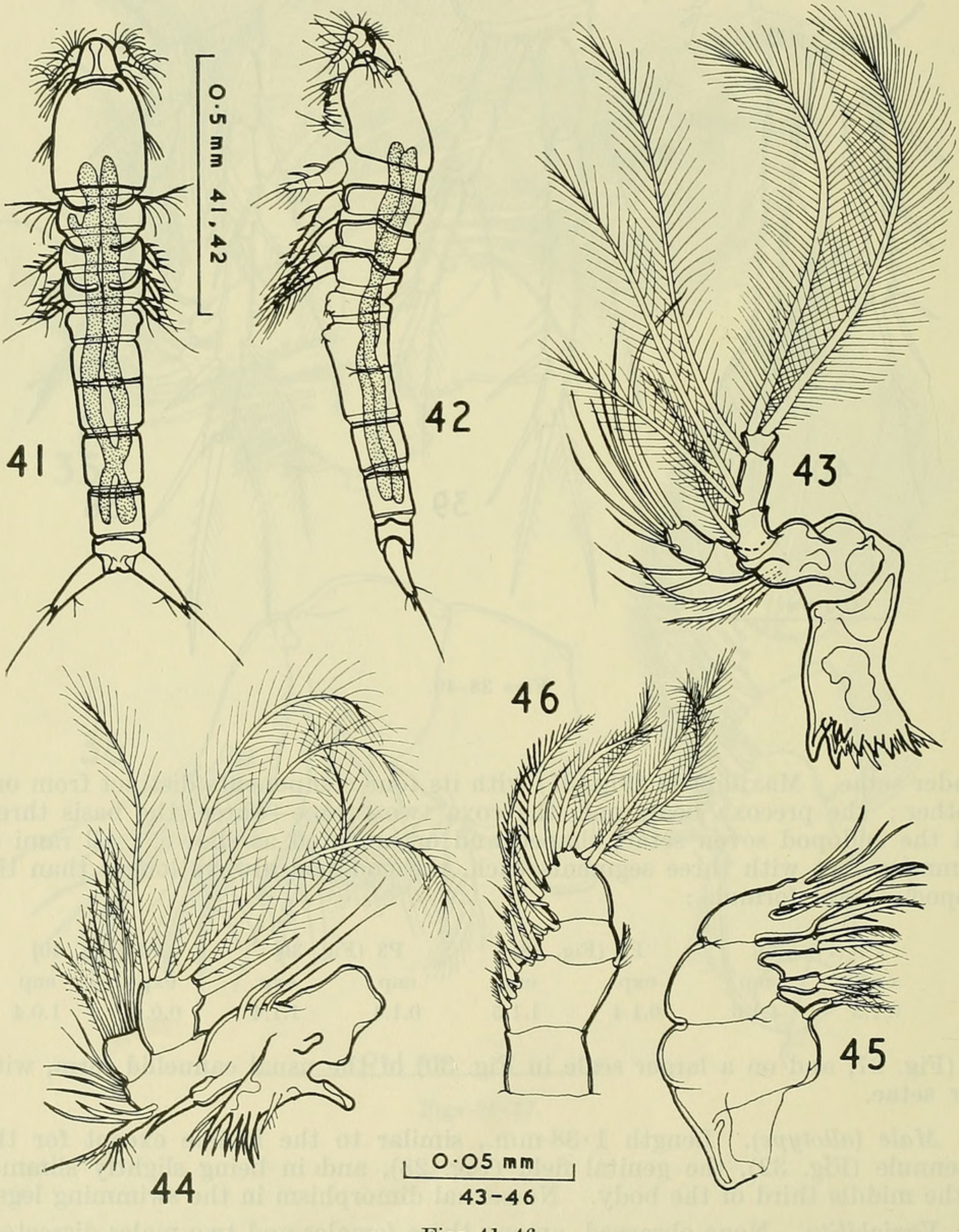
P5 (Fig. 27, and on a larger scale in Fig. 30) of the usual canuellid form, with four setae.

Male (*allotype*). Length 1·38 mm., similar to the female except for the antennule (Fig. 32), the genital field (Fig. 28), and in being slightly slimmer in the middle third of the body. No sexual dimorphism in the swimming legs.

Variability. None observed, among three females and two males dissected.

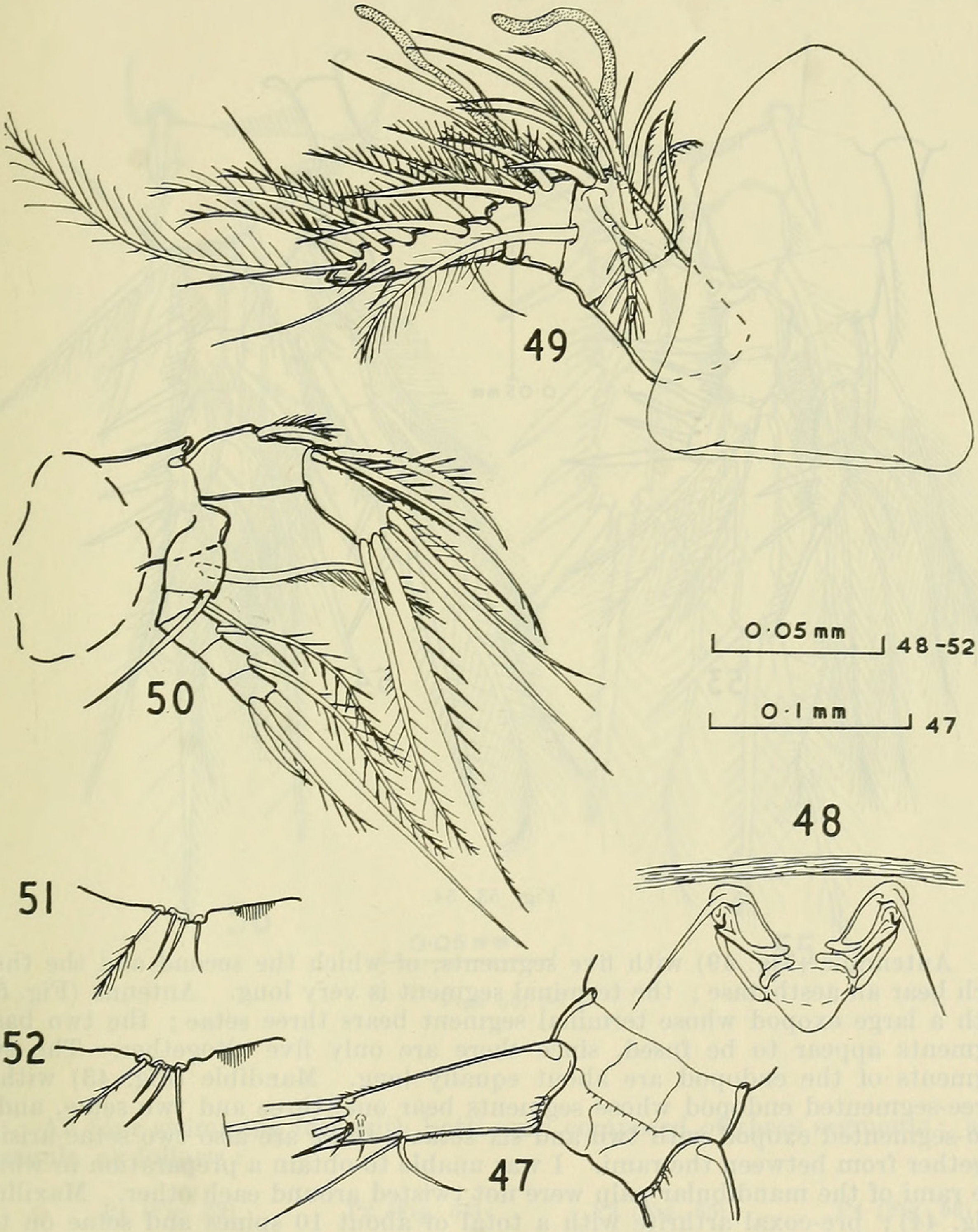
Brianola pori nov. sp.
(Figs 41–60)

