

SOME COPEPODA PARASITIC
ON FISHES
OF THE NEW ZEALAND REGION

by

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ABSTRACT

Material representing 38 species of parasitic Copepoda, Order Caligoida, from New Zealand marine fishes, belonging to 20 genera and six families is discussed. Except for Lepeophtheirus erecsoni Thomson, of which only damaged material was available, the species are described and figured in detail. Previous records from New Zealand waters are discussed. The name Caligus vicarius is proposed for C. longicaudatus Brady which is preoccupied. Species examined and their hosts are as follows (new hosts for previously known species, and previously known species newly recorded from New Zealand are marked with asterisks) - Caligidae: Caligus brevis Shiino^x on Pseudolabrus pittensis^x, P. miles^x and P. celidotus^x; C. aesopus Wilson^x on Seriola grandis^x; C. pelamydis Krøyer^x on Thyrsites atun^x; C. buechlerae Hewitt on Tripterygion sp.; Lepeophtheirus erecsoni Thomson on Latridopsis ciliaris; L. scutiger Shiino^x on Pseudolabrus pittensis^x, P. miles^x and P. celidotus^x; L. insignis Wilson^x on Mola mola; L. polyprioni Hewitt on Polyprion oxygenios and P. moeone; L. argentus Hewitt on Hyperoglyphe porosa; L. heegaardi Hewitt on Lepidopus caudatus; L. distinctus Hewitt on Genypterus blacodes; Euyphoridae: Gloiopotes huttoni (Thomson) on Makaira mitsukurii and M. marlina; Elytrophora brachyptera Gerstaeker^x on Thunnus alalunga and T. maccoyi^x; Pandaridae: Nesippus orientalis Heller^x on Mustelus antarcticus

and Notorhynchus pectorosus^x; N. borealis (Steenstrup and Lütken)^x on Isurus oxyrinchus^x; Dinemoura latifolia Steenstrup and Lütken on Carcharodon carcharias, Isurus oxyrinchus and Galeorhinus australis; D. producta (Müller) on Cetorhinus maximus and Carcharodon carcharias; Demoleus latus Shiino^x on Squalus acanthias^x; Echthrogaleus braccatus (Dana) on an unrecorded host; E. coleopratus (Guérin)^x on Prionace glauca and Lamna nasus; E. denticulatus Smith on an unrecorded host; Phyllothyreus cornutus (Milne-Edwards)^x on Isurus oxyrinchus; Pandarus bicolor Leach^x on Squalus acanthias, Galeorhinus australis^x, Notorhynchus pectorosus^x and Cyprimulus sp.^x; P. cranchii Leach on Galeorhinus australis^x and Isurus oxyrinchus; Perissopus dentatus Steenstrup and Lütken^x on a hammerhead shark; Cecropidae: Cecrops latreillii Leach on Mola mola; Eudactylinidae: Nemesis lamna Risso^x on Carcharodon carcharias, Cetorhinus maximus and Isurus oxyrinchus; N. robusta (van Beneden)^x on Alopias vulpinus; Congericola pallidus van Beneden^x on Conger vereauxi^x; Dichelesthiidae: Pseudocycnus appendiculatus Heller^x on Thunnus alalunga; a new species of Hatschekia on Allomycterus jaculiferus; a further new species of Hatschekia on Lepidopus caudatus; Anthosomidae: a new species of Pseudolernanthropus on Thyrsites atun and Jordanidia solandri; a new species of Lernanthropus on Seriotelella brama; Aethon percis (Thomson) on Parapercis coelias; two new species of Aethon on Cheilodactylus macropterus and Latridopus caudatus; Anthosoma crassum (Abildgaard) on Carcharodon carcharias, Isurus oxyrinchus, Lamna nasus and Galeorhinus

galeus^x; this collection includes all species belonging to these families which have previously and reliably been recorded from New Zealand waters, and of which adequate descriptions exist.

The similarities of the cephalic appendages of caligoid copepods to those of free living copepods is discussed.

The biogeographical relationships of the species here recorded are considered and it is concluded that many of these species, particularly those parasitic on elasmobranchs, are widespread, and that many of those with apparently restricted distributions may become known from other regions, especially when the little investigated parasite faunas of fishes from the South Pacific and South Atlantic become more fully known; the hosts from which the present species have been recorded are compared; it is shown that species occurring on elasmobranchs are confined to this but show little host specificity within it; teleost parasites may be restricted to one host species, one host genus, one host family, or to host families with systematic or ecological affinities; Cecrops latreillii is unique among these parasites in occurring on three quite different and apparently unrelated host species.

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GENERAL INTRODUCTION

This study began because of an interest in the diverse morphological adaptations found among parasitic Copepoda. My original intention was to study the functional reasons for these adaptations in order to gain an understanding of the selection pressures responsible for them.

It rapidly became obvious that the base of systematics necessary to such a study was not available. Apart from a few brief references, the only records of parasitic copepods from New Zealand were found in Thomson's paper of 1889. The specimens studied by Thomson consisted of a few specimens collected by the captain of the barque "Splendid" while on a whaling cruise, others collected by a Napier resident, a small collection from the Otago Museum, and a few collected by Thomson himself "chiefly on fishes bought for household use". Not only was the collection limited, but Thomson notes several times in the course of the paper that he did not have available to him some of the references he required. It was soon clear that many of Thomson's species required taxonomic revision and that some required redescription, although many of Thomson's descriptions were remarkably detailed when compared to the work of some of his overseas contemporaries working in the same group.

I was fortunate in having available (a) a collection of parasitic Copepoda built up over several years by the Dominion Museum, Wellington, (b) a collection made by Dr. H. Manter in 1951 when he was conducting an investigation of the trematode parasites of New Zealand marine fishes, and deposited in the Zoology Department, Victoria University of Wellington, and (c) several other smaller collections mentioned in the following papers. In addition I made collections myself by going out with commercial fishermen, handlining, spearfishing and visiting the weigh-in areas during local spearfishing championships. Research students at both Victoria University of Wellington and Canterbury University, Christchurch were good enough to pass on to me parasitic copepods that they came across during their own studies.

Although in totality this did not represent a large collection, it represents collections from many of the more common New Zealand fishes, and a few of the rarer ones, and is perhaps larger than might have been expected considering the impoverished nature of New Zealand's fish fauna and the lack of opportunity for regular and systematic collection.

I was also fortunate in having in Wellington Professor J.A.F. Garrick, Zoology Department, Victoria University of Wellington and Mr. J. Moreland, Dominion Museum, authorities on elasmobranchs and teleosts respectively. These colleagues were able to provide information on the habits and relationships

of host fishes recorded from both New Zealand and overseas, of a quality that must rarely be available to workers on fish parasites, and which was of enormous assistance in the present study.

With this material and information available I decided to proceed with this initial, largely morphological and systematic, study of New Zealand's parasitic Copepoda, and of the Order Caligoida in the first instance.

A number of factors make the study of the systematics of parasitic copepods very difficult. Very little data exist of variation within species of this group. Few samples of sufficient size for such studies were available to me. Where they were (e. g. Gloiopotes huttoni, Dinemoura latifolia, D. producta and Nemesis lamna in the papers presented below) most of the characters usually used as a basis for classification, i. e. body shape and proportion, and the armament of the appendages, proved to be subject to considerable variation. The only information available in the literature as a basis of comparison with local material is in most cases a description of these same morphological characters which the present study has shown to be variable in at least some cases. Thus decisions on what constitutes a specific difference within this group must contain a large element of subjectivity.

Variation is particularly marked where species occur on different hosts, and in these cases it is very hard to decide

whether this variation is phenotypic or genotypic in origin. The obvious methods of testing this are by transferring specimens from one host to another, which presents practical difficulties when the hosts concerned are too large to keep in aquaria, or by culture of specimens apart from the host. Unfortunately nobody has yet succeeded in raising specimens of parasitic copepods to the adult stage in vitro.

A further difficulty encountered in the present study is the scattered nature of the literature, many of the early papers particularly having been published in journals that have since ceased publication and are difficult to obtain. A start at overcoming this problem has been made by Yamaguti (1963) with his "Parasitic Copepoda and Brachyura of Fishes", which lists many species and gives reproductions of some original illustrations. However, although it is a useful initial reference, this publication cannot be considered a complete list, and in addition many of the references cited are inaccurate.

Most of the families encountered in the present study are represented by few genera. These fit conveniently into the classification of families used by Wilson (1932) to group the genera he encountered in the Woods Hole, Mass. region, and which were defined or, in the case of those that had been proposed as families before Wilson's study, redefined by Yamaguti (1963). I have, however, suggested (paper 11) that

the differences separating the Pseudocycnidae and Dichelesthidae, as defined by Yamaguti, are not of the same order as those separating other groups, and that these two families should be recombined.

No reference is made here to the subfamily divisions suggested by Yamaguti (1963) and others. The number of genera within each family considered in the present study does not seem to warrant the use of subfamilies. In fact, considering that few of the families in the Order Caligoida have more than 12 genera so far assigned to them, the general usefulness of subfamily divisions within this order might well be questioned.

From the basis of this thesis, I hope to proceed to a study of the other parasitic Copepoda available to me, mostly members of the Order Lernaepodoida (Lernaepodidae, Naobranchiidae, and Sphyridae) and the Order Cyclopoida (Chondracanthidae). Once this basic systematic work is completed I intend to prepare an illustrated key and check list of the New Zealand parasitic copepod fauna for use by non-systematists. With this completed, it will be possible to proceed to the studies of the structure and function within the group which I had in mind when starting this thesis.

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Some New Zealand Parasitic Copepoda of the Family
Caligidae

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Abstract

PARASITIC Copepoda of the family Caligidae, taken from New Zealand marine fishes, belong to nine species. *Caligus brevis* Shiino occurs here on three species of *Pseudolabrus*; *C. aesopus* Wilson on *Seriola grandis*; *C. pelamydis* Kroyer on *Thyrssites atun*. *Lepeophtheirus ericsoni* Thomson occurs on *Latridopsis ciliaris*; *L. scutiger* Shiino on three species of *Pseudolabrus*; four new species of *Lepeophtheirus* on *Polyprion oxygenios* and *P. maeone*, *Hyperglyphe porosa*, *Lepidopus caudatus*, and from an unidentified host, probably *Genypterus blacodes*. *Caligus longicaudatus* Brady should now be known as *C. vicarius* nom. nov., since this former name is preoccupied (Bassett-Smith, 1898); *Lepeophtheirus huttoni* Thomson is correctly in *Gloiopotes*, following Bassett-Smith (1899); the record in Hutton's *Index Faunae Novae Zealandiae* (1904) of *Caligus productus* Dana from New Zealand is unsupported.

INTRODUCTION

APART from a few scattered references to individual species, no systematic work on parasitic copepods has been published in New Zealand since the list prepared, presumably by G. M. Thomson, for Hutton's *Index Faunae Novae Zealandiae* in 1904. The Australian fauna was even less known until Heegaard's study was published in 1962. Barnard (1955) surveyed the group in his extensive "South African Parasitic Copepoda". The South American fauna is known from a few small papers and scattered references in expedition reports (Heller, 1865; Dana, 1852; Wilson, 1940, etc.). The present paper covers the caligid copepods in the material available to me. This comes from a variety of sources such that I am unable to give a total for the number of species and of fish that have been examined, but it is clear that copepods of this family can be taken from a relatively small number of host fish. The *Index Faunae Novae Zealandiae* lists 14 species under the Caligidae. These include the three species so far reported from New Zealand which are still included in the Caligidae, the subfamilies of that time having since been raised to familial level. Of these *Lepeophtheirus ericsoni*

Thomson is the first record of this family from New Zealand, *Caligus productus* Dana is not recorded in other sources as occurring here, and the single male specimen called *C. longicaudatus* by Brady is recorded from a plankton tow. The author has obtained one species of caligid from the Dominion Museum, and another from the University collection made by H. W. Manter in 1951. Further material was collected by the author from fishes taken in traps, by setline and handline and by spearfishing methods. This enabled catches from rocky and sandy bottoms in a variety of depths. The author collected all copepods immediately after the capture of the fish, since the more mobile species tend to leave the host when it dies. This may account for the relatively few specimens of this family in the collections examined by the author. Specimens were preserved in 70% alcohol with a little menthol added, unless they were numerous, when some were preserved in 5% formalin which will in time damage the specimens but retains some pigments, that are rapidly lost in alcohol, for several hours.

METHODS OF STUDY

Specimens were placed in a watchglass containing 70% alcohol and examined under a monocular microscope. With specimens of 5mm or more the mouth parts and antennae were drawn *in situ*; one set of appendages were then dissected off and drawn in the watch glass. If any particular appendages presented difficulties they were mounted temporarily on a slide in 70% alcohol, care being taken that they did not dry out. When drawings were complete all parts were then returned to the original preservative. Specimens of less than 5mm were made up into whole mounts in polyvinyl alcohol M.A.2 (Salmon, 1951) and drawings made of the appendages from specimens mounted in this medium. However, it was found necessary to compare these drawings with the appendages of unmounted specimens, since this medium tended to give a slight distortion to some structures. Measurements were made by means of a graduated eyepiece, calibrated against a measured slide.

SYSTEMATIC CHARACTERS

The identification of species described by some overseas authors is hampered by the meagreness of the descriptions and measurements and by the reliance of some authors on the host fish as an aid to identification. Although the Caligidae species tend to occur within particular host families, there are many cases of caligids with several diverse hosts. As Wilson (1905) states, "the relative lengths of the different body regions is the most constant character available for the identification of species". I found that the use of relative widths and length to width ratios of the body regions was also useful. Full descriptions of appendages have also been given since, although not as reliable for initial identifications as in some copepod groups, they are useful in confirming systematic decisions in most cases.

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The author wishes to thank Professor L. R. Richardson, Dr P. Ralph and Mr P. Castle of the Zoology Department, Victoria University and Dr P. Heegaard of the University of Copenhagen for assistance in preparing this work; the staff of the Dominion Museum, Wellington, for assistance in identifying host fishes, and for the loan of its collection; Mr P. Johns, Canterbury University, for the loan of his private collection, and Mr W. Hickman and Mr P. Thomas, of Island Bay, and Mr Atkinson, of York Bay, for assistance in the collection of material in the field.

Order CALIGOIDA

This order of Copepoda contains a greater variety of morphological types than any other. Although all within the order are parasites, they range from the Caligidae, which have several movable articulations between the segments, four pairs of well developed pereopods and often rudiments of others, and which still retain the power of free swimming, to the Lernaeidae in which the body is rigid, the pereopods reduced in size and often in number, and the adult life is spent with the head immovably fixed in the flesh of the host. There is also much variation in the life histories, the development of caligids being of the normal copepod type with only the adult parasitic, while in other families some stages may be passed in the egg, or more than one stage may be parasitic; Lernaeids have an intermediate host.

Because of the wide range of types included the order is rather hard to characterise, but in general it may be recognised in the following manner (largely drawn from the diagnosis of the order given by Wilson (1932, p. 397)): If any movable body articulations are present there will be a movable articulation between the third and fourth thoracic segments; the first antenna reduced to one or two segments; second antenna prehensile, armed with claws; first maxilla a prehensile claw; first maxilliped the chief organ of attachment; sternal furca, an unpaired median structure found only in the Caligoida, present between the bases of the second maxillipeds. All are parasites of fishes, aquatic mammals or rarely invertebrates.

Wilson (1905, pp. 530-532) redefined the family Caligidae as it was then recognised and divided it into five subfamilies, the Caliginae, Euryphorinae, Trebinae, Pandarinae and Cecropinae. Shortly after this, however, the distinctness of these subfamilies was recognised and they were raised to familial level. The group now known as the Caligidae is the least specialised of this group of families, and this group in turn is the least specialised among the Caligoida. The families other than the Caligidae show an increase in the rigidity of the body, brought about by the addition of plates to the body segments or by a reduction in movable articulations between the segments, a decrease in the size and often in the number of the appendages, and an increasing tendency for the adult to be immovably fixed to the host.

Family CALIGIDAE

Caligoida in which the first three thoracic segments are included in the cephalothorax, which is broad and flattened dorso-ventrally; the line of union between the first and second thoracic segments being marked by the H-shaped dorsal rib; the fourth thoracic and genital segments freely articulated; the genital segment the result of the fusion of the fifth and sixth thoracic segments; the genital segment generally larger than the fourth thoracic segment but smaller than the carapace. Second and third pairs of pereopods always biramose, first and fourth pairs usually uniramous. Fifth and sixth pairs of pereopods usually present as two pairs of small papillae on the genital segment in the male, but often as only one pair in the female, and sometimes missing. Adults active, the females, as well as the males, sometimes taken free-swimming in the plankton.

The family contains several genera, most of which contain few species. The exceptions are *Caligus*, which contain some 180 species, and *Lepeophtheirus* with about half this number. All of the species mentioned below belong in these latter genera.

Caligus Müller, 1785.

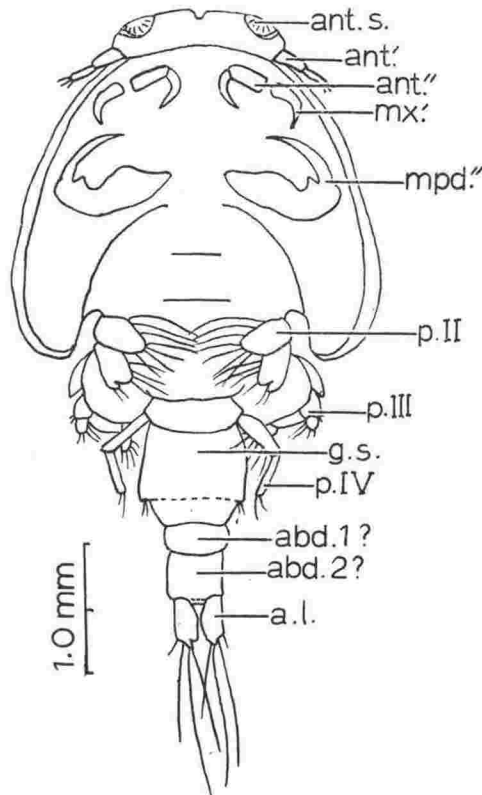
(The following generic description is based on that of Wilson (1905, p. 555), but additional information has been given, especially with reference to the male.)

Caligids in which the large and shield-shaped carapace is never folded. The frontal plates are armed with a pair of anterior suckers which are placed at the bases of the first antennae. Both segments of the first antennae are heavily armed with setae. Mandibles toothed along one or both margins. Second maxillae simple and spine-like. First and fourth pereopods always uniramous, second and third biramous. Fourth, freely articulated, thoracic segment short; genital usually smaller, never much larger than the carapace; flattened but not elongated, without processes. Abdomen with one to many segments. Anal lamellae strongly flattened and armed with plumose setae. The male usually resembling the female except in size, in the size and structure of the second antennae and second maxillipeds, and in the size and shape of the genital segment, which is usually smaller and slimmer.

Caligus vicarius nom. nov.

1901. *Caligus longicaudatus* Brady: *Trans. Zool. Soc. Lond.* XV, Pl. XII, fig. 26.

This species was first described as *Caligus longicaudatus* by Brady from a single specimen taken in a plankton tow at Port Chalmers. This name is pre-occupied by *C. longicaudatus* Bassett-Smith, 1898. The diagnostic characters given



TEXT-FIG. 1.—*Caligus vicarius* nom. nov. Male specimen, dorsal view, based on Brady's figure.

by Brady assume that his specimen is a female, whereas examination of his figure reveals the small genital segment characteristic of a male *Caligus*. Consideration of Brady's figure reveals characters which should allow this species to be identified when further specimens come to hand.

Brady states that the total length of his specimen is 5mm. Study of his figure shows: carapace as long as wide (3.0mm x 2.9mm); frontal area half the width of the carapace, one-fifth as long as wide; anterior suckers of moderate size, being one-quarter the width of the frontal area in diameter; fourth free thoracic segment one-quarter the width of the carapace, one-third as long as wide (0.25mm x 0.75mm); genital segment subrectangular, as long as the fourth thoracic segment is wide, four-fifths as long as wide (0.70mm x 0.85mm), narrowing anteriorly to four-fifths and posteriorly to five-sevenths this width, lateral margins curved. The abdomen appears to be two segmented, first segment suboval, as long as the fourth thoracic segment, and twice as wide as long (0.25mm x 0.50mm); second segment half as long again as the first, a little wider than long, rectangular in shape (0.37mm x 0.40mm). Anal laminae suboval in shape, as long as the second joint of the abdomen, half as wide as long, each bearing a small plumose seta on the posterolateral angle and three long plumose setae on the posterior margins. The appendages are not clearly figured by Brady. However, it appears that the rami of the third pereopods are well separated and that there is at least one pair of rudimentary pereopods clearly visible on the genital segment.

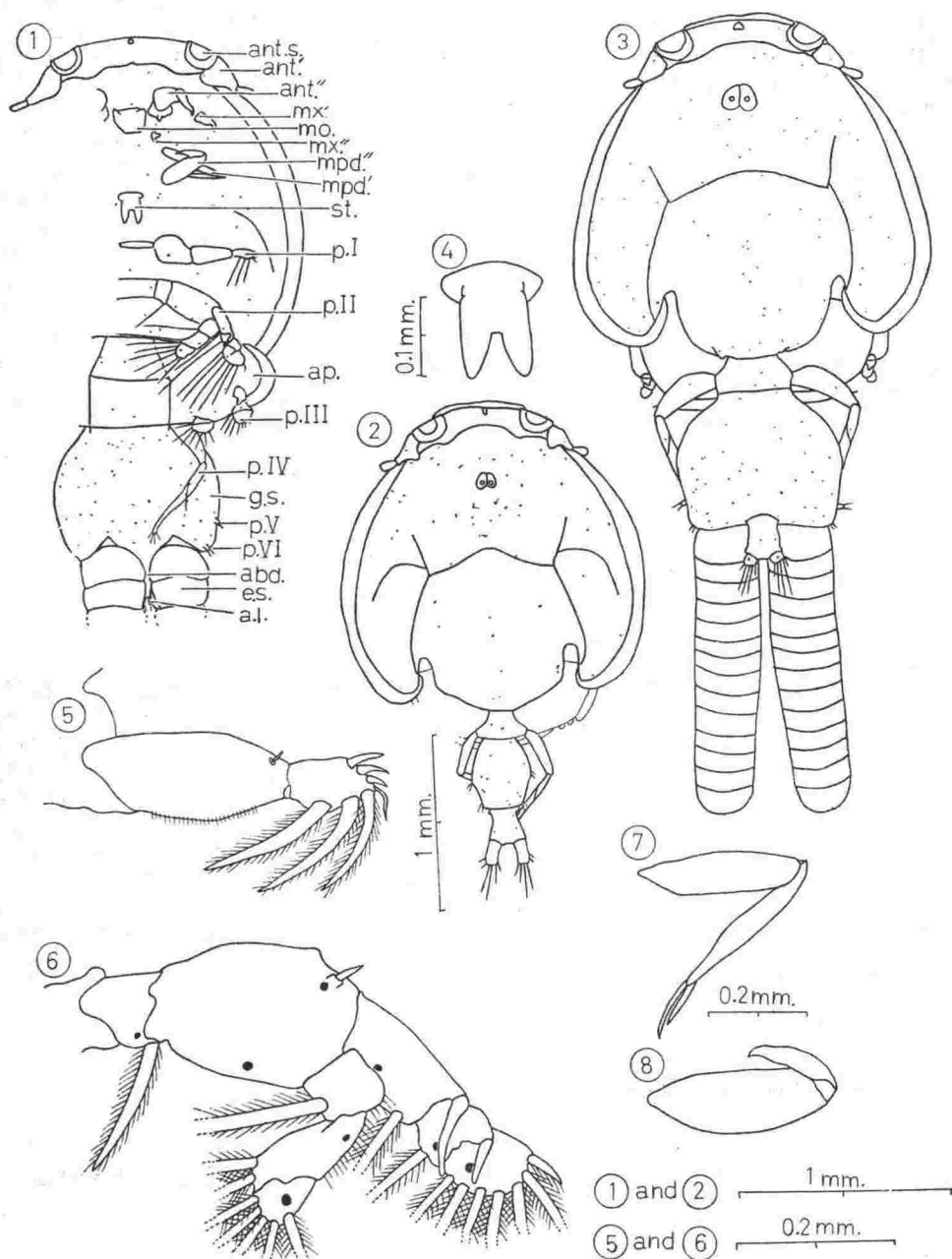
Caligus productus Dana, 1852

This species is included in Hutton's *Index Faunae Novae Zealandiae*, 1904, as occurring in New Zealand. Dana, however, makes no comment on the source of his material, other than the statement, "found with the preceding (*Caligus thymni* Dana, 1852) within the gill covers of the Bonito, on the operculum". Bassett-Smith (1899, p. 452) lists it as from the West Indies on fishes of the genera *Coryphaena* (dolphins) and *Balistes* (trigger fishes). Wilson (1905) re-describes the species, stating that his specimens were from fishes of the above genera. It has also been recorded by Steenstrup & Lütken (1861) from "Barra-cuda" (*Sphyræna*) and by Krøyer (1865) also on *Coryphaena* sp. Thus the above listing is the only record of this species from New Zealand, and I consider that, since so few details are given, this record should be considered doubtful until it is confirmed by further specimens.

Caligus brevis Shiino, 1954.

Caligus brevis Shiino, *Bull. Jap. Soc. sci. Fish.*, 20 (3): 178-183, Figs. 1 and 2.

Caligids in which both sexes are small, transparent with purple pigment spots, which, however, are lost on preservation in alcohol, the specimens then becoming yellowish-brown. In the female the carapace is definitely more than half the total body length, about as long as wide; the fourth segment is short, one-quarter as wide as the carapace. The one segmented abdomen, less than half but more than one-quarter as long as the genital segment. Lateral margins of the genital segment always entire, never crooked. The male is smaller than the female in most of its measurements, the genital segment being only one-quarter the length of the carapace. Both male and female have well developed papillae on the genital segment, representing the fifth and sixth pairs of pereopods.



TEXT-FIG. 2.—*Caligus brevis*. (1) Female, ventral view. (2) Male, dorsal view. (3) Female, dorsal view. (4) Female, sternal furca. (5) Female, first pereiopod. (6) Female, second pereiopod. (7) Female, first maxilliped. (8) Female, second maxilliped.

Abbreviations (for all text-figures): abd., abdomen; ant.', first antenna; ant.", second antenna; ant.s., anterior sucker; ap., apron of the third pereiopods; a.l., anal laminae; e.s., egg strings; g.s., genital segment; mx., maxillary hook (: first maxilla); mo., mouth tube; mpd.', first maxilliped; mpd.", second maxilliped; mx.", second maxilla; p. I, II, III, IV, V, and VI, pereiopods; st., sternal furca.

DESCRIPTION. FEMALE: Female rather short (2.26mm–2.69mm); carapace normally about three-quarters length of animal.

Carapace a little longer than wide (1.68mm–1.95mm x 1.53mm–1.92mm). Frontal area half as wide as carapace, one-seventh as long as wide over most of its width but slightly shorter medially, curved to a depth equal to its median length; anterior suckers (lunules) well developed, being one-fifth width of frontal area in diameter, almost touching its posterior margin. Transverse dorsal rib central in carapace, arched anteriorly to a depth equal to one-twelfth length of carapace; anterior longitudinal branches diverging anteriorly, short, one-sixth length of carapace, half length of laterally curved posterior longitudinal branches; posterior sinuses small, as long as median length of frontal area, rather wide posteriorly. Lateral areas slightly pointed posteriorly; median posterior area as wide as frontal area, angles rounded, extending beyond lateral lobes for a distance equal to length of frontal area. Eyes one-quarter of the distance from anterior margin of carapace, large, equal in length to frontal area, two-thirds as wide as long, touching on two-thirds of their medial margins. Flange on lateral areas rather narrow (0.1mm) narrowing further anteriorly, tapering abruptly at posterior terminations of posterior longitudinal branches of dorsal rib.

Fourth, freely articulated, thoracic segment two-ninths as wide as carapace, half as long as wide (0.09mm–0.15mm x 0.36mm–0.49mm), narrowing to two-thirds this width over anterior half of its length; posterior margin linear and articulating with the genital segment over its full width.

Genital segment subrectangular posteriorly, bulges slightly medially and narrows anteriorly; two-fifths as long as the carapace, wider than long (0.52mm–0.72mm x 0.85mm–1.10mm), narrowing to less than half this width at anterior margin.

Abdomen one-segmented, rectangular except for slight emargination at the postero-lateral points of attachment of the anal laminae; rather short (0.15mm–0.22mm) and two-thirds as wide as long.

Anal laminae small, rectangular, one-quarter length of abdomen and two-thirds as long as wide. Each bears a small plumose seta on its inner and outer posterior angles, three long plumose setae along its terminal margin, and a row of cirri along the inner margin.

Egg strings show the wide range of length and number of eggs which is seen in other species of this genus. Most specimens had egg strings 1.00mm–1.40mm in length, containing 14–18 eggs, which are thus rather large considering the size of the specimens.

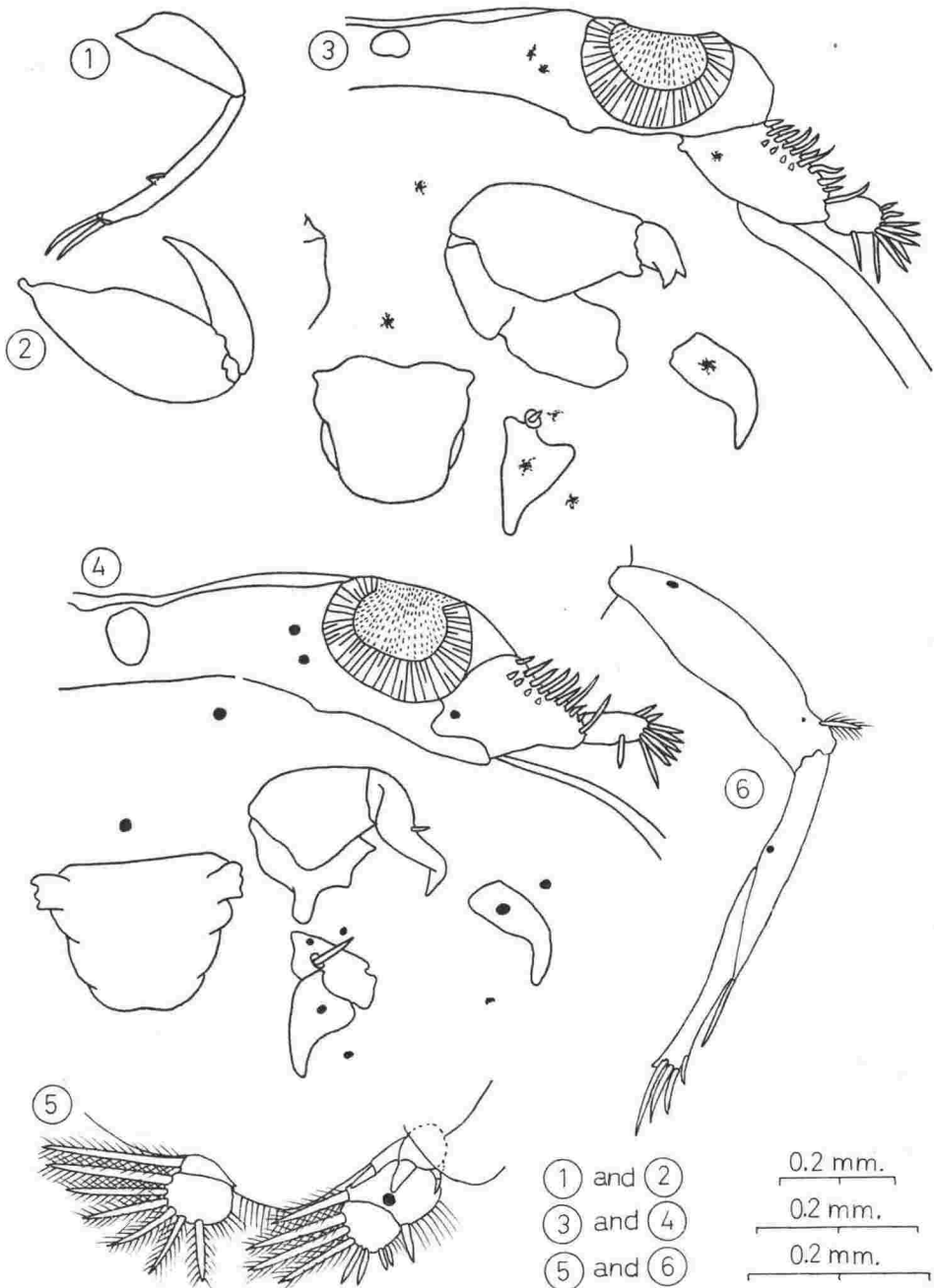
First antennae two-jointed, rather short; first joint one-fifth as long as width of frontal area, two-thirds as wide as long, irregularly rounded proximally, narrowing over its distal two-thirds to terminate in a rounded margin; second joint half as long as the first, half as wide as long, rounded distally. First joint bears eight long setae on its outer margin and one medially on its terminal margin, four small setae on ventral surface one-fifth of distance from anterior margin and one on outer distal angle; terminal joint bears eight long setae terminally and a further long seta on inner margin one-third of the distance from inner distal angle.

Second antennae two-jointed, one-sixth longer than first antennae. First joint three-quarters as long as second, subrectangular, four-fifths as wide as long, narrowing gradually to three-sevenths this width distally, outer margin curved convexly. Second joint narrowing gradually to a point, in the form of a sigmoid curve, proximal curve twice diameter of distal, bearing a small spine distally on its outer margin. Second antennae are set on irregular bases, equal in area to first joint and bearing a blunt spine on the posterior margin which is one-third as long as first joint and half as wide as long.

First maxillae one-jointed, simple, as long as first joint of second antennae. Basal half swollen to one-third as wide as the length of the maxilla, distal half curved to a depth equal to one-fifth the length of joint, and narrowing to a blunt tip.

Second maxillae one-jointed, simple, equal in length to first maxillae, three-fifths as wide at the base as long, narrowing distally to a rather sharp point; they curve laterally to a depth equal to one-fifth their length, and are set on bases which are three-quarters as wide as the maxillae are long, half as long as wide, and bear single long spines, half as long as the maxillae, on raised bosses beside the inner proximal margins of the maxillae. The maxillae extend beyond the mouth tube for two-thirds of their length.

Mouth tube on the midline of carapace two-ninths of distance from anterior margin; tube half this distance in length; proximally one-eighth wider than long, narrowing to one-half this width distally before terminating in a rounded distal margin. Mandibles contained in mouth tube each bear twelve teeth on their distal inner margins.



TEXT-FIG. 3.—*Caligus brevis*. (1) Male, first maxilliped. (2) Male, second maxilliped. (3) Male, mouth parts and first antenna. (4) Female, mouth parts and first antenna. (5) Female, third pereiopod. (6) Female, fourth pereiopod.

First maxillipeds two-jointed, equal in length to half width of carapace in this region, joints subequal in length. First joint one-quarter as wide as long, subtriangular in cross-section near the base, oval distally; second joint one-seventh as wide as long over the proximal half of its length, narrowing distally to terminate in a blunt tip; bearing two hairs distally, innermost two-fifths the length of the joint, outermost three-quarters this length.

Second maxillipeds two-jointed, subchelate, three-quarters as long as first maxillipeds. First joint twice as long as second, suboval, narrowing gradually distally and more rapidly proximally; second joint half as wide at the base as long, narrowing distally to a sharp point, rather shallowly curved to a depth equal to one-quarter its length.

Sternal furca median in ventral surface of carapace, one-twelfth as long as carapace, as wide at the base as long, narrowing to two-thirds this width immediately above the base. Lateral margins above the base parallel, furca dividing at its mid point into two branches which are separated by a straight margin, one-fifth width of furca. Branches of furca narrow distally, terminating in a rounded tip.

First pereopods three-jointed, three-elevenths as long as carapace. Basipod nine-tenths and terminal joint two-fifths length of penultimate joint. Basipod four-fifths as wide as long, subrectangular, ramus being carried on a posterolateral extension on basipod; second joint broad, three-sevenths as wide as long, narrowing somewhat distally; bears a small spine, one-twelfth as long as joint, one-eighth of the distance from distal margin and just medial to outer margin, and a row of short cilia along median three-fifths of inner margin; terminal joint three-fifths as wide as long, inner margin swollen medially; three spines on distal margin, outermost three-sevenths as long as joint, others progressively smaller; nonplumose seta on inner distal angle which is as long as the outermost spine; three subequal, well developed plumose setae on distal two-thirds of inner margin.

Second pereopods biramous, each ramus three-jointed, basipod two-jointed. *Basipod* four-elevenths as long as first pereopod, exopod one-thirteenth longer and endopod one-thirteenth shorter than basipod. First joint of the basipod is three-eighths as long as second, as wide as long, curved proximally, bearing a single long plumose seta on inner margin beside inner distal angle; second joint of the basipod swollen distally to twice width of first, bearing a stout spine, one-seventh as long as joint, on a raised boss just medial to outer margin, one-seventh of distance from outer distal angle. First joint of the *exopod* occupies half its length, other two joints being subequal to each other; first joint subrectangular, half as wide as long, inner margin two-thirds length of outer, bearing a long plumose seta immediately proximal to inner distal angle, and a long spine, three-fifths length of joint, on outer distal angle, directed inwards and distally from this angle. Second joint subreniform, curving proximally; bears a single long plumose seta in the middle of its inner margin and a spine parallel to that of first joint and half its length, on outer distal angle; third joint oval, five-sixths as wide as long, and bears six long, plumose setae on its inner and distal margins, and a shorter seta, plumose only on its inner border, on outer distal angle. First joint of the *endopod* is three-sevenths as long as second and equal to third, subrectangular, as wide as long, extending outwards beyond the junctions with the basipod and second joint for one-third its length, and bearing a single plumose seta medially on its inner margin, and a row of long cilia on that part of the distal margin that extends out from junction with second joint; third joint subtriangular, inset into the second so that their outer and distal margins are sublinear, third joint being separated from second by an irregular junction running from a median position on combined distal margin to another on lateral margin, two-fifths of the distance from outer distal angle. Combined distal margin half as wide as the second joint is long, bears two long plumose setae on portion from second joint and four on portion from third, a further long plumose seta being placed on outer distal angle. Outer margin of second joint bears a row of long cilia. Second joint narrows proximally to a width equal to its distal width.

Third pereopods have their basipods united in the broad *apron* found in other species of this genus, suboval, five-sixths as wide as carapace, one-third as long as wide, free lateral and posterior margins surrounded by a chitinous flange, as wide as that on lateral areas of carapace, which is entire except for interruption at posterolateral insertion of rami. Apron divided longitudinally by two ribs which are separated anteriorly by a distance equal to half length of apron, diverging to nearly twice this distance at their midpoint, where they are joined by a transverse rib and then continue parallel to posterior margin. Each carries a long plumose seta on its most posterior point. Rami small, three-jointed exopod being three-sevenths as long as apron, two-jointed endopod half this length. Exopod directed medially along the margin of the apron but does not overlies endopod, their bases being separated by a curved margin, half as long again as exopod, which bears

long cilia. First joint of *exopod* four-fifths as long as second and equal in length to third, three-fifths as long as wide, crescent shaped, the distal margin curved concavely to a depth equal to one-quarter its length; it bears single spines on both distal angles, that on inner being three-quarters as long as joint, the other half this size. There is a further spine, as long as the former but stouter, directed medially from a circular raised area which occupies most of dorsal surface of joint. Second joint, an elongate semicircle, with a sublinear distal margin, four-fifths as wide as long; it bears a long plumose seta on the slightly extended inner distal angle, a spine, five-eighths as long as the joint, on outer distal angle, and a row of long cilia on distal three-fifths of outer margin; third joint subcircular, two-thirds as long as wide, the proximal margin sublinear, slightly curved convexly, bearing a tuft of cilia on outer part of margin, two equal spines, half as long as joint, on outer distal part of margin, and five setae over rest of free margin; outermost two of these setae nonplumose and slightly shorter than the three inner plumose setae. First joint of *endopod* half as long as second, two-fifths as long as wide; its outer margin one-third as long as inner, which bears a long plumose seta medially, distal margin straight, proximal margin curved; second joint semicircular, five-sevenths as long as wide, proximal margin straight, free margin an entire curve; it bears a row of long cilia on inner distal region, covering one-fifth of free margin, and six long plumose setae placed evenly on distal and inner regions of free margin.

Fourth pereopods three-jointed, five-elevenths as long as carapace when straight; second joint seven-eighths, fourth four-fifths, as long as first. First joint rather slender, median width being one-quarter its length, narrowing slightly distally and more sharply proximally; it bears a short plumose seta, two-thirteenths as long as joint, on outer margin one-tenth of distance from outer distal angle. Second joint elongate, one-seventh as wide as long, subtriangular, outer margin twice as long as inner, so that inner and distal margins are sublinear; outer distal angle bears a slender spine, three-tenths as long as joint. Third joint one-tenth as wide as long, outer margin half as long as inner, so that distal margin is at right angles to joint; joint waisted a little between distal extremity of its junction with second joint and distal margin of third, bears three spines on terminal margin, inner one three-eighths as long as joint, outer spine half as long as inner, median spine intermediate in length. There is a further spine, one-eighth as long as joint, on outer margin one-sixth of distance from outer distal angle.

Fifth and sixth pereopods rudimentary but present, and usually visible in dorsal view; represented by two pairs of small tubercles on ventral surface of genital segment, one pair posterolateral, other pair on ventrolateral margin one-quarter of distance from posterior margin. Each tubercle carries two small spines.

Male: Male smaller than the female (2.06mm–2.56mm), about four-fifths as long as female.

Carapace of male very similar to that of female; same length, in proportion to total body length as that of female (1.57mm–1.92mm in length), usually a little longer than wide (1.46mm–1.95mm in width). Major differences are that cross bar of dorsal rib is more deeply curved, curvature being deepest towards midline, while in female, cross bar is an entire even curve.

Eyes are as in female.

Fourth, freely articulated, thoracic segment similar in form to that of female, but slightly different in proportion, being three-fifths as long as wide, and one-sixth as wide as carapace (0.07mm–0.09mm x 0.25mm–0.38mm).

Genital segment rather different from that of female; two-ninths as long as carapace, eight-ninths as long as wide (0.43mm–0.53mm x 0.50mm–0.58mm). Anterior and posterior margins linear, lateral margins entire convex curves, curved to a depth equal to one-fifth their length.

Abdomen of same form as in female (length 0.13mm–0.18mm).

Anal laminae rectangular, same width proportionately as those of female, twice as long as wide. In addition to three long and two short plumose setae found on each caudal ramus in female, male bears another small plumose seta on outer margin, just anterior to outer posterior angle.

First antennae generally as in female, although second joint may be a little wider.

Second antennae differ markedly from those of female. They are as long as the first antennae, two-jointed, second joint one-quarter as long as first. Base subrectangular, six-sevenths as wide as joint is long, four-ninths as long as wide. First joint subrectangular, two-thirds as wide as long at the base, narrowing to half this width distally, distal margin appears slightly serrate. Second joint one-third as wide as long at the base, narrowing to

half this width one-quarter of distance from distal extremity, at which point it divides into two equal divergent branches, which end in sharp points.

First maxillae differ from those of female only in width of basal portion, which is proportionately one-third wider.

Second maxillae similar to those of female except that lateral margins are sublinear, not curved, and basal plate is rather indistinct, though present and of same form as that of female.

Mouth tube is as in female.

First maxillipeds differ from those of female only in two respects. First joint proportionately one-third shorter, and second joint bears a small spine, one-eighth as long as joint on inner margin, three-eighths of distance from inner distal angle.

Second maxillipeds are as in female, except that second joint is, in proportion, half as long again and half as wide again.

Pereiopods, including rudimentary fifth and sixth pereiopods, are as in female.

HOST FISHES: *Pseudolabrus pittensis* Waite 1910 (the banded parrot fish), *P. miles* (Bloch and Schneider), (scarlet parrot fish), and *P. celadotus* (Forster 1801), (spotty).

LOCALITY: Makara, Wellington Harbour and Cape Turakirae.

LOCATION: On dorsal and caudal fins and on the sides of the head and body.

NUMBERS OBTAINED: This information is given below, together with that for *Lepeophtheirus scutiger* Shiino obtained from the same host species.

DISCUSSION

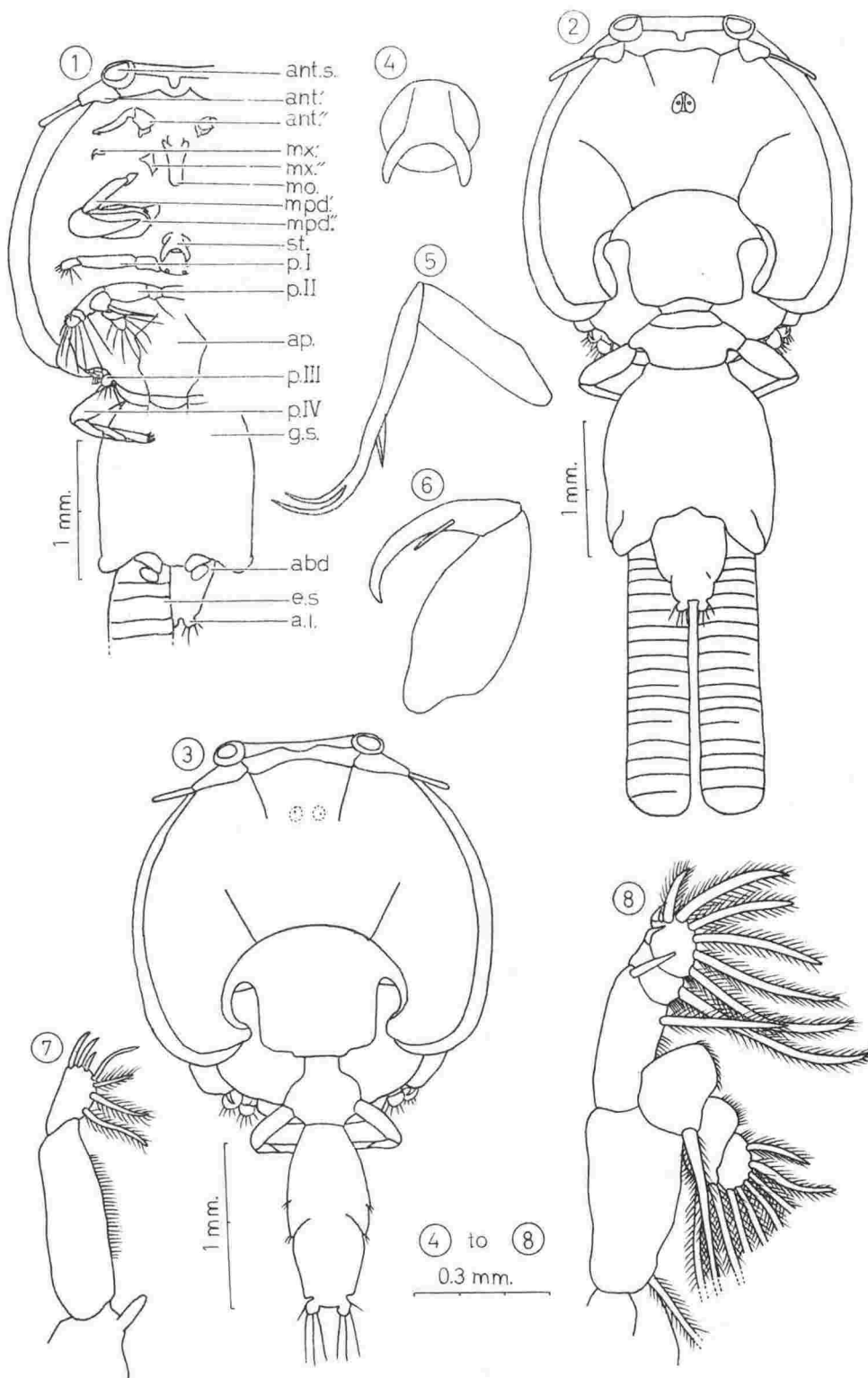
Shiino's specimens are recorded from three species of Labridae, *Pseudolabrus japonicus* (Houttuyn), *Duymaeria flagellifera* (C. and V.) and *Halichoeres poecilopterus* (T. and S.) from Hamazima and some specimens from Sirahama obtained from a bottle in which specimens of the families Blenniidae and Scorpaenidae had been preserved. The type specimens were taken from the first named host.

While there is overall agreement in the details of most appendages, and in general body form, between these specimens and those described by Shiino, there are also marked differences. The size, the female 2.26mm–2.69mm in length, the male 2.06mm–2.56mm is somewhat smaller than those described as the types but agree with the other specimens that Shiino obtained from Sirahama. The colour of the pigment spots in the present specimens is purple while that of Shiino's specimens is given as brown. The sternal furca in the present specimens has straight branches, while those of Shiino's specimens are distinctly curved.

Caligus aesopus Wilson, 1940.

Caligus aesopus Wilson, 1940. *The Natural History of Juan Fernandez and Easter Island* (Ed. C. Skottsberg) p. 72.

Medium sized caligids, coloured yellowish-brown after preservation in alcohol. The anterior suckers are large, the carapace is about half the entire length, wider than long; the fourth segment is wider than long; the genital segment is longer than wide, less than half as wide as the carapace, with well developed posterior lobes in the female. In the female the abdomen is indistinctly two-jointed, the first joint longer than the second, not as long as, but more than half the length of, the genital segment. In the male, the lateral margins of the genital segment and abdomen lie along the same curve, interrupted at their junction only by the rudimentary sixth pereiopods. The anal laminae are small in both sexes.



TEXT-FIG. 4.—*Caligus aesopus*. (1) Ventral view of female. (2) Dorsal view of female. (3) Dorsal view of male. (4) Sternal furca of female. (5) First maxilliped of male. (6) Second maxilliped of male. (7) First pereopod of female. (8) Second pereopod of female.

Carapace subcircular, a little wider than long (2.2mm–2.1mm x 2.21mm–2.49mm), frontal area three-elevenths as wide as carapace, two-thirteenths as long as wide, except where a posterior swelling of lateral portion of posterior margin increases length by two-fifths, anterior margin straight. Anterior suckers large, two-sevenths width of frontal area in diameter, and attached to it by their median halves. Transverse bar of dorsal rib is united with posterior longitudinal branches in an entire curve, having a total length equal to three-quarters the length of carapace, curved anteriorly to three-fifths of the distance from the anterior margin of carapace, posteriorly meeting with posterior sinuses at their most anterior point; posterior longitudinal branches comprise two-fifths of this curve; anterior longitudinal branches are twice this length and diverge sharply. Further small branches occur from posterior branches which run parallel to, and one-fifteenth of width of carapace lateral to posterior sinuses. Posterior sinuses are rather large, one-fifth length of carapace, half as wide as long, narrowing posteriorly. Lateral areas giving appearance of having been truncated posteriorly. Median posterior area as wide posteriorly as frontal area, only just extending posteriorly beyond lateral areas, posterior margin shallowly curved concavely. Flange on lateral areas of moderate width (0.12mm).

Eyes situated midway between crossbar of dorsal rib and anterior margin of carapace, on midline; rather small, being four-fifths the length of the frontal area, half as wide as long; oval, separated anteriorly and posteriorly by a distance equal to half their widths, and by half this distance at their midpoint but never touching.

Fourth freely, articulated thoracic segment unusually large, particularly in length (0.51mm–0.55mm x 0.60mm–0.77mm). Anterior margin two-thirds as long as posterior margin. Lateral margins slightly curved convexly, to a depth equal to one-sixth of their length. Fourth pereopods borne laterally on rectangular medial protrusions from lateral margins, which are one-sixth as long as segment is wide, as wide as long, directed postero-laterally.

Genital segment subrectangular and large (1.34mm–1.45mm x 1.10mm–1.18mm), two-thirds as long as carapace. Two-elevenths of this length is the result of two rather narrow posterolateral lobes, which are three-tenths as wide as segment at their bases, their margins an entire curve, a little pointed posteriorly; separated at their bases by a margin one-third as wide as the segment, straight laterally but the median third emarginated to a depth equal to one-third its length. Angle between this margin and the posterolateral lobes rounded. Straight anterior margin of segment is half as long as segment is wide, segment widening gradually posteriorly until it reaches its maximum width one-third of distance from anterior margin, then maintains this width posteriorly to posterolateral lobes.

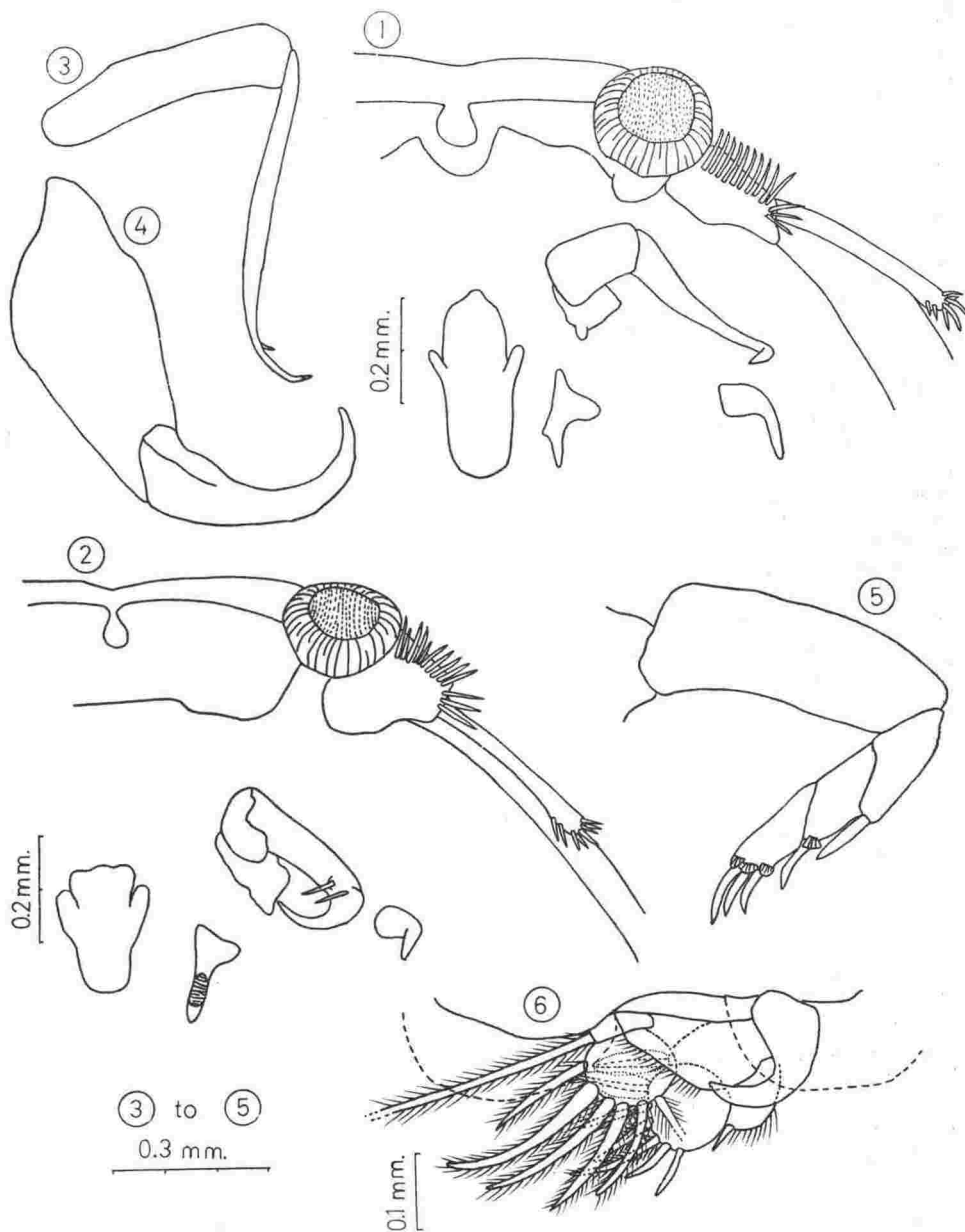
Abdomen indistinctly two-segmented, one-third as long as the carapace, the second segment two-thirds as long as the first (0.65mm–0.72mm x 0.50mm–0.55mm). First segment as wide anteriorly as long, narrowing to three-fifths this width posteriorly, lateral margins an entire curve. Second segment appears to articulate posterodorsally with first, two-thirds as long as wide, subrectangular, lateral margins slightly convexly curved.

Anal laminae small (0.05mm–0.08mm in length), their point of articulation with abdomen being indistinct. Their inner margins are straight and bear rows of cilia along their full lengths; outer and posterior margins united in an irregular curve; each bear three long plumose setae on terminal margins, and another long plumose seta on midpoint of lateral margin.

Egg strings straight, from 1.7mm to 2.1mm in length in specimens in hand, rather small compared to those of other species of the genus, considering length of specimens. They each contain from 14 to 17 eggs.

First antennae two-jointed, three-quarters as long as the frontal area, first joint only three-fifths as long as the unusually long second joint. First joint is seven-eighths as wide as long proximally, narrowing rapidly to three-fifths this width over distal half of its length. Elongate second joint one-eleventh as wide as long proximally, swollen to twice this width over distal fifth of its length, distal margin rounded, attached to outer part of straight distal margin of first joint. First joint bears ten setae on its outer margin, three medially on its distal margin and second joint bears five long setae distally with two shorter setae on inner distal area of terminal margin.

Second antennae two-jointed, equal in length to first, first joint three-sevenths as long as unusually long second joint. First joint set on a rectangular basal plate which is directed posterolaterally, two-thirds as long as first joint, as wide as long, bearing a small, blunt, posteriorly directed spine on its most posterior angle, which is one-quarter as long as plate and as wide as long. First joint of the antenna subrectangular, two-thirds as wide at the base as long, gradually narrowing slightly distally; elongate second joint one-fifth as wide at the base as long, narrowing distally to a sharp point, S-shaped, first shallow



TEXT-FIG. 5.—*Caligus aesopus*. (1) Mouth parts and first antennae of female. (2) Mouth parts and first antennae of male. (3) First maxilliped of female. (4) Second maxilliped of female. (5) Fourth pereiopod of female. (6) Third pereiopod of female.

DESCRIPTION. *Female*: Female of medium size (4.45mm–4.70mm), carapace constituting a little less than half total body length.

curve occupying three-quarters of length, second curve sharp, turning tip ventrally almost at right angles.

First maxillae one-jointed, simple, as long as first joint of second antennae. They are one-third as wide as long for first two-fifths of their length, then narrow abruptly to three-eighths this width and turn posteriorly at right angles to basal portion, ending in a bluntly rounded distal margin.

Second maxillae one-jointed, simple, three-quarters as long as the first, two-thirds as wide at the base as long, narrowing to two-fifths of this width medially owing to deep curvature of outer margin; two-fifths of length of joint the result of spine-like projection of lateral half of distal margin. They do not project beyond mouth tube posteriorly.

Mouth tube on midline of carapace, one-quarter of distance from anterior margin, rather long and narrow, being one-sixth as long as carapace, and one-third as wide as long throughout its length, proximal and distal margins being rounded and entire. Mandibles are contained in mouth tube and each bear twelve teeth distally on their inner margins.

First maxillipeds two-jointed, equal in length to two-fifths width of carapace in this region of body, first joint one-ninth shorter than second. First joint is subrectangular, angles rounded, one-fifth as wide as long; second joint narrow, one-twelfth as wide as long medially, narrowing to three-quarters this width proximally and narrowing distally to joint without a marked articulation with the longer of two terminal spines, which is one-quarter as long as joint. Smaller outer spine one-fifth as long as inner, both spines terminating in sharp points.

Second maxillipeds two-jointed, subchelate, seven-eighths as long as first. First joint one-seventh shorter than second, one-third as wide as long, two-fifths of the distance from proximal margin, narrowing to a blunt point proximally, and more gradually distally to half maximum width. Second joint one-quarter as wide as long at subtriangular base, becoming round in cross-section and narrowing distally to end in a sharp point, whole joint being curved to a depth equal to one-third its length.

Sternal furca on the midline of carapace, three-fifths of distance from anterior margin, and of rather an unusual form. It is situated on a circular base, with a diameter equal to one-twelfth width of carapace, furca arising from this base as two branches which form a semi-circle with an inner diameter equal to three-quarters that of base, branches one-eighth as wide as base throughout their length, their ends rounded or tapering abruptly to a point.

First pereopods three-jointed, two-sevenths as long as carapace. Basipod and terminal joint subequal in length, two-fifths as long as penultimate joint. Basipod subrectangular, three-fifths as wide as long, angles rounded, a spine two-thirds length of joint projecting from inner distal angle. Second joint elongate, subrectangular, three-tenths as wide as long proximally, proximal margin rounded, narrowing distally to two-thirds this width, inner margin bearing a row of long cilia over median three-fifths of its length. Third joint semi-circular, outer margin straight, other three united in an entire curve. It is half as wide as long and bears, on its inner margin, three comparatively short plumose setae which decrease in length distally, longest (most proximal) being only as long as joint, the others shorter. It also bears three claw-like spines on the terminal margin, of which longest (outermost) is half as long as joint, innermost half this length, and median spine intermediate in length. There is also a long nonplumose seta, four-fifths as long as the joint, on inner distal region of margin.

