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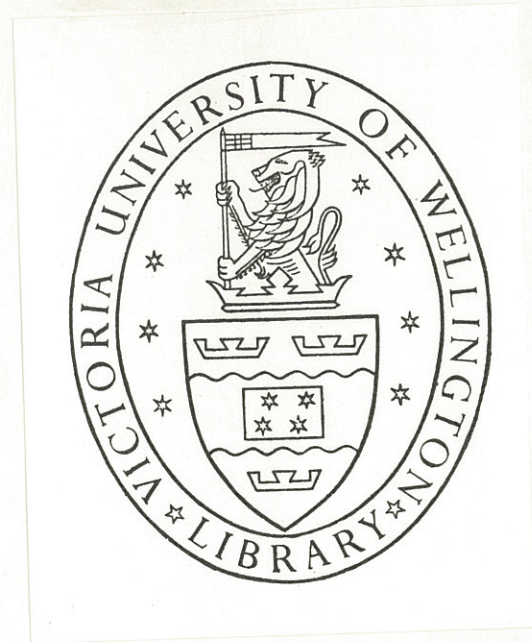
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SOME NEW ZEALAND PARASITIC COPEPODA  
OF THE FAMILY EUDACTYLINIDAE

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ABSTRACT

*Nemesis lamna* Risso is reported from New Zealand waters on *Isurus oxyrinchus*, *Carcharodon carcharias* and *Cetorhinus maximus*; the specimens from the last host are considered subspecifically distinct and identified as *N.l. vermi* Scott; *Nemesis robusta* (van Beneden) is reported from *Alopias vulpinus*; *N. pallida* Wilson is a synonym of *N. robusta*; *Congericola pallidus* van Beneden is reported from *Conger vereauxi*; variation in *Nemesis* due to contraction, host influence and individual variation in spination is recorded; previous records of all the above species are discussed.

INTRODUCTION

The family Endactylinidae has not previously been recorded from New Zealand. However the collections of parasitic copepods available to me contain several samples of *Nemesis*, a widely distributed genus of shark parasite, and two samples of *Congericola*. The latter genus has previously been recorded only from the North Atlantic and the Mediterranean, but, considering the wide distribution of the conger eels on which it is found, it is hardly surprising that its distribution should also be widespread.

NEMESIS Risso, 1826

*Nemesis lamna* Risso, 1826

*N. lamna* Risso, 1826, p. 136, pl. v, fig. 25.

*Nemesis lamna lamna* Risso, 1826

*N. lamna* Risso, 1826, p. 136, pl. v, fig. 25; Milne Edwards, 1840, p. 486; Brian, 1906, p. 71; Wilson, 1922, p. 59; Fage, 1923, p. 282; Wilson, 1932, p. 461, pl. 32; Brian 1944, p. 197, pl. 5, figs. 41-42; Delamare Deboutteville and Nunes-Ruivo, 1953, p. 213; Heegaard, 1962, p. 184, fig. 201; Cressey, 1968, p. 11.

*N. carchariarum* Roux, 1828, pl. 20, fig. 10-11; Milne Edwards, 1840, p. 486 (mispelt *carcherium*).

*N. mediterranea* Heller, 1868, p. 220, pl. 21, fig. 2; Valle, 1880, p. 66; Brian, 1898, p. 213.

(?) *N. lamna sinuata* Valle, 1878 (non-vidae); Brian, 1906, p. 72, pl. 5, fig. 2.

MATERIAL

On *Isurus oxyrinchus*—five females and three males collected at Makara, near Wellington, by Professor J. A. F. Garrick on 29th June 1955; 18 females and one male collected by the Fisheries Laboratory, Marine Department at Mernoo Bank, East of New Zealand on 30 November 1964.

On *Carcharodon carcharias*—nine females and one male, collected at South Bay, Kaikoura, by Mr. H. G. Upston on 9 January 1965, forwarded by Dr. J. M. Bradford.

DESCRIPTION

FEMALE (figs. 1-14)

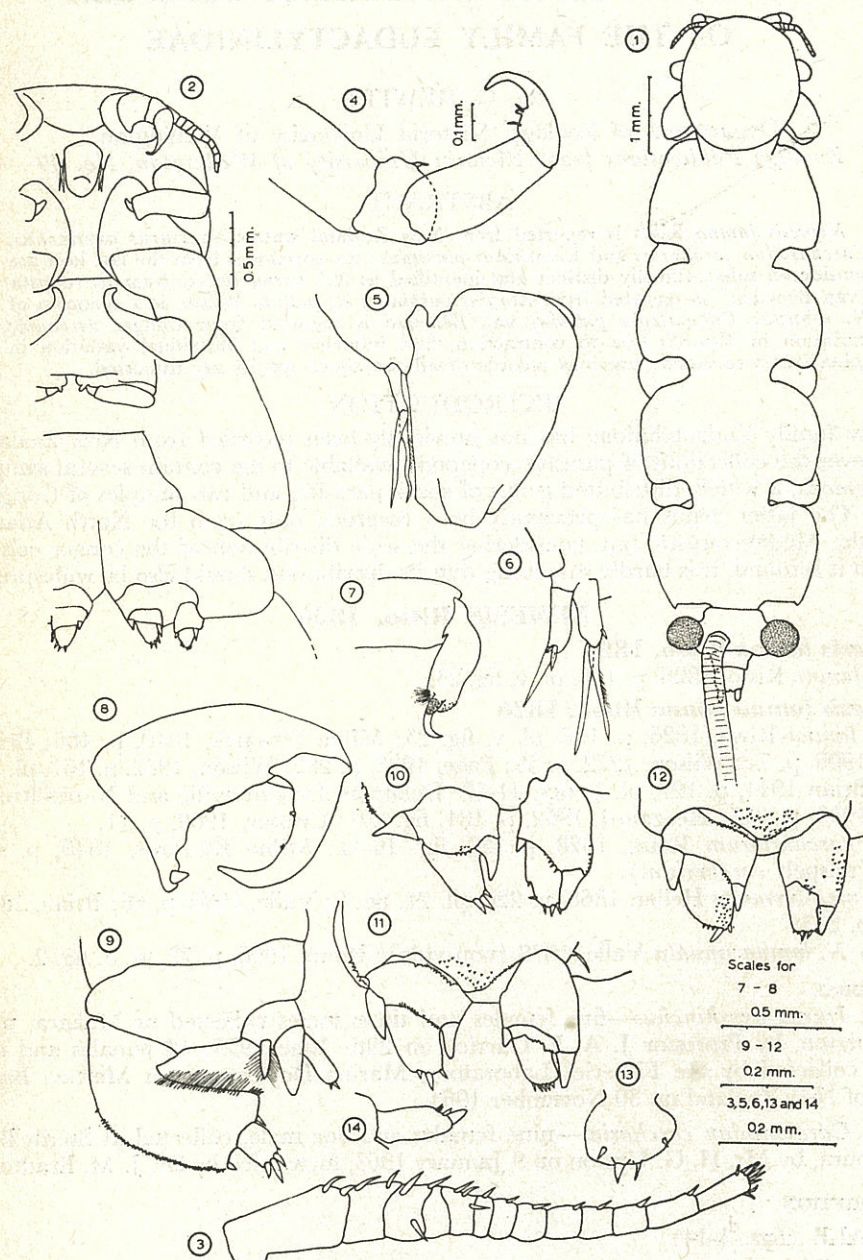
Overall length 8.2 mm-10.1 mm.

CEPHALOTHORAX subovate, width four-fifths length (2.06 mm-2.3 mm x 1.7 mm-1.85 mm), a little wider posteriorly than anteriorly; attached to second thoracic segment by a short neck, about three-quarters carapace width.

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*Nemesis lamna lamna* Risso, 1826 from *Isurus oxyrinchus*. Female—fig. 1: dorsal view; fig. 2: anterior ventral view; fig. 3: first antenna; fig. 4: second antenna; fig. 5: mouth tube and mandibular palp, dorsolateral view; fig. 6: mandibular palp; fig. 7: maxilla; fig. 8: maxilliped; fig. 9: first pereopod; fig. 10: second pereopod; fig. 11: third pereopod; fig. 12: fourth pereopod; fig. 13: fifth pereopod; fig. 14: caudal lamina.

**SECOND THORACIC SEGMENT** subrectangular, length three-fifths width (1.5 mm-1.7 mm x 2.2 mm-2.6 mm), anterior width four-fifths posterior width, posterior margin sublinear, angles rounded; separated from third thoracic segment by a short neck which is three-quarters width of second thoracic segment.

**THIRD THORACIC SEGMENT** subovate, length three-fifths width (1.2 mm-1.5 mm x 2.2 mm-2.6 mm), anterior angles broadly rounded, posterior angles rounded and swollen slightly posteriorly; the swelling of the posterior angles, of both second and third segments, is generally more pronounced in specimens from *Carcharodon carcharias* than in those from *Isurus oxyrinchus*; separated from the fourth thoracic segment by a short neck, two-thirds width of third segment.

**FOURTH THORACIC SEGMENT** similar in size and shape to third (1.3 mm-1.6 mm x 2.2 mm-2.6 mm), but in some cases posterior angles are not swollen posteriorly to the same extent as in the third segment; separated from fifth segment by a neck, seven-tenths width of fourth segment, which is slightly longer than those between the three preceding segments.

**FIFTH THORACIC SEGMENT** subrectangular, length three-fifths width (1.2 mm-1.5 mm x 1.9 mm-2.5 mm), narrowing to three-quarters this width posteriorly, anterior angles broadly rounded and swollen anteriorly, posterior margin sublinear, posterolateral angles with small acute swellings.

**GENITAL SEGMENT** subrectangular, a little wider than long (0.7 mm-0.95 mm x 0.8 mm-1.1 mm), with spermathecae which are dark brown in colour and about 0.4 mm in diameter borne laterally.

**FIRST ABDOMINAL SEGMENT** subrectangular, length two-fifths width (0.2 mm x 0.4 mm-0.55 mm), narrowing slightly posteriorly.

**SECOND ABDOMINAL SEGMENT** a little wider than long (0.3 mm-0.4 mm x 0.3 mm-0.45 mm), lateral margins very slightly swollen, with caudal laminae borne laterally on posterior margin.

**CAUDAL LAMINAE**, width one-third length (0.2 mm x 0.07 mm-0.08 mm), narrowing slightly at the base, posterior margin rounded, with four spines, the most medial very large the others small.

**EGG STRINGS** long, 31 mm-43 mm, eggs uniseriate.

**FIRST ANTENNA** of thirteen segments, although the segmentation is not always distinct, ratio of lengths of segments—13:6:4:3:4:2:3:4:4:4:4:6:6; segments disc-shaped or subcylindrical; first segment, width half length, with two setae near outer distal angle; second segment as long as wide, with one seta near outer distal angle and one seta near outer proximal angle; third segment, length two-thirds width, with a seta near each of the distal angles and the outer proximal angle; fourth segment, length three-fifths width, without setae; fifth segment, length three-quarters width, with two setae near middle of outer margin and another seta on distal margin near outer distal angle; sixth segment, length half width, with one seta medially on outer margin; seventh segment, length two-thirds width, with one seta medially on outer margin; eighth to eleventh segments as long as wide, each with a single seta between middle of outer margin and outer distal angle; twelfth segment, width half length, with one seta near outer distal angle; thirteenth segment, width two-fifths length, with about nine setae on or near distal margin.

**SECOND ANTENNA** of four segments, first, third and fourth segments subequal in length, second segment half this length; first segment subrectangular, width two-thirds length; second segment, subrectangular, rounded medially, as long as wide, with one seta on inner margin; third segment, basal width two-fifths length, narrowing



to three-quarters this width distally; fourth segment a sharp claw, basal width two-fifths length, distal two-thirds rapidly narrowed, ending in a sharp point distally, swollen proximal portion with one spine near inner proximal angle, and a small projection near inner distal termination of swollen section, this projection bearing a further small spine.

**MOUTH TUBE** 0.4 mm in length, basal width two-thirds length, narrowing gradually to half this width distally, distal margin irregularly rounded.

**MANDIBULAR PALP** biramous, each ramus of one segment, segments subequal in length, one-quarter length of mouth tube, width one-third length; outer ramus with one long seta and two very short setae distally, inner ramus with two very long setae, one plumose over the median third of its inner margin, and one short spine.

**MAXILLA** of two segments; first segment four-fifths length of second, subrectangular, width half length; second segment basal width one-third length, distal third a process arising just proximal to a rounded margin which terminates the wider portion of the segment, the process narrowing to a point distally, distal margin of wider portion covered in small spines, and with a clump of long cilia just inside process, a second process, two-fifths length of first, arises near its base, is rounded distally and covered in small spines.

**MAXILLIPED** of two segments, subchelate; first segment basal width half length, narrowing rapidly and then more gradually to two-fifths this width distally, rounded distally, outer margin an entire curve, with a stout spine near inner proximal angle, and a small process on inner margin near point at which second segment closes against it; second segment basal width two-fifths length, narrowing gradually to a point distally, outer margin an entire curve, inner margin divided roughly into thirds by two small spines, the more distal one bearing an even smaller spine on its inner margin.

**FIRST PEREIOPOD** biramous; basipod of two segments, each segment subrectangular, length two-fifths width; exopod two segmented, first segment subrectangular, width two-fifths length, curving sharply medially near base, with a small spine on outer distal angle, a further small spine on distal margin near outer margin of second segment, a row of very short spines over distal two-fifths of outer margin, a row of long cilia over medial two-thirds of inner margin, and a group of very short spines on inner distal angle which is slightly rounded; second segment subrectangular, width three-quarters length, with three stout spines on distal margin, and a very small spine on inner distal angle; endopod basal segment subrectangular, length half width, with a very stout plumose seta on outer distal angle, and two well developed processes on distal margin each twice as long as segment, their basal width half their length, one narrowing to a more or less sharp point distally, with a few very small spines on its surface, the other, which is rounded distally and bears two short spines on the distal margin, may be the second segment of the endopod.

**SECOND PEREIOPOD** biramous, each ramus of two segments; basipod of two segments, much larger than basipod of first pereio pod, basal segment slightly swollen laterally, with a short row of very small spines just medial to endopod; exopod two-fifths length of basipod, first segment subrectangular, outer distal angle swollen and rounded, outer margin slightly curved, with a stout spine on outer distal angle, a smaller spine on inner distal angle, a row of spines on distal quarter of outer margin and lateral half of distal margin, second exopod segment subsemiovate, proximal margin sublinear, two-thirds length of first segment, width two-thirds length, with five small spines on distal margin; endopod five-sixths length of exopod, first segment subrectangular, length two-thirds width, with a very stout spine on outer distal angle,

another on inner margin, and a row of very small spines on outer part of distal margin, second segment subsemiovate, proximal margin sublinear, length subequal to basal width, narrowing slightly distally, with three spines on distal margin.

**THIRD PEREIOPOD** similar to second except that basipod has a group of very small spines between the rami, and a small plumose seta just lateral to exopod.

**FOURTH PEREIOPOD** similar to second and third except that the basipod bears more very small spines between the rami, the exopod has a wide band of very small spines near outer margin, the second segment of the exopod has six small spines on its distal margin, and second segment of endopod has a wide band of very small spines near outer margin, two well developed spines on distal margin and three smaller spines just medial to these.

**FIFTH PEREIOPOD** small, subovate, length two-thirds width, with four spines on or near distal margin, the middle two being much larger than the outer and inner spines.

**MALE** (figs. 15-26).

Overall length 5.9 mm-6.3 mm.

**CEPHALOTHORAX** shaped as in female, as wide as long (1.6 mm-1.8 mm x 1.4 mm-1.8 mm).

**SECOND THORACIC SEGMENT** subrectangular, length three-fifths width (1.0 mm-1.2 mm x 1.8 mm-2.2 mm), anterior angles broadly rounded, posterior margin sublinear.

**THIRD THORACIC SEGMENT** similar in shape to second but smaller (0.9 mm-1.1 mm x 1.6 mm-2.0 mm).

**FOURTH THORACIC SEGMENT** similar in shape to second and third except that posterior angles are slightly more rounded, and the segment is even smaller than the third (0.8 mm-1.05 mm x 1.5 mm-1.8 mm).

**FIFTH THORACIC SEGMENT** much smaller than preceding segments, length half width (0.3 mm-0.4 mm x 0.5 mm-0.7 mm), widest posteriorly, narrowing to two-thirds this width anteriorly at junction with fourth thoracic segment, broad curved posterior margin articulating with genital segment.

**GENITAL SEGMENT** subovate, anterior and posterior margins sublinear, a little wider than long (0.9 mm-1.3 mm x 1.05 mm-1.3 mm).

**FIRST ABDOMINAL SEGMENT** subrectangular, length half width (0.3 mm-0.4 mm x 0.5 mm-0.7 mm), narrowing slightly posteriorly, posterior angles rounded.

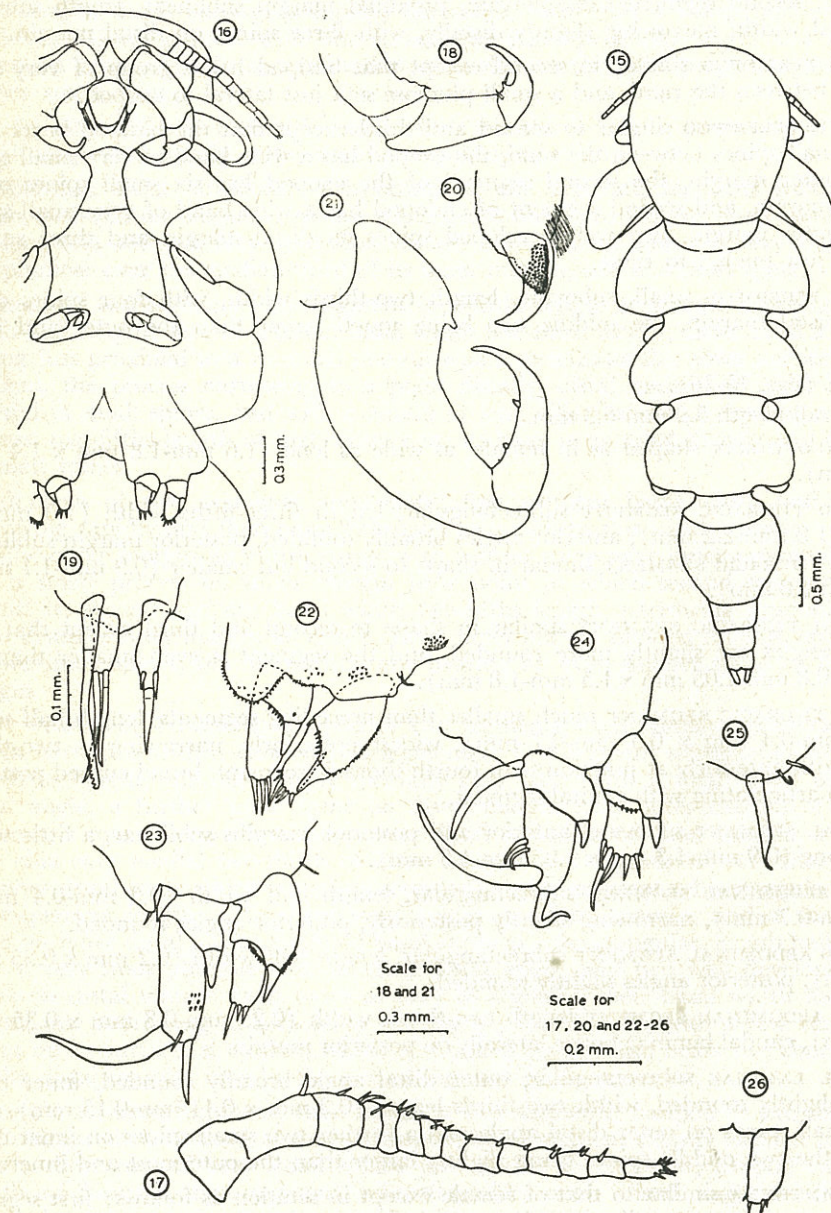
**SECOND ABDOMINAL SEGMENT** subrectangular, length half width (0.2 mm x 0.35 mm-0.5 mm), posterior angles slightly rounded.