Female (*holotype*). Length 1·1 mm. Rostrum bell-shaped (Fig. 49); prosome (Fig. 41) in dorsal view distinctly parallel-sided with a broadly rounded front, and noticeably wider than the rest of the body, which is slender and very slightly tapering. Genital double-somite divided dorsally and laterally, but not ventrally (Figs 41, 42); genital area as in Fig. 48. There is no spiny pre-operculum; the operculum (Fig. 47) has a straight edge with angulate corners,



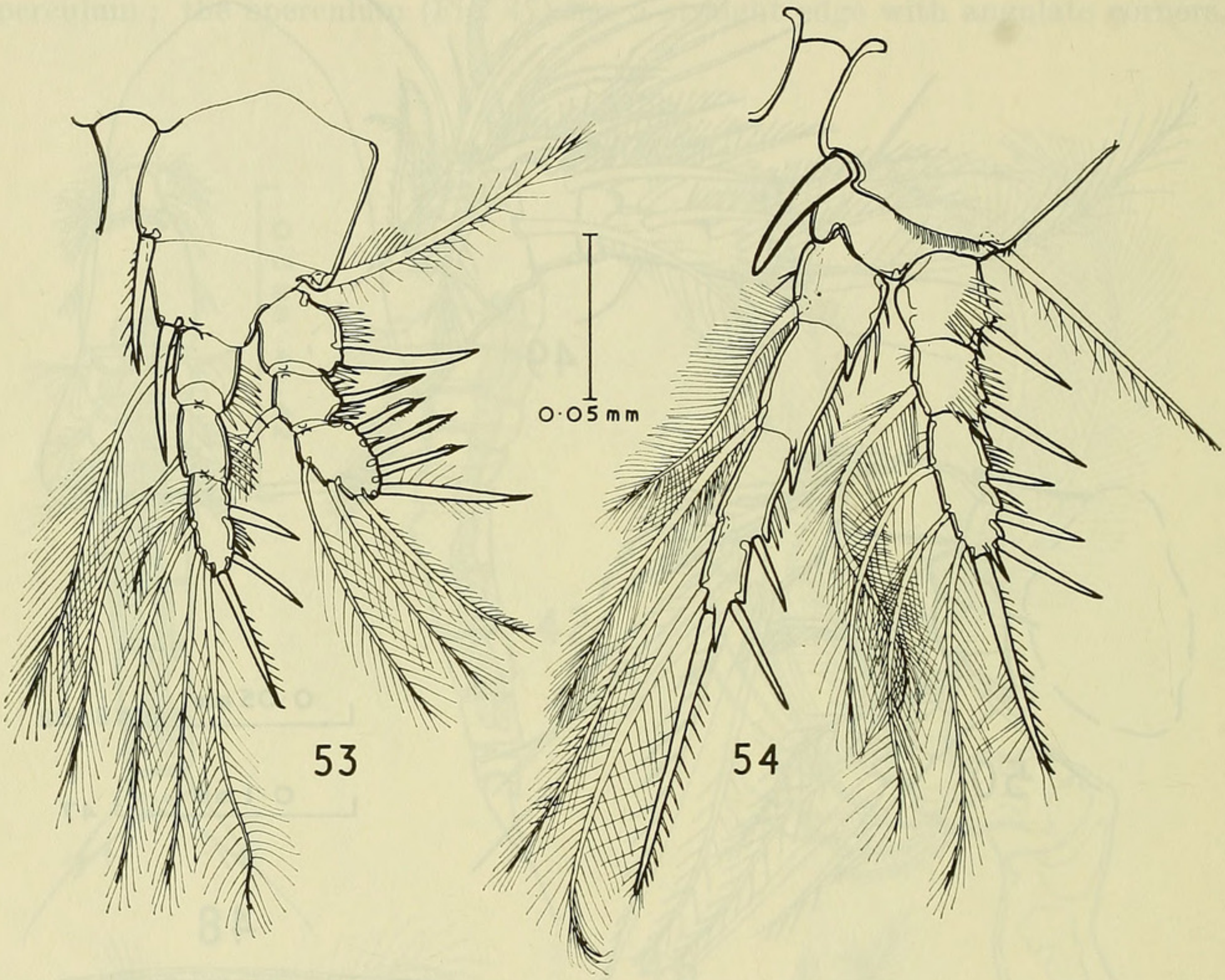
Figs 41–46.

and with a few very small blunt marginal teeth ; it is very transparent and difficult to see. Furcal rami diverging at somewhat more than a right angle ; each furcal ramus is long and tapering, almost straight, and produced apically into a long sharp thorn on the inner side ; there is no ventral apical projection.



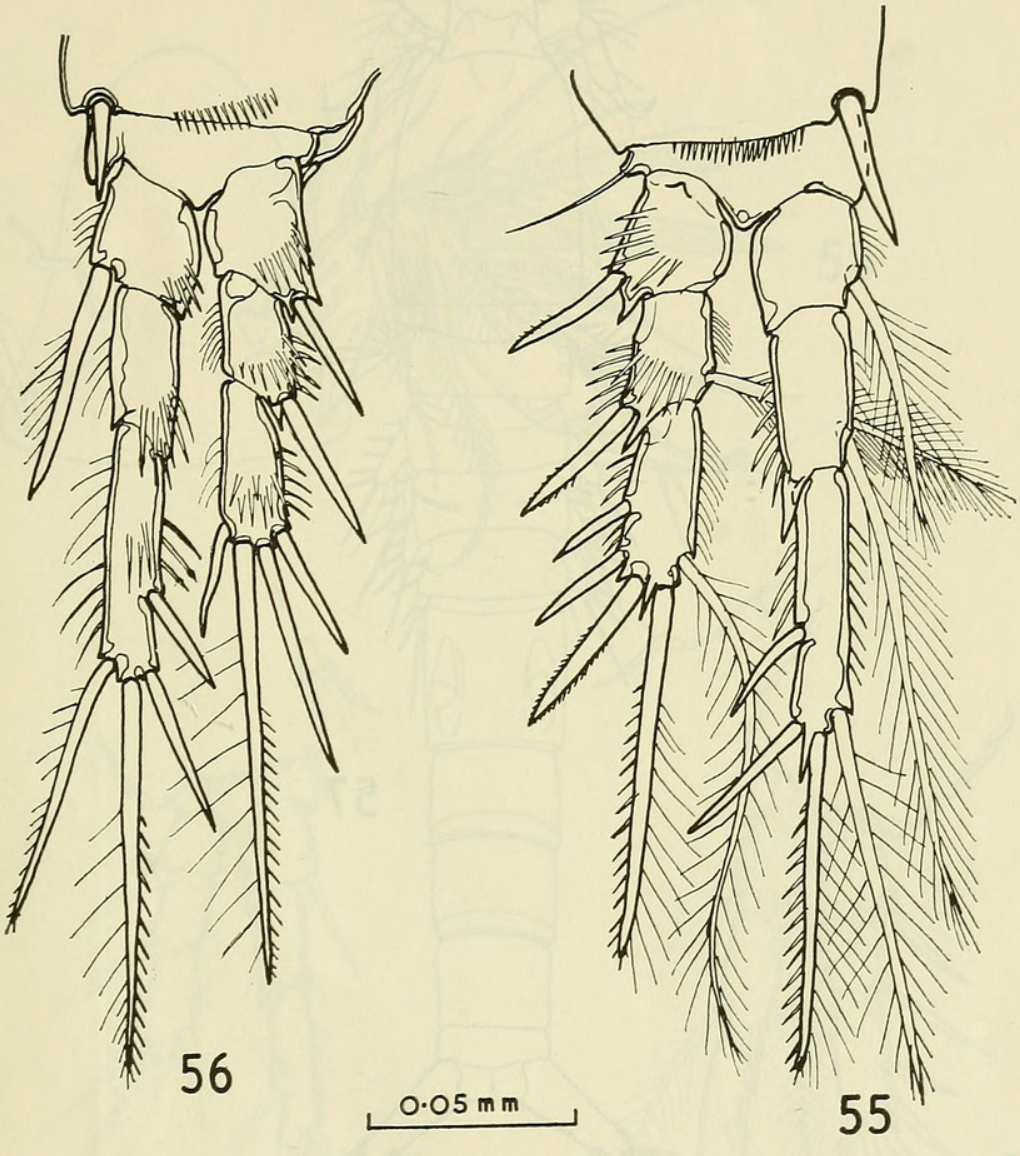
Figs 47–52.