Second pereopod biramose, each ramus three-jointed, basipod two-jointed, and two-thirds the length of the entire first pereopod, exopod subequal in length to basipod and endopod two-thirds this length. First joint of *basipod* one-fifth as long as second, two-thirds as long as wide; junction with second joint rather indistinct, free margins rounded; it bears a single long plumose seta medially on its inner margin, second joint subrectangular, half as wide proximally as long, broadening to half this width again distally; first joint of *exopod* is subrectangular, four-fifths as long as basipod, two-fifths as wide as long, slightly curved; it bears, on outer distal angle, a spine which is one-third as long as joint, and on inner margin, a long plumose seta one-sixth of distance from inner distal angle, as well as row of cilia along the median third of this margin; second joint one-fifth as long as first, twice as wide as long, subrectangular somewhat curved in a proximal direction; it bears a curved, claw-like spine on outer distal angle, a long plumose seta on inner margin, one-third of distance from inner distal angle, and a row of long cilia between this angle and inner proximal angle; terminal joint of *exopod* is suboval, two-thirds as wide as long; it bears a spine, three-sevenths as long as joint, on outermost portion of the margin, six long

plumose setae increasing in length from outer to inner, over terminal and inner parts of margin, and a tuft of long cilia between most proximal of these and inner proximal angle. First joint of *endopod* subrectangular, four-ninths as long as the basipod, as wide as long proximally, narrowing to two-thirds this width distally, proximal margin deeply curved; it bears a long plumose seta on inner proximal angle and a row of curved cirri over entire length of distal margin; second joint attached to proximal two-thirds of inner margin, dorso-laterally. Second joint two-thirds as long as first, two-thirds as long as wide, semi-circular, distal margin straight; it bears two long plumose setae on inner distal angle and rows of cilia on inner and outer margins; terminal joint also semicircular, proximal margin straight, three-quarters as long as second, three-quarters as long as wide. It bears long cilia over outer one-sixth of margin, and six long plumose setae spaced evenly around rest of margin.

Third pereopods have their basipods united to form a broad *apron*, suboval, two-thirds as wide as carapace, half as long as wide, the free lateral and posterior margins surrounded by a flange of same width as that found on lateral areas of carapace, which is entire except for a posterolateral interruption at insertion of rami: *apron* divided longitudinally by two ribs which are separated by half width of *apron* over median half of their lengths, converging to half this distance apart proximally and distally. Each rib carries a long plumose seta on its most posterior point: rami small, three-jointed *exopod* being one-sixth as long as *apron*, two jointed *endopod* half as long as *exopod*. Rami overlap slightly at their distal extremities. First joint of the *exopod* rather unusual, since it is reduced to the large sharp spine which makes up part of this joint in other species of this genus. It is as long as the second and third joints together but curves medially to a depth equal to two-fifths its length so that it overlies second and third joints to some extent; base, which overlies outer part of base of second joint, half as wide as spine is long; second joint subsemicircular, five-sixths as wide as long, distal margin concave at its articulation with third joint, bears a long plumose seta on its inner distal angle, a spine, one-quarter as long as joint, on outer distal angle, and a row of long cilia over distal third of outer margin; third joint is circular, as wide as long, and bears two spines, each two-thirds as long as joint, and four plumose setae on inner two-thirds of free terminal margin; spines to outside of setae, and the latter decrease slightly in length from outermost to innermost: first joint of *endopod* one-quarter as long as second, subrectangular, two-fifths as long as wide, narrowing laterally to two-thirds median length, entire inner margin occupied by the base of a very large plumose seta; second joint of *endopod* oval, four-fifths as long as wide; it bears six long plumose setae over inner three-fifths of free margin. A ventral plate partially obscures both rami in ventral view; it is wide medially, as second joint of *endopod* is long, narrowing to half this width laterally; it extends around the border of *apron* from the midpoint of the first joint of *endopod* to midpoint of base of spine-like first joint of *exopod*; it bears long cilia over inner half of its distal margin.

Fourth pereopods four-jointed, half as long as carapace when straight; three distal joints subequal in length, three-sevenths as long as first; all joints appear to be rather broader than in most species of this genus. First joint two-fifths as wide as long proximally, narrowing to half this width at rounded distal margin; second joint three-sevenths as wide as long, and appears subpyriform, since inner margin is one-tenth as long as outer, proximal and distal margins being equal in length; it bears a sharp spine which is half as long as the joint, on the outer distal angle; third joint rhomboid and bearing, on its outer distal margin, a spine which is guarded at its base by a small semi-circular ribbed flange, which is one-fifth as long as joint; fourth joint one-third as wide as long, outer margin one-third as long as inner; it bears three spines, each with an associated flange similar to that on third joint, and these are spaced evenly on terminal margin; inner spine two-thirds as long as joint, the other two being four-fifths this length.

Fifth pereopods appear to be completely missing in female.

Male: Male comparatively large, being four-fifths as long as female (4.0mm).

Carapace rather similar to that of female (2.2mm x 2.3mm). Major differences are as follows: anterior suckers placed rather higher on base of first antennae so that they are separated by one-quarter more, in proportion, than those of female; anterior branches of dorsal rib straight, not curved, and only one-fifth as long as carapace; unusual short branches of posterolateral branches of dorsal rib as found in female missing in male, and transverse bar and posterolateral branches united in an entire curve.

Eyes indistinct in material examined.

Fourth, freely articulated thoracic segment similar in form to that of female, except that it is narrower, being one-fifth as wide as carapace, and elongated anteriorly to give a total length equal to three-quarters width (0.50mm x 0.64mm).

Genital segment very much smaller than that of female and very different in form; it is subrectangular, one-third as long as the carapace, two-thirds as wide as long posteriorly, narrowing to half this width anteriorly (0.70mm x 0.52mm); posterior margin an entire curve, curved to a depth equal to two-sevenths its length, lateral margins also entire curves; lateral margins of abdomen continue curve of lateral margins of genital segment, and posterior margin of genital segment rather indistinct. This, at first, suggested to the author that this was a juvenile form, but clearing in oil of cedarwood revealed that male sex organs were fully developed.

Abdomen as wide as genital segment anteriorly, narrowing to two-thirds this width posteriorly, as long as wide (0.50mm x 0.52mm). Median five-sevenths of straight posterior margin projects posteriorly for a distance equal to three-tenths this width and bears anal laminae laterally.

First antennae have their bases at a greater angle to the vertical than do those of female and first joint is thus longer in dorsal view and shorter in ventral view; otherwise they are very similar.

Second antennae differ markedly from those of female; base elongated posterolaterally, being twice as long as wide; first joint very much shorter, being one-third as long as joint of first antennae at inner margin, narrowing to two-thirds this width at outer margin; it is twice as wide as long, subreniform, proximal margin being curved convexly to a depth equal to two-sevenths its length, distal margin curved only over the medial half of its length; second joint six times as long as first, one-fifth as wide at base as long, narrowing gradually distally to a sharp point; it is straight and directed laterally for proximal half of length, but distal half curves posteriorly and medially in a semicircle; second joint bears a spine, one-tenth as long as the joint, half way along midline of ventral surface, and another similar spine one-tenth nearer distal extremity.

First maxillae as in female.

Second maxillae in form of simple spines. They are five-sixths as long as first joint of second antennae, five-ninths as wide at base as long, narrowing rapidly to one-third this width one-third of the distance from base, this width being maintained until spine terminates by tapering abruptly to a point; spine carries an oval striated area, which is two-fifths as long as maxilla and commences two-fifths of distance from its base, occupying whole width of maxilla.

Mouth tube as in female. (In the figure it is standing up from the surface.)

First maxillipeds differ markedly from those of the female. First joint subrectangular and elongate, but wider than that of female, being one-quarter as wide as long, proximal margin rounded; it is four-fifths as long as second joint. Second joint one-seventh as wide as long, narrowing slightly distally, bears two spines terminally, inner being three-sevenths as long as joint, outer spine three-quarters length of inner; on inner margin, two-fifths of the distance from end, there is a further spine, one-seventh as long as joint, which is directed rather distally and which bears a triangular chitinous flange extending from whole length of outer margin to a point just proximal to its base.

Second maxillipeds differ from those of female in two respects: first joint stouter, being two-fifths as wide as long; second joint bears a slender spine, one-quarter as long as joint, on midline of its ventral surface one-third of distance from proximal margin.

Sternal furca as in female.

Pereiopods as in female, except that, in male, genital segment bears two pairs of small papillae, representing reduced pereiopods, one pair on posterolateral angles, other on lateral margins, one-quarter of distance from posterior termination of these margins; papillae each bear two short plumose setae.

HOST FISH. *Seriola grandis* Castelnau, 1872 (kingfish, yellow tail or haku).

LOCALITY: New Zealand waters. The collector gives no other information on this point but they were probably obtained in the Wellington area.

SOURCE OF MATERIAL: Four female and one male specimens were obtained by H. Manter in 1958 and presented together with other parasitic Crustacea to the Zoology Department, Victoria University of Wellington.

DISCUSSION

The present specimens can be recognised as *Caligus aesopus* Wilson, on the general body proportions, which agree closely except that the carapace is a little wider than long, while in Wilson's material it is as wide as long. Further, there is agreement in the structure of the sternal furca, the particularly long rudimentary endopod on the first pereopods and the form and armament of the fourth legs. The material differs in size, 4.45mm–4.70mm as against 5.45mm for Wilson's specimens, the lack of the small spine on the outer distal angle of the first joint of the first pereopod, the non-plumose nature of the seta on the inner distal angle of the terminal joint of the first pereopods, and the lack of the rudimentary fifth pereopods on the posterior corners of the genital segment. These latter may, however, have been lost during the preservation of the material. These differences are not particularly significant in the light of the overall agreement of characters.

Wilson had only female specimens, so that this is the first description of the male.

Wilson recorded this species from the Juan Fernandez Islands, "probably from *Seriola peruana*".

Caligus pelamydis Kröyer, 1863

- 1863. *Caligus pelamydis* Kröyer: *Naturhistorisk Tidskrift*, (3), ii, p. 124 (*vide* Stebbing) p. 50, (*vide* Wilson), Pl. 4, figs. 4 a-g.
- 1880. *Caligus pelamydis* Kr. Richiardi: *Catal. Sez. Ital. Esposizione Intern. di Pesca*, Berlin, p. 148.
- 1882. *Caligus pelamydis* Kr. Valle: *Boll. Soc. Adriat. Sc. Nat. Trieste*, VII, p. 1.
- 1885. *Caligus pelamydis* Kr. Carus: *Prodomus faunae mediterraneae*, Stuttgart, p. 357.
- 1896. *Caligus scromberi* Basset-Smith: *Ann. Mag. nat. Hist.*, (6), 18, p. 11, Pl. 111, fig. 2.
- 1899. *Caligus pelamydis* Kr. Brian: *Atti. Soc. linguistica Sci. nat. geogr.*, X, p. 198.
- 1899. *Caligus pelamydis* Kr. Basset-Smith: *Proc. zool. Soc. Lond.*, 1899, p. 452.
- 1899. *Caligus scromberi* Basset-Smith: *Proc. zool. Soc. Lond.*, 1899, p. 450.
- 1901. *Caligus scromberi* B.-S. Scott, T.: *Rep. Fish. Bd. Scot.*, XIX (iii), p. 148.
- 1905. *Caligus pelamydis* Kr. Wilson: *Proc. U.S. nat. Mus.*, 28, p. 549, Pls. XIII, XIV.
- 1906. *Caligus scromberi* B.-S. Scott, A.: *Proc. Lpool. biol. Soc.*, XX, p. 52, Pl. VI.
- 1906. *Caligus pelamydis* Kr. Norman and Scott, T.: *Crustacea of Devon and Cornwall*. London. p. 206.
- 1910. *Caligus pelamydis* Kr. Brady: *Deutch Südpol Exp.*, xi (Zool III), p. 589, fig. 69.
- 1910. *Caligus pelamydis* Kr. Stebbing: *Ann. S. Afr. Mus.*, VI (iv), p. 558.
- 1913. *Caligus pelamydis* Kr. Scott, T. and Scott, A.: *The British Parasitic Copepoda*. London. p. 57 (Vol. 1), Pls. VII, IX, LXXI (Vol. 2).
- 1932. *Caligus pelamydis* Kr. Wilson, C. B.: *U.S. nat. Mus. Bull.*, 158, p. 406, fig. 254.
- 1935. *Caligus pelamydis* Kr. Brian, A.: *Ann. Mus. Stor. nat. Genova*, LVII, p. 183, figs. XII (after Wilson), XIII.
- 1943. *Caligus pelamydis* Kr. Heegaard: *Ark. Zool. Stockholm*, 34A (18), p. 5.
- 1953. *Caligus pelamydis* Kr. Causey: *Publ. Inst. Mar. Sci. Univ. Texas*, III (1), p. 10.
- 1955. *Caligus pelamydis* Kr. Barnard: *Ann. S. Afr. Mus.*, XLI, p. 245.

Caligids in which the anterior suckers are small; the carapace is about one-third the total length, a little wider than long; fourth thoracic segment wider than long; genital segment large, as wide as long, nearly as wide as the carapace, posterolateral lobes poorly developed or missing; abdomen two-segmented, the first segment four times as long as the second, longer than the genital segment; anal laminae of moderate size, colour yellowish-brown in alcohol. Females only in the present collection.

DESCRIPTION. *Female:* Female of moderate size (4.42mm–4.48mm); carapace a little more than a third of this length.

Carapace suboval, a little wider than long (1.40mm–1.42mm x 1.50mm–1.46mm); frontal area half as wide as carapace, two-fifths as long as wide, difficult to see in dorsal view owing to anterior margin of carapace curling ventrally in both present specimens; bordered anteriorly by a flange, one-fortieth the width of the carapace; anterior suckers one-quarter width of frontal plate in diameter; transverse bar of dorsal rib three-eighths width of carapace, curves anteriorly so its midpoint is two-fifths of distance from anterior margin of carapace; anterolateral margins of dorsal rib one-fifth length of carapace, curved to a depth equal to half their length, their anterior terminations separated by a distance one-third greater than width of transverse bar; posterolateral branches pass posteriorly and laterally to be separated by twice width of transverse bar at level of anterior margins of posterior sinuses, then curve medially to terminate at posterior point of lateral margins of these sinuses. Posterior sinuses suboval, two-fifteenths as long as carapace, half as wide as long, open posteriorly, parallel, and separated throughout their width by a subrectangular portion of median posterior area; this portion is half width of carapace and extends beyond the lateral areas for a distance equal to length of frontal areas, terminating in a straight margin, the posterior angles broadly rounded; laterally the sinuses are bordered by a narrow strip of the median posterior area, which separates it from the lateral areas. Lateral areas rounded posteriorly, and carry a uniform flange, one-twentieth width of carapace, on their free margins. Eyes situated in median cephalic region, midway between transverse rib and anterior margin of carapace, rounded, three-quarters length of frontal area in diameter, touching medially but not joining.

Fourth, freely articulated, thoracic segment one-third to one-half as long as wide, one-third width of carapace (0.23mm–0.15mm x 0.43–0.52mm), narrowing to one-quarter this length over lateral quarters of its width.

Genital segment suboval, truncated posteriorly, posterolateral lobes developed poorly or not at all. It is nine-tenths as long as carapace, as long as wide (1.27mm x 1.27mm–1.25mm); narrows to one-third this width anteriorly at junction with fourth thoracic segment, anterior angles sharp, posterior angles rounded.

Abdomen two-segmented, subequal in length to carapace, first segment subrectangular and four times as long as subtrapezoid second segment, (1st segment 1.07mm–1.03mm x 0.48mm–0.51mm, 2nd segment 0.27mm x 0.25mm–0.22mm); first segment half as wide as long, narrowing slightly where it meets genital segment anteriorly and second abdominal segment posteriorly; second segment seven-eighths width of first segment anteriorly but narrows to half this width posteriorly.

Anal laminae situated laterally on posterior margin of second segment of abdomen and occupying almost entire margin, two-thirds as long as second segment of abdomen (0.18mm–0.15mm), subrectangular, angles rounded, two-thirds as wide as long; they each bear three long plumose setae posteriorly and two shorter plumose setae posterolaterally.

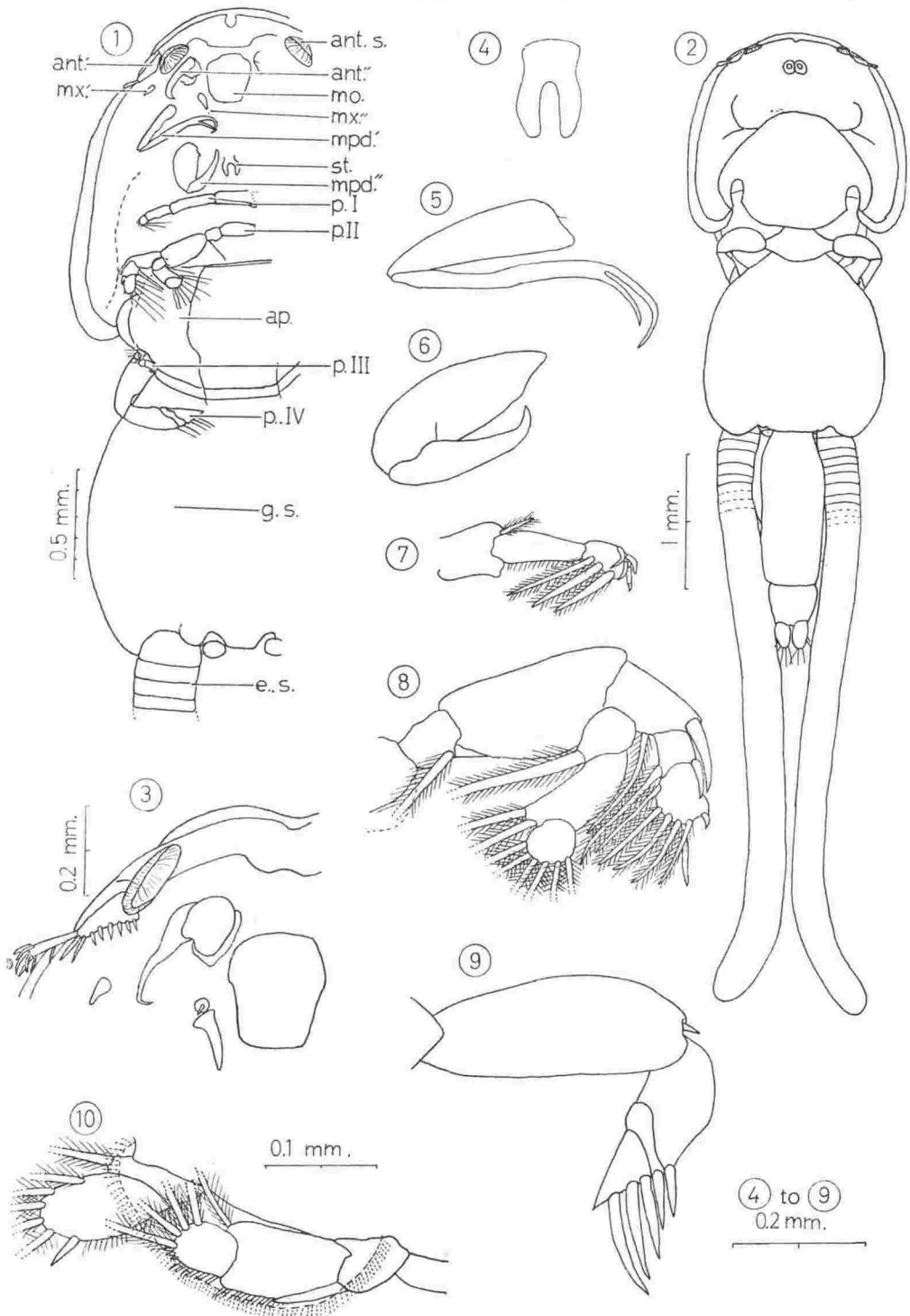
Egg strings were only present on one of the two specimens. In this case they were subequal in length to the body, and each contained 60 eggs. They appear to have a characteristic shape, curving posterolaterally for first one-ninth of their length, then curving posteromedially except for terminal one-fifth of their length, which once more curves posterolaterally, so that they are thrown into a sigmoid curve.

First antennae one-sixth width of carapace in length, two-jointed, joints subequal in length; first joint is half as wide at the base as long, narrowing to half this width distally, bears six short setae on its anterior margin and two longer setae on its outer distal angle; second joint one-quarter as wide as long, and bears six setae distally and a further seta on midpoint of outer margin.

Second antennae half as long again as first, two-jointed, first joint half as long as second; base barely protrudes from under first joint and is without a spine. First joint one-quarter wider than long, narrowing to two-thirds this width distally, angles rounded; second joint two-sevenths as wide at base as long, narrowing distally to a sharp tip, distal quarter of its length sharply curved.

First maxillae one-third as long as first antennae, one-jointed, little curved, half as wide as long at base narrowing to half this width at midpoint, terminal margin bluntly rounded.

Second maxillae half as long as first antennae, simple, spine-like, and extending beyond mouth tube for two-fifths of their length; half as wide as long at base, but narrow rapidly and ending in a sharp point; each have a small spine on a raised boss near their bases.



TEXT-FIG. 6.—*Caligus pelamydis*. Female only. (1) Ventral view. (2) Dorsal view. (3) Antennae and mouth parts. (4) Sternal furca. (5) First maxilliped. (6) Second maxilliped. (7) First pereopod. (8) Second pereopod. (9) Fourth pereopod. (10) Third pereopod.

Mouth tube one-sixth as long as carapace, four-fifths as wide at base as long, narrowing to three-quarters this width distally, terminal margin sublinear.

First maxillipeds seven-tenths as long as carapace is wide, two-jointed, first joint three-quarters as long as second; first joint one-third as wide at base, narrowing to half this width distally, terminal margin rounded; second joint elongate and narrow, one-tenth as wide as long, bearing distally two sharp spines, inner being half as long as joint, outer four-sevenths length of inner.

Second maxillipeds seven-eighths as long as first maxillipeds, two-jointed, subchelate, second joint nine-tenths as long as first; first joint suboval, two-fifths as wide as long at base, which is subtriangular in cross-section, rounded distally, distal margin an entire curve; second joint half as wide at base as long, narrowing distally to a point, and curved to a depth equal to one-quarter its length.

Sternal furca small, one-fourteenth length of carapace, situated on midline, four-tenths of distance from anterior margin of carapace; it is half as wide at base as long, branches simple and three-fifths as long as furca; each branch is half as wide as base and they are separated for most of their length by a distance equal to their width; they are bluntly rounded distally.

First pereiopods short, one-sixth as long as carapace is wide, three-jointed, second joint three-quarters as long as third. *Basipod* long and narrow, and bears a single plumose seta of moderate length on its outer distal angle. Second joint two-fifths as wide at base as long, narrowing distally to two-thirds this width; inner margin straight, outer margin slightly curved; a row of cilia along the full length of the inner margin; third joint subrectangular, two-thirds as wide as long, angles rounded, bearing three long plumose setae on inner margin, three curved spines, four-sevenths as long as joint on distal margin and a curious blunt spine, which has a small hooked spine one-fifth its length on its distal termination, on distal margin beside inner distal angle.

Second pereiopods three times as long as first pereiopods, biramose, each ramus three-jointed. *Basipod* four-sevenths length of pereiopod, two-jointed; first joint one-third length of second, subrectangular, as wide as long, and bearing a single long plumose seta on its inner distal angle; second joint two-fifths as wide as long proximally, increasing to half this width again distally. First joint of *Exopod* is as long as other two together, two distal joints being subequal in length. First joint subrectangular, two-thirds as wide as long proximally, narrowing to one-third this width distally, outer margin straight, inner margin curved; it bears a long plumose seta on inner distal angle and a spine, four-fifths as long as the joint on outer distal angle; second joint subrectangular, as wide as long, distal margin concave, and bears a single long plumose seta on inner distal angle and a spine, as long as joint, on outer distal angle; terminal joint subcircular, outer margin straight, and bears five long plumose setae along the terminal and inner margins, a spine, as long as joint, medially on outer margin, and a spine one-third length of joint on outer distal angle. First joint of *endopod* half length of second and subequal in length to third; it is subcircular, one-third wider than long, inner margin being elongated and serving as base for a long plumose seta; second joint subrectangular, half as wide as long, curving slightly medially, inner distal angle being emarginated to a depth equal to half width of distal margin for insertion of third joint; free portion of distal margin of second joint carries two long plumose setae; third joint circular and bears six long plumose setae spaced evenly over inner and distal parts of its free margin.

Third pereiopods have their basipods united in a broad *apron* which is flattened, suboval, three-quarters as wide as carapace, five-eighths as long as wide; free lateral and posterior margins united in a curve which is entire except for small posterolateral emarginations for insertion of podites; free margins surrounded by a flange, which is entire except for a gap at insertion of podites, and is intermediate in width between those on frontal area and lateral areas of carapace. Apron is divided into three areas by two longitudinal ribs, which are separated anteriorly and posteriorly by a distance equal to one-third width of apron and curve laterally to a depth equal to one-eighth their length; each rib bears a plumose seta, a little longer than flange is wide, on its posterior termination. Rami small, *endopod* being one-ninth length of apron, *exopod* half as long again as *endopod* but closely appressed to margin of apron. *Exopod* three-jointed, first joint two-thirds as long as second and subequal in length to third; first joint in shape of a quarter circle, inner margin being reduced, outer margin curved; it bears a slender spine as long as joint on outer distal angle; second joint subrectangular, three-fifths as wide as long, angles rounded; outer margin bears a row of long cilia along its full length and inner distal angle bears a single plumose seta; terminal joint subrectangular, five-sixths as wide as long, angles rounded; it bears a row of long cilia on its outer margin, three small spines

on outer distal angle, and four long plumose setae on terminal margin. *Endopod* two-jointed, first joint one-quarter length of second. First joint rectangular, three times as wide as long, and bears a long plumose seta on its terminal margin; second joint suboval, two-thirds as wide as long, and bears five long plumose setae on its terminal margin, a spine which is one-third as long as joint on outer distal part of margin, and a row of long cilia on inner part of margin. Bases of rami separated by a distance equal to length of endopod, but because of appression of exopod to apron they appear much closer: all exopod and first joint of endopod covered by a semicircular flange, margin of which bears long cilia along its full length.

Fourth pereopods four-jointed, five-eighths as long as carapace when straight: first joint one-fifth longer than the other three together, second joint as long as distal two together, and third is two-fifths as long as terminal joint. First joint two-fifths as wide as long, suboval, proximal and distal margins rounded; it bears a small spine distally, just outside second joint; second joint distally two-thirds as wide as long, half this width proximally, outer distal angle elongated to one-third length of joint and bearing a spine one-third as long as joint; third joint only two-fifths as long as wide and shortens to half this length towards outer margin; whole of outer margin occupied by base of a spine which is a little longer than preceding joint; terminal joint subtriangular, outer margin completely reduced, thus giving the limb the appearance of ending in a sharp point; terminal margin of joint bears three long spines, outermost a little longer than that of preceding joint, innermost three-quarters this length, median one intermediate in length. Because of shape of terminal joint and shortness of third joint, five spines of last three joints lie close together in a straight line.

HOST FISH. *Thyrstites atun* (Euphrasen, 1791), barracuta or manga.

LOCALITY: Off Cape Turakerae.

LOCATION. On gill covers.

NUMBERS OBTAINED: Two female specimens were obtained from the same host fish. Two other fishes of this species were examined but did not carry this parasite.

DISCUSSION

This species is easily recognised by its short carapace (less than half the entire length), its long two-segmented abdomen, the first joint being more than twice the length of the second, and the very broad ovate genital segment, as well as the rather unusual nature of the fourth pereopods, these features making it distinct from all other described species.

This is the first record of this species from the New Zealand region and the first record of its occurrence on the above host. It has been previously recorded as follows:

Mediterranean area: Kröyer (1863) on *Gymnosarda pelamis*, Richiardi (1870) on *Scomber scombrus*, Carus (1882), Valle (1885), Brian, A. (1899 and 1935), Heegaard (1943) on *Pelamys sarda*.

British Isles: Bassett-Smith (1896 and 1899), Scott, T. (1901), Scott, A. (1906), all on *Scomber scombrus*.

East Coast of the United States: Wilson (1905 and 1932) on *Scomber scombrus*, Causey (1953) on *Pogonias cromis*, *Scomberomorus cavalla* and *Sarda sarda*.

South Africa: Barnard (1955).

Among the descriptions by European authors that of Scott and Scott (1913, p. 57) seems to be among the fullest. There seems to be no significant difference between the specimens described by these authors and the present material. Wilson's description (1905, p. 594) is the most complete so far given. The present material differs from his description as follows: in Wilson's specimens the median posterior area of carapace is less than half the entire width, while here it is

rather more than half the entire width and the median posterior area reaches beyond the midpoint of the carapace, which, Wilson states, does not occur in his specimens. In the present material the abdomen appears to be wider than in Wilson's and the articulations of the abdomen, which Wilson notes as becoming indistinct after preservation in alcohol, were still quite clear in the author's specimens after some months in this preservative. The egg strings here contain 60 eggs each, as opposed to 30 in Wilson's specimens, but as has been noted before, this character is extremely variable in all species of this genus. Wilson also states that in his material the fourth joint of the fourth pereopod is the shortest, while here the third joint is shorter than the others.

Despite these minor differences, the parallel structure of the appendages as well as the features mentioned at the beginning of this discussion leaves no doubt that the specimens here examined belong to the species described by the above authors. It is possible, however, that there are a number of races or subspecies involved. This is suggested by the differences discussed above and also by the variations in the size given for this species by different authors—e.g., Bassett-Smith (1896) 7mm, Scott, T. (1901) 5.5mm, Wilson (1905) 3.5–4mm. The size of the present specimens (4.4mm–4.5mm) is thus between those given by Scott and Wilson. Collections from several different areas would have to be compared before this point could be decided.

***Lepeophtheirus* Nordmann, 1832.**

This diagnosis is based on that of Wilson (1905, p. 615).

Caligids in which the carapace is large and shield-shaped, never folded. Frontal plates without the anterior suckers which are characteristic of the genus *Caligus*; the two joints of the first antennae articulate freely and are heavily armed with setae. Mandibles toothed only on the inner margin. Second maxillae small, bifurcated, the branches acuminate. First and fourth pereopods always uniramous, second and third biramous. Fourth freely articulated thoracic segment short; genital segment usually smaller, never much larger, than the carapace, flattened but not elongated, without plates or processes. Abdomen with one or more segments. Anal laminae strongly flattened and armed with plumose setae. The male usually resembles the female except in size, in the structure of the second antennae and the second maxillipeds, and in the form of the genital segment.

***Lepeophtheirus huttoni* Thomson, 1889.**

This species was originally placed in the genus *Lepeophtheirus* by Thomson (1889, p. 354). It was later correctly transferred to the genus *Gloiopotes* (Family Euryphoridae) by Bassett-Smith (1899, p. 458).

***Lepeophtheirus ericsoni* Thomson, 1890.**

1890. *Lepeophtheirus ericsoni* Thomson: *Trans. N.Z. Inst.*, XXIII, pp. 227–229, Pl. XXIII.

1899. *Lepeophtheirus ericsoni* Thomson, Bassett-Smith: *Proc. Zool. Soc. Lond.*, 1899, p. 455 (spelt *ericsoni*).

1905. *Lepeophtheirus ericsoni* Thomson, Wilson: *Proc. U.S. nat. Mus.*, 28, p. 616.

One adult male and three juvenile specimens of this species were obtained from a single specimen of *Latridopsis ciliaris* (Forster, 1801) Moki. These were examined and identified as the same species as Thomson obtained from this host fish. Unfortunately the specimens were too badly damaged by storage in formalin for more detailed work to be done on them. In so far as structure could be ascertained, they appeared to agree entirely with Thomson's description and figures.

Lepeophtheirus scutiger Shiino, 1952, *Rep. Fac. Fish. Univ. Mie*, 1 (2): 108–112, figs. 13 and 14.

Lepeophtheirus scutiger Shiino. Shen, C. J. 1958. *Acta. zool. Sinica*, 10 (2): 139, Pl. I.

Small caligids with purple-red pigment spots. In the female the carapace is definitely more than half the entire length, as wide as long; the fourth thoracic segment is about three times as wide as long; the genital segment is wider than long, about half the width of the carapace, moderately well lobed, abdomen one-segmented, one-quarter the length of the genital segment or less; furca simple, the branches not bifurcated. The male always smaller than the female, with similar pigment spots (not shown for the male in the text figure).

DESCRIPTION. *Female:* Rather small compared to other species of this genus (3.82mm–4.34mm in length).

Carapace subcircular, two-thirds total length of body, sometimes a little wider than long (2.45mm–3.0mm x 2.62mm–3.05mm); frontal area half as wide as carapace, one-twelfth as long as wide, curved to a depth equal to twice this length, narrowing slightly laterally; transverse bar of dorsal rib curved slightly forward, its midpoint central in carapace, five-ninths as wide as carapace; anterior longitudinal branches one-fifth length of carapace, diverging by one-fifteenth their posterior distance apart over posterior third of their length, then subparallel; posterior branches one-third length of carapace, inclined laterally to increase their distance apart by one-quarter at a point two-ninths of distance from their posterior termination, then converging sharply to nearly their anterior distance apart; posterior sinuses small, suboval and broad, as wide as flange on lateral areas, one-third longer than wide; lateral areas rounded posteriorly; median posterior area between two sinuses as wide as frontal area posteriorly, a little wider anteriorly, posterior margin slightly curved, extending posteriorly beyond lateral areas for a distance equal to length of frontal area. Eyes situated on mid-line, one-quarter of distance from anterior margin of carapace, well developed, as long as the frontal area, half as wide as long, separated posteriorly by a distance equal to their width, touching but not fusing anteriorly. Flange on lateral areas of carapace of moderate width considering the size of animal (0.05mm–0.08mm), narrowing slightly anteriorly and posteriorly; flange on frontal area half this width.

Fourth, freely articulated, thoracic segment one-thirteenth length of carapace, narrowing to two-fifths this length laterally, four times as wide as long (0.12mm–0.25mm x 0.60mm–0.82mm); lateral one-seventh of segment turned posterolaterally before articulating with fourth pereopods; segment articulates with genital segment over median five-sevenths of posterior margin.

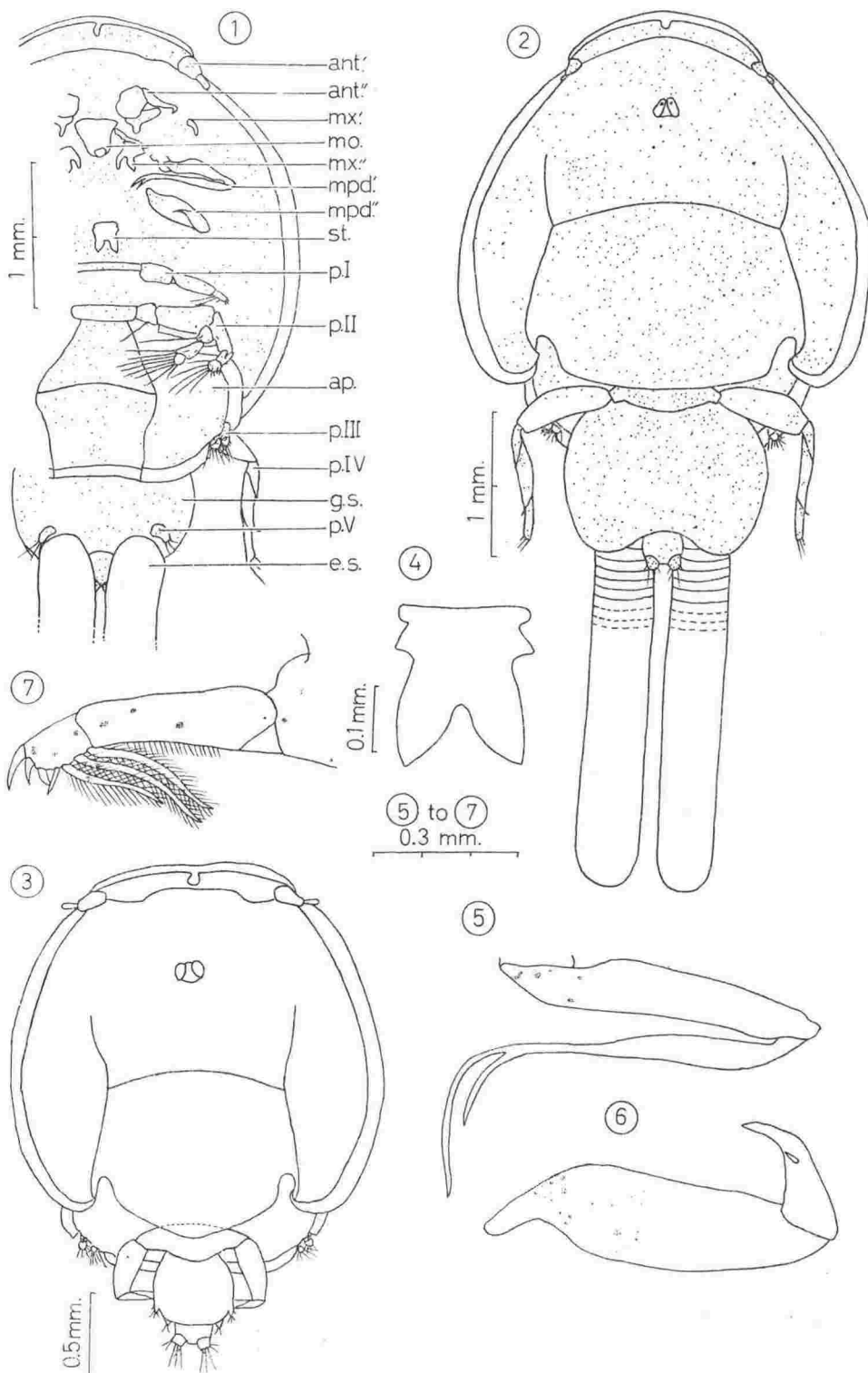
Genital segment subcircular, half as wide as carapace, distinctly wider than long (0.90mm–1.21mm x 1.28mm–1.61mm); lateral lobes broad and short, equal to one-seventh length of segment, they are one-third its width at their bases, bases joined by a margin one-fifth as wide as segment, which is curved concavely to a depth equal to one-seventh its length; ends of lobes bluntly rounded, their lateral margins included with lateral margins of segment in entire curves.

Abdomen subrectangular, one-segmented, rather small, as wide as long (0.15mm–0.29mm x 0.16mm–0.27mm), narrows anteriorly and posteriorly to six-sevenths its maximum width; posterior margin straight and emarginated for one-third its width laterally for insertion of anal laminae.

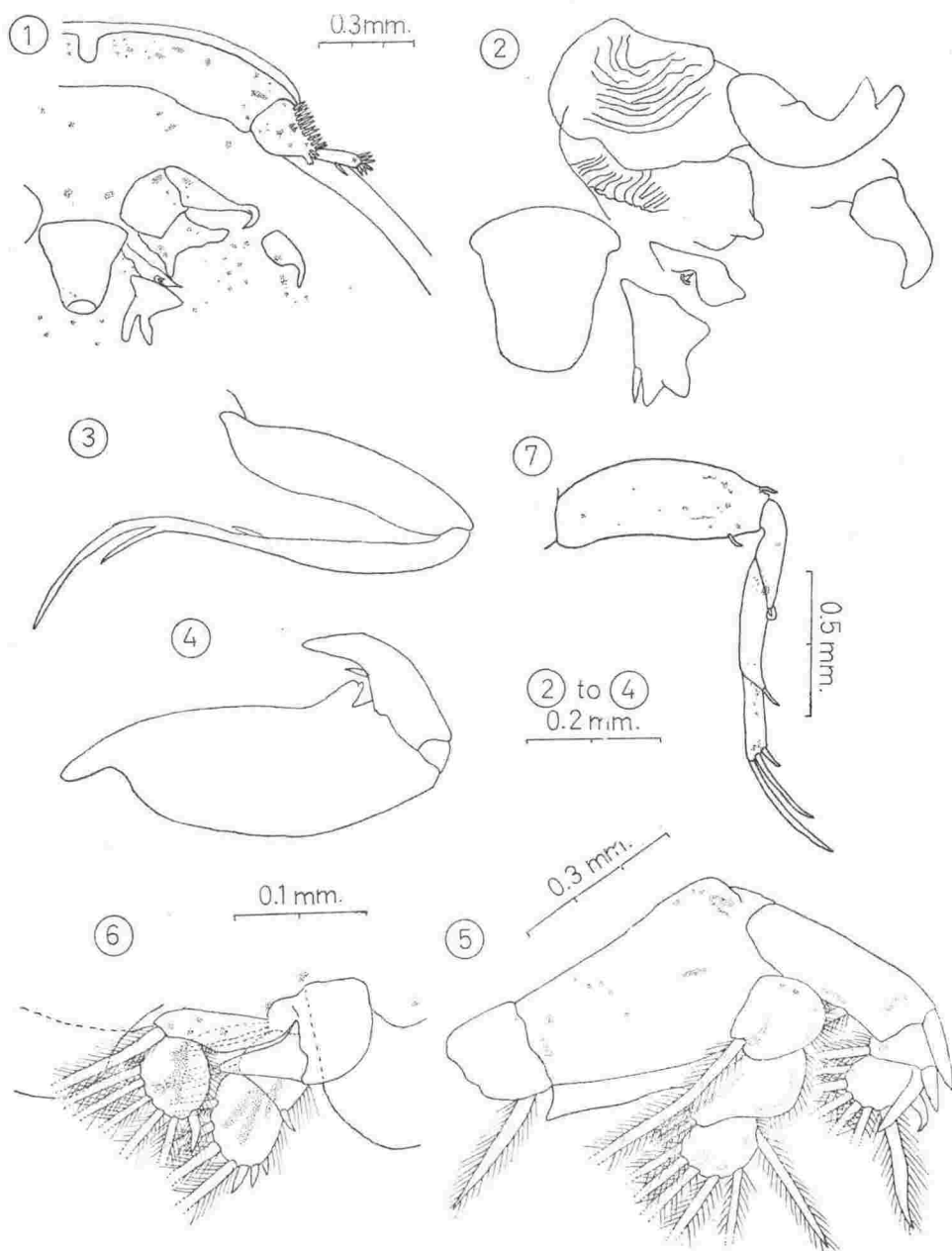
Anal laminae very short (0.06mm–0.12mm), as wide as long posteriorly, one-quarter wider at their bases, subrectangular, posterior angles rounded, posterior margins each bearing small plumose setae on their inner and outer angles and two long plumose setae terminally.

Egg strings very variable in length (1.35mm–2.27mm), and also varying in number of eggs contained, but in general the number is small as compared to other members of this genus, being generally from 20 to 34 per egg string.

First antennae two-jointed, very short, one-eleventh width of carapace in length, first joint one-quarter longer than second; first joint three-quarters as wide as long over its proximal half, after which inner margin curves sharply to reduce distal width to three-sevenths proximal; second joint elongate, one-quarter as wide as long, distal margin rounded; first joint bears 12 hairs on its outer margin and two short hairs in middle of ventral



TEXT-FIG. 7.—*Lepeophtheirus scutiger*. (1) Female, ventral view. (2) Female, dorsal view. (3) Male, dorsal view. (4) Female, sternal furca. (5) Female, first maxilliped. (6) Female, second maxilliped. (7) Female, first pereopod.



TEXT-FIG. 8.—*Lepeophtheirus scutiger*. (1) Female, mouth parts and first antenna. (2) Male, mouth parts. (3) Male, first maxilliped. (4) Male, second maxilliped. (5) Female, second pereopod. (6) Female, third pereopod. (7) Female, fourth pereopod.

surface, distal margin has two long hairs placed just medial to inner distal angle, which is elongated to one-fifth length of joint and slightly forked at tip; second joint bears six long hairs terminally and a further long hair in a median position on inner margin.

Second antennae two-jointed, two-fifths longer than first antennae, first joint two-fifths as long and half as wide again as second. The basal plate subtriangular, twice as wide as first joint posteriorly, narrowing to its width at articulation, half as long as wide and bearing on inner posterior angle a spine which is half as long as the base, and half as wide at base as long, rounded terminally; first joint is square, inner margin almost completely reduced but outer margin long and L-shaped; second joint elongate, two-sevenths as wide at base as long, narrowing to one-sixth this width two-thirds of distance from proximal margin, maintaining this width until it ends abruptly in a sharp point; distal one-third of the joint curves abruptly away from body.

First maxillae one-jointed, simple, half as long as second joint of second antennae, each one three-quarters as wide as long for first half of its length, then narrows rapidly, owing to curving of inner margin, to one-third previous length, then narrowing still further distally to terminate in a sharp point; distal half curved to a depth equal to width of joint.

Second maxillae one-jointed, as long as first maxillae, bifurcated distally, eight-ninths as wide at the base as long, narrowing to half this width just above the base, then narrowing more slowly to four-fifths this width before dividing into two unequal branches at midpoint; branches subequal in width at their bases, inner one narrowing to four-fifths this width distally before terminating in a rounded margin, other widening slightly at its midpoint before narrowing distally to half its basal width and terminating in a rounded margin; both branches curve laterally, outer branch more strongly than inner. At bases of maxillae are small elongate plates, one-third wider than bases of maxillae, one-fifth as wide as long, running from proximal lateral angles of mouth tube to outer proximal angles of maxillae, touching maxillae at midpoints of their bases; these plates each bear small spines, half as long as plates are wide, on raised bosses, very close to midpoints of bases of maxillae.

Mouth tube median in position, three-elevenths of distance from anterior margin of carapace; tube itself half this distance in length, nine-tenths as wide at the base as long, narrows to three-fifths of this distance at the midpoint and then narrows more slowly to two-fifths proximal width before terminating in a rounded mouth. Mandibles carried in mouth tube and each bears twelve sharp teeth on inner surface distally.

First maxillipeds two-jointed, equal in length to half width of carapace in this region of body. First joint two-thirds length of second, elongate, one-sixth as wide as long at widest point, three-tenths of distance from proximal margin, narrowing rather rapidly to one-fifth this width proximally, proximal margin rounded, narrowing more slowly to half greatest width distally; second joint one-tenth as wide as long at midpoint, narrowing slightly proximally and very sharply to half this width just beyond midpoint, maintaining this width to distal margin, which bears two spines, of which inner one is half length of joint, outer one half this length. Base of each spine is half width of distal margin, and both end in sharp points.

Second maxillipeds two-jointed, subchelate. First joint subequal in length to first joint of first maxillipeds, second joint three-sevenths this length; first joint one-quarter as long as wide three-sevenths of distance from proximal margin, narrowing rapidly to one-fifth this width and turning somewhat posteriorly before terminating in rounded proximal margin, narrowing more gradually distally to half greatest width, distal margin also rounded; second joint three-eighths as wide at base as long, narrowing gradually to terminate distally in a sharp point; distal two-fifths of joint curved to a depth equal to basal width; joint bears a small spine, one-eighth the length of the joint, centrally on ventral surface.

Sternal furca situated on ventral midline of carapace, three-fifths of distance from anterior margin, one-eleventh as long as carapace, seven-ninths as wide at base as long; base rectangular, all four angles a little produced; furca narrows immediately above base to three-quarters its basal width and then widens again to nearly basal width before dividing into two equal branches, four-sevenths of distance from base; two branches diverge at 45°, maintaining their basal width for half their lengths, then narrowing abruptly to end in sharp points.

First pereopods three-jointed, one-quarter as long as carapace is wide. Basipod is three-quarters as long as second joint, third joint one-third length of second; basipod subrectangular, two-thirds as wide as long, second joint articulating with the posterior part of the outer margin; second joint subrectangular, one-third as wide as long proximally, narrowing to two-thirds this width distally, proximal margin rounded, bearing a row of cilia along median two-thirds of inner margin; third joint is subrectangular, inner distal

angle rounded, two-sevenths as wide as long; it bears three stout spines on terminal margin, outermost four-fifths as long as joint, innermost half this length and middle spine intermediate in length; it also bears a slender non-plumose seta, which is two-thirds as long as joint, immediately proximal to inner distal angle and three long plumose setae spaced evenly on inner margin, two most proximal setae subequal in length, most distal seta shorter.

Second pereopods biramose, each ramus three-jointed, basipod two-jointed. Basipod two-thirds as long as entire first pereopod, exopod as long as basipod and endopod three-quarters this length. First joint of *basipod* one-quarter as long as second, subrectangular, three-quarters as long as wide, inner proximal angle rounded and bears a long plumose seta medially on inner margin. Second joint as wide as first proximally but widens distally by three-quarters this width, distal margin irregularly rounded, and bears a flange, two-fifths proximal width of joint, along full length of inner margin. Second joint of *exopod* one-quarter as long as first, third two-thirds as long as second. First joint subrectangular, one-third as wide as long, proximal margin rounded; it bears a long plumose seta on inner margin, one-third of distance from inner distal angle, a row of long cilia from this seta to inner proximal angle and a sharp spine, two-thirds as long as joint, on outer distal angle; second joint subsemicircular, distal margin straight, two-thirds as wide as long, and bears a long plumose seta on its inner distal angle, a row of cilia along its inner margin and a spine, half as long as that on first joint but of equal basal width, on outer distal angle; third joint is subcircular, as wide as long, proximal margin straight; it bears a spine, as long as joint, on its outer proximal angle, and a further spine at midpoint of outer margin, two-thirds as long and dorsal to proximal spine; joint also bears six long plumose setae around terminal and inner parts of margin. Second joint of *endopod* is half as long again as first, third being three-quarters length of first. First joint is subcircular, as wide as long, proximal margin straight, outer part of margin four times inner, proximal and distal parts subequal; it bears a row of long cilia over distal third of outer margin and a long plumose seta on inner margin; second joint subpyriform, half as wide as long medially but narrowing to two-thirds this width proximally and half this width distally as a result of curving of outer margin; it bears a row of long cilia along free outer margin and two long plumose setae terminally; third joint is borne on terminal third of outer margin and is subcircular, proximal margin straight, as wide as long and bears six long plumose setae on free terminal margin, decreasing in size from inner to outer, bases of inner setae more crowded; there is a small tuft of cilia between most proximal outer seta and outer proximal angle.

Third pereopods have their bases united to form broad apron found in other members of this genus. *Apron* suboval, five-sevenths as wide as carapace, half as long as wide; free lateral and posterior margin surrounded by a flange, subequal in width to those on lateral areas of carapace, which is entire except for posterolateral interruptions for insertion of rami; apron divided longitudinally by two ribs which are separated by half width of apron at their midpoint, by one-third this distance anteriorly and two-thirds this distance posteriorly; connected at their midpoint by a transverse rib; each longitudinal rib bears, posteriorly, a plumose seta as long as posterior part of flange. Rami small, three-jointed exopod being one-ninth as long as the apron, two-jointed endopod half this length. The exopod and endopod are turned in towards each other so that their setae overlap and the rami themselves nearly overlap. In *exopod* first joint is half length of exopod and overlaps second, which is two-thirds as long as first and subequal in length to third; first joint subrectangular, as wide as long, outer distal angle broadly rounded; outer three-quarters of joint swollen and overlaps second joint distally; inner margin of swollen portion bears a stout inwardly directed spine distally, spine as long as joint, two-thirds as wide at base as long, ending in a rather blunt point; there is a plumose seta carried on inner distal angle; second joint subsemicircular, distal margin straight, others forming an entire curve, as wide as long; it bears a plumose seta on its inner distal angle, a spine, three-sevenths as long as joint, on outer distal angle, and a row of cilia along distal two-thirds of outer margin; third joint similarly shaped, in this case proximal margin being straight; it bears four plumose setae on outer distal part of free margin, a row of long cilia over outer part of margin, and three spines on outermost part of margin, innermost two-fifths as long as joint, outermost half this length and other intermediate in length. First joint of exopod short and broad, three-sevenths as long as second, three times as wide as long, second joint borne on the innermost part of distal margin, proximal margin a little longer than distal, inner margin being angled so that long plumose seta it bears is directed posterolaterally; second joint subcircular, as wide as long, and bears six plumose setae on inner distal part of its free margin; inner and outer parts of free margin, not occupied by setae, carry long cilia.

Fourth pereopods four-jointed, four-sevenths as long as carapace when straight. Second joint half as long as first, third one-seventh longer than second, and fourth one-

fifth shorter than second. First joint subrectangular, one-third as wide as long as the midpoint, narrowing to half this width proximally and distally; it bears two non-plumose setae, one on outer margin, other on inner, both close to distal angles; second joint subpyriform, one-quarter as wide as long, inner margin two-sevenths length of outer which meets distal margin in an acute angle; it bears a rudimentary spine, one-tenth as long as joint, on outer distal angle, partially surrounded by a semicircular flange which is half as long again as spine; third joint subrectangular, one-quarter as wide as long, outer margin two-thirds as long as inner, and bears a spine, one-sixth as long as joint, on outer distal angle; third joint subtrapezoid, one-quarter as wide as long, the outer margin two-thirds as long as inner, and bears three spines on terminal margin, inner one as long as third joint, outer spine one-fifth this length and middle spine intermediate in length. No spines except that on second joint, have associated flanges.

Fifth pereopods represented by unusually large protuberances, one-seventh as long as genital segment on which they are situated; they are found on the ventral surface of this segment close to point of origin of external egg strings; they are two-thirds as wide as long in rounded proximal region, narrowing to two-thirds this width in more elongate distal region. They each bear three long setae distally.

Male: Male is considerably smaller than female (2.30mm–4.34mm) partly as result of very much smaller genital segment.

Carapace comprises about three-quarters of total length and is about as wide as long (1.67mm–2.21mm x 1.55mm–2.17mm). Frontal area similar in proportions to that of female, but curves anteriorly to a depth equal to only two-fifths its length, and also differs in possessing posterior swellings, which increase its length by half over lateral one-fifth of its width on either side. Transverse bar of the dorsal rib situated one-eleventh of length of carapace further back than in female, and is only half as long as carapace is wide; anterolateral branches of dorsal rib rather straighter than in female. Posterior margin of the median area projects twice as far, posteriorly, as in female, and is in form of a curve one-fifth as deep as margin is long and slightly pointed medially. Eyes situated halfway between transverse bar and anterior margin of carapace, as in the female, but differ in that they do not quite touch anteriorly.

Fourth, freely articulated thoracic segment resembles that of female in shape but is a little narrower and longer (0.13mm–0.17mm x 0.33mm–0.50mm).

Genital segment one-quarter length of carapace, subrectangular, as wide as long (0.45mm–0.52mm x 0.45mm–0.52mm). It narrows to two-thirds its widest (median) width anteriorly and to three-quarters this width posteriorly, lateral margins curved, posterior angles rounded; it bears two pairs of papillae, presumably representing obsolete fifth and sixth pereopods; first of these carried laterally, one-fifth of the distance from posterior margin, each bearing three short plumose setae terminally and another even shorter plumose seta laterally at its base; other papillae placed laterally on posterior margin and each bears two plumose setae.

Abdomen broader than in female, being three-fifths as long as wide (0.13mm–0.17mm x 0.20mm–0.27mm).

Anal laminae one-third longer than in female, (0.10mm–0.15mm in length), but are similarly armed.

First antennae as in female.

Second antennae same length as first antennae, two-jointed, first joint subequal in length to second. Base subrectangular, as wide as first joint is long, half as long as wide, and carries first joint medially. It bears a small, blunt spine on outer margin and a striated area along median third of its length, over inner half of its width; first joint subrectangular, three-quarters as wide as long, narrowing to two-thirds this width distally; has a raised striated area, striations arranged in concentric semicircles about the midpoint of outer margin, largest semicircle having a diameter equal to two-thirds length of joint; second joint one-third as wide, at the base, as long, narrowing to half this width at midpoint and maintaining it throughout rest of its length, including lateral margins of two equal branches produced by a forking of joint one-sixth of distance from its end; joint is curved almost into a semicircle.

First maxillae very similar to those of female except that distal half of single joint is rather thicker.

Second maxillae subequal in size to those of female and are associated with a similar plate. However, they do not branch until one-quarter of distance from end of joint, and

by comparison with those of female they are one-third broader from midpoint to distal termination, including branches, which are short and stout but are sharply pointed distally. Maxillae armed with single spines on their inner margins, which are directed distally from same level as branches and are subequal in length to branches.

First maxillipeds very similar to those of female, differing only in rather broader nature of first joint, which is two-ninths as wide as long, and in that each is armed with a small spine, one-sixteenth as long as joint and directed distally, which is found on inner margin, two-thirds of distance from proximal angle.

Second maxillipeds twice as long as first joint of first maxillipeds, second joint half as long as first. First joint one-third as wide as long over distal three-quarters of its length, narrowing rapidly by a sudden curvature of outer margin to one-quarter this width proximally; there is a large protrusion on joint, one-tenth as long as joint, and as wide at base as long, placed one-thirteenth of distance from distal angle; it appears that second joint closes against this protrusion; second joint three-sevenths as wide, at base, as long, narrowing distally to a sharp point and curved to a depth equal to one-quarter its length; it bears a spine, medially on inner margin, which is one-seventh as long as joint.

Sternal furca, *mouth tube* and *pereiopods*, except for rudimentary fifth and sixth pereiopods described above, as in the female.

HOST FISHES: *Pseudolabrus miles* (Bloch and Schneider), the scarlet parrot fish, *P. celidotus* (Forster, 1801), the spotty and *P. pittensis* Waite, 1910, the banded parrot fish.

LOCALITY: Wellington Harbour.

LOCATION: On head, sides and fins in all three host species.

NUMBERS COLLECTED: The numbers of *Caligus brevis* (described above), which were taken from the same three host species will also be given here.

From *P. miles*: 13 of these fish were examined. Three of these yielded no specimens of either parasite, one was infected only with *C. brevis* and three with only *L. scutiger*. A total of eight females, eight males and four juveniles of *L. scutiger* and nine females, 12 males and one juvenile of *C. brevis* were obtained from these fishes.

From *P. pittensis*: Only two specimens were examined. Of these one was infected with a single female specimen of *C. brevis*, the other, carrying two female specimens of *C. brevis* and 11 female, five male and six juvenile specimens of *L. scutiger*. Reports from spear-fishermen appear to indicate that this species is usually more heavily parasitised by "sea lice" than either of the other host fishes.

From *P. celidotus*: This species appears to be the least heavily infected: 40 fishes were examined, of which 24 were not infected with either parasite, three of the remaining 16 carrying one juvenile *L. scutiger* each. A total of seven females, 13 males and one juvenile *C. brevis* were taken from this host, though no one fish carried more than three specimens.

DISCUSSION

This species was originally described by Shiino (1952) from specimens obtained from *Hexagrammos otakii* Jordan and Starks, at Momotori, Mie Pref. and later by Shen (1958) from the former host at Da-lien, Liaoning province and also from *Platichthys bicoloratus* (Basilewsky) from a fish market at Antung, Liaoning Province. The present material differs from the type material as follows: they differ in size, 3.80mm–4.34mm as against 3.45mm in Shiino's specimens, but overlap the size range of Shen's specimens, 3.60mm–4.58mm; the fourth thoracic segment is relatively shorter in the present material; the pigment spots

found on all segments, are rapidly lost in alcohol in the present material, but Shiino states that the pigment spots of his specimens are retained in alcohol; the seta on the inner distal angle of the terminal joint of the first pereopod is non-plumose here but plumose in Shiino's material; the flange on the outer region of the first joint of the exopod of the second pereopods is lacking, as are the small flanges shown at the bases of the four most distal spines of Shiino's and Shen's specimens; the basal joint of the fourth pereopod is shorter here than in Shiino's and the four most distal spines are not serrated as they are in Shiino's and Shen's specimens; the branches of the sternal furca are not curved as in Shiino's material and in this the present material is similar to Shen's. The author considers that the above differences are insufficient to allow the proposal of a new species for the present material considering the overall similarity of body form and the general form of the appendages.

It is interesting to note that *L. scutiger* occurs here with *Caligus brevis* Shiino on fishes of the family Labridae, but that unlike *C. brevis* which occurs on a labrid in Japan also, it is found on a member of the Hexagrammidae in Japan and China.

Lepeophtheirus polyprioni n.sp.

Caligids in which the female is moderately large, pale yellow-brown in alcohol; the carapace definitely more than half the entire length, a little wider than long; the fourth thoracic segment three times as wide as long; the genital segment wider than long, about half as wide as the carapace, with well developed lobes; the abdomen two-segmented, the first segment twice as long as the second, altogether about one-third the length of the genital segment. The males always much smaller than the females.