**THIRD ABDOMINAL SEGMENT** length two-thirds width (0.25 mm-0.3 mm x 0.35 mm-0.4 mm), caudal laminae borne laterally on posterior margin.

**CAUDAL LAMINAE** subrectangular, outer distal angle broadly rounded, inner distal angle slightly rounded, width two-thirds length (0.2 mm x 0.11 mm-0.15 mm), with two small spines on outer distal angle and a further two small spines on inner distal angle, the two middle spines being slightly larger than the outermost and innermost.

**FIRST ANTENNA** similar to that of female except in setation as follows: first segment has one seta on outer distal angle, second segment has one seta medially on outer margin and two on the outer distal angle, third segment has one seta near middle of outer margin, fourth segment has two setae on outer distal angle, fifth segment has one seta on outer margin and one on outer distal angle, fourth segment has two setae on middle of outer margin and one on outer distal angle, seventh, eighth and ninth segments have one seta each on outer distal angle, tenth and eleventh segments have





*Nemesis lamna lamna* Risso, 1826 from *Isurus oxyrinchus*. Male—fig. 15: dorsal view; fig. 16: anterior, ventral view; fig. 17: first antenna; fig. 18: second antenna; fig. 19: mandible and mandibular palp; fig. 20: tip of maxilla; fig. 21: maxilliped; fig. 22: second pereopod; fig. 23: third pereopod; fig. 24: fourth pereopod; fig. 25: fifth pereopod; fig. 26: caudal lamina.

two setae each on outer distal angle, twelfth segment has one seta proximal to mid-point of outer margin, thirteenth segment has nine setae on or near distal margin which is more rounded than in female.

SECOND ANTENNA, MOUTH TUBE, MANDIBULAR PALP, MAXILLA AND MAXILLIPED as in female, except that inner margin of narrowing process on terminal segment of maxilla has most of inner margin slightly serrate.

FIRST PEREIOPOD as in female.

SECOND PEREIOPOD as in female except that the segments of the rami are somewhat longer and narrower, the basipod has a less well developed lateral expansions and a greater number of small spines in the region of the rami, a number of small spines on the rami themselves are in the same area but increased in relative size, the large spine on the inner margin of endopod is missing, there are six spines on the distal margin of the second segment of the exopod.

THIRD PEREIOPOD biramous, each ramus of two segments, first segment subrectangular, width two-thirds length, outer distal angle somewhat extended and bearing a stout spine, distal quarter of outer margin with a row of very small spines, and medial third of distal margin with a row of very small spines, second segment subovate, width half length, with three spines distally, the innermost longer than the other two; endopod subequal in length to exopod, first segment subrectangular, inner margin half length of outer, with large spines on outer distal angle and inner margin, second segment width two-fifths length, rounded distally, with one small spine and two setae on distal margin, the longer seta subequal in length to ramus, the outer seta half length of inner, and with a group of very small spines near middle of outer margin.

FOURTH PEREIOPOD biramous, each ramus of two segments, segments similar in shape to those of third pereopod; first segment of exopod with a stout spine on outer distal angle, and a row of small spines on distal margin, second segment with five large spines and one small spine on distal margin; first segment of endopod with a few small spines associated with its base, a stout spine on outer distal angle, and a long seta a little shorter than ramus, on inner margin, second segment with distal setae like those of third pereopod, and two smaller setae on inner margin near its mid-point.

FIFTH PEREIOPOD consisting of one large and two very small setae on a small swelling borne on fifth segment.

#### *Nemesis lamna vermi* Scott, 1929

*N. vermi* Scott, 1929, p. 96, pl. 2, figs. 1-14.

*N. lamna* Risso, 1826, Fage, 1923, p. 282; Legendre, 1923, p. 278; Yamaguti, 1939, p. 455; Deboutteville, 1948, p. 447; Mathews and Parker, 1950, p. 571; Delamare Deboutteville and Euzet, 1952, p. 216; Delamare Deboutteville and Nunes-Ruivo, 1954.

#### MATERIAL

On *Cetorhinus maximus*—16 females and eight males collected at Oaro, South of Kaikoura by Dr. J. M. Bradford on 19 January 1965.

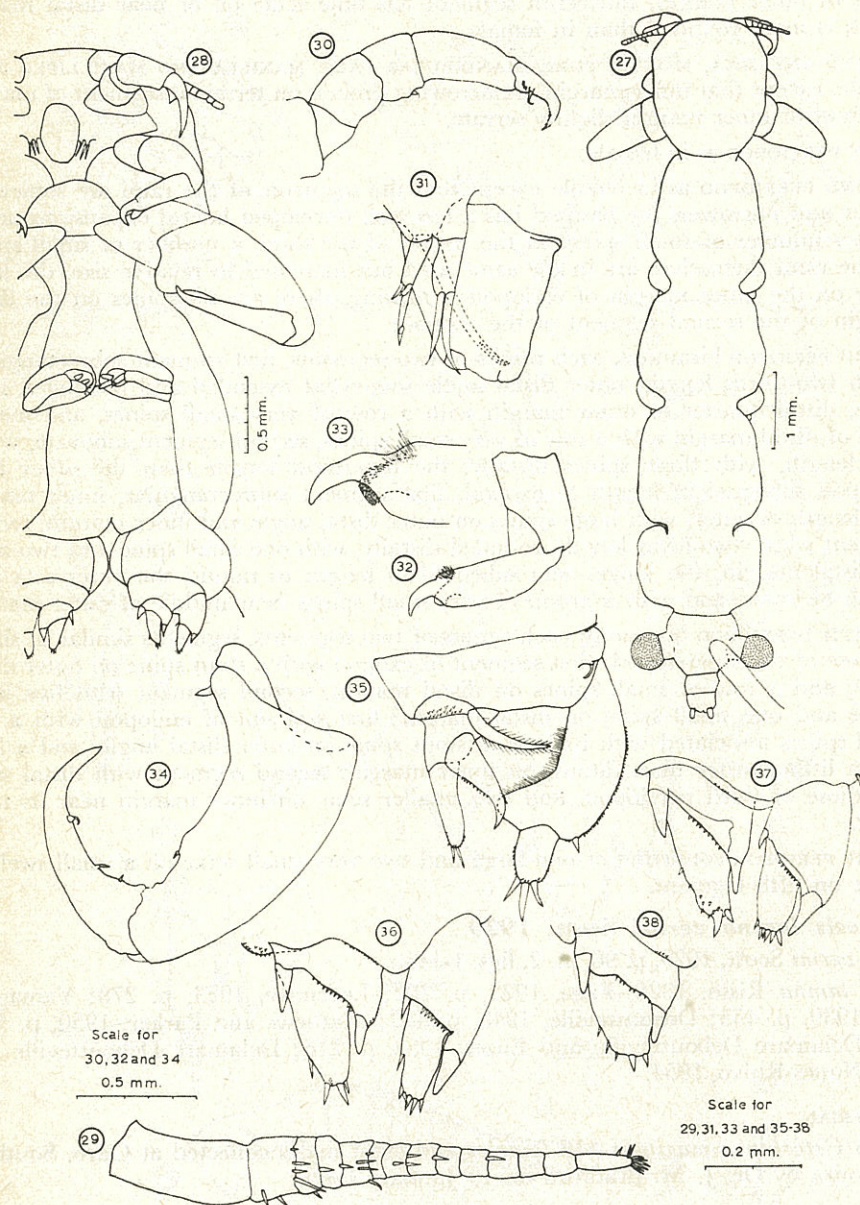
#### DESCRIPTION

FEMALE (figs. 27-38).

Overall length 8.4 mm-9.3 mm.

CEPHALOTHORAX subovate, width four-fifths length (1.7 mm-2.0 mm x 1.4 mm-1.5 mm), median third of lateral margins sublinear.





*Nemesis lamna vermi* Scott, 1929 from *Cetorhinus maximus*. Female—fig. 27: dorsal view; fig. 28: anterior, ventral view; fig. 29: first antenna; fig. 30: second antenna; fig. 31: mouth tube and mandibular palp; fig. 32: maxilla; fig. 33: tip of maxilla; fig. 34: maxilliped; fig. 35: first pereopod; fig. 36: second pereopod; fig. 37: third pereopod; fig. 38: endopod of fourth pereopod.

SECOND THORACIC SEGMENT a little longer than wide (1.6 mm-1.7 mm x 1.4 mm-1.7 mm), widest posteriorly, two-thirds this width anteriorly, anterior angles rounded, posterior angles broadly rounded.

THIRD THORACIC SEGMENT similar in shape to second, but a little wider than long (1.35 mm-1.7 mm x 1.5 mm-1.7 mm).

FOURTH THORACIC SEGMENT similar in shape to second and third except that it is not narrowed as strongly anteriorly, as long as wide (1.5 mm-1.7 mm x 1.5 mm-1.8 mm).

FIFTH THORACIC SEGMENT subrectangular, length two-thirds width (0.9 mm-1.1 mm x 1.5 mm-1.6 mm), posterior angles rounded, anterior angles rounded and swollen anteriorly, separated from fourth thoracic segment by a short neck, about 1.1 mm in width.

GENITAL SEGMENT as wide as long (0.8 mm-0.9 mm x 0.8 mm-1.0 mm), lateral margins curved, bearing spermathecae which are about 0.4 mm in diameter laterally. FIRST ABDOMINAL SEGMENT subrectangular, length two-fifths width (0.2 mm-0.25 mm x 0.4 mm-0.5 mm).

SECOND ABDOMINAL SEGMENT subrectangular, length three-quarters width (0.3 mm-0.35 mm x 0.35 mm-0.4 mm), caudal laminae borne laterally on posterior margin.

CAUDAL LAMINAE subrectangular, rounded distally, width half length (0.17 mm-0.20 mm x 0.07 mm-0.10 mm), with two spines and three very slender setae on distal margin.

EGG STRINGS damaged or missing in most specimens, total length 16 mm and 25 mm in two specimens in which they are apparently undamaged.

FIRST ANTENNA apparently of fourteen segments, their relative lengths given by the ratio 18:6:3:3:4:2:3:4:3:4:4:3:4:7; all segments subrectangular, the distal segment rounded distally; first segment width half length; second segment length three-quarters width, with four setae on distal margin and two setae medially; third segment length two-fifths width, with one seta on outer distal angle, and one seta medially; fourth segment length two-fifths width, with one seta on distal margin; fifth segment length three-quarters width, with two setae on distal margin and two setae medially; sixth segment length half width; seventh segment length two-thirds width, with two setae on distal margin and one seta medially; eighth segment as long as wide, with one seta on distal margin; ninth segment length four-fifths width; tenth to twelfth segments as long as wide, tenth segment with one seta on distal margin; thirteenth segment width two-thirds length; terminal segment width one-third length, with about eight setae distally, and one further seta a little proximal to these.

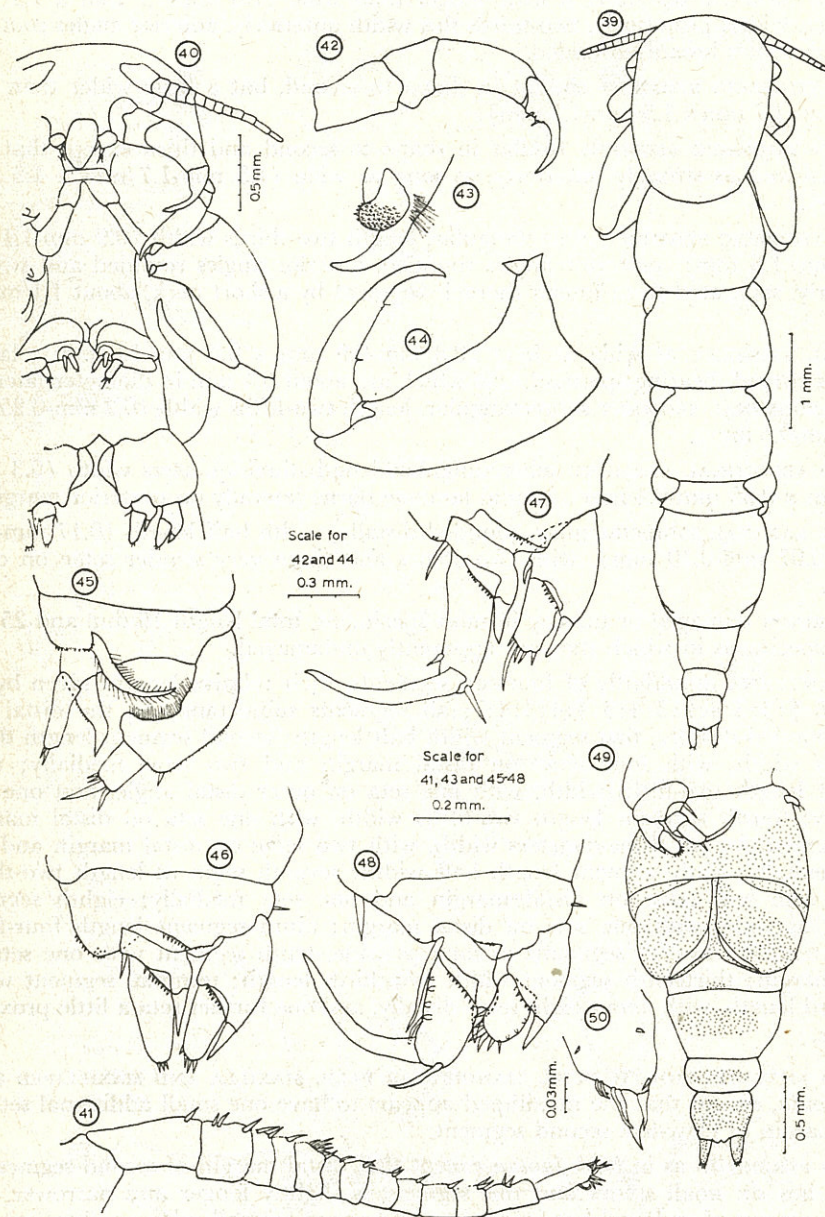
SECOND ANTENNA MOUTH TUBE, MANDIBULAR PALP, MAXILLA AND MAXILLIPED as in *N. l. lamna*, except that the maxilliped appears to have one small additional seta on inner margin of claw-like second segment.

SECOND PEREIOPOD as in *N. l. lamna* except that distal margin of second segment of exopod has six small spines and this segment is slightly longer and narrower, and second segment of endopod has four spines and one very small spine on distal margin.

THIRD PEREIOPOD similar to second except that the second endopod segment narrows slightly more distally, and the distal margin of the segment bears only two spines, the inner spines of the second pereopod being replaced by a group of very small spines.

FOURTH PEREIOPOD similar to second except that spines of endopod second segment are spaced slightly further apart.





*Nemesis lamna vermi* Scott, 1929 from *Cetorhinus maximus*. Male—fig. 39: dorsal view; fig. 40: anterior, ventral view; fig. 41: first antenna; fig. 42: second antenna; fig. 43: tip of maxilla; fig. 44: maxilliped; fig. 45: first pereopod; fig. 46: second pereopod; fig. 47: third pereopod; fig. 48: fourth pereopod; fig. 49: genital segment and abdomen, ventral view; fig. 50: tip of caudal lamina.

MALE (figs. 39-50).

Overall length 6.7 mm-7.2 mm.

CEPHALOTHORAX shaped as in female (1.5 mm-2.0 mm x 1.4 mm-1.45 mm).

SECOND THORACIC SEGMENT similar in shape to that of female but smaller (1.2 mm-1.4 mm x 1.25 mm-1.4 mm).

THIRD THORACIC SEGMENT similar in shape to first, except shorter, length four-fifths width (0.9 mm-1.0 mm x 1.2 mm-1.3 mm).

FOURTH THORACIC SEGMENT similar to third but anterior angles more broadly rounded (0.9 mm-1.0 mm x 1.2 mm-1.3 mm).

FIFTH THORACIC SEGMENT, length half width (0.45 mm-0.6 mm x 1.0 mm-1.1 mm), narrowing to two-thirds this width anteriorly.

GENITAL SEGMENT subovate, as long as wide (1.15 mm - 1.3 mm x 1.15 mm-1.2 mm).

FIRST ABDOMINAL SEGMENT subrectangular, length two-thirds width (0.4 mm-0.5 mm x 0.6 mm-0.8 mm), widest anteriorly, narrowing to two-thirds this width distally.

SECOND ABDOMINAL SEGMENT disc-shaped, lateral margins convex curves, length three-fifths width (0.2 mm-0.3 mm x 0.4 mm-0.45 mm).

THIRD ABDOMINAL SEGMENT subrectangular, lateral margins slightly distended, length three-quarters width (0.25 mm-0.35 mm x 0.3 mm-0.4 mm), caudal laminae borne laterally on distal margin.

CAUDAL LAMINAE as in female.

FIRST ANTENNA apparently of thirteen segments, their relative lengths represented by the ratio—16:6:3:3:4:2:4:4:3:4:4:6:8; first segment, width two-fifths length, with one seta near outer distal angle; second segment a little wider than long, with one seta on distal margin and two setae medially; third segment length half width, with one seta on distal margin and one seta medially; fourth segment length two-fifths width, with one seta medially; fifth segment length three-quarters width with one seta on distal margin and five setae on outer margin; sixth segment length half width, with one seta near distal margin; seventh segment, length two-thirds width, with two setae on distal margin; eighth segment, as long as wide, with two setae on distal margin; ninth segment length three-quarters width, with one seta near distal margin; tenth segment as long as wide, with one seta near distal margin; eleventh segment as long as wide, with two setae near distal margin; twelfth segment width half length, narrowing slightly medially, perhaps composed of two indistinctly separated segments, with two setae medially; terminal segment, width one-third length, with about seven setae distally, and a further seta just proximal to these.

SECOND ANTENNA, MOUTH TUBE, MANDIBULAR PALP, MAXILLA, MAXILLIPED AND FIRST PEREIOPOD all as in female.

SECOND PEREIOPOD as in female except as follows: first segment of exopod lacks spine on inner distal angle, second segment of exopod has only four spines on distal margin, and second segment of endopod has only three spines on distal margin.

THIRD PEREIOPOD as in male of *N. l. lamna* except as follows: first segment of exopod has a spine on inner margin, second segment of exopod has one long spine and four short spines on distal margin, spine on inner margin of first segment of endopod is more slender, and second segment of endopod lacks the group of small spines near middle of outer margin.

FOURTH PEREIOPOD as in male of *N. l. lamna* except that second segment of endopod has only one small seta on inner margin.



## DISCUSSION

The genus *Nemesis* presents some systematic problems since it is capable of considerable contraction (see plate A, page 28) so that relative lengths of segments cannot safely be used as a systematic character. However the females can be separated into two groups:

- (a) small specimens (ca 3 mm-5 mm) in which the fifth thoracic segment (fourth freely articulated segment) is significantly narrower (by 25%-50%) than the fourth thoracic segment, and the abdomen is three-segmented.  
 (b) relatively large specimens (ca 7 mm-12 mm)\* in which the fifth thoracic segment is not significantly narrower than the fourth, and the abdomen is two segmented.