A pair of smooth setae arise at about two-thirds of the length of the inner edge, at the base of which there is also a row of four or five large spinules (Fig. 47) ; terminally there are two large setae (of which the inner is broken off on both sides) and three small ones (dorsal, ventral, and exterolateral). There is no sign of " butterfly-scales ", but there is a row or band of tiny spines along the outer and the inner edges. There is a ventral fringe of needle-like spinules running right across the body on the rear margin of the genital double-somite (rear half only), of the somite behind it (but not of the somite behind that), and of the very short anal (=opercular) somite ; otherwise, there is no somitic ornamentation anywhere on the body.



Figs 53, 54.

Antennule (Fig. 49) with five segments, of which the second and the third each bear an aesthetase ; the terminal segment is very long. Antenna (Fig. 50) with a large exopod whose terminal segment bears three setae ; the two basal segments appear to be fused, since there are only five altogether. The two segments of the endopod are about equally long. Mandible (Fig. 43) with a three-segmented endopod whose segments bear one, three and two setae, and a two-segmented exopod with two and six setae ; there are also two setae arising together from between the rami. I was unable to obtain a preparation in which the rami of the mandibular palp were not twisted around each other. Maxillule (Fig. 44) ; pre-coxal arthrite with a total of about 10 spines and setae on the biting edge ; coxa with a spine on the arthrite and with three epipodal setae ; basis with a large inner seta (whose thickened base is covered with setules), and with three smooth inner setae, two on one face and one on the other face ; rami each of one segment, exopod with six and endopod with seven setae. Maxilla (Fig. 45) with one precoxal endite and two coxal endites ; basis prolonged internally into a heavy hooked spine with a thick spinous seta arising laterally from its base ; endopod not distinct from basis, and bearing a total of seven setae. Maxillipede (Fig. 46) with its four components (as in *B. sydneyensis*) distinct, bearing nought, seven, three and nine setae respectively ; the precoxa is unusual in lacking a seta and in the junction between it and the coxa being straight instead of at a steep angle.



Figs 55, 56

All four swimming feet with both rami composed of three segments ; setal formula as follows :

P1 (Fig. 53)		P2 (Fig. 54)		P3 (Fig. 55)		P4 (Fig. 56)	
exp	enp	exp	enp	exp	enp	exp	enp
0.1.7	1.1.6	0.1.7	1.1.5	0.1.5	1.1.4	0.0.4	1.0.4

The swimming endopods are all longer than their respective exopods. An inner spine is present on the coxa of each swimming foot, but that of P2 is much larger than any of the others ; there is an inner spine on the basis of P1 only. P5 (Figs 51, 52) consisting of four setae, of which the abaxial is sparsely plumose.

Male (*allotype*). In general very like the female, from which it differs only in being slightly slimmer (Fig. 57) and smaller (length 0·83 mm.), in the usual

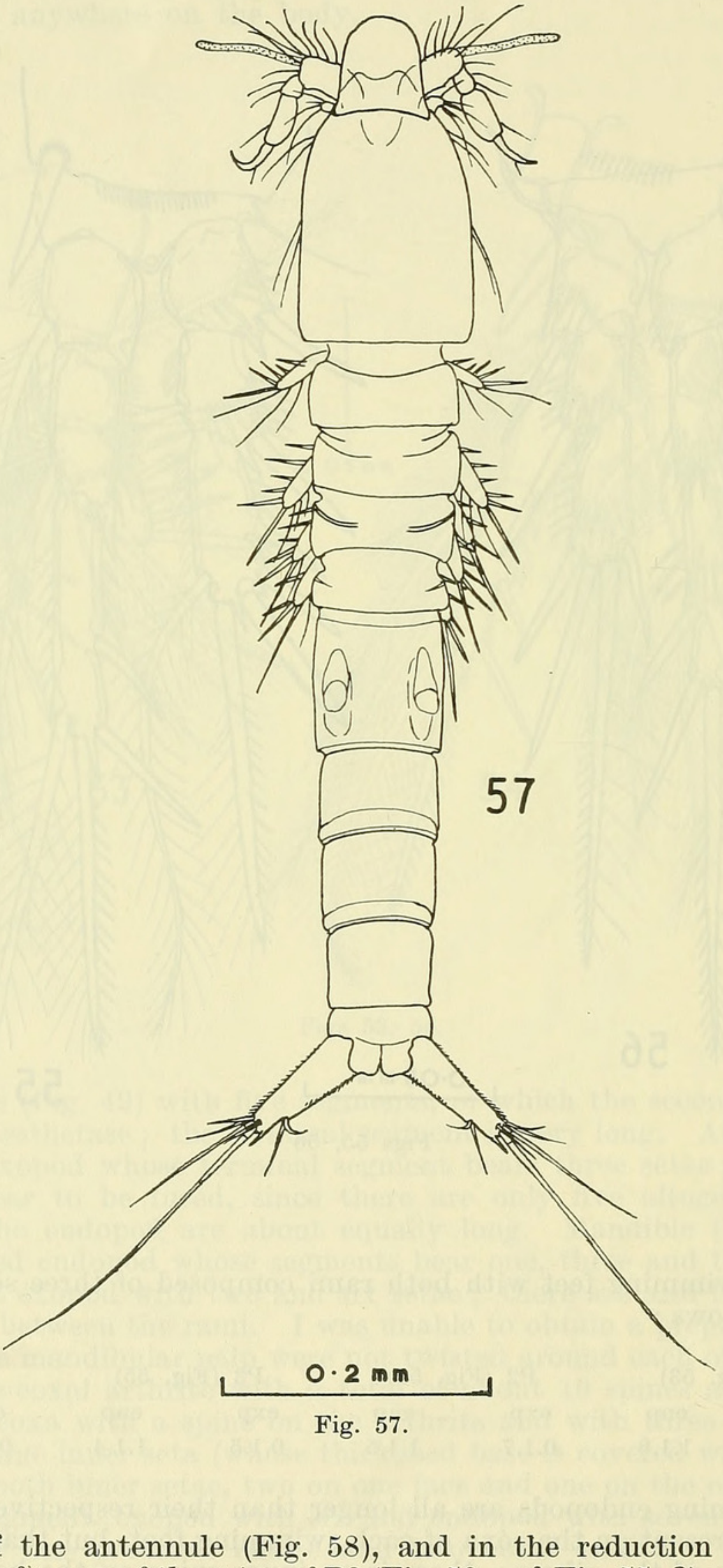
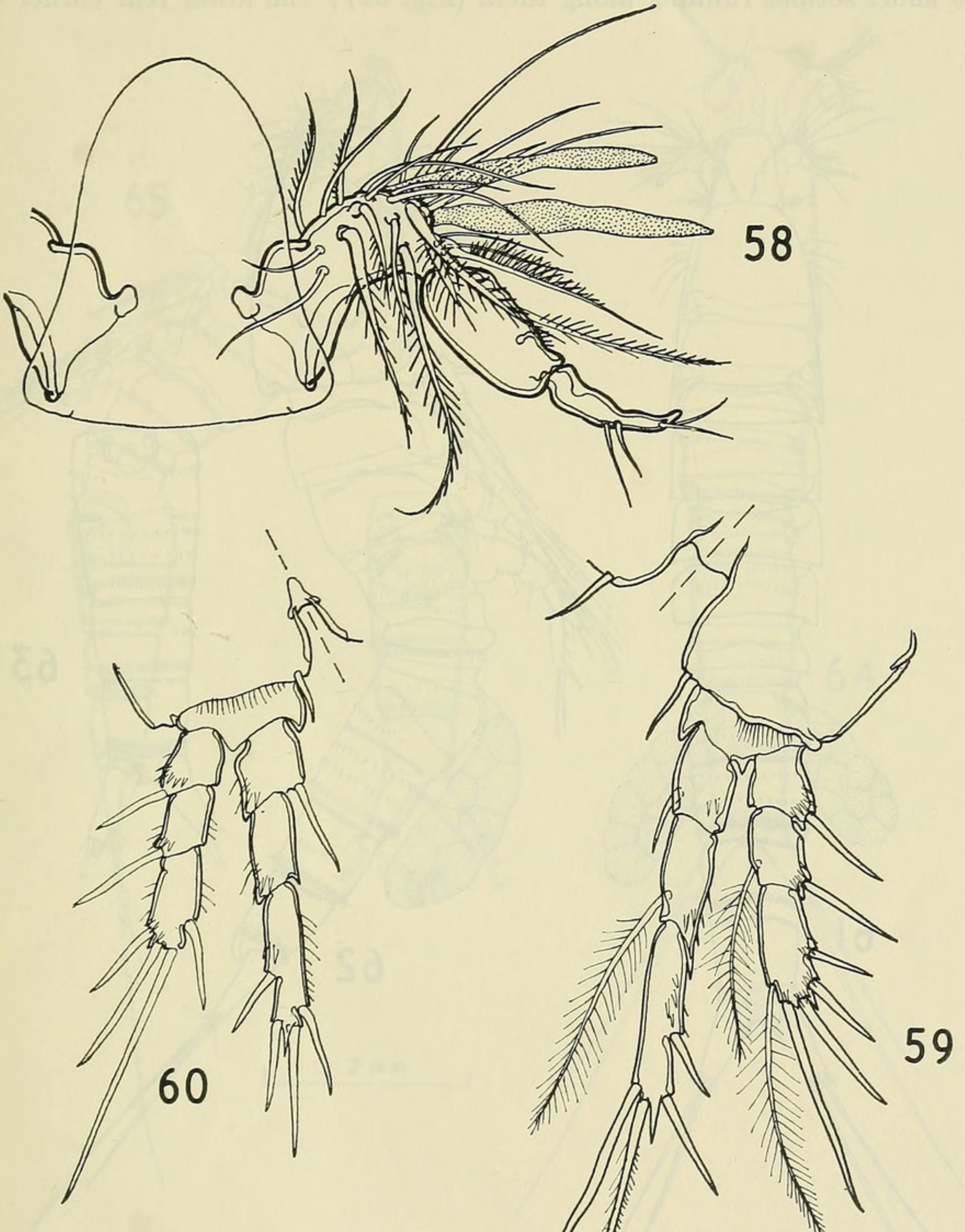