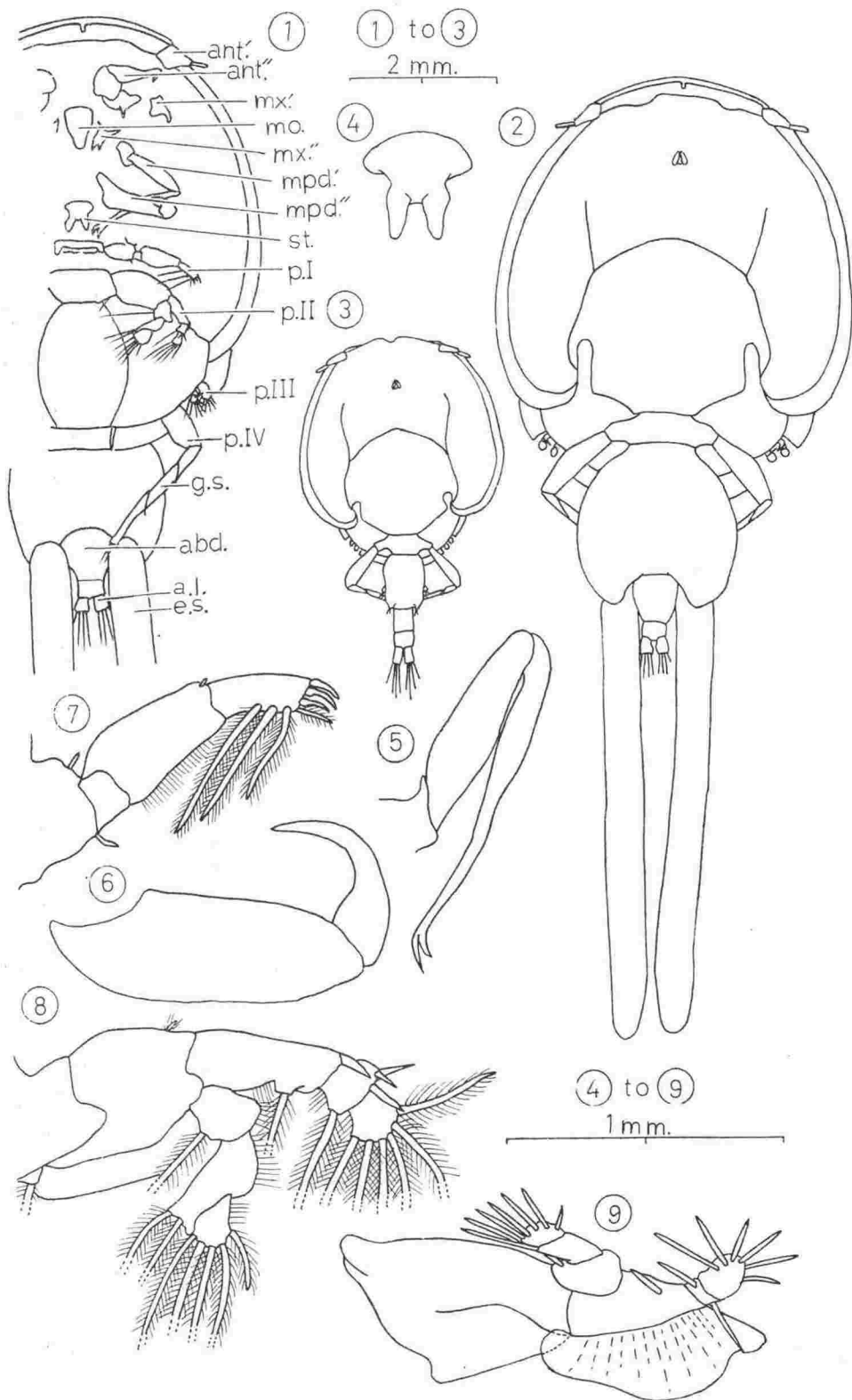
DESCRIPTION. *Female:* Females of this species large compared to those of other species of this genus (7.70mm–8.25mm), carapace normally three-fifths length of animal.

Carapace sub-ovate, a little wider than long (4.80mm–4.95mm × 4.80mm–5.20mm); frontal area half as wide as carapace and one-tenth as long as wide; it is curved anteriorly to a depth equal to twice its length, and swells posteriorly over lateral one-fifth of its width to twice its median length. Transverse bar of dorsal rib curved anteriorly, its junctions with longitudinal branches being two-thirds of distance from anterior margin of carapace, its midpoint one-eighth nearer this margin; anterior longitudinal branches of dorsal rib straight, one-fifth length of carapace and diverge slightly; posterior longitudinal branches three-tenths as long as carapace, straight and diverging by one-quarter their anterior separation for first three-quarters of their length, then incline slightly towards each other before terminating at posterior sinuses. Posterior sinuses long and narrow, as wide as flange on lateral areas, three times as long as wide, parallel to each other, bounded laterally by a strip of median posterior area which is only three-quarters width of sinuses. Lateral areas rounded posteriorly; median posterior area as wide as frontal area but tapers abruptly to half this width posteriorly, then terminating in a straight margin; it extends beyond sinuses for a distance equal to posterior width of flange on lateral areas. Eyes small, one-sixtieth length of carapace, situated three-tenths of distance from anterior margin of carapace; they are two-fifths as wide as long, separated by a distance equal to half their length posteriorly, touching but not joined anteriorly. Flange on lateral margin of carapace moderately wide (0.15mm–0.21mm).

Fourth, freely articulated thoracic segment broad but very short (0.50mm–0.55mm × 1.25mm–1.60mm); it is subrectangular, narrowing slightly laterally to articulation with the genital segment, lateral margins rounded.

Genital segment subcircular, a little wider than long, about half width of carapace (2.0mm–2.40mm × 2.05mm–2.65mm); subsemicircular posterolateral lobes, which are very slightly pointed posteriorly, make up one-fifth of length of segment; lobes separated anteriorly by a straight margin one-sixth width of segment, and posteriorly by a distance equal to half width of segment.

Abdomen subtrapezoid, two segmented, one-sixth length of carapace, second segment half as long as first (1st segment 0.48mm–0.61mm × 0.50mm–0.55mm; 2nd segment 0.22mm–



TEXT-FIG. 9.—*Lepeophtheirus polyprioni* n.sp. (1) Female, ventral view. (2) Female, dorsal view. (3) Male, dorsal view. (4) Female, sternal furca. (5) Female, first maxilliped. (6) Female, second maxilliped. (7) Female, first pereiopod. (8) Female, second pereiopod, view from ventral aspect. (9) Female, second pereiopod, view from posterior aspect.

–0.30mm (length)); first segment widest at base, narrowing to half this width posteriorly; second segment rectangular, one-quarter wider than long, emarginated posterolaterally for insertion of anal laminae.

Anal laminae rectangular, a little shorter than second segment of abdomen (0.16mm–0.25mm), separated at their bases by a distance equal to half their widths and bear three long plumose setae terminally and one smaller plumose setae, half length of others, posterolaterally.

Egg strings vary considerably in length and in number of eggs. Generally they are about three-quarters length of body (2.60mm–6.52mm) and they usually contain from 80 to 100 eggs each, although some specimens have much fewer.

First antennae small, two-fifteenths width of carapace in length, two-jointed, first joint twice length of second. First joint subcircular in cross-section, two-fifths as wide at base as long, narrowing to one-third this width distally; second joint rectangular, one-fifth as wide as long; outer margin of first joint bears 12 hairs and second joint eight hairs on its distal margin, a further single hair being situated on inner margin, one-third of distance from inner distal angle.

Second antennae two-thirds as long again as first antennae, two-jointed, first joint half as long as second. They are each situated on a base which is as wide as first joint is long, four-fifths as long as wide, subrectangular, margins uneven; posteriorly it bears a single spine, half as long as base, half as wide at base as long, slightly pointed distally; first joint subrectangular, five-sixths as long as wide, curved slightly laterally; second joint elongate, S-shaped, second curve directed ventrally from body and about half as long as first; it is two-fifths as wide as long at base and terminates in a sharp point.

First maxillae as long as first joint of second antennae, one-jointed, the proximal margin is V-shaped, point medial to joint; joint half as wide as long at base, narrowing to two-thirds this width over proximal three-fifths of joint, then narrowing sharply to one-third basal width and curving in a quarter circle, tip bluntly rounded.

Second maxillae as long as first maxillae, one-jointed, bifurcated distally, and extend beyond mouth tube for one-third of their length; they are four-fifths as wide at base as long, narrowing to one-half this width at midpoint, widening again by one-quarter this width before dividing into two uneven forks two-thirds of distance from base; inner margin of each fork curved laterally, outer margins straight, inner fork being two-thirds as wide at base and one-third longer than outer, angle between them about 20°. At base of each maxilla there is a small rectangular plate, parallel to and nearly as wide as the base; one-third as long as wide and which have associated with their posterior margins small raised bosses, each bearing two small spines, outer spine half width of plate in length, inner spine half this length.

Mouth tube median in position, small, as long as base of second antenna is wide, twice this distance from anterior margin of carapace; it is three-quarters as wide as long at base, narrowing to half this width half way along its length, and further to one-third the basal width distally; distal margin rounded. Mandibles contained within mouth tube, and each bear twelve teeth on their inner margins distally.

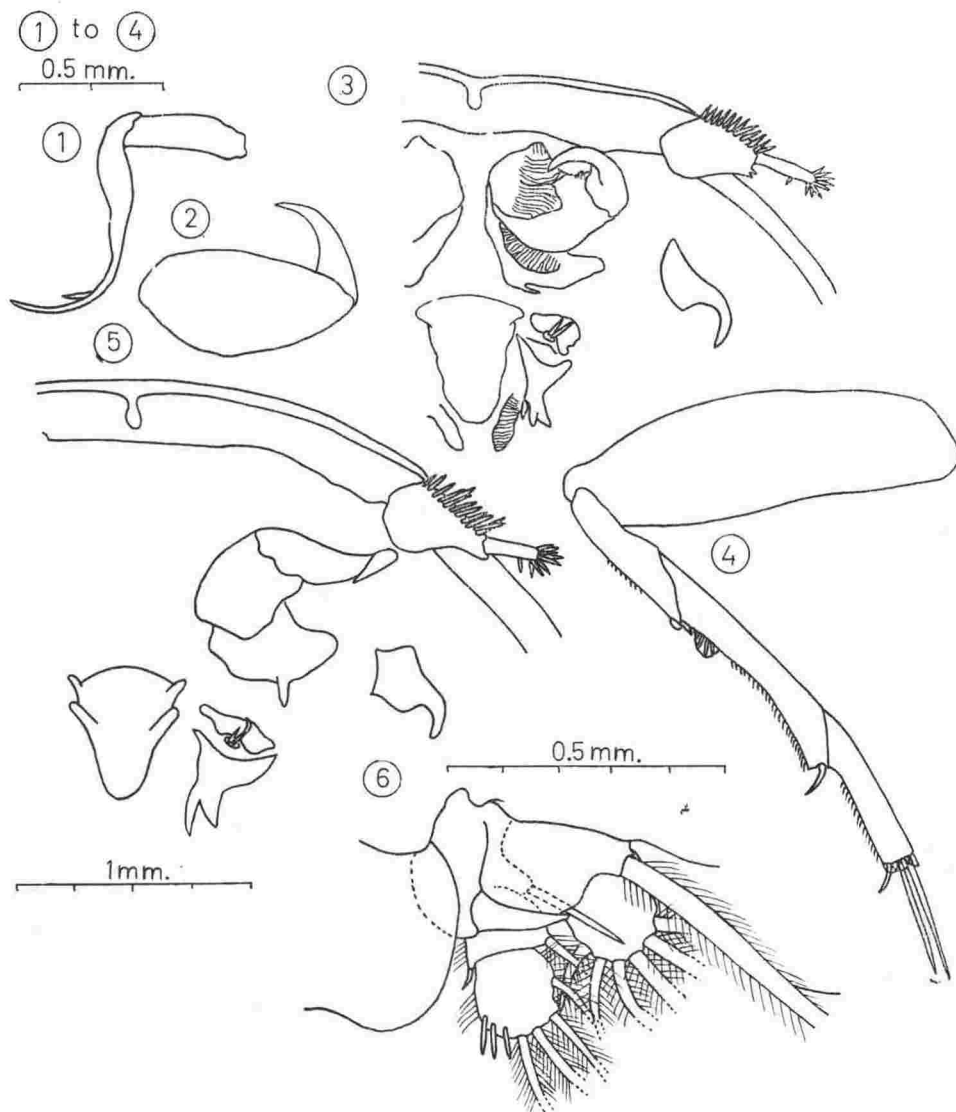
First maxillipeds long, two-jointed, half as long as carapace; second joint two-fifths longer than first; first joint elongated, one-quarter as wide as long medially, narrowing to two-thirds this width proximally and distally, distal margin rounded; second joint one-tenth as wide at base as long, narrowing rather rapidly to half this width at midpoint, then tapering gradually to one-third this distance distally, where it bears two short, sharp spines, inner spine one-tenth length of joint, the outer two-thirds length of inner.

Second maxillipeds two-jointed, subchelate, equal in length to first maxillipeds minus terminal spines. First joint two-thirds longer than second, suboval, one-third as wide as long, medially, basal margin curved distally, terminal margin rounded; second joint one-third as wide at base as long, narrowing rapidly to half this width one-quarter of distance from proximal margin, then narrowing more gradually to a sharp point distally; inner margin curved to a depth equal to three-quarters maximum width.

Sternal furca median in position, three-sevenths of distance from anterior margin of carapace, one-ninth length of carapace, as wide at the base as long; it narrows to half this width at midpoint, widening again by one-fifth, one-third of distance from distal end, at level of branching; branches simple, one-quarter width of base of furca proximally, narrowing gradually to half this width distally, distal margins rounded, slightly divergent.

First pereopods three-jointed, one-fifth as long as carapace is wide. Basipod one-quarter and third joint one-third shorter than second joint. Basipod suboval, its margins

irregular; it bears two short hairs, one on its inner distal angle, other on outer margin, one-fifth of distance from outer distal angle; second joint subrectangular, half as wide as long, its widest point one-fifth of distance from proximal margin, narrowing to two-thirds this width at proximal and distal margins; inner margin straight, outer margin curved; it bears a rudimentary spine on outer distal angle, and a row of cilia along its inner margin; terminal joint subrectangular, three-eighths as wide as long throughout its length, curved so that outer margin is half as long again as inner; distal margin bears three subequal spines, one-quarter length of joint, inner distal angle bears a short plumose seta, one-quarter longer than spines, and inner margin bears three long plumose setae, decreasing in length from most proximal, which is median on inner margin, to more distal ones, which are spaced evenly between it and inner distal angle.



TEXT-FIG. 10.—*Lepeophtheirus polyprioni* n.sp. (1) Male, first maxilliped. (2) Male, second maxilliped. (3) Male, mouth parts and first antennae. (4) Female, fourth pereopod. (5) Female, mouth parts and first antennae. (6) Female, third pereopod.

Second pereopods biramose, each ramus three-jointed. Basipod three-fifths as long as first pereopod, exopod half as long again as basipod, and endopod equal in length to basipod. *Basipod* two-jointed, first joint subrectangular, half as long as second, which it overlaps for half its length; it bears a long plumose seta on free portion of its inner margin, distal two-thirds of inner margin joining in articulation with second joint outer margin being entirely free; second joint suboval with proximal and distal truncations, three-quarters as wide as long medially, two-thirds this width proximally and distally; it bears a flange, one-quarter as wide as basipod on its inner margin and a small plumose setae, one-tenth as long as basipod on its outer margin, one-fifth of distance from outer distal angle. First joint of *exopod* eight-ninths as long as basipod, second and third being equal in length, one-quarter as long as first; first joint subrectangular, two-fifths as wide as long proximally, narrowing to three-quarters this width distally; it bears a row of cilia over median sixth of its inner margin, a long plumose seta immediately distal to these cilia, a spine two-sevenths as long as joint on outer distal angle, and a chitinous flange, half as wide as the joint is long, directed ventrally from full length of outer margin; second joint subtrapezoid, half as wide again as long distally, three-fifths this width proximally; it bears a row of cilia over proximal half of inner margin, a long plumose seta on inner distal angle, and two spines placed one above the other, ventral spine two-thirds as long as dorsal spine, which is as long as joint; third joint subtrapezoid, half as wide as long proximally, half as wide again at convexly curved distal margin; it bears a row of cilia along its inner margin, a spine which is as long as joint on outer proximal angle, and six long plumose setae, decreasing in size from innermost towards the outer, on terminal margin. First joint of *endopod* three-eighths as long as basipod, third joint equal in length to first, and second twice this length; first joint subrectangular, six-sevenths as wide as long, angles rounded; second joint attached to inner half of distal margin, free portion of this margin bearing a row of long cilia, and inner margin bears a long plumose seta medially; second joint subrectangular, half as wide as long medially, two-thirds this width at proximal margin and also over distal half of its length which appears to be emarginated for attachment of third joint; inner and distal margins straight, outer margin curved and covered with long cilia over free portion of its length; free part of distal margin bears two long plumose setae; third joint subtriangular, distal margin curved and bearing five long setae, inner margin straight and bearing long cilia.

Third pereopods have their basipods united in a broad suboval apron, five-sixths as wide as carapace, half as long as wide, free posterior and lateral margins bordered by a flange which is two-thirds as wide again as that on the lateral areas of the carapace; this flange is interrupted posterolaterally at insertion of podites; median quarter of apron separated from rest by two laterally curved longitudinal ribs; each rib bears a spine, as long as flange is wide, on its posterior termination; rami small, biramose, exopod three-jointed, endopod two-jointed. *Exopod* one-seventh length of apron, its second joint half and its third joint two-thirds as long as first; first joint subrectangular, as wide as long, curved laterally to a depth equal to one-fifth its width; it bears a slender spine which is as long as joint on inner distal angle; outer half of this joint swollen ventrally and bears distally a stout spine, as long as other but two-fifths as wide at base as long, which is turned medially, inner distal margin curved; second joint semicircular, one-fifth wider than long, distal margin straight; it bears a large plumose seta on inner distal angle, a spine one-third as long as joint on outer distal angle and a row of cilia on distal half of outer margin; terminal joint rounded, proximal margin only slightly curved, other three forming an entire curve, as wide as long and bearing rows of cilia on its inner and outer margins, three subequal spines two-fifths as long as the joint on outer distal region of free margin and four large plumose setae, decreasing in size from outer to inner on terminal and inner distal regions of free margin. *Endopod* is two-jointed, half as long as exopod, first joint half as long as second; first joint square, but closely associated with a flange at its inner margin. This flange is two and a-half times as long as first joint, one-eighth wider than long, attached proximally to margin of apron; it extends out to partially obscure unswollen half of first joint of exopod; first joint of endopod bears a very large plumose seta on its inner margin; second joint sub-circular, similar in shape to third joint of exopod; it bears six large plumose setae evenly spaced on outer distal and terminal regions of free margin.

Fourth pereopods four-jointed, five-eighths as long as carapace, third joint two-thirds as long as first joint, second and fourth each three-quarters as long as third. First joint subrectangular, three-tenths as wide as long medially, narrowing to three-fifths this width proximally and distally; second joint one-fifth as wide as long proximally, but widens to half this width again at level of inner distal angle; outer margin two-thirds as long again as inner so that outer distal angle is acute; this angle bears a small spine, one-tenth as long as the joint, which has a semicircular flange as long as spine associated with its base; joint also bears a row of distally curved cirri on medial two-sevenths of its outer margin; third

DESCRIPTION. *Female:* Female rather large (9.55mm–11.00mm in length); carapace comprises a little more than half the length.

Carapace subcircular, a little wider than long (5.50mm–5.95mm x 5.70mm–6.20mm). The frontal area two-fifths as wide as carapace, one-ninth as long as wide medially, but swollen to twice this length one-quarter of distance from lateral margin; area curves anteriorly for a distance equal to its own length. Transverse dorsal rib of carapace one-third width of carapace, arched sharply forward so that its midpoint is central in carapace, and meets lateral longitudinal branches one-twelfth of length of carapace posterior to its midpoint; anterior branches straight, one-quarter length of carapace, diverging so that their anterior terminations are separated by one-ninth more than width of transverse groove; posterior branches which are one-third length of carapace, also diverge for first two-thirds of their length so as to increase their distance apart by one-sixth, then continuing parallel to longitudinal body axis, closely lateral to posterior sinuses. Narrow sub-oval posterior sinuses one-seventh length of carapace, two-fifths as wide as long. Lateral areas rounded posteriorly; median posterior area two-fifths as wide as carapace at level of posterior sinuses, narrowing rapidly beyond them to one-third this width at articulation with fourth thoracic segment, and extending posteriorly beyond lateral lobes for a distance equal to lateral length of frontal area. Eyes one-quarter of distance from anterior margin of carapace, oval, as long as median length of frontal area, half as wide as long, separated posteriorly by a distance equal to their width, touching anteriorly. Flange on free margin of lateral areas wide (0.15mm–0.20mm), and of constant width until it ends by tapering abruptly postero-medially; flange on free margin of frontal area two-thirds width of flange on lateral areas.

Fourth, freely articulated, thoracic segment half as wide as carapace and three-eighths as long as wide (0.75mm–0.80mm x 2.00mm–2.32mm), narrowing laterally to half this width, lateral margins rounded.

Genital segment subovate, four-ninths width of carapace and usually a little longer than wide (2.80mm–3.01mm x 2.70mm–3.14mm); posterolateral lobes large, comprising one-quarter of length of segment, separated by a straight margin, one-fifth as long as segment is wide, with which abdomen articulates.

Abdomen two-segmented, first segment four times as long as second, greatest width half total length (1st segment: 0.85mm–1.05mm x 0.55mm–0.69mm, 2nd segment 0.20mm–0.30mm in length); first segment narrows posteriorly to two-thirds its anterior width; sides of second segment parallel.

Anal laminae as long as second segment of abdomen (0.22mm–0.35mm), one-third as wide as long; posterior margins bear single small plumose setae on their inner and outer angles, and three long plumose setae distally; long setae as long as the laminae and short setae are half this length.

Egg strings show considerable variation in length and in number of eggs. Most specimens had egg strings from 7.35mm–10.80mm in length and containing from 121–142 eggs each.

First antennae two-jointed and rather short, one-eighth width of carapace in length, first joint twice as long as second. First joint subtrapezoid, two-thirds as wide as long, narrowing distally to one-third this width, proximal margin curved to a depth equal to two-fifths length of joint; outer and distal margins bear 11–15 hairs; second joint subrectangular, two-fifths as wide as long at midpoint, narrowing to two-thirds this width proximally and distally; terminal margin rounded and bears eight or nine hairs, joint also bearing a single hair on inner margin, two-thirds of distance from proximal margin.

Second antennae two-jointed, one-third as long again as first antennae, first joint three-fifths as long and three times as wide as second; first joint in form of a quarter circle, proximal and inner margins straight, second joint borne on distal half of inner margin; second joint elongate, slightly S-shaped, second curve being at right angles to first and about half its length, and terminates in a sharp point; basal plates subsemicircular, articulating with first joint along a straight margin, rest of margin curved; each one as wide as first joint and three-fifths as long as wide; on its posterior margin it bears a spine, two-thirds as long as base and half as wide as long proximally, distal end bluntly rounded.

First maxillae one-jointed, simple, half as long again as second joint of first antennae; basal half two-fifths as wide as maxilla is long, narrowing by one-quarter this width distally; distal half narrows rapidly to half width of basal part and narrows more slowly distally to terminate in a point; distal half is curved to a depth equal to two-fifths its width.

Second maxillae one-jointed, bifurcated distally, three-quarters as long again as first maxillae, width at base equal to half length; inner margin straight, outer margin deeply

curved. Maxilla bifurcated for distal third of its length, outer branch half as long again as inner and diverging from it at an angle of about 15° ; they are situated immediately posterior to subtriangular plates which are one-quarter as wide again as bases of maxillae, one-third as long as wide, and bearing on their posterior margins two spines placed on a single raised boss; outer spine half as long as plate, inner spine half length of outer.

Mouth tube on ventral midline of carapace, one-quarter of distance from anterior margin; tube itself three-sevenths this distance in length, six-sevenths as wide as long in its proximal region, half as wide as long in its distal region, lateral and distal margins making a continuous somewhat irregular curve. Mandibles contained within mouth tube and each bears twelve teeth distally on its inner margin.

First maxillipeds two-jointed, equal in length to half width of carapace in this region of body, joints subequal in length. First joint one-quarter as wide as long, narrowing slightly distally and more sharply proximally, proximal and distal margins rounded; second joint one-seventh as wide as long for proximal two-sevenths of its length, after which it narrows rapidly to two-thirds this width, then narrowing more slowly towards its distal extremity where it is one-third its maximum length; terminal spines are equal in width at their bases, inner spine two-fifths as long as second joint, outer spine half this length; outer spine bears a row of cirri along full length of outer margin.

Second maxillipeds two-jointed, subchelate, first joint equal in length to first joint of first maxillipeds, second joint three-fifths this length; first joint suboval, one-third as wide as long at widest point one-third of distance from base, narrowing rather rapidly towards base, proximal and distal margins rounded. Second joint two-fifths as wide at base as long, narrowing evenly to a sharp point distally, inner margin curved to a depth equal to one-quarter its length.

Sternal furca central in ventral surface of carapace, one-thirteenth length of carapace, half as wide at the base as long, narrowing to three-fifths this width immediately above base and then widening again by one-eighth before dividing into two equal divergent branches which constitute half length of furca. Median margins of furca straight, lateral margins parallel to them for half their length, then curving medially so that branches end in blunt tips, which are separated by a distance equal to width of furca at its narrowest point.

First pereopods three-jointed, of moderate size, one-quarter as long as carapace is wide; basipod one-eighth and distal joint one-half shorter than second joint. Basipod two-thirds as wide as long for distal third of its length, but narrows to half as wide as long at proximal margin; inner margin straight and bears a small plumose seta one-fifth of distance from inner proximal angle and a short blunt spine one-eighth of distance from inner distal angle; second joint subrectangular, half as wide as long proximally, narrowing to half this width distally; it bears a rudimentary spine on its outer distal angle and a row of cilia along median half of its inner margin; third joint subrectangular, half as wide as long and bears three spines on its straight distal margin, outer one five-ninths as long as joint, inner one three-eighths as long as joint and middle one intermediate in length; two inner spines each bear rows of short cirri over distal halves of their outer borders and proximal halves of their inner borders; inner margin of joint bears three long plumose setae on distal three-quarters of its length, setae decreasing in length distally; inner distal angle bears a non-plumose seta which is one-third as long as smallest of the three plumose setae.

Second pereopods biramous, each ramus three-jointed, the basipod two-jointed. Basipod half as long as entire first pereopod, exopod one-twelfth and endopod one-sixth shorter than basipod. First joint of *basipod* two-sevenths as long as second and mostly obscured by it except for a small triangular area visible at rounded inner proximal angle of second joint; it bears a long plumose seta on its inner margin; second joint subrectangular, two-thirds as wide as long and bears a very small plumose seta on its outer distal angle and a flange, one-quarter as wide as basipod, on distal five-sevenths of inner margin. First joint of *exopod* three-fifths its length, other two joints subequal in length; first joint two-thirds as wide as long, proximally, narrowing to two-thirds this width distally, and bears a long plumose seta on its inner margin one-fifth of distance from inner distal angle, a row of cilia proximal to this reaching to mid point of inner margin and a spine on outer distal angle which is as long as proximal width of joint; second joint one-third wider than long, outer margin half as long again as inner; it bears a long plumose seta medially on inner margin with a tuft of cilia occupying inner margin proximal to seta, and a spine on outer distal angle which is half as long as that on first joint; third joint of *exopod* is subsemicircular, as wide as long, proximal margin only slightly curved, other margins forming an entire curve; it bears two spines on outer margin, their bases transversely adjacent, subequal to each other and joint; one has a row of cilia along its outer border; distal margin

bears six plumose setae, decreasing in size towards outer angle; inner margin bears a short row of cilia proximally. First joint of *endopod* one-third its length, third joint subequal to it and third joint twice length of first joint; it is subrectangular, inner margin very short, outer margin long and bent at right angles to make two sides of rectangle; it is as long as wide except for a slight excavation where it meets the second joint; it bears a row of cilia on distal side of outer margin and a large plumose seta on inner distal angle; second joint subrectangular, half as wide as long, outer distal angle excavated to one-third width and half length of joint for insertion of third joint; it bears two long plumose setae on free part of distal margin and a row of long cilia on free part of outer margin; third joint suboval, three-quarters as long as wide, and bears six long plumose setae distally and a row of long cilia on outer margin.

Third pereopods have their basipods united to form the broad *apron* usually found in species of this genus; it is suboval, three-quarters as wide as carapace, four-tenths as wide as long, free lateral and posterior margins surrounded by a flange as wide as those on lateral areas of carapace, or a little wider, which is entire except for posterolateral interruptions for insertion of rami; apron is divided into three areas by two longitudinal ribs which are separated anteriorly by a distance equal to one-quarter width of apron, curve laterally to increase their distance apart by one-half and then converge slightly posteriorly until they meet posterior margin, their junction with which is associated with setae which are as long as flange is wide. Rami small, *endopod* three-jointed, *exopod* two-jointed. *Exopod* one-fifth as long as apron, *endopod* four-ninths as long as *exopod*. First joint of *exopod* one-half longer than second and second one-fifth longer than third; first joint one-third wider than long, semi-circular, proximal margin straight, other three forming an entire curve; outer margin bears a ribbed flange over distal third of its length and three thin hairs, one at proximal end of flange, one median on margin and one intermediate in position; hairs one-ninth as long as joint is wide and flange half as wide as hairs are long; inner margin of joint bears a row of cilia over medial half of its length, and a long plumose seta on its distal angle; second joint attached to ventral surface of first joint, proximal half of which is raised to a line from inner proximal angle to outer distal angle and slightly overhangs second joint; a large distally directed spine, one-fifth as wide as joint and three-fifths as long, is situated on distal margin of this raised part, one-quarter of distance from outer distal angle, and overhangs second joint. Second joint a semi-oval, distal margin straight, other three united in an entire curve, as wide as long; inner and outer margins each have a row of cilia along their full lengths; outer distal angle bears a spine one-fifth as long as joint and inner distal angle bears a long plumose seta; third joint in form of a truncated oval, one-quarter wider than long, proximal margin straight, two-thirds greatest width of joint, other three margins forming an entire curve; inner and outer margins each have rows of cilia along their full lengths, terminal margin carries four long plumose setae and three spines subequal in length and one-quarter longer than spine on second joint, on distal outer area of margin, second joint of *endopod* twice as long as first. First joint subrectangular, two-thirds as long as wide, inner margin twice as long as outer; inner margin bears a single long plumose seta which occupies distal half of margin; second joint subcircular, as wide as long, and bears a row of cilia on both inner and outer margins and six long plumose setae terminally, decreasing in length from innermost to outermost.

Fourth pereopods uniramous, four-jointed, three-fifths as long as carapace when straight. Second and fourth joints are each half as long as first joint, third joint three-tenths as long as first joint. First joint subrectangular, one third as wide medially, as long; the inner margin straight, outer margin curved so that proximal and distal width is one-third narrower than median width; second joint pyriform because of elongation of outer margin and reduction of inner, three-tenths as wide as long, inner margin three-sevenths as long as outer, outer distal angle bearing a small spine, one-twentieth as long as joint, partly guarded at its base by a semi-circular flange, which is one-tenth as long as the joint and as wide as long; outer margin bears a row of short curved cirri along distal half of its length, which gives a saw-toothed appearance to this part of margin; outer margins of third and fourth joints carry similar rows of curved cirri along their full lengths; third joint subrectangular, one-third as wide as long, outer distal angle elongated to one-ninth length of joint, involving half width of distal margin, and carrying a spine one-fifth as long as the joint, base of which is guarded by a flange similar to that associated with spine on second joint; fourth joint subrectangular, one-quarter as wide as long, bearing three spines on terminal margin, outer spine as long as that on third joint, the innermost two and two-thirds this length, middle spine being a little shorter than inner one; all three have flanges associated with their bases, similar to those on other spines of pereopod.

Fifth pereopods represented by small subtriangular structures on either side of genital

segment immediately ventral to point of attachment of egg strings. They are two-fifths as long as abdomen, their proximal margin one-quarter as wide as abdomen is long; inner margin straight, outer margin curved laterally, outer margin half as long again as inner; each of pereopods bears two small spines, one-fifth their length, one on outer distal angle, other one-fifth nearer inner proximal angle.

Male: Male considerably smaller than female (6.60mm and 7.00mm in the two male specimens taken), narrow elongated abdomen comprising two-ninths of this length.

Carapace a little more than half entire length and is one-twelfth wider than long (3.61mm and 3.72mm x 3.90mm and 4.03mm). Frontal area three-sevenths as wide as carapace, one-eighth as long as wide, less curved than in female, and has no lateral posterior swelling. Anterior longitudinal branches of transverse rib shorter than those of female but diverge more rapidly so that they are separated by one-fifth more anteriorly than posteriorly. Otherwise carapace strongly resembles that of female.

Fourth, freely articulated thoracic segment very similar to that of female and is proportionately of a similar size (0.48mm and 0.55mm x 1.36mm and 1.10mm).

Genital segment subrectangular, one-third as long as carapace, two-thirds as wide as long (1.20mm and 1.10mm x 0.88mm and 0.85mm); its sides are parallel over median two-fifths of its length but segment narrows anteriorly to four-fifths its maximum width and posteriorly to half anterior width. Rudiments of fifth pereopods appear on narrowing posterior part of segment as single short spines carried on papillae which are as long as flange on lateral areas of carapace and half as wide as long.

Abdomen two-segmented and similar to that of female in shape; relative size of joints a little different (1st joint 1.36mm and 1.05mm x 0.32mm and 0.37mm, 2nd joint 0.32mm and 0.35mm, length).

Anal laminae similar in size and shape to those of female (0.22mm and 0.24mm length). Unlike female they only carry four plumose setae and these tend to be subequal to each other and to laminae in length.

First antennae similar to those of female.

Second antennae very different from those of female. As in female they are uniramous, two-jointed and set on basal plates; basal plate one-sixth as wide as carapace at same level of body and two-fifths as long as wide; its margins irregular, but it tends to have its long axis at 45° to the longitudinal body axis, inner angle anterior to outer; it has a subreniform ridged area covering two-thirds of its length nearest to its junction with first joint, and median half of its width: first joint half as long as base, proximal margin slightly curved, twice as long as rather irregular distal margin, inner margin straight, two-fifths as long as outer margin which is curved and meets distal margin in an obtuse angle; this joint also bears a ridged area, and in this case area runs from one-eleventh of distance from midpoint of proximal margin to midpoint of outer margin and is half as wide as joint; ridges in that half of area which is closest to proximal margin are parallel to that margin, rest forming concentric semicircles directed proximally and extending on to a spine, one-ninth as long as joint, situated on outer margin and directed distally at an angle of 45° to that margin; there is a smaller blunt spine, also ridged, on outer distal angle: second joint subequal in length to first, in form of a bifurcated claw, turning anteriorly and medially to close on larger spine on outer margin of first joint; joint two-thirds as wide at base as first joint, narrowing to half this width at point at which it forks, branches comprising two-sevenths of length of joint, branch which meets first joint being twice length of other; both branches end in blunt tips.

First maxillae are as in female.

Second maxillae have associated plates similar in form to those of female. Proximal half of maxillae are as in female but distal halves are rather different; each maxilla forks for only one-fifth its length; two branches are stout, equal in length to each other and to a stout spine which has its base on inner margin at level of bifurcation.

Mouth tube in male wider in proportion than that of female but is otherwise similar.

In male there are small suboval ridged areas on ventral surface of carapace itself, between tips of second maxillae and distal margin of mouth tube; they are half as long as maxillae and half as wide as long; inclined at an angle of 45° to the longitudinal body axis, their posterior borders being more medial; ridges close together and at right angles to long axis of ridged areas.

First maxillipeds have their first joints as in female. Second joints subequal in length to first but only bear a single long spine distally; this spine is one-fifth length of joint and bears a row of very short cirri along its outer margin; in place of usual longer inner spine

it bears three short spines, one-third as long as outer spine, which are joined to each other and larger spine by a flange which produces a webbed effect.

Second maxillipeds of same shape and proportions as those of female but differ in having a small narrow spine on first joint, one-third of distance medially from inner margin and one-quarter of distance from proximal angle. It is one-fifth as long as joint and one-fifth as wide at base as long, terminating in a sharp point.

Pereiopods similar to those of female with exception of vestiges of fifth which are described above.

HOST FISH: *Hyperoglyphe porosa* (Richardson, 1845), bream (known in the Wellington district as "bonito", but this is not the "bonito" of other areas of New Zealand).

LOCALITY: Off Cape Turakirae.

LOCATION: On sides, head and fins.

NUMBERS OBTAINED: Eight females and two males from one host fish.

DISCUSSION

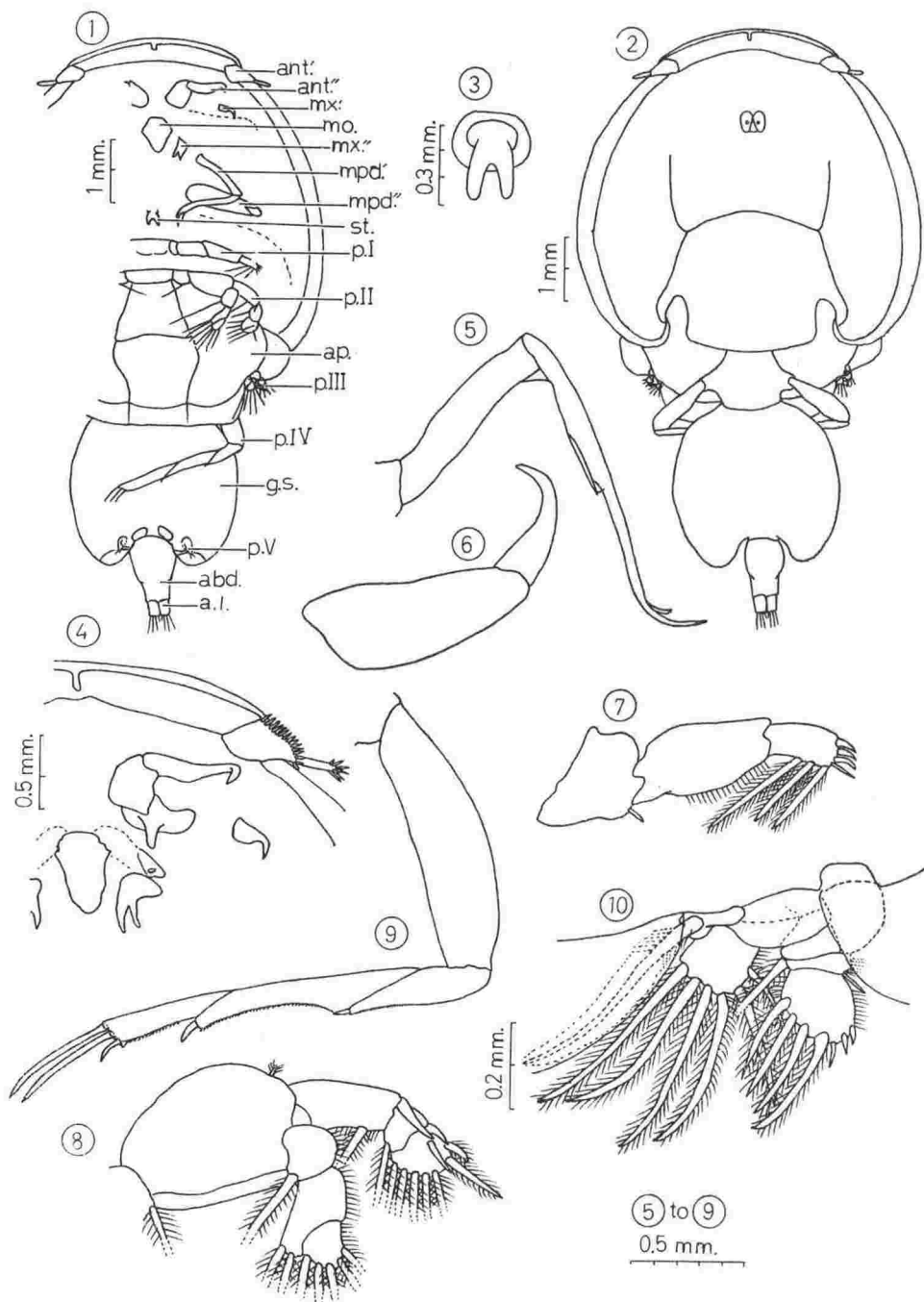
This species is closely similar to *L. polyprioni*, the females differ as follows: the overall size is greater by one-quarter; the lateral areas of the carapace are wider as compared to the total width; the fourth segment is narrower, one-third the width of the genital segment as compared to two-fifths in *L. polyprioni*; the genital segment is more slender and possesses a silvery pigmentation which is lacking in *L. Polyprioni*; the first segment of the abdomen is four times as long as the second, while in *L. polyprioni* it is only twice the length of the second; the mouth parts are generally similar although the maxillae are rather more slender; in the first pereiopods the inner two claws are serrated over part of both inner and outer surfaces while in *L. polyprioni* all the claws are smooth; the flange, which *L. polyprioni* bears on the first joint of the exopod is missing in *L. argentus*; the exopod of the third pereiopods differ markedly both in shape of joints and number of spines; the second joint of the fourth pereiopods bears a ribbed flange near its base which is missing in *L. polyprioni*. Of these differences the silvery pigmentation of the genital segment and the comparatively greater length of the first joint of the abdomen are the more important. The males may also be separated on this latter character.

Lepeophtheirus heegaardi n.sp.

Large caligids, coloured yellowish-brown in alcohol. In the female the carapace is definitely more than half the entire length, as wide as long; the fourth thoracic segment is about twice as wide as long; the genital segment is about half as wide as the carapace, as wide as long, with well developed posterolateral lobes; the abdomen is indistinctly two-segmented, the segments subequal in length, together two-fifths the length of the genital segment. Only a single female specimen in the present collection.

DESCRIPTION. A large specimen (8.8mm) without egg strings but with a large and rounded genital segment which suggests that it is a mature specimen.

Carapace subcircular, more than half total length of animal, as wide as long (5.1mm x 5.1mm). Frontal area half as wide as carapace, one-ninth as long as wide throughout its width. Transverse bar of dorsal rib three-eighths as wide as carapace, curved anteriorly to a depth equal to one-sixth its length, so that its midpoint is one-eighth of length of carapace posterior to midpoint of carapace; anterior longitudinal branches of dorsal rib one-quarter as long as carapace, diverging slightly over posterior half of their length so that



TEXT-FIG. 13.—*Lepeophtheirus heegaardi* n.sp. Female only. (1) Ventral view. (2) Dorsal view. (3) Sternal furca. (4) Mouth parts and first antennae. (5) First maxilliped. (6) Second maxilliped. (7) First pereiopod. (8) Second pereiopod. (9) Fourth pereiopod. (10) Third pereiopod.

they are one-sixth further apart at their midpoint than at their junction with transverse bar, anterior halves of their lengths parallel; posterior branches of dorsal rib, which are two-sevenths the length of the carapace, diverge for anterior nine-tenths of their lengths, at which point they are two-fifths further apart than at their junction with transverse bar, and then converge sharply over posterior one-tenth of their length so that their posterior separation is only one-third greater than their anterior separation. Rather broad, suboval posterior sinuses one-sixteenth length of carapace, two-thirds as wide as long, and bordered laterally by strips of median posterior area which are two-thirds as wide as sinuses. Free posterior margin of lateral areas rounded and meeting posterior longitudinal branches of dorsal rib almost at right angles; median part of median posterior area extends beyond lateral areas posteriorly for a distance equal to one-thirtieth length of carapace and terminates posteriorly in a margin which is entire and slightly curved; flange on lateral areas of carapace 0.20mm in width laterally, narrowing slightly anteriorly and posteriorly where it terminates by tapering posterolaterally. Eyes situated on dorsal surface of carapace halfway between transverse bar and anterior margin, suboval, one-twenty-fifth as long as carapace, half as wide as long, separated posteriorly by a distance equal to their width and touching but not joining anteriorly.

Fourth, freely articulated, thoracic segment long but not wide in comparison to length (0.7mm x 1.5mm). Anterior margin half median width, posterior margin one-third wider than anterior; segment narrows very rapidly laterally to lateral articulations with fourth pereopods.

Genital segment subovate, as wide as long, half width of carapace (2.4mm x 2.4mm); posterior third of its length is constituted by two broad evenly rounded posterolateral lobes their margins entire curves; bases of these lobes are one-third width of segment and are separated by a straight margin one-sixth width of segment; lateral margins of segment, including lateral margins of lobes, form entire curves.

Abdomen indistinctly two-segmented, two-fifths length of genital segment; second segment, which is rectangular, a little smaller than first, both slightly wider than long (1st segment 0.5mm x 0.6mm, 2nd segment 0.4mm x 0.5mm); first segment narrows to one-third its median width at both posterior and anterior margins, its lateral margins rounded; posterior margin of second segment straight and its entire width occupied by anal laminae.

Anal laminae rectangular, one-third as long as abdomen (0.3mm), two-thirds as wide as long and overlapping posteriorly in this specimen; they each bear three long plumose setae with a smaller plumose seta medial to these, all on posterior margins; long setae as long as laminae, shorter setae two-fifths this length.

First antennae small, two-jointed, one-eighth width of carapace in length, second joint two-thirds length of first. First joint diamond shaped, two proximal margins attached to frontal area, second joint borne distally on anterior distal margin; at its widest point, which is median, it is half as wide as long; joint bears 15 hairs anterodistally evenly spaced except for distal pair which are close together on distal angle; second joint subrectangular, distal margin rounded, one-quarter as wide as long; it bears five long hairs and three short hairs distally.

Second antennae two-thirds as long again as first antennae, two-jointed, first joint half as long and twice as wide as second. Basal plates one-quarter as long as antennae, subreniform, twice as wide as long, anterior and posterior margins curved posteriorly; each plate bears a large spine directed posteriorly, half as long as first joint of antennae, as wide at base as long but narrowing rapidly to half this width and terminating in a blunt rounded tip. First joint subrectangular, as wide as long, outer margin a little longer than inner; second joint elongate, outer and inner margins parallel for half length and then narrowing gradually to a sharp point, at same time curving sharply ventrally.

First maxillae simple, one jointed, as long as first joint of second antennae, proximal half two-fifths as wide as joint, joint then narrowing sharply to half this width and then narrowing more gradually to a sharp point distally; distal half sharply curved.

Second maxillae extend beyond mouth tube for two-sevenths of their lengths; each is one-jointed and bifurcated distally, one-fifth longer than first maxillae. Base three-quarters as wide as maxilla is long, both inner and outer margins curved medially but outer margin curved more sharply so that width of maxilla is reduced to half at midpoint, at which point joint branches; outer branch one-fifth shorter than inner, both branches terminating in blunt tips. Each second maxilla has a plate associated with its base which is one-third as long as maxilla, twice as wide as long and bears two short spines on a raised boss; plate directed posterolaterally at an angle of 45° to longitudinal axis of body.

Mouth tube median in position, one-quarter of distance from anterior margin of cara-

pace; tube itself half this distance in length, two-thirds as wide, at base as long, proximal and distal margins rounded, narrowing distally to half its basal width. Mandibles contained in mouth tube and each bear twelve teeth distally on their inner margins.

First maxillipeds two-jointed, three-eighths as long as carapace is wide, first joint five-eighths length and twice width of second. First joint rectangular, one-quarter as wide as long throughout its length; second joint reaches its widest point two-fifths of distance from proximal margin, narrowing gradually to three-quarters this width at this margin; distally it narrows to half this width at distal margin which bears two spines; innermost spine one-quarter the length of joint, continues narrowing of joint until it terminates in a sharp point; outermost spine two-fifths length of inner and also terminates in a sharp point; joint also bears a spine attached to inner margin three-tenths of distance from proximal margin and appressed to inner margin for first three-quarters of its length; final quarter extends beyond widest point of joint but appears to be attached to margin by a flange; this spine is two-ninths length of joint, very narrow and ends in a sharp point.

Second maxillipeds two-jointed, subchelate, as long as second joint of first maxillipeds; second joint three-fifths as long as first. First joint subtriangular, proximal margin two-fifths as wide as joint is long, joint narrowing to half this width distally, distal margin rounded; second joint two-sevenths as wide at base as long and narrows evenly distally to terminate in a sharp point; joint curved to a depth equal to two-sevenths its length, reaching its maximum curvature one-third of distance from its distal end.

First pereopods one-quarter as long as carapace is wide, three-jointed; basipod one-eighth and terminal joint one-half as long as second joint. Basipod two-thirds as long as wide, subrectangular and bearing a small non-plumose seta on its inner distal angle which is one-third as long as joint; second joint subrectangular, one-half as wide as long over medial third of its length, gradually narrowing to two-thirds this width proximally and distally; it bears a row of long cilia along distal two-thirds of its inner margin; terminal joint rectangular, half as wide as long; it bears three long plumose setae evenly spaced over distal half of its inner margin, decreasing in length distally, three subequal spines, one-third length of joint, their bases occupying entire distal margin, and a single non-plumose seta, subequal in length to the spines, on inner distal angle.

Second pereopods biramous, each ramus three-jointed; basipod three-fifths as long as entire first pereopod, exopod subequal to basipod and endopod four-fifths this length. *Basipod* two-jointed, first joint one-quarter as long as second, two-thirds as long as wide, bearing a long plumose seta on its inner distal angle; second joint subrectangular, three-quarters as wide as long medially, narrowing to two-thirds this width distally and two-fifths this width proximally, inner margin straight, outer margin an entire curve. Inner margin bears a flange, one-seventh as wide as joint, along its full length, and there is a very short plumose seta on outer margin near distal angle. First joint of *exopod* half as long as basipod, second one-third as long as first and third one-third longer than second; first joint subrectangular, half as wide as long proximally, narrowing to three-quarters this width distally; it bears a distally directed spine, half as long as joint, on its outer distal angle, a row of cilia along its inner margin and a single long plumose seta one-sixth of distance from inner distal angle; second joint subtrapezoid, inner and outer margins straight and subequal in length, proximal margin straight and two-thirds the length of concavely curving distal margin; joint bears a distally directed spine, subequal in length to joint, on outer distal angle and a long plumose seta on inner margin beside distal angle; third joint subsemicircular, proximal margin straight, others united in a single, entire curve; joint one-fifth wider than long and bears a spine, one-fifth shorter than joint, directed distally, on ventral surface of joint, one-quarter of distance from outer distal region, a small plumose seta as long as the spine on second joint and another plumose seta twice this length on outer distal part of margin as well as five closely placed long plumose setae on inner part of margin. First joint of *endopod* two-sevenths length of basipod, second joint two-thirds as long again as first and the third one-quarter shorter; first joint subsemicircular, outer and distal margins being united in an entire curve; outer margin six times as long as reduced inner margin, proximal and distal margins subequal in length; joint bears long cilia on distal half of outer margin and entire inner margin occupied by base of a long plumose seta; second joint subrectangular, two-thirds as wide as long, outer distal angle excavated to a depth equal to half width and one-third length of joint for articulation of third joint; remaining part of distal margin bears two long plumose setae and remaining part of outer margin bears a row of cilia; third joint is as wide as long at base but narrows to two-thirds this width distally, distal margin rounded; it bears a row of cilia along outer part of margin and five long plumose setae on remaining part of free margin.

Third pereopods have their basipods united to form broad suboval *apron* found in other species of this genus, four-fifths as wide as carapace, half as long as wide; free margins

entire and bordered by a flange, half as wide again as those on the lateral areas of carapace, which is entire except for a posterolateral interruption at insertion of rami; apron divided by two longitudinal ribs, separated by a distance equal to two-fifths width of apron medially and narrowing, converging to half this distance anteriorly and two-thirds this distance posteriorly; ribs connected by a further transverse rib just anterior to their widest separation and both bear spines equal in length to width of flange. Rami small, exopod three-jointed, one-eighth as long as apron, endopod two-jointed, half length of exopod. Three joints of *exopod* subequal in length; first joint two-fifths wider than long for proximal third of its length; distal two-thirds, which overlap second joint, three-quarters as wide as joint is long; distal overlapping part semicircular and swollen, bearing a large spine, distally on its straight inner margin, which is three-quarters as long as joint and turned at right angles to it; spine half as wide at base as long, narrowing to half this width distally before terminating in a rounded margin; second joint subtrapezoid, inner and outer margins subequal, distal margin twice proximal margin; it is as wide distally as long and bears a row of cilia along distal fifth of its outer margin, a spine two-fifths as long as joint, on outer distal angle, and a long plumose seta on inner distal angle; third joint subrectangular, distal angles broadly rounded, as wide as long; inner margin twice as long as outer; it bears a row of cilia along distal two-thirds of its outer margin, and another along full length of its inner margin; terminal margin bears three long spines along its outer third, outermost being one-quarter as long as joint, innermost half this length again and middle spine intermediate between these; inner two-thirds of terminal margin occupied by four long plumose setae which decrease in size from outermost to innermost. First joint of *endopod* one-third as long as second, short, two-fifths as long as wide, inner half of joint swollen to twice length of outer; it bears a single very long plumose seta on its outer margin; second joint square, margins equal and sublinear; outer margin bears a row of cilia over proximal half of its length and two plumose setae on distal half of its length; terminal margin bears four plumose setae spaced evenly over its full length. Six setae show a decrease in length from innermost to outermost. A rather wide flange is present between exopod and endopod, flange being as wide as terminal joint of endopod.

Fourth pereopods four-jointed, half length of carapace when straight; second joint half as long as first, third half as long again as second, fourth five-sixths as long as second. First joint elongate, subrectangular, one-quarter as wide as long at its midpoint but gradually narrowing to three-fifths this width proximally and distally; second joint pyriform, outer margin being seven times as long as inner, proximal, inner and distal margins all united in a shallow, entire curve; joint bears a row of short cirri over distal third of outer margin and a short spine, one-tenth as long as joint, on very acute outer distal angle; third joint elongate, one-sixth as wide as long proximally and distally, but narrowing to half this width medially because of curvature of outer margin; it bears a row of small cirri over distal five-sixths of outer margin and a spine which is one-third longer and wider than that on second joint, on its outer distal angle; fourth joint one-sixth as wide as long distally, but narrows to five-sixths this width proximally; outer margin four-sevenths as long as inner so that terminal margin is almost at right angles to inner and outer margins; joint bears a row of cirri over distal five-sixths of its outer margin and three spines on its terminal margin; innermost of these spines as long as joint, second one-twelfth shorter, outermost only one-quarter this length.

Fifth pereopods represented by two small protuberances on ventral surface of genital segment on either side of attachment of abdomen; they are one-eleventh as long as genital segment, pyriform, rounded at their point of origin, bearing two short spines on their acute distal terminations.

HOST FISH: *Lepidopus caudatus* (Euphrasen, 1788), frost fish, para.

SOURCE OF MATERIAL: This material was among a collection of parasitic Crustacea made by Dr Manter in 1951, in the course of collecting Trematoda and later presented by him to the Zoology Department, Victoria University of Wellington.

NUMBER OF SPECIMENS: One apparently mature female.

DISCUSSION

This species has some similarity to *L. polyprioni* but is easily distinguished from it. The body is generally more rounded, the carapace and genital segment

both being as wide as long, while in *L. polyprioni* both are a little wider than long; the posterolateral lobes of the genital segment are broader in the present species; the first segment of the abdomen is here only one-quarter longer than the second, while in *L. polyprioni* it is twice the length of the second; the setae on the first antennae are shorter in *L. heegaardi* and the second joint of the second antennae is longer compared with the first joint; the second joint of the first maxilliped bears a long spine on its inner margin, not found in *L. polyprioni*; the seta on the inner distal angle of the terminal joint of the first pereopods is non-plumose and the small outer distal spine of the first joint of the pereopod of *L. polyprioni* is not present in *L. heegaardi*; the fourth pereopods lack both the flanges associated with the spines and the ridged flange found on the second joint of *L. polyprioni*. The more rounded nature of the body and the more equal abdomen segments are the most distinctive features.

Lepeophtheirus distinctus n.sp.

Moderately large caligids, coloured yellowish-brown in alcohol. In the female the carapace is definitely more than half the entire length, longer than wide; the fourth thoracic segment is about four times as wide as long; the genital segment is wider than long, less than half the width of the carapace, well lobed; the abdomen is one-segmented, a little less than one-third the length of the genital segment. No male specimens were present in the collection.

DESCRIPTION. *Female:* Female of moderate size for a member of this genus (6.9mm–7.2mm in length).

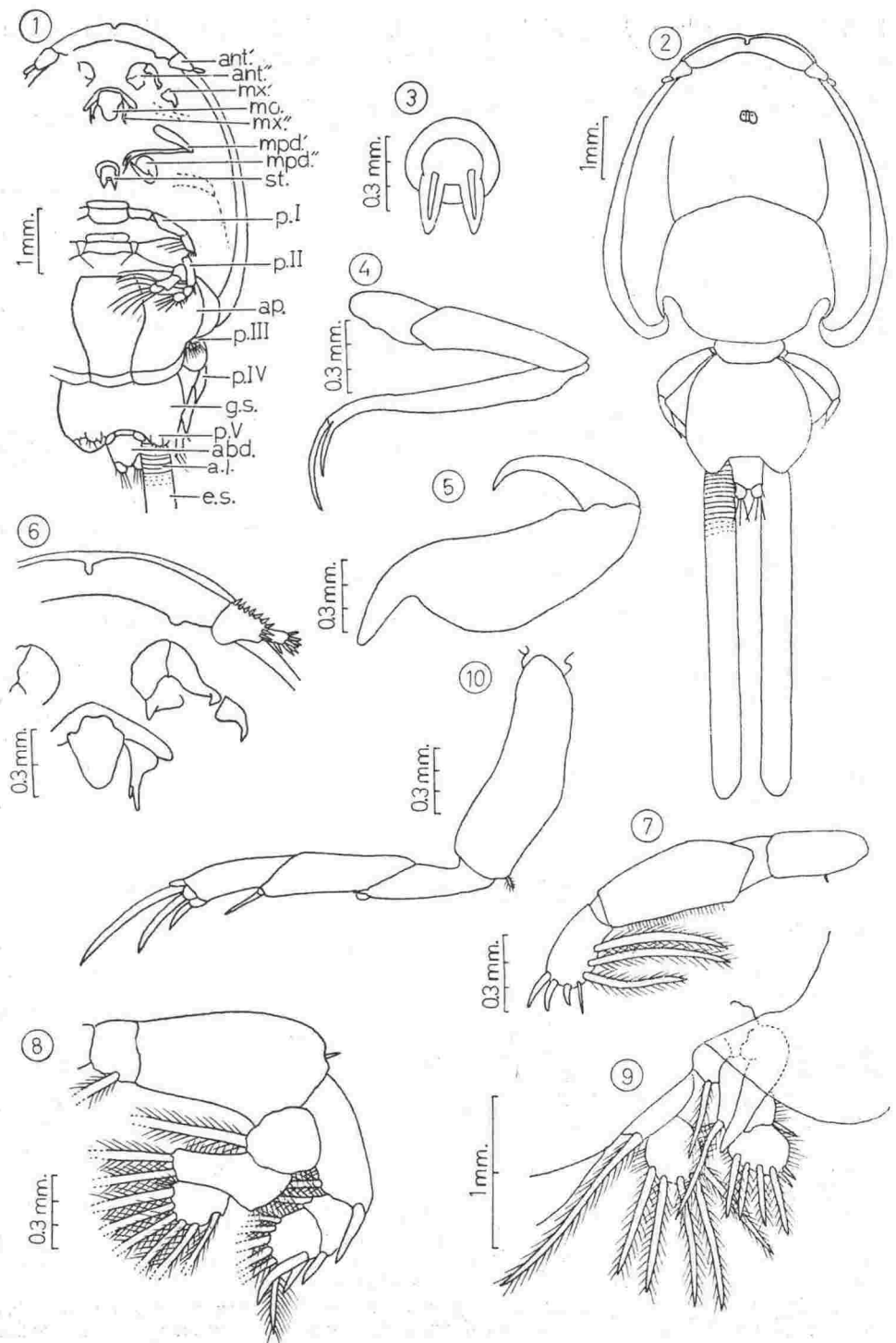
Carapace five-sevenths length of body, a little longer than wide (4.6mm–4.9mm x 4.4mm–4.7mm). Frontal area half width of carapace, one-sixth as long as wide, laterally, narrowing to four-fifths this width over median third, and is curved to a depth equal to its length. Transverse bar of dorsal rib half as wide as carapace and curves forward to a depth equal to one-sixth its length so that its midpoint is central in carapace; anterior longitudinal branches two-sevenths as long as carapace, separated by same distance anteriorly as posteriorly, but curving out to increase separation by one-tenth medially; posterior longitudinal branches also diverge over anterior three-quarters of their length, to increase their distance apart by one-quarter, converging again to seven-eighths this distance apart where they meet the posterior sinuses. Posterior sinuses small, subovate, as long as frontal area, half as wide as long, diverging anteriorly by a distance equal to their width; bordered laterally by a strip of median posterior area which is one-third as wide as sinus anteriorly, narrowing posteriorly. Part of median posterior area between sinuses is as wide as frontal area anteriorly, narrowing to four-fifths this width posteriorly, angles rounded; it extends posteriorly, beyond lateral areas, for a distance equal to width of flange. Eyes situated dorsally, one-quarter of distance from anterior margin of carapace, rather small, half as long as frontal area, two-thirds as wide as long; they are separated posteriorly by a distance equal to half their width posteriorly, and converge to half this distance apart anteriorly; they do not appear to touch. Flange on free margin of lateral areas wide (0.20mm–0.25mm), narrowing gradually anteriorly, abruptly terminating medio-posteriorly.

Fourth, freely articulated, thoracic segment small, subovate, one-quarter as wide as the carapace, one-quarter as long as wide (0.25mm–0.41mm x 1.12mm–1.28mm), lateral margins and angles rounded; fourth pereopods carried on short lateral extensions of segment, which are one-seventh as wide as segment and as wide as long.

Genital segment rather small, less than half length of carapace, a little wider than long (1.51mm–1.86mm x 1.75mm–1.99mm); posterolateral lobes comprise one-eighth length of segment, and are somewhat pointed posteriorly; lateral margins of segment, including lateral margins of lobes, entire curves; lobes one quarter as wide as segment at their bases, separated by a linear margin one-fifth as long as segment is wide.

Abdomen small, one-segmented, subtrapezoid, one-tenth as long as carapace, as wide as long (0.41mm–0.49mm x 0.41mm–0.49mm), narrowing to seven-ninths this width posteriorly; posterior margin slightly emarginated laterally for articulation of anal laminae.