*N. robusta*, discussed below, belongs to the first group. All the other specimens of *Nemesis* available to me belong to the second group.

There has been considerable discussion (Parker and Mathews, 1951, p. 571; Delamare Deboutteville and Nunes-Ruivo, 1953, p. 215) about whether this group should properly be divided into more than one species. In an effort to resolve this issue I have compared the widths of segments in figures of these animals by several authors, and in my material.

## NOTE:

1. In the following tables segment widths are expressed as segment width divided by cephalothorax width in order to allow easier comparison.
2. The host is given only where authors leave no doubt as to which species was host for their figured specimen.

TABLE 1  
Previous records (females)

Author	Year	Host	Seg. 2	Seg. 3	Seg. 4	Seg. 5	Gen. Seg.	Abd. 1	Total Length (mm)
1923	<i>Cetorhinus</i>	Fage <i>maximus</i>	1.13	1.16	1.23	1.07	0.53	0.21	10-12
Yamaguti	1939	"	1.18	1.16	1.16	0.96	0.56	0.27	7.2
Scott	1929	"	1.20	1.35	1.27	1.03	0.60	0.36	9.6
Wilson	1932	<i>Carcharodon</i> <i>carcharias</i>	1.28	1.35	1.32	1.20	0.46	0.23	10-12
Heller	1868	"haifische"	1.30	1.47	1.35	1.27	0.49	0.23	10-12
Heegaard	1962	"shark"	1.37	1.49	1.47	1.30	0.50	0.28	3.14
Brian	1944	<i>Lamna nasus</i>	1.41	1.41	1.47	1.39	0.53	0.27	8-10
Brian	1906	Either <i>Carcharodon</i> <i>carcharias</i> or <i>Isurus</i> <i>oxyrinchus</i>	1.49	1.59	1.56	1.45	0.45	0.32	9
Cressey	1967	<i>Isurus</i> <i>oxyrinchus</i> <i>Isurus</i> sp. <i>Carcharodon</i> <i>carcharias</i>	1.54	1.60	1.59	1.39	0.64	0.28	5.85-7.95

(seg. = thoracic segment; gen. seg. = genital segment; abd. 1 = anterior abdominal segment)

\* *N. lamna*, Heegaard, 1962, fig. 210 which, according to the scale given, is 3.14 mm in length, seems an exception to this size range but agrees with the other two criteria.

TABLE 2  
Present material (females)

Host	Area	Seg. 2	Seg. 3	Seg. 4	Seg. 5	Gen. Seg.	Abd. 1	Total Length (mm)
<i>Cetorhinus</i> <i>maximus</i>	Oaro	0.93	1.0	1.0	1.0	0.53	0.30	9.2
		1.0	1.06	1.14	1.0	0.57	0.30	8.4
		1.0	1.14	1.14	1.06	0.67	0.33	8.6
		1.06	1.06	1.06	1.06	0.53	0.30	9.0
		1.06	1.06	1.14	1.0	0.53	0.30	9.0
		1.06	1.14	1.20	1.0	0.53	0.30	8.4
		1.08	1.14	1.22	1.08	0.57	0.29	8.8
		1.14	1.14	1.06	1.06	0.60	0.27	9.1
		1.14	1.14	1.14	1.08	0.57	0.29	8.8
		1.18	1.18	1.18	1.10	0.62	0.34	9.3
<i>Carcharodon</i> <i>carcharias</i>	Kaikoura	1.16	1.25	1.28	1.37	0.56	0.29	10.1
		1.18	1.30	1.30	1.41	0.62	0.32	9.3
		1.23	1.30	1.30	1.41	0.59	0.29	9.8
		1.23	1.35	1.27	1.23	0.53	0.26	8.7
		1.27	1.35	1.30	1.35	0.60	0.30	9.5
<i>Isurus</i> <i>oxyrinchus</i>	Makara	1.28	1.39	1.30	1.05	0.50	0.22	8.9
		1.35	1.54	1.35	1.35	0.53	0.29	9.1
<i>Isurus</i> <i>oxyrinchus</i>	Mernoo Bank	1.49	1.56	1.49	1.49	0.50	0.25	9.1
		1.54	1.59	1.54	1.41	0.59	0.26	9.8
		1.54	1.64	1.64	1.28	0.57	0.29	8.2

These figures have not been treated statistically since samples from several host fishes would be required to make such analysis meaningful. However a general trend is clearly evident.

These figures suggest a strong host influence and their demonstration of continuous variation indicates that all these specimens can be identified as Risso's *Nemesis lamna*. This identification is further borne out by the similarity of appendages, variations in which, as recorded above and by previous authors, can reasonably be accepted as individual variation.

However, female specimens from *Cetorhinus maximus* can readily be distinguished from those recorded from other hosts, not only because they are narrower, but also by the shape of the first three free thoracic segments which are subcylindrical and narrowed anteriorly with shallow sinuses between them. In specimens from other hosts the third and fourth thoracic segments have their posterolateral angles swollen posteriorly and the sinuses are deeper. Further, the *Cetorhinus* females differ more in these characters from specimens from *Carcharodon* than from *Isurus*, although in ratios of width they are much closer to these specimens than those from *Isurus*.

The males from *Cetorhinus maximus* can similarly be separated from the males from other host species by their shallow intersegmental sinuses, and by the absence of the significant differences in width between the second and third thoracic segments and between the fourth and fifth thoracic segments which are found in specimens from other host species.

I consider that these differences are sufficient to retain Scott's name *vermi* as a subspecies of *N. lamna*.



Valle's *N. l. sinuata*, as recorded by Brian (1906, p. 72), has wider dimensions than all other recorded specimens of *N. lamna*; further information on it may show it to be a third subspecies.

On the available evidence it seems likely that specimens previously recorded as *Nemesis lamna* from *Cetorhinus maximus* are *N. l. vermi* and those from other species, *N. l. lamna*. However, in the absence of description or figures by many authors recording this species, no attempt has been made to separate the two subspecies in the following list of previous records.

NORTHEAST ATLANTIC—on *Cetorhinus maximus*: Firth of Clyde, Scotland (Scott, 1929, p. 98); Hebrides (Mathews and Parker, 1950, p. 571); Concarneau (Legendre, 1923, p. 278 and Fage, 1923, p. 280).

MEDITERRANEAN—no host specified: (Heller, 1868, p. 221).

on *Cetorhinus maximus*: Banyuls-sur-Mer (Delamare Deboutteville, 1948, p. 447); Narbonne (Delamare Deboutteville and Euzet, 1952, p. 217).

on *Isurus oxyrinchus*: (Richiardi, 1880, p. 150 *vide* Brian, 1906); Palavas (Delamare Deboutteville and Nunes-Ruivo, 1953, p. 213); Genova (Brian, 1898, p. 213); Genova (Brian, 1898, p. 213); Portoferraio (Brian 1906, p. 72); Adriatic (Valle, 1880, p. 66).

on *Carcharodon carcharias*: Porto ferraio (Brian, 1906, p. 72); Adriatic (Valle 1880, p. 66).

on *Lamna nasus*: Nice (Risso, 1826, p. 136; Roux, 1828, both *vide* Brian, 1906).

on *Alopias vulpinus*: Nice (Roux, 1828 *vide* Brian 1906); Genova (Brian, 1898, p. 213).

on *Odontaspis ferox*: Genova (Brian, 1898, p. 213).

on *Lichia amia*: (Richiardi, 1880, p. 150 *vide* Brian, 1906). *Note*: this fish is a teleost and this record must be considered doubtful in the absence of further confirmation.

NORTHWEST ATLANTIC—on *Carcharodon carcharias*: Marthas Vineyard, Mass. (Wilson, 1932, p. 461).

SOUTHWEST ATLANTIC—on *Lamna nasus*: Mar del Plata (Brian, 1944, p. 197).

NORTHEAST PACIFIC—on *L. nasus*: Coast of California (Wilson, 1932, p. 461).

on *Isurus oxyrinchus*: La Jolla, Calif. (Cressey, 1968, p. 11).

SOUTHEAST PACIFIC—on *Isurus oxyrinchus*: off Chile and Peru (Cressey, 1968, p. 11).

NORTHWEST PACIFIC—on *Carcharodon carcharias*: Simizu, Sizenoka Prefecture, Japan (Yamaguti, 1939, p. 455).

SOUTHWEST PACIFIC—on unnamed shark: Port Jackson, N.S.W., Australia (Heegaard, 1962, p. 184).

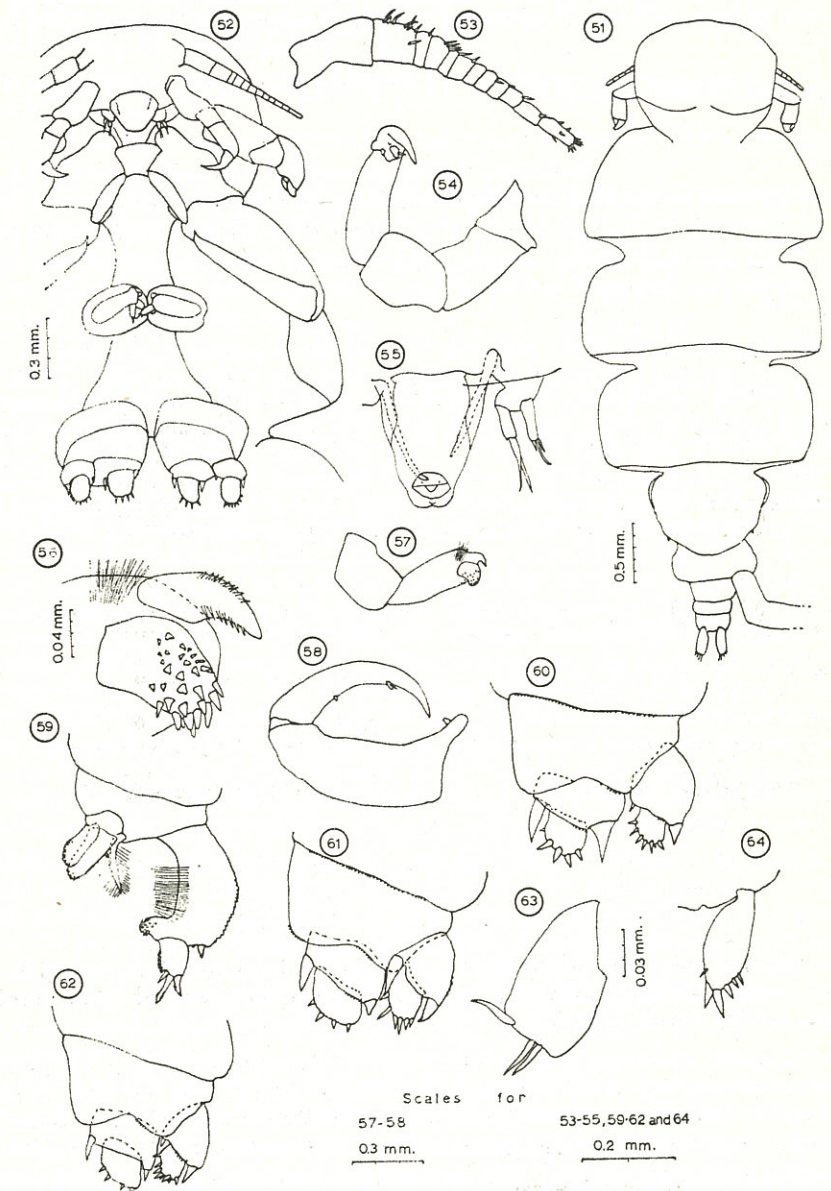
INDIAN OCEAN—on *Isurus* sp., *I. oxyrinchus* and *Carcharodon carcharias* (Cressey, 1967, p. 6).

### *Nemesis robusta* (van Beneden, 1851)

*Ergasilina robusta* van Beneden, 1851, p. 97, pl. 3, figs. 1-2; van Beneden, 1870, p. 15; Valle, 1880, p. 67.

*Pagodina robusta* van Beneden, 1853, p. 246; van Beneden, 1870, pp. 4-5.

*Nemesis robusta* (van Beneden), Heller, 1868, p. 221; Valle, 1884, p. 1; Brian, 1906, p. 74; Brian, 1924, p. 400; Leigh-Sharpe, 1936, p. 410; Delamare Deboutteville and Nunes-Ruivo, 1953, p. 211; Nunes-Ruivo, 1956.



*Nemesis robusta* (van Beneden), 1851) from *Alopias vulpinus*. Female—fig. 51: dorsal view; fig. 52: anterior, ventral view; fig. 53: first antenna; fig. 54: second antenna; fig. 55: mouth tube and mandibular palp; fig. 56: tip of maxilla; fig. 57: maxilla; fig. 58: maxilliped; fig. 59: first pereopod; fig. 60: second pereopod; fig. 61: third pereopod; fig. 62: fourth pereopod; fig. 63: fifth pereopod; fig. 64: caudal lamina.



*N. pallida* Wilson, 1932, p. 464, pl. 33, figs. b-p; Wilson, 1935, p. 340; Bere, 1936, p. 604; Wilson, 1937, p. 29; Pearse, 1947, p. 9; Barnard, 1948, p. 250; Causey, 1953, p. 14.

*N. aggregatus* Cressey, 1967, p. 6.

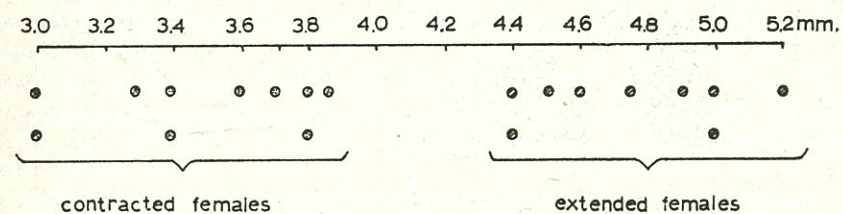
#### MATERIAL

On *Alopias vulpinus*: 21 females and 5 males probably from Cooks Strait or near this area, collected by J. A. F. Garrick, 11 March 1960 (Dominion Museum Collection).

#### DESCRIPTION

##### FEMALE (figs. 51-64).

Overall length 3.0-5.2 mm, composed of two types of individual, contracted forms (3.0 mm-3.9 mm) in which the second, third and fourth thoracic segments overlap each other slightly (see Plate A figs 1-2) and extended forms (4.3 mm-5.2 mm) in which the second, third and fourth thoracic segments are not overlapped to any extent and may be separated by a short neck (see Plate A figs. 3-5). Of 19 individuals, 10 were contracted, the other nine extended, see Graph 1 below.



Graph 1

CEPHALOTHORAX subovate, width four-fifths length (1.3 mm-1.45 mm x 1.1 mm-1.2 mm), separated from the second thoracic segment in extended specimens by a short neck (ca 0.2 mm x 0.7 mm).

SECOND THORACIC SEGMENT, length half width (0.75 mm-1.05 mm x 1.6 mm-1.85 mm), anterior angled broadly rounded, posterior angles less broadly rounded, segment widest posteriorly, narrowing by almost one-third anteriorly, separated from third thoracic segment in extended specimens by a short neck (ca 0.07 mm x 1.2 mm).

THIRD THORACIC SEGMENT subrectangular, length two-fifths width (0.7 mm-0.9 mm x 1.6 mm-1.9 mm), angles rounded, narrowing very slightly anteriorly, separated from fourth thoracic segment in extended specimens by a short neck (ca 0.06 mm x 1.0 mm).

FOURTH THORACIC SEGMENT subrectangular, length half width (0.65 mm-0.8 mm x 1.4 mm-1.7 mm), angles rounded, anterior angles slightly more broadly rounded than posterior.

FIFTH THORACIC SEGMENT, length three-quarters width (0.45 mm-0.75 mm x 0.75 mm-0.9 mm), anterior margins sublinear, lateral and posterior margins united in a somewhat irregular entire curve.

GENITAL SEGMENT, length half width (0.3 mm-0.35 mm x 0.6 mm-0.7 mm), lateral margins rounded.

FIRST ABDOMINAL SEGMENT subrectangular, length one-third width (0.07 mm-0.13 mm x 0.33 mm-0.40 mm), narrowing slightly posteriorly.

SECOND ABDOMINAL SEGMENT disc-shaped, length one-third width (0.06 mm-0.12 mm x 0.29 mm-0.32 mm).

THIRD ABDOMINAL SEGMENT subrectangular, length two-thirds width (0.18 mm-0.21 mm x 0.27 mm-0.35 mm), posterior angles slightly rounded, the caudal laminae borne laterally on posterior margin.

CAUDAL LAMINAE subovate, width one-third length (0.20 mm-0.25 mm x 0.07 mm-0.10 mm), with six spines on distal margin, the innermost and the two outermost being very small.

EGG STRINGS missing or damaged in all specimens so that total length could not be reliably measured.

FIRST ANTENNA apparently of twelve segments, their proportionate lengths being given by the following ratio—16:8:2:4:2:4:2:3:3:2:5:7; all segments subrectangular, distal segment rounded distally; first segment length twice width; second segment as long as wide, with two setae on distal margin and six setae on outer margin; third segment length half width, with one seta on distal margin; fourth segment length two-thirds width, with four setae on or near outer distal angle; fifth segment, length two-fifths width, with one seta on outer distal angle; sixth segment, length three-quarters width, with one seta on outer distal angle; seventh segment, length half width; eighth segment length two-thirds width, with one seta near outer distal angle; ninth segment length three-quarters width, with one seta on outer distal angle; tenth segment as long as wide, with one seta on outer distal angle; eleventh segment width two-thirds length, with one seta on outer distal angle; twelfth segment width two-fifths length, with about eight setae distally and four setae placed more proximally.

SECOND ANTENNA of four segments, first and third segments subequal in length, second and terminal segments two-thirds this length; first segment subrectangular, width half length; second segment subrectangular, width two-thirds length with a few to 39 very small spines on inner distal area; third segment subrectangular, width one-third length with two to 21 very small spines in rows and patches; terminal segment, basal width one-third length, narrowing rapidly from the base to terminate in a sharp point distally, sharply curved into a claw, with three small spines near the base, one on a raised boss.

MOUTH TUBE 0.3 mm in length, basal width two-thirds length, narrowing gradually to two-fifths this width distally, distal margin irregularly rounded.

MANDIBULAR PALP biramous, rami placed on a subrectangular base; outer ramus subrectangular, width one-third length, with one long and two short setae distally; inner ramus subrectangular, width two-fifths length, with two long setae distally.

MAXILLA of two segments, segments subequal in length, first segment subrectangular, width half length; second segment width one-third length, rounded distally, with two processes distally, each one-quarter length of segment, outer process width three-quarters length, rounded distally, distal half covered in stout spines, inner process width two-fifths length, narrowing distally, with rows of small sharp spines on inner and outer margins, segment also bears a tuft of long cilia just proximal to the bases



of these processes, and a group of small spines on outer margin near base of outer process.