Fig. 57.

modification of the antennule (Fig. 58), and in the reduction in size and in ornamentation of many of the setae of P3 (Fig. 59 ; *cf*. Fig. 55, ♀) and P4 (Fig. 60 ; *cf*. Fig. 56, ♀).

Variability. None observed among three females and two males dissected.

I have pleasure in naming this species after Dr. F. D. Por, Hebrew University, Jerusalem, distinguished for his work on harpacticoids.

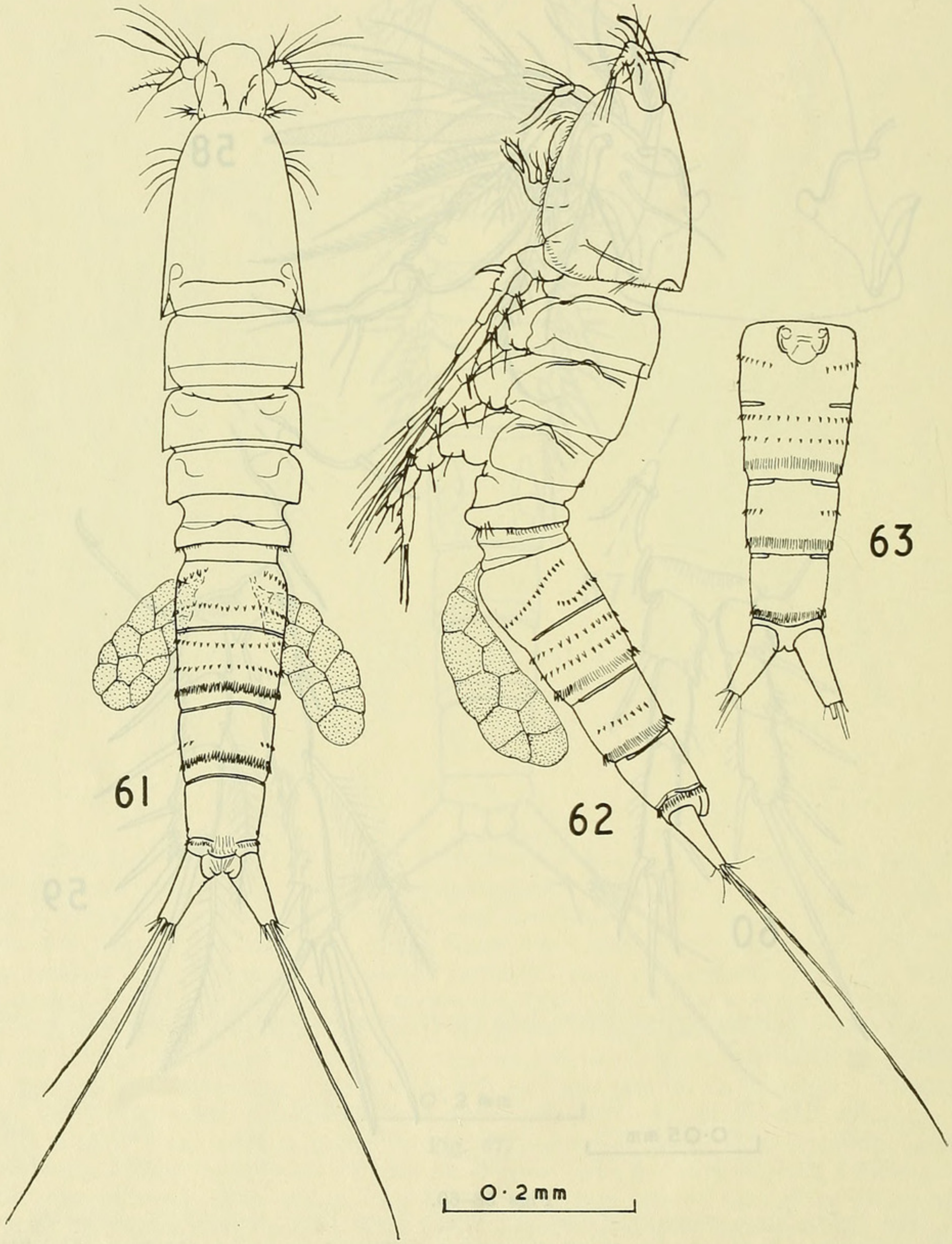


Figs 58–60.

Brianola elegans nov. sp.