Anal laminae half as long as abdomen (0.15mm–0.23mm in length), subrectangular two-thirds as wide as long; inner margins two-thirds as long as outer and slightly curved;



TEXT-FIG. 14.—*Lepeophtheirus distinctus* n.sp. Female only. (1) Ventral view. (2) Dorsal view. (3) Sternal furca. (4) First maxilliped. (5) Second maxilliped. (6) Mouth parts and first antenna. (7) First pereiopod. (8) Second pereiopod. (9) Third pereiopod. (10) Fourth pereiopod.

each bears a small plumose seta on outer posterior angle and three long plumose setae on posterior margin.

Egg strings were present in only seven of 15 specimens, although all appeared to be mature females on basis of size and shape of genital segment and overall size of specimens. Those that were present ranged from 2.9mm to 5.6mm and from 23 to 76 eggs per string.

First antennae two-jointed, one-eighth width of carapace in length, second joint half as long as first. First joint subtrapezoid, half as wide as long distally, increasing in width proximally to half this width again at midpoint and then swelling to twice this width over proximal third as result of a posterior swelling of inner margin; this joint bears seven hairs on outer margin and two slightly longer hairs on distal margin; second joint rectangular half as long as wide, distal margin rounded, and bears six hairs terminally and a further single hair medially on inner margin.

Second antennae twice as long as first antennae, two-jointed, the first joint two-thirds as long as second. Basal plates subtriangular, one-third as long as first joint, twice as wide as long; median posterior angle bears a triangular spine, two-thirds as long as base, half as wide at base as long; first joint articulates with its base anteromedially; first joint in form of a segment of a circle, inner margin reduced, outer margin long and curved, proximal and distal margins half length of outer margin; second joint one-third as wide at base as long, gradually narrowing distally to terminate in a sharp point; it is faintly S-shaped, first curve shallow, second curve, involving two-fifths of length, causing joint to curve sharply away from body.

First maxillae one-jointed, twice as long as second joint of first antennae; each one half as wide, at straight proximal margin, as long, narrowing to half this width at midpoint, then narrowing more rapidly, terminating distally in a sharp point; joint curved to a depth equal to one-quarter its length.

Second maxillae extend beyond mouth tube for one-third of their length; they are one-jointed and not bifurcated, second branch usually found in this genus being apparently replaced by a spine; they are one-half as long again as first maxillae, and associated with a plate, one-third wider than maxillae are long, one-fifth as long as wide, which runs from proximal margin of each maxilla to proximal margin of mouth tube, at which point plates from each side meet and appear to fuse; maxilla itself five-ninths as wide at base as long, narrowing rapidly to one-third this width over median third, as a result of curvature of outer margin; one-third of distance from distal termination joint starts to narrow again and turns slightly laterally, and at this point there is a spine, one-fifth as long as maxilla, one-third as wide as long, terminating bluntly and borne on inner margin; maxilla gradually narrows beyond this point and terminates in a bluntly rounded tip.

Mouth tube on ventral midline of carapace, two-ninths of distance from anterior margin; tube itself small, three-sevenths this distance in length, four-fifths as wide as long, one-quarter of distance from proximal margin, narrowing to half this width proximally and distally, distal margin rounded. Mandibles contained within mouth tube and each bears twelve teeth distally on inner margin.

First maxillipeds two-jointed, equal in length to half width of carapace in this region of body; first joint two-thirds as long as the second, one-quarter as wide as long proximally, narrowing to half this width distally, inner distal angle rounded; second joint one-ninth as wide as long proximally, narrowing to half this width distally; it bears two spines on its terminal margin, inner spine one-quarter as long as joint, outer five-ninths as long as inner, both ending in sharp points.

Second maxillipeds two-jointed, subchelate, first joint two-sevenths longer than first joint of first maxillipeds; second joint half as long as first. First joint three-tenths as wide as long at its midpoint, narrowing rapidly to two-fifths this width at elongate proximal margin which constitutes one-quarter of joint and is turned posteromedially; distally joint is half median width, distal margin almost in line with outer margin; second joint one-third as long as wide at base, narrowing gradually to a sharp point distally; curved to a depth equal to one-fifth its length.

Sternal furca central in ventral surface of carapace; it is one-sixteenth length of carapace, basal portion rounded with a diameter equal to two-thirds length of furca; furca divides into two equal branches with bases two-fifths as wide as base of furca and separated proximally by a distance equal to two-thirds their basal width; branches narrow to rather blunt points distally and diverge slightly so that they are separated distally by three times their basal distance apart.

First pereopods one-fifth as long as carapace is wide, three-jointed, basipod four-fifths and third joint half length of second joint. Basipod subrectangular, half as wide as long,

proximal margin rounded; it bears a small non-plumose seta medially on inner margin. Second joint subrectangular, three-eighths as wide as long, one-quarter of distance from proximal margin, narrowing gradually to half this width distally, narrowing abruptly proximally so that proximal margin is a blunt V-shape; joint bears a row of cilia along full length of inner margin; third joint half as wide as long proximally, increasing in width by one-seventh distally owing to swelling of inner margin; terminal margin, including inner angle, rounded, and bears three curved spines, inner one one-third length of joint, outer spine half length of joint and middle spine intermediate in length; inner distal angle bears a single fine non-plumose seta, and swollen distal half of inner margin bears three long plumose setae, most proximal two subequal in length, distal seta shorter.

Second pereopods biramose, each ramus three-jointed, basipod two-jointed. Basipod is two-thirds as long as entire first pereopod, exopod one-tenth shorter and endopod two-thirds this length. First joint of *basipod* one-fifth as long as second, subrectangular, three-quarters as long as wide, proximal angles rounded, and bears a long plumose seta medially on inner margin; second joint subrectangular, as wide as first joint proximally, swelling to twice this width distally, outer distal angle rounded; it bears a short spine on a short indentation in outer distal angle; second joint of *exopod* two-fifths as long as first, third three-eighths as long as first; first joint subrectangular, three-sevenths as wide as long, inner margin half as long as outer; it bears a spine, directed distally, on outer distal angle which is half as long as joint, and a row of long cilia along full length of inner margin except where they are interrupted by base of a long plumose seta immediately proximal to inner distal angle; second joint subtrapezoid, as wide as long, distal margin one-third longer than proximal; proximal half of inner margin bears a row of long cilia, distal half being occupied by base of a long plumose seta; outer distal angle bears a distally directed spine, three-quarters as long as the joint; third joint subrectangular, distal angles rounded, as wide as long; inner margin bears a row of long cilia along its full length, terminal margin bears six long plumose setae, and outer margin bears two spines medially; more ventral spine one-fifth longer than joint and curved, more dorsal spine being half this length and straight. First joint of *endopod* two-thirds as long as second and the third is three-quarters as long as first; first joint subcircular, as wide as long, inner margin two-sevenths as long as outer margin, which is straight for median two-thirds of its length; inner margin bears a long plumose seta medially and outer margin a row of long cilia along its distal two-sevenths; second joint subrectangular, three-fifths as wide as long, outer distal angle emarginated to half depth and two-thirds length of joint; third joint is borne on distal two-thirds of emargination; inner margin of second joint and part of outer margin which is not emarginated both bear rows of cilia; free part of distal margin bears two long plumose setae; third joint subsemicircular, three-quarters as wide as long; it bears a tuft of cilia on short, straight inner margin, which is one-quarter as long as joint and terminal margin bears six long plumose setae.

Third pereopods have their basipods united to form a broad suboval *apron*, which is three-quarters as wide as carapace, half as long as wide, free lateral and posterior margins surrounded by a flange, same width as that found on lateral margin of lateral areas of carapace, which is entire except for posterolateral interruptions at insertions of rami; it is divided into three areas by two longitudinal ribs which are separated by two-fifths width of apron medially but curve so as to be separated by three-quarters this distance anteriorly and half this distance posteriorly; each rib bears a spine, as long as flange is wide, on its posterior termination; rami small, three-jointed exopod being one-ninth length of apron and four-fifths longer than two-jointed endopod. First joint of *exopod* half as long as second and subequal in length to third; first joint rectangular, twice as wide as long, distal angles rounded; outer half is somewhat swollen and bears a large spine on outer distal angle which is directed diagonally across second joint, which is as wide at its base as joint is long and five times its basal width in length; there is a long plumose seta on inner distal angle; second joint subrectangular, terminal margin slightly swollen medially, proximal angles rounded; it bears a row of long cilia along distal third of its outer margin, a narrow spine, half as long as joint, on outer distal angle and a long plumose seta on inner margin beside inner distal angle; third joint subcircular, as wide as long, proximal margin sub-linear; outer third and inner sixth of its free margin bear long cilia, there are two subequal spines, three-eighths as long as joint on outer distal part of margin, and terminal part of margin bears four long plumose setae. First joint of *endopod* two-sevenths as long as second, two-sevenths as long as wide, outer distal angle rounded and inner margin bears a long plumose seta distally; second joint subcircular, proximal margin straight, as wide as long; distal half of outer two-fifths and inner one-fifth of free margin bear long cilia; there are five long plumose setae borne terminally.

Fourth pereopods four-jointed, half as long as carapace when straight. Second and

fourth joints are subequal in length and equal to half length of first, third joint two-thirds length of first. First joint elongate, subrectangular, one-quarter as wide as long proximally, increasing this width by one-fifth distally, proximal margin rounded; outer distal angle bears a rudimentary plumose seta; second joint one-fifth as wide as long proximally, one-third wider distally, outer margin three times length of inner so that joint appears subpyriform; outer distal angle bears a spine, one-tenth as long as joint guarded by a semi-circular flange of equal length; third joint as wide proximally as distal portion of second, one-sixth wider distally, proximal and distal margins parallel; outer distal angle bears a spine two-sevenths as long as joint, guarded at its base by a flange similar to that associated with spine on first joint; fourth joint one-quarter as wide as long throughout its length, outer margin twice as long as inner, so that distal margin is almost at right angles to lateral margins; terminal margin bears three spines outermost one-third as long as joint, innermost three and a-half times this length, middle spines intermediate in length.

Fifth pereopods represented by a pair of lobes on ventral surface of genital segment on either side of abdomen, which are one-ninth as long as genital segment, semicircular, the otherwise entire curve broken by a median triangular, spine-like lobe, which is one-third as long as rounded part, borne posteromedially; rounded distal margin bears three setae; lateral to these main lobes there are single small papillae, one-third as long as lobes, pointed distally which each bear a single seta.

HOST FISH: This is unrecorded, but as the specimens were taken together with *Acanthochondria genypteri* (Thomson, 1889) (Fam. Chondracanthidae) which has only been recorded from *Genypterus blacodes* Bloch & Schneider, 1801, the ling, it seems possible that this fish is also the host for the present species.

LOCALITY: Chatham Islands.

LOCATION: Unrecorded.

NUMBERS OBTAINED: 15 females, only seven with egg strings attached but all apparently at the same stage of development.

SOURCE OF MATERIAL: Dominion Museum collection.

DISCUSSION

L. distinctus shows some similarity to *L. parviventris* Wilson, 1905, but can easily be separated from it. In *L. distinctus* the lateral areas of the carapace are narrower; the fourth thoracic segment is three-fifths as wide as the genital segment while that of *L. parviventris* is less than half the width of this segment; the genital segment is here three-eighths the length of the carapace and wider than long, while in Wilson's species it is more than half the length of the carapace and is as wide as long; the first joint of the first antenna is longer than the second although these joints are of equal length in *L. parviventris*; the inner branch of the second maxilla is here replaced by a spine whereas both branches are of normal form in *L. parviventris*; the spines on the distal joint of the first pereopods lack the serrations shown by Wilson in his figure of *L. parviventris*. The differences in body proportions are sufficient to indicate that *L. distinctus* is a new species, despite the apparent similarity of appendages.

GENERAL DISCUSSION AND SUMMARY

The systematics of the Caligidae is rendered difficult by the large number of species present in the two major genera and by the need to rely on body proportions for identification in many cases. The armament of the appendages is not such a reliable guide to identification as in other copepod groups since this armament consists chiefly of plumose setae which may be damaged or lost very easily. The nature of the spines on the pereopods may be of assistance but cannot always

be relied upon—e.g., Shiino reports variation in the spines of the first pereopods in two different populations of *Caligus brevis* and the flanges at the bases of the spines of the fourth pereopods in *Lepeophtheirus scutiger* are shown as fairly well developed in Shiino's figure, smaller in Shen's and appear to be missing in my specimens. The actual shape of such structures as the maxillae and sternal furca may be very useful but must be used with caution as the variation in the degree of curvature of the branches of the sternal furca of *L. scutiger* illustrates. The more robust armament and the shape of the appendages may be used as specific characters where the differences are sufficiently marked, for example, *L. distinctus* and *L. parviventris* may be separated on the structure of the maxillae, *L. argentus*, *L. polyprioni* and *L. longipes* may all be separated on the nature of the serrations on the spines on the first pereopods or the lack of these serrations, and the arrangement of spines on the fourth pereopod of *Caligus pelamydis* appears to be unique. However, because of the variation described above, it is not desirable to use the structure of appendages and their armament as the sole evidence for specific differences. The relative proportions of the joints of the appendages may be of assistance in some cases as in the differences in the length of the joints of the first antennae in *L. heegaardi* and *L. polyprioni*, but these proportions have not usually been given by other workers and their value

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Paper 1 - CALIGIDAE

NOTE

The figures used in this paper are those from my M.Sc. Thesis ("Some New Zealand parasitic Copepoda of the family Caligidae"). However, the descriptions have been completely rewritten following further examination of the material, and the remainder of the text rewritten following a much more extensive investigation of the literature.

G. C. Hewitt.

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A New Species of *Caligus* (Copepoda) on a Species of
Tripterygion from New Zealand

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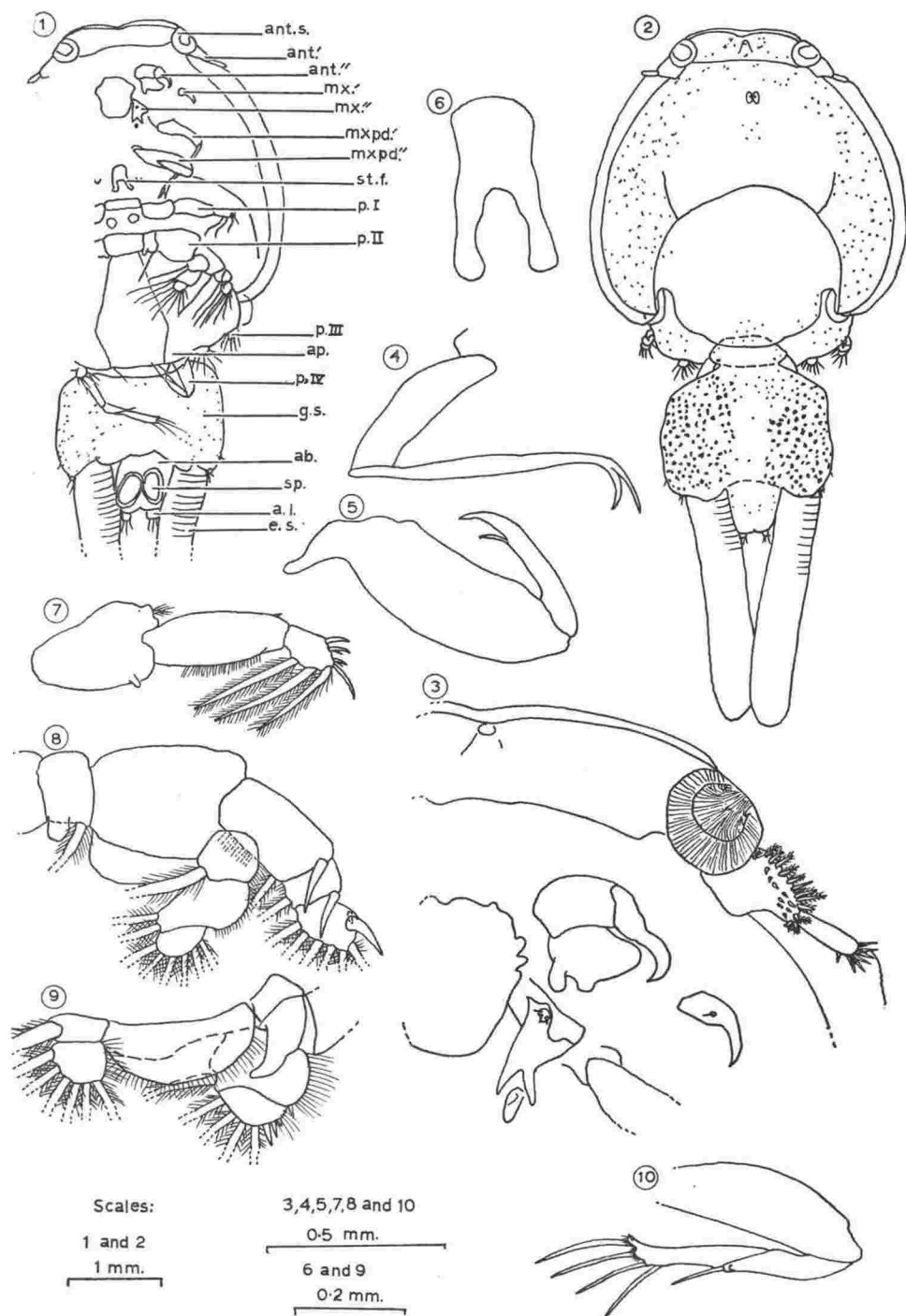
Abstract

A male and female *Caligus* were taken on a species of *Tripterygion* in Wellington Harbour. Three female and two male specimens were taken at Banks Peninsula from a collection in which it was not possible to positively identify the host; two further female specimens from this area were subsequently taken from *Tripterygion*. These specimens are all placed in the new species, *Caligus büchlerae*.

THREE mature female specimens, all with egg strings attached, and two male specimens of this rather unusual species of *Caligus* were collected by Miss M. Büchler, of Canterbury University, from the bottom of a jar containing a thornfish (*Bovichtus variegatus*), two sucker fish (*Diplocrepis* sp.) and two specimens of *Tripterygion* sp. which were collected from a rock pool at Bank's Peninsula on 27/7/63. Subsequently, on 10/9/63, Mr M. Howell, of Victoria University of Wellington, collected a female and male specimen of *Caligus* from a specimen of *Tripterygion* sp. taken in Wellington Harbour. These latter specimens of *Caligus* proved to be morphologically similar to those from Bank's Peninsula. Mr Howell states that he has examined large numbers of *Tripterygion* from the same locality in search of trematode parasites and these are the first caligids he has seen. This would suggest that, either this species does not normally occur on *Tripterygion* or that it is rare on this host in this locality. In January, 1964, Miss Büchler collected two further female specimens of this species directly from *Tripterygion* sp. taken in the same locality as her previous material. It seems certain, therefore, that *Tripterygion* is a common host for this species in that locality.

Caligus büchlerae n.sp.

A species of *Caligus* of moderate overall size, with orange-red pigment spots which gradually fade in alcohol to leave the animal a yellowish-brown colour. The carapace is as long as wide, the fourth thoracic segment half as long as wide, the abdomen is wider than long, one-third the length of the genital segment or less; in the female the genital segment is wider than long, subrectangular, about half the width of the carapace, and the second maxilla is bifurcated as in many species of *Lepeophtheirus*. In the male there are two pairs of spines on the ventral surface of the carapace among the mouth parts, and there is an unusual development of the fifth and sixth pereopods, the sixth pereopods reaching to the end of the anal laminae.



TEXT-FIG. 1.—*Caligus buchlerae* n.sp. ♀.—1—Ventral view. 2—Dorsal view. 3—Mouth parts and antennae. 4—First maxilliped. 5—Second maxilliped. 6—Sternal furca. 7—First pereopod. 8—Second pereopod. 9—Third pereopod. 10—Fourth pereopod.

Female:

Of moderate size, 4.77mm–5.40mm in total body length in the Bank's Peninsula specimens, 3.15mm for the Wellington specimen. (The Wellington specimen is generally two-thirds the size of the former specimens and only the measurements for the Bank's Peninsula specimens will be given below.) Orange-red pigment spots are found over most of the dorsal body surface, these spots being largest on the genital segment. The genital segment also has small pigment spots on its ventral surface. There are orange-red bands of pigment on the dorsal side of the egg cases between the individual eggs.

Carapace subcircular, as long as wide (2.97mm–3.20mm x 2.96mm–3.36mm), three-fifths the total body length. Frontal area three-fifths width of carapace, one-quarter as long as wide, posterior margin sublinear; anterior suckers (lunules) well developed (0.28mm–0.33mm in diameter), one-quarter width of frontal plate in diameter. Transverse dorsal rib half width of carapace, its mid-point median in carapace, forming an entire curve with the posterior longitudinal branches which are two-sevenths length of carapace; anterior longitudinal branches one-seventh length of carapace, only slightly curved, diverging anteriorly; posterior sinuses small, one-fourteenth length of carapace, two-thirds as wide as long; lateral areas rather pointed posteriorly; median posterior area at level of sinuses half width of carapace, posterior margin an entire curve and extending beyond lateral lobes for a distance equal to length of sinuses. Flange on free margin of lateral areas of moderate width (0.14mm–0.17mm), narrowing posteriorly to terminate at the sinus which bears a small separate flange on its lateral margin; flange on frontal area narrow. Eyes small and situated well forward, one-fifth of distance from anterior margin of carapace.

Fourth, freely articulated, thoracic segment one-quarter as wide as carapace, half as long as wide (0.33mm–0.38mm x 0.71mm–0.80mm), lateral margins rounded. Fourth pereopods borne on rather ventral lateral projections. Junction with genital segment indistinct.

Genital segment subrectangular, half width of carapace, four-fifths as long as wide (1.31mm–1.45mm x 1.63mm–1.83mm), angles rounded, posterolateral lobes poorly developed. Junction with abdomen indistinct.

Abdomen one-segmented, less than half length of genital segment, slightly wider than long (0.59mm–0.61mm x 0.71mm–0.80mm), lateral margins linear, posterior angles slightly rounded. Large spermathecae, about two-thirds length of abdomen, are borne on its ventral surface.

Anal laminae very small, one-fifth length of abdomen (0.11mm–0.12mm in length), subrectangular, as wide as long, placed on posterior margin of abdomen near lateral angles. Each lamina bears three long plumose setae posteriorly and a shorter plumose seta on the lateral margin near the posterior angle, as well as a row of cilia along the medial margin.

Egg strings short (2.6mm–3.3mm in length) and containing 32 to 41 eggs per string.

First antenna two-jointed, rather short, one-third as long as frontal area is wide, second joint two-thirds as long as first. First joint two-thirds as wide as long, narrowing to one-third this width distally, distal margin rounded. Second joint one-quarter as wide as long, distal margin rounded. First joint bears about eight plumose setae and two non-plumose setae on the anterior margin and four plumose setae on the distal margin as well as about 10 non-plumose setae medial to these margins; second joint bears six short and six long hairs distally and another long hair on inner margin one-quarter of distance from inner distal angle.

Second antenna two-jointed, subequal in length to first, first joint two-thirds length of second, set on an irregular base which is as wide as first joint is long and bears a broad spatulate spine two-fifths as long as base is broad. First joint of antenna two-thirds as wide as long, subrectangular, slightly curved; second joint two-fifths as wide at base as long, narrowing to a sharp point distally, distal one-third curving posteriorly.

First maxilla one-jointed, half length of second antenna, distal two-thirds curved to a depth equal to one-sixth length of maxilla, ending in a sharp point and bearing a small sensory hair on a raised boss.

Second maxilla one-jointed, subequal in length to first, distal two-fifths bifurcated as in many species of *Lepeophtheirus*, branches subequal in length and pointed distally; three very small hairs are borne on a single raised boss near the base; the bifurcated portion of the maxilla extends beyond the mouth tube posteriorly. There is a spine-like process, one-third the length of the maxilla borne on ventral surface of carapace between the distal branches of maxilla.

Mouth-tube one-eighth length of carapace, situated immediately ventral to the eyes, four-fifths as wide as long, narrowing to half this width distally, distal margin slightly curved.

First maxilliped one-third as long as carapace is wide in this region, two-jointed, first joint half as long as second; first joint one-quarter as wide as long, second joint one-fourteenth as wide as long, terminating in two subequal spines which comprise one-sixth the length of the joint.

Second maxilliped two-jointed, subchelate, as long as first maxilliped, second joint four-sevenths as long as first; first joint one-third as wide as long, rounded distally; second joint one-quarter as wide at base as long, narrowing to a sharp tip distally, distal two-sevenths, only, curved, curve shallow; slender spine, one-sixth as long as joint, borne on second joint at base of curved portion.

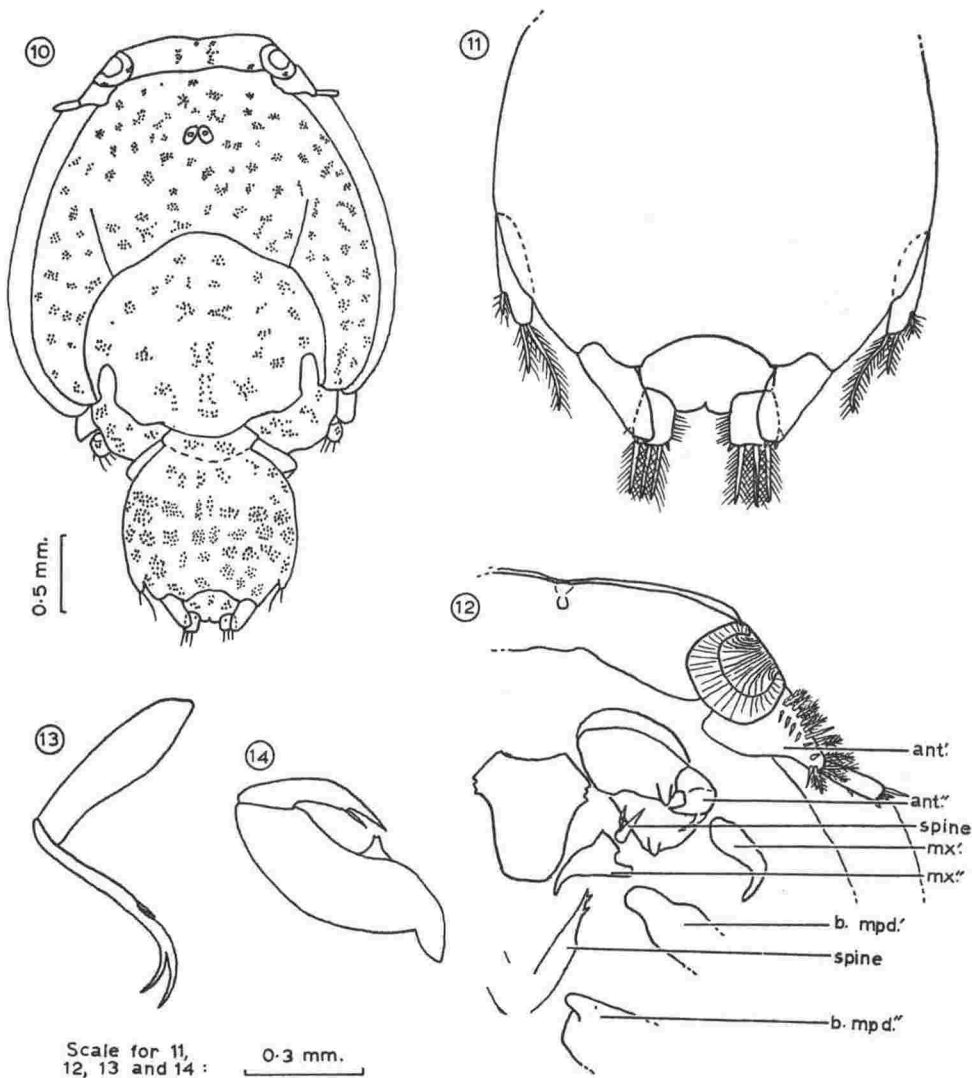
Sternal furca on midline of carapace just anterior to centre, two-thirds as long as mouth tube, distal half branched, branches separated by a curved margin proximally, slightly divergent, branches widening distally, distal margins rounded.

First pereopod three-jointed, as long as second joint of first maxilliped, basipod four-fifths as long as second joint, third joint half this length. Basipod two-thirds as wide as long, bearing a short plumose seta near the outer distal angle and a small process, probably representing endopod, on inner margin near distal angle; second joint two-fifths as wide as long medially, narrowing to half this width proximally and distally, bearing a row of cilia along the medial two-thirds of the inner margin, and a small spine on the outer margin near the distal angle; third joint subrectangular, two-thirds as wide as long, bearing three long plumose setae on inner margin, a shorter non-plumose seta on inner distal angle and three spines, the outermost half length of joint, the other two progressively shorter; two innermost with auxiliary spines, that on the median spine being half length of spine and attached to midpoint of spine, that on innermost being subequal in length to spine and attached near its base.

Second pereopods biramose, each ramus three-jointed, basipod two-jointed. *Basipod* two-thirds length of first pereopod, first joint one-third length of second, two-thirds as long as wide, sub-rectangular, bearing a long plumose seta on inner margin near distal angle and a ventral flange on posterior half of inner margin; second joint three-quarters as wide as long distally, narrowing to three-quarters this width proximally, outer distal angle rounded, bearing a broad flange on inner margin. *Exopod* subequal in length to basipod, second joint one-quarter as long as first, third joint half as long as first, first and second joints each with a long plumose seta on inner margin near distal angle, a row of long cilia over proximal half of inner margin and a long spine, half as long as first joint on outer distal angle; both joints subrectangular, the first joint half as wide as long, angles rounded, second joint half as long as wide; third joint subrectangular, four-fifths as wide as long, bearing six plumose setae on inner and distal margins, a long non-plumose seta on outer distal angle and a very small spine on dorsal surface near outer distal angle. *Endopod* two-thirds as long as basipod, first joint half length of endopod, second joint three-quarters this length and third joint subequal in length to first; first joint subrectangular, two-thirds as long as wide, outer margin three times length of inner and curved, bearing cilia over distal half, inner margin bearing a long plumose seta; second joint two-thirds as wide as long medially, narrowing proximally, outer distal angle emarginated for two-fifths length and half width of joint for attachment of third joint, outer margin curved and bearing cilia, free distal margin with two long plumose setae; third joint semicircular, proximal margin straight, curved margin bearing six long plumose setae.

Third pereopod attached to apron as in other species of the genus. Endopod and exopod well separated, the area between them bearing a semicircular flange with a ciliated free margin; endopod two-fifths length of exopod; basal spine of *exopod* two-thirds length of podite distal one-third only curved, curve slight, tip blunt; second joint two-fifths length of podite, two-thirds as long as wide, narrowing proximally and distally, inner and outer margins curved, inner margin with a long plumose seta near distal angle, outer margin bearing a row of long cilia and a short spine on the outer distal angle; third joint sub-semicircular, half as long as wide, proximal margin sublinear, outer part of margin with long cilia and three spines, the most proximal two-thirds as long as joint, the other two progressively smaller, distal and inner parts of margin bearing four long plumose setae. *Endopod* two-jointed, first joint two-thirds length of second, twice as wide as long, sub-rectangular, angles slightly rounded, bearing a long plumose seta on inner margin; second joint subrectangular, as wide as long at base, narrowing to three-quarters this width distally, angles rounded, bearing a row of long cilia over outer margin and six long plumose setae on inner and distal margins.

Fourth pereopod four-sevenths length of carapace, three-jointed, first joint half length of pereopod, distal two subequal in length; first joint one-third as wide as long, narrowing proximally and distally, outer margin curved, distal margin rounded; second joint two-ninths as wide as long, subpyriform owing to outer margin being four times length of inner, bearing a slender spine, two-fifths length of joint, on outer distal angle with a very small semicircular flange near its base; third joint one-fifth as wide as long proximally and distally, narrowing to two-thirds this width medially, inner margin twice length of outer,



TEXT-FIG. 2.—*Caligus buchlerae* n.sp. ♂. 10—Dorsal view. 11—Dorsal view, genital segment. 12—Mouth parts and antennae. 13—First maxilliped. 14—Second maxilliped.

Abbreviations.—a.l. = anal laminae; ab. = abdomen; ant' = first antenna; ant'' = second antenna; ant. s. = anterior sucker (= lunule); ap. = apron of third pereopods; b. mpd.' = base of first maxilliped; b. mpd.'' = base of second maxilliped; e.s. = egg strings; g.s. = genital segment; mx.' = first maxillae; mx.'' = second maxillae; mpd.' = first maxilliped; mpd.'' = second maxilliped; p. I-IV = first to fourth pereopods; sp. = spermathecae; st. f. = sternal furca.

bearing three spines on distal margin, innermost two-thirds length of joint, other two progressively a little shorter, innermost and medial spines each with small flanges near their bases, the flanges having cirri on their margins, outermost spine with a very small flange, its outer margin without ornamentation; a fourth spine, subequal in length to the outermost of the other three is borne subterminally on the outer margin.

Fifth and sixth pereopods are represented by two protuberances on the genital segment; the first is situated on lateral margin one-quarter of distance from posterior angle and bears a single short plumose seta; the second is borne on the posterolateral angle as seen in ventral view and bears two plumose setae, the innermost much longer than the outer. Although visible in dorsal view, both protuberances are very small.

Male.

The male is smaller than the female (3.58mm–3.85mm in over-all body length). (As with the female the Wellington specimen is smaller, 2.46mm, and its other body measurements are also approximately two-thirds those of the Banks Peninsula males, and are not given below.) The pigment spots are similar in colour to those of the female but tend to be larger, and the plumose setae of the third and fourth pereopods, and those of the anal laminae, may be pigmented.

Carapace similar in form to that of the female (2.34mm–2.64mm x 2.30mm–2.61mm). The anterior suckers are also similar (0.21mm–0.25mm in diameter).

Fourth, freely articulated, thoracic segment also similar in form to that of the female (0.25mm–0.26mm x 0.61mm–0.75mm).

Genital segment subovate, both lateral margins entire curves, two-fifths as long as carapace, a little wider than long at the mid-point, narrowing to half this width anteriorly and posteriorly (0.99mm–1.07mm x 1.17mm–1.19mm). The junction with the abdomen is much more distinct than in the female.

Abdomen much shorter than in the female, about one-fifth length of genital segment, much wider than long (0.15mm–0.19mm x 0.33mm–0.35mm).

Anal laminae similar in shape and ornamentation to those of the female and about the same size (0.12mm–0.14mm in length).

First antenna very similar in form and ornamentation to that of the female except that it possesses fewer terminal setae on the second joint.

Second antenna is two-jointed, the second joint half as long as first; first joint half as wide at base as long, narrowing slightly distally and bearing a protuberance, half as long as the joint is wide, distally on its inner margin. Second joint half as wide at base as long, dividing at its midpoint into two branches, both of which end in sharp points, the stouter of the two turning so that it may be closed against the protuberance on the first joint.

First maxilla as in the female except that the proximal portion is a little more slender, and the appendage is comparatively longer.

Second maxilla arises from a basal portion similar to that in the female but does not branch. Instead it curves slightly away from the midline and terminates in a sharp point.

Between the bases of the second antenna and the second maxilla there is a slender, sharp, anteriorly directed spine, about two-thirds as long as the maxilla. Medially on the base of this spine there is a seta which is about two-thirds the length of the spine.

Mouth tube is similar to that of the female.

First maxilliped as in the female but with the addition of a small distally directed spine, one-sixth the length of the second joint on which it is situated on the inner margin, one-third of the distance from the inner distal angle.

Second maxilliped as in the female except that the inner margin of the first joint bears medially a protuberance, half as long as the joint is wide, against which the second joint can close.

There is a large, sharp, anterolaterally directed spine arising from the ventral surface of the carapace between the bases of the maxillipeds and the mouth tube. It is as long as the mouth tube, and bears two small spines on its outer margin near the tip.

First, second, third and fourth pereopods and sternal furca all as in female.

Fifth pereopod situated on the lateral margin of the genital segment, one-fifth of the distance from the posterolateral angle; it is one-fifth the length of the genital segment, subrectangular, one-quarter as wide as long, and bears two long, plumose setae distally and a further short plumose seta just proximal to the outer distal angle.

Sixth pereopod situated on the posterior margin of the genital segment beside the posterolateral angle; subovate, one-quarter length of genital segment, half as wide as long and bearing two small spines distally. The length of this structure is such that it extends to the distal end of the anal laminae even when it is directed postero-medially, as it normally seems to be.

DISCUSSION

Superficially this new species closely resembles *C. orientalis* Gussev, 1951, *C. brevis* Shiino, 1954, *C. calotomi* Shiino, 1954, *C. latigenitalis* Shiino, 1954, *C. punctatus* Shiino, 1955, *C. communis* Shen, 1957, and *C. aduncus* Shen, 1959, as it possesses, as do all these species from the seas about China and Japan, a large carapace, subrectangular genital segment and small one-segmented abdomen. However, it can be separated from these, and all other species of *Caligus* so far described, by the bifurcated nature of the second maxillae. The only other species of this genus in which an appendage of similar appearance occurs is *C. alatus* Heegaard, 1943, and Heegaard states that in this case the appearance is caused by a spine at its base and is not a true bifurcation.

Although the simple spinelike state of the second maxilla is normally included as one of the generic characters of *Caligus* the author does not suggest that the present material belongs to a new genus. The other characters usually associated with the genus *Caligus*—e.g., the anterior suckers and the form of the pereopods are all clearly shown by the present specimens. Therefore it seems proper to regard the present species of *Caligus* as illustrating part of a range of variation in the form of the 2nd maxilla, similar to the variation in the form of the 2nd maxilla which occurs in the closely related genus *Lepeophtheirus*.

The male of this species *C. büchlerae* is readily distinguished since, although it lacks the bifurcate maxilla of the female, it possesses unusual spines beside the mouth parts and unusually well developed fifth and sixth pereopods, which make it very easy to identify.

The Wellington specimens are two-thirds the size of those taken at Banks Peninsula. Perhaps this reflects a physiological difference in the host, or that the species has reached the northern-most limit of its range and that it is a measure of the difference between the two localities in some ecological factor.

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Paper 2 - CALIGIDAE

NOTE

The name Caligus büchlerae is an incorrect original spelling (Art. 27 of the International code of zoological nomenclature, 1963) and is corrected to C. buechlerae in paper 14 of this thesis.

G. C. Hewitt.

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The Occurrence of *Lepeophtheirus insignis* Wilson (Copepoda
parasitica) in New Zealand Waters and Its Relationship to
L. molae Heegaard

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[Received by the Editor, August 8, 1963.]

Abstract

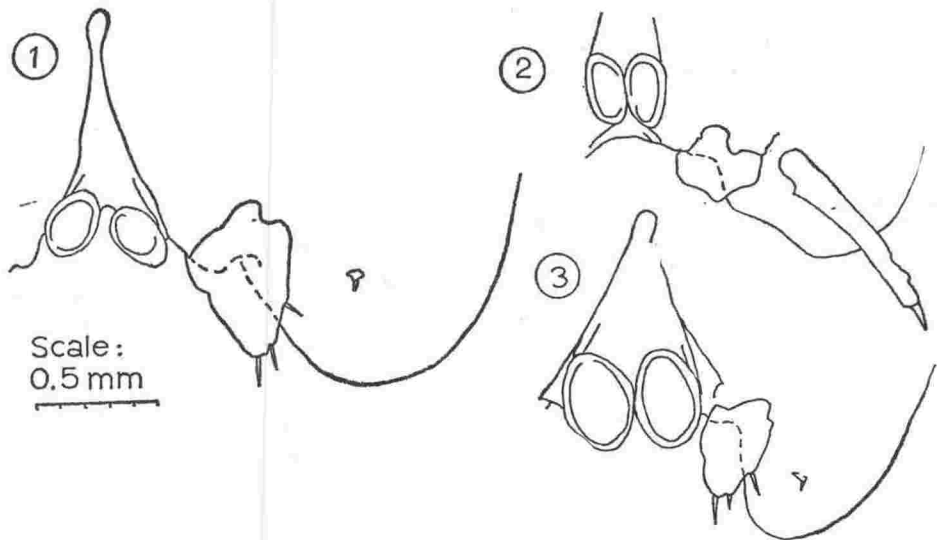
SPECIMENS of *Lepeophtheirus* from the sunfish (*Mola mola* L.) taken in New Zealand waters are identical with cotype material of *L. insignis* Wilson. Paratype specimens of *L. molae* Heegaard from Australian waters differ from *L. insignis* only in the shorter, wider genital segment, in the much greater development of the rudimentary fifth pereopods and in the further suppression of the rudimentary sixth pereopods, and these two species are clearly closely related.

FOUR male and four female specimens of *Lepeophtheirus*, taken from the skin of a specimen of *Mola mola* brought ashore in a seine net off Rona Bay, Eastbourne, on 30.11.1960, were lent to the author by the Dominion Museum, Wellington. Examination showed them to be very similar to descriptions of both *L. insignis* Wilson, 1908 and *L. molae* Heegaard, 1962. In order to resolve their identity the author borrowed one male and one female cotype of *L. insignis* together with three male and three female specimens identified as such by C. B. Wilson from the United States National Museum (Cat. no. U.S. 74370) and four female paratypes of *L. molae* from the Australian Museum (Cat. no. G.5213). Unfortunately Heegaard's single male specimen could not be located.

After comparison, it was found that the females of all three lots were morphologically similar in every respect, except that in the New Zealand and North American material the sixth pereopods are obvious, consistently flattened, carrying three setae, the fifth pereopods are minute; the genital segment is more than half the length of the carapace and longer than wide; in the Australian material the sixth pereopods are smaller and lack setae, but the fifth are elongated, large and obvious, while the genital segment is less than half the length of the carapace and wider than long. From the literature it appears that the specimens figured and described by Barnard (1955, p. 169, fig. 11) as *L. insignis* are similar to the Australian material.

Heegaard noted the great similarity between his material and Wilson's. Of the differences suggested by Heegaard (p. 171), the "spine on the carapace"

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Posterior part of genital segment showing the fifth and sixth pereopods, Fig. 1: in *Lepeophtheirus insignis* from New Zealand waters; Fig. 2: in *L. molae* from Australia; Fig. 3, in *L. insignis* from Southern California.

beside the posterior sinuses is a ridge caused by the dorsal bulging of that part of the median posterior area that lies lateral to this sinus and is present in all the specimens examined (some indication of this may have been intended in Wilson's figure, Pl. 70, fig. 37); the cresta on the first maxilliped is present in Wilson's material although not figured or described by him; the third pereopod of all specimens appears to be similar; the abdomen in Wilson's material is indistinctly two segmented (although he appears to have overlooked this fact) as it is in the New Zealand material; it seems probable that this is also the case with Barnard's material which was figured by him as being one-segmented. I am unable to make a comparison of the males in the absence of Heegaard's male specimen but the New Zealand males are similar to those described by Wilson. Thus the similarity between Heegaard's material and Wilson's is greater than the latter's description would suggest.

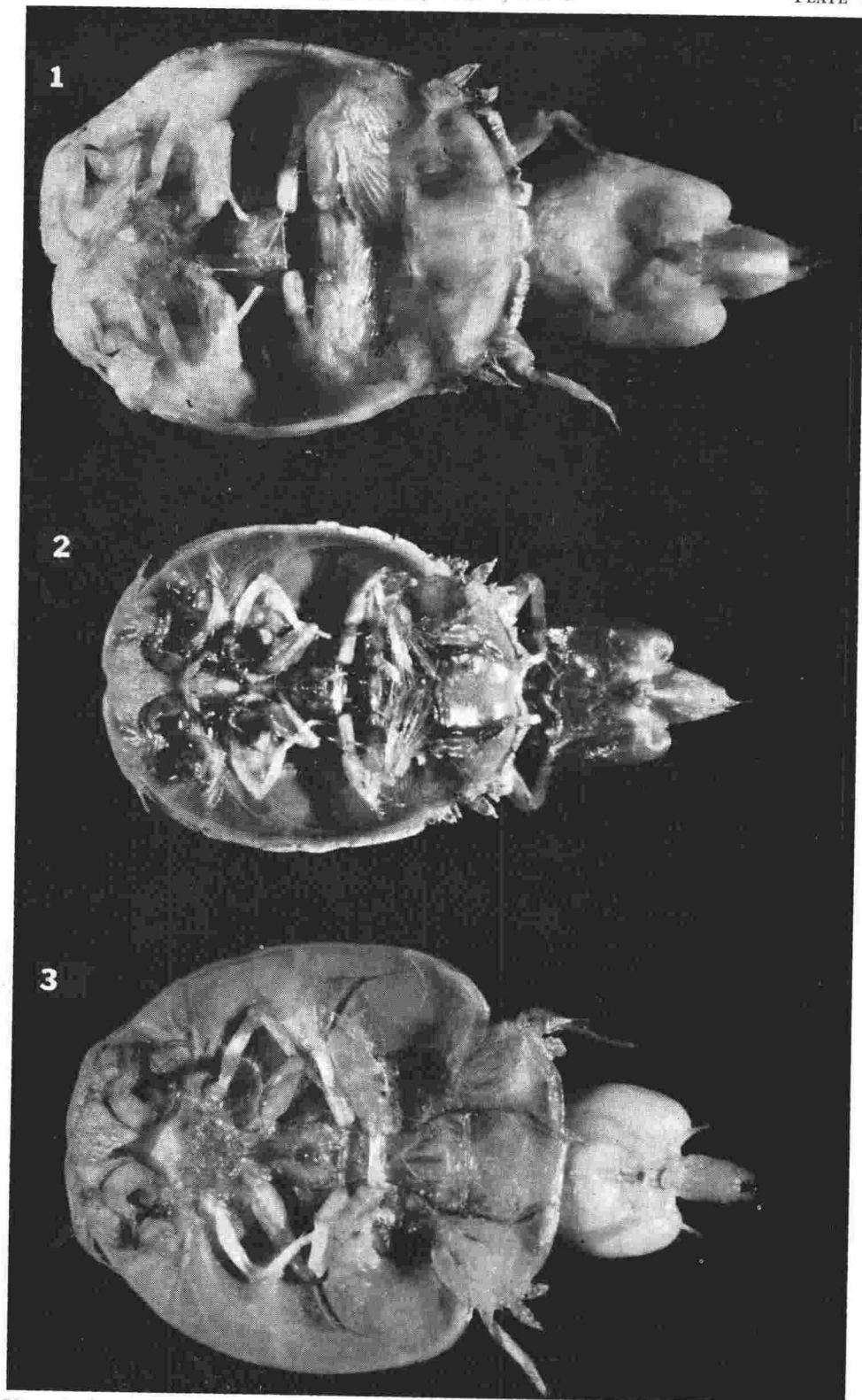
The figures of juvenile specimens by both Heegaard and Wilson suggest that the differences in the fifth and sixth pereopods occur early in the postchalmus development, if not before, and must therefore be regarded as significant ones, as are the differences in the shape of the genital segment. However, considering the close similarity of all other structures, the species are clearly closely related. The two species may be separated as follows:

Lepeophtheirus insignis

Lepeophtheirus insignis Wilson, 1908. *Proc. U.S. nat. Mus.*, 35: 444-447, Pls. 70-71.

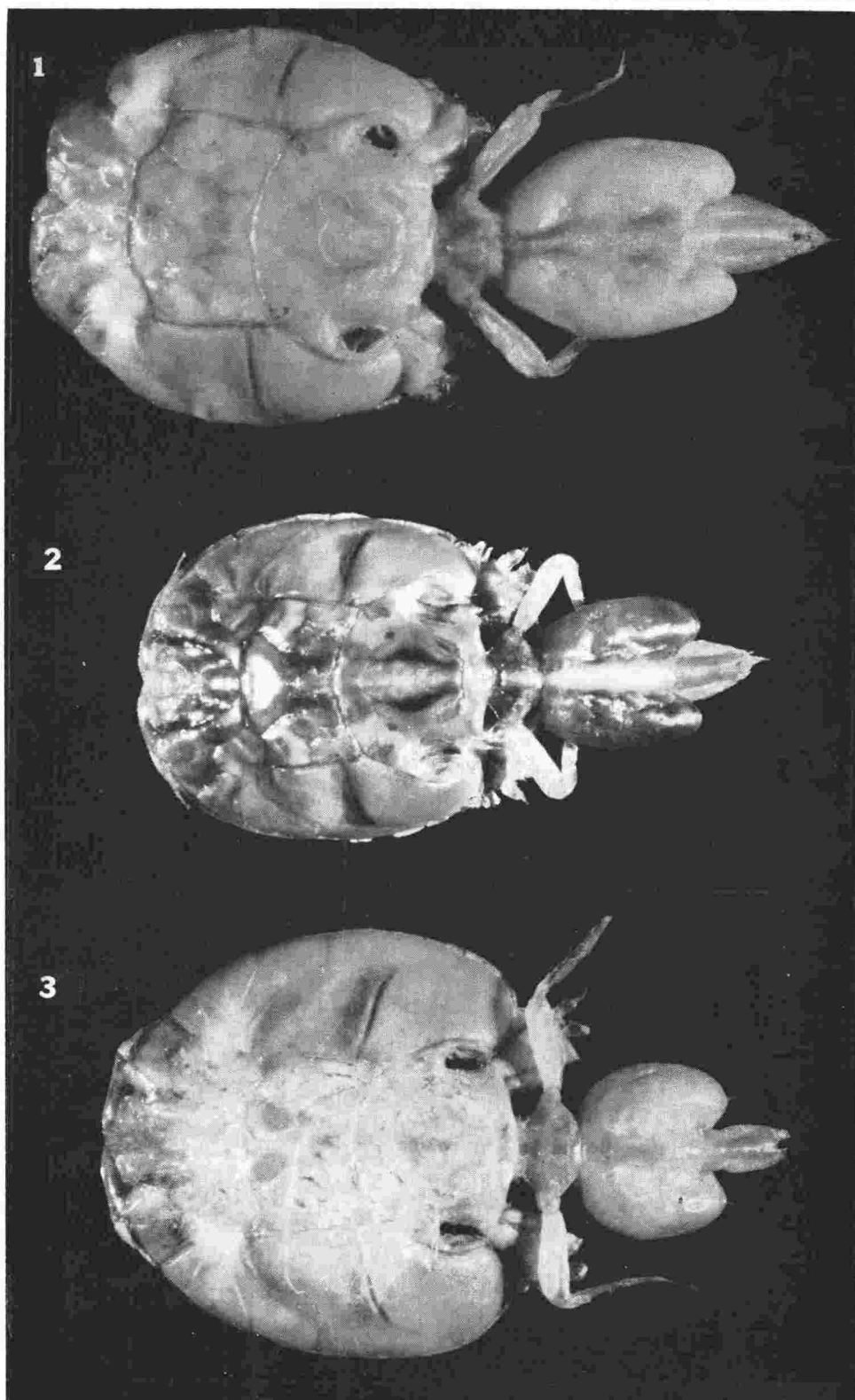
Genital segment longer than wide, two-thirds the length of the carapace; the fifth pereopod is reduced to a small papilla bearing a single seta, the sixth pereopod well developed, about one-seventh the length of the genital segment, subsemicircular, flattened and bearing three setae.

KNOWN DISTRIBUTION. Wellington, New Zealand and Southern California.



Ventral views of: 1—*Lepeophtheirus insignis* from New Zealand waters. Length, 13.3 mm. 2—*L. insignis* from Southern California. Length, 10.5 mm. 3—*L. molae* from Australian waters. Length, 11.7 mm.

Photographs by M. D. King.



Dorsal views of: 1—*Lepeophtheirus insignis* from New Zealand waters. Length, 13.3 mm. 2—*L. insignis* from Southern California. Length, 10.5 mm. 3—*L. molae* from Australian waters. Length, 11.7 mm.

Photographs by M. D. King.

Lepeophtheirus molae

Lepeophtheirus molae Heegaard, 1962. *Rec. Aust. Mus.*, 25 (9): 169–171, figs. 124–134.

Lepeophtheirus insignis Wilson, Barnard, 1955. *Ann. S. Afr. Mus.*, 41: 251–252, figs. 11 a-c.

Genital segment clearly wider than long, three-eighths the length of the carapace; the fifth pereopod is long and styliform, about one-third the length of the genital segment and one-seventh as wide at the base as long, narrowing to half this width distally; each has a terminal spine in the present specimens but no setae; setae are, however, reported by both Barnard and Heegaard and may have been lost in the material lent to the author; two emarginations on the lateral margin of these pereopods are probably the bases for the missing setae; the sixth pereopod is one-third the length of the fifth pereopod and lacks setae, although the shape is similar to the shape of these pereopods in the other species.

KNOWN DISTRIBUTION. Port Jackson, New South Wales, and Table Bay, South Africa.

ACKNOWLEDGMENTS

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A Redescription of *Gloiopotes huttoni* (Thomson, 1889),
with a Key to the Species of the Genus

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[Received by the Editor, February 6, 1964.]

Abstract

A redescription of *Gloiopotes huttoni* (Thomson, 1889) is given together with comments on variations in body form and ornamentation as seen in the author's material. It is concluded that *Gloiopotes longicaudatus* (Marukawa, 1925), *G. watsoni* Kirtisinge, 1934, and *G. zeugopteri* Satyanarayana Rao, 1951, are synonyms of *G. huttoni*. Other species of the genus are briefly discussed and a key to the species is given.

INTRODUCTION

The genus *Gloiopotes* is parasitic on several of the larger pelagic fishes and is essentially cosmopolitan in distribution.

In the past most of the species of *Gloiopotes* have been described from a few specimens only, but the present material is sufficiently abundant to obtain a good idea of the variability of some characters. The range of variation shown has necessitated a reconsideration of the specific characters of other described species.

MATERIAL EXAMINED. Material from the Dominion Museum, Wellington: From the striped marlin (*Makaira mitsukurii*); Mayor Island, 2.3.1948, six females (three damaged) and one male; Bay of Islands, 2.3.1957, ("from flank, near vent"), six females and five males; Bay of Islands, —/3/1960 ("from flank"), seven females and two males. From the black marlin (*Makaira marlina*); Bay of Islands, —/3/1960 ("from flank") two females and two males.

Material from M. J. Daniels, N.Z. Forest Service: From the striped marlin; off Russell, Bay of Islands, —/2/1963, nine females and two males.

Total number of New Zealand specimens, 30 females and 12 males.

Material from the British Museum (Natural History): From *Histiophorus brevirostris*; Madras, one female and one male.

Gloiopotes Steenstrup and Lütken, 1861

(After Wilson, 1907, p. 698, modified as required by the description of later species.)

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Wellington, P.O. Box 196, Wellington.

Carapace large, oval, shield shaped, first antenna slender and two jointed but usually with the second joint pigmented distally so that the antenna appears three jointed, second maxilla bifurcated in the female, sternal furca bifurcated with each branch dividing again distally, first pereopod with endopod reduced or missing, second and third pereopods biramous, fourth pereopod uniramous, two of the terminal claws on the first pereopods tri-parted; fourth thoracic segment freely articulated, with two lateral plates that may obscure part of the genital segment in dorsal view; genital segment large, produced backwards in the females on either side of the abdomen as two more or less slender posterolateral lobes; the male without these lobes; in both male and female the genital segment bears laterally a pair of posteriorly directed styliform processes, possibly derived from the fifth pereopods; abdomen slender and two segmented; anal laminae slender and elongated; surface of body with spines, mainly on the dorsal surface and dorsal surface of carapace bearing rows of sensory hairs; egg strings large, eggs uniserial, flattened, plate-like.

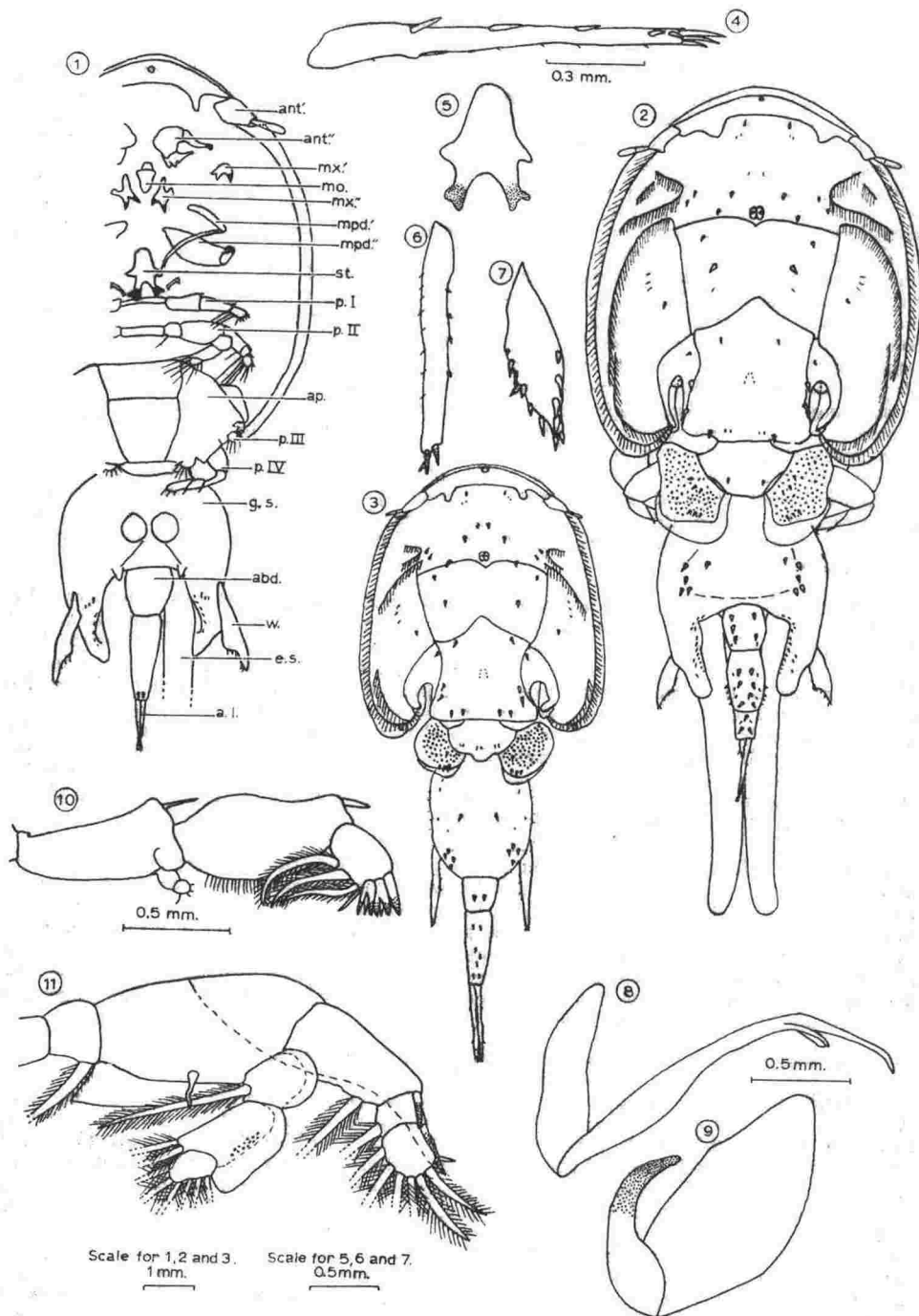
Gloiopotes huttoni (Thomson, 1889)

- Lepeophtheirus huttoni* Thomson, 1889. *Trans. Proc. N.Z. Inst.*: 354-356, Pl. 28, fig. 10, a-c; Pl. 29, a-m.
Gloiopotes huttoni (Th.) Bassett-Smith, 1899. *Proc. zool. Soc. Lond.*, 1899: 458.
Caligus longicaudatus Marukawa, 1925. *Illustrated Encyclopedia of the Fauna of Japan*, 1925: 1243, fig. 2396; 1947: 927, fig. 2654.
Gloiopotes watsoni Kirtisinge, 1934. *Parasitol.*, 26: 167-173, figs. 1-17.
Gloiopotes sp. Yamaguti, 1936. *Parasitic copepods from fishes of Japan*: Part 3 Caligoida, II, 1936: 4-5, Pl. II, fig. 20 and Pl. III, figs. 21-35.
Gloiopotes zeugopteri Satyanarayana Rao, 1951. *Proc. Ind. Acad. Sci.*, 34B: 248-255, figs. 1-15.
Gloiopotes longicaudatus (Marukawa) Shiino, 1954. *Rep. Fac. Fish. Pref. Univ. Mie*, 1 (3): 273-278, figs. 1 A-I. 2 A-H.
Gloiopotes longicaudatus (Marukawa) Shiino, 1959. *Rep. Fac. Fish. Univ. Mie*, 3 (2): 348-349.
Gloiopotes longicaudatus (Marukawa) Heegaard, 1962. *Rec. Aust. Mus.*, 25 (9): 174, figs. 151-153.
Gloiopotes longicaudatus (Marukawa) Ho, 1963. *Crustaceana*, 5 (2): 87-90, figs. 6-10.

DESCRIPTION. (Measurements given are from 25 females and ten males from striped marlin and two females and two males from black marlin. As the specimens from the black marlin tend to be smaller than any of those from the striped marlin their measurements are given separately as follows: measurement of specimens from striped marlin minimum-maximum (average); measurement of specimens from black marlin; measurements from both the male or female specimens from black marlin is only given where these are very different, otherwise only the average is given.)

Female. Large compared to other records of *Gloiopotes*, 12.1mm-14.0mm (13.0mm); 11.6mm total body length. Carapace about half length of body.

Carapace a little longer than wide, 6.0mm-6.7mm (6.3mm); 6.1mm; length 5.5mm-6.4mm (13.0mm); 11.6mm. Frontal area half width of carapace, one-ninth as long as wide medially, becoming shorter laterally except for two posterior bulges which double length at a point midway between lateral margin and midpoint. There are two transverse ribs, one one-third of distance from anterior margin, the other two-thirds this distance at its posterior extremities; anterior transverse rib half carapace width, in form of two shallow curves meeting in a shallow V immediately posterior to median eyes; posterior transverse rib one-third carapace width; from posterior transverse rib a posterior longitudinal rib passes back to meet posterior sinuses posteromedially; from a point just posterior to junction of this rib with posterior transverse rib a very short branch passes laterally to join with a further longitudinal rib which passes forward to join the lateral extremities of the anterior transverse rib and terminate just anterior to it; same longitudinal rib. passes posteriorly, curving laterally as it does so, to terminate posterolaterally at posterior sinuses.