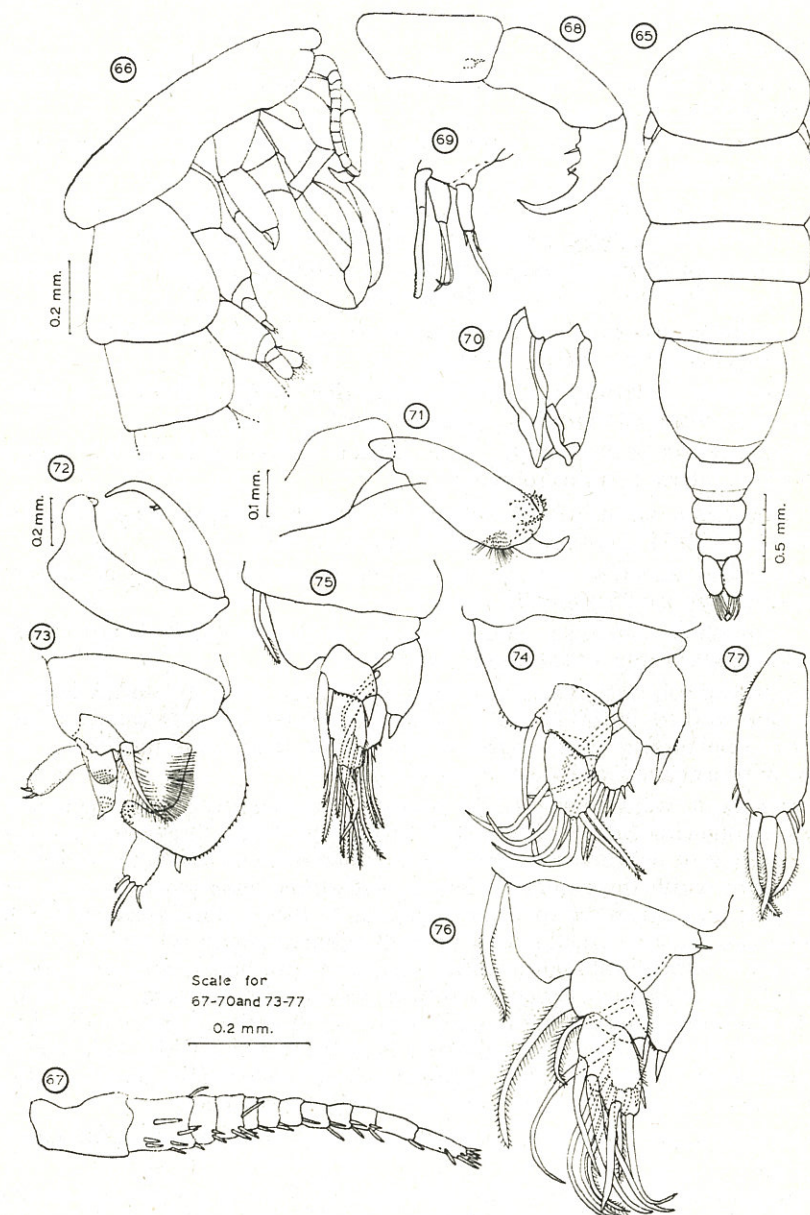
**MAXILLIPED** subchelate, of two segments; first segment basal width half length, narrowing to half this width distally, with a blunt spine or process on inner margin near base; second segment basal width one-quarter length, narrowing gradually to a sharp point distally, segment a smooth curve, with two small spines on inner margin, the first one-quarter distance from base, the second three-fifths distance from base, the more distal spine with a small hair arising at its midpoint.

**FIRST PEREIOPOD** biramous, the basipod of two subrectangular segments, the second narrower and shorter than the first; exopod of two segments, first segment width half length, a little narrower at the base, inner distal angle expanded to increase width by one half, expansion rounded and covered in short stout spines, distal half of outer margin covered in very short spines, one spine and one very short spine on distal margin beside outer distal angle, inner margin covered in very long cilia; second segment one-third length of first, width three-quarters length, distal angles rounded, inner margin with about seven very small spines, distal margin with three long spines; basal segment of endopod two-thirds length of second segment of exopod, length two-thirds width, with a long plumose seta at outer proximal angle, and with two large processes on distal margin, each twice length of segment, the innermost, width two-fifths length, has very short spines on the rounded distal and inner distal region of margin, the outer process, which may be second segment of endopod, is rounded distally, basal width half length, slightly narrower distally, with a small spine on outer margin one-third distance from base, and a group of very short spines on and near distal margin.

**SECOND PEREIOPOD** biramous, each ramus of two segments; basipod of two subrectangular segments, the second shorter and narrower than the first, larger than those of the first pereio pod; first segment of exopod as long as wide, inner margin two-sevenths length of curved outer margin, with a large spine on outer distal angle, a spine on inner distal angle, and a row of very short spines on distal margin near outer distal angle; second segment two-fifths length of first, as long as wide, rounded distally, with six to eight spines on distal margin, one of which may be significantly smaller than the rest, most spines about half length of segment; endopod subequal in length to exopod, first segment subrectangular, length half width, with very large spines on outer and inner distal angles, and a row of very small spines on distal margin near outer distal angle; second segment two-thirds length of first, as long as wide, rounded distally, with five or six spines on distal margin, one of which may be significantly smaller than the rest.

**THIRD PEREIOPOD** biramous, each ramus of two segments, the basipod and segments similar in shape and size to those of second pereio pod, the first segment of exopod with a large spine on outer and inner distal angles, and a row of small spines on distal half of outer margin, distal margin of exopod second segment with six or seven spines, of which none to three may be significantly smaller than the rest, first segment of endopod with a large spine on inner distal angle and a slightly shorter spine on outer distal angle, second endopod segment with four spines on distal margin of which one may be significantly shorter than the rest.

**FOURTH PEREIOPOD** similar in form to second, but a little smaller; endopod first segment armed as in second pereio pod, second segment with six to eight small spines on distal margin; first endopod segment armed as in second pereio pod except that spines on distal angles are a little smaller, second endopod segment with three to six spines on distal margin.



*Nemesis robusta* (van Beneden, 1851) from *Alopias vulpinus*. Male—fig. 65: dorsal view; fig. 66: anterior, lateral view; fig. 67: first antenna; fig. 68: second antenna; fig. 69: mandible and mandibular palp; fig. 70: mouth tube; fig. 71: maxilla; fig. 72: maxilliped; fig. 73: first pereio pod; fig. 74: second pereio pod; fig. 75: third pereio pod; fig. 76: fourth pereio pod; fig. 77: caudal lamina.



FIFTH PEREIOPOD of one segment, small, subrectangular, width two-thirds length, with three setae on distal margin.

MALE (figs. 65-77).

Overall length 3.3 mm-3.7 mm, with no evidence in this sample of the contractile powers possessed by the female.

CEPHALOTHORAX as in female, width three-quarters length (1.25 mm-1.32 mm x 1.00 mm-1.04 mm).

SECOND THORACIC SEGMENT length three-fifths width (0.61 mm-0.66 mm x 1.07 mm-1.18 mm), narrowing slightly posteriorly and anteriorly, lateral margins rounded.

THIRD THORACIC SEGMENT similar in shape to second but smaller, length two-fifths width (0.41 mm-0.47 mm x 1.06 mm-1.08 mm).

FOURTH THORACIC SEGMENT similar in shape to third, length two-fifths width (0.39 mm-0.47 mm x 0.94 mm-1.0 mm).

GENITAL SEGMENT subovate, anterior and posterior margins sublinear, a little wider than long (0.76 mm-0.80 mm x 0.81 mm-0.91 mm).

FIRST ABDOMINAL SEGMENT, length three-quarters width (0.27 mm-0.34 mm x 0.43 mm-0.45 mm), lateral margins rounded.

SECOND ABDOMINAL SEGMENT subrectangular, angles rounded, length one-third to two-thirds width (0.11 mm-0.24 mm x 0.31 mm-0.33 mm).

THIRD ABDOMINAL SEGMENT subrectangular, angles rounded, length two-fifths width (0.10 mm-0.12 mm x 0.26 mm-0.27 mm).

FOURTH ABDOMINAL SEGMENT subrectangular, angles rounded, length three-fifths width (0.14 mm-0.17 mm x 0.24 mm-0.26 mm).

CAUDAL LAMINAE subovate, anterior margin sublinear, width two-fifths length (0.25 mm-0.28 mm x 0.10 mm-0.11 mm), with three long plumose setae on posterior margin, two smaller setae just medial to these, three small setae just lateral to these, and a row of short cilia near base of outer margin.

FIRST ANTENNA of twelve segments, the proportionate lengths of these segments being given by the following ratio—14:9:4:4:2:3:3:4:4:4:6:8; all segments subrectangular, distal margin of terminal segment rounded; first segment width two-thirds length; second segment width three-quarters length, with three setae placed widely apart on distal margin, and a further six setae proximal to these; third segment length half width, with two setae on distal margin; fourth segment length two-thirds width, with four setae on or near distal margin; fifth segment length half width, with one seta on distal margin; sixth segment length two-thirds width, with one seta on distal margin; seventh to tenth segments as long as wide, the seventh with one seta on distal margin, the others with two setae on distal margin; eleventh segment width half length, with one seta on distal margin; twelfth segment width two-sevenths length, with seven setae on or near distal margin, and one seta proximal to these.

SECOND ANTENNA, MOUTH TUBE, MANDIBULAR PALP, MAXILLA AND MAXILLIPED as in female.

FIRST PEREIOPOD as in female except that second segment of exopod has small spines on outer margin instead of inner, and first segment of endopod bears three processes, all rounded distally, two of which are twice length of first segment, the other two-thirds their length, all have groups of small spines on and near their distal margins, and in addition the two longer processes have one and two larger spines respectively; the larger process with two spines is a little wider distally than the process with one spine and probably represents the second segment of the endopod.

TABLE 3  
Previous records (females)

Species	Author	Year	Host (if only one specified)	Seg. 2 (width divided by)	Seg. 3	Seg. 4	Seg. 5	Gen. Seg. 5	Gen. Seg. 5	Gen. Seg. 5	Total Length (mm)
<i>N. atlantica</i>	Wilson	1922	<i>Scoliodon tetraneuriae</i>	1.22	1.33	1.22	0.77	0.68	0.33	0.33	5
<i>N. macrocephalus</i>	Shiino	1957	<i>Carcharinus melanopterus</i>	1.28	1.22	0.97	0.71	0.39	0.29	0.29	3.14
<i>N. pilosus</i>	Pearse	1951	<i>Carcharias littoralis</i>	1.47	1.47	1.14	0.80	0.50	0.31	0.31	3.0
<i>N. versicolor</i>	Wilson	1913	<i>Sphyrna zygaena</i>	1.54	1.49	1.33	0.72	0.53	0.30	0.30	3.1
<i>N. pallida</i>	Wilson	1932	Several species (type from <i>Vulpecula marina</i> )	1.49	1.52	1.33	0.95	0.65	0.30	0.30	4.5-5
<i>N. pallida</i> Wilson	Barnard	1955	<i>Alopias</i> sp.	1.56	1.61	1.33	0.94	0.62	0.44	0.44	4.5
<i>N. aggregatus</i>	Cressey	1967	<i>Alopias vulpinus</i>	1.56	1.65	1.63	0.85	0.67	0.33	0.33	4.5
<i>N. robusta</i> (van Beneden)	Delamare Deboutteville and Nunes-Ruivo	1953	<i>Carcharias glaucus</i>	1.59	1.64	1.56	0.72	0.54	0.28	0.28	3.8
<i>N. tiburo</i>	Pearse	1952	<i>Sphyrna tiburo</i>	1.79	7.19	1.56	0.79	0.61	0.31	0.31	2.7
<i>N. robusta</i> (van Beneden)	Brian	1906	—	2.17	2.17	1.96	1.28	1.0	0.55	0.55	5



SECOND PEREIOPOD biramous, each ramus of two segments; basipod two segmented, second segment narrower and shorter than first; first segment of exopod width three-quarters length, inner margin one-third length of outer, outer margin curved, with a long plumose seta on inner distal angle, a well developed spine on outer distal angle, and a row of very short spines just proximal to the outer distal angle; second segment subovate, proximal margin sublinear, width three-quarters length, with four long setae on inner part of distal margin and four spines on outer part of distal margin; endopod a little shorter than exopod, first segment length four-fifths width, sub-rectangular, outer margin curved, with a well developed spine on outer distal angle, a long seta on inner distal angle, and a row of short spines along distal margin; second segment half as long again as first, width two-thirds length, distal margin rounded, with six long setae on distal margin.

THIRD PEREIOPOD similar to second except as follows: rami are a little shorter, first segment of basipod bears a plumose seta on inner distal angle, distal margin of second segment of exopod bears five setae and three spines and distal margin of second segment of endopod bears five normal setae and one very stout seta.

FOURTH PEREIOPOD very similar to third except as follows: rami are a little larger, endopod has rows of cilia along outer margins of both segments, and lacks the row of spines along the distal margin of the first segment, and distal margin of second endopod segment has only five setae which are all normal.

#### DISCUSSION

These specimens are members of the first broad group defined in the discussion of females of *Nemesis lamna*, i.e. small specimens (3.0 mm-5.0 mm) with a three-segmented abdomen and the fifth thoracic segment significantly smaller (25%-50%) than the fourth.

A number of described species come within this group.

In an attempt to separate these species I used the method described above to produce a ratio of widths, the cephalothorax being counted as 1, and the measurements placed in order of increasing relative width (see tables 3 and 4).

TABLE 4  
Present material (females)

Host	Area	Seg. 2	Seg. 3	Seg. 4	Seg. 5	Gen. Seg.	Abd. 1	Total Length (mm)
<i>Alopias vulpinus</i>	Probably	1.39	1.35	1.22	0.74	0.55	0.31	3.0
	Cooks	1.47	1.56	1.39	0.69	0.54	0.29	4.6
	Strait	1.52	1.56	1.47	0.65	0.61	0.31	5.0
		1.54	1.59	1.37	0.71	0.58	0.27	3.6
		1.56	1.56	1.35	0.78	0.54	0.35	3.8
		1.56	1.61	1.39	0.69	0.59	0.31	3.85
		1.59	1.45	1.27	0.72	0.57	—	3.0
		1.64	1.69	1.54	0.72	0.59	0.30	5.0
		1.64	1.69	1.54	0.72	0.64	0.32	4.9
		1.64	1.69	1.54	0.86	0.59	0.33	4.3

The following characters distinguish the described females in this group of the genus *Nemesis*:

*N. atlantica* Wilson (1922, p. 60) has a comparatively broader cephalothorax than other described species and is also unique in having notches on the lateral margins of its second thoracic segment.

*N. macrocephalus* Shiino (1957, p. 392) and *N. pilosus* Pearse (1951, p. 362) are similar in having their fourth thoracic segment subequal in width to the cephalothorax (in other species, with the exception of *N. atlantica*, this segment is 33%, or more, wider than the cephalothorax) and also in having the spines on the second segment of the exopod of the second pereopod subequal in length to this segment, in contrast to the much smaller spines described for other species. I am unable to separate these two species on the basis of descriptions in the literature.

*N. versicolor* Wilson (1913, p. 236) is unique in possessing a knob of each lateral margin of the cephalothorax.

*N. pallida* Wilson (1932, p. 464) and *N. robusta* (van Beneden) as described by Delamare Deboutteville and Nunes-Ruivo (1953, p. 211) differ mainly in the comparative width of their fifth thoracic segments. Considering the range of variation of this segment in the present material this character does not seem sufficient to regard these as separate species.

Cressey (1967, p. 6) described *N. aggregatus* which he separated from most other species on the basis of 10-12 small spines on the second segment of the second antenna, stating that these other species had 25-40 even smaller spines, and from *N. tiburo* and *N. versicolor* since in his species the row of very small spines, on the third segment of the second antenna of these species, was missing. In my material the second segment of this appendage has from a few to 39 very small spines, which vary considerably in size, although none are as large as those shown in his figure (p. 7, fig. 9). Also in my specimens the spination of the third segment varies from two to 21 very small spines, some of which may be arranged in one or two longitudinal rows. Under these circumstances the use of the spination of the second antenna as the sole criteria of taximonic distinctness must be considered doubtful until it has been investigated in further collection.

*N. robusta* (van Beneden) as described by Brian (1906, p. 72) is quite distinct from any described species of *Nemesis* in the narrowness of its cephalothorax which is about half the width of the second thoracic segment, while in other species it is two-thirds the width of this segment or wider. However, it seems likely, considering the usual accuracy of Brian's identifications and that similar specimens have not been recorded since, that the specimen figured was simply an aberrant individual.

*N. tiburo* Pearse (1952, p. 217) is described from a single, small (2.7 mm total length) specimen, without egg strings. It could easily be a juvenile form of one of the above species.

The present material clearly belongs to *N. robusta* as described by Wilson (1932) and Delamare Deboutteville and Nunes-Ruivo (1953).

Unfortunately van Beneden's original description and figures appear to refer to the male, and his figures (1851, pl. 3, figs. 1-2) show his specimen only in side view. However his specimens seem to correspond quite closely with the males in the present collection.

Previous records which appear to be of this species include:

NORTHEAST ATLANTIC—on *Prionace glauca*, *Mustelus mustelus*, *Dasyatis pastinaca*: Belgium (van Beneden, 1851, p. 97, 1870, pp. 4, 5 and 15).

on *Alopias vulpinus*: Brighton, England (Leigh-Sharpe, 1936, p. 410).

on *Sphyrna* sp.: Mauritania (Brian, 1924, p. 400).

on *Cetorhinus maximus*:\* Ayrshire, England (Jenkins, 1936, p. 316).

\* Jenkins' record is the only one from this host fish and unless confirmed by later collections it must be regarded as doubtful. *Nemesis lamna* is a common parasite on this species of shark.



SOUTHEAST ATLANTIC—on *Sphyrna zygaena* and *Mustelus* sp.: Angola (Nunes-Ruivo, 1956\*).

on *Alopias vulpinus*: Table Bay, South Africa (Barnard, 1948, p. 250).

MEDITERRANEAN—on *Prionace glauca*: Sète (Delamare Deboutteville and Nunes-Ruivo, 1953, p. 211).

on *Mustelus mustelus*, *Dasyatis aspersa*, *Raja oxyrincha*, and *R. macrorhynchus*:

Adriatic (Valle, 1880, p. 67).

on *Hexanchus griseus*: Adriatic (Valle, 1884, p. 1).

NORTHWEST ATLANTIC—on *Alopias vulpinus*, *Carcharhinus milberti*, *C. obscurus*, *Carcharodon carcharias*, *Odontaspis taurus*, *Galeocerdo cuvieri*: Marthas Vineyard, Mass. (Wilson, 1932, p. 464).

on *Carcharhinus limbatus*: Beaufort, Carolina (Pearse, 1947, p. 9).

on *C. obscurus*, *Rizoprionodon terraenovae*, *Sphyrna* sp., *S. tiburo*, smooth-toothed shark (*Aprionodon isodon* (?)), spot tipped ground shark: Lemon Bay, Florida (Bere, 1936, p. 604).

on *C. limbatus*: Port Aransas, Texas (Causey, 1953, p. 14).

on *Negaprion brevirostris*: Dry Tortugas (Wilson, 1935, p. 340).

So far as I am aware, this is the first record of this species outside the Atlantic and Mediterranean.

#### CONGERICOLA van Beneden, 1854

*Cycnus* Milne-Edwards (1840, p. 495)—preoccupied.

#### *Congericola pallidus* van Beneden, 1854

*Congericola pallida* van Beneden, 1854, p. 583. Norman and Scott, 1906 (*non vide*); Scott and Scott, 1913, p. 124; Brian, 1924, p. 400; Scott, 1929, p. 100; Delamare Deboutteville and Nunes-Ruivo, 1958, p. 226; Willey, 1958, p. 370.

*Cycnus pallidus* (van Beneden), Richiardi, 1880, p. 150; Valle, 1884, p. 2; Scott, 1900, p. 160; Scott, 1901, p. 127; Brian, 1906, p. 76.