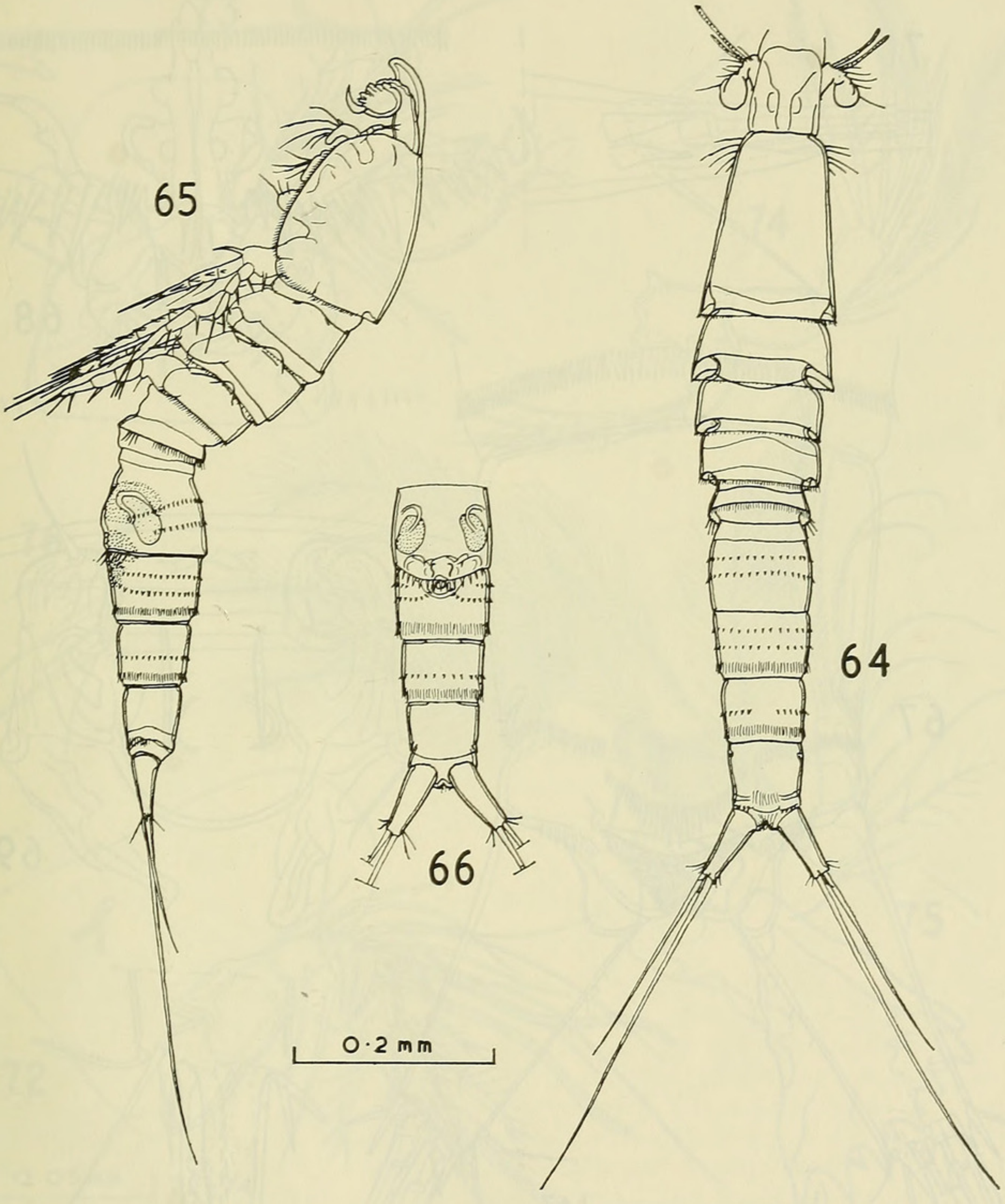
(Figs 61–83)

Female (*holotype*). Length 0·97 mm. ; in dorsal view (Fig. 61) the thorax is parallel-sided, and from it the prosome tapers forwards and the abdomen towards the furca. Rostrum (Fig. 72) less pointed than in *B. pori* or *B. sydneyensis*. The ventral and rear margins of the prosomal shield have a single row of short setules running along them (Fig. 62) ; the lower rear corner of the



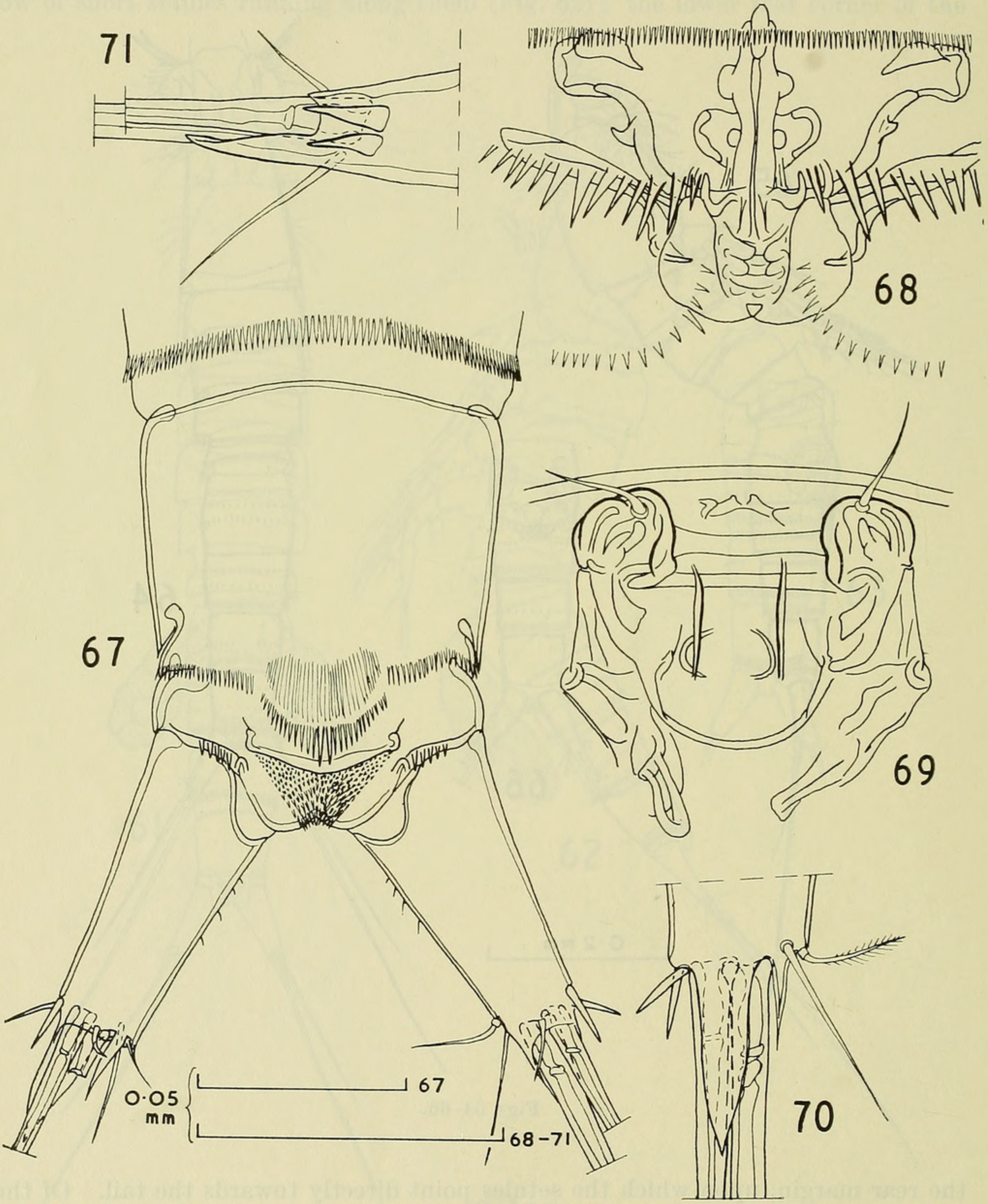
Figs 61–63.

shield is separated from the ventral and rear margins, in each case by a thin pleat-like groove in the integument (as if the chitin had been lightly scored with a sharp blade). Along the ventral margin the setules are recurved and are set upon the very edge itself ; on the lower rear corner the setules leave the edge in order to follow a shorter path across the corner, and regain the edge on reaching