Gloiopotes huttoni (Thomson, 1889). Text-figs 1-11. Fig. 1—Female, ventral view. Fig. 2—Female, dorsal view. Fig. 3—Male, dorsal view. Fig. 4—Female, anal lamina. Fig. 5—Female, sternal furca. Fig. 6—Male, styliform process. Fig. 7—Female, styliform process. Fig. 8—Female, first maxilliped. Fig. 9—Female, second maxilliped. Fig. 10—Female, first pereiopod. Fig. 11—Female, second pereiopod.

Abbreviations: ant.—first antenna; ant."—second antenna; mx.—first maxilla, mx."—second maxilla; mo.—mouth tube; mpd.—first maxilliped; mpd."—second maxilliped; st.—sternal furca; p. I-IV—first to fourth pereiopods; ap.—apron of third pereiopods; g. s.—genital segment; abd.—abdomen; w.—styliform process; e. s.—egg strings; a. l.—anal laminae.

A further pair of what appear at first to be ribs pass anteriorly from points on the anterior transverse rib just lateral to the eyes; the author considers these to be the separation of muscle masses rather than ribs and they are therefore not shown in the figure. Lateral margins of carapace bear flanges, 0.2mm–0.25mm in width, along their full lengths, ending posterolaterally at the posterior sinuses; frontal margin of carapace and outer margins of posterior sinuses carry flanges about half this width, and there are further small flanges on the anterior margin of the posterior sinuses. The posterior sinuses are narrow, one-seventh the length of carapace and half as wide as long medially, narrower posteriorly; small area about them raised, especially that part between them and the outer posterior longitudinal rib. Lateral margins of carapace bear rows of wavy hairs along their full lengths, hairs nearly as long as flange is wide and differ from hairs on other parts of carapace since in this case each hair has a separate base, but other hairs arise in pairs from common bases; a row of these double hairs arises from anterior termination of anterior longitudinal rib, passes laterally and posteriorly to terminate at level of anterior margin of posterior sinus, a further row arising just medial to posterior fifth of this row and passing posteriorly gradually approaching lateral margin of carapace as it does so, to terminate at posterolateral margin of posterior sinus; a further row of hairs is bluntly V-shaped, apex rounded and directed medially, posterior arm subparallel to and just anterior to anterior quarter of row which has its origin at the anterior tip of anterior longitudinal rib, other branch directed towards but not reaching bases of first antennae; between extremities of arms of this row there is a further short row, subparallel to the lateral margin of carapace, sometimes separate from the V-shaped row, sometimes united with it to form a D-shape.

In some specimens there are a pair of small spines and two pairs of very small spines between the posterior bulges of the frontal area, but these are either very small or missing in most specimens; there are two small spines in line with eyes, two-thirds of distance from anterior margin to eyes, a pair of moderate sized spines immediately anterior to midpoints of each curve of the anterior transverse rib, a pair of moderate sized spines midway between these and the small spines anterior to the eyes, and two pairs of moderate sized spines immediately medial to the apex of the V-shaped row of hairs; a row of three spines running subparallel to the anterior longitudinal rib, half way between this rib and midline, anterior two of moderate size, third one very small and usually missing; another spine of moderate size an equal distance lateral to this rib with a row of three small spines placed anterolaterally to it, between it and lateral row of hairs; a pair of small spines halfway between inner of two posterior longitudinal ribs and midline; a pair of small spines situated just inside angle formed by the junction of two posterior longitudinal ribs; two large spines, usually about one-quarter length of sinus, between the posterior sinus and the inner of the posterior ribs; three pairs of very small spines in the centre of area between the sinuses, placed either in a V-formation, apex anterior, or about periphery of an oval, in some cases one pair being considerably larger than others; one large spine near posterior margin of carapace, halfway between sinus and midline, two very small spines halfway between these spines and midline, but these two very small spines often replaced by one large one which is usually smaller than outer one.

Eyes paired and parallel, about as long as flange on lateral areas is wide.

Fourth, freely articulated, thoracic segment, without considering dorsal plates, one-third width of carapace anteriorly, joined to carapace along half its anterior margin, narrowing to half this width posteriorly; half as long as wide; 0.7mm–1.2mm (1.0mm); 0.9mm length; 1.7mm–2.1mm (1.9mm); 1.9mm width. It bears two spines, usually small in size, near its posterior corners. Plates subrectangular, about two-thirds as long as wide, deeply invaginated for the first half of its length where it is attached to segment, corners rounded, texture giving a stippled appearance to a greater or lesser extent. Plates bear three small spines near posterior margin and a further three more or less parallel to junction with segment, but any of these spines may be very small and one or more in each row is often missing. Plates also bear a flange which at its widest point is twice as wide as that on lateral areas of carapace but narrows medially to terminate at segment and laterally to terminate two-fifths of way along lateral margin. Taking plates into account fourth thoracic segment has following measurements: 1.7mm–2.4mm (2.1mm); 1.8mm length; 3.2mm–3.7mm (3.5mm); 3.1mm width.

Genital segment more than half length of carapace, longer than wide, two-fifths of length due to the long and narrow posterolateral lobes; measurements of genital segment including lobes: 3.4mm–4.4mm (3.8 mm); 2.5mm and 3.4mm length; 2.8mm–3.7mm (3.3mm); 2.5mm and 3.0mm width. Lateral margins of segment including lobes an entire

curve; lobes half as wide as long, narrowing at midpoint to two-thirds this width, rounded posteriorly, with a slight dorsal medial lip posteriorly; margin between lobes a shallow concave curve meeting the straight inner margins of the lobes in sharp angles; median two-thirds of area anterior to lobes gently depressed. Segment bears a row of three spines along posterior lateral margin of depression, rarely another spine medial to most anterior of these and sometimes yet another spine just lateral to posterior angles of depression; two small spines just medial to anal laminae on margin between them, another three small spines just posterolateral to these and a row of eight to 15 small spines, decreasing in size posteriorly which extend along inner dorsal margin of the posterolateral lobes and may extend down to and around the posterior margin; three or four small spines lateral to this row on medial third of lobes; a row of four to six very small spines on inner ventral margin of the lobes, usually with one small and two very small spines placed half way between most anterior of these and bases of styliform processes. Styliform processes attached to genital segment just medial to outer margin of lobes, near their origin; three-sevenths as long as genital segment, one-third as wide as long at mid-point, narrowing to three-quarters this width at base and to a sharp point distally; they project beyond segment at various angles so that they may hardly extend beyond the lobes or they may reach almost to the posterior end of the abdomen; from 1.0mm to 1.9mm of length of processes visible in dorsal view; process bears six spines along distal half of outer margin and eight spines along distal two-thirds of inner margin, which is three-quarters length of outer; spines tending to decrease in size proximally.

Abdomen two-segmented, first segment half as long as second, as wide as long at midpoint, narrowing to three-quarters this width anteriorly and posteriorly, lateral margins entire curves; second segment two-fifths as wide as long at a point two-fifths of the distance from anterior margin, narrowing to two-thirds this width anteriorly and half this width posteriorly, anterior two-thirds sharply swollen dorsally so that abdomen appears to be three-segmented in dorsal view in some specimens; first segment: 0.6mm–1.0mm (0.8mm); 0.7mm length; 0.7mm–1.0mm (0.8mm); 0.8mm width; second segment: 1.5mm–2.0mm (1.7mm); 1.5mm length; 0.6mm–0.9mm (0.7mm); 0.6mm width. First segment bears from three to five moderate sized spines, same size as those on posterior margin of carapace, in two rows situated halfway between lateral margin and midline, and a pair of small spines just inside the posterior angles of the segment; second joint bears nine to eleven spines, often in the form of two rows of five pairs situated one-third of segment width in from lateral margin, with a single median spine between fourth and fifth pairs, but either one of either of second and third pairs may be missing, leaving a single asymmetrically placed spine on other side; a further eight to ten small spines are placed in single rows between larger spines and lateral margins, usually alternating with larger spines; there are three to five large spines on median third of each lateral margin; two moderate sized spines have their bases immediately anterior to posterior margin of ventral surface.

Anal laminae long and narrow; 1.0mm–1.3mm (1.1mm); 1.2mm length; one-eighth as wide as long proximally, narrowing to two-fifths this width distally; each bears five spines on outer margin decreasing in length distally; three spines as long as basal width on distal margin, a further spine as long as proximal spine on outer margin, placed opposite it on inner margin, and a row of about six small hairs on remainder of inner margin.

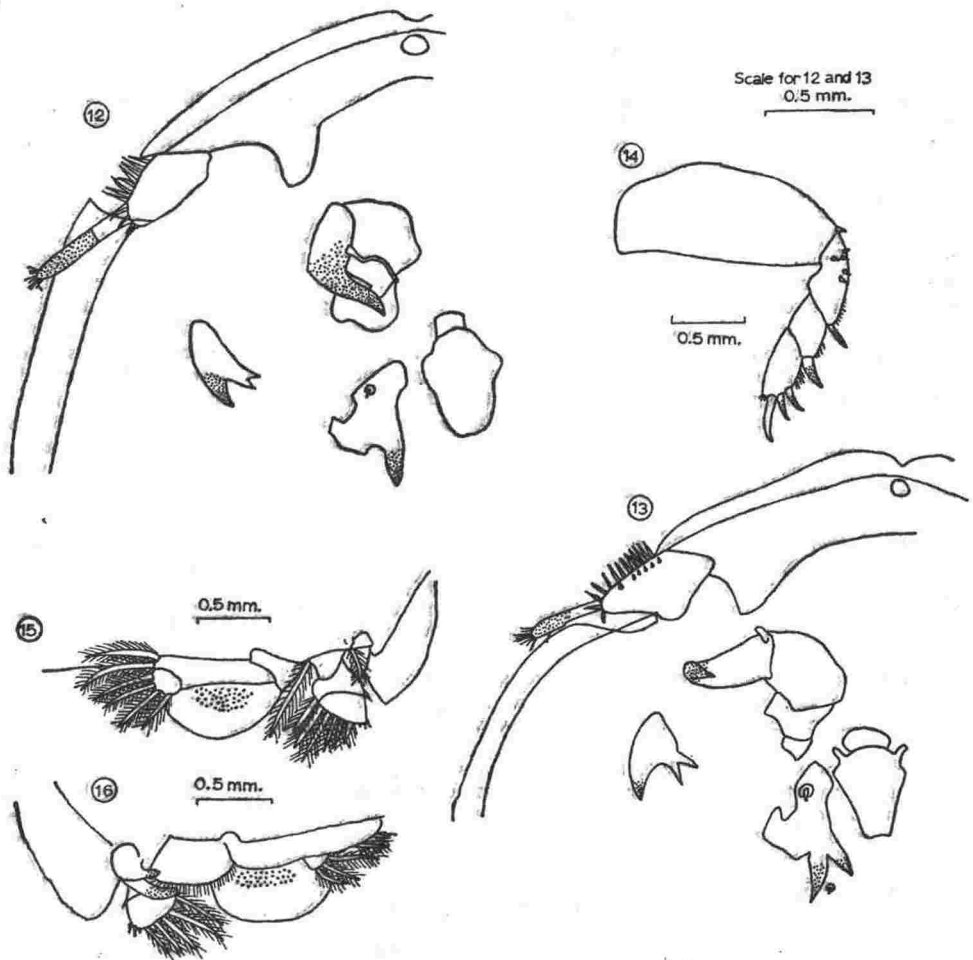
Egg strings from 4.7mm–6.0mm, containing from 91 to 114 eggs per string. Unfortunately the egg strings were damaged on 14 of the 19 specimens that carried them, to such an extent that either they could not be measured or the eggs could not be counted.

First antenna two-jointed, second joint two-thirds as long as first; first joint half as wide as long at subrectangular base, narrowing to two-sevenths this width distally, distal margin rounded. Second joint one-seventh as wide at the base as long, a little wider distally, distal margin rounded; distal half deeply pigmented so that antenna appears three jointed. First joint bears about 14 setae along the outer and terminal margin and six small setae immediately posterior to anterior margin; the second joint bears about 11 fine hairs terminally and a further fine hair half way along inner margin of pigmented portion.

Second antenna subequal in length to first, two-jointed, first joint two-thirds as long as second; set on a base that is as wide as first joint, three-quarters as long as wide, and bears a posteriorly directed awl-shaped spine on posterior margin. First joint three-quarters as wide as long, curved outer margin six times as long as straight inner margin; second joint one-third as wide at base as long, narrowing gradually to a distal point, distal third curved ventrally; outer proximal angle bearing a slight ridge.

First maxilla two-thirds as long as first joint of first antenna, basal width two-thirds the length, base giving off a spinous projection posteriorly which is four-fifths as long as base is wide, as wide at base as long, distal half pigmented; proximal margin of maxilla and inner margin of projection forming a single entire curve; maxilla narrows to one-third the basal width at a point one-third of distance from distal end before dividing into two subequal, divergent branches, each of which ends in a sharp point.

Second maxilla four-fifths as long as the first, placed on a subrectangular plate, half as wide again as the maxilla is long, half as long laterally as wide, narrowing to two-thirds this length medially, proximal margin with a large sub-rectangular invagination over median third and a spine on a raised boss immediately medial to this invagination. Maxilla a little narrower at base than long, narrowing rapidly to half this width, then dividing into two unequal branches one-third of the distance from base; inner branch straight, two-thirds the length and two-thirds basal width of outer branch which curves slightly laterally; both branches sharply pointed distally and both with brown pigmentation over most of their lengths. There is a small spine on a raised boss on ventral surface of carapace between branches of this maxilla.



Gloiopotes huttoni (Thomson, 1889). Text-figs. 12-16.—Fig. 12—Antennae and mouth parts of male. Fig. 13—Antennae and mouth parts of female. Fig. 14—Female, fourth pereopod. Fig. 15—Female, third pereopod, dorsal aspect. Fig. 16—Female, third pereopod, ventral aspect.

Mouth tube as long as second joint of first antenna, three-quarters as wide at base as long, narrowing to one-third this width distally, distal margin sublinear.

First maxilliped one-third as long as carapace is wide, first joint half as long as second, one-quarter as wide as long, proximal and distal margins rounded; second joint one-seventh as wide as long, narrowing to half this width proximally, proximal margin rounded, and one-third this width distally, distal margins carrying two spines, innermost half the length of joint, outer spine two-fifths length of inner and with a narrow flange along its outer margin, both spines ending in sharp points.

Second maxilliped three-quarters as long as first, second joint three-quarters as long as first; first joint suboval, median width half length; second joint one-third as wide at base as long, narrowing distally to a point, curved to a depth equal to one-fifth its length; distal half of second joint pigmented dark brown.

Sternal furca on midline of ventral surface of carapace, immediately posterior to second maxillipeds which are halfway between anterior and posterior margins of carapace, one-seventh length of carapace. Base subtriangular, anterior apex broadly rounded, length equal to half length of furca, posterior width five-sixths length of base. Branches of furca one-third length of furca, broadly divergent, basal width four-fifths length, narrowing to two-thirds this width two-thirds of the distance from the base, then branching into two widely diverging secondary branches; distal half of primary branches brown pigmented.

First pereopod one-quarter as long as carapace is wide, three-jointed, first joint (basipod) as long as second, twice as long as third, basal width one-fifth length, broadening to twice this width distally, angles only slightly rounded, inner distal angle with a subcircular swelling, outer distal angle bearing a narrow spine one-quarter the length of the joint; inner distal angle bears a rudimentary endopod, one-seventh length of exopod, two-jointed, the first joint suboval, twice length of second joint, which is rounded and bears a few small setae; second joint attached to inner half of distal margin of first joint, half as wide as long medially, narrowing to two-fifths this width proximally and distally, inner margin an entire curve, inner margin bearing a row of long cilia, outer distal angle carrying a spine one-sixth as long as joint; third joint sub-rectangular, angles rounded, two-thirds as wide as long, attached to inner distal angle of second joint, bearing three long plumose setae on distal two-thirds of inner margin, a non-plumose seta on inner distal angle and three spines distally; outermost of spines simple, two-thirds as long as joint, distal half pigmented, other two slightly shorter, branching distally, these branches pigmented, a further unpigmented branch arising between these two.

Second pereopod biramose, each ramus three-jointed; *basipod* two-jointed, as long as two distal joints of first pereopods together, first joint one-quarter as long as second, distal width equal to length, narrowing to two-thirds this width proximally, bearing a very large plumose seta on inner distal angle; second joint half as wide as long distally, narrowing to nearly half this width proximally, distal angles rounded, bearing a short non-plumose seta halfway along inner margin and a flange two-fifths distal width of joint along full length of inner margin. Second joint of *exopod* one-quarter as long as first, half as long as second; first joint half as wide as long at base, narrowing to two-thirds this width distally, inner margin three-quarters as long as outer, bearing a long plumose seta on inner margin one-fifth of distance from inner distal angle and a spine on outer distal angle that is one-quarter as long as joint, pigmented over distal two-thirds; second joint two-thirds as long as wide, bearing a long plumose seta immediately proximal to inner distal angle and a spine on outer distal angle similar to that on first joint; third joint as wide as long, rounded distally, a spine similar to those on the first and second joints halfway along outer margin, a small nonplumose seta on outer distal area and a row of six plumose setae on terminal and inner margins, those on inner margin being the longest. There is a long flange, its medial width equal to width of first joint of exopod, narrowing proximally and distally, which is attached to outer margin of distal half of basipod and all three joints of exopod. Third joint of *endopod* half as long as second, four-fifths as long as first; first joint half as wide as long at rounded outer margin, narrowing to half this length at inner margin, outer seventh of joint thin and flange-like, long plumose seta borne on middle of inner margin; second joint three-fifths as wide as long, proximal margin rounded, attached to first joint by inner half of proximal margin, outer distal angle invaginated for one-third length of joint and two-thirds width at attachment of third joint, outer third of second joint thin and flange-like, area immediately medial to flattened area having a stippled appearance, two long setae borne on free part of distal margin; third joint sub-oval, half as wide as long, bearing six plumose setae on outer and distal margins.

Third pereopod with its *basipods* united in a broad apron which is one-third as long and half as wide as carapace, podites placed posterolaterally; apron divided longitudinally by two ribs, separated by a distance equal to two-fifths width of apron anteriorly and half this distance posteriorly, joined by a transverse rib one-third of distance from anterior margin; wide flanges on lateral and posterior margins. Endopod nearly half length of apron, but turned medially so that inner margin touches apron, exopod two-thirds length of endopod. Exopod three-jointed, joints subequal in length; first joint subtriangular, two-thirds as long as wide, outer margin reduced, carrying a plumose seta on inner proximal angle and a large forked spine, subequal in length to the exopod, pigmented over distal half of each fork, directed medially from outer half of joint; a further plumose seta near outer proximal angle may be borne on this angle but appears to be borne on margin of apron; second joint two-thirds as long as wide, bearing a plumose seta on inner distal angle and a short spine on outer distal angle; third joint subtriangular, two-thirds as long as wide, inner margin reduced and combined with distal margin, three short spines on outer distal angle of joint and six plumose setae on terminal and inner margins. Endopod two-jointed, second joint one-fifth as long as first and contained in a semicircular invagination of outer distal angle of first joint; second joint one-quarter as wide as long at base of second joint, slightly narrower proximally, bearing two plumose setae on part of distal margin which is free; second joint suboval, two-thirds as long as wide, carrying four plumose setae distally.

Fourth pereopod four-jointed, first joint one-quarter longer than other three together, third joint half as long as second, two-thirds as long as fourth; first joint two-fifths as wide as long medially, two-thirds this width proximally, two-fifths this width distally, outer margin curved, inner margin sublinear, bearing a short spine on outer distal angle; second joint half as wide as long distally, two-thirds this width proximally, inner margin one-third length of outer, bearing five small spines situated one- to three-fifths of distance from outer proximal angle, a row of about eight very small spines over the distal two-sevenths of outer margin and a spine one-third as long as joint, of which distal two-thirds is pigmented, on outer distal angle; third joint as wide as long, bearing about four very short spines on distal half of outer margin and a spine, equal in length to that of second joint and similarly pigmented, on outer distal angle; fourth joint half as wide as long, outer margin two-fifths length of inner, bearing about five very short and narrow spines on outer margin, three very short spines on inner distal angle and three long spines on terminal margin, outer two similar in length and pigmentation to those on second and third joints, the innermost half as long again and not pigmented.

Fifth pereopod appears to be missing, although there is a small protrusion, one-fifteenth as long as the genital segment, as wide at base as long, rather irregular in outline, situated on genital segment on margin between posterolateral lobes and abdomen, which may represent this appendage.

Male. Rather smaller than the female, 9.5mm–12.2mm (11.4mm); 8.7mm total body length. Carapace almost half body length.

Carapace a little longer than wide, 4.8mm–5.1mm (4.9mm); 4.4mm length; 4.5mm–4.8mm (4.6mm); 3.9mm width. Carapace very similar in structure and ornamentation to that of female except as follows: third pair of spines in central area of carapace is missing; short row of hairs between arms of V-shaped row reduced or missing; row of hairs passing posteriorly from anterior end of longitudinal ribs may extend back as in female but usually only extends half as far back.

Fourth, freely articulated, thoracic segment not considering dorsal plates, similar in shape to that of female, and of similar proportions, 0.6mm–0.9mm (0.8mm); 0.6mm length; 1.3mm–1.5mm (1.5mm); 1.4mm width. It bears six very small spines, one-quarter of distance from posterior margin, arranged in three pairs, one pair on midline, others halfway between this pair and lateral margins. Dorsal plates of similar size proportionate to total body size as those of female but much more rounded and with much smaller posterior flange, 1.0mm–1.3mm (1.2mm); 1.0mm length; 2.6mm–3.0mm (2.8mm); 2.5mm total width of segment including plates. Each plate bears two rows of spines, anterior row of one or two spines at level of posterior margin of rest of segment, and a posterior row of two or three spines of varying size just anterior to posterior margin of plate.

Genital segment about half length of carapace, longer than wide, 2.2mm–2.6mm (2.4mm); 2.1mm length; 2.0mm–2.2mm (2.1mm); 1.8mm width; subrectangular, angles rounded. It bears about five small hairs on lateral margins, four very small spines in an irregular line just in from lateral margin, over anterior two-thirds of segment; two large spines halfway along segment, one-third of distance from lateral margins and three or more, usually four, moderate sized spines in a group on dorsal aspect of posterior angles.

Styliform process longer and narrower than in female, 1.3mm–1.7mm (1.6mm); 1.8mm length; one-seventh as wide as long at base, narrowing to two-thirds this width distally; outer margin one-third longer than inner as process turns posteriorly immediately above base; four small spines placed evenly over proximal two-thirds of inner margin and about eight very small spines on outer margin; three spines on terminal margin, subequal in length, as long as distal width of process, all three pigmented over distal two-thirds.

Abdomen two-segmented, first segment half as long as second, as wide anteriorly as long, two-thirds this width posteriorly; second segment two-fifths as wide anteriorly as long, half this width distally; first segment: 0.6mm–0.9mm (0.7mm); 0.6mm length; 0.6mm–0.7mm (0.7mm); 0.6mm width; second segment: 1.3mm–1.5mm (1.4mm); 1.2mm length; 0.5mm–0.6mm (0.6mm); 0.5mm width. First segment bears two moderate sized spines, second segment bears about seven spines in two longitudinal rows, usually with two pairs and three unpaired.

Anal laminae very similar to those of female but longer, 1.2mm–1.5mm (1.4mm); 1.4mm length.

First antenna similar to that of female but first joint proportionately longer, longer than second, and setae on first joint and hairs on second somewhat fewer than in female.

Second antenna with base and first joint similar to that of female, but base without an awl-shaped spine; second joint one-quarter longer than first, turning medially from base and forking, outer fork half length of joint, inner fork half this length, all of outer fork and distal part of base pigmented, a nonplumose seta, half length of joint, borne near inner proximal angle.

First maxilla of similar form to that of female but posterior spine-like process at much smaller angle to main maxilla and branching of maxilla taking place more distally.

Second maxilla as in female except that fork is replaced by a single spine. The small spine placed on a boss on ventral surface of carapace just posterior to maxilla in female is missing in male.

Mouth tube more rounded distally in male.

First and second maxillipeds as in female except that there is a nonplumose seta near base of second joint in male.

Sternal furca and pereopods of male very similar to those of female.

VARIABILITY OF CHARACTERS

As the present author has had a larger number of specimens than most previous authors he has been able to make a limited investigation of the variation that occurs in some characters. Of characters that have previously been used by some authors as specific characters the following were observed to vary: the spines near the posterior margin of the posterior median area and those immediately behind the frontal area of the carapace, those on the fourth thoracic segment including the plates and those on the genital segment and abdomen, the variation affecting the size of spines and the presence or absence of some of the smaller spines; the length of the row of hairs which runs posterolaterally from the anterior termination of the longitudinal rib varies to a considerable extent in the male and to a lesser extent in the female; the extent to which the styliform process on the genital segment protrudes in dorsal view and its angle to this segment vary, so that the extent to which these extend beyond the segment cannot be considered a reliable character. The shape of the plates on the fourth thoracic segment does not appear to vary but they may be inclined at various angles to this segment so that a plane drawing in dorsal view may misrepresent their shape; further the posterior flanges, which have only previously been figured by Yamaguti (1936, Pl. 2, fig. 20 and Pl. 3, fig. 21) may have been included or excluded by other authors in their representation and measurement of this plate.

Unfortunately, in the species of *Gloiopotes* so far described, there appear to be comparatively few variations in the body form with the exception of the plates on the fourth thoracic segment, or in the appendages, although a system of classification may be derived from the ornamentation of the third pereopods (see Shiino, 1954, p. 278). The disadvantage of this system is that the setae and spines may very easily be damaged and this system must only be used, as it is by Shiino, to confirm identification by other means. Thus it is still necessary to rely to a considerable extent on the spines on the body and the plates on the fourth thoracic segment for identification. However, bearing in mind the variation mentioned above, the author considers that only where the differences in spination involve the presence or complete absence of entire groups or rows of spines and where the differences in the plates involve marked differences in the sinus between the plates, or the shape of the plates, may these characters be used in proposing that differences are specific.

DISCUSSION

The original description of *Gloiopotes huttoni* made by Thomson in 1889 under the name *Lepeophtheirus* leaves little doubt that the present specimens are the same species, although the specimen described by him as a male is obviously a young female as has been pointed out by Wilson (1907, p. 701; 1920, p. 315). Thomson does not illustrate the rows of long hairs and many of the spines on the dorsal body surface. Nonetheless, the size and general body proportions as figured by Thomson are very close to those of the present material provided that the posterior part of the plates on the fourth thoracic segment as shown by Thomson is taken as representing the flange. This assumption seems justified by his figure (Pl. 29, 1a). Thomson's figures and description of the appendages are very full and agree closely with the present material, except in the setation of the endopod of the third pereopod. This he shows as having one seta on the first joint and three on the second, which would agree with the condition found in *G. costatus*. Perhaps Thomson's material was damaged. But, since the exopod of this limb, as well as the other appendages, agree with the present material, the present material is regarded here as belonging to Thomson's species.

Specimens of *Gloiopotes* from *Histiophorus brevirostris* taken at Madras were identified by Bassett-Smith (1899, p. 458) as *G. huttoni*. The British Museum (Natural History) kindly lent a male and a female specimen from this collection to the present author. These specimens differ from the specimens taken in New Zealand waters only in the length of the row of hairs which runs posterolaterally from the anterior termination of the anterior longitudinal rib. This row of hairs is a little shorter in the females from Madras than in local material, but this difference is not significant in the light of the variation discussed above. The specimens are a little smaller than the local specimens, the female 10.0mm in total length, the male 8.8mm in total length, but this size difference is not considered here to be of taxonomic significance compared with the overall agreement of body proportions and appendages, and the present author agrees with Bassett-Smith that the specimens from Madras are *G. huttoni*.

G. longicaudatus (Marukawa, 1925) is included in the synonymy of *G. huttoni* since the descriptions by Shiino (1954) and Heegaard (1962) show that their material differs from the present material only in the length of the longitudinal row of hairs on the carapace and in the arrangement of a few small spines on the dorsal surface of the body. Both these characters have been shown to vary in the present material.

Shiino (1954) has already pointed out the synonymy of *Gloiopotes longicaudatus* (Marukawa, 1925), *G. sp.* Yamaguti, 1936, and *G. zeugopteri* Satyanarayana Rao, 1951.

G. watsoni Kirtisinghe, 1934, differs from the present material in having only one plumose seta on the first joint of the endopod of the third pereopod. Since in most cases this podite in preserved material is partly turned under the apron, the other seta could easily have been overlooked. The endopod of the first pereopod is not shown in Kirtisinghe's figure, but as the pereopod appears to have been drawn from the other side it has probably been obscured. There are no marked differences in the spination, and the rows of hairs, although not figured, are described and do not appear to differ from those in the present material. The shape of the plates on the fourth segment and the sinus between them resemble those of the present material as do the general proportions of the body. Thus the present author considers *G. watsoni* to be yet another synonym of *G. huttoni*.

G. auriculatus Barnard, 1957, is not included in the key given below, since the present author is unable to separate it from *G. costatus* Wilson, 1920, from the literature.

The present author agrees with Shiino (1960b, p. 546) that *G. crassus* Wilson and Bere, 1936, is more properly considered a species of the genus *Lepeophtheirus* and this species is not included in the key.

Shiino's redescription (1960a, p. 533) of *G. hygomianus* Stp. & Ltk., 1861, confirms the major diagnostic characters given by these authors for the female and by Stebbing (1900, p. 670) for the male.

KEY TO THE FEMALES OF THE GENUS *Gloiopotes*

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|--|--|
| 1 (2) Plates of fourth thoracic segment covering almost all the dorsum of the genital segment except the posterior processes | <i>G. hygomianus</i> Stp. & Ltk., 1861 |
| 2 (1) Plates of fourth segment covering two-thirds or less of the dorsum of the genital segment. | |
| 3 (4) Plates of fourth segment close together | <i>G. costatus</i> Wilson, 1920. |
| 4 (3) Plates of fourth segment well separated. | |
| 5 (6) Lateral margin of genital segment with well developed spines | <i>G. ornatus</i> Wilson, 1907 |
| 6 (5) Lateral margin of genital segment without well developed spines | <i>G. huttoni</i> (Thomson, 1889). |

KEY TO THE MALES OF *Gloiopotes*

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|--|---|
| 1 (2) Plates of fourth thoracic segment sharply pointed posterolaterally | <i>G. hygomianus</i> Stp. & Ltk., 1861. |
| 2 (1) Plates of fourth segment not sharply pointed posterolaterally | |
| 3 (4) Plates of fourth segment well separated | <i>G. huttoni</i> (Thomson, 1889). |
| 4 (3) Plates of fourth segment close together | |
| 5 (6) Plates of fourth segment rounded | <i>G. costatus</i> Wilson, 1920. |
| 6 (5) Plates of fourth segment suboval, anterior margin linear | <i>G. ornatus</i> Wilson, 1907. |

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ELYTROPHORA BRACHYPTERA GERSTAECKER (EURYPHORIDAE,
CALIGOIDA) FROM NEW ZEALAND WATERS, WITH A TENTATIVE
REVISION OF THE GENUS

by

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Elytrophora brachyptera Gerstaecker (Euryphoridae, Caligoida)
from New Zealand waters, with a tentative revision of the genus

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Wellington, New Zealand.

ABSTRACT

A female specimen of Elytrophora brachyptera Gerstaecker is recorded from Thunnus maccoyii and a male specimen from T. alalunga in New Zealand waters. A study of the literature appears to confirm that three sub-species of Elytrophora brachyptera, E. b. brachyptera Gerstaecker, E. b. atlantica Wilson, and E. b. indica Shiino can be distinguished on characters of the female. The present female specimen is E. b. brachyptera; the male specimen is tentatively placed in the same sub-species; E. coryphaenae Pearse is a synonym of Euryphorus normanni Milne Edwards.

INTRODUCTION

Members of the genus Elytrophora are parasites of the large pelagic fishes belonging to the family Thunnidae and as such can be expected to be widespread in their distribution. Although the present collection consists of only a single female and a single male it seems noteworthy as the most southerly record to date and only the fourth record from the Pacific (all other Pacific records are from the North-west Pacific).

Elytrophora brachyptera brachyptera Gerstaecker, 1853.

E. brachyptera Gerstaecker, 1853. pp. 58 -63, pl. 3.

E. hemiptera Wilson, 1921. pp. 4-6, pl. 2, figs. 13-19.

E. brachyptera Gerstaecker. Yamaguti, 1936, p. 3, pl. 2, figs. 13-19.

E. brachyptera Gerstaecker. Delamare Deboutteville and Nunes-Ruivo, 1953, pp. 202-203, fig. 1.

E. brachyptera Gerstaecker. Shiino, 1954, pp. 279-284, figs. 3-4.

E. hemiptera Wilson. Shiino, 1958, pp. 105-107.

MATERIAL

One female from Thunnus maccoyii taken off Fiordland by the Marine Department in February, 1964, and one male from T. alalunga near Ariel Reef, Gisborne, collected by Mr. P. E. Roberts of the Zoology Department, Victoria University of Wellington, on 17 February, 1967. The former specimen is returned to the collection of the Fisheries Laboratory, Marine Department, Wellington, the latter deposited in the Dominion Museum, Wellington.

Description

Female (figs. 1-10).

Overall length 8.8 mm.

Carapace wider than long (4.4 mm - 4.7 mm); frontal plate half carapace width; second and third thoracic segments fused together, and fused to carapace, but separated from remainder of carapace by a stout rib, length of thoracic segment one-third carapace length, width half carapace width; median area half carapace width, bordered laterally by longitudinal ribs which diverge slightly

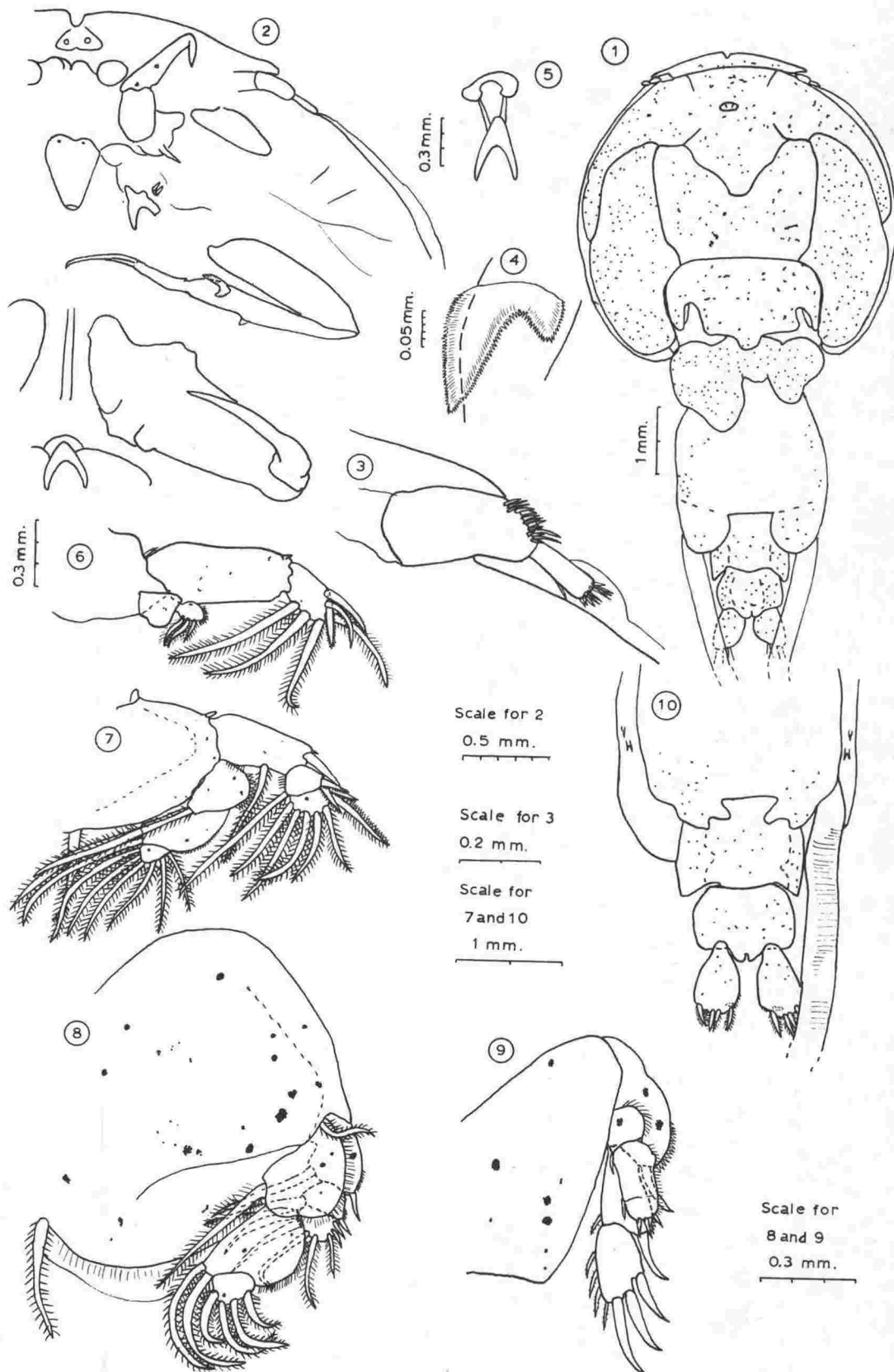
figs 1-10 Elytrophora brachyptera brachyptera Gerstaecker female:

fig. 1: dorsal; 2: antennae and mouth parts; 3: first antenna;

4: flange on second segment of first maxilliped; 5: furca;

6: first pereopod; 7: second pereopod; 8: third pereopod;

9: fourth pereopod; 10: genital segment and abdomen in ventral view.



anteriorly, joined anteriorly, two-sevenths carapace length from anterior margin, by a transverse rib the median two-thirds of which curve posteriorly to half length of median area; further ribs, running from anterolateral angles of median area posterolaterally to margin of carapace two-fifths distance from posterior termination, separate the lateral areas from an irregularly crescent-shaped anterior area; lateral areas extend posteriorly beyond median area for a distance equal to one-third carapace length, median margin of posterior processes of lateral areas fused with thoracic area for four-fifths its length; thoracic area (fused second and third thoracic segments, fused with rest of cephalothorax, but separated from it by a pronounced rib) two-sevenths carapace length, anterior half half carapace width, posterior half two-thirds this width, lateral posterior extensions of anterior-half are one-third thoracic area length, fused laterally with lateral areas, creating a narrow sinus between the posterior extension and the posterior half of segment, median margin of posterior extension with a narrow flange; a narrow flange borders the lateral margin of carapace widening slightly posteriorly and terminating at junction of lateral area with thoracic area; eyes on mid-line, one-fifth distance from anterior margin.

Fourth thoracic segment, freely articulating with thoracic area of carapace anteriorly and genital segment posteriorly, length including plates three-fifths width (1.4 mm x 2.3 mm), plates somewhat rounded anteriorly, narrowing over posterior two-fifths, right hand plate two-thirds length of left hand plate due to either damage or

deformity, probably the latter since the posterior margin forms an entire curve similar to posterior margin of left hand plate; right hand plate is also somewhat narrower so that sinus between plates which would otherwise have a depth equal to three-fifths length of larger plate, is wider than if the animal were normal.

Genital segment, width three-quarters length (2.9 mm x 2.2mm) one-quarter this length due to subcircular posterior processes which are one-third segment width, with a sublinear margin of equal width between them. Ventral to abdomen a further pair of posterior processes, one-tenth segment length, project posteromedially and are slightly bifurcated distally.

Abdomen of two segments, first segment a little wider than long (0.9 mm x 1.1 mm) lateral margins slightly curved convexly, posterolateral angles rather acute and extended posteriorly beyond median part of posterior margin for a distance equal to one-fifth segment length; second segment, length two-thirds width (0.7 mm x 1.0 mm) subrectangular, angles rounded, median third of posterior margin slightly swollen, caudal rami attached on either side of this swelling.

Caudal rami, length twice width (0.7 mm x 0.4 mm), subovate, width near base one-third distal width, have four plumose setae posteriorly, one each on inner and outer distal areas, two close together medially, and two small spines one between medial and outer setae and one directed medially on ventral surface near inner seta, medial margin of ramus with a short row of cilia distally.

Egg strings 10.1 mm in length, with about 200 eggs per string.

First antenna of two segments, second segment half length of first; first segment width half length, subrectangular, outer distal angle rounded, with about 15 setae of various lengths over outer distal and distal margins; second segment, width one-third length, rounded distally, with nine setae distally and a further seta on inner margin.

Second antenna of three segments, second segment a little longer than first, half length of third; first segment as wide as long, with a well developed spine; second segment subrectangular, width three-quarters length, angles rounded; third segment, width at the base one-fifth length, narrowing steadily to a sharp point distally, distal third sharply curved, with two spines; one near proximal margin, the other one-third of distance from base.

Mouth tube 0.5 mm in length, width at the base three-fifths length, narrowing gradually to one-third this width distally, distal margin rounded.

Second maxilla lateral to mouth tube, half length of mouth tube, on a wide base; a small raised boss associated with it has two small spines.

First maxilliped of two segments, first segment half length of second, width one-quarter length; second segment, median width one-twelfth length, narrowing gradually to two-thirds this width proximally, and more rapidly to half this width distally, distal quarter of segment in form of a slender branch with a smaller

branch, two-fifths its length, beside it, both branches flattened, the smaller branch with minute striations, the segment having a membranous bifid structure near its mid-point, each branch subrectangular, the apex directed distally, the margins serrate, and a smaller membranous structure on outer margin one-quarter closer to proximal margin.

Second maxilliped of two segments, first segment, width at the base two-fifths length, narrowing to two-fifths this width distally, rounded distally, with a stout subovate area at base which may close against a similar area on other second maxilliped; second joint, width at the base one-sixth length, narrowing steadily to a sharp point, sharply curved from the base.

Caudal furca 0.4 mm in length, branches slender, the angle between them about 40 degrees (measured when the furca is flat).

First pereopod biramous, each ramus of two segments, endopod one-third length of exopod; basipod subrectangular, half length of exopod, width four-fifths length, with a short plumose seta on outer distal angle; second segment of exopod two-fifths length of first; first segment subrectangular, width two-fifths length, angles rounded; second segment subovate, with three long spines on outer distal angle (two dentate over posterior margin, one dentate over both margins), and a further long plumose spine on distal margin, and three long plumose setae on inner margin; second segment of endopod two-thirds length of first, first segment subrectangular, as wide as long; second segment subovate, width two-thirds length, distal margin covered in cirri, inner margin with three plumose setae.

Second pereopod biramous, each ramus of three segments, endopod five-sixths length of exopod; basipod as long as exopod, width three-quarters length, swollen dorsally, with a short blunt spine on outer distal angle and a flange along posterior margin; second segment of exopod as long as third, second and third together half length of first; first segment subrectangular, width half length, with a stout spine on outer distal angle, a plumose seta medially on inner margin, and a row of cilia proximal to this seta; second segment subsemicircular, distal margin sublinear, length three-quarters width, a well developed spine with dentate posterior margin on outer distal angle, a long plumose seta on inner distal angle, and a row of cilia on inner margin; third segment subsemicircular, proximal margin sublinear, length half width, with two spines with dentate posterior margins on outer margin, a seta just distal to these with cirri on outer margin and cilia on inner margin and a further five plumose setae on distal and inner margins; third segment of endopod half length of first, one-third length of second; first segment, length two-thirds width, outer margin rounded and with cirri, a long plumose seta on inner distal angle; second segment subrectangular, width half length, with two long plumose setae on inner distal angle, outer distal angle indented at articulation of third segment; third segment subsemicircular, proximal margin sublinear, with six long plumose setae around free margin.

Third pereopod biramous, each ramus of three segments, exopod two-thirds length of endopod; basipod twice length of exopod, as wide as long, swollen dorsally, with a flange on posterior margin and a plumose seta on outer distal angle near attachment of exopod; second segment of exopod as long as third, second and third together four-fifths length of first; first segment slightly curved, width three-quarters length, with a spine on outer distal angle, a row of cilia just proximal to this spine, and a long plumose seta on outer distal angle; second segment subsemicircular, distal margin sublinear, length three-quarters width, with a spine on outer distal angle, a row of cilia just proximal to this spine, and a long plumose seta on outer distal angle; third segment subsemicircular, proximal margin sublinear, length half width, with two spines on outer margin, and five plumose setae on distal and inner margins; endopod similar to endopod of second pereopod except that first segment is as wide as long, second and third segments have outer margins more curved and covered in long cilia, and third segment bears only four plumose setae.

Fourth pereopod biramous, exopod of three segments, endopod of two segments, endopod less than half length of exopod; basipod as long as exopod, width at the base two-thirds length, narrowing to two-fifths this width distally, distal margin rounded; second segment of exopod as long as third, two-thirds as long as first; first segment, width half length of outer margin, inner margin short, outer margin rounded, outer margin with cirri along distal third, and segment has a stout spine on outer distal angle; second

segment subrectangular, width two-thirds length, narrowing to two-thirds this width at base, with a row of cirri on distal third of outer margin, a long spine on outer distal angle, and a short slender seta covered in very short spines on outer distal angle; third segment subrectangular, angles rounded, width two-thirds length, with three stout spines on distal margin and four short slender setae covered in short spines on inner margin; first segment of endopod two-fifths length of second, length three-quarters width, outer margin swollen, rounded, and covered in long cilia, with a slender seta on inner distal angle; second segment subovate, width near base half length, four-fifths this width for most of length, with long cilia over outer margin, three spines on distal margin, and a further spine on inner margin two-thirds of distance from inner proximal angle; there is some indication that the second segment of the endopod is the result of the fusion of two segments, the distal being half length of the more proximal.

Fifth and sixth pereopods represented respectively by one and two small spines on raised bosses on ventral surface of genital segment near midpoint of lateral margin.

Male (figs. 11-18).

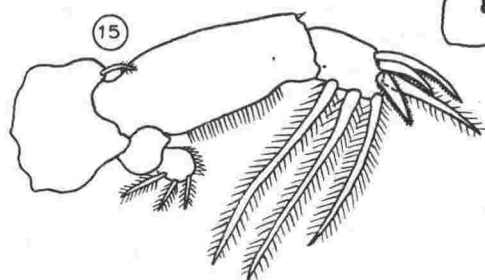
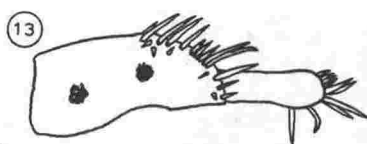
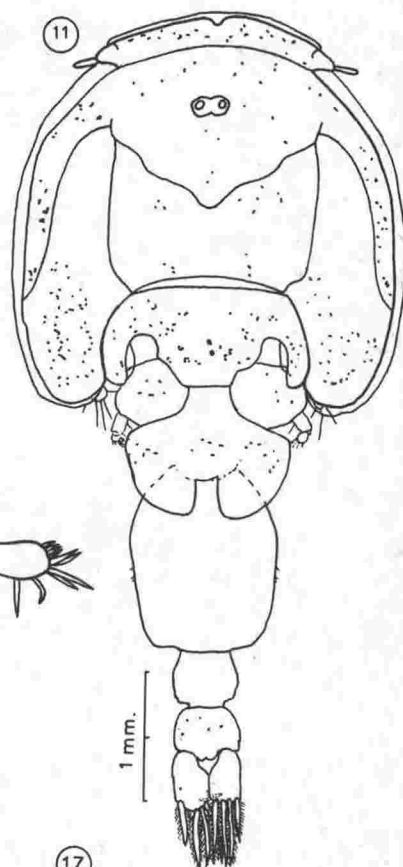
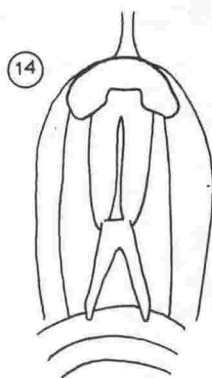
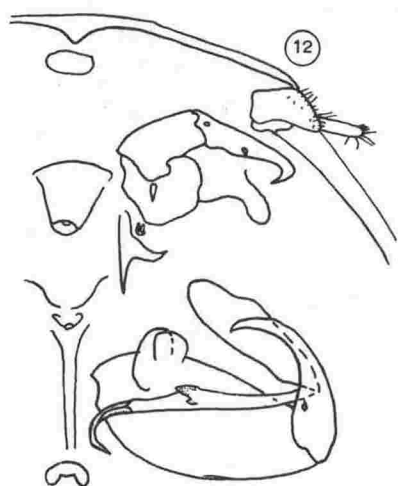
Overall length 6.2 mm.

Carapace as wide as long (3.0 mm x 3.0 mm), frontal plate two-thirds carapace width, a little longer than in female; median part of median thoracic area narrowing by half over posterior quarter of length to articulate with fourth segment; otherwise carapace as in female.

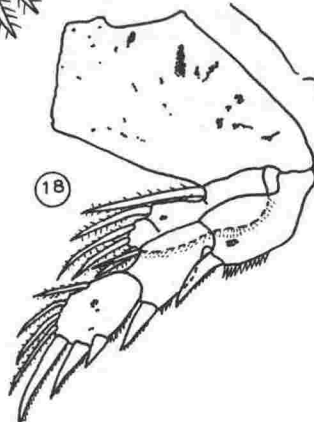
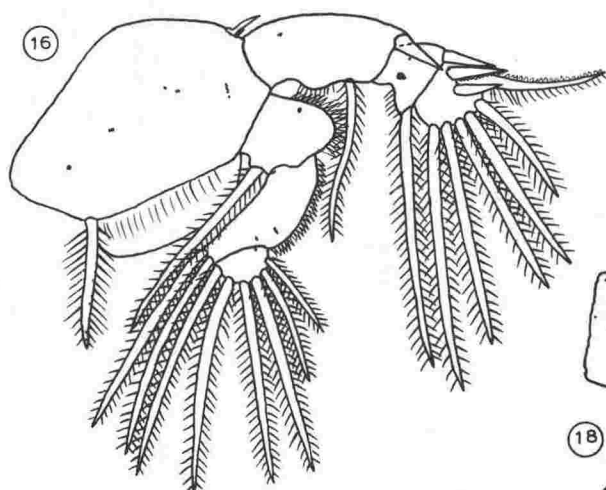
figs. 11-18 Elytrophora brachyptera brachyptera Gerstaecker male:

fig. 11: dorsal; 12: antennae and mouth parts; 13: first antenna;

14: furca; 15: first pereopod; 16: second pereopod; 17: third
pereopod; 18: fourth pereopod.



Scale for 12
0.5 mm.



Scale for
15 ~ 18
0.3 mm.

Scale for
13 and 14
0.2 mm.

Fourth thoracic segment freely articulated, length including plates three-quarters width (1.0 mm x 1.3 mm), plates rounded posterolaterally, anterior and medial margins sublinear, posterior and lateral angles rounded, sinus between plates one-seventh segment width.

Genital segment longer than wide (1.4 mm x 1.2 mm), subrectangular, posterior angles rounded, anterior angles broadly rounded, slightly wider anteriorly than posteriorly.

First abdominal segment wider than long (0.4 mm x 0.5 mm), subrectangular, width greatest at the midpoint.

Second abdominal segment wider than long (0.4 mm x 0.5 mm), subrectangular, angles rounded, median third of posterior margin swollen, with caudal rami on either side of swelling.

Caudal rami longer than wide (0.5 mm x 0.3 mm), armed as in the female.

Appendages and mouth parts remarkably similar to those of the female, the only notable exceptions being the first maxilliped in which the major branch is striated like the smaller branch (in the female the major branch is smooth), the second maxilliped in which there is a pronounced bifid structure near the base, and the fourth pereopod in which the setae on the inner margins of the exopod and on the inner and terminal margins of the endopod are proportionately longer than in the female. The fifth and sixth pereopods are as in the female and are placed on ventral surface of genital segment near lateral margin, one-third distance from posterior margin.

DISCUSSION

Five species have been described in the genus Elytrophora. Elytrophora coryphaenae Pearse, 1952 was originally called Electrophora but this is corrected to Elytrophora in an errata sheet of the journal. His species, described as a female, is clearly identical to the male of Euryphorus normanni Milne-Edwards. (Lewis, 1967, pp. 32-39 gives a detailed description of this species).

The position of the four remaining species (E. brachyptera Gerstaecker, E. atlantica Wilson, E. indica Shiino, E. hemiptera Wilson) is not so clear. As Shiino (1958, p.105) states, there is remarkably little difference in the appendages of these species. A careful comparison of their body shapes and proportions must therefore be made in order to decide their relationships. Body size alone is seldom, if ever, a sufficiently constant character for it to be useful; moreover the range given in the literature for the four species is small (8.3 mm - 12 mm for females, 6.0 mm - 9mm for males).

Further, as Lewis (1967, p. 54-56) states, considerable changes take place in the female as she matures, and these must be taken into account when considering morphological differences. Examination of the descriptions and figures given by previous authors does not reveal any marked differences in body measurements except for the following:-

- (1) the great length of the genital segment in Scott and Scott's figure (1913, pl. 23, fig. 1) of the female of E. brachyptera. No other differences are apparent, hence I am inclined to regard this specimen as an individual variant.
- (2) the fourth thoracic segment and plates in Wilson's description of the female of E. atlantica are only three-quarters the length or breadth found in other descriptions. Furthermore Wilson's specimens differ in the posteromedial inclination of the posterior processes of the abdomen, and the possession of only three setae on the caudal rami (in other descriptions the processes extend directly posteriorly and there are four setae on the caudal rami). These differences do not seem of specific rank but certainly E. atlantica must be considered as a subspecific variant of E. brachyptera.

Shiino described as E. indica a form in which the posterolateral angles of the first abdominal segment in the female are extended and rounded. This form has been recorded by European authors as E. brachyptera (see distribution, below) but the differences given by Shiino seem sufficient to consider it as at least a separate subspecies of the species.

E. hemiptera Wilson, 1921 does not seem to me to differ sufficiently from E. brachyptera to allow separation even at the subspecies level.

I have been unable to separate satisfactorily the males so far described. Accordingly the male in the present collection is only tentatively placed in the same subspecies as the female. It is from a different host species and though they have geographical proximity this is obviously no guide to identity, since E. brachyptera and E. indica, at least, are known to have overlapping ranges and further collecting may well show other members of this genus also occur in the New Zealand region.

In the light of the above discussion it is not possible to give a key to the males. For the females only a tentative key can be given as follows:-

Key to the subspecies of the females of E. brachyptera Gerstaecker.

- 1 (2) Caudal rami with three setae, posterolateral processes of genital segment directed posteromedially-----E. b. atlantica Wilson, 1921.
- 2 (1) Caudal rami with four setae, posterolateral processes of genital segment directed posteriorly.
- 3 (4) Posterior angles of first abdominal segment short and acute----- E. b. brachyptera Gerstaecker, 1853.
- 4 (3) Posterior angles of first abdominal segment extended and rounded----- E. b. indica Shiino, 1958.

The first abdominal segment in E. b. atlantica is similar to that in E. b. brachyptera.

Assigning previous records on the basis of this key gives the following host and locality data:-

E. brachyptera atlantica - on Thunnus thynnus at Woods Hole, Mass.
(Wilson, 1921, p. 417).

E. brachyptera brachyptera

AUTHOR'S IDENTIFICATION	HOST	AUTHOR	LOCALITY
<u>E. brachyptera</u>	<u>Thunnus thynnus</u>	Gerstaecker (1853, p. 58)	Mediterranean
"	"thon rouge"	Delamare Deboutteville and Nunes Ruivo (1953, p. 202)	Sète, Mediterranean
<u>E. hemiptera</u>	<u>T. albacares</u>	Shiino (1958, p. 105)	0° 42' S, 74° 37' E; 1° 13' S, 73° 32' E; (Indian Ocean)
"	<u>T. alalunga</u>	Shiino (1965, p. 422)	9° 56' S, 135° 16' W (Arafura Sea)
<u>E. brachyptera</u>	<u>T. thynnus</u> and <u>T. alalunga</u>	Yamaguti (1936, p. 3)	Northwest Pacific
<u>E. hemiptera</u>	unnamed	Wilson (1921, p. 4)	Nagasaki, Japan
<u>E. brachyptera</u>	<u>T. thynnus</u> <u>T. albacares</u> <u>T. obesus</u>	Shiino (1957, p. 364)	Kesennuma, Miyagi Prefecture, Japan
"	<u>T. thynnus</u>	Shiino (1954, p. 279)	Tyosi, Tiba Prefecture, Japan
"	"	"	Owasi Market, Mie Prefecture, Japan
"	<u>T. obesus</u>	"	Irôzaki Point, Sizuoka Prefecture, Japan.

E. brachyptera indica

Author's Identification	Host	Author	Locality
<u>E. brachyptera</u>	unnamed	Scott & Scott (1913, p. 83)	Outer Hebrides Scotland
"	<u>Thynnus thynnus</u>	Bassett-Smith (1886, p. 12)	Plymouth, England.
" (immature females)	planktonic	Heegaard (1955, p. 46)	20° 04' N, 22° 33' W, (Northeast Atlantic)
<u>E. brachyptera</u>	<u>T. thynnus</u>	Heller (1865, p. 189)	Mediterranean
"	"	Brian (1906, p. 51)	Adriatic, Genoa, Naples, Portoferraio
<u>E. indica</u>	<u>T. obesus</u>	Shiino (1958, p. 107)	1° 13' S, 73° 32' E 1° 15' S, 72° 20' E (Indian Ocean)
"	<u>T. obesus</u>	Shiino (1965, p. 422)	0° 59.8' S, 101° 42' W, (Indian Ocean)
<u>E. brachyptera</u>	<u>T. sibi</u> (= ? <u>obesus</u>) <u>T. macropterus</u> <u>T. macropterus</u> (?) unnamed <u>T. macropterus</u>	Lewis (1967, p. 43)	Honolulu Fish Market Christmas Is. (Line Islands) " North of Christmas Island 0° 29' N, 157° 47' W. (North Pacific)

Acknowledgements

The author wishes to thank the Fisheries Laboratory, Marine Department, Wellington, and Mr. P. Roberts for providing the specimens described, Professor J.A.F. Garrick for helpful criticism of the text and Mr. J. Moreland of the Dominion Museum for assistance in bringing up to date the names previously given to host fishes.

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SOME NEW ZEALAND PARASITIC
COPEPODA OF THE FAMILY
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SOME NEW ZEALAND PARASITIC COPEPODA OF THE FAMILY PANDARIDAE

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SUMMARY

The 723 copepods from 42 sharks captured in New Zealand waters belong to seven genera and 11 species of the family Pandaridae. Of these, *Nesippus borealis* (St. and Lüt.), recorded for the first time from a host fish, *Dinemoura latifolia* St. and Lüt., *D. producta* (Müller), *Phyllothyreus cornutus* (Milne-Edwards), *Pandarus cranchii* Leach, and *Echthrogaleus coleoptratus* (Guérin) are widespread species. *Pandarus bicolor* Leach, *Nesippus orientalis* Heller, and *Perissopus dentatus* St. and Lüt. are each recorded from the Pacific for the second time, and the last two may be restricted to warmer waters. *Demoleus latus* Shiino and *Echthrogaleus braccatus* (Dana) are respectively recorded for the second and third time only and may be restricted to the western Pacific. *Nesippus alatus* Wilson, *N. ornatus* Thomsen and *N. incisus* Heegaard are probable synonyms of *N. orientalis* Heller; *Dinemoura hamiltoni* Thomson is a synonym of *D. latifolia* St. and Lüt. *D. carcharodonti* Thomson is a synonym of *D. producta* Dana and *D. affinis* Thomsen is probably a host form of this species. *Pandarus armatus* Heller may be a synonym of *P. cranchii* Leach and *P. armatus* as recorded by Thomson (1889) certainly belongs to the latter species; *P. cranchii* and *P. satyrus* Dana have not been satisfactorily separated in the literature.

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Pandaridae

Nesippus orientalis Heller ♀.

N. borealis (St. and Lüt.) ♂.

Dinemoura latifolia St. and Lüt. ♀ and ♂.

D. producta (Müller) ♀ and ♂.

Demoleus latus Shiino ♀ and ♂.

Echthrogaleus coleoptratus (Guérin) ♀.

E. braccatus (Dana) ♀.

Phyllothyreus cornutus (Milne-Edwards) ♀.

Pandarus bicolor Leach ♀ and ♂.

P. cranchii Leach ♀.

Perissopus dentatus St. and Lüt. ♀.

Conclusions

Literature Cited

INTRODUCTION

The present collection of parasitic Copepoda consists of specimens from a variety of sources and from many parts off both the North and South Islands of New Zealand. Most pandarid copepods, including all the species discussed below, are exclusively shark parasites.

When it is considered that many species of shark have a wide distribution and that pandarids, while exhibiting host preferences, are seldom, if ever, host specific, it is not surprising that of the species considered in this paper only one, *Echthrogaleus braccatus* (Dana), appears to have a very restricted distribution.