Yamaguti (1963, p. 159) has pointed out that *Congericola* is masculine.

#### MATERIAL

On *Conger vereauxi*: five females taken at Moa Point, Wellington, collected by the author, 10 December 1964; two females presumably from the Wellington area, collected by H. Manter in 1951.

#### DESCRIPTION

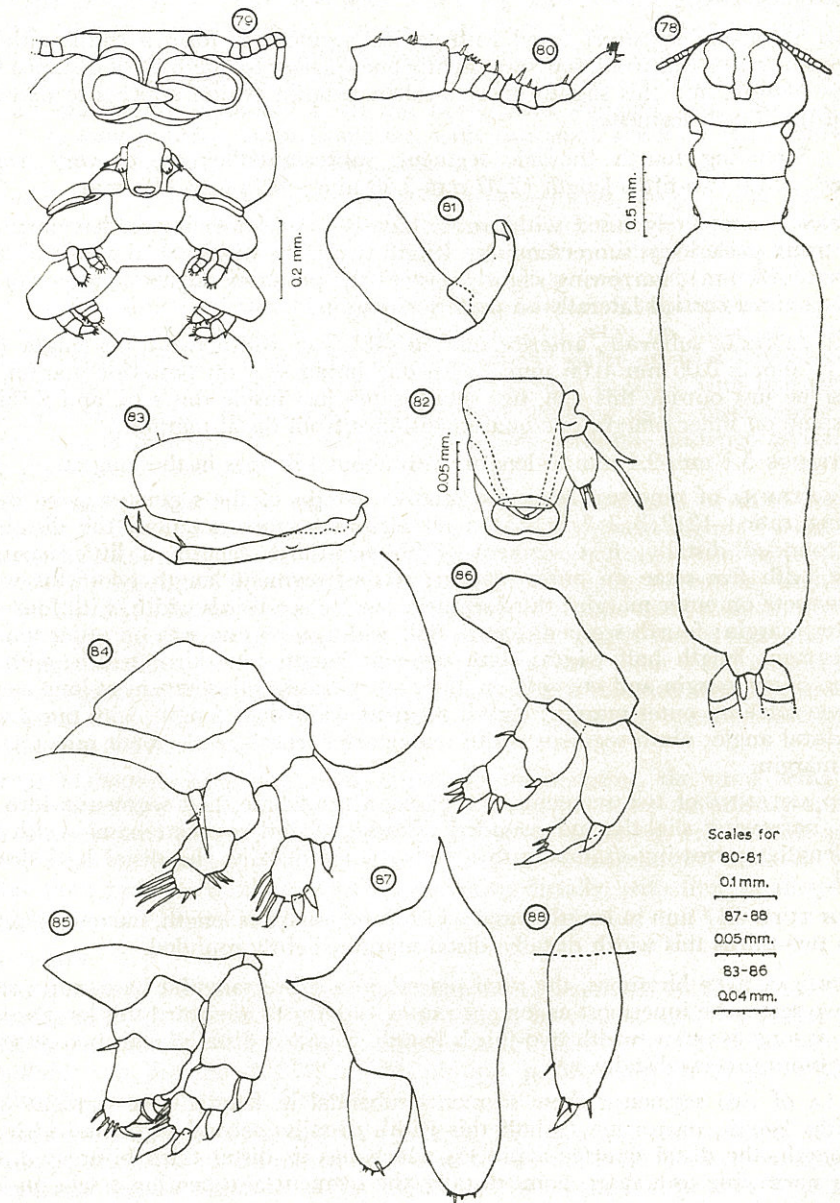
FEMALE (figs. 78-88).

Overall length 3.62 mm-4.02 mm.

CEPHALOTHORAX subovate, length three-quarters width (0.54 mm-0.62 mm x 0.78 mm-0.83 mm), the antennae borne laterally on a short anterior extension, one-third carapace width, the anterior margin of which is sublinear; anterior half of carapace with two irregularly subovate markings lying either side of the mid line, and joined posteriorly by a groove in the form of three sides of a rectangle, directed posteriorly.

SECOND THORACIC SEGMENT, length half width (0.27 mm-0.36 mm x 0.57 mm-0.63 mm) narrowing slightly anteriorly and posteriorly, lateral margins curved.

\* From a translation, original page numbers not retained.



*Congericola pallidus* van Beneden, 1854. Female—fig. 78: dorsal view; fig. 79: anterior, ventral view; fig. 80: first antenna; fig. 81: second antenna; fig. 82: mouth tube and mandibular palp; fig. 83: maxilla; fig. 84: first pereopod; fig. 85: second pereopod; fig. 86: third pereopod; fig. 87: fourth pereopod; fig. 88: caudal lamina.



THIRD THORACIC SEGMENT similar in shape and size to second (0.25 mm-0.38 mm x 0.57 mm-0.64 mm).

FOURTH THORACIC SEGMENT fused with genital segment to form a trunk, although in some specimens this trunk narrows slightly one-quarter to one-fifth of distance from anterior margin, and this slightly more swollen anterior region appears to mark the limit of the fourth segment.

TRUNK including fourth thoracic segment, subrectangular, angles very broadly rounded, width two-fifths length (2.07 mm-2.58 mm x 0.95 mm-1.05 mm).

ABDOMEN incompletely fused with trunk, but distinguishable by sudden narrowing of the trunk posteriorly, subrectangular, length two-fifths width (0.16 mm-0.19 mm x 0.23 mm-0.48 mm), narrowing slightly posteriorly, posterior angles slightly rounded, caudal laminae carried laterally on posterior margin.

CAUDAL LAMINAE subovate, anterior margin sublinear, width two-fifths length (0.14 mm-0.17 mm x 0.05 mm-0.06 mm), with one broad seta on posterior margin, one small spine just outside this seta, two small spines just inside this seta, and a further small spine on inner margin one-quarter distance from distal margin.

EGG STRINGS 5.1 mm-9.4 mm in length, with about 130 eggs in the longest.

FIRST ANTENNA of nine segments, the relative lengths of the segments given by the following ratio—12:2:3:2:2:2:2:5:8; all segments subrectangular, the distal segment rounded distally; first segment width two-thirds length, a little narrowed distally, with five setae on outer margin; second segment length two-fifths width, with one seta on outer margin; third segment length two-thirds width, with four setae on outer margin; fourth segment length half width, with one seta on outer margin; fifth segment length half width; sixth segment length two-thirds width, with two setae on outer margin and one seta on inner margin; seventh segment as long as wide with two setae on outer margin; eighth segment width half length, with one seta on outer distal angle; ninth segment width one-quarter length, with about nine setae on distal margin.

SECOND ANTENNA of two segments, placed on a stout base, first segment width half length, narrowing slightly and rounded distally; second segment basal width one-third length, narrowing gradually to a sharp point distally, the distal half strongly curved.

MOUTH TUBE 0.17 mm in length, basal width three-quarters length, narrowing gradually to two-thirds this width distally, distal margin slightly rounded.

MANDIBULAR PALP biramous, the rami placed on a subrectangular base, outer ramus with two setae, the innermost as long as ramus, outermost one-third this length; inner ramus as long as outer, width two-thirds length, rounded distally, with two setae and a short blunt process distally.

MAXILLA of two segments, these segments subequal in length, first segment width two-fifths length, narrowing to half this width distally; second segment width one-fifth length, the distal quarter a process which has its distal third bifurcated, each branch narrowing to a sharp point distally, the segment also bearing a seta on inner margin near base of process.

FIRST PEREIOPOD biramous, exopod of two segments, endopod of three segments, rami subequal in length, basipod of two segments, the basal segment expanded and broadly rounded laterally, the second segment narrower and shorter, with a large seta on distal margin, near inner margin of endopod; first segment of exopod subrectangular, outer margin slightly curved, width two-thirds length, with a flattened seta on outer

distal angle; second exopod segment four-fifths length of first, subovate, width two-thirds length, with three flattened setae and three normal setae on distal region; first endopod segment subrectangular, outer margin curved, as wide as long, with a small seta near inner distal angle; second segment similar in shape but a little smaller, with one seta on inner distal angle and three setae near outer distal angle, this segment indistinctly separated from the next; third segment two-thirds length of second, as long as wide, subsemicircular, with two small setae on outer distal area and four normal setae on inner distal area.

SECOND PEREIOPOD biramous, each ramus of three segments, basipod as in first pereopod; first exopod segment width two-thirds length, outer margin slightly curved, with a flattened seta on outer distal angle, and a small seta on inner distal angle; second segment subrectangular, half length of first, as wide as long, with a flattened seta on outer distal angle; third segment almost as long as second, subsemicircular, as wide as long, with two flattened setae and three normal setae on distal margin; first endopod segment length four-fifths width, inner and outer margins slightly curved; second segment subrectangular, as long as first, as long as wide, with one seta near inner proximal angle, and two curved flattened setae on outer distal angle; third segment two-fifths length of second, subsemicircular, with one flattened seta and five small normal setae on distal region.

THIRD PEREIOPOD biramous, exopod of two segments, endopod of three segments, basipod as in first and second pereopods; first exopod segment slightly curved, width half length, distal margin rounded, with a flattened seta on outer distal region; second segment half length of first, basal width two-thirds length, narrowing slightly and rounded distally, a flattened seta on outer distal region, three small setae on remainder of distal region; first endopod segment subrectangular, a little longer than wide, outer distal angle swollen and rounded with setae on inner and outer distal angles; second endopod segment a little wider than long, outer margin rounded with two setae near outer distal angle; third segment two-thirds length of second, rounded distally, with four setae on distal margin.

FOURTH PEREIOPOD biramous, each ramus of one segment, the rami being broad flattened lamellae, basipod subrectangular, as long as wide, indistinctly separated from the exopod; exopod three-quarters length of basipod, width three-quarters length, rounded distally, with five small spines on distal margin; endopod a little shorter than exopod, width half length, rounded distally, with four small spines on distal region.

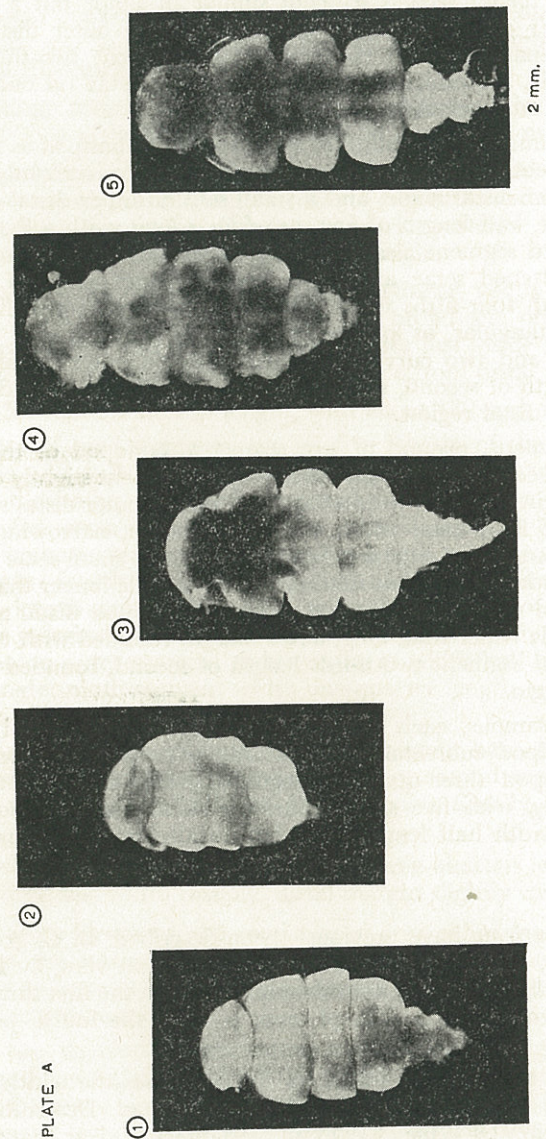
#### DISCUSSION

Two species of *Congericola* have previously been described. In *C. gracilis* (Milne-Edwards, 1840, p. 496, pl. 41, fig. 1), as shown in ventral view by Heller (1868, pl. 22, fig 6a), the fourth pereopods are subequal in size to the first three, whereas in *C. pallidus* van Beneden (1854, p. 583, pl. opp. p. 589) the fourth pereopods are significantly larger than the first three.

Wilson in his key to these species (1922, p. 58) also uses the width of the freely articulated segments as compared to the width of the head. Descriptions by other authors, and the discussion by Willey (1958, p. 370) make it clear that these animals have considerable contractile powers, hence body proportions are not useful in their taxonomy.

Apart from the original drawings by van Beneden, which are not particularly detailed, no full description of *C. pallidus* has ever been given. However, the present specimens are, in my opinion, sufficiently close to van Beneden's description and figures to allow them to be ascribed to his species.





*Nemesia robusta* (van Beneden) female. 1-2 contracted females; 3-5 extended females.

This is the first record of this species in the Pacific and only the second outside the Northeast Atlantic, Mediterranean area.

Previous records include:

NORTHEAST ATLANTIC—on *Conger vulgaris*: Irish Sea and Llanddwyn Is., Caernarvon Bay (Scott, 1929, p. 100); Lancashire Coast (Scott and Scott, 1913, p. 124); Bay of Nigg (Scott, 1901, p. 127); Firth of Clyde (Scott, 1900, p. 160); Aberdeen (Scott and Scott, 1913, p. 124); Belgium (van Beneden, 1854, p. 583).  
on *Conger conger*: Mauritania (Brian, 1924, p. 400).

MEDITERRANEAN—on *Conger vulgaris*: (Richiardi, 1880, p. 150); Banyuls-sur-Mer (Delamare Deboutteville and Nunes-Ruivo, 1958, p. 226); Liguria (Brian, 1906, p. 76); Adriatic (Valle, 1884, p. 2).

NORTHWEST ATLANTIC—on *Conger vulgaris*: Woods Hole, Mass. (Willey, 1958, p. 370).

The occurrence of this species in New Zealand waters suggests that its distribution must be much more widespread than the above list would indicate.

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A NEW SPECIES OF *PAEONODES* (THERODAMASIDAE, CYCLOPOIDA, COPEPODA) PARASITIC ON NEW ZEALAND FRESHWATER FISH, WITH A RE-EXAMINATION OF *PAEONODES EXIGUUS* WILSON

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ABSTRACT

A new species of copepod is described from brown trout (*Salmo trutta*) and reported from salmon (*Oncorhynchus tshawytscha*) in New Zealand freshwater; from information gained from an examination of the type of *Paeonodes exiguus* the new species is placed in this genus, and the genus transferred to the family Therodamasidae. Since most, if not all, New Zealand salmonids were introduced as fertilized ova, the new parasite may later be found on endemic fish species.

Family THERODOMASIDAE Tripathi, 1960

CYCLOPOIDA. FEMALES: Body consisting of a head, with or without processes, and a long neck which are embedded in the tissue of the host, a trunk which may be indistinctly segmented, a small, separate genital segment, and a one segmented abdomen with a very small pair of caudal laminae; eggs multiserrate, egg strings club-shaped, arising ventro-laterally from the genital segment; first antennae five-segmented, second antennae subchelate, mouth parts small, structure as in Ergasilidae, three or four pairs of very small biramous pereopods confined to the trunk, rami of the first three pairs three-segmented, the fourth, when present, one-segmented. MALE: unknown. Parasitic on teleosts.

Type genus: *Therodomas* Kröyer.

*PAEONODES* Wilson, 1944 (modified)

CYCLOPOIDA; THERODOMASIDAE. FEMALE: Head, with dorsolateral, rounded processes, continuous with the neck, which is continuous with the trunk, which may have transverse striations but has no sign of segmentation; one pair of pereopods placed medially on ventral surface of trunk, the other three pairs close together on ventral posterior margin of trunk. MALE: unknown.

Type species: *Paeonodes exiguus* Wilson.

*Paeonodes nemaformis* n.sp.

MATERIAL

Four females, three bearing eggs, taken from the gills, gill covers and base of the pectoral fins of a brown trout (*Salmo trutta* L.) captured in the Haupiri River near Kopara, Greymouth, South Island on 2 November 1963, and forwarded by the Chief Field Officer of the Wildlife Branch, Department of Internal Affairs to the Fisheries Laboratory, Marine Department, Wellington. The parasites were dissected out, and passed on to me by Mr. C. L. Hopkins of the Fisheries Laboratory who reports that the parasites had their heads and necks buried in the host tissue, causing a lesion at the site of attachment.

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Mr. Hopkins also reports that he has seen similar copepods on a salmon (*Oncorhynchus tshawytscha* (Walb.)) from the Queenstown region, sent to his office by the Fisheries Officer of the Office of the Conservator of Wildlife, Queenstown, on 18 December 1962.

DESCRIPTION

FEMALE only (figs. 1-13).

Overall length, excluding egg strings, 3.74 mm-4.46 mm.

HEAD a little wider than long (0.48 mm-0.52 mm), narrowing to half this width anteriorly, anterior margin rounded, with a small median rostrum; posterolateral angles of head expanded into broad, bilobate processes. First and second antennae carried near anterior margin, mouthtube and remaining cephalic appendages reduced in size, and carried one-quarter distance from anterior margin.

NECK very long and narrow (2.24 mm-3.05 mm x 0.17 mm-0.25 mm), narrowest anteriorly (0.10 mm-0.15 mm) very gradually becoming wider near the trunk.

TRUNK width two-thirds length (0.78 mm-1.14 mm x 0.54 mm-0.72 mm), widest posteriorly, narrowing rapidly to fuse with neck over anterior third, with a further slight narrowing at the midpoint; posterior angles broadly rounded, posterior margin with dorsal and ventral swellings over median third, so that in posterior view the trunk is almost + -shaped, the branches short and rounded.

GENITAL SEGMENT small, as wide as long (0.09 mm-0.11 mm x 0.09 mm-0.12 mm), the lateral margins broadly rounded, the egg strings arising ventrolaterally about half way along the segment.

ABDOMEN as wide as long (0.06 mm-0.07 mm x 0.06 mm-0.08 mm), widest anteriorly, narrowing to two-thirds this width posteriorly, posterior angles rounded; on ventral surface of segment there is a transverse row of very short spines one-third distance from anterior margin, a further row with a median discontinuity two-thirds distance from this margin, and a further transverse row at the base of each caudal lamella.

CAUDAL LAMELLA carried postero-ventrally on the posterior angles of the abdomen, a little longer than wide (0.020 mm x 0.014 mm), angles rounded, with two setae carried on posterior margin.