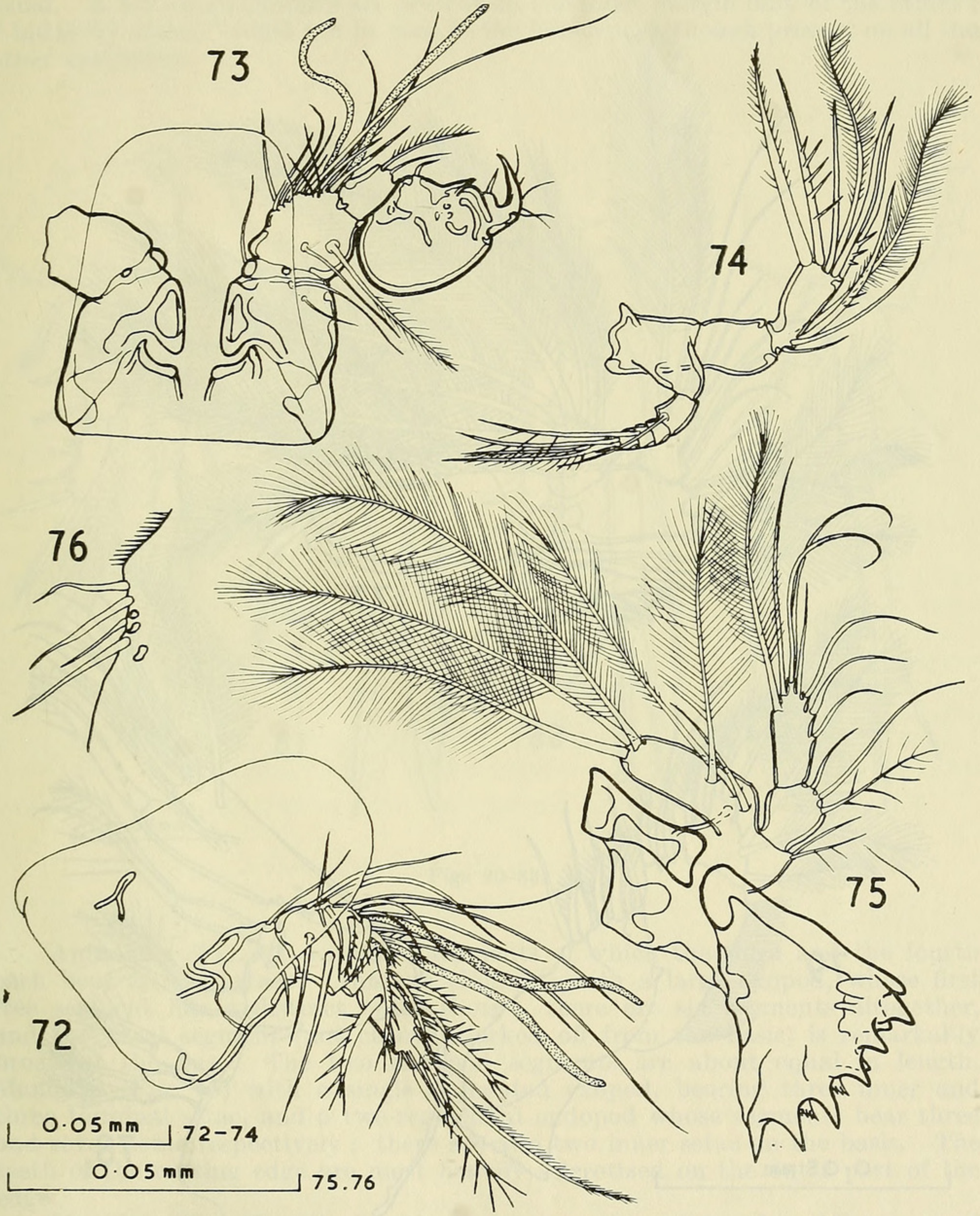
Figs 64–66.

the rear margin, upon which the setules point directly towards the tail. Of the pedigers only the fifth has any ornamentation, consisting of a lateral comb ot spinules on the rear margin ; this comb begins some way above P5 and does not extend more than a short way on to the dorsal surface. The genital double-somite is divided on all sides except ventrally ; on the front half there is a comb of small widely spaced denticles running from just behind the genital area (Fig. 63 ; detail, Fig. 69) to the dorsolateral surface (curving forwards as it does so), and behind it another comb running across the dorsal surface and extending a short way on to the lateral surface. The rear half has two such combs, and a rear-marginal fringe of spinules ; all three encircle the body without interruption,



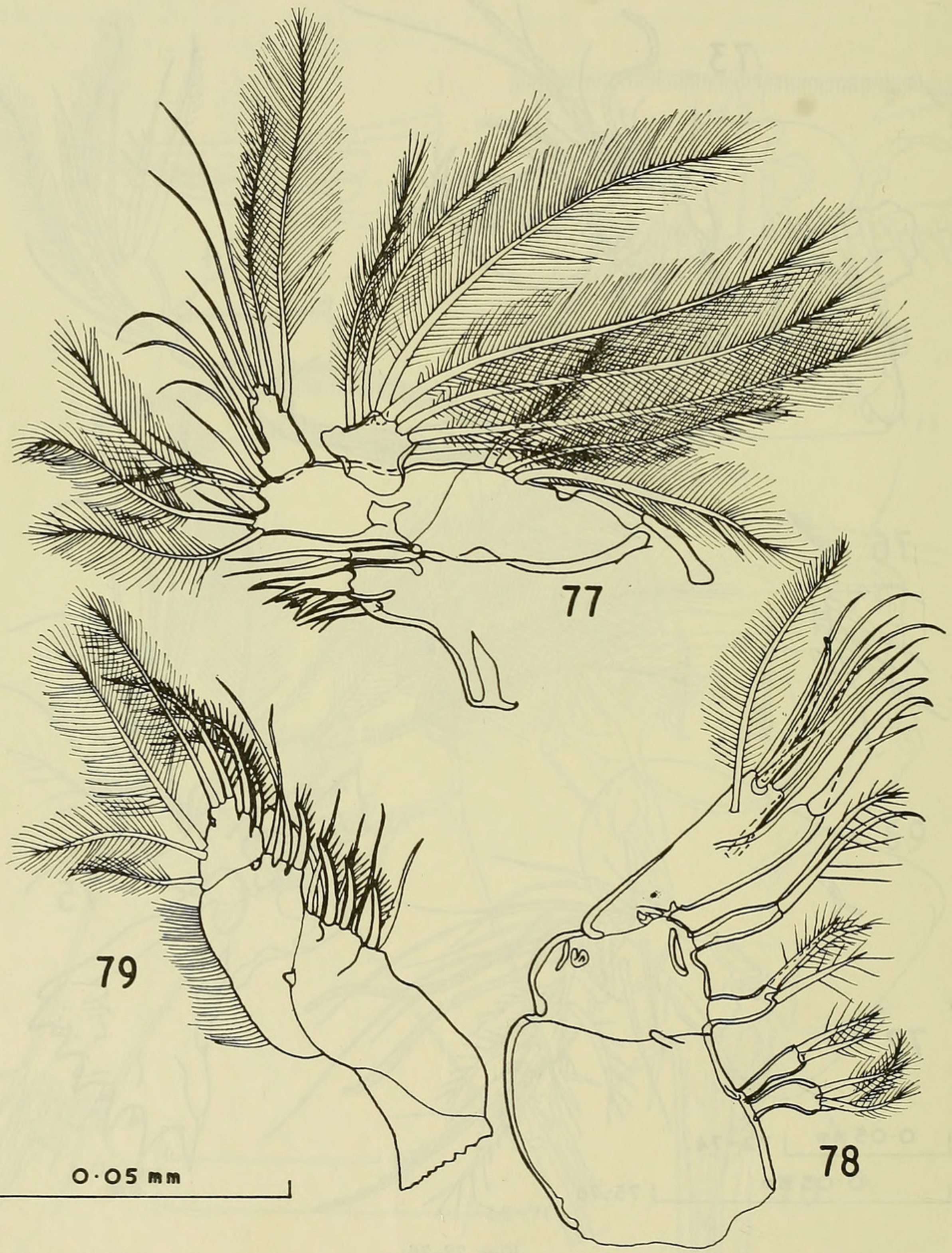
Figs 67–71.