So far there have been only 11 records of species of pandarid copepods from New Zealand. The earliest are by Milne-Edwards (1840), of *Pandarus dentatus*, which has since been synonymised with *P. cranchii* Leach by Wilson (1907), and *Dinematura affinis*, which has been referred to the genus *Echthrogaleus* by Steenstrup and Lütken (1861) and was not included in the present collection. Dana (1853) recorded four species from New Zealand; three of these (*Nogagus validis*, *Pandarus brevicaudis*, and *Specilligus curticaudis*) are male forms which were not taken in the present collection. Dana's fourth species, *Dinemoura braccata*, has been transferred to the genus *Echthrogaleus* by Steenstrup and Lütken (1861) and is included in the present collection. Heller (1868) records two species from New Zealand: *Pandarus armatus* which may be a valid species, in which case it was not included in the present collection, or may be a synonym of *P. cranchii*; and *Nogagus elongatus* which is a male form and was not included in the present collection. Thomson (1885 and 1889) recorded three new species of *Dinemoura* from New Zealand. One of these (*D. neozealanica*) will be dealt with in a later paper. Thomson's *D. hamiltoni* is a synonym of *D. latifolia* Steenstrup and Lütken and his *D. carcharodonti* is a synonym of *D. producta* (Müller). The only other record of pandarid copepods from near New Zealand is included in Heegaard (1962) in his work on the Australian parasitic copepod fauna. Heegaard's *Nesippus australis* is considered as a synonym of *N. orientalis* Heller, which is included in the present collection. Five of the other six species recorded by Heegaard are also among the 11 species described here. The exception is *Nesippus incisus* Heegaard, 1962, which was not in the present collection.

METHODS

Where possible I have given measurements from a range of at least 10 specimens of each species, and from more than one host fish. Measurements were taken from a sample from each host species where more than one was involved.

At least one specimen of each species of parasite was cleared in benzyl alcohol and the appendages removed for closer examination. A Zeiss camera lucida fitted to a binocular microscope was used for all drawings and measurements.

TERMINOLOGY

I retain the name **second maxilla** for the structure sometimes called the post-oral process, and the two following appendages are consequently referred to as the **first** and **second maxillipeds**. Although there is some doubt whether the structures here referred to as the **second maxillae** are really appendages, the **first maxilla** (or postantennal process) being absent in pandarids, I favour the retention of these unambiguous terms until such time as the issue is finally resolved. The present variation in terminology from one author to another seems to warrant this action. The term **anal plate** is here used for the structure called the "plate of the sixth segment" by Wilson (1907) and the "anal lamina" by Lewis (1964). The latter term seems unsuitable, as it has been used previously by Wilson and others for the structure now usually called the **caudal rami** (see labelled figure 113).

HOST FISHES

As far as possible, the scientific names of host fishes cited in this work have been brought up to date. In cases of doubtful identity the original name has been retained.

COLOUR

Like many parasitic copepods, pandarids are usually yellow-brown in colour after preservation in alcohol. The exceptions in the present collection are a few of the female specimens of *Pandarus bicolor* Leach in which the pereopods are pale pink, and the specimen of *Perissopus dentatus* St. and Lüt. which is brown-green. Both species of *Pandarus* recorded here also have variable areas of deep brown pigmentation on the dorsal surface.

Family PANDARIDAE

(Taken mainly from Wilson, 1907, p. 345 and Yamaguti, 1963, p. 107)

Caligoida, in which the first thoracic segment is fused with the carapace, the others freely articulated except that the fifth and sixth segments are fused to form the genital segment, and in a few species the second and third segments may be partly or wholly fused. Sexual dimorphism marked.

In the female the carapace is well rounded, frontal plates distinct. Eyes usually three in number, fused on midline, lenses arranged in the form of a triangle. One or more of the freely-articulated thoracic segments with paired dorsal plates; genital segment enlarged, often covered with similar plates. Caudal rami usually well developed and broad, usually with stout plumose setae. Eggs numerous, uniseriate; egg cases usually visible for their entire length and usually much longer than the body. Mouth tube slender, frequently tapering to a sharp

point; first maxilla absent; second maxilla simple, usually spine-like; second maxillipeds massive and nodose; all four pairs of legs biramous, some or all of them lamellar and without plumose setae.

In the male the carapace is more elongate than in the female, and produced posteriorly into better defined posterolateral lobes. The freely-articulated segments show no sign of fusion and are of approximately the same length but diminish regularly in width, none of them armed with dorsal plates. Genital segment also without dorsal plates and not as large compared with the other segments as in the female. Abdomen two-segmented; caudal rami large and foliaceous, furnished with long and stout plumose setae.

The females, because of the development of dorsal plates, are rather rigid and have little power of movement about the host being firmly fixed in place by the powerful second maxillipeds, aided by the second antennae. The males, on the other hand, move about as freely as caligid copepods on the host and are capable of active swimming.

Parasitic almost exclusively on elasmobranchs.

Genus *Nesippus* Heller, 1868

Nesippus orientalis Heller, 1868.

(Figs 1-9)

Nesippus orientalis Heller, 1868. pp. 194-6, pl. 18, figs. 2-3.

Nesippus alatus Wilson, 1905a. p. 130.

Nesippus ornatus Thomsen, 1949. pp. 17-19, pl. 6, figs. 1-11.

Nesippus orientalis Heller. Capart, 1953, pp. 658-9, fig. 6.

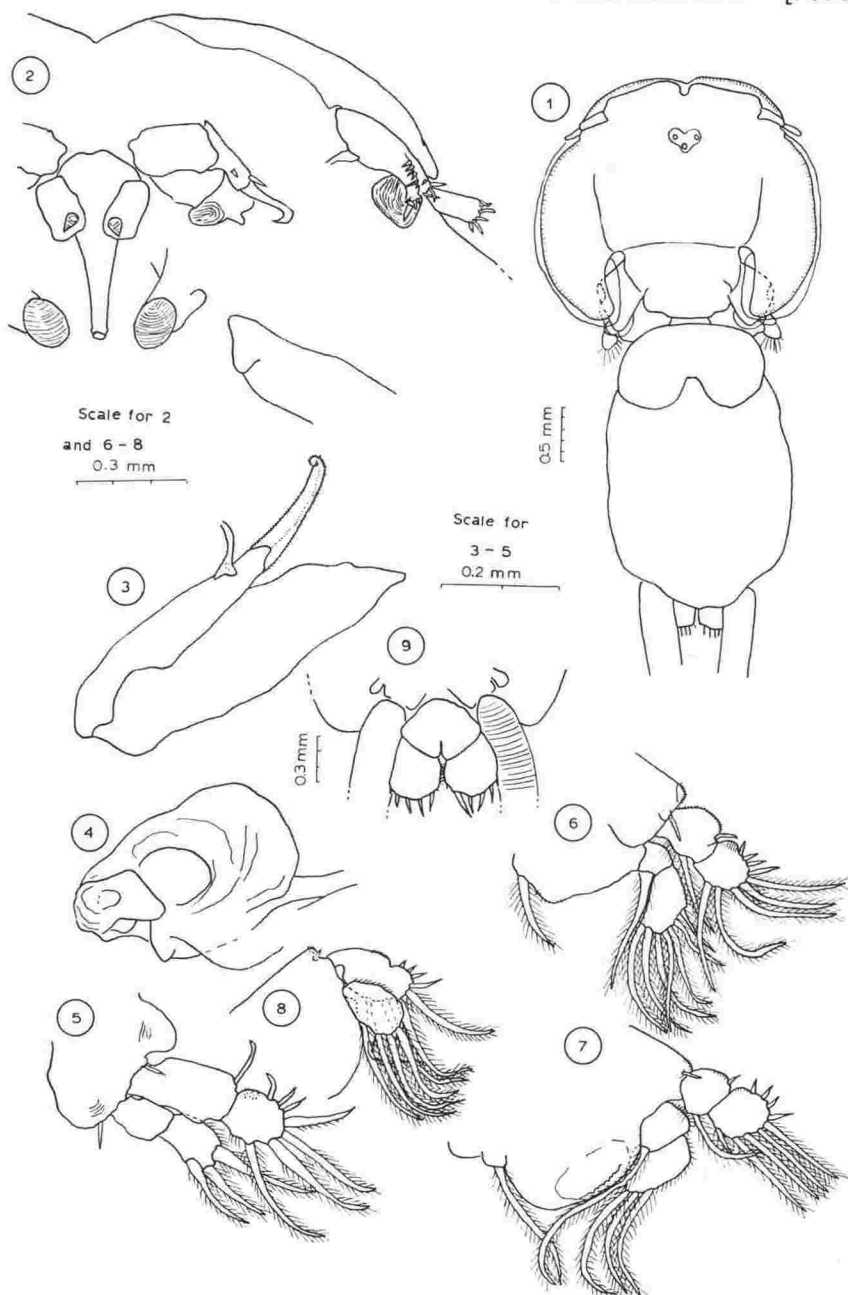
Nesippus incisus Heegaard, 1962. pp. 179-81, figs. 173-81.

MATERIAL: Three mature females, two with eggstrings, from the buccal cavity of a seven-gill shark (*Notorhynchus pectorosus*) collected near Oamaru on 4 February 1965 by the author; two mature females, both with eggstrings, taken from the smooth hound (*Mustelus antarcticus*) collected by Dr H. Manter in 1951, presumably from near Wellington.

DESCRIPTION

FEMALE only, overall length 4.3 mm-5.2 mm.

CARAPACE a little wider than long (1.9 mm-2.2 mm x 2.3 mm-2.4 mm); frontal plate four-fifths width of carapace, width fifteen times length, with a large number of small longitudinal ribs; median area of carapace a little more than half its width, bounded laterally by two longitudinal ribs about one-third carapace length, posteriorly by a sublinear margin; lateral areas bear short, rather indistinct, horizontal ribs laterally; postero-lateral processes one-third carapace length, one-quarter its width at base, posterior margin an entire curve, medial margin concave in dorsal view; lateral flange rather narrow, widening posteriorly, continuous around the postero-lateral processes, terminating near the origin of the median area.



FIGS 1-9—*Nesippus orientalis* Heller, female. Fig. 1—dorsal; 2—anterior mouth parts and antennae; 3—first maxilliped; 4—second maxilliped; 5—first pereopod; 6—second pereopod; 7—third pereopod; 8—fourth pereopod; 9—abdomen and caudal rami.

SECOND AND THIRD SEGMENTS incompletely fused; second segment width three times length (0.3 mm x 0.9 mm), four-fifths of its lateral margins occupied by plates, two-fifths as long as segment is wide, which expand slightly distally, their free margins sublinear, angles rounded; third segment width more than twice length (0.35 mm x 0.8 mm), angles rounded, median half of posterior margin extended slightly posteriorly.

FOURTH SEGMENT, including the well developed plates, length three-fifths width (0.75 mm x 1.25 mm), subovate, anterior and lateral margins forming an entire curve continuous with that of the posterior margins of the plates; the plates occupy three-eighths of length of segment, the short length of free posterior margin of the segment which lies between them being sublinear or slightly concave.

GENITAL SEGMENT subovate, width three-quarters length (2.15 mm x 1.65 mm), median half of rounded posterior margin projecting posteriorly in a secondary curve. In the specimens from *Mustelus* there are signs of the development of slight posterolateral lobes like those described by Heegaard (1962, p. 180) for *N. incisus*, but not as pronounced.

ABDOMEN completely concealed in dorsal view, anterior and posterior margins curved, meeting in bluntly rounded lateral angles; as wide as long or a little wider (0.5 mm x 0.5 mm).

CAUDAL RAMI subrectangular, three-quarters abdomen length, as wide as long, have plumose setae on the inner margin, four long and one short spine on posterior margin, the long spines decreasing in size laterally.

FIRST ANTENNA partially hidden in dorsal view by a lateral extension of the frontal plate, two segmented; first segment twice as long as second, width at base two-fifths length, narrowing to two-thirds this width distally, distal margin rounded, with about 14 setae over the distal margin and distal third of the outer margin; second segment, width one-third length, sublinear, terminal margin rounded with six setae.

SECOND ANTENNA apparently of five segments, the distal four segments being subequal in length, about twice length of basal segment; proximal three segments subequal in width, distal two narrowing progressively; basal segment with an oval adhesion pad three-quarters its length and two-thirds as wide as long, fourth segment with a short spine medially, a longer spine on its terminal margin, terminal segment curving sharply over its distal half to form a hook terminating in a sharp point.

A suboval adhesion pad is situated immediately posterior to first antenna and is as long as second segment of this antenna.

SECOND MAXILLA partly overlying the base of the mouth tube, one-third length of mouth tube, of two segments, the first half as wide as long, subrectangular, the second one-third length of first, subtriangular, base rounded, pointed distally, ventral surface ridged.

MOUTH TUBE about 0.5 mm in length, width at base half length, narrowing to one-fifth this width distally.

FIRST MAXILLIPED of two segments, the second slightly longer than first, with a branch covered in small spines two-fifths of the distance from its termination, distal third of second segment narrows evenly to end in a small suboval structure and carries rows of small spines.

SECOND MAXILLIPED of two segments, the second bifid distally and closing against a pad carried on the first; first segment suboval, width two-thirds length, surface rough; second segment one-third as long as first, length twice width.

FIRST PEREIOPOD biramous, each ramus of two segments; basipod with swollen inner and outer margins, has ridged areas on its ventral surface and two spines, one near attachment of outer margin of exopod, the other just internal to attachment of inner margin of endopod; first segment of exopod twice as long as second, width half length, subrectangular, with a long spine on outer distal angle; second segment subcircular, as wide as long, proximal margin sublinear, has a group of very small spines on outer margin, three well developed spines on rounded outer distal angle, four long plumose setae on distal margin and inner distal angle, a small row of cilia on inner margin; endopod two-thirds length of exopod, first segment as long as second, subrectangular, width two-thirds length; second segment subrectangular, width two-thirds length, outer margin a shallow convex curve with cilia, terminal margin has three long plumose setae.

SECOND PEREIOPOD biramous, each ramus of two segments, rami of equal length, as long as endopod of first pereopod; basipod much larger than that of first pereopod, has a group of very small spines on outer distal angle and part of inner margin, and a well developed spine ventral to the attachment of exopod; first segment of exopod as long as second, outer margin expanded, has row of minute spines, outer distal angle has a long spine, inner margin has a long plumose seta medially, and long cilia between this seta and the attachment to the basipod; second segment subcircular, as wide as long, proximal margin sublinear, outer margin expanded and ridged proximally, outer distal angle rounded with four spines, most distal half as long again as other three, distal margin and inner distal angle with five long plumose setae, most proximal rather shorter than the others; first segment of endopod half length of second, subrectangular, as wide as long, outer margin slightly curved, with short cilia, inner margin entirely occupied by the base of a long plumose seta; second segment subrectangular, two-fifths as wide as long at the base, twice this width distally, outer margin covered with cilia, distal margin with six or seven long cilia.

THIRD PEREIOPOD biramous, the rami two segmented, as long as those of second pereopod; basipod larger than that of second pereopod, with similar minute spines and a well developed spine; first segment of exopod as long as second, as wide as long, outer margin ridged over

its distal half, with a spine on outer distal angle, inner margin has a long plumose seta; second segment as wide as long, proximal half of outer margin slightly expanded and ridged, distal half and outer distal angle with four spines, distal margin and inner distal angle with five long plumose setae; first segment of endopod two-thirds length of second, length two-thirds width, outer margin rounded, with cilia, inner margin short and has a long plumose seta; second segment, width two-thirds length, outer margin curved, with cilia, curved distal margin has three long plumose setae.

FOURTH PEREIOPOD biramous, each ramus of one segment, exopod as long as exopod of third pereopod, basipod rather smaller than that of third pereopod, with a group of very short spines on outer distal angle, a longer spine close to outer proximal angle of the exopod; exopod suboval, width half length, medial fifth of outer margin has a small group of minute spines, rounded outer distal angle has four spines, the most distal twice length of others, terminal margin and distal half of inner margin with four long plumose setae; endopod subovate, width half length, proximal half of outer margin with cilia, inner distal areas of margin with four long plumose setae.

DISCUSSION

The systematic status of female specimens of the genus *Nesippus* is not clear. They can be divided into four groups: (1) *N. orientalis* Heller, 1868, *N. alatus* Wilson, 1905, *N. ornatus* Thomsen, 1949, and *N. incisus* Heegaard, 1962, in which the plates on the fourth segment are well developed and the posterior processes of the genital segment poorly or not at all developed; (2) *N. crypturus* Heller, 1868, *N. occultis* Wilson, 1924, *N. gracilis* Wilson, 1935, *N. gonosaccus* Heegaard, 1943, and *N. costatus* Wilson, 1924, in which the plates on the fourth segment are poorly developed while the posterior processes of the genital segment are very large; (3) *N. angustatus* (van Beneden, 1892) and *N. australis* Heegaard, 1962, which appear to be intermediate between the two groups, having the plates on the fourth segment and the posterior processes of the genital segment only slightly developed; (4) *N. vespa* Kirtsinghe, 1964, which is distinct from all these, having both plates and processes well developed.

The present material clearly belongs to the first of these groups. I believe, from a study of the literature, that the four species in the group are best considered synonymous until further proof of their relationships is available. Their body proportions are, as Capart (1953, p. 659) states, variable characters, much affected by fixatives and the age of the specimens. Differences in figures of the appendages could be explained in terms of the angle from which they were drawn.

Wilson (1907, p. 425) in his key to this genus separates *N. alatus* from *N. orientalis* on the grounds of its more angular plates on the second segment and the greater posterior extension of the plates on the fourth segment. It seems probable that Heller has exaggerated the rounded nature of the former plates and for the latter he shows

a ciliated margin which suggests that this margin was either damaged or partly obscured, since such a margin is unknown in any other members of this group. Brian (1924, p. 394) identifies his specimens as *N. orientalis* on the grounds of "leur taille élancée". If all four species are regarded as synonymous, however, we have a complete range of body lengths, e.g. 4 mm (Heller, 1868, p. 194), 4.3 mm–5.2 mm in the present material, 5 mm–6 mm (Thomsen, 1949, p. 17), 6 mm–7 mm (Barnard, 1955, p. 265). All other records known to me lie within the range 4 mm–7 mm. This wide variation in body length could be the result of a number of factors including geographical variation.

Thomsen (1949) gives the ribbed appearance of the lateral and anterior margins of his specimens as the chief specific character of *N. ornatus*. However, it is clear from the present material that the distinctness of this ribbing varies.

The main difference between Heegaard's *N. incisus* and previously described specimens appears to be the degree of development of postero-lateral lobes on the genital segment. These suggest that the posterior margin has a separate median lobe. However, as stated above, the degree of development of these lobes differs significantly even in the present small collection.

If my contention that these species are synonymous is correct, *N. orientalis* is a rather variable, widely distributed species, choosing as a host a wide variety of sharks, apparently without reference to their size, habitat, or skin structure. Previous records are as follows:

NORTH-EAST ATLANTIC: on *Mustelus asterias* and *Sphyrna zygaena* off Mauritania (Brian, 1924, p. 33); on *Sphyrna lewini* at Gorée, Senegal (Capart, 1953, p. 658).

MEDITERRANEAN: on *Alopias vulpinus* and *Mustelus mustelus* at Naples and Genoa (Brian, 1906, pp. 49–50).

NORTH-WEST ATLANTIC: on *Odontaspis taurus* at Massachusetts (Wilson, 1905a, p. 130); on *Alopias vulpinus*, *Carcharodon carcharias*, *Carcharhinus obscurus*, *Mustelus* sp., *Carcharhinus milberti* and *Rhizoprionodon terraenovae* at Massachusetts (Wilson, 1907, p. 431, 1932, pp. 438–9); on *Rhizoprionodon terraenovae*, *Sphyrna zygaena* and *S. tiburo* at Beaufort, Nth. Carolina (Wilson, 1932, pp. 438–9); on the dusky shark (*Carcharhinus obscurus*), bay shark, and spot tipped ground shark at Florida (Bere, 1936, p. 595); on *Sphyrna tiburo* and *Ginglymostoma cirratum* at Texas (Pearse, 1952, p. 27); on 'sharks' from the West Indies (Heegaard, 1943, p. 27).

SOUTH-WEST ATLANTIC: on *Mustelus schmitti* near Uruguay (Thomsen, 1949, p. 19).

INDIAN OCEAN: on *Carcharhinus menisorrhah* off Java (Heller, 1868, p. 196); on *Carcharodon carcharias* at Durban (Barnard, 1955, p. 265).

SOUTH-WEST PACIFIC: on *Mustelus antarcticus* off north Queensland (Heegaard, 1962, p. 173).

From these records it seems that this parasite usually occurs in warmer waters in small numbers (up to three) on any particular host specimen, although collections of up to 10 are not uncommon. In all records known to me the site of attachment has been inside the buccal cavity.

All the above records refer to female copepods. The systematic position of the males in this species is also complicated and in the absence of any male specimens in the present collection I am loath to comment on such records as Dana's "*Specilligus curticaudis*" which might well belong to *Nesippus orientalis*.

Nesippus borealis (Steenstrup and Lütken, 1861) (Figs. 10–20)

Nogagus borealis Steenstrup and Lütken, 1861, p. 387, pl. 11, fig. 21.

Nesippus borealis (St. and Lüt.) Wilson, 1907, p. 437, pl. 37.

MATERIAL: A single male specimen on the body surface of a mako shark (*Isurus oxyrinchus*) taken in 40 fms (73 m) over Mernoo Bank (east of New Zealand) by the Fisheries Laboratory, Marine Department, on 30 November 1964.

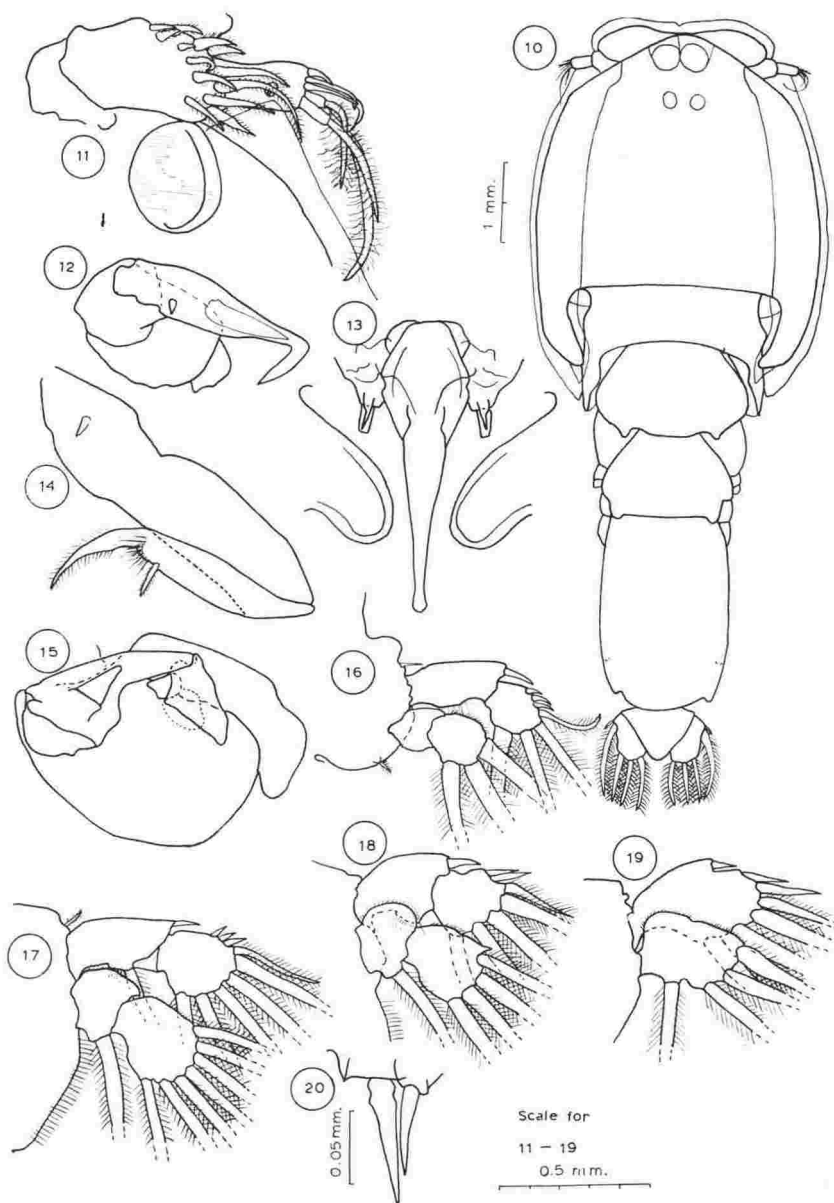
DESCRIPTION

MALE only, overall length 9.2 mm.

CARAPACE much longer than wide (4.2 mm x 3.7 mm); frontal plate five-sixths carapace width, width five times greatest length, short medially, lateral margins rounded; median area three-quarters carapace width, anterior margin a sharp convex curve, bordered laterally by ribs which run forward to anterior margin; posterior margin sublinear with two large adjoining conspicilla near anterior margin; eyes, of which only two are clearly visible, placed one-quarter length of median area from anterior margin; lateral areas narrow, continuing posteriorly as processes which occupy one-quarter length of carapace, bearing a flange on their outer margins which expands posteriorly and terminates in a point on posterior margin of posterior processes, and a second flange on inner margin of these processes which terminates anteriorly at origin of longitudinal ribs and posteriorly at posterior margin of posterior processes, sharply pointed near its posterior termination.

SECOND SEGMENT much wider than long (1.6 mm x 2.3 mm) narrow posterolateral plates comprising half length; lateral margins of segment slightly swollen, posterior margin a shallow concave curve.

THIRD SEGMENT wider than long (1.2 mm x 1.9 mm), lateral margins expanded as entire curves, posterior margin slightly curved, bearing two short (0.1 mm) posterolateral processes.



FIGS 10-20—*Nesippus borealis* (Steenstrup and Lütken), male. Fig. 10—dorsal; 11—first antenna; 12—second antenna; 13—mouth tube and second maxillae; 14—first maxilliped; 15—second maxilliped; 16—first pereopod; 17—second pereopod; 18—third pereopod; 19—fourth pereopod; 20—vestigial fifth leg.

FOURTH SEGMENT wider than long (1.1 mm x 1.7 mm), similar in shape to third, except that it narrows rather suddenly one-quarter of the distance from posterior margin, and posterior margin between processes is sublinear.

GENITAL SEGMENT longer than wide (2.5 mm x 1.6 mm), subrectangular, lateral margin slightly curved, the posterior margin more strongly curved, with very small lobes posterolaterally and vestigial fifth legs laterally on the ventral surface one-quarter of the distance from the posterior margin.

ABDOMEN subtriangular, the apex posterior, 0.6 mm in length, width 0.9 mm at base, rounded posteriorly.

CAUDAL RAMI subrectangular (0.3 mm x 0.6 mm), not reaching beyond posterior termination of abdomen; have three long plumose setae posteriorly, and an even longer plumose seta laterally near base of abdomen.

FIRST ANTENNA two segmented, first segment twice length of second, width half length, with (on outer and distal margins) about 13 plumose setae, one longer than second segment, others progressively smaller; second segment, width half length, subrectangular, with a short spine medially on ventral surface, four setae on outer half of distal margin, one almost as long as segment, and three very long setae on inner half of this margin, each with a distinct base and covered with tortuous cilia, the longest seta being more than twice length of segment.

SECOND ANTENNA of four segments, basal segment small, second segment stout, one-third total length, third segment two-thirds size of second; terminal segment a hook, sharply curved over distal third of length and ending in a sharp point, bearing a short stout spine on inner margin near inner proximal angle.

An oval adhesion pad is situated immediately posterior to first antenna, as long as second segment of that antenna, a little longer than wide.

SECOND MAXILLA a solid base from which arise a rectangular blunt spine, and slightly longer sharp spine immediately ventral to the blunt spine.

MOUTH TUBE about 1 mm in length including base, base one-third as wide as total length, tube narrowing rapidly, slender for most of its length.

FIRST MAXILLIPED of two segments, first segment a little longer than second, width one-quarter length, with a short spine on ventral surface near base; second segment, width one-sixth length, distal third of its length plumose, narrowing rapidly and terminating in a sharp point, a transverse row of long cilia standing at base of this region and with a plumose branch, one-seventh length of segment, just proximal to these cilia.

SECOND MAXILLIPED of two segments, second segment half as long again as first, width two-thirds length; second segment a slightly curved blunt claw, width at the base half length, closing against a raised and distally bifurcated portion of second segment, with a stout spine, one-quarter its length, one-quarter of distance from proximal margin.

FIRST PEREIOPOD biramous, each ramus of two segments, exopod one-quarter longer than endopod; basipod with a spine just outside exopod and a short plumose seta just inside endopod; first joint of exopod almost twice length of second, subrectangular, length half width, with a row of long cilia on median third of inner margin and a long spine on outer distal angle; second segment subcircular, as wide as long, with three spines on outer distal region and four long plumose setae, outermost rather smaller than others, on distal region; first segment of endopod as long as second, width four-fifths length; second segment subcircular, as wide as long, with cilia along outer margin and three long plumose setae distally.

SECOND PEREIOPOD biramous, each ramus of two segments, exopod one-quarter longer than endopod; basipod with a small plumose seta just outside exopod; first segment of exopod a little longer than second, similar to corresponding segment of first pereopod with the addition of a long plumose seta just distal to cilia on inner margin; second segment subcircular, a little longer than wide, with three spines on outer distal region and six long plumose setae, the outermost smaller than the others, on distal margin; first segment of endopod half length of second, with cilia on outer margin and a long plumose seta on inner distal angle; second segment subrectangular, slightly curved, one-quarter longer than wide, with cilia on outer margin and seven long plumose setae on distal margin.

THIRD PEREIOPOD biramous, each ramus of two segments, rami subequal in length; first segment of exopod one-third longer than second, subrectangular, median third of inner margin expanded, bearing cilia, outer distal angle swollen and with a spine; second segment as wide as long, with two spines on distal part of outer margin and five plumose setae terminally, the outermost seta smaller than the others; first segment of endopod two-thirds as long as second, length two-thirds width, outer margin swollen and curved, with cilia, inner margin with a long plumose seta medially; second segment subrectangular, a little longer than wide, with cilia on outer margin and four long plumose setae distally.

FOURTH PEREIOPOD biramous, each ramus of one segment, although the endopod shows some signs of being the result of fusion of two segments; exopod one-third longer than endopod, width at the base one-third length, doubling in width and becoming subcircular distally, three spines on outer distal region and four long plumose setae on distal region and inner distal region; endopod subrectangular, width two-thirds length with narrowed base, has cilia on outer margin, three long plumose setae on terminal margin and another medially on inner margin.

FIFTH LEG reduced to two short spines on a slightly raised base on genital segment.

DISCUSSION

The present material is notable from several points of view. It is the only specimen so far recorded from the Southern Hemisphere, only the second record from the Pacific, and the only specimen so far taken from a fish. Previous records (Steenstrup and Lütken, 1861, p.387, Hansen, 1923, p.37, Wilson, 1923, p.10, Heegaard, 1945, p.16) have been of planktonic specimens from those regions of the North Atlantic fed by the Gulf Stream, with the exception of a single planktonic specimen from Alaska (Wilson, 1907, p. 438).

The host in the present case is a large oceanic shark. Such a host was predicted by Wilson (1923). The present record also suggests that the frequently planktonic male is much more widely distributed than previous records would suggest and it can be expected to occur in plankton in the southern Pacific area.

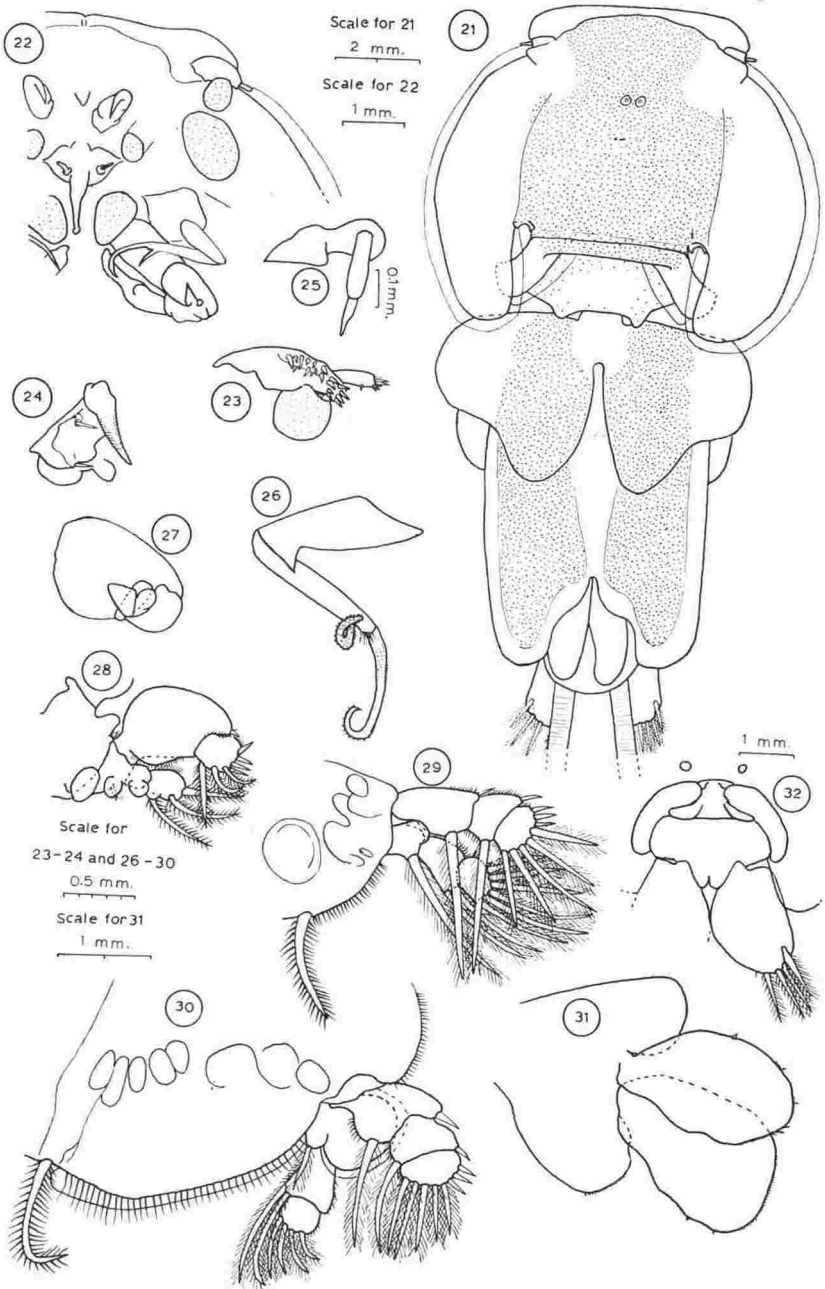
The present specimen differs somewhat from that described by Wilson (1907) in the curvature of the lateral margins of the third and fourth segments and in the rather straighter hook on the second maxillipeds. However, considering the similarity of other features including the unusually large size, elongate setae on the first antennae, and the overall agreement in the rest of the body form and the nature of the pereopods, these differences are not significant.

Genus *Dinemoura* Latreille

Dinemoura Latreille

- Caligus* (*C. productus*) Müller, 1785, p.132.
- Dinemoura* (*D. producta*) Latreille, 1829, p.197.
- Dinematura* Latreille, Burmeister, 1833, p.284.
- Dinemoura* Latreille, van Beneden, 1857, p.226.
- Dinemoura* Latreille, Milne-Edwards, 1840, p.463.
- Dinematura* Latreille, Wilson, 1907, p.375.
- Dinemoura* Latreille, Scott and Scott, 1912, p.85.
- Dinematura* Latreille, Heegaard, 1945, p.15.
- Dinemoura* Latreille, Yamaguti, 1963, p.116.

According to Milne-Edwards and Wilson, Burmeister changed the spelling of Latreille's genus *Dinemoura* to *Dinematura* to make the name correspond "more correctly to the etymology". However, this is not a valid reason for such a change under the rules of taxonomy (Article 32(a)—*International Code of Zoological Nomenclature*, 1961), and Burmeister's spelling must be regarded as an incorrect subsequent spelling. Nor can it be retained on the grounds of common usage, since, despite Wilson's statement that this name was "at once adopted universally", reference to the literature shows that the original spelling has been used by a number of authors over the years.



FIGS 21-32—*Dinemoura latifolia* Steenstrup and Lütken, female. Fig 21—dorsal; 22—anterior mouth parts and antennae; 23—first antenna; 24—second antenna; 25—second maxilla; 26—first maxilliped; 27—second maxilliped; 28—first pereopod; 29—second pereopod; 30—third pereopod; 31—fourth pereopod; 32—abdomen and caudal rami.

Dinemoura latifolia Steenstrup and Lütken, 1861 (Figs 21–43)

Dinematura latifolia Steenstrup and Lütken, 1861, p.378.

Dinematura hamiltoni Thomson, 1889, p.357.

Dinemoura latifolia Steenstrup and Lütken, Yamaguti, 1963, p.117.

MATERIAL: 61 females from the ventral body surface of *Carcharodon carcharias* taken in Tory Channel, collected by Mr C. McCann of the Dominion Museum on 7 July 1958; 30 females and seven males from the buccal cavity of *Galeorhinus australis* taken in Tory Channel, collected by Professor J. A. F. Garrick of Victoria University of Wellington in 1955; 12 females and four males from a "large shark" taken near Napier, collected by Mr A. Hamilton and deposited by Professor G. M. Thomson in the Otago Museum in 1911; four females from *Isurus oxyrinchus* taken in the Bay of Islands, collector and date not recorded, deposited in the Dominion Museum; 10 females from *Isurus oxyrinchus* taken near Paraparaumu, collected by Mr J. Moreland of the Dominion Museum on 23 April 1953; 10 adult females, two juvenile females and two males from the caudal peduncle of *Isurus oxyrinchus* taken near Cape Brett, collected by Mr A. Baker of Victoria University of Wellington on 16 May 1964; four females from the gills and skin of *Isurus oxyrinchus* taken near Makara, collected by Professor J. A. F. Garrick on 29 June 1955.

DESCRIPTION

FEMALE (Figs 21–32, overall length very variable, 12.6 mm–17.4 mm. However, the variability among specimens from the same host fish is much less, i.e. from *Isurus oxyrinchus* taken at Cape Brett (8 specimens) mean = 13.06, SE_m (standard error of mean) = 0.08; taken at Paraparaumu (8 specimens) mean = 13.05, SE_m = 0.15; taken at Makara (3 specimens) mean = 12.87, SE_m = 0.15; taken at Bay of Islands (4 specimens) mean = 13.88, SE_m = 0.13. The differences in total length between parasites on the four different host specimens are significant at the 1% level. Equivalent measurements for specimens from the other two identified hosts are—from *Galeorhinus australis* (20 specimens measured) mean = 15.50, SE_m 0.12; from *Carcharodon carcharias* (20 specimens measured) mean = 16.66, SE_m 0.10. These differences are significant at less than 0.1% level. It looks from this small sample as though the variation between lengths of parasites from different species is greater than between those from individual hosts within the same species but the sample is too small for the results to be conclusive.

CARAPACE wider than long (6.1 mm–7.8 mm x 6.7 mm–8.8 mm). Frontal plate little more than half carapace width (3.5mm–4.7 mm), lateral length one-sixth width, anterior margin sublinear, lateral margins rounded. Median area of carapace just less than half carapace width, bounded laterally for posterior three-quarters of its length by slightly curved longitudinal ribs, anterior margin curved, posterior margin thickened, sublinear; lateral areas extended posteriorly beyond the median area as rounded posterolateral processes which comprise one-

quarter of carapace length and are two-ninths its width at their bases; lateral flange of almost constant width is borne over entire free margin of lateral areas, ending at junction of this margin with median area; carapace near this junction somewhat swollen dorsally; two eyes placed one-third of distance from anterior margin of median area, on either side of midline.

SECOND SEGMENT, exclusive of plates, subrectangular, very short (0.4 mm–0.8 mm x 2.9 mm–3.3 mm); plates extend posterolaterally to increase length of segment by three to four times and width by one-half; plates are subrectangular, distal angles rounded and with a flange on their inner free margins.

THIRD SEGMENT, width twice length (1.3 mm–1.4 mm x 2.7 mm–3.2 mm), lateral margins expanded and curved, short process extending posteriorly from posterior margin on either side of attachment to fourth segment for a distance one-sixth length of third segment.

FOURTH SEGMENT, including plates, width twice length (3.1 mm–3.8 mm x 5.0 mm–6.7 mm), plates narrowing suddenly to half previous width one-third of distance from rounded posterior margins; a deep narrow incision, rounded anteriorly, between them.

GENITAL SEGMENT, width three-quarters length (5.3 mm–7.0 mm x 4.0 mm–5.1 mm), the posterior two-sevenths in form of postero-lateral processes with a narrow incision anteriorly, widening posteriorly as the processes narrow suddenly at the midpoint to two-thirds their previous width, dorsal plates covering much of surface of segment.

SIXTH SEGMENT subcircular, as long as wide (1.5 mm–2.0 mm x 1.5 mm–2.0 mm), the dorsal plates reaching nearly to end of segment; segment usually extending beyond posterolateral processes for about one-sixth its own length.

ABDOMEN much wider than long, width much more variable than length (1.2 mm–1.4 mm x 1.5 mm–2.3 mm); lateral margins rounded, median half of posterior margin expanded posteriorly, bearing the caudal rami on the sides of this posterior projection.

CAUDAL RAMI subrectangular, inner and posterior margins a continuous curve, half as long again as abdomen, width two-thirds length; has three long plumose setae posteriorly.

FIRST ANTENNA two segmented, first segment three times length of second, rounded distally, with about 20 setae over distal half of outer margin and on distal margin; second segment subrectangular, width one-third length, with about seven setae terminally and another on inner margin, one-third of distance from inner distal angle.

SECOND ANTENNA of three segments, first segment short, other two subequal in length, basal and second segments each bearing sharp spines, one-quarter length of second segment; third segment curved but not sharply, narrowing to a point distally and with transverse ridges on outer surface.

An adhesion pad, which is immediately posterior to the first antenna, is as long as its second segment, subcircular, as wide as long. A further larger adhesion pad lies directly posterior to it, this pad being subovate, twice length of anterior pad, width three-quarters length.

SECOND MAXILLA in form of a spine placed on a raised boss beside base of mouth tube, 0.03 mm in length, distal third narrower than the rest and narrowing still further distally. An adhesion pad is placed antero-laterally from this maxilla, as long as that near the first antenna but only two-thirds its width.

MOUTH TUBE slender, a little more than 1 mm in length. Postero-laterally from its base is a fourth pair of adhesion pads, two-thirds as long again as those associated with the first antenna, width two-thirds length, suboval, a little wider anteriorly than posteriorly.

FIRST MAXILLIPED of two segments, second segment twice length of first; first segment subrectangular, width one-third length, narrowing distally; second segment slender, width one-twelfth length, distal half consisting of narrowing branch covered in rows of very small spines and with a tuft of long cilia at its base; just proximal to its base another branch arises, only half its length and covered rather more densely with small spines.

SECOND MAXILLIPED of two segments, first segment twice length of second, angles rounded, with an oval pad against which the second claw-like segment closes; second segment moderately curved, narrowing very rapidly to a sharp point.

FIRST PEREIOPOD biramous, each ramus of two segments; basipod with an adhesion pad on inner distal angle and a small plumose seta on outer distal angle; first segment of exopod three times length of second, suboval, inner and outer margins expanded and curved, inner margin with a row of cilia, outer distal angle produced and has a small spine, with a row of very small spines on free part of distal margin beside this angle; second segment subcircular, as wide as long, with a row of cilia on outer margin, four spines on distal margin and three long plumose setae on inner margin; endopod two-thirds length of exopod, first segment one-third longer than second, as wide at the base as long but narrowing rapidly to half this width, rounded distally, with two adhesion pads and a small plumose seta on inner margin; second segment suboval, width two-thirds length, with cilia on outer part of margin and three long plumose setae on distal and inner parts of margin.

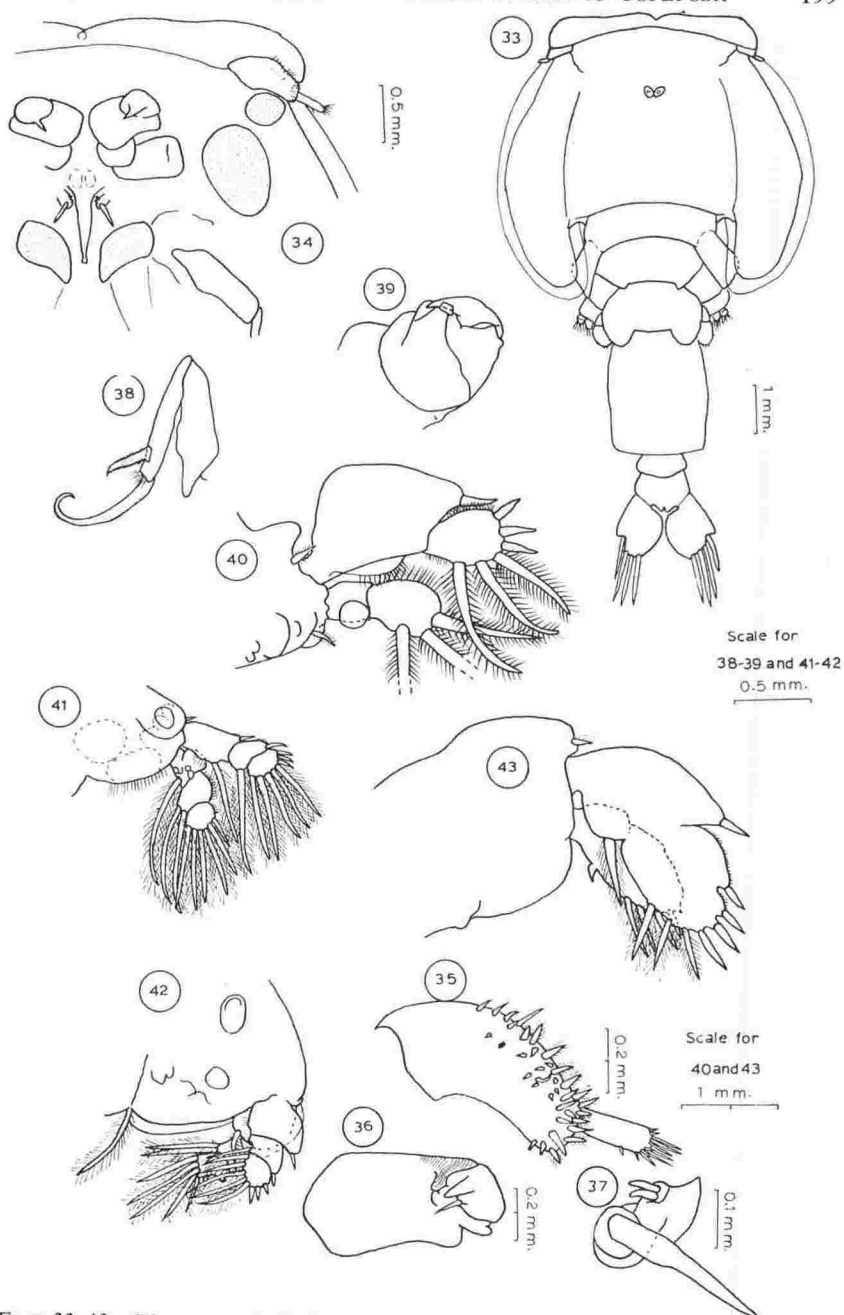
SECOND PEREIOPOD biramous, each ramus of three segments, exopod one-quarter longer than endopod; basipod much larger than that of first pereopod, with one small and one large adhesion pad, cilia on inner margin and a long plumose seta on inner proximal angle; first segment of exopod two and one-half times as long as second which is as long as third; first segment, width half length, subrectangular, with cilia along distal third of outer margin, a spine on outer distal angle, and a long plumose seta just proximal to inner distal angle; second

segment subsemicircular, as wide at the base as long but two-thirds wider at sublinear distal margin, with cilia along outer margin, a spine on outer distal angle, a long plumose seta just proximal to inner distal angle and a row of cilia between this seta and inner proximal angle; third segment subovate, two-thirds wider than long, with cilia on free inner and outer proximal margins, three spines on outer distal area and five long plumose setae on inner distal area; first segment of endopod two-thirds length of second, subequal in length to third; first segment subrectangular, as wide as long, outer distal angle swollen, with a long plumose seta on inner distal angle; second segment subrectangular, width at the base two-fifths length, expanding by two-thirds its basal width distally, with cilia on distal third of outer margin, and two long plumose setae on projecting inner distal angle; third segment subcircular, a little longer than wide, inner margin sublinear, outer margin with cilia, distal margin has six long plumose setae.

THIRD PEREIOPOD biramous, each ramus of three segments, the rami subequal in length; basipod much bigger than that of second pereiopod, with a characteristic pattern of circular areas resembling poorly developed adhesion pads, inner and outer margins have cilia, inner proximal angle has a long plumose seta; third segment of exopod three-quarters length of second, half length of first; first segment subrectangular, as wide as long, inner margin expanded with cilia over median third, a long plumose seta just proximal to inner proximal angle, expanded outer distal angle has a spine; second segment similar in form to corresponding segment of second pereiopod but lacking cilia on outer margin; third segment similar in form to corresponding segment of second pereiopod; third segment of endopod two-thirds length of second and half length of third; first segment as long as wide, subovate due chiefly to expansion of outer margin and outer distal angle in a continuous curve bearing a flange, inner distal angle with a long plumose seta; second segment similar in form to corresponding segment of second pereiopod with the addition of a row of cilia along inner margin; third segment similar in form to corresponding segment of second pereiopod except that there are only four terminal setae and these are reduced in size.

FOURTH PEREIOPOD biramous, each ramus of one segment, the rami subequal in length; basipod subequal in area to that of second pereiopod, inner and outer distal angles expanded and rounded, inner angle bearing a row of very short spines; exopod, two-thirds longer than wide, suboval, has a single small spine medially on outer part of margin and five small spines on distal part, the inner three close together, the outer two associated with short rows of very short spines; endopod, width two-thirds length, suboval, has two small spines on distal part of inner margin and a row of very small spines along distal margin.

MALE (Figs. 33-43), overall length 8.9 mm-10.1 mm. The range is not large and there is no indication that there is any significant difference in this measurement in specimens taken from different hosts.



FIGS 33-43—*Dinemoura latifolia* Steenstrup and Lütken, male. Fig. 33—dorsal; 34—anterior mouth parts and antennae; 35—first antenna; 36—second antenna; 37—second maxilla; 38—first maxilliped; 39—second maxilliped; 40—first pereiopod; 41—second pereiopod; 42—third pereiopod; 43—fourth pereiopod.

CARAPACE wider than long (4.2 mm–5.1 mm x 4.8 mm–6.0 mm); frontal plate two-thirds carapace width, one-seventh as long laterally as wide, somewhat shorter medially, anterior margin sublinear; median area half carapace width, bordered laterally by longitudinal ribs that converge slightly anteriorly, the eyes situated two-fifths of distance from its anterior margin; lateral areas extending posteriorly beyond the median area for one-third their length, their outer margin an entire curve, posterior margin rounded; bearing a flange on outer margins which expands slightly posteriorly and ends at the junctions of median and lateral areas.

SECOND SEGMENT, width four times length (0.45 mm–0.6 mm x 1.8 mm–2.2 mm), posterior margin a concave curve, bearing posterolaterally a pair of plates which are as wide as segment length and with length nearly twice width.

THIRD SEGMENT, length two-thirds width (1.3 mm–1.7 mm x 2.3 mm–3.1 mm), narrowing posteriorly to half interior width, posterolateral angles slightly produced.

FOURTH SEGMENT, width twice length (0.8 mm–1.0 mm x 1.5 mm–1.8 mm), lateral third of posterior margin expanded posteriorly as a pair of semicircular plates, which are one-third as long as the segment.

GENITAL SEGMENT subrectangular, width three-quarters length (2.1 mm–2.4 mm x 1.4 mm–1.9 mm).

ABDOMEN two-segmented, second segment one-sixth wider and half as long again as first; first segment rounded laterally, widening slightly posteriorly, length two-thirds width (0.4 mm–0.5 mm x 0.7 mm–0.8 mm); second segment length three-quarters width (0.6 mm–0.8 mm x 0.7 mm–1.0 mm), also widening slightly posteriorly.

CAUDAL RAMI carried posterolaterally on second abdominal segment, subrectangular, width two-thirds length (1.0 mm–1.2 mm x 0.7 mm–0.9 mm), with four long setae on the posterior margin.

FIRST ANTENNA two segmented, first segment twice length of second, length twice width, with numerous setae on distal half of outer margin and on distal margin; second segment, length three times width, with about eight setae terminally and another seta on inner margin one-third of distance from distal margin.

Near base of first antenna is situated an oval adhesion pad, as long as first segment of first antenna is wide, and slightly wider than long.

SECOND ANTENNA of three segments, basal segment small, one-quarter total length, subrectangular; second segment, length twice width, with a striated area on distal outer region and a raised area near distal margin against which the claw-like third segment can close; third segment two-thirds length of second, distal half suddenly narrowed and narrowing further distally to form a claw, basal half with a long spine beside the claw.

Between second antenna and carapace margin is a large oval adhesion pad, one-third longer than first segment of first antenna and width two-thirds length.

SECOND MAXILLA a long spine (one-third length of mouth tube) lateral to mouth tube on a raised boss, and with two smaller spines, one-fifth its length, associated with it on a further raised boss.

MOUTH TUBE long and slender.

A subreniform adhesion pad curves anteriorly and laterally from beside tip of mouth tube; it is subequal in width to the pad lateral to second antenna, but half its length, and is slightly pointed posteriorly.

FIRST MAXILLIPED of two segments, first segment half length of second, width one-third length; second segment width one-thirteenth length, distal half narrowing distally as a spine-like projection covered in longitudinal rows of small spines and with a tuft of cilia at its base; a further spine two-fifths its length arises on outer margin just proximal to its base, also with longitudinal rows of small spines.

SECOND MAXILLIPED of three segments, first segment, length two-thirds width, subequal in length to third segment which is in the form of a claw closing against a raised bifid area on outer margin of first segment; second segment two-thirds length of first, subtriangular in lateral view, serving as a base for the claw.

PEREIOPODS of male very similar to those of female with the exception of the fourth pereopod. Fourth pereopod is borne on a subrectangular basipod which has a very small plumose seta on outer distal angle; exopod of one segment indistinctly divided into two segments of equal length, first segment curved, outer margin twice length of inner, distal width equal to length but narrowing rapidly near base to one-third this width, with a spine on extended outer distal angle and a plumose seta on inner margin near inner distal angle; second segment a little longer than wide, distal margin rounded, with four spines on its outer region and three plumose setae on its inner region; rows of short cilia along outer margin and between the two outermost spines.

DISCUSSION

This species has been recorded from many parts of the world as *Dinemoura latifolia*. Until now Thomson's species, *D. hamiltoni*, has been recognised as a separate species. I have been fortunate in having access to material in the Otago Museum labelled *D. hamiltoni*, and also to Professor Thomson's workbook which contains original sketches for the plates that appear in his papers on parasitic Copepoda and other Crustacea. Sgt. J. A. West, officer in charge of handwriting analysis with the Wellington Police, considers the handwriting on the label and in the workbook are the same. Examination of the specimens shows that they are *D. latifolia*. Moreover, examination of Thomson's figures (pl. XXV, fig. 1, a-j) indicates that figures 1 and 1h are clearly from a male *D. latifolia*, 1b, 1i and 1j are from a female of this species and

the remainder of the figures are not inconsistent with corresponding appendages of either sex, since the first antennae, mouth tube, first maxillipeds and first three pairs of pereopods are very similar in the two sexes. Thomson's description of the appendages (pp. 357-8) is consistent with their belonging to *D. latifolia*. The difficulty seems to have arisen through several mistakes in his description of the animal as seen in dorsal view (p.357). These are partly the result of an initial confusion on Thomson's part as to the sex of his specimens. In his workbook there are two drawings of the male in ventral view, one of which is labelled as female; his measurements show that this confusion was ultimately resolved but a number of inconsistencies remain in the description. Of the female he states, "Cephalothorax two-thirds as long as body". This is obviously a mistake although it is hard to see how it arose. Of the male he states, "Last thoracic segment nearly three times as long as broad". There is no indication of any lengthening of the region of the fourth pereopods, as shown by Thomson in ventral view, to suggest such a marked difference from the normal shape of the fourth segment. He then states "Abdomen nearly square, only one joint apparent from above", although in one of the figures in his sketch book the abdomen is clearly shown as being two-segmented. His final detailed drawing of the abdomen and caudal rami (fig. 1j) is from a female and it seems that he may have confused this drawing with those he had made of the male.

Thus, despite the discrepancies in the description, I consider that the details of the appendages and the drawing of the male, when taken together with the specimens labelled by Thomson, leave no doubt that the specimen described by Thomson and *D. hamiltoni* are *D. latifolia*.

PREVIOUS RECORDS OF THIS SPECIES:

Author	Area	Host	Females		Males	
			number	length (mm)	number	length (mm)
Wilson (1907, p.386)	120 miles off Woods Hole, Mass.	<i>Lamna nasus</i>	16	15	3	8.3
Wilson (1907, p.386)	Cox's Ledge, Mass.	<i>Lamna nasus</i>	6	—	0	—
Wilson (1932, p.432)	Martha's Vineyard, Mass.	<i>Lamna nasus</i>	—	14-16	—	8-8.5
Wilson (1932, p.432)	Martha's Vineyard, Mass.	<i>Carcharodon carcharias</i>	—	14-16	—	8-8.5
St. and Lüt. (1861, p.378)	27°N 23°W	<i>Isurus oxyrinchus</i>	—	12.5	0	—
Brian (1944, p.201)	Mar del Plata, Argentina	<i>Lamna nasus</i>	2	13-15	0	—
Wilson (1923, p.6)	Durban	?	32	—	33	—

[continued]

continued]

Author	Area	Host	Females number length (mm)		Males number length (mm)	
Wilson (1907, p.386)	English Coast	<i>Lamna nasus</i>	1	—	0	—
Carus (1885)	Nth Atlantic	<i>Isurus</i>	—	—	—	—
Brian (1898, p.212)		<i>oxyrinchus</i>	—	—	—	—
Deboutville & Nunes-Ruivo (1953, p.204)	Palavas	<i>Isurus</i> <i>oxyrinchus</i>	10	—	0	—
Wilson (1923, p.6)	Messina, Italy	?	1	—	—	—
Wilson (1923, p.6)	Messina, Italy	<i>Isurus</i> <i>oxyrinchus</i>	3	up to 18	0	—
Richiardi (Brian, 1898, p.212)	Italy	<i>Prionace</i> <i>glauca</i> *	—	—	—	—
Valle (Brian, 1898, p.212)	Adriatic	<i>Carcharodon</i> <i>carcharias</i> *	—	—	—	—
Brian (1898, p.212)	Genova	<i>Isurus</i> <i>oxyrinchus</i>	—	—	—	—
Brian (1906, p.52)	Carloforte	<i>Alopias</i> <i>vulpinus</i> *	—	—	—	—
Heller (Brian, 1906, p.53)	Mediterranean	"pesce-cane"	—	—	—	—
Shiino (1954, p.308)	Izu, Japan	<i>Isurus</i> <i>glauca</i>	3	14.5	0	—
Shiino (1957, p.365)	Kesennuma, Japan	<i>Lamna</i> <i>distropis</i>	4	—	0	—
Shiino (1957, p.365)	West Pacific	<i>Isurus</i> <i>glauca</i>	5	—	0	—
Yamaguti (1936, p.9)	Pacific	<i>Isurus</i> <i>glauca</i>	5	12-14	0	—
Shiino (1963, p.345)	24° 51'S 103° 16'W	?	5	11.39	0	—
Thomson (1889, p.357)	Napier, New Zealand	Large shark	—	12-15	—	9
Heegaard (1962, p.177)	Port Hacking, N.S.W.	<i>Isurus</i> <i>oxyrinchus</i>	4	—	0	—
PRESENT RECORDS (for measurements see p.195):						
	Makara	<i>Isurus</i> <i>oxyrinchus</i>	4		0	
	Cape Brett	<i>Isurus</i> <i>oxyrinchus</i>	12		2	
	Paraparaumu	<i>Isurus</i> <i>oxyrinchus</i>	10		0	
	Bay of Islands	<i>Isurus</i> <i>oxyrinchus</i>	4		0	
	Nth Auckland	<i>Isurus</i> <i>oxyrinchus</i>	1		0	
	Tory Channel	<i>Galeorhinus</i> <i>australis</i>	30		7	
	Tory Channel	<i>Carcharodon</i> <i>carcharias</i> *	61		0	

From these records several points emerge:

1. The species is probably cosmopolitan although it has not yet been reported from the Indian Ocean.
2. The usual host fishes are members of the family Lamnidae (the exceptions among the identified hosts are marked with an asterisk in the table above).
3. There is a surprising range of size (as measured by total length) among the females of this species (11.39 mm to "up to 18 mm"). Although records of males are as yet much rarer than those of females there does not seem to be such a marked variation in the size of males. Correlations with temperature and salinity are difficult because of the extreme mobility of the host species. However, there is a significant variation in size between individuals from one individual host specimen and another (p. 00) and probably an even greater variation in specimens from different host species. It is not clear why these differences should be so marked.

***Dinemoura producta* (Müller, 1785)**

(Figs. 44-71)

Caligus producta Müller, 1785, p. 132, pl. 21, figs. 3, 4.

Dinemoura producta (Müller) Latreille, 1829, p. 197.

Pandarus lamnae Johnston, 1835, p. 203, fig. 22.

Dinemoura lamnae (Johnston) Baird, 1850, p. 286, pl. 33, fig. 8.