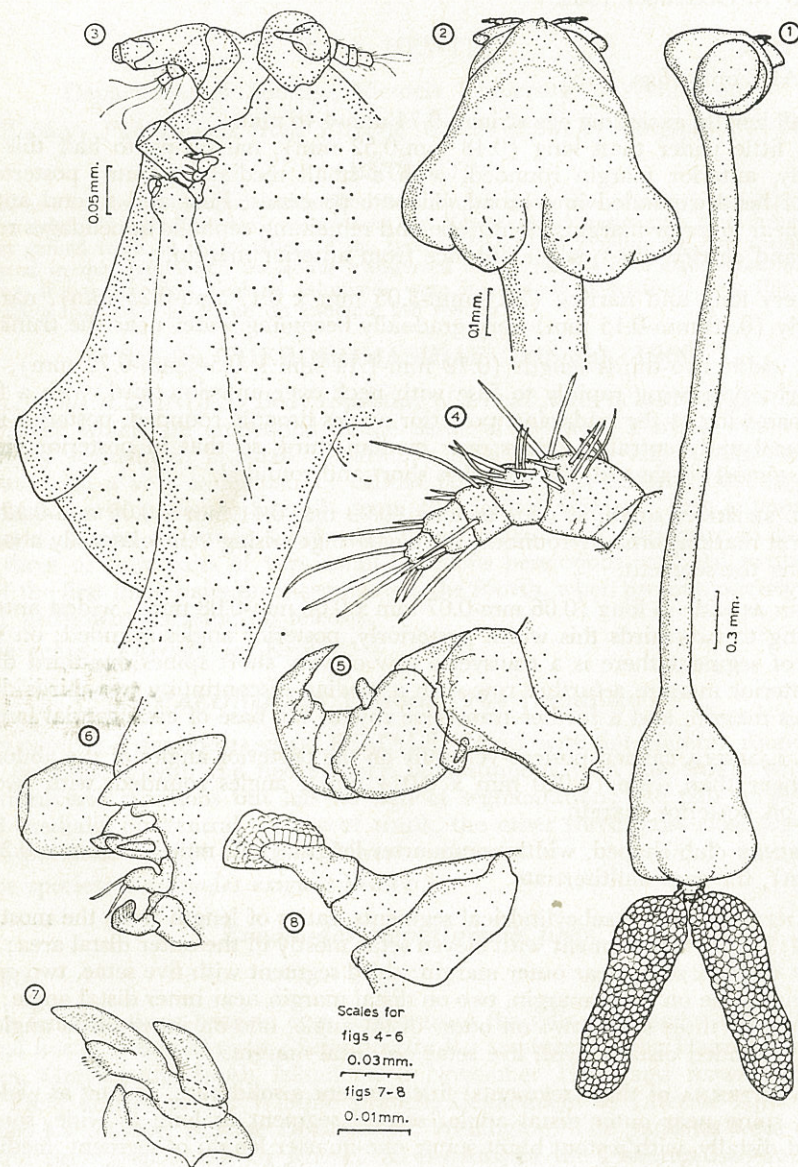
EGG STRINGS club shaped, width one-quarter length (1.12 mm-1.33 mm x 0.25 mm-0.31 mm), the eggs multiserrate.

FIRST ANTENNA of five subcylindrical segments, ratios of length from the most proximal 6:4:3:3:2; first segment with eleven setae mostly in the outer distal area; second segment with six setae near outer margin; third segment with five setae, two on outer distal angle, one on outer margin, two on distal margin near inner distal angle; fourth segment with three setae, two on outer distal angle, one on inner distal angle; fifth segment rounded distally, with five setae on distal margin.

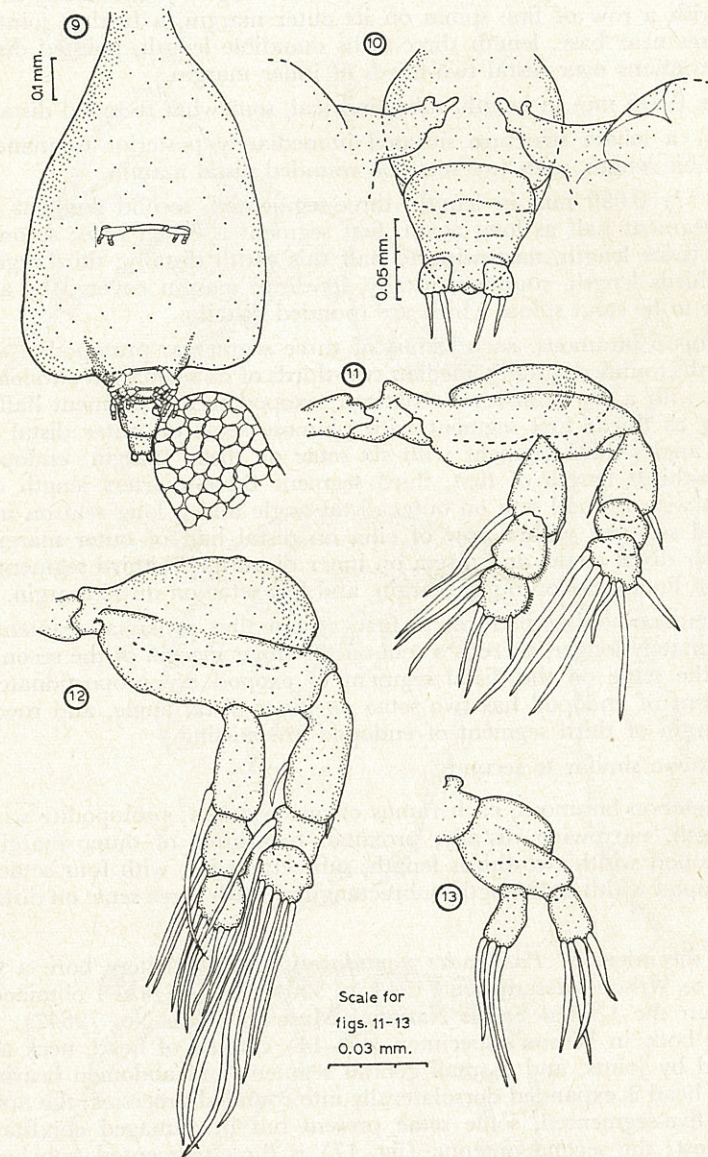
SECOND ANTENNA of three segments; first segment a solid base, as long as wide, with a small spine near outer distal angle; second segment as long as wide, somewhat rounded distally, with a stout blunt spine, one-quarter length of segment, medially on inner margin; third segment as long as second, width two-thirds length, narrowing distally to a blunt point, curved medially, forming a claw which closes against the second segment.

LABRUM a scale-like structure 0.06 mm in length, width one-third length, situated immediately anterolateral to mouthtube.





*Paeonodes nemaformis* n.sp., female—Fig. 1: dorsal aspect; fig. 2: head, dorsal aspect; fig. 3: head, ventrolateral aspect; fig. 4: first antenna; fig. 5: second antenna; fig. 6: mouth parts, lateral view; fig. 7: mandible; fig. 8: maxilliped (?).



*Paeonodes nemaformis* n.sp., female—Fig. 9: trunk, ventral; fig. 10: genital segment, abdomen and caudal laminae, ventral; fig. 11: first pereopod; fig. 12: second pereopod; fig. 13: fourth pereopod.



MANDIBLE 0.027 mm in length, situated on a small wide base, basal width of mandible one-third length, narrowing slightly immediately distal to base, then widening but narrowing again over distal sixth to form a blunt point, a series of small transverse striations over distal half, a branch, one-quarter length of mandible, arising from midpoint, with a row of fine spines on its outer margin, a further jointed branch (palp?) arises near base, length three-fifths mandible length, pointed distally, with transverse striations over distal two-thirds of inner margin.

MOUTHTUBE 0.045 mm in length, subcylindrical, somewhat rounded distally.

MAXILLA (?) a lobate structure situated immediately posterior to mandible, two-thirds mandible length, with two setae on rounded distal margin.

MAXILLIPED (?) 0.039 mm in length, three-segmented, second segment as long as first, third segment half as long again, first segment a broad base; second segment basal width twice length, narrowing to half this width distally; third segment basal width two-thirds length, rounded distally, its distal margin covered by a clump of what appear to be stout spines which are rounded distally.

FIRST PEREIOPOD biramous, each ramus of three segments; protopodite width one-quarter length, rounded distally, median two-thirds of outer margin swollen ventrally, the swelling with a few transverse striations; exopod second segment half length of first, as long as third; first segment with plumose setae on outer distal angle and inner distal angle, third segment with six setae on distal margin; endopod second segment two-thirds length of first, third segment three-quarters length of second; first segment with a small seta on outer distal angle and a long seta on inner distal angle, second segment with a row of cilia on distal half of outer margin and on rounded outer distal angle, and a seta on inner distal angle, third segment rounded, with a row of fine spines on outer margin, and five setae on distal margin.

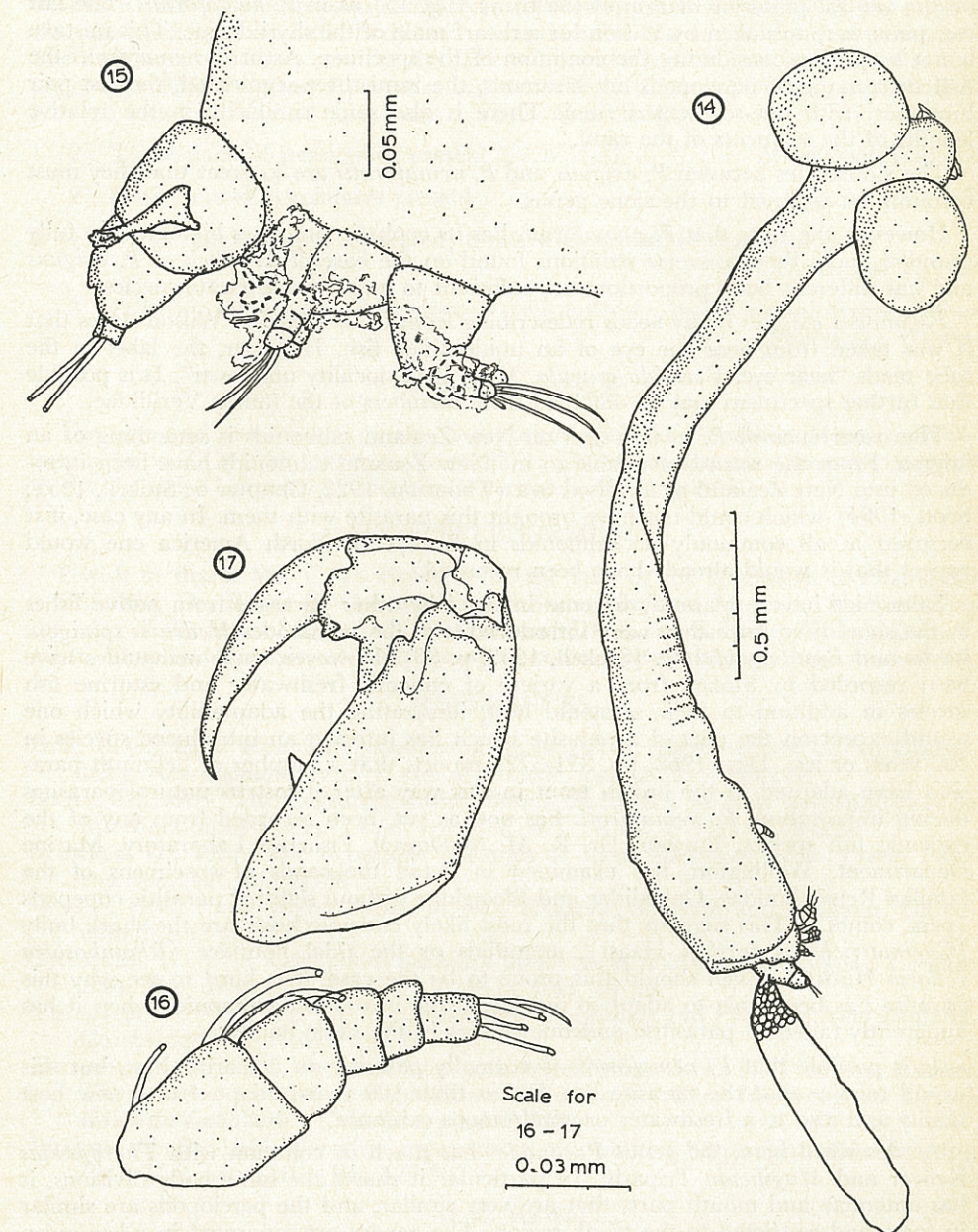
SECOND PEREIOPOD similar in form to first, except that proximal segments of rami are proportionately longer, there is a seta on the inner margin of the second segment of exopod, the setae on the distal segment of exopod are proportionately longer, second segment of endopod has two setae on inner distal angle, and row of spines on outer margin of third segment of endopod are missing.

THIRD PEREIOPOD similar to second.

FOURTH PEREIOPOD biramous, each ramus of one segment; protopodite width three-quarters length, narrowing distally, proximal two-thirds of outer margin swollen ventrally; exopod width two-thirds length, subrectangular, with four setae on distal margin; endopod width half length, subrectangular, with three setae on distal margin.

#### DISCUSSION

Since the specimens of *Paeonodes nemaformis* described here bore a superficial resemblance to Wilson's description (1944, p. 550) of *P. exiguus* I obtained his type specimen from the United States National Museum (Cat. No. 79642). As in my material, the body in Wilson's specimen (fig. 14) consists of head, neck and trunk, not separated by joints, and a small genital segment and abdomen bearing caudal laminae; the head is expanded dorsolaterally into rounded processes; the first antenna (fig. 16) is five-segmented, some setae present but in damaged condition, others presumably lost; the second antenna (fig. 17) is three-segmented, subchelate, with spines on the first and second segments. All of this agrees with Wilson's description. I was unable to locate the mouth parts. The pereopods were in poor condition, covered in mucus, dust, and crystalline material which could not safely be removed since this is the only recorded specimen of this species. However, with the aid of phase contrast microscopy, I was able to determine that the structure described by



*Paeonodes exiguus* Wilson, female—Fig. 14: whole view; fig. 15: posterior part of body, showing positions of pereopods 2-4, broken lines indicate the position of structures seen from another aspect; fig. 16: first antenna; fig. 17: second antenna.







## NEW COLLEMBOLA FROM INDIA

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*Zoology Publications from Victoria University of Wellington, No. 51*

### ABSTRACT

A new monospecific genus and five new species of Collembola from India are described.

The collembola dealt with in this paper were collected in India by Dr. T. Clay of the British Museum, Natural History. Holotype and paratype specimens are deposited in the British Museum, Natural History, London; paratypes of some species are also held in the author's collection and these are indicated in the text.

### COLLEMBOLA NEOARTHROPLEONA

Family: Setanuridae Salmon, 1964

#### *Spinanurida* n.g.

Mandibles and maxillae both present and toothed. Mandible without molar area, but typified by large projecting plate-like group of teeth. Ocelli eight to each side. PAO and furcula absent. Unguiculus absent or vestigial as a small mound of cuticular granules. Anal spines present. Setae mainly simple but some may be both finely serrate and finely clavate. Clavate tenent hairs present on tibia-tarsi. Ant. IV with apical retractile knob and several types of sensory rods. Cuticle finely granulate and finely tuberculate.

Type species for the genus *Spinanurida mandibulata* n.sp.

This new genus is closely related to *Setanurida*, known at present only from East Africa, differing from this genus mainly through the presence of anal spines and the rather unusual morphology of the mandible. The toothlike projection on the mandible which consists of three teeth is very much more prominent than the large group of three basal teeth present on the mandible of *Setanurida*. The maxilla is very similar in morphology to that of *Setanurida* (Fig. 4).

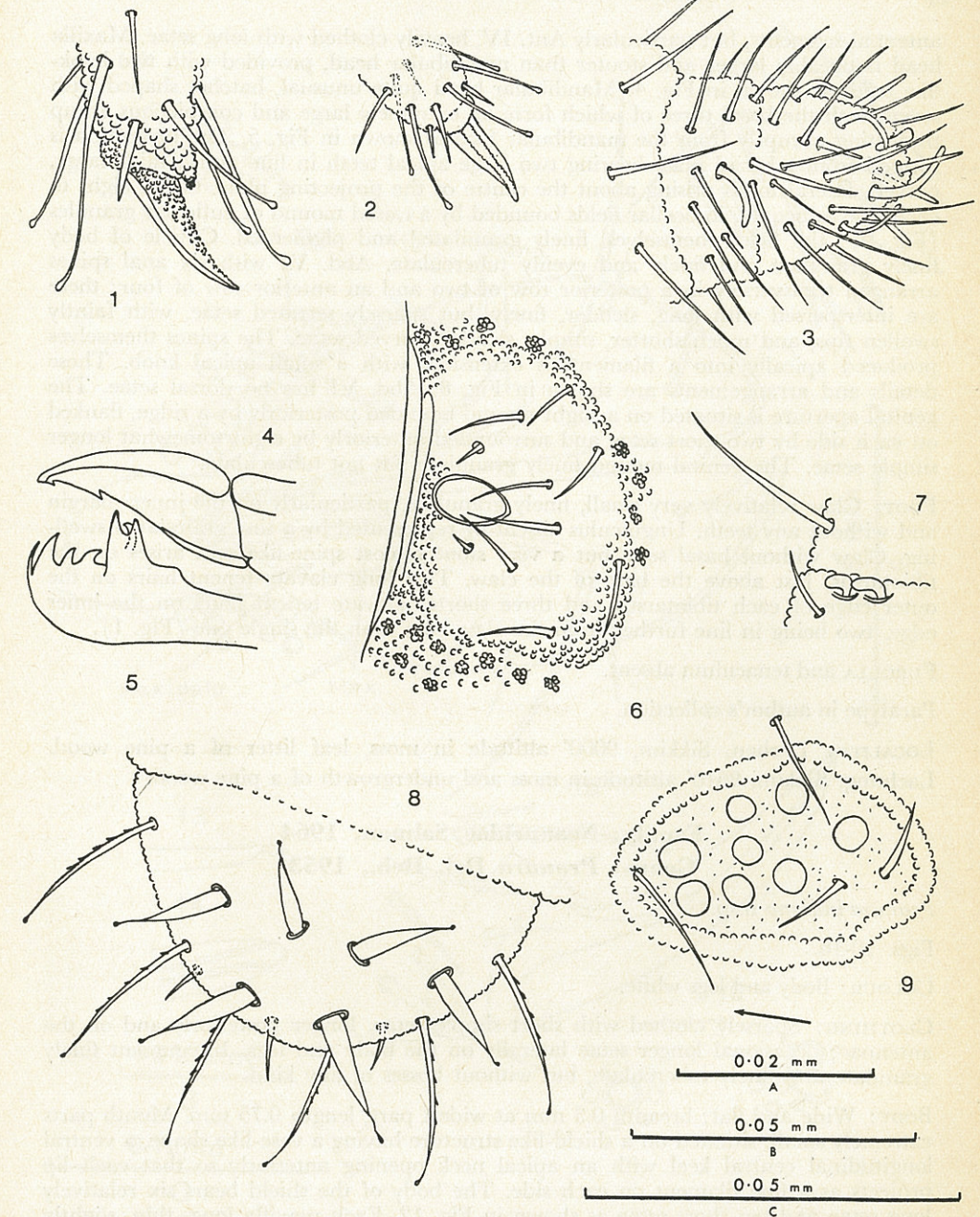
*Spinanurida mandibulata* n.g. et n.sp.

Figs. 1-9.

COLOUR: Creamy-white sparsely overlaid with scattered dark blue pigment granules. CLOTHING: Sparsely clothed with short simple curved setae, with longer, tapering, finely serrated setae posteriorly, the latter often with a small apical swelling. Long slender simple setae on the antennae and occasionally on the head and legs.