as does the rear-marginal fringe on the somite behind the genital double-somite. This latter somite has only a small lateral comb of denticles, and the somite behind it has no denticles at all, but has a rear-marginal fringe which is incomplete dorsally owing to the presence of the spiny pseudoperculum (Fig. 67), which



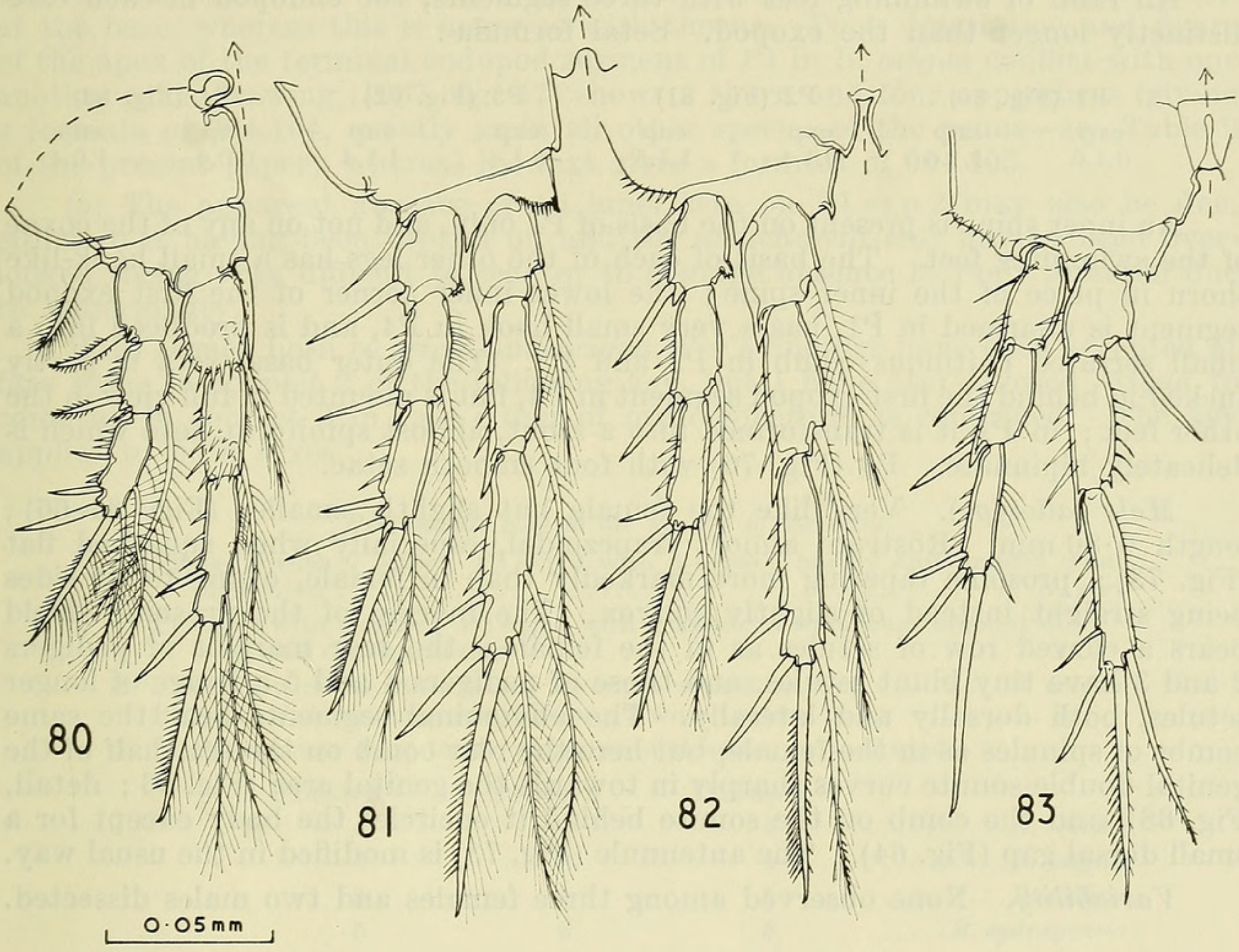
Figs 72–76.

differs at first glance from that of *B. sydneyensis* (Fig. 24) in that the teeth are longest in the middle from which they decrease regularly towards either side. The operculum has a rounded apex, and straight sides ending in bluntly angulate corners ; immediately below and behind it, the integument is covered with tiny chitinous warts which are small and round nearest the operculum, but become progressively longer and more like setules going away from it. A similar area of roughened integument below and behind the operculum is found elsewhere among harpacticoids only in the diosaccid genus *Robertgurneya* (Lang, 1948, 1965 ; own observations).



Figs 77–79.

The furca diverges at about 70°, and each ramus is almost straight ; it tapers less than in either *B. pori* or *B. sydneyensis*. The two inner setae are subterminal, and the apex is drawn out into both an inner sharp thorn (Fig. 70) and a long and strong (but very transparent) tongue-like ventral projection. There is a small dorsal seta, and the two outer setae have become flattened spines, broadest in lateral view (Fig. 71) but narrow when seen from above (Fig. 67) or from below (Fig. 70). There are also two large terminal setae, as usual. A few small spinules are present on the inner margin only of the ramus ; " butterfly-scales " could not be seen in the holotype, although present on all the other specimens.



Figs 80–83.

Antennule (Fig. 72) with five segments of which the third and the fourth each bear an aesthetasc. Antenna (Fig. 74) with a large exopod, whose first free segment has a distinct outer thorn ; there are six segments altogether, and the basal segment (not clearly marked off from the basis) is remarkably broad at the base. The two endopod segments are about equal in length. Mandible (Fig. 75) with a single-segmented exopod, bearing three inner and three terminal setae, and a two-segmented endopod whose segments bear three and seven setae respectively ; there are also two inner setae on the basis. The teeth of the cutting edge are most heavily sclerotized on the outer part of the edge.

Maxillule (Fig. 77) with about seven teeth on the cutting edge of the precoxal arthrite ; the precoxa, coxa, and basis are not very clearly separated. The coxa has three epipodal setae and an arthrite with two setae ; the basis is very long and narrow, with two terminal groups of four and three setae respectively ; the exopod is pentagonal, with seven setae of which the outermost is short and heavily barbed ; the endopod has three inner and six terminal setae. Each ramus is one-segmented. Maxilla (Fig. 78) with two precoxal and two coxal endites ; the endopod is not separated from the basis, and bears a total of seven terminal setae, as well as one on its outer surface ; there is also a seta arising from between the endopod and the basis, but on the far side (its proximal part is shown dashed in Fig. 78). Maxillipede (Fig. 79) consisting of the usual four components, which are all clearly distinct, the coxa being separated on either side by very steeply sloping sutures. The setation of the four components is as follows : precoxa, nil ; coxa, two + four + two ; basis, three ; endopod, seven.

All rami of swimming feet with three segments, the endopod in each case distinctly longer than the exopod. Setal formula :

P1 (Fig. 80)		P2 (Fig. 81)		P3 (Fig. 82)		P4 (Fig. 83)	
exp	enp	exp	enp	exp	enp	exp	enp
0.1.6	1.1.6	0.1.4	1.1.5	0.1.4	1.1.4	0.0.4	1.0.4

An inner spine is present on the basis of P1 only, and not on any of the coxae of the swimming feet. The basis of each of the other legs has a small hook-like thorn in place of the inner spine ; the lower inner corner of the first exopod segment is unarmed in P1, has a very small hook in P4, and is produced into a small serrated chitinous comb in P2 and P3. The outer basal seta is partly tucked in behind the first exopod segment in P4, but is mounted in full view in the other feet ; in P1 it is transformed into a stout, almost spiniform, seta which is delicately bipinnate. P5 (Fig. 76) with four smooth setae.