Nogagus productus (Müller) Gerstaecker, 1853, p. 63, pl. 4, figs. 1-10.

Dinematura elongata Van Beneden, 1857, p. 226; 1861, p. 149, pl. 24.

Dinematura producta (Müller) Steenstrup and Lütken, 1861, pp. 371, 374, pl. VII, fig. 13.

Dinematura elongata Van Beneden, 1892b (male), p. 231, pl. 2, figs. 11-13.

Dinematura carcharodonti Thomson, 1889, p. 360, pl. 26, fig. 2.

Dinematura producta (Müller) Bassett-Smith, 1899, p. 463.

Dinematura producta (Müller) Wilson, 1907, pp. 380-3, pl. 23.

Dinematura producta (Müller) Scott and Scott, 1912, pp. 86-8, pl. 22, fig. 3, pl. 26, figs. 1-3, pl. 27, figs. 1-8.

Dinematura affinis Thomsen, 1949, pp. 14-17, pl. 5, figs. 1-12.

Dinematura producta (Müller) Mathews and Parker, 1950, pp. 568-71, figs. 14, 15.

Dinematura affinis (Thomsen) Shiino, 1957, pp. 365-9, figs. 3, 4.

MATERIAL: Form A: all from *Carcharodon carcharias*; one female, host taken in Tory Channel, 28 July 1955, Dominion Museum collection; 301 females and 61 males (20 males attached to females) collected by C. McCann, host taken in Tory Channel, 7 July 1958, located on ventral surface near caudal fin, Dominion Museum collection; three females and one male, collected by Fisheries Laboratory staff, Marine Department, host taken at Mernoo Bank, East of New Zealand, 30 November 1964; 16 females and one male, collected by H. G. Upton (specimens forwarded by Dr J. Grieve), host taken at Kaikoura, 11 January 1965, located on ventral surface about 20 cm anterior to caudal fin.*

* Many of these specimens were heavily infested with specimens of the thecate hydrozoan *Phialella quadrata* (Forbes, 1848) (identified by Dr P. M. Ralph of Victoria University of Wellington).

Form B: from *Cetorhinus maximus*; 52 females, collected by H. Healey and M. Patterson, host taken off New Plymouth, 5 November 1958, Dominion Museum collection.

DESCRIPTION

FEMALE, two forms present, those from *Carcharodon* (figs 44–53) differing in several respects from those from *Cetorhinus* (figs 54–61). Total length (both forms) 19.7 mm–22.2 mm.

CARAPACE wider than long (form A: 6.8 mm–7.5 mm x 7.3 mm–7.9 mm; form B: 5.7 mm–6.7 mm x 6.9 mm–7.4 mm). Frontal plate about half carapace width in form B (3.7 mm–4.1 mm), a little wider in form A (4.4 mm–4.9 mm), length one-tenth width; median area of carapace half to two-thirds carapace width, bounded laterally by two longitudinal ribs, slightly curved, two-fifths carapace length and bounded posteriorly by a slightly swollen sublinear margin which extends posteriorly as curved lateral projections by medial margins of posterolateral processes; these processes two-sevenths carapace length, tending to curve medially towards their posterior termination; lateral flange forming an entire curve around posterior processes, slightly wider on their median margins, terminating at their junction with the median area.

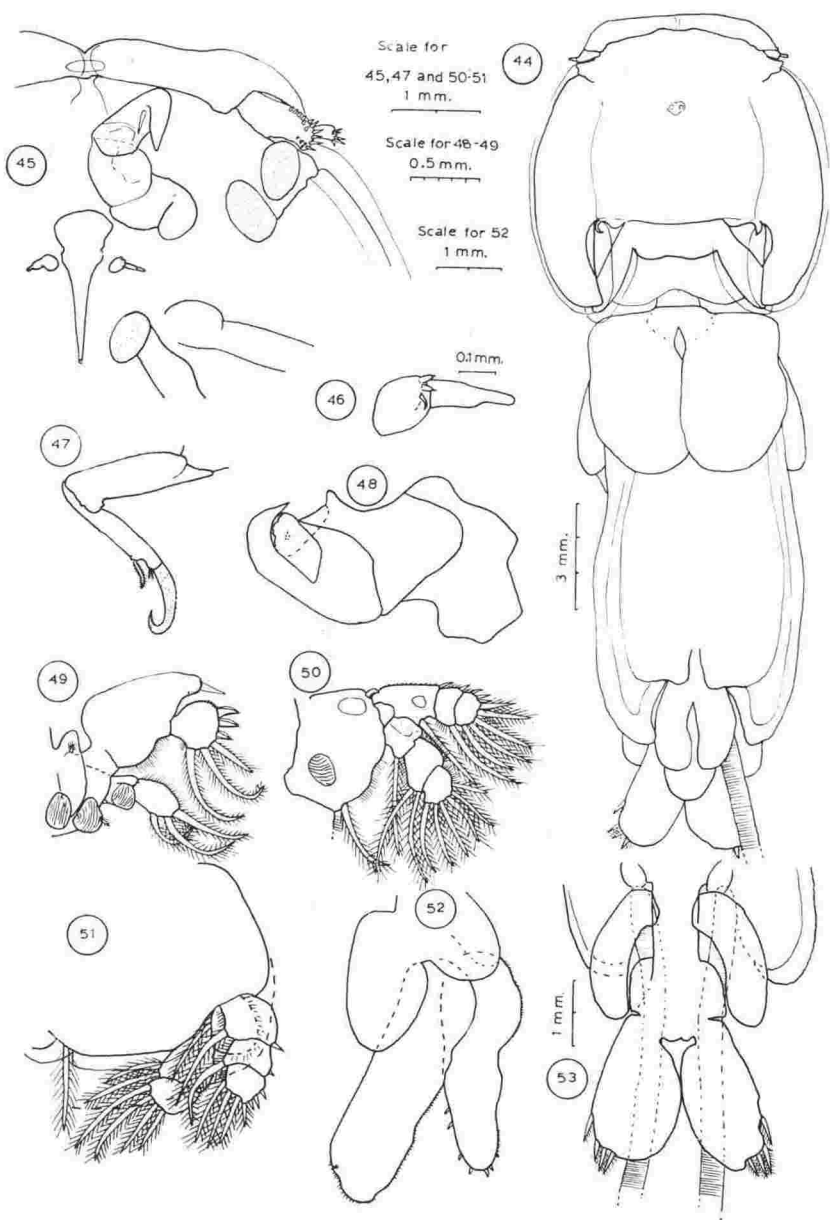
SECOND SEGMENT, width three times length (0.7 mm–1.2 mm x 2.5 mm–3.2 mm); with posterolateral plates, two-thirds as wide as segment length, length two to three times width, extending beyond the third segment in some but not all specimens of form A, with a continuous flange on inner and posterior margins of plate.

THIRD SEGMENT wider than long (1.2 mm–1.6 mm x 2.7 mm–3.1 mm), anterior width two-thirds posterior, posterior margin concave at point of attachment of fourth segment.

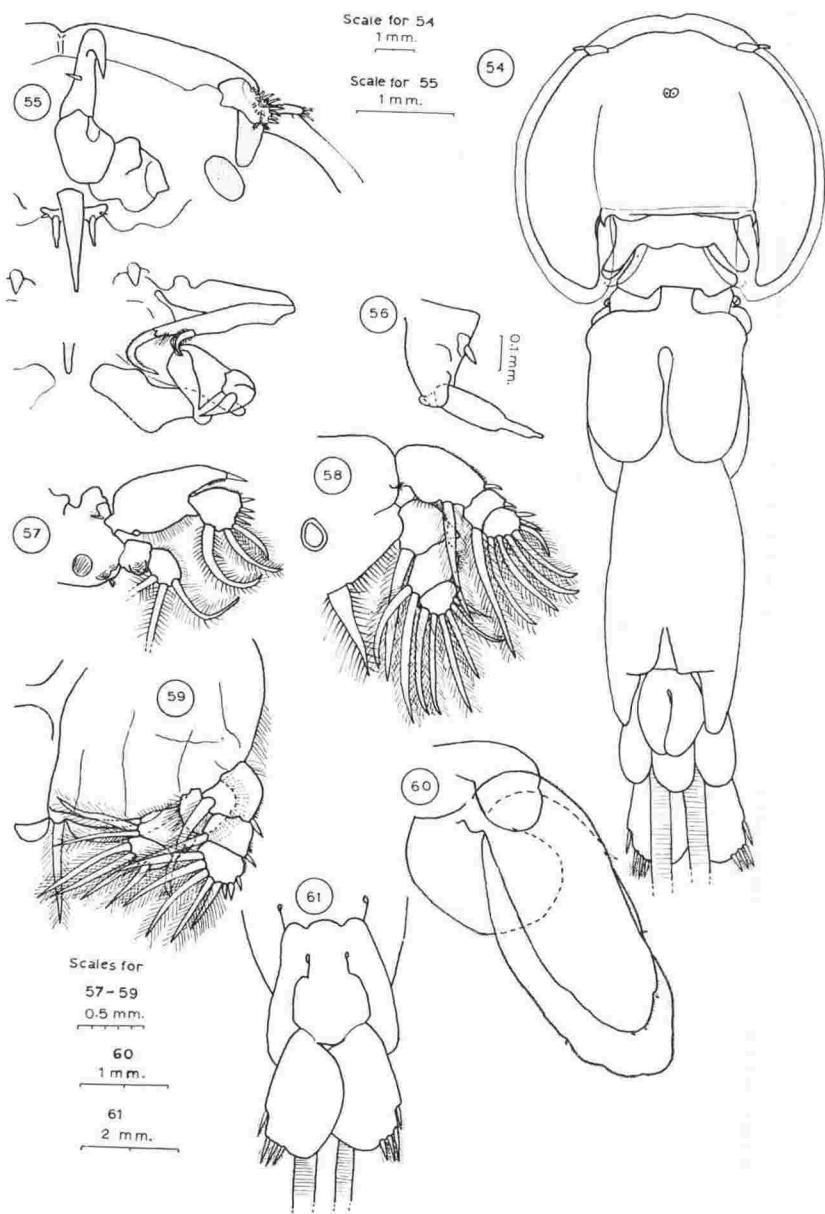
FOURTH SEGMENT, including well developed plates, a little wider than long in form A (4.1 mm–5.2 mm x 4.5 mm–5.3 mm), a little longer than wide in form B (4.1 mm–4.3 mm x 3.5 mm–4.2 mm), outer, medial and posterior margins of plates forming an entire curve, medial margins slightly overlapping in some specimens, sinus between them narrow.

GENITAL SEGMENT, length twice width, slightly larger in form A (9.4 mm–10.7 mm x 4.7 mm–6.0 mm) than in form B (7.7 mm–8.8 mm x 3.9 mm–4.8 mm); one-sixth of length consisting of posterolateral processes which are one-quarter segment width at their bases; dorsal plates cover much of the surface of the segment.

ANAL PLATE subovate, width half length, narrower in form B than form A (length: 1.8 mm–2.7 mm; width form A: 1.3 mm–1.5 mm, form B: 0.8 mm–1.2 mm), extending beyond posterolateral processes of genital segment for half their length.



FIGS 44-53—*Dinemoura producta* (Müller), female from *Carcharodon carcharias* (form A). Fig. 44—dorsal; 45—anterior mouth parts and antennae; 46—second maxilla; 47—first maxilliped; 48—second maxilliped; 49—first pereiopod; 50—second pereiopod; 51—third pereiopod; 52—fourth pereiopod; 53—abdomen and caudal rami.



FIGS 54-61—*Dinemoura producta* (Müller), female from *Cetorhinus maximus* (form B). Fig. 54—dorsal; 55—anterior mouth parts and antennae; 56—second maxilla; 57—first pereopod; 58—second pereopod; 59—third pereopod; 60—fourth pereopod; 61—abdomen and caudal rami. Note: fig. 60 is drawn from a slightly smaller specimen than that from which the other figures are taken.

ABDOMEN subrectangular, as wide as long or a little wider, smaller in form B (form A: 1.6 mm–1.8 mm x 1.7 mm–2.1 mm; form B: 1.3 mm–1.5 mm x 1.2 mm–1.7 mm), caudal rami carried on indentations at posterolateral angles of abdomen.

CAUDAL RAMI longer than wide (2.5 mm–2.9 mm x 1.2 mm–1.6 mm), subovate, outer margins straight, inner and posterior margins forming an entire curve, with three plumose setae on lateral half of posterior margin and a further plumose seta on outer margin one-quarter of distance from posterolateral angle.

EGG STRINGS very long and narrow, 60 mm–93 mm in length.

FIRST ANTENNA of two segments, first segment twice length of second, width two-fifths length, rounded distally, has about ten small plumose setae on distal margin and distal part of inner and outer margin as well as about ten small spines on ventral surface; second segment subrectangular, rounded distally, length three times width, with a group of setae distally and a further seta on inner margin.

Immediately posterior to first antenna is an adhesion pad, half as long as antenna, width two-thirds length, subovate, tending to be narrower and slightly truncated anteriorly in form B; immediately posterior to this is a further adhesion pad similar in form to anterior pad in form A but with its longitudinal axis inclined anteromedially.

SECOND ANTENNA of three segments, first segment as long as second, two-thirds length of third, as wide as long; second segment subrectangular, as wide as long, narrowing to two-thirds this width distally; third segment, width at the base one-third length, narrowing to a sharp point distally, distal half strongly curved, with a spine one-third of distance from proximal margin.

MOUTH TUBE one-fifth carapace length, width at the base one-third length, narrowing rapidly so that tube is very narrow for most of its length.

SECOND MAXILLA on a plate lateral to mouth tube, consisting of a segment one-quarter mouth tube length, basal part one-quarter as wide as segment length, distal third narrowing suddenly to half this width; in form A there are two small projections, each tipped with a minute spine, and one small seta near base of joint, in form B only a single spine-like projection.

FIRST MAXILLIPED of two segments, first segment two-thirds length of second, width one-quarter length; second segment, width one-tenth length, distal third consisting of a branch, covered in longitudinal rows of fine spines, which narrows gradually to a sharp point distally; a second branch, half as long as terminal branch, is situated on midpoint of outer margin, and has setae on its inner and outer margins; a tuft of long cilia is carried on a small raised area between the two branches.

Just medial to base of first maxilliped in form A is an adhesion pad similar in size and shape to that immediately posterior to first antenna

in most cases but in some specimens it is narrowed posteriorly and is almost spine-like. In form B this pad is replaced in all specimens examined by a posteriorly directed spine, which however may be blunt and pad-like.

SECOND MAXILLIPED of three segments, first segment with a wide base, narrowing to about half basal width where it meets second segment; second segment subtriangular, with a projection against which the claw-like third segment closes, the projection being blunt in form A, with a roughened area where the claw touches, but in form B sharp and spine-like, both projections about the same size; distal third of terminal joint sharply curved and narrowing rapidly to a sharp point.

FIRST PEREIOPOD biramous, each ramus of two segments; basipod small, with small plumose setae near inner and outer distal angles and two adhesion pads near inner margin; exopod twice length of endopod, its second segment two-fifths length of first; first segment, width two-fifths length, outer distal angle extended to form one-third of segment length, bearing a long spine; near base of spine and medial to it is a row of short cirri, inner margin of segment has a row of long cilia; second segment subcircular, as wide as long, with short cirri on outer margin, and three or four well developed spines on distal margin, three long plumose setae on inner distal angle and a tuft of cilia just proximal to the most proximal of these setae; first segment of endopod two-thirds length of second, subrectangular, as wide as long, with an attachment pad near inner distal angle; second segment subovate, width two-thirds length, with a row of cilia on outer margin and three long plumose setae on terminal margin.

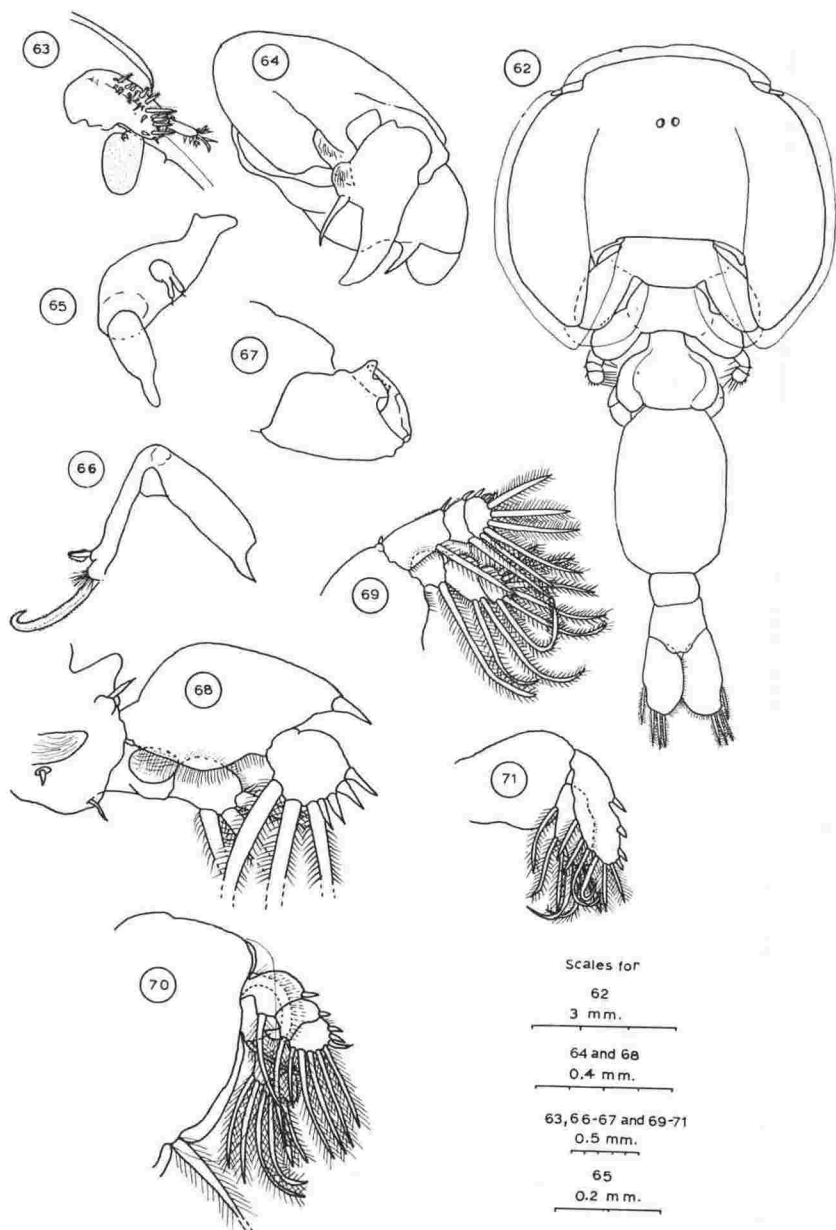
SECOND PEREIOPOD biramous, each ramus of three segments, exopod slightly longer than endopod, basipod broad, subrectangular, bearing two adhesion pads, the more posterior better developed; second and third segments of exopod the same length, together two-thirds length of first segment, which is two-thirds as wide as long, has a row of short cirri on outer margin, a short spine on outer distal angle, a long plumose seta just behind inner distal angle and a row of cilia along the somewhat distended median third of inner margin; second segment subrectangular, length two-thirds width, with a row of short cirri on outer margin, a short spine on outer distal angle, a long plumose seta on inner distal angle and a row of cilia on inner margin; third segment subcircular, as wide as long, with a row of short cirri on outer margin, two spines on outer distal angle and five long plumose setae over distal and inner margins; third segment of exopod three-quarters length of second, second three-quarters length of first; first segment subrectangular, as wide as long, with a row of cilia on outer margin and a long plumose seta on inner distal angle; second segment subrectangular, as wide as long, with a row of long cilia on outer margin and two, or rarely one, long plumose setae on inner distal angle; specimens with a single seta had this abnormality on both sides; third segment subsemicircular, proximal margin sublinear, length two-thirds width, with cilia on outer part of margin and five long plumose setae on distal and inner parts of margin.

THIRD PEREIOPOD biramous, each ramus of three segments, endopod and exopod subequal in length; basipods broad and united to form an apron; third segment of exopod as long as second, two-thirds length of first; first segment as wide as long, outer margin curved, with a few long cilia on proximal part of outer margin, a short row of small cirri on distal part of that margin, a spine on outer distal angle and a long plumose seta on inner margin; second segment subrectangular, length three-quarters width, with a short row of small cirri on distal part of outer margin, a spine on outer distal angle, a row of cilia on inner margin, and a long plumose seta on inner distal angle; third segment subsemicircular, proximal margin sublinear, as wide as long, with a row of small cirri on proximal part of outer margin, three spines on distal part of this margin, a row of short cilia on inner margin and usually five setae on distal margin; a small sample of form A, however, showed one specimen with four distal setae (Fig. 51) and one with six, and a small sample of form B showed one with four; first and second segments of endopod subequal in length, third segment two-thirds this length; first segment subcircular, outer margin much expanded and with long cilia, a long plumose seta carried on inner margin; second segment as wide as long, with two long plumose setae on slightly extended inner distal angle and a row of cilia on inner margin; third segment subovate, length two-thirds width, with four long plumose setae on terminal margin.

FOURTH PEREIOPOD biramous, each ramus of one segment, exopod a little shorter than endopod; basipod with a swollen flange on inner margin, flange subcircular, half length of exopod, with very small spines around margin and some groups of these spines on ventral surface; exopod subovate, length three times width, somewhat swollen proximally, terminal and outer margins incompletely and irregularly bordered by very small spines of which from four to ten may be noticeably enlarged (number variable in both forms); endopod subovate, width two-fifths length, outer, terminal, and up to half of distal inner margin bordered by very small spines of which usually only one, situated near inner distal angle, is noticeably larger than the rest.

MALE (form A only) (Figs. 62-71), overall length 12.1 mm-13.8 mm.

CARAPACE as long as wide (5.6 mm-6.1 mm x 5.4 mm-6.0 mm); frontal plate two-thirds carapace width, length one-tenth width; median area one-half carapace width, bordered laterally for posterior two-thirds of length by two longitudinal ribs, which converge slightly anteriorly, eyes situated one-third of distance from anterior margin, posterior margin sublinear, lateral parts of posterior margin raised and directed posteriorly but not as long or curved a projection as in female; lateral areas projecting beyond median area for one-third of their length, outer margins entire curves, posterior section narrowed slightly but posterior margin also an entire curve; bearing a flange which expands to twice its lateral width where it bounds the medial part of lateral area.



FIGS 62-71—*Dinemoura producta* (Müller), male from *Carcharodon carcharias* (form A). Fig. 62—dorsal; 63—first antenna; 64—second antenna; 65—second maxilla; 66—first maxilliped; 67—second maxilliped; 68—first pereopod; 69—second pereopod; 70—third pereopod; 71—fourth pereopod.

SECOND SEGMENT, width nearly three times length (0.7 mm–0.8 mm x 2.0 mm–2.5 mm), bearing on the lateral margins subovate posterolaterally directed plates which are half as long again as the segment and two-thirds as wide as long; plates surrounded posteriorly and distally by a wide flange.

THIRD SEGMENT, width twice length (0.9 mm–1.0 mm x 2.0 mm–2.5 mm), lateral margins rounded, posterior part of lateral margin with posterolaterally directed rounded plates, as long as the segment and as wide as long.

FOURTH SEGMENT a little wider than long (1.3 mm–1.7 mm x 1.9 mm–2.1 mm), lateral margins rounded, anterior fifth narrowing rapidly to one-third greatest width; lateral margins of segment flattened dorsoventrally.

GENITAL SEGMENT subovate, width two-thirds length (3.1 mm–3.5 mm x 2.1 mm–2.4 mm), anterior and posterior angles rounded.

ABDOMEN two segmented, first segment three-quarters length of second (second segment 0.9 mm–1.1 mm x 1.2 mm–1.3 mm, first segment 0.5 mm–0.9 mm x 0.8 mm–1.1 mm); first segment subrectangular, angles slightly rounded; second segment subrectangular, posterior angles indented for the attachment of the caudal rami.

CAUDAL RAMI, length twice width (1.4 mm–1.8 mm x 0.8 mm–0.1 mm), subovate, lateral margins sublinear, with three long plumose setae on posterior margin, a further long plumose seta on lateral margin one-third of distance from posterior margin and a row of cilia along inner margins.

FIRST ANTENNA of two segments, first segment three times length of second, width half length, with about 10 plumose setae and 14 small spines on outer and rounded distal margins; second segment, length three times width, with about 10 setae distally.

Adhesion pad associated with antenna similar to that in female except that it is somewhat truncated anteriorly and carries a small spine on a raised boss near anterior margin.

SECOND ANTENNA of three segments, first and second segments subequal in length, the third two-thirds their length; first and second segments subovate, width half length, the second segment with a striated area near distal part of inner margin; third segment, width at the base half length, narrowing suddenly from the inner margin to half this width at its midpoint, distal half narrowing gradually to a dull point, has a ridged area on inner margin just proximal to the point at which the joint narrows and a long spine distal to this area.

MOUTH TUBE long and slender.

SECOND MAXILLA lateral to base of mouth tube, like female in that the associated boss has two projections each tipped with a small spine, but there is no associated seta.

FIRST MAXILLIPED as in female, a similar adhesion pad associated with its base.

SECOND MAXILLIPED as in female except that the projection on second segment against which the claw-like third segment closes is bifurcated so that third segment closes against a V-shaped indentation in this projection.

FIRST PEREIOPOD biramous, each ramus of two segments; exopod twice length of endopod; basipod small, carrying a striated adhesion pad medially and a small spine posterior to this pad and further spines on the outer and inner distal angles; first segment of exopod three times length of second, width half length, with a stout spine on outer distal angle which is produced to form one-quarter length of segment, and a row of long cilia on inner margin; second segment subcircular, as wide as long, with four stout spines distally and three long plumose setae on inner margin; endopod as in female.

SECOND AND THIRD PEREIOPODS as in female.

FOURTH PEREIOPOD biramous, each ramus of one segment; endopod three-quarters length of exopod; exopod subovate, length three times width, with four spines on distal half of outer margin and six long plumose setae on distal half of inner margin; endopod, width half length, with short cilia on distal half of outer margin and six long plumose setae on inner margin.

There is a raised area on genital segment just medial to the posterior angles which bears a small two-segmented spine. This may well be a vestige of the fifth pereopod.

Note: These specimens were identified as form A of this species (*Dinemoura producta*) since

1. The females of this form occurred in each of the three samples in which the male was taken. The only sample which contained another species or form of *Dinemoura* (*D. latifolia*) had five times as many females of the present species.
2. In the largest sample of these males, which also included *D. latifolia*, 20 of the 61 males were attached to females of *D. producta*.
3. The present male specimens seem to agree with the description of the male of *D. producta* given by Wilson (1923, pp. 8-9, pl. 2, figs. 11-18) except that he states that the plates on the second segment are truncated while in the present material they are clearly rounded. However, even in the present material the plates may appear truncated when viewed from certain angles, and Wilson may have been mistaken on this point. Wilson also says the exopod of the fourth pereopods is clearly of three segments. In the present material these segments are indistinct and in many specimens are absent. This character seems to be variable.

DISCUSSION

This species has been recorded from many parts of the world on a variety of host species, of which the most common appear to be *Lamna nasus*, *Carcharodon carcharias*, and *Cetorhinus maximus*. From the present records and from the descriptions by other authors, in particular Scott and Scott (1912), Fage (1923), Thomsen (1949), Mathews and Parker (1950), and Shiino (1957), there seem to be at least three forms of this species or possibly three different species, one occurring on each of the main host species.

I have chosen to regard these different types as forms of the same species (as suggested by Mathews and Parker). The only characters consistently different in the present material, and in descriptions of material from the same host but from various geographical areas, appear to be ones affecting the attachment devices. Considering the many similarities between the three forms, I am of the opinion that the differences may well be due to variation in the skin structure of the host rather than being genetically constant.

My specimens from *Cetorhinus maximus* differ from those described by Thomson since in his the posterior processes on the genital segment extend beyond the sixth segment, but they agree with the descriptions by both Thomson and Mathews and Parker in the second maxilliped, which consists of a spine closing against another spine and in the nature of the two adhesion pads posterior to the first antenna, which are much narrower than in the other two forms.

The present specimens from *Carcharodon carcharias* agree in most respects with those described by Thomson (1889, p. 361) as *Dinematura carcharodonti*, including the form of the plates on the second segment. In some of the present specimens this extends past the third segment, as shown in Thomson's drawing (pl. 26, fig. 2). Basset-Smith (1899, p. 463) and Wilson (1907, p. 376) suggest that Thomson's specimens were really *D. ferox*, but this seems to be ruled out by the length of the anal plate which, as illustrated, is much longer than in *D. ferox* but of the usual form for this structure in *D. producta*. That the present material was taken from the same host species is added evidence that Thomson's material was really *D. producta*. The present material from *Carcharodon* is clearly distinguished from descriptions of material from *Cetorhinus* in having much wider adhesion pads posterior to the first antenna, a pad rather than a spine near the base of the first maxilliped, and the second maxilliped made up of a spine closing against a pad rather than two spines. In this last characteristic, the illustration by Wilson (1907, pl. 23, fig. 82) resembles the present material much more closely than any others described and may therefore be a similar host form.

Descriptions of specimens taken from species of the genus *Lamna* are given by Scott and Scott, Mathews and Parker, and Shiino. Their specimens resemble those from *Carcharodon* in having large oval adhesion pads posterior to the first antennae but differ in having the

second maxillipeds intermediate between the spine and pad found in specimens from *Carcharodon* and the two distinct spines found in specimens from *Cetorhinus*. Fage mentions differences in the number of plumose setae on the pereopods but the variations shown in this character by the present study suggest that such differences would require statistical treatment to be definitive.

Previous records of this species cover much the same area as records for *D. latifolia*, i.e. North and South Pacific and Atlantic and the Mediterranean Sea, and include:

NORTH ATLANTIC: on *Lamna nasus* at Alten, Denmark (Krøyer, 1863, p. 179); on *L. nasus* at 63° 56' N, 6° 11' E (Jensen, after Hansen, 1923, p. 35); on *L. nasus* at the Faroes Islands and Kattegut, North Sea (Steenstrup and Lütken, 1861, p. 374); on *L. nasus* at Berwick Bay (Johnston, 1835, p. 203); on *L. nasus* and *Alopias vulpinus* in British waters (Scott, T. and A.), also recorded from *Somniosus microcephalis*, but Wilson, 1907, p. 382, states that some early records from this species were the result of a piece of skin being misidentified and that the parasites actually came from *L. nasus* so that this record must be regarded as doubtful; on *L. nasus* in the north Atlantic (van Beneden, 1861, p. 149); on *Cetorhinus maximus* and *L. nasus* in the north-east Atlantic (Mathews and Parker, 1950, p. 568); on *L. nasus* at Brittany (Brian, 1906, p. 52); on *Cetorhinus maximus* at Concarneau (Fage, 1923, p. 281); on unknown hosts at Casco Bay, Maine, and at 38° 07' N, 74° 21' W (Wilson, 1907, p. 383).

MEDITERRANEAN SEA: on *L. nasus* at Nice, and on *Cetorhinus maximus* at Livorno (Brian, 1939, p. 10); on an unknown host in the Gulf of Genoa (Brian, 1898, p. 212).

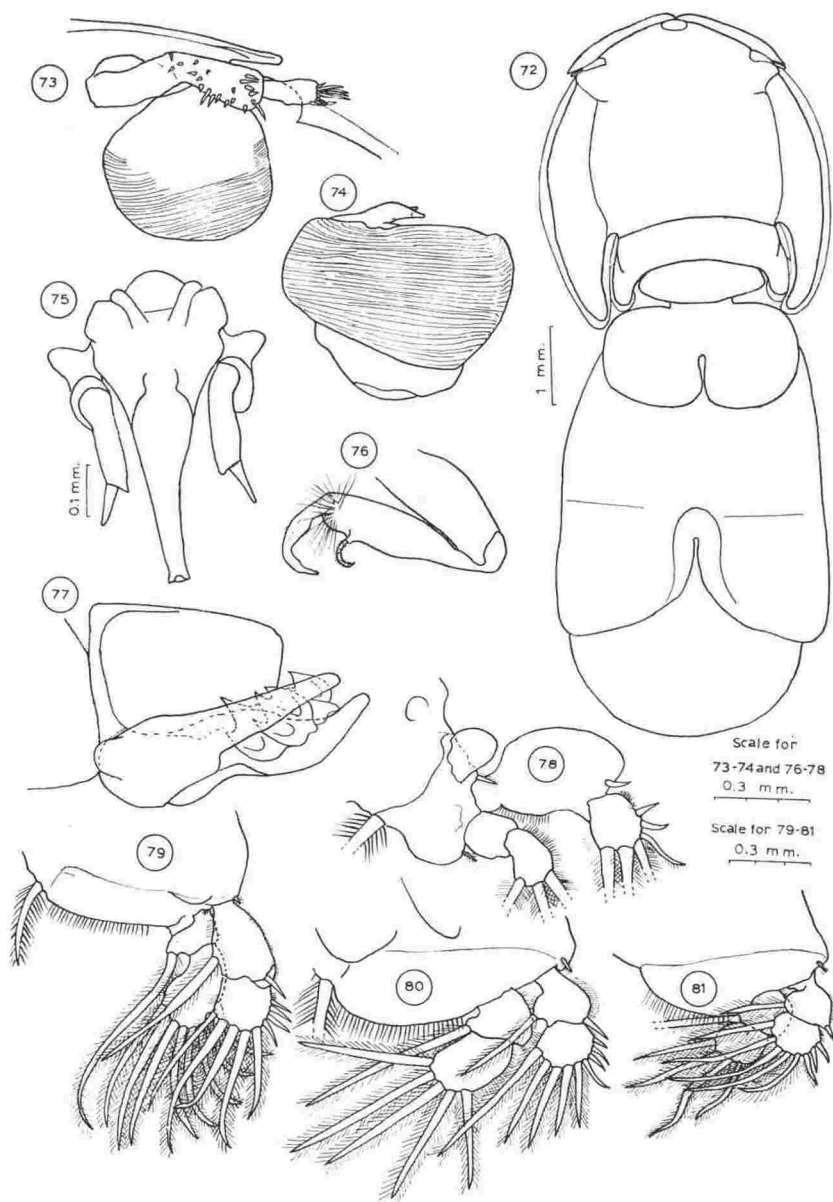
SOUTH ATLANTIC: on a "shark" in the Mar del Plata, Argentina (Brian, 1939, p. 10); at Puerto de la Paloma, Uruguay (Thomsen, 1949, p. 17).

NORTH PACIFIC: on *Isurus glaucus* at Sagami, Japan (Heegaard, 1943, p. 26); on *Lamna ditropis* in the north-west Pacific (Shiino, 1957, p. 365); on *Isurus glaucus* at San Pedro, California (Heegaard, 1945, p. 16).

SOUTH PACIFIC: on *Carcharodon carcharias*, presumably from New Zealand waters (Thomson, 1889, p. 361); on *Cetorhinus maximus*, probably from Australian waters (Heegaard, 1962, p. 177).

INDIAN OCEAN: on an unknown host at Durban, South Africa (Wilson, 1923, p. 8).

The only other valid species in this genus of which I am aware are *Dinemoura latifolia* (from which *D. producta* can be distinguished by its proportionately much narrower body) and *D. ferox* (in which the anal plate is much shorter). *Dinemoura latifolia* has a very similar distribution pattern to the present species, but *D. ferox* seems to be much rarer and more restricted.



FIGS 72-81—*Demoleus latus* Shiino, female. Fig. 72—dorsal; 73—first antenna; 74—second antenna; 75—mouth tube and second maxillae; 76—first maxilliped; 77—second maxilliped; 78—first pereopod; 79—second pereopod; 80—third pereopod; 81—fourth pereopod.

Demoleus latus Shiino, 1954

(Figs 72–92)

Demoleus latus Shiino, 1954, pp. 325–31.

MATERIAL: Five females and one male from a spiny dogfish (*Squalus acanthias*) taken 10 miles east of Cuvier Island (Hauraki Gulf) by the Fisheries Laboratory, Marine Department, on 11 November 1964.

DESCRIPTION

FEMALE (Figs. 72–82) overall length 8.45 mm–9.1 mm.

CARAPACE slightly longer than wide (3.7 mm–3.9 mm x 3.4 mm–3.5 mm), frontal plate three-quarters carapace width (2.5 mm–2.6 mm), length one-fifteenth width, strongly curved, with a distinct medial notch, projecting laterally as far as second segment of first antenna; median area two-thirds carapace width, bounded laterally by longitudinal ribs which converge slightly anteriorly and then join side ribs which reach margin near first antennae; lateral areas projecting posteriorly beyond median area for two-sevenths carapace length, rounded posteriorly, bordered by a flange which terminates at junction of lateral and median areas.

SECOND SEGMENT, excluding plates, width almost four times length (0.6 mm x 1.8 mm–1.9 mm), plates extending posterolaterally for a distance equal to length of segment, width half length, bounded by a narrow flange.

THIRD SEGMENT, width three times length (0.5 mm x 1.5 mm–1.7 mm), subovate.

FOURTH SEGMENT, including plates, width twice length (1.2 mm–1.4 mm x 2.4 mm–2.6 mm), plates rounded with narrow incision between them.

GENITAL SEGMENT, width four-fifths length (3.6 mm–4.0 mm x 3.2 mm), narrowing anteriorly to two-thirds posterior width, posterior margin incised medially to a depth of one-third total length of segment, so that posterior margin consists of two convex curves meeting in a narrow sinus, postero-lateral angles rounded.

ANAL PLATE sub-semicircular, as wide as long (2.6 mm–2.8 mm x 2.9 mm–3.1 mm), posterior margin an entire curve.

ABDOMEN, width twice length (1.3 mm–1.6 mm x 2.7 mm–2.9 mm), lateral length one-seventh medial length, posterior and anterior margins V-shaped, lateral margins rounded, attached to genital segment by a short anterior neck-like region; caudal rami on each side of the V-shaped posterior margin.

CAUDAL RAMI very large, width two-thirds length (2.3 mm–2.5 mm x 1.5 mm–1.8 mm), posterior and outer margin forming an entire curve, inner posterior angle rounded, rami overlapping posteriorly with a narrow sinus between them anteriorly, bearing four well-developed spines on posterior margin.

EGG STRINGS coiled between the broad anal plate and the enlarged caudal rami, length 15 mm–18 mm, each egg string containing about 250 eggs.

FIRST ANTENNA two segmented, second segment one-third length of first; first segment narrow in ventral view, width one-quarter length, with about 20 spines in region of outer margin; second segment, width two-fifths length, with about 10 setae distally.

Immediately posterior to first antenna there is a large adhesion pad as wide as first segment of first antenna is long, nearly as long as wide, subcircular, with transverse striations.

SECOND ANTENNA of three segments, first segment a subcircular base half as long as second, subequal in length to third; second segment completely covered by a large adhesion pad, length two-thirds width, with transverse striations; third segment narrowing rapidly near base to be half as wide as long, narrowing distally and tipped with a spine, with a small accessory spine near small distal spine.

MOUTH TUBE 0.5 mm long, width at the base half length, narrowing to one-fifth this width distally.

SECOND MAXILLA lateral to mouth tube, half length of mouth tube, in form of two-segmented spine, second segment half length of first; first segment on raised boss, width one-quarter length, second segment half as wide at the base as first segment, narrowing distally to blunt point.

FIRST MAXILLIPED of two segments, first segment half length of second, width one-third length; second segment, medial width one-seventh length, distal third in form of branch which narrows to a point distally and is covered with rows of very short spines, a further branch is separated from the major branch by a distance equal to one-third its length, this branch being half as long as distal branch and bearing short spines; the maxilliped has a tuft of long cilia between these two branches.

SECOND MAXILLIPED of three segments, basal segment three-quarters length of second, as long as third, in form of subrectangular base on which second segment is borne; second segment, width at the base one-third length, narrowing gradually distally, rounded at distal termination, the distal half a spine which closes against a similar but slightly more curved spine which constitutes most of length of third segment, so that second and third segments are in the form of a pair of powerful pincers.

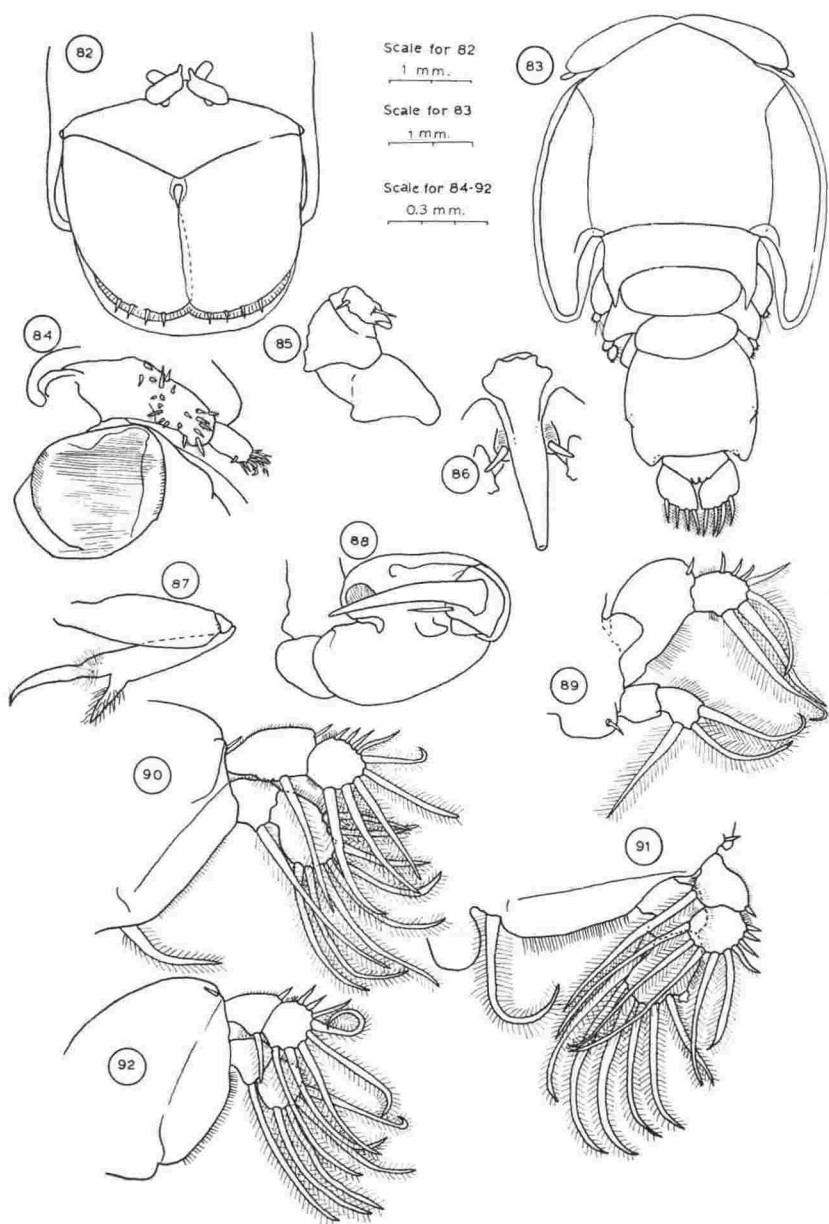
FIRST PEREIOPOD biramous, each ramus of two segments, endopod half length of exopod; basipod small, width twice length, with a large plumose seta on inner proximal angle and small plumose setae on inner and outer distal angles, as well as a subcircular flange, half as long as basipod is wide, near outer margin; second segment of exopod two-fifths as long as first; first segment, width half length, with a spine near outer distal angle, and a row of cilia along proximal two-thirds of inner

margin; second segment subovate, as long as wide, with a row of short cirri along outer margin, two spines on outer distal region, immediately followed by a short seta, plumose only on its inner margin, and three long plumose setae on distal margin, and a row of long cilia on inner margin; first segment of exopod as long as second, subrectangular, as wide as long; second segment subovate, width two-thirds length, with a row of long cilia on outer margin and three long plumose setae distally.

SECOND PEREIOPOD biramous, each ramus of two segments, exopod as long as endopod; basipod with a long plumose seta on inner proximal angle, a row of long cilia on inner margin, and a short plumose seta on outer distal angle, basipod much larger than in first pereopod; second segment of exopod two-thirds length of first; first segment, width two-thirds length, narrowed at base to half this width, with a row of short cilia on outer margin, a spine near outer distal angle, a row of cilia on proximal third of inner margin, and a long plumose seta near inner proximal angle; second segment subrectangular, distal angles rounded, with a very short row of cirri on outer margin, four long spines on outer distal region, five long plumose setae on distal margin, and a tuft of cilia near inner distal angle; first segment of endopod one-third length of second, subrectangular, length two-thirds width, with a row of short cilia on outer margin, and a long plumose seta on an extended base on inner margin; second segment subrectangular, width half length, outer margin curved and has short cilia, distal angles rounded, distal margin with eight long plumose setae, distal two-thirds of inner margin has long cilia.

THIRD PEREIOPOD biramous, each ramus of two segments; basipod well developed, similar to basipod of second pereopod but larger; exopod one-sixth shorter than endopod; first segment of exopod one-fifth longer than second, as wide as long medially, width at the base half length, with a row of cirri on outer margin, a spine on outer distal angle, a long plumose seta on inner margin near inner distal angle, and a short row of cilia just proximal to this seta; second segment subcircular, as wide as long, with three spines and a non-plumose seta on outer distal region, five long plumose setae distally and short rows of cilia on inner and outer margins; first segment of endopod three-quarters length of second, length two-thirds width, outer margin three times length of inner and bearing long cilia, inner margin with a long plumose seta at inner distal angle; second segment subovate, width four-fifths length, with a row of cilia on outer and inner margins and five long plumose setae distally.

FOURTH PEREIOPOD biramous, each ramus of two segments, rami subequal in length; basipod smaller than for third pereopod but similar in structure; first segment of exopod similar to first segment of exopod in third pereopod, second segment similar except that outer distal angle has only two spines, and seta on outer distal angle has short cilia; first segment of endopod as in third pereopod; second segment subcircular, as wide as long, with cilia on outer and inner margins, and four long plumose setae distally.



FIGS 82-92—*Demoleus latus* Shiino, female. Fig. 82—abdomen and caudal rami. Male. Fig. 83—dorsal; 84—first antenna; 85—second antenna; 86—mouth tube and second maxillae; 87—first maxilliped; 88—second maxilliped; 89—first pereiopod; 90—second pereiopod; 91—third pereiopod; 92—fourth pereiopod.

MALE (Figs 83-92), single specimen, total length 5.6 mm.

CARAPACE a little longer than wide (3.3 mm-3.0 mm); frontal plate five-sixths carapace width (2.5 mm), greatest length one-eighth width, rounded laterally, shorter medially, strongly curved; median area two-thirds carapace width, bordered laterally by longitudinal ribs which converge slightly anteriorly before joining a small side rib extending from just posterior to the first antennae; lateral areas extending posterior to median area for a distance equal to one-quarter carapace length, bordered laterally and medially by a flange; a small ridge is borne on dorsal surface of carapace near junction of medial and lateral areas posteriorly.

SECOND SEGMENT, median length one-third width (0.6 mm x 1.8 mm), posterolateral angles extended to end in a sharp point, increasing length of segment to 1.2 mm.

THIRD SEGMENT subovate, width three times length (0.5 mm x 1.45 mm).

FOURTH SEGMENT subovate, length two-fifths width (0.5 mm x 1.2 mm).

GENITAL SEGMENT a little wider than long (1.3 mm x 1.5 mm), subrectangular, narrowing anteriorly to three-quarters posterior width, posterolateral angles slightly extended, with two small spines on a slight protuberance on lateral margin, one-third of distance from posterior angles.

ABDOMEN one-segmented, subtriangular, width twice length (0.4 mm x 0.8 mm), posterior margin one-quarter width of anterior margin, bearing caudal rami on angled lateral margins.

CAUDAL RAMI a little longer than wide (0.6 mm x 0.5 mm), with four long plumose setae on posterior margin.

FIRST ANTENNA and its associated adhesion pad similar to those in female.

SECOND ANTENNA three-segmented, first segment twice length of second, width half length; second segment as wide at the base as long, half as wide distally; third segment as long as second, width at the base one-quarter length, distal half narrowing rapidly to a sharp point, with a sharp spine near inner proximal angle, and a longer spine medially, near point at which joint starts to narrow.

MOUTH TUBE 0.6 mm in length, width at the base half length, narrowing gradually distally.

SECOND MAXILLA situated lateral to mouth tube consisting of a sharp spine one-sixth length of mouth tube, seated on a raised, laterally striated boss.

FIRST MAXILLIPED as in female, except that setation on smaller branch of second segment is much longer than in female.

SECOND MAXILLIPED very different from that in female, of three segments, basal segment small, one-third length of second, subovate, width two-thirds length; second segment, width two-thirds length, outer margin expanded, with a rounded extension near outer proximal angle which has a rounded striated area against which the third segment closes; third segment long and spine-like, four-fifths length of second segment, width at the base one-quarter length, narrowing steadily distally to a sharp point; a slender spine, one-quarter length of third segment, is carried on second joint near base of third joint.

PEREIOPODS as in the female except as follows: second segment of exopod of first pereopod has three spines near outer distal region; second segment of second pereopod has a short plumose seta in place of more distal spine or seta found on outer margin in female; third pereopod differs in same way as second; in fourth pereopod the short seta on outer distal area lacks the plumose fringe found in the equivalent seta in the female.

DISCUSSION

The present material does not appear to differ significantly from that originally described by Shiino. However, the specimen described here as a male seems to correspond with his young female (p. 326, fig. 18C). I have identified it as a male since, when the specimen was cleared in benzyl alcohol, the internal structure of the genital segment (Fig. 93) seems to resemble that of a male rather than that of an immature female. The structures are interpreted as being a wide vas deferens leading from the anterior of the segment in a sigmoid curve into a spermatophore receptacle, with which there are associated several gland-like structures, and from which a further duct passes back to the posterior margin of the segment (terminology used according to Wilson, 1905b, p. 528). Further evidence that this specimen is a male is found in the distinct differences in the appendages from those of the female; in particular, in the first antenna and the first maxilliped. Shiino originally recorded *Demoleus latus* from the body surface of

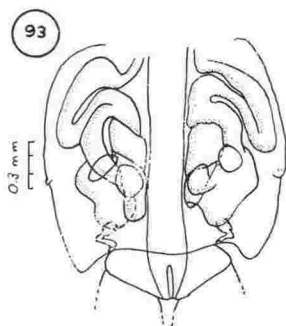


FIG. 93—*Demoleus latus* Shiino, male. Genital segment after clearing in benzyl alcohol.

Deania eglantina taken at Kannoura, Tokushima Prefecture, Japan, at a depth of 200–400 m. This is therefore a new area and host record for this species which, so far as I am aware, has not been recorded since its original description by Professor Shiino.

Genus **Echthrogaleus** Steenstrup and Lütken, 1861

Echthrogaleus coleoptratus (Guérin, 1837)

(Figs 94–101)

Dinematura coleoptrata Guérin, 1837. Pl. 35, fig. 6.

Dinematura alatus Guérin, 1837. Pl. 35, fig. 7.

Pandarus alatus (Milne-Edwards) Johnston, 1835, p. 202, 2 text figs.

Echthrogaleus coleoptratus (Guérin) Steenstrup and Lütken, 1861, p. 380, pl. 8, fig. 15.

MATERIAL: One female collected from the “sides” of *Prionace glauca* (blue shark) at Kaikoura by F. Abernethy on 14 May 1953, in Dominion Museum collection; one female from *Lamna nasus* (porbeagle shark) in Cook Strait by the author on 23 August 1960.

DESCRIPTION

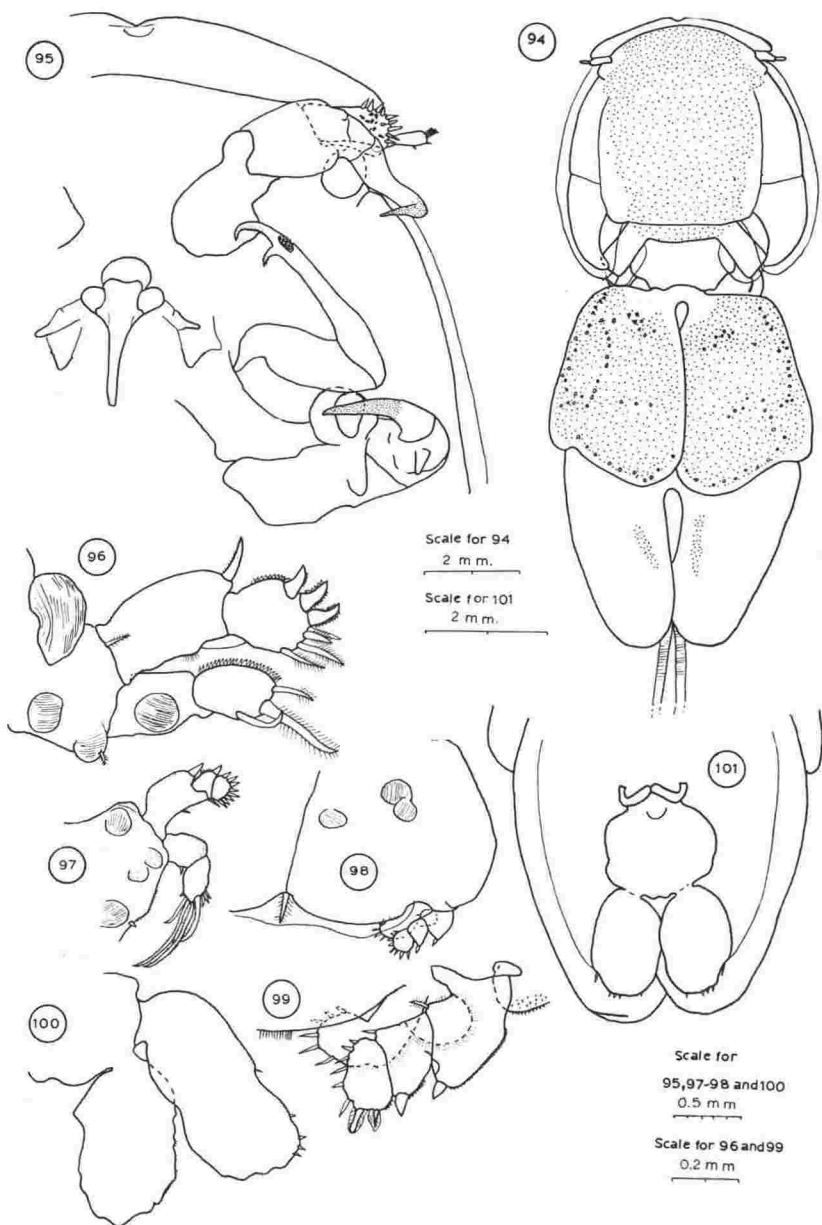
FEMALE only, total length 10.9 mm and 12.6 mm.

CARAPACE as long as wide (4.6 mm and 5.2 mm x 4.6 mm and 5.0 mm); frontal plate four-fifths carapace width, length one-fifteenth width, expanded and rounded laterally, notched medially; median area two-thirds carapace width, bounded laterally by longitudinal ribs which converge slightly anteriorly and terminate at a distance one-quarter length of median area from anterior margin; lateral areas divided medially by a transverse rib, extending posterior to median area for a distance equal to one-fifth length of carapace, bordered laterally by a flange which widens along median part of lateral areas before terminating at junction of median and lateral areas.

SECOND SEGMENT subovate, width six times length (0.4 mm x 2.2 mm and 2.6 mm), has plates directed posterolaterally, which are half as long as segment width, width two-thirds length, somewhat truncated distally, with a wide flange distally and medially.

THIRD SEGMENT subrectangular, width twice length (0.8 mm x 1.7 mm and 2.1 mm), narrowing over the posterior half of its length to two-thirds this width at its posterior margin.

FOURTH SEGMENT including plates, a little wider than long (4.0 mm and 4.2 mm x 5.4 mm and 5.7 mm), incision between plates extending anteriorly for nine-tenths length of segment, plates overlapping posteriorly, with rounded sinus anteriorly; posterior margin of plate expanded medially and to a lesser extent laterally, lateral expansion with very slight denticulation, numerous rounded transparent spots in dorsum of plate.



FIGS 94-101—*Echthrogaleus coleoptratus* (Guérin), female. Fig. 94—dorsal; 95—anterior mouth parts and antennae; 96—first pereiopod; 97—second pereiopod; 98—third pereiopod; 99—rami of third pereiopod further magnified; 100—fourth pereiopod; 101—abdomen and caudal rami.

GENITAL SEGMENT width two-thirds length (5.8 mm and 6.7 mm x 4.7 mm and 4.8 mm), two-thirds of this length being due to long posterolateral processes, each two-fifths width of segment, sinus between them narrow and rounded anteriorly, the processes overlapping posteriorly.

ABDOMEN subrectangular, as wide as long (1.6 mm and 1.8 mm x 1.6 mm and 1.8 mm), angles somewhat rounded; caudal rami carried on posterior margin near posterolateral angles; neither abdomen nor caudal rami visible in dorsal view.

CAUDAL RAMI width two-thirds length (1.5 mm and 1.8 mm x 1.1 mm and 1.2 mm), subovate, with four small spines on posterior margin, three near outer angle and one near inner angle, and a further slightly longer spine on outer margin one-quarter of distance from posterior margin.

FIRST ANTENNA of two segments, second segment twice length of first; first segment, width half length, subrectangular, with nine spines on distal and distal third of outer margins, and about nine small spines on ventral surface near outer distal angle; second segment, width one-third length, with a tuft of setae distally and a further single seta on inner margin one-third of distance from terminal margin.

SECOND ANTENNA of three segments, first segment as long as second and third, width two-thirds length; second segment, width two-thirds length, narrowing somewhat distally and proximally; third segment, width at the base one-fifth length, distal half sharply curved, ending in a sharp point.

MOUTH TUBE 1 mm in length, width at the base two-fifths length narrowing rapidly to be slender for most of length.

SECOND MAXILLA in form of simple spine lying lateral to mouth tube.

FIRST MAXILLIPED of two segments, first segment two-thirds length of second, subrectangular, width one-third length; second segment, width near base one-seventh length, narrowing steadily distally so that distal quarter is in form of a branch which ends in a sharp point distally, the distal two-thirds of which are covered with rows of small spines, a second branch which is two-fifths as long as main branch is also covered with rows of short spines, and there is a thick cluster of spines covering a subovate area just beside smaller branch.

SECOND MAXILLIPED of three segments, segments subequal in length, basal segment subrectangular, width two-fifths length; second segment subovate, inner proximal angle extended and rounded, with a subovate area against which the claw-like third segment closes, second segment also with a heavy spine, one-fifth length of segment, near base of third segment; third segment, width at base one-third length, curved, narrowing rapidly to a sharp point distally.

FIRST PEREIOPOD biramous, each ramus of two segments, endopod four-fifths length of exopod; basipod subrectangular, small, with a raised striated area on anterior margin, two subcircular striated areas near posterior margin, and a short plumose seta near base of exopod; second segment of exopod one-third longer than first; first segment subrectangular, width two-thirds length, outer margin somewhat curved, with a spine with short cilia on inner margin on outer distal angle, and a short row of cilia medially on inner margin; second segment subcircular, a little longer than wide, with a row of cirri on outer margin, three stout spines on outer distal region, the most distal two of these bearing cirri on outer and inner margins, the most proximal of them bearing cirri on outer margin only, a slender spine just distal to the stout spines, and three short plumose setae on the inner distal area of margin; first segment of endopod as long as second, subrectangular, width three-quarters length, with a large circular striated area near midpoint of inner margin; second segment subovate, width two-thirds length, with cirri on outer margin and three setae, the two outermost being plumose, on distal margin.

SECOND PEREIOPOD biramous, exopod of three segments, endopod of two segments; basipod with two subovate striated adhesion pads, one near outer distal angle the other near inner proximal angle, outer distal angle covered in fine spines as are two subovate areas near inner distal angle, inner margin with short spines; second and third segments of exopod subequal in length, together two-thirds length of first segment; first segment subrectangular, width two-thirds length, with a stout spine on somewhat extended outer distal angle, and a slender spine medially on inner margin; second segment subcircular, distal margin sublinear, length three-quarters width, with a stout spine on outer distal angle, a slender seta on inner distal angle, and a row of cirri on outer margin; third segment subcircular, proximal margin sublinear, length three-quarters width, with three spines on outer distal region and five setae on inner distal region; first segment of endopod as long as second, subrectangular, width two-thirds length, with a small seta medially on inner margin; second segment subovate, width half length, with three small setae on outer distal region, four long setae, the outer three with short cirri, on terminal margin, and a very short spine on inner distal angle; all segments of both rami with fine spines on outer margins.

THIRD PEREIOPOD biramous, exopod of three segments, endopod of two segments, endopod as long as first two segments of exopod; basipod large, basipods united to form an apron, have several subovate striated adhesion pads, and small spines in region of rounded outer distal angle; second and third segments of exopod subequal in length, together as long as first segment; first segment as wide as long, outer margin four times length of inner, with a stout spine on outer distal angle, a row of cirri on outer margin, a small plumose seta on inner distal angle, and a short row of cilia on inner margin; second segment subsemicircular, inner and distal margins sublinear, as wide as long, with a stout spine on outer distal angle, a row of cirri on distal half of outer margin, a small seta on inner distal angle; third segment subovate, length two-

thirds width, with two stout spines, each with a margin, on outer distal region, six short setae on terminal margin, and a row of cirri on outer margin; first segment of endopod one-third length of second, subrectangular, as wide as long, with an associated flange, subsemicircular, half length of exopod; second segment curved, width half length, with a row of cilia on outer margin, and seven setae on distal part of outer margin and on distal margin.

FOURTH PEREIOPOD biramous, each ramus of one segment, endopod three-quarters length of exopod; exopod subovate, width two-fifths length, with two groups of very small spines on outer margin, one group medially, one near outer distal region, each with a small spine associated with it, and three small spines on outer distal region; exopod irregularly subovate, width half length, with scattered areas of very small spines on outer margin.

DISCUSSION

These specimens agree very well in most respects with the descriptions given by Yamaguti (1936) and Shiino (1954) for *Echthrogaleus coleoptratus* from the northern Pacific, except that the posterolateral denticulation of the plates on the fourth segment is not as marked as shown in Shiino's figure (p. 294, fig. 2K).

This is a very widely distributed species and previous records include:

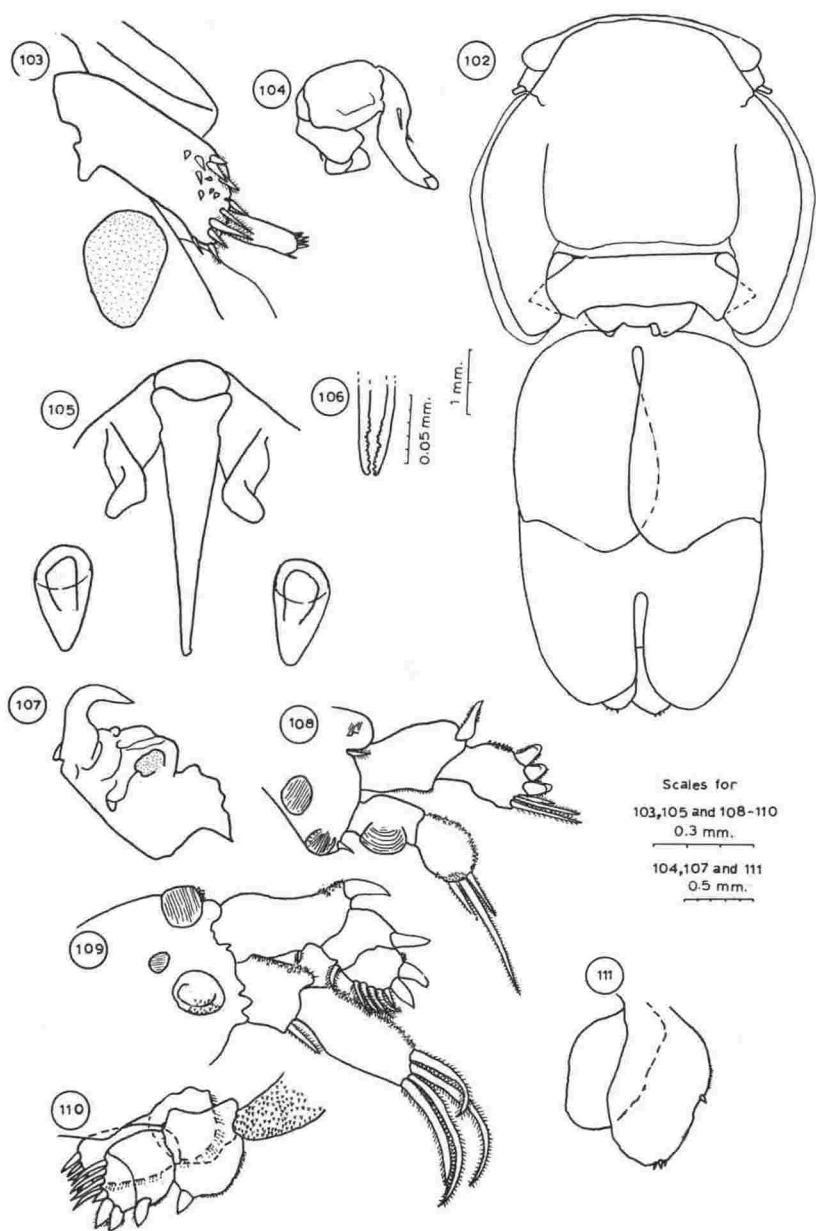
NORTH-EAST ATLANTIC: on *Lamna nasus* (Steenstrup and Lütken, 1861, p. 380); on *Squalus acanthias*, Faroes Is. (Hansen, 1923, p. 36); on *L. nasus* landed at Aberdeen (Scott, T., 1901, p. 125); on *L. nasus*, Berwick Bay (Johnston, 1835, p. 202); on *Squalus acanthias*, Bohusian Coast, Sweden (Olsson, 1868, p. 20); on *Prionace glauca* and *L. nasus*, Polperro, Cornwall (Norman—quoted in Scott, T. and A., 1913, p. 90); on unnamed host, Cornwall (Wilson, 1907, p. 369); on dogfish, east of Fair Is. (Scott, T., 1901, p. 125); on *Squalus* sp., Atlantic (probably N.E.) (unknown source quoted by Olsson, 1868, p. 20).

MEDITERRANEAN: on *Prionace glauca*, Sète, France (Deboutteville and Nunes-Ruivo, 1953, p. 204); on *Centrophorus granulosus*, Genoa, and on *Carcharodon carcharias*, Portoferraio (Brian, 1906, pp. 53-4).

NORTH-WEST ATLANTIC: on *Isurus oxyrinchus*, Woods Hole, Mass. (Wilson, 1907, p. 369), and on *Carcharhinus milberti* (Wilson, 1932, p. 427).

SOUTH ATLANTIC: on a shark, Mar del Plata (Brian, 1944, p. 202); on *Prionace glauca*, False Bay, Sth. Africa (Barnard, 1955, p. 264); on *Orthogoriscus mola*, Table Bay, Sth. Africa (Stebbing, 1910, p. 559—a doubtful record—see Barnard, 1955, p. 264).

NORTH-EAST PACIFIC: on unnamed shark, Unalaska, Alaska (Wilson, 1907, p. 369).



FIGS 102-111—*Echthrogaleus braccatus* (Dana), female. Fig. 102—dorsal; 103—first antenna; 104—second antenna; 105—mouth tube and second maxillae; 106—mandibles; 107—second maxilliped; 108—first pereopod; 109—second pereopod; 110—third pereopod; 111—fourth pereopod.

NORTH-WEST PACIFIC: on *Prionace glauca* (Yamaguti, 1936, p. 7); on *Isurus glaucus*, landed at Owase market, Mie Prefecture, Japan (Shiino, 1954, p. 291), Kesennuma, Miyagi Prefecture, Japan (Shiino, 1957, p. 364).

SOUTH-EAST PACIFIC: on *Prionace glauca*, Valparaiso (Stuardo and Fagetti, 1961, p. 78); on *Squalus* sp., Marianas Is. (unknown source quoted by Olsson, 1868, p. 20).

SOUTH-WEST PACIFIC: on *Prionace glauca*, Cape Catastrophe, South Australia (Heegaard, 1962, p. 177).

INDIAN OCEAN: on dogfish (Milne-Edwards, 1840, p. 464); on an unnamed host, Durban, South Africa (Wilson, 1923, p. 13).

Although *E. coleoptratus* has been recorded from many places it has not been recorded as being common in any of them. This may be a reflection of the rarity of collections rather than the result of a low level of infection among the hosts.

Echthrogaleus braccatus (Dana, 1853) (Figs 102–111)

Dinematura braccata Dana, 1853, pp. 1370–1, pl. 95, figs 4a–b.

Echthrogaleus braccatus (Dana). Heller, 1865, pp. 197–9, pl. 20, figs 3, 3a–3f.

Echthrogaleus braccatus (Dana). Thomson, 1889, pp. 361–2.

MATERIAL: Five females and three males in damaged condition, from a large shark taken at Napier, collected by Mr A. Hamilton, labelled "Dep. G.M.T., 1910", from the Otago Museum, presumably deposited by Professor G. M. Thomson. The specimens appear to have been dried out at least once and are in very poor condition. Specimens were mounted in polyvynl alcohol M.A.2.

DESCRIPTION

FEMALE, overall length 9.0 mm–9.7 mm.

CARAPACE longer than wide (4.2 mm–5.3 mm x 3.8 mm–4.5 mm), frontal plate two-thirds carapace width, maximum length one-fifth width, narrowing to one-fifth this length medially, lateral margins rounded; median area three-fifths carapace width, bordered laterally by longitudinal ribs for the posterior half of its length, ribs converging slightly anteriorly; lateral areas projecting posteriorly beyond median area for a distance equal to one-third carapace length, bordered laterally by a flange.

SECOND SEGMENT subrectangular, width four times length (0.5 mm–0.7 mm x 1.9 mm–2.4 mm), has posterolaterally directed plates on the lateral margins, the plates being as wide as carapace length and as long as wide, squarely truncated distally.

THIRD SEGMENT clearly separate from second segment, width twice length (0.8 mm–0.9 mm x 1.6 mm–2.1 mm) articulating with fourth segment over median quarter of posterior margin, posterior margin lateral to this attachment united with lateral margins in entire curves.

FOURTH SEGMENT, including plates, a little wider than long (2.9 mm–3.3 mm x 3.5 mm–4.0 mm), plates separated by a deep sinus extending nearly to anterior margin of segment, sinus between them narrow anteriorly, plates overlapping over posterior three-quarters of their length, posterior margin expanded posteriorly medially and with a further small posterior expansion laterally.

GENITAL SEGMENT, width three-quarters length (4.5 mm–5.0 mm x 3.4 mm–3.7 mm), posterior processes constituting one-third length of segment, with a narrow sinus between them, posterior processes overlapping slightly in some specimens.

ABDOMEN subrectangular, wider than long (0.9 mm–1.2 mm x 1.1 mm–1.3 mm), bearing caudal rami on posterior margin.

CAUDAL RAMI, width two-thirds length (1.1 mm–1.2 mm x 0.7 mm–0.8 mm), inner margin sublinear, lateral and posterior margins forming an entire curve, with four small spines on posterior margin, three near inner posterior angle, one near outer posterior angle. The posterior parts of the caudal rami are clearly visible in dorsal view.

FIRST ANTENNA of two segments, second segment two-fifths length of first; first segment subrectangular, width one-third length, with about nine plumose setae on outer distal angle and distal margin, and about nine small spines on ventral surface in region of outer distal angle; second segment, width one-third length, distal margin rounded, with a group of about seven small setae on outer distal region and a single seta on inner distal angle.

Immediately posterior to first antenna is a large adhesion pad, subovate, slightly wider anteriorly than posteriorly, half as long as first segment of first antenna, width two-thirds length.

MOUTH TUBE 0.9 mm in length, width at the base one-quarter length, narrowing steadily distally.

SECOND MAXILLA near base of mouth tube, in form of a roughly rounded projection which may, however, be a sharp spine which has the point broken off.

There are two very stout spines borne on the ventral surface of the carapace lateral to the tip of the mouth tube, each two-fifths as long as the mouth tube, width at the base half length, ending in a dull point.

FIRST MAXILLIPED severely damaged in all specimens, but apparently of the usual two-segmented form, the distal segment being two branched and probably with an accessory spine near base of smaller branch.

SECOND MAXILLIPED of three segments; basal segment as long as second, two-thirds length of third, as wide as long; second segment a little wider than long at the base, narrowing to half this width distally, with a stout spinous projection posteriorly near base, and a

rounded area against which the third segment closes on ventral surface near base; third segment a sharply curved claw, width at the base two-fifths length, narrowing gradually distally to a sharp point, segment sharply curved, and with a stout spine posteriorly near its base.

FIRST PEREIOPOD biramous, each ramus of two segments, endopod three-quarters length of exopod; basipod small with three striated adhesion pads, one anterior and two near posterior margin, with a small plumose seta near base of exopod and a small seta near base of endopod; first segment of exopod slightly longer than second, subrectangular, with a stout spine fringed with cirri on expanded outer distal angle, and a row of short cilia on distal two-thirds of inner margin; second segment subovate, width two-thirds length, with three stout spines fringed with cirri on outer distal region, one short and two long plumose setae with short cilia on inner distal region, and a group of spines on outer margin; first segment of endopod subequal in length to second, subrectangular, width two-thirds length, with a subcircular striated area on inner margin; second segment subovate, width two-thirds length, with two short plumose setae on either side of a long plumose seta, outer margin covered with very short spines, and a further group of very short spines on inner distal region.

SECOND PEREIOPOD biramous, exopod of three segments, endopod of two segments, rami subequal in length; basipod with two semicircular striated regions, one near outer distal angle, one medial and a further circular area partly covered with spines near inner distal angle; third segment of exopod as long as second, both one-third length of first; first segment subrectangular, width two-fifths lengths, with a large spine on slightly extended outer distal angle, a very short plumose seta on inner margin one-third of distance from inner distal angle, and a group of very small spines on outer margin near base of spine; second segment subrectangular, outer margin curved, length three-quarters width, with a stout spine on outer distal angle and a small plumose seta on inner distal angle; third segment subsemicircular, length three-quarters width, proximal margin sublinear, with two stout spines on outer distal region, a small group of very small spines just proximal to these, and five short plumose setae on inner distal region; first segment of endopod subrectangular, half length of second, a little longer than wide, bearing a short plumose seta on inner distal angle, outer margin lined with very short spines; second segment subrectangular, length twice width, with four long plumose setae distally, outer margin covered with very short spines.

THIRD PEREIOPOD biramous, exopod of three segments, endopod of two segments, exopod and endopod subequal in length; basipods enlarged and united to form an apron, with many very small spines on outer distal region; first segment of exopod as long as second and third together, second and third subequal in length; first segment subrectangular, as long as wide, with a stout spine on outer distal angle and a row of short cilia on outer margin; second segment subsemicircular, distal margin a concave curve, as wide as long, with a stout

fringed spine on outer distal angle and a row of short cilia on outer margin; third segment subovate, inner region narrowing to a point, with two stout fringed spines on outer distal region, a smaller spine just medial to these, and four non-plumose setae on inner distal region; first segment of endopod half length of second, subrectangular, as wide as long, associated with a broad semicircular flange fringed with cilia which is two-thirds length of second segment; second segment subrectangular, length twice width, with cilia on outer margin and four setae on distal margin.

FOURTH PEREIOPOD biramous, each ramus of one segment, endopod three-quarters length of exopod; exopod subovate, width two-thirds length, with three small spines on outer distal region, one small spine half way along outer margin, a group of very small spines between the three spines and the single spine, and further very small spines proximal to the single spine; endopod subovate, width two-thirds length, with a row of very short spines on distal half to third of outer margin.

MALE. The males were too badly damaged for useful description.

DISCUSSION

This species was originally described by Dana (1853) from Tongatabu on the body of an unnamed shark. The present specimens agree with Dana's figures and description. It was recorded again by Heller (1865) at Auckland on an unnamed shark. Heller described and figured the male, and the damaged specimens in the present collection do not differ, so far as can be seen, from his description.

Bassett-Smith (1899, pp. 460 and 464) suggested that Dana's female was *Echthrogaleus affinis* (Milne-Edwards, 1840), and he called Heller's male *Nogagus braccatus* (Heller). However, Wilson (1907, pp. 366-7) agreed with Dana that the difference in the shape of the lateral plates on the second thoracic segment, the size and position of the caudal rami, the relative size of the carapace and genital segment, and the size and shape of the third thoracic segment, clearly separated the species from *Echthrogaleus affinis*. The present specimens support Wilson's contention. Wilson goes on to suggest that the species is much more similar to *Echthrogaleus coleoptratus* and might be a young female of this species. However, in the present specimens the caudal rami are clearly visible in dorsal view, there is no overlapping of the posterior processes of the genital segment, and there are no transparent spots on the dorsal plates of the fourth segment. These differences from *Echthrogaleus coleoptratus* seem sufficient to allow Dana's species to stand since several of the females have egg strings and are clearly adults.

This species has been recorded so far only from a small area of the Pacific. It seems likely that it has a restricted distribution and

may be rare even within this restricted range. It is unfortunate that the host shark has not been identified in any of the three collections so far made.

Genus *Phyllothyreus* Norman, 1903

Phyllothyreus cornutus (Milne-Edwards, 1840) (Figs 112–122)

- Phyllophora cornuta* Milne-Edwards, 1840, p. 472, pl. 38, figs 13–14.
Nogagus grandis Steenstrup and Lütken, 1861, p. 386, pl. 10, fig. 19.
Phyllophorus crassus Richiardi, 1880, p. 148.
Phyllophora crassa Richiardi. Carus, 1885, p. 361.
Phyllophorus cornutus Milne-Edwards. Bassett-Smith, 1899, p. 465.
Laminifera cornuta (Milne-Edwards) Poche, 1902, p. 8 (*Fide* Wilson 1907, p. 361) *non vid.*
Phyllothyreus cornutus (Milne-Edwards). Norman, 1903, pp. 368–9.
Phyllophora crassa Richiardi. Brian 1906, pp. 55, 128, 178, 182.
Phyllothyreus cornutus (Milne-Edwards). Norman and Scott 1906, p. 212, pl. 24, figs 9–17.
Laminifera cornuta (Milne-Edwards). Wilson 1907, p. 361.
Phyllothyreus cornutus (Milne-Edwards). Scott and Scott, 1913, pp. 92–4, pl. 19, figs 11–18, and pl. 23, fig. 3.
Parapandarus nodosus Wilson, 1924, pp. 8–11, pl. 2, figs 19–24, and pl. 3, figs 25–34.
Parapandarus nodosus Wilson. Wilson, 1932, pp. 440–1, fig. 277.
Laminifera cornuta (Milne-Edwards). Leigh-Sharpe, 1933, p. 109.
Phyllothyreus cornutus (Milne-Edwards). Monod and Dollfus, 1938, p. 196, figs 1–15.
Phyllothyreus nodosus (Wilson). Monod and Dollfus, 1938, p. 202.
Laminifera doello-juradoi Brian, 1944, p. 205, pl. 4, figs 30–37, pl. 5, figs 38–39.
Phyllothyreus cornutus (Milne-Edwards). Brian, 1946, p. 142.
Phyllothyreus cornutus (Milne-Edwards). Lewis, 1966, pp. 96–102, figs 17–19.

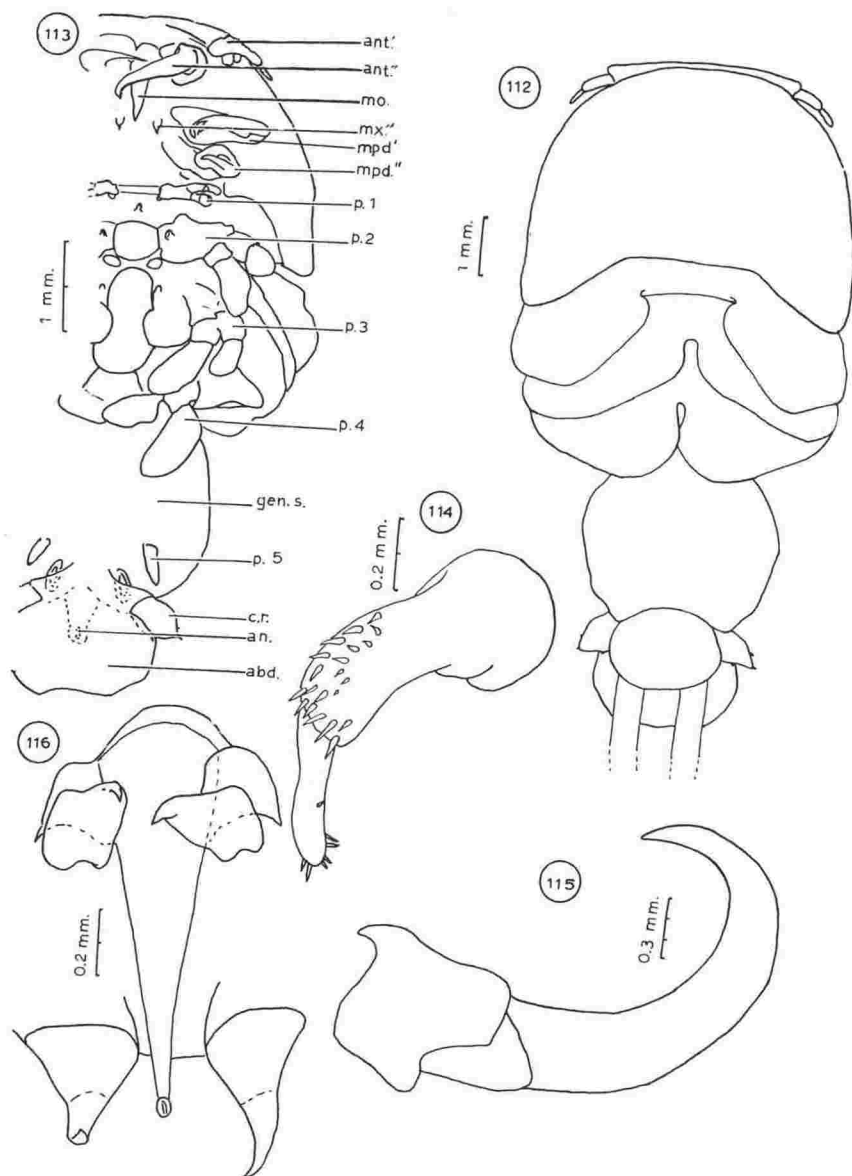
MATERIAL: Two female specimens on *Isurus oxyrinchus* taken at Makara by Professor J. A. F. Garrick on 29 June 1955; three females taken on *Isurus oxyrinchus* at Mernoo Bank by the Fisheries Laboratory, Marine Department, on 30 November 1964. In each case the sharks were heavily infested with other species of parasitic copepod as well.

DESCRIPTION

FEMALE only, overall length 10.7 mm–12.5 mm.

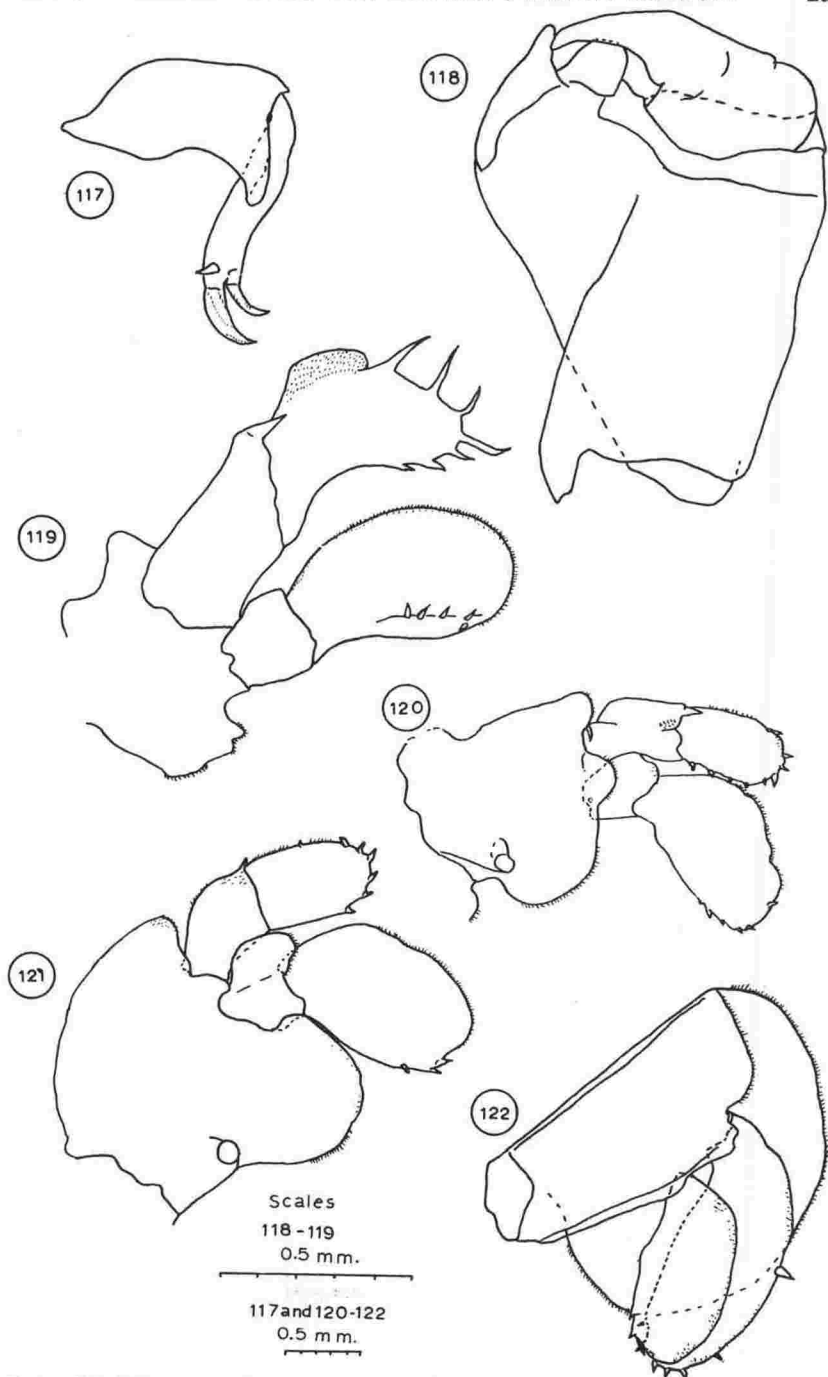
CARAPACE wider than long (4.8 mm–5.4 mm x 5.6 mm–6.1 mm); frontal plate three-fifths carapace width, very short; median and lateral areas completely fused, lateral and anterior margins of carapace forming an entire curve, median two-fifths of posterior margin of carapace sublinear, posterolateral margins extended posteriorly for a distance equal to one-quarter carapace length, angles rounded.

SECOND SEGMENT short (0.6 mm–0.9 mm), size increased to width twice length by large subrectangular plates, with rounded angles, which extend posteriorly from posterolateral part of segment, size including plates 2.2 mm–3.4 mm x 5.7 mm–6.8 mm.



FIGS 112-116—*Phyllothyreus cornutus* (Milne-Edwards), female. Fig. 112—dorsal; 113—ventral; 114—first antenna; 115—second antenna; 116—mouth tube and second maxillae.

Abbreviations: abd—abdomen; an—anus; ant'—first antenna; ant''—second antenna; c.r.—caudal rami; gen. seg.—genital segment; mo—mouth tube; mpd'—first maxilliped; mpd''—second maxilliped; mx''—second maxilla; p.1-5—pereopods one to five.



FIGS 117-122—*Phyllothyreus cornutus* (Milne-Edwards), female. Fig 117—first maxilliped; 118—second maxilliped; 119—first pereopod; 120—second pereopod; 121—third pereopod; 122—fourth pereopod.

THIRD SEGMENT short (0.5 mm–0.7 mm), size increased to width twice length by plates which extend posteriorly from posterolateral part of segment, plates three times as long laterally as medially, with a narrow sinus between them which is rounded anteriorly, size including plates 2.1 mm–2.8 mm x 5.2 mm–6.3 mm.

FOURTH SEGMENT short (1.3 mm), size increased considerably by plates which extend posteriorly from lateral part of posterior margin, plates twice as long medially as laterally, angles broadly rounded, a narrow sinus between the two plates rounded anteriorly, plates overlapping somewhat posteriorly in some specimens, just touching in others, size including plates 2.6 mm–2.8 mm x 4.6 mm–5.5 mm.

GENITAL SEGMENT subovate, as wide as long or wider (3.4 mm–4.1 mm x 4.0 mm–4.1 mm), lateral margins entire curves, posterior margin concave, angle made by posterior and lateral margins produced slightly and rounded.

ANAL PLATE subovate, length three-quarters width (1.5 mm–1.8 mm x 2.0–2.5 mm).

ABDOMEN, width twice length (0.9 mm–1.5 mm x 2.2 mm–2.4 mm), attached to genital segment by a narrowed area two-thirds maximum width, one-fifth total length, which bears the caudal rami laterally, wider posterior part subovate.

CAUDAL RAMI, width two-fifths length (1.0 mm x 0.4 mm), subrectangular, narrowing rapidly over the distal third to a rounded angle which bears a very small spine, inner and outer margins also carrying very small spines.

FIRST ANTENNA of two segments, first segment twice length of second, subrectangular, length three times width, with about 21 setae of various sizes on distal half of outer margin and distal margin; second segment width one-fifth length, with about six setae distally and a further very small seta on inner margin two-fifths of distance from distal margin.

SECOND ANTENNA of three segments, first segment as long again as second, one-third length of third, subrectangular, width three-quarters length; second segment subtriangular, a little longer than wide, inner margin much shorter than outer; third segment width at the base one-fifth length, narrowing steadily to a sharp point distally, strongly curved.

MOUTH TUBE 1.2 mm in length, width at the base one-third length, narrowing steadily distally.

SECOND MAXILLA, lateral to mouth tube, in form of a short spine on a stout base, together being two-sevenths length of mouth tube, width two-thirds length, spine-like distal portion being one-quarter total length.

There are two stout spines each ending in a sharp point just lateral to tip of mouth tube, two-fifths length of mouth tube, two-thirds as wide at the base as long, slightly curved distally.

FIRST MAXILLIPED of two segments, first segment a little shorter than second, subrectangular, width half length, inner distal angle somewhat extended; second segment, width one-seventh length, distal third a stout branch covered with rows of fine spines and ending in a sharp point, with a further branch, two-thirds this length and similarly armed, just proximal to it, and a short stout spine just proximal to the base of the stouter branch.

SECOND MAXILLIPED of three segments, first segment a stout base; second segment width at the base half length, inner distal angle expanded to increase this width by one-third, this angle bearing two projections between which the claw-like third segment closes; third segment four-fifths length of second, width at the base two-thirds length, curved sharply medially one-quarter distance from base, then narrowing rapidly to a sharp point distally and curving slightly.

FIRST PEREIOPOD biramous, each ramus of two segments, endopod a little shorter than exopod; basipod with two rows of short spines on posterior margin; first segment of exopod as long as second, subrectangular, length twice width, outer margin twice length of inner, outer distal angle has a sharp spine; second segment subovate, proximal margin sublinear, width two-thirds length, outer margin somewhat expanded and with rows of short spines, rounded distal margin with seven spines; first segment of endopod two-fifths length of second, subrectangular, a little longer than wide; second segment subovate, proximal margin sublinear, width half length, with rows of short spines on outer and distal margins, and five small spines near distal half of inner margin.

SECOND PEREIOPOD biramous, each ramus of two segments, exopod a little shorter than endopod; basipod with rows of short spines on expanded posterior margin and on two expansions of distal margin, and a short seta near outer proximal angle of exopod; first segment of exopod as long as second, subrectangular, width two-thirds length, outer margin somewhat expanded from near base, with a spine on outer distal angle, and a patch of small spines on inner part of expanded outer distal angle; second segment subovate, width two-thirds length, with a row of very short spines on outer margin and nine spines on distal and inner margins, a group of very short spines between the two spines nearest outer distal angle; first segment of endopod two-fifths length of second, subrectangular, with a group of very short spines on rounded outer distal angle; second segment subovate, width two-thirds length, with a row of very short spines on distal two-thirds of outer margin and five short spines on distal margin and distal third of inner margin.

THIRD PEREIOPOD biramous, each ramus of two segments, endopod a little longer than exopod; basipod length two-thirds width, with a rounded attachment pad near inner margin, a group of spines on rounded outer distal angle, and a row of very short spines on rounded inner distal angle; first segment of exopod four-fifths length of second, subrectangular, outer margin slightly expanded and with a row of very

short spines, width two-thirds length, a spine on outer distal angle, with a group of very short spines around its base; second segment subovate, proximal margin sublinear, width two-thirds length, with a row of very short spines on outer margin, a short spine medially on this margin, and six short spines on rounded distal angle; first segment of endopod half length of second, subrectangular, as wide as long, outer distal angle expanded to be one-third total length, inner part of this angle has a row of very short spines; second segment subovate, width two-thirds length, with a row of very short spines on distal three-fifths of outer margin, and three short spines on inner distal angle.

FOURTH PEREIOPOD biramous, each ramus of one segment; basipod subrectangular, length twice width, outer margin with a subsemicircular flange with a diameter twice width of basipod, extending posteriorly and fringed with very small spines, as is distal margin of basipod, rami borne near inner distal angle; exopod subovate, width two-fifths length, with a spine on midpoint of outer margin, groups of very small spines on outer margin, and six small spines on rounded distal angle; endopod two-thirds length of exopod, subovate, width half length, with groups of very small spines near outer margin, and three spines on inner distal angle.

DISCUSSION

So far as I am aware this is only the ninth locality record for *Phyllothyreus cornutus*. It is, therefore, probably a rare species since other species of parasitic copepods are frequently recorded from the same hosts. Despite the few records of this species it has been discussed by many authors and has been known by at least eleven different names or name combinations. All but two of these have previously been synonymised. The two remaining names are *Phyllothyreus cornutus* (Milne-Edwards) and *P. nodosus* (Wilson). Monod and Dollfus have defined the differences between the two species and expressed doubts as to their distinctness. The differences which they enumerate are: in the female, the degree of development of the dorsal plates of the third segment, the extent to which these plates overlap and the degree of concavity of the posterior border of the carapace (the first two characters they state to be variable); in the male, the armament of the legs. These characteristics have proved to be variable in other species of the genus and I feel that the material described under these two names can safely be regarded as the same species.

Although this species has not been recorded frequently its distribution is none the less wide. Previous records are:

NORTH-EAST ATLANTIC: on *Prionace glauca* at Polperro, Cornwall (Norman, 1903, pp. 368-9); on *Prionace glauca*, *Isurus oxyrinchus* and *Lamna nasus* at Concarneau (Monod and Dollfus, 1938, p. 196); on an unnamed host in warmer parts of North Atlantic (Steenstrup and Lütken, 1861, pp. 386-7).

MEDITERRANEAN: on *Prionace glauca* at Italy (Richiardi, 1880, p. 148).

SOUTH ATLANTIC: on *Lamna nasus* at Mar del Plata (Brian, 1944, p. 205).

NORTH-WEST PACIFIC: on *Sphyrna zygaena*, *Prionace glauca*, *Carcharhinus milberti* at Woods Hole (Wilson, 1924, pp. 8–11, 1932, pp. 440–1).

NORTH PACIFIC: on *Prionace glauca* at 40° 15' north, 170° 16' west (Lewis, 1966, pp. 96–7).

SOUTH PACIFIC: on unnamed host at Tongatabu (Milne-Edwards, 1840, p. 471).

Genus *Pandarus* Leach, 1816

Pandarus bicolor Leach, 1816

(Figs 123–40)

Pandarus bicolor Leach, 1816, p. 405, pl. 20, 2 figs.

Pandarus boscii Leach, 1816, p. 406, pl. 20, 10 figs.

Caligus bicolor (Leach). Lamarck, 1818, p. 142.

Pandarus fissifrons Milne-Edwards, 1840 (?), p. 470.

Nogagus augustatus Gerstaecker, 1854, p. 193, pl. 7, fig. 17.

Nogagus augustatus Gerstaecker, van Beneden 1892b, pp. 245–9, pl. 1, figs 5–10.

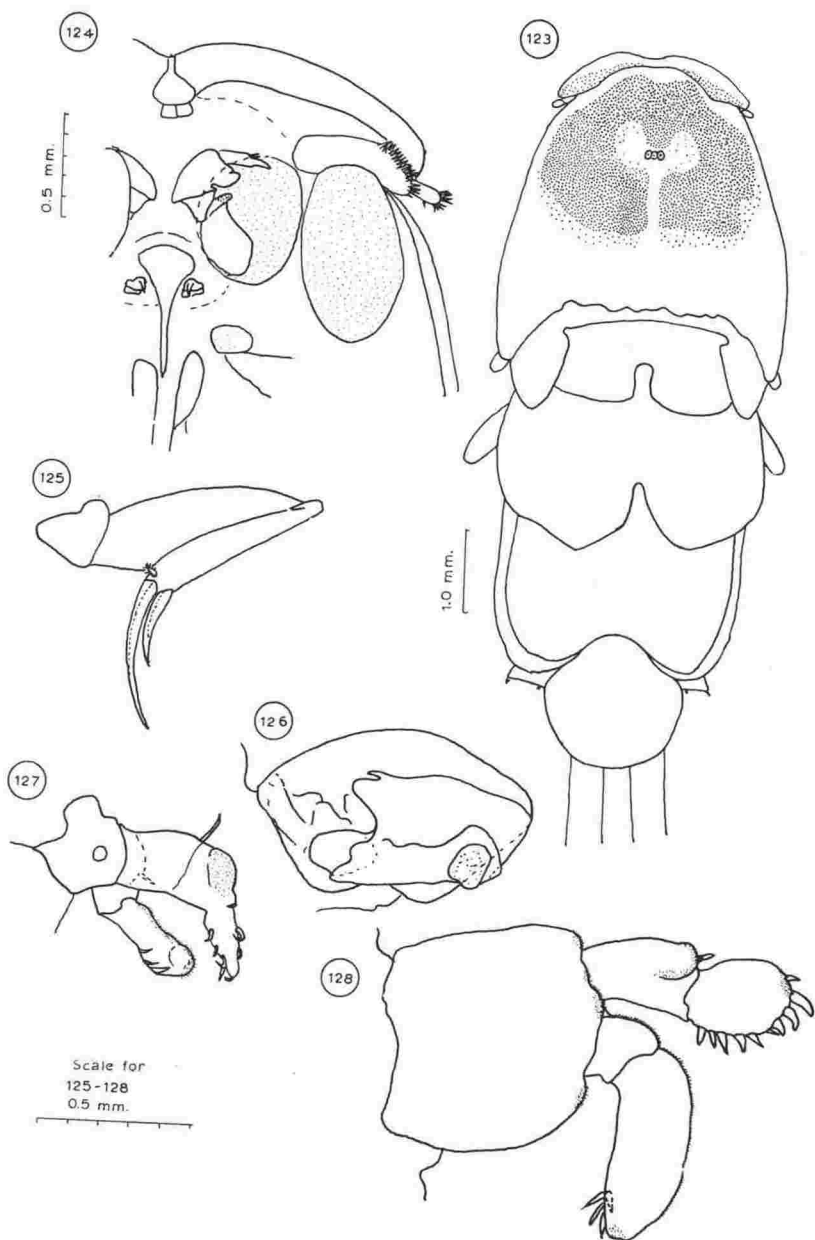
Pandarus bicolor Leach. Scott, T., 1900, p. 157, pl. 6, figs 33–8.

Pandarus bicolor Leach. Wilson, 1907, p. 400, pl. 27.

Nogagus latus Scott, T., 1907, p. 216, pl. 15, figs 1–9.

Pandarus bicolor Leach. Scott, T and A., 1912, p. 95, pl. 21, fig. 2, pl. 22, figs 5–6, pl. 26, figs 4–19, pl. 58, figs 1–8.

MATERIAL: Two lots of one female on *Squalus acanthias* at Oamaru collected by the author on 4 February 1965, one female and one male collected on *S. acanthias* at Oamaru by the author on 4 February 1965, one female and one male on *Notorhynchus pectorosus* at Oamaru collected by the author on 4 February 1965, five females and one juvenile female on *Galeorhinus australis* at Oamaru collected by J. Graham on October 1962; two males on grey shark at Karitane collected by Dr E. J. Batham on 27 February 1944; four females and two juvenile females on *S. acanthias* at Kaikoura collected by Mr M. Mannering (forwarded by Dr J. Grieve) on 14 April 1964; two females on *Cyprilum* sp. in Cook Strait collected by Mr R. Greco on 2 May 1956, Dominion Museum collection (Number 1927); one female on *S. acanthias* in Cook Strait collected by the author on 22 February 1961; two females on *G. australis* in Cook Strait by the author on 22 February 1963; one female on *G. australis* at Palliser Bay collected by the Oceanographic Institute on 8 November 1959; six females on *S. acanthias* at Palliser Bay by the author on 12 May 1966; on *G. australis* collected at Palliser Bay by the author on 18 June 1966: one adult female and one juvenile female; two adult females; one adult female and one juvenile female; two adult females, two juvenile females and one adult male respectively; three females on *G. australis* at Cape Turakirae by the author on 9 April 1960; 11 females on *G. australis* (?) at Makara by Mr Paterson, no date; one female and one male on *N. pectorosus* off Raumati Beach collected by Mr L. J. Paul on 13 April 1966; 10 females on "small shark" taken west of Cape Brett by the Fisheries Laboratory, Marine Department, in February 1962;



FIGS 123-128—*Pandarus bicolor* Leach, female. Fig. 123—dorsal; 124—antennae and anterior mouth parts; 125—first maxilliped; 126—second maxilliped; 127—first pereopod; 128—second pereopod.

16 females on "shark" from unnamed area, presumably New Zealand waters, collected by Mr Erecson in 1891 (deposited by G. M. Thompson, 1910, in the Otago Museum). The site of infestation, where recorded, is given either as the body surface or fins.

DESCRIPTION

FEMALE (Figs. 123–131), overall length 8.1 mm–8.8 mm.

CARAPACE a little longer than wide (3.7 mm–4.1 mm x 3.5 mm–3.8 mm); frontal plate three-fifths carapace width, length one-eighth width shortened to half this length medially, rounded laterally, somewhat curved; remainder of carapace with anterior and lateral margins united in entire curves, posterior margin irregular in adult specimens, but in the form of about 10 subsemioval posterior projections in young specimens, posterolateral angles extended posteriorly to a length equal to one-quarter total length of carapace, posteriorly rounded.

SECOND SEGMENT subrectangular, width seven times length (0.3 mm–0.5 mm x 2.0 mm–2.4 mm), with large posterolaterally directed plates from the lateral margins which increase the width by one-third and extend posteriorly for a distance equal to five times length of segment, rounded distally.

THIRD SEGMENT subrectangular, much wider than long (0.3 mm–0.6 mm x 1.6 mm–2.0 mm), bearing posterolateral plates which increase the width of the segment by one-quarter and extend posteriorly for a distance equal to three times length of segment, with a narrow sinus between the plates, which is rounded anteriorly.

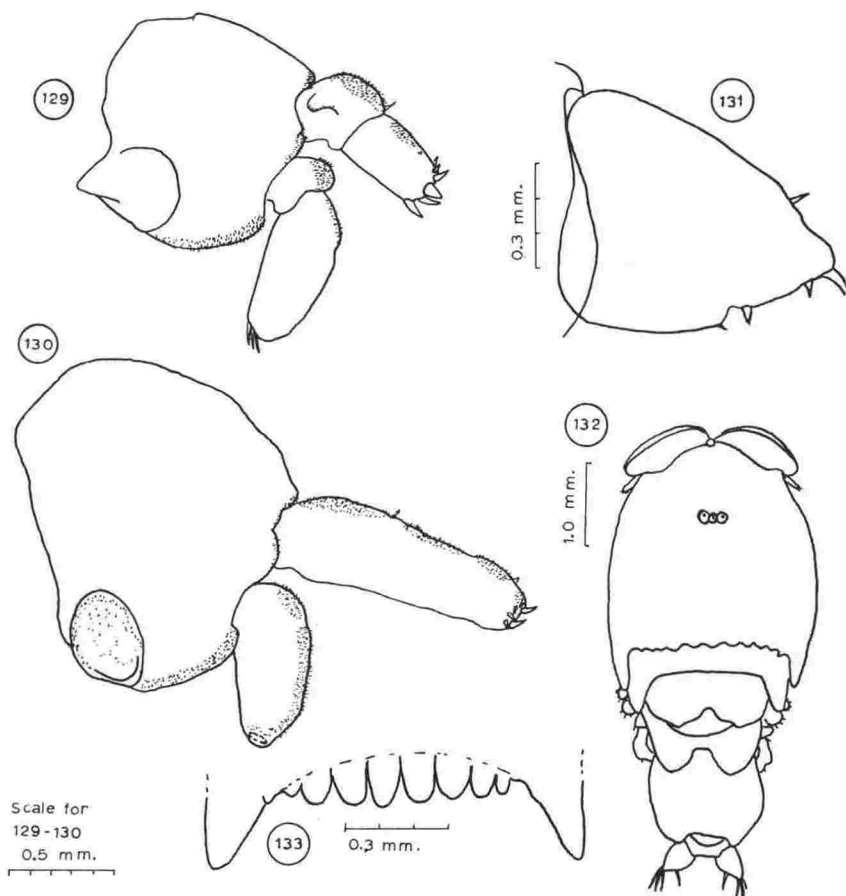
FOURTH SEGMENT, including plates, length two-thirds width (1.9 mm–2.4 mm x 2.9 mm–3.3 mm), incision between plates extending anteriorly for a distance equal to one-third length of segment, incision subrectangular, rounded anteriorly.

GENITAL SEGMENT as wide as long (2.6 mm–3.2 mm x 2.7 mm–3.3 mm), subrectangular, posterolateral angles rounded, posterolateral processes constituting one-eighth total length of segment.

ANAL PLATE subcircular, as wide as long (1.2 mm–1.6 mm x 1.2 mm–1.6 mm).

ABDOMEN subovate, a little wider than long (1.0 mm–1.2 mm x 1.2 mm–1.5 mm), caudal rami borne laterally.

CAUDAL RAMI subtriangular, a little longer than the basal width, angles rounded, with a spine distally and a further spine on outer margin one-quarter distance from distal angle, a further spine on inner margin equidistant from distal angle, and two further spines on inner margin, one near distal angle, the other very small and borne just proximal to former spine on inner margin.



FIGS 129-133—*Pandarus bicolor* Leach, female. Fig. 129—third pereiopod; 130—fourth pereiopod; 131—caudal ramus; 132—juvenile female, dorsal; 133—posterior margin of carapace in an even younger female.

FIRST ANTENNA of two segments, second segment two-fifths length of first; first segment, width one-third length, with about 20 setae on rounded outer distal angle; second segment, width one-third length, with about 10 setae distally and a further seta on inner margin one-third of distance from rounded distal margin.

Immediately posterior to first antenna is a large adhesion pad, subovate, four-fifths as wide as first segment of first antenna is long, length twice width.

SECOND ANTENNA of three segments, first segment as long as other two together, a large base, width half length; second segment, as long as third, as wide as long as a result of expansion of inner margin to

constitute one-third of width; third segment, width one-quarter length, narrowing to half this width one-third of distance from distal end, with a small spine at this point, distal third narrowing slightly to a point.

Partly overlying the second antenna is a large subovate adhesion pad, as wide as that immediately behind the first antenna, one-quarter longer than wide.

MOUTH TUBE 0.7 mm in length, width at the base two-fifths length, narrowing rapidly so that distal two-thirds is very slender.

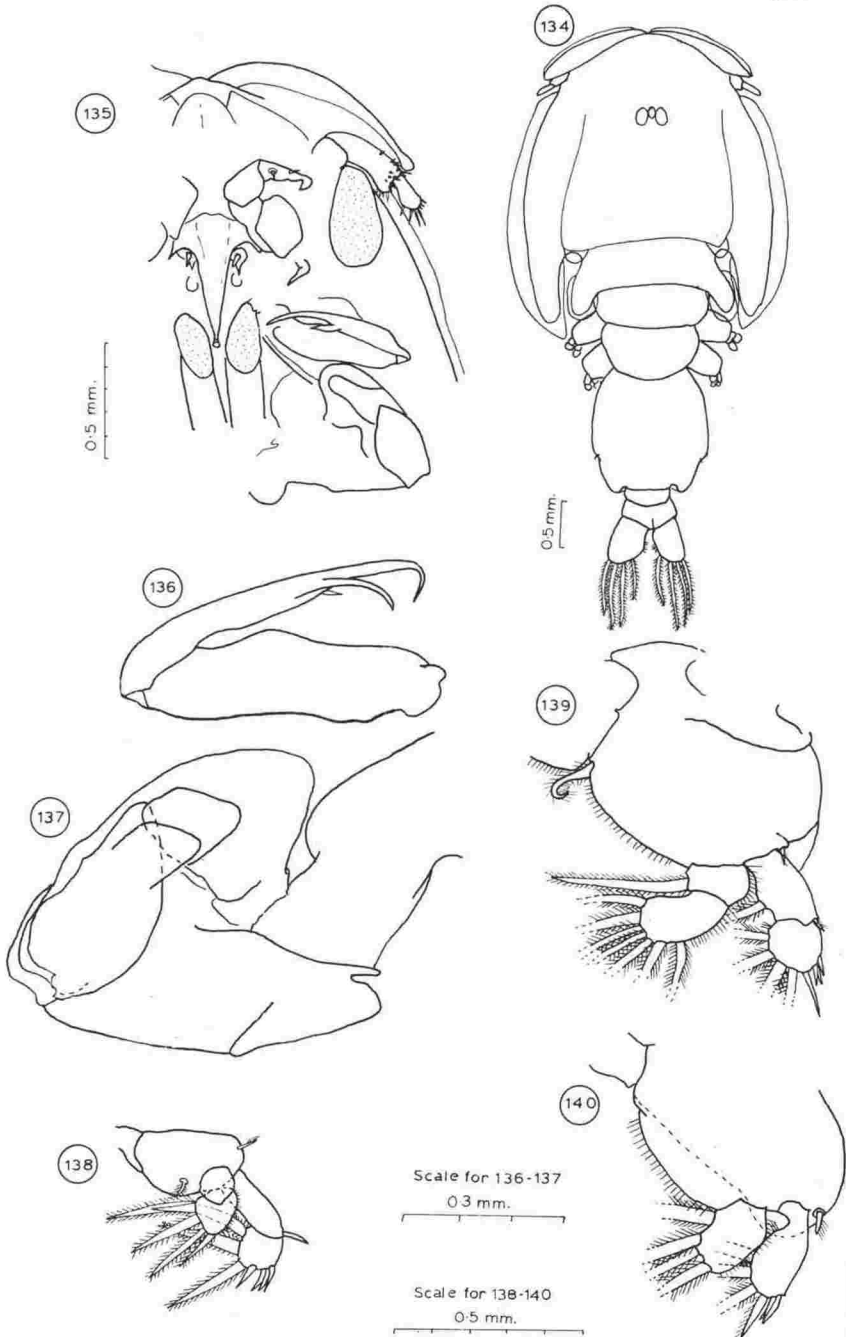
SECOND MAXILLA situated near base of mouth tube, in form of a small curved spinous projection from a subrectangular base.

FIRST MAXILLIPED of two segments, first segment three-quarters length of second, median width two-sevenths length, somewhat narrowed proximally and distally; second segment, width one-tenth length, major branch constituting two-fifths length of segment, a smaller branch half length of major branch, both with longitudinal rows of very small spines, segment also has a small plumose seta near base of major branch.

SECOND MAXILLIPED of three segments, first segment a solid base on which second segment rests; second segment, width half length, with a roughened area medially against which the third segment closes; third segment two-thirds length of second, width two-thirds length, a stout blunt claw.

FIRST PEREIOPOD biramous, each ramus of two segments, segments of exopod indistinctly divided; endopod two-thirds length of exopod; basipod small; first segment of exopod subrectangular, two-thirds length of second, a little longer than wide, with a long spine on outer distal angle; second segment, width at the base half length, narrowing distally to one-quarter this width, distal margin rounded, segment curving medially at a sharp angle one-third distance from base, with a subovate raised area on outer margin at this point which is covered with very short spines, and bearing eight spines on inner, outer and terminal margins over distal half of joint; first segment of endopod two-thirds length of second, subrectangular, width two-thirds length, with a small spine on outer margin; second segment, width one-third length, rounded distally, with very short spines along outer and distal margins and three spines on inner distal region.

SECOND PEREIOPOD biramous, each ramus of two segments, exopod and endopod subequal in length; basipod subrectangular, as long as rami, as wide as long, with groups of small spines along distal margin; first segment of exopod as long as second, subrectangular, width two-thirds length, outer distal angle with a rounded projection with very short spines around its margin and a spine borne medially; second segment subovate, width three-quarters length, with 10 spines along distal and inner margins, and a group of very small spines on outer distal region; first segment of endopod one-third length of second, subrectangular, as wide as long, outer margin expanded to twice length of inner and



FIGS 134-140—*Pandarus bicolor* Leach, male. Fig. 134—dorsal; 135—antennae and anterior mouth parts; 136—first maxilliped; 137—second maxilliped; 138—first pereopod; 139—second pereopod; 140—fourth pereopod.

with a row of very short spines; second segment subovate, proximal margin sublinear, width two-fifths length, outer margin bordered by very short spines, a group of very short spines on inner distal region, and a group of four spines just proximal to these.

THIRD PEREIOPOD biramous, each ramus of two segments, endopod a little longer than exopod; basipod as long as endopod, subrectangular, as wide as long, with groups of very short spines on outer distal angle, on rounded inner distal angle, and between the points of attachment of the two rami; first segment of exopod two-thirds length of second, as wide as long, slightly curved, with very short spines around outer margin, a spine on outer distal angle and a row of very short spines on a raised medial area; second segment subrectangular, width two-thirds length, distal margin rounded, with a group of very short spines on medial half of outer margin, and three small and three large spines on distal margin; first segment of endopod one-fifth length of second, outer and inner distal angles rounded, length two-thirds width, with a group of very short spines on rounded outer distal angle; second segment subovate, width two-fifths length, with a group of very short spines along proximal third of outer margin, and three spines on inner distal region.

FOURTH PEREIOPOD biramous, each ramus of one segment, endopod two-thirds length of exopod; basipod as long as exopod, subrectangular, a little wider than long, with groups of very small spines as in third pereopod and a subovate raised area on inner proximal region which is covered also in very short spines; exopod subovate, width one-third length, outer margin has three groups of very short spines, with a small spine just distal to the most proximal and most distal of these groups, a further group of very short spines on outer distal region, and a group of four small and two slightly larger spines on or near distal margin; endopod subovate, width half length, with a band of very short spines along outer and distal margins, and a larger spine near inner distal region.

JUVENILE FEMALE (figs 132-3). The collection contains a few juvenile females which are rather similar to the juvenile females of *Pandarus sinuatus* illustrated by Wilson (1907, pl. 32, fig. 182), but differ in the wider genital segment and third segment, and also in the extent to which the genital segment is covered by the plates of the fourth segment. The eyes are much more clearly visible in the juvenile than in the adult, and the dentate-posterior region of the carapace is much more regular in the juvenile forms.

MALE (figs 134-40), overall length 5.0 mm-5.5 mm.

CARAPACE slightly longer than wide (2.8 mm x 2.6 mm-2.7 mm); frontal plate four-fifths carapace width (1.8 mm-2.1 mm), length one-tenth width, with a deep median notch, rounded laterally and extending to beyond first segment of first antenna; median area two-thirds carapace width, bordered laterally by longitudinal ribs which converge slightly medially; lateral areas extending beyond posterior margin of

median area for a distance equal to one-quarter carapace length, posterolateral projections rounded posteriorly, free margin of lateral area bordered by a broad flange, as are the posterolateral angles of the median area.

SECOND SEGMENT subrectangular, width three times length (0.5 mm–0.7 mm x 1.4 mm–2.0 mm), with posterolateral plates three-quarters as long as segment, width two-thirds length, rounded distally, with a flange around its free margin.

THIRD SEGMENT subovate, width three times length (0.5 mm–0.7 mm x 1.4 mm–1.7 mm).

FOURTH SEGMENT subrectangular, posterior margin convexly curved, width twice length (0.5 mm–0.7 mm x 1.1 mm–1.6 mm).

GENITAL SEGMENT longer than wide in specimen from *Squalus acanthias*, but as long as wide in other specimens which appear to be younger (specimen from *Squalus acanthias* 1.9 mm x 1.5 mm; other specimens 0.9 mm–1.1 mm x 1.0 mm–1.1 mm), narrowing anteriorly and posteriorly to two-thirds median width, has a small spine laterally on a slightly raised area one-third of distance from posterolateral angles, posterolateral angles produced slightly posteriorly on either side of first segment of abdomen.

ABDOMEN two segmented (except in a few smaller specimens where it is still one segmented), first segment subrectangular, wider than long (0.2 mm x 0.5 mm), subrectangular, posterolateral angles slightly rounded; second segment subrectangular, wider than long (0.3 mm x 0.7 mm), posterior margin V-shaped, apex projected posteriorly, caudal rami borne on either side of the posterior margin.

CAUDAL RAMI longer than wide (0.5 mm x 0.3 mm), posterolateral angle slightly rounded, posteromedial angle broadly rounded, with three long plumose setae on posterior margin, a further long plumose seta on median posterior region, and a short row of cilia on inner margins.

FIRST ANTENNA of two segments, first segment twice length of second, subrectangular, distal width two-fifths length, narrowing slightly proximally, with about 20 short setae over distal margin and distal angles; second segment, distal width two-fifths length, slightly narrower proximally, rounded distally, with about three short setae and four longer setae on distal margin.

Immediately posterior to first antenna is a subovate adhesion pad as long as first antenna, width half length.

SECOND ANTENNA of three segments, first segment as long as third, second segment four-fifths this length; second segment subrectangular, width two-thirds length, inner distal angle rounded; third segment, width at the base one-quarter length, narrowing gradually to a point distally, distal two-fifths sharply curved, with two spines on proximal half of joint, the most proximal on a raised boss.

MOUTh TUBE 0.6 mm in length, width at the base one-third length, narrowing gradually to a blunt point distally.

SECONd MAXILLA lateral to base of mouth tube, a spinous projection on a subovate plate which is pointed posteriorly.

FIRST MAXILLIPED of two segments, second segment a little longer than first; first segment subrectangular, width one-quarter length; second segment, width at the base one-sixth length, narrowing distally, branched distally, major branch constituting two-fifths length of segment, smaller branch two-thirds this length, a small seta borne near base of smaller branch.

SECONd MAXILLIPED of three segments, first segment a solid base, second segment irregularly shaped, bearing a subrectangular pad on expanded outer distal angle against which a third segment closes; third segment as wide as long, distal third a subrectangular projection, distal angles rounded, which closes against pad on second segment.

Lateral to tip of mouth tube are two subovate adhesion pads each two-thirds length of that posterior to first antenna, width half length.

FIRST PEREIOPOD biramous, each ramus of two segments, endopod two-thirds length of exopod; basipod small, subovate, width two-thirds length, with plumose setae on rounded outer distal angle and just proximal to rounded inner distal angle; first segment of exopod twice length of second, width two-fifths length, rounded distally, with a spine on outer distal angle; second segment subovate, as wide as long, with four spines on distal margin and three plumose setae on inner margin; first segment of endopod three-quarters length of second, subrectangular, as wide as long, angles rounded; second segment subtriangular, as wide at the base as long, angles broadly rounded, with a row of cilia on outer margin and four long plumose setae on inner margin.

SECONd PEREIOPOD biramous, each ramus of two segments, rami subequal in length, basipod much larger than in first pereio pod, longer than wide, with a small plumose seta near base of exopod and a row of cilia along posterior margin; second segment of exopod two-thirds length of first; first segment subrectangular, width two-thirds length, with a small plumose seta on outer distal angle which is somewhat expanded, and a large plumose seta on a slightly expanded medial portion of inner margin; second segment subovate, as wide as long, with four spines on outer distal region, four long plumose setae on inner margin and inner part of distal margin, and a tuft of cilia on proximal part of inner margin; first segment of endopod half length of second, length two-thirds width, subrectangular, outer margin a convex curve covered in long cilia, a long plumose seta borne on inner margin; second segment subovate, slightly curved, proximal margin sublinear, width half length, with a row of long cilia on outer margin and seven long plumose setae on distal margin and outer distal angle.

THIRd PEREIOPOD very similar to second.

FOURTH PEREIOPOD biramous, each ramus of one segment, exopod slightly longer than endopod; basipod similar in size to that of second and third pereopods, with a plumose seta near base of exopod and a row of cilia along posterior margin; exopod rounded distally, width half length, narrowing to half this width near base, with three spines on outer distal angle and four long plumose setae on inner distal region and a tuft of cilia on proximal part of inner margin; endopod subrectangular, angles slightly rounded, width two-thirds length, with a row of cilia on outer margin and four long plumose setae over distal and inner margins.

DISCUSSION

This species is very similar to *Pandarus sinuatus* Say but can be distinguished from it by the shape of the second segment, and by the two ratios: width of sixth segment to width of genital segment (0.5 in *P. bicolor*, 0.4 in *P. sinuatus*) and width of third plate visible in dorsal view to width of carapace (0.6 in *P. bicolor*, 0.4 in *P. sinuatus*). There are a number of other differences but the ones cited seem to provide a convenient and rapid means of determination.

I agree with Barnard (1955, p. 257) that the male described by Wilson (1932, p. 436) and Scott, T. (1900, p. 157) is a very young specimen. The males in the present collection agree with Barnard's figure and are much closer to the typical adult *Pandarus* male than those described by the other authors.

The distribution of this species as known at present is fairly wide and will no doubt be extended. Previous records include:

NORTH-EAST ATLANTIC: on dogfish off coast of Shetland Is. (Wilson, 1907, p. 403); on *Mustelus canis* landed at Aberdeen fish market (Scott, T., 1900, pp. 157-8); on *Mustelus canis* and *Mustelus mustelus* at Torcross, Devonshire (Leach, 1816, p. 405); on *Prionace glauca* at Falmouth (Baird, 1850, p. 288). Presumably the records by Bassett-Smith (1899, p. 466) on *Scyliorhinus catulus* and by Gerstaecker (*vide* Brian, 1906, p. 55) on *Squalus acanthias* are also from this area. On "sharks" in Swedish waters (Bresciani and Lützen, 1962, p. 405); on *Galeorhinus galeus* at Northern Kattegat and North Sea (Krøyer, 1838*).

MEDITERRANEAN: on *Prionace glauca* near Italy (Richiardi, 1880, p. 149); on *