BODY: Length up to 0.66 mm. Antennae four segmented, but with segments III and IV almost completely fused, the segments related as 25:20:42, the basal segment very broad, being 25 long: 49 wide. Sense organ of Ant. III situated on the distal margin and consisting of two stout, bent, fully exposed sense clubs arising from separate but closely approximating pits, and with one short detached guard seta. Also near the centre of Ant. III, a very long and very stout curved sense rod. Ant. IV with sub-apical retractile knob in sensory pit; two very stout, almost straight apical sense rods and at least three similar subapical sense rods; a very stout long curved apical sense rod and at least three similar but smaller subapical sense rods. All

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Figs. 1-9, *Spinanurida mandibulata* n.g. et sp. Fig. 1, Hind foot. Fig. 2, Hind foot inner margin showing tenent hairs. Fig. 3, Ants. II, III, IV. Fig. 4, Maxilla head. Fig. 5, Head of mandible. Fig. 6, Genital aperture. Fig. 7, Sense organ Ant. III. Fig. 8, Abd. VI showing anal spines and setae. Fig. 9, Ocelli. Figs. 1, 6 and 7, Scale A; Figs. 2, 8 and 9, Scale B; Figs. 3, 4 and 5, Scale C.



antennal segments, but particularly Ant. IV, heavily clothed with long setae. Maxilla head noticeably larger and stouter than mandibular head, provided with two hook-like teeth as shown in Fig. 4. Mandibular head quite unusual, hatchet shaped with seven teeth the basal three of which form an extremely large and conspicuous group projecting abruptly from the mandibular face as shown in Fig. 5. The projection is formed from a broad plate bearing two large apical teeth in line and a third large, curved, lateral tooth arising about the centre of the projecting plate. Ocelli eight to each side, subequal, in ocellar fields bounded by a raised mound of cuticular granules (Fig. 9); the fields themselves, finely granulated and pigmented. Cuticle of body finely granulate and finely and evenly tuberculate. Abd. VI with six anal spines arranged transversely in a posterior row of two and an anterior row of four; these are interspersed with long, slender, finely, but sparsely serrated setae, with faintly swollen tips, and much shorter, simple, slender, curved setae. The spines themselves produced apically into a filamentous extension, with a small apical knob. These details and arrangements are shown in Fig. 8. Abd. VI has no dorsal setae. The genital aperture is situated on a slight mound bounded posteriorly by a ridge, flanked on each side by two short setae and surrounded anteriorly by eight somewhat longer simple setae. The genital mound finely granulate but not tuberculate.

FOOT: Claw relatively very small, finely granulate, particularly on the inner margin and without any teeth. Unguiculus absent or represented by a tiny granulated swelling. Claw without basal seta, but a very stout almost spine-like seta arises on the tibiotarsus, just above the base of the claw. Two long clavate tenent hairs on the outer edge of each tibiotarsus and three shorter clavate tenent hairs on the inner edge, two being in line further from the claw base than the single one (Fig. 1).

FURCULA and tenaculum absent.

Paratype in author's collection.

LOCALITY: Lachen, Sikkim, 9000' altitude in moss, leaf litter of a pine wood. Lachung, Sikkim, 8610' altitude in moss and undergrowth of a pine wood.

Family: Neanuridae Salmon, 1964

Genus: *Pronura* Del. Deb., 1953

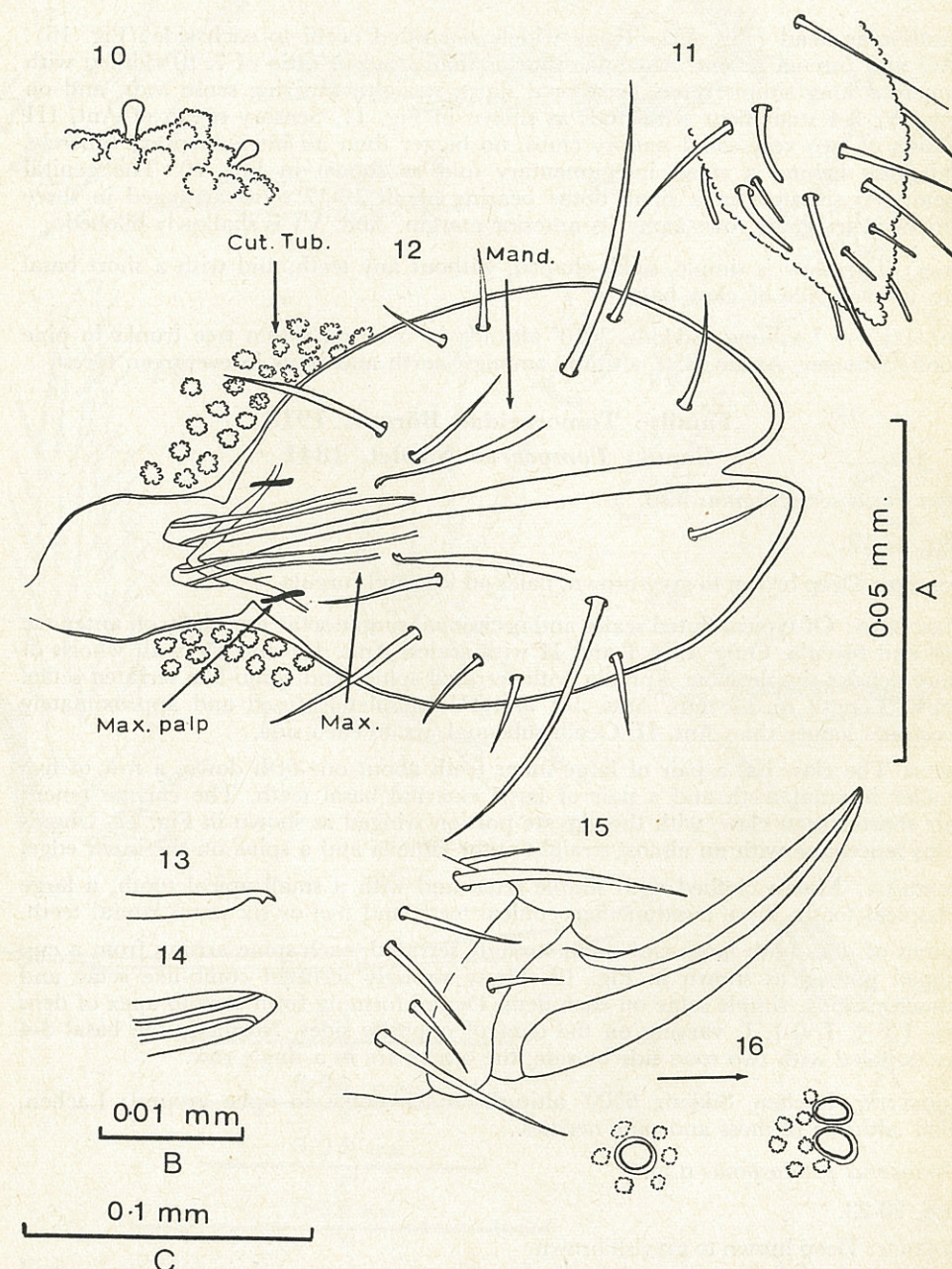
*Pronura indiana* n.sp.

Figs. 10-16.

COLOUR: Body and legs white.

CLOTHING: Sparsely clothed with short simple setae, longer posteriorly and on the antennae; occasional longer setae laterally on the body and legs. Integument finely granulate and finely tuberculate, but without bosses of any kind.

BODY: Wide and flat; breadth 0.3 mm at widest part, length 0.75 mm. Mouth parts extremely small, situated on a shield-like structure having a vase-like shape, a ventral longitudinal central keel with an apical neck opening anteriorly so that each lip projects as a fine filament on each side. The body of the shield bears six relatively long setae and ten short setae as shown in Fig. 12. Each maxilla long, thin, slightly tapering and capillary-like with the apex opening out to a small funnel shape (Fig. 14). Alongside the maxillae are two needle-like structures which may be part of maxillary palp (Fig. 12). The mandibles are long, thin, tapering, slightly curved and needle-like, with two extremely small apical teeth forming a heavily pigmented



Figs. 10-16, *Pronura indiana* n.sp. Fig. 10, Sense organ Ant. III. Fig. 11, Apex Ant. IV. Fig. 12, Mouth parts in situ. Fig. 13, Mandible. Fig. 14, Maxilla. Fig. 15, Hind foot. Fig. 16, Ocelli. Figs. 10, 11, 12 and 15, Scale A; Figs. 13 and 14, Scale B; Fig. 16, Scale C. Mand. = mandible; Max. = maxilla; Max. palp. = maxillary palp; Cut. Tub. = cuticular tubercle.



mandibular head (Fig. 13). Three widely separated ocelli to each side (Fig. 16). PAO and furcula absent. Antennae shorter than head in ratio of 7:10 clothed with numerous long simple setae, occasional short, straight, tapering sense rods, and on Ant. IV, 3-4 stout bent sense rods as shown in Fig. 11. Sensory organ of Ant. III consists of two very small sensory clubs, no bigger than an integumentary tubercle, and lying behind a small integumentary fold as shown in Fig. 10. The genital opening is situated on a small dome bearing about 16-17 setae arranged in three somewhat irregular rows along its anterior margin. Abd. VI is shallowly bilobed.

LEGS: The claw is simple, sickle-shaped, without any teeth, and with a short basal seta to each side of claw base.

LOCALITIES: Lachung, Sikkim, 8610' altitude in moss on rotten tree trunks in pine wood; Sibsager, Assam, 350' altitude amongst earth and roots in evergreen forest.

**Family: Tomoceridae Börner, 1913**

**Genus: *Tomocerus* Nicolet, 1841**

*Tomocerus serratospinus* n.sp.

Figs. 17-19.

COLOUR: Deep brown to grey-brown, paler on legs and furcula.

CLOTHING: Of typical fluted scales and occasional simple setae especially on antennae legs and furcula. Only Ants. I and II with scales. Ants. III and IV with whorls of short slender simple setae. Furcula with serrated spines and comb-like serrated setae. BODY: Length to 2.3 mm. Ants. III and IV completely fused and approximately five times longer than Ant. II. Ocelli subequal, six to each side.

LEGS: The claw has a pair of large inner teeth about one-fifth down, a row of five smaller internal teeth and a pair of large external basal teeth. The clavate tenent hair shorter than claw, with the clavate portion winged as shown in Fig. 17. Unguiculus lanceolate with an almost straight outer lamella and a spine on the inner edge.

FURCULA: Mucro clothed with simple setae and with a small apical tooth, a large subapical tooth, three large median conical teeth and five or six small lateral teeth.

Spines of dens both large and small strongly serrated, each spine arising from a cup shaped process as shown in Fig. 19. Many strongly serrated comb-like setae and numerous long, simple setae on each dens. Dental formula from base to apex of dens 3-4, 1/3-4, 1, 0-1, 1, varying on the dens of opposite sides. Normally the basal 3-4 are doubled with two rows side by side, the others are in a single row.

LOCALITY: Lachen, Sikkim, 9500' altitude under stones in open ground; Lachen, 8950' altitude in moss and pine needles.

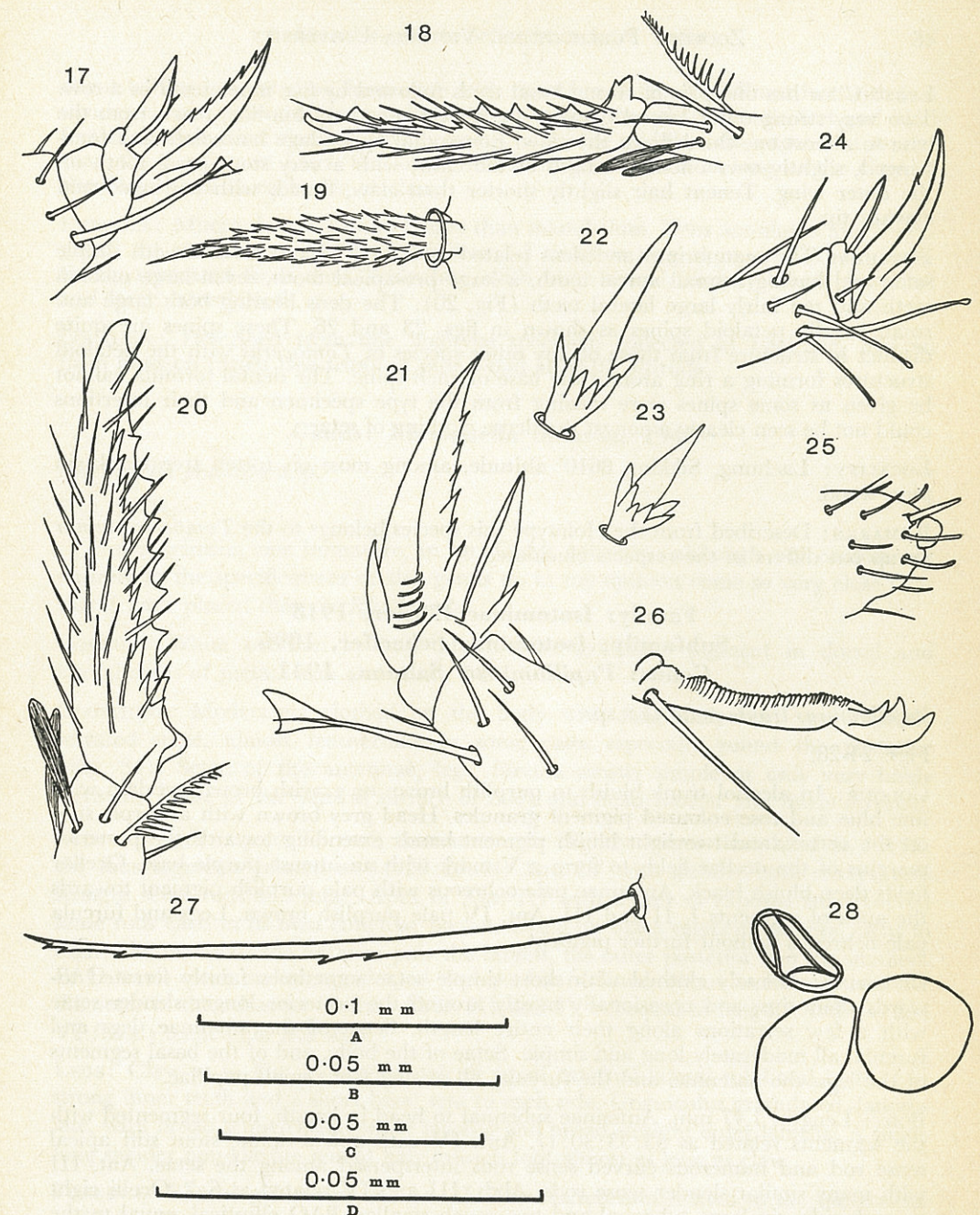
*Tomocerus petalospinus* n.sp.

Figs. 20-23.

COLOUR: Deep brown to greyish brown.

CLOTHING: Long plain setae and many strongly fluted scales.

BODY: Length up to 4.5 mm. Ants. III and IV more or less fused with Ant. IV shorter than Ant. III as 5:7 and the combined length four times as long as Ant. II. Ants. III and IV strongly annulated, with whorls of setae; Ants. I and II scaled. On the apex of the mesotergum is a cluster of stiff bristle-like setae, very finely ciliated.



Figs. 17-19, *Tomocerus serratospinus*. Fig. 17, Hind foot. Fig. 18, Mucro and apex of dens with serrate seta. Fig. 19, Dental spine. Figs. 20-23, *Tomoceros petalospinus* n.sp. Fig. 20, Mucro and apex of dens. Fig. 21, Hind foot. Fig. 22, Large dental spine. Fig. 23, Small dental spine. Figs. 24-28, *Papillomurus transequatoria* n.sp. Fig. 24, Hind foot. Fig. 25, Apex Ant. IV. Fig. 26, Mucro and apex of dens. Fig. 27, Serrated seta from posterior of body. Fig. 28, Anterior ocelli and PAO. Figs. 17, 18, 20, 21, 22 and 23, Scale A; Figs. 19, 25 and 28, Scale B; Fig. 24, Scale C; Figs. 26 and 27, Scale D.



**LEGS:** Claw has one pair of strong basal teeth followed by five inner teeth in a row. Two very strong outer lateral basal teeth, almost pseudonychia-like, reach from the base to almost one-third down the claw. Eompodial appendage lanceolate and four-winged, slightly over one-half length of the claw, with a very stout basal tooth on the outer wing. Tenent hair slightly shorter than claw, fluted, with a winged and clavate tip.

**FURCULA:** The manubrium and dens related as 25:41. Mucro clothed with simple setae and having a small apical tooth, a large pre-apical tooth, seven large median teeth and ten fairly large lateral teeth (Fig. 20). The dens bearing both large and small basally petaloid spines as shown in figs. 23 and 26. These spines are quite distinct in structure from those of any other species of *Tomoceros* with the petaloid structures forming a ring around the base of each spine. The dental formula cannot be given as some spines were missing from the type specimen and their insertions could not be seen clearly amongst the dense clothing of setae.

**LOCALITY:** Lachung, Sikkim, 8610' altitude, among moss on rotten tree trunks in pine wood.

**REMARKS:** Described from the Holotype this species belongs to the *Tomoceros minor* group but differs in the respects elucidated.

**Family: Isotomidae Börner, 1913**  
**Subfamily: Isotominae Schaeffer, 1896**  
**Genus: Papillomurus Salmon, 1941**

*Papillomurus transequatoria* n.sp.

Figs. 24-28.

**COLOUR:** In alcohol trunk bluish to purplish brown or grayish brown overlain with fine blue and rose coloured pigment granules. Head grey brown with a purple spot on the vertex, and two light bluish pigment bands extending towards the posterior margins of the ocellar fields to form a V mark with an intense purple base. Ocellar fields deep bluish black. Antennae pale ochreous with pale purplish pigment towards the apex of segments I, II and III. Ant. IV pale purplish brown. Legs and furcula pale ochreous without further pigment.

**CLOTHING:** Densely clothed with short simple setae sometimes faintly serrated towards their tips, and occasionally mostly around the posterior longer slender setae with a few serrations along their entire length. Setae of the antennae, legs and furcula, all moderately long and simple. Setae of the body, and of the basal segments of the legs, the antennae and the furcula, all arising from small papillae.

**BODY:** Length, 1.47 mm. Antennae subequal to head in length, four segmented with the segments related as 53:33:30:17. Ant. IV with apical dome, stout stiff apical sense rod and numerous curved sense rods interspersed among the setae. Ant. III with many similar slender sense rods. Abds. III and IV related as 6:7. Ocelli eight to each side, six large subequal and two much smaller. PAO elliptical, equal to the diameter of an adjacent ocellus and with lateral lamellae as in Fig. 28. Rami of tenaculum each with four barbs, the corpus with a transverse basal row of three simple setae.

**LEGS:** Claw with two strong exterior lateral teeth about half way down and one small inner tooth about two-thirds down. Base of claw finely granulate, unguiculus

about half as long as claw, lanceolate with three broad lamellae. Front feet with two slender clavate tenent hairs one slightly longer than the other. Middle feet and hind feet each with three slender clavate tenent hairs, the middle hair longer and stouter than the two lateral hairs, the longer middle hair not quite as long as the claw. A short basal seta to each side of claw.

**FURCULA:** Mucro dens 3.2 times longer than manubrium. Dens annulated and corrugated, the uncorrugated part of the dens 2-3 times as long as mucro. Mucro indistinctly separated from dens, tridentate, with large apical, slightly longer preapical and large lateral teeth.

**LOCALITY:** Described from one holotype specimen collected at Lachung, Sikkim, from moss on rotten tree trunk in pine wood at 8610' altitude.

**Genus: Rhodanella Salmon, 1945**

*Rhodanella plumosa* n.sp.

Figs. 29-34.

Two specimens, one immature, in Dr. Clay's collection although not conforming entirely to the specifications of this genus do in my opinion come so very close to it that I have placed them in *Rhodanella*.

**COLOUR:** White overlain by pale bluish-violet granulate pigment in dorsal and lateral areas of metathorax and Abds. I-IV.

**CLOTHING:** Moderately clothed on the body with long and short very coarsely serrated setae, almost feather-like in some cases especially round the posterior (Fig. 34). Setae of the antennae, legs, furcula mostly simple or only very finely serrated. Those of the ventral surface of body and head shorter and finely serrated.

**BODY:** Length: up to 0.6 mm. Antennae only slightly longer than head as 16:13; the four segments related as 14:20:26:44. Ant. IV with slender both curved and straight sense rods and setae. Apex of Ant. III with a pair of exposed stout curved sense rods each in its own cuticular pocket. Ocelli on black pigment patches, eight to each side, unequal; the anterior pair the largest, the outer posterior two the smallest. PAO small more or less egg-shaped and double outlined, about as long as half the diameter of the adjacent ocellus. Abds. III and IV subequal in length; Abds. V and VI fused; tenaculum not seen.

**LEGS:** Claw as in Fig. 31 with a pair of small external lateral sub-basal teeth, two strong inner teeth and a short basal seta to each side. Unguiculus granulated, lanceolate, with broad semicircular inner lamella and broad straight outer lamella. A single long slender non-clavate tenent hair to each foot almost as long as claw.

**FURCULA:** Reaching forward to Abd. II. The manubrium related to the mucrodens as 30:95. Mucro indistinctly separated from dens, small, related to the dens as 91:4, and with three prominent teeth as in Figs. 32-33. Dens annulated and corrugated, the uncorrugated portion about 2.5 times as long as mucro.

**LOCALITIES:** Lachung, Sikkim, 8610' altitude in moss on pine trunks in pine woods; Imphal, Manipur State in rotting Eichornig.



Family: Entomobryidae Tomosvary, 1882  
 Subfamily: Entomobryinae Schaeffer, 1896  
 Genus: *Setogaster* Salmon, 1951

*Setogaster manipuri* n.sp.

Figs. 35-38.

COLOUR: Pale yellow with violet pigmented ocellar fields.

CLOTHING: Of hyaline lightly striated scales and ciliated setae.

BODY: Length: ♀ up to 1 mm, ♂ up to 1.3 mm. The antennae annulated on III-IV in female and on IV only in male. Ant. IV with short plain sensory setae, short ciliated setae apically, and longer ciliated setae proximally. Ant. III with longer ciliated setae and occasional long slender plain setae. Ocellar fields each with six large anterior subequal ocelli and two much smaller posterior ones to each side; several short stout ciliated setae arise within each ocellar field. Abd. IV four times longer than Abd. III. Rami of tenaculum each with four barbs.

LEGS: Claw lightly but distinctly granulated around base; unguiculus strongly and markedly granulate all over and, in female, lanceolate, with four widely spaced serrations down outer lamella (Fig. 35); in male, truncate, with outer edge finely crenate (Fig. 38). Claw with a pair of strong outer lateral teeth; five inner teeth in male and six inner teeth in female arranged as in Figs. 38 and 35; the proximal pair of teeth in female just beyond half-way down inner edge, and, in male at about half-way down. A slender very faintly clavate tenent hair, shorter than claw, to each foot.

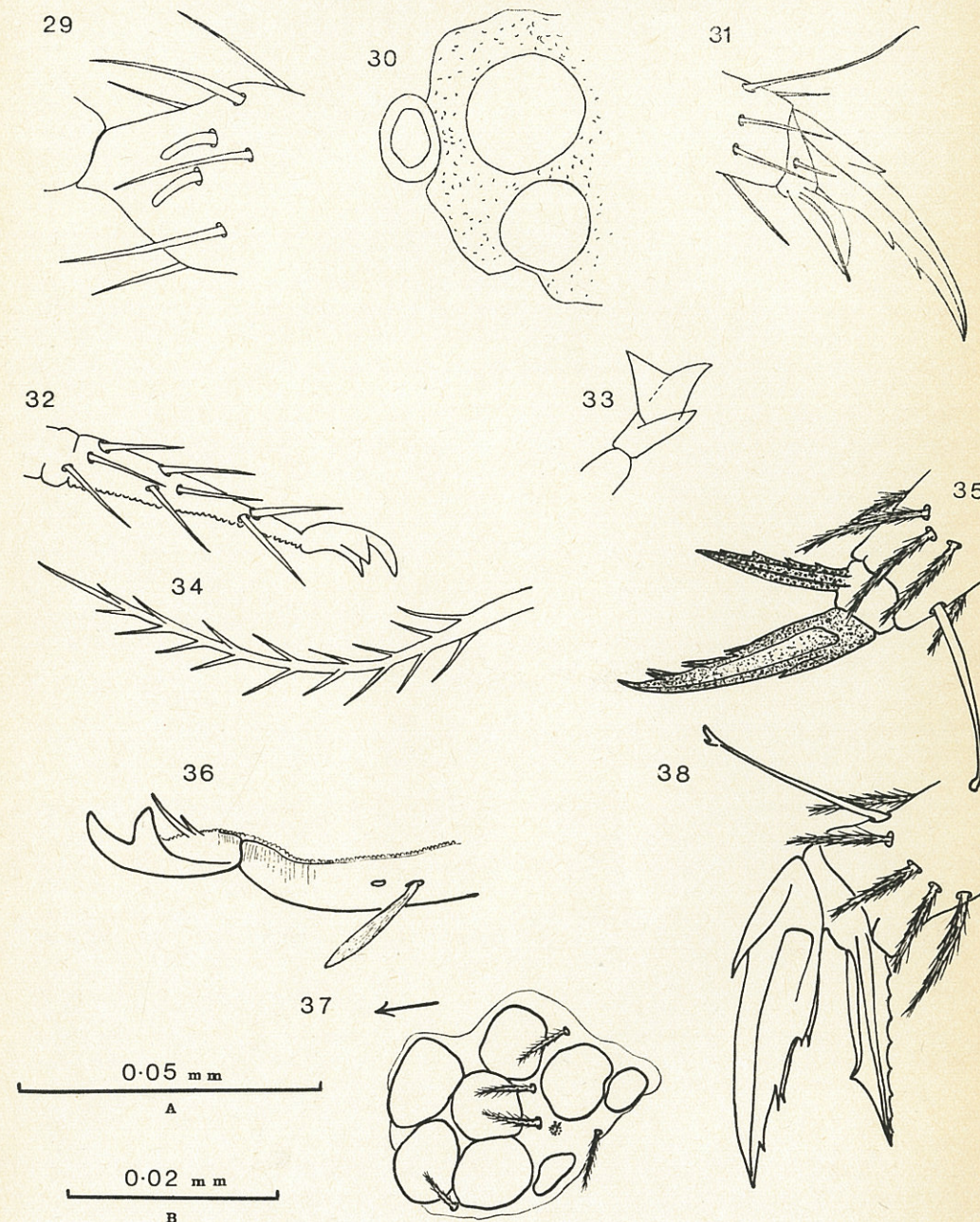
FURCULA: Reaching forward to ventral tube. Manubrium and dens subequal in female but the dens slightly longer in male. Dens annulated and corrugated; the mucro with very prominent, slightly curved, double basal spine as in Fig. 36. Lamella serrated, extending across mucro-dens junction to base of sub-apical tooth. Uncorrugated portion of dens 2.5-3 times length of mucro.

LOCALITY: Manipur; Moraing, 2600' altitude; in dead leaves and in grass at edge of a wood.

TYPES: Holotype and Allotype on separate slides in British Museum Natural History.

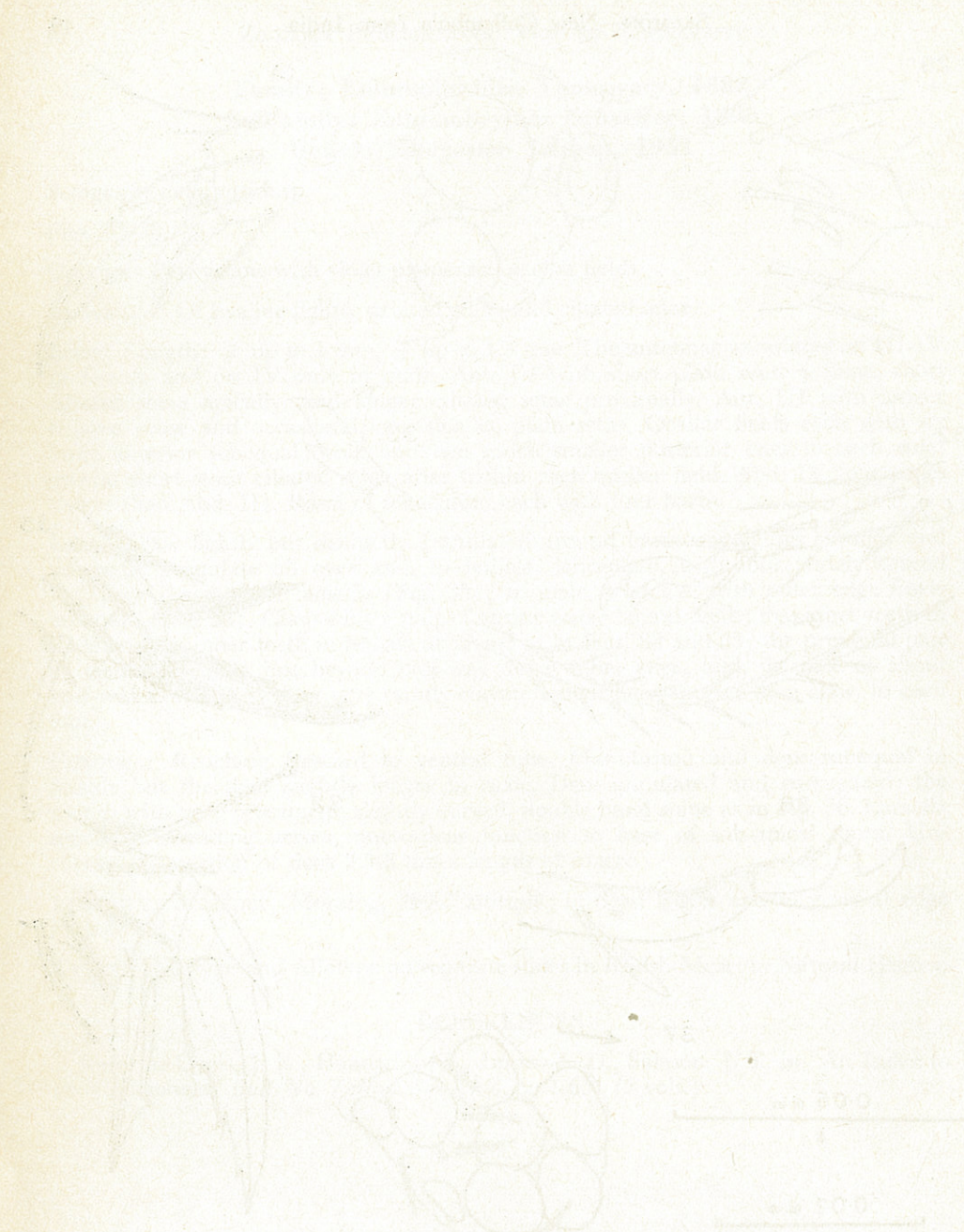
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Refer to Denis, J. R., Handschin, E., Imms, A. D., Salmon, J. T. in "An Index to the Collembola" *Bull. No. 7, Roy. Soc. N.Z.* pp 1-651 (3 vols.).

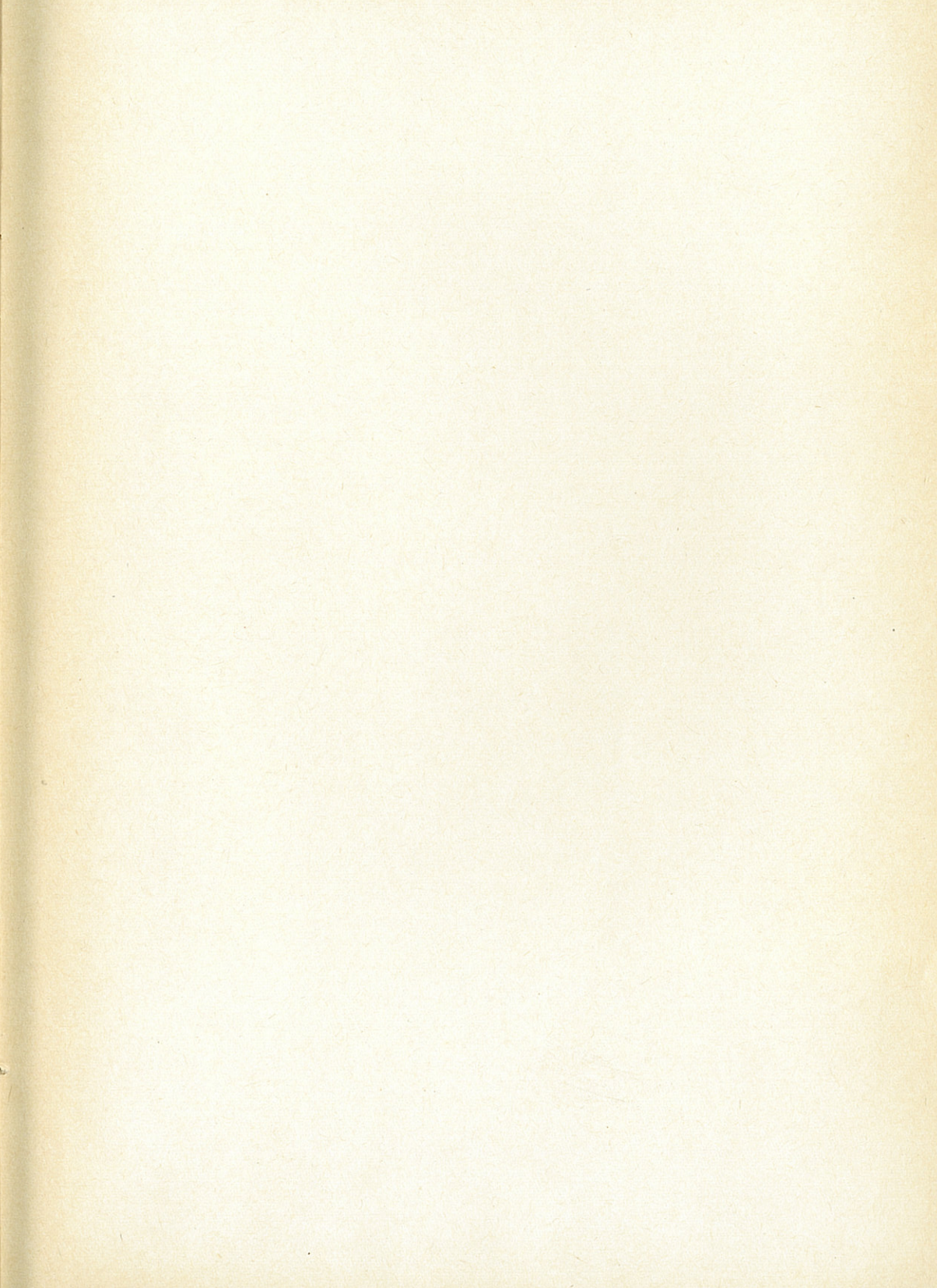


Figs. 29-34, *Rhodanella plumosa* n.sp. Fig. 29, Sense organ Ant. III. Fig. 30, PAO and ocelli. Fig. 31, Hind foot. Fig. 32, Right mucro from side and apex dens. Fig. 33, Left mucro from above. Fig. 34, Seta from body dorsum. Figs. 35-38, *Setogaster manipuri* n.sp. Fig. 35, Hind foot ♀. Fig. 36, Mucro. Fig. 37, Ocelli. Fig. 38, Hind foot ♂, granulations on ♂ foot as in ♀. Figs. 29, 30, 31, 32, 33 and 34, Scale A; Figs. 35, 36, 37 and 38, Scale B.

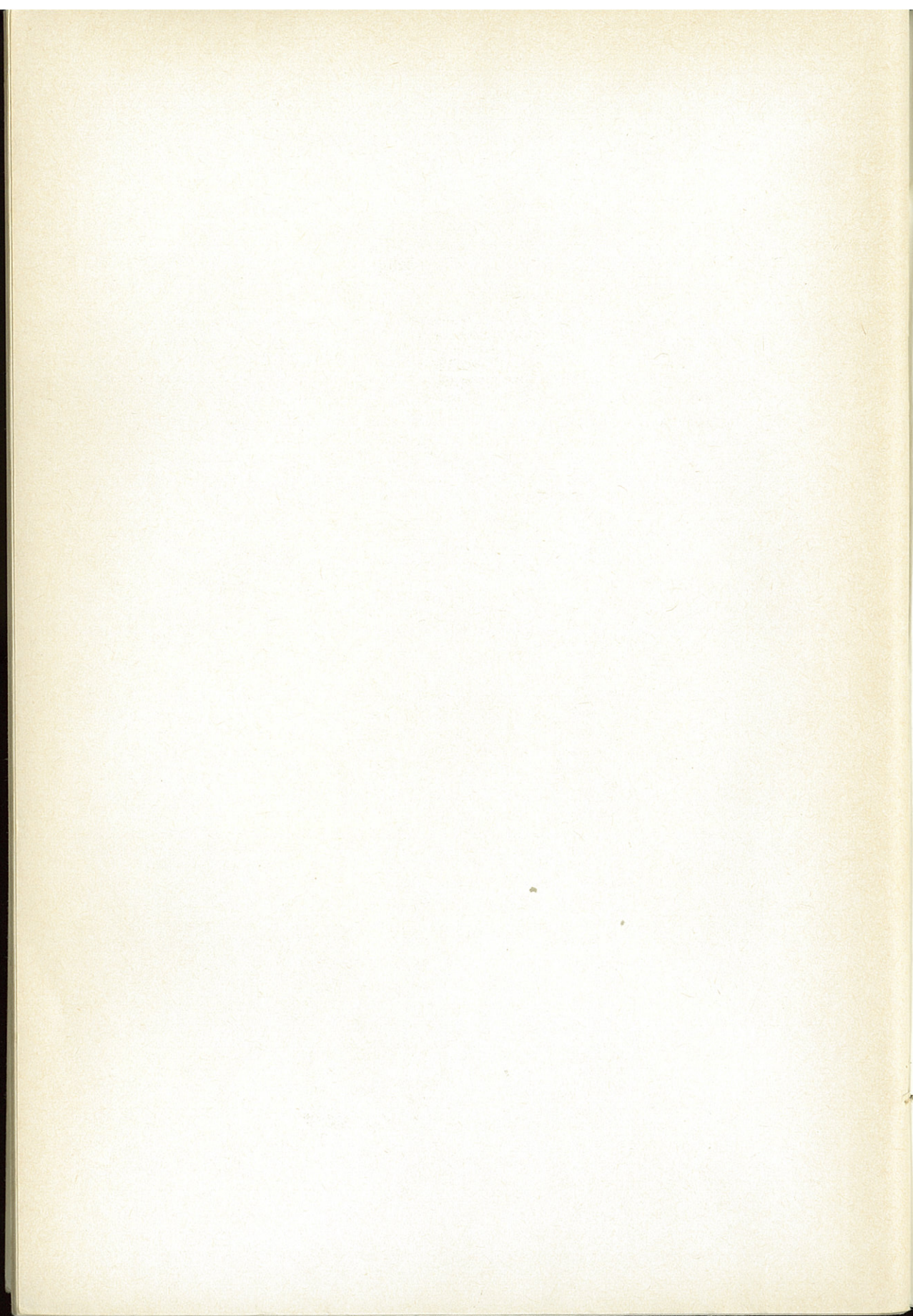




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