Male (*allotype*). Very like the female but slightly smaller (Figs 64–66) ; length 0·80 mm. Rostrum almost trapezoidal, especially when squashed flat (Fig. 73) ; prosome tapering more markedly than in female, owing to its sides being straight instead of slightly convex. The margin of the prosome shield bears a curved row of setules as in the female ; the rear margins of pedigers 2 and 3 have tiny blunt setules, and those of pedigers 4 and 5 a fringe of longer setules, both dorsally and laterally. The abdominal segments bear the same combs of spinules as in the female, but here the rear comb on the rear half of the genital double-somite curves sharply in towards the genital area (Fig. 66 ; detail, Fig. 68), and the comb on the somite behind it encircles the body except for a small dorsal gap (Fig. 64). The antennule (Fig. 73) is modified in the usual way.

Variability. None observed among three females and two males dissected.

Remarks on the Species of *Brianola*

The only species known to Lang (1948, p. 166) was the type of the genus, *B. stebleri* Monard (1926, as *Brianella* preocc., replaced by *Brianola* nom. nov. in Monard, 1927, p. 145), known only from females. Por (1964) described certain features of the male of *B. stebleri*, and a new species *Canuella reichi* which was later (Por, 1967) transferred to *Brianola* ; in the latter paper he also described *Brianola exigua*. All these three species are now known from both sexes, but none has been figured completely in regard to such features as the structure of the furcal apex, or the exact pattern of somitic ornamentation, or the relationship between operculum and pseudoperculum. The following conclusions may, however, be drawn.

(1) *B. reichi*, although included in the following key, should perhaps be removed from this genus, since it differs from the remaining species in several characters (Por, 1964, pp. 60–61) in which the other species agree among themselves. However, at the moment it is quite impossible to suggest any other genus as appropriate for *reichi*.

(2) *B. exigua* presents two doubtful features :

(*a*) The swimming-feet of cannuellids bear, on the margins of their segments, and of many other copepods, more or less pointed projections which I have called thorns (Hamond, 1968, top of p. 46) and which are integral with the somite bearing them, as distinct from appendices (spines and setae taken together) which have an articulated base and are thus distinct from the somite bearing them, although set into some kind of scar or socket on or near the somite margin. Spines and setae, although often distinct, are connected by many intermediates, and in some harpacticoids (of which the cannuellids are a good example) the appendices round the end of a ramus could equally well be described either as spines or as setae. In drawings, appendices always have a line of demarcation at the base, whereas this is never so with thorns. Por's description and figure of the apex of the terminal endopod segment of P4 in *B. exigua* conflict with one another ; his drawing (1967, fig. 47) shows a thorn and four appendices (giving a formula of 004.104, exactly as in all other species of the genus—see Table 2 of the present paper), whereas his text gives a formula of 004.105.

(*b*) The apparent absence of an inner seta on P1 exp 2 may also be due, either to it having been broken off and the attachment-scar having been overlooked (being very difficult to see), or to genuine absence in Por's material due to abnormality.

With regard both to *reichi* and *exigua*, Por's findings have been accepted at face value in couplet 2 of the following key, but I have also allowed *exigua* to come up in couplet 3 in case either of my conjectures is confirmed. The key applies to both sexes.

Provisional Key to the species of Brianola

1. P2 exp 3 with 7 setae ; P3 exp 3 with 5 setae ; hardly any somitic ornamentation .... *B. pori*
   P2 exp 3 with 4 setae ; P3 exp 3 with 4 setae ; a significant amount of somitic ornamentation 2
2. P1 exp 2 with no inner seta ; P4 enp 3 with 5 setae .... *B. exigua*
   P1 exp 2 with an inner seta ; P4 enp 3 with 4 setae 3
3. Limb-segments bear totals of spines and setae, as indicated :

P1 exp 3	P1 enp 3	P2 enp 3	
4	5	4	..........*B. reichi*
4	6	4	..........*B. exigua*
5	4	5	..........*B. stebleri*
5	6	5	......*B. sydneyensis*
6	6	5	..........*B. elegans*

When using this key, it is always desirable to confirm the initial determination by inspection of other characters, such as the shape of the body in dorsal view, the pseudoperculum, the somitic ornamentation, and the appearance of the furcal ramus.

Discussion

The current opinion (Por, 1967, p. 104) that the family Canuellidae is centred within the largely unexplored and faunistically inexhaustible Indo-West Pacific realm, is certainly borne out by the present findings ; when one remembers that no less than four species of the family, all of them new, were found simultaneously with the same population of hermit-crabs (the previous record being two such species simultaneously ; Humes and Ho, 1969), in collections along an infinitesimal fraction of the long Australian coastline, the potential wealth of species remaining to be discovered needs no emphasis. This being so, the need to describe every new species in as detailed and careful a way as possible becomes more imperative than ever, especially considering what a homogeneous family the canuellids are, and how little some of the alleged species appear to differ morphologically from one another. *Sunaristes* seems to be a natural genus when restricted to the five species in the keys on p. 177, but a formal generic diagnosis is not feasible at present owing to the large number of insufficiently known species, any of which might turn out to belong to this genus, but none of which should be positively admitted to it until they have been thoroughly redescribed and refigured. On the other hand, *Brianola* is a dumping-ground rather than a genus (although its members have many points in common) ; in the present state of our knowledge, to transfer species to or from it would only increase the prevailing confusion.

By analogy with *S. paguri*, the association between *S. tranteri* and *Diogenes senex* is probably a very close one ; however, this may well not be true of any of the new species of *Brianola* because the holotype of *B. pori* was found in a place from which no pagurids have been recorded (see Material and Methods), and because other species of this genus appear to be free-living. I have not yet had either the chance to examine other species of pagurid in the Sydney area or the time to go through my numerous samples of Sydney harpacticoids in a search for canuellids ; however, from observations while sorting these samples, it seems that canuellids are much scarcer than certain other families.

Acknowledgements

I am most grateful to Dr. D. J. G. Griffin (Australian Museum, Sydney) for identifying *Diogenes senex*, and to him, to Miss Isobel Bennett (formerly of the University of Sydney) and to Dr. R. J. MacIntyre (University of New South Wales), for information about the lack of pagurids in Narrabeen Lagoon ; also to Dr. W. Ponder (Australian Museum, Sydney) for the authorships of the names *Pyrazus ebeninus* and *Crassostrea commercialis*, and to the Chief of the Division of Fisheries and Oceanography, C.S.I.R.O., Cronulla, for the loan of phase-contrast equipment.

Addendum

Since the above was written, Humes (1971) has found *Sunaristes dardani* in the Pacific ; the variations in spinulation recorded by him have been omitted from Table 1, and do not affect the key in the present paper.

Table 2

Setal Formulae of Brianola *spp.*

	P1		P2		P3		P4	
	exp	enp	exp	enp	exp	enp	exp	enp
stebleri ..	0.1.5	1.1.4	0.1.4	1.1.5	0.1.4	1.1.4	0.0.4	1.0.4
reichi	0.1.4	1.1.5	0.1.4	1.1.4	0.1.4	1.1.4	0.0.4	1.0.4
exigua ..	0.0.4	1.1.6	0.1.4	1.1.4	0.1.4	1.1.4	0.0.4	1.0.5
sydneyensis ..	0.1.5	1.1.6	0.1.4	1.1.5	0.1.4	1.1.4	0.0.4	1.0.4
pori	0.1.7	1.1.6	0.1.7	1.1.5	0.1.5	1.1.4	0.0.4	1.0.4
elegans ..	0.1.6	1.1.6	0.1.4	1.1.5	0.1.4	1.1.4	0.0.4	1.0.4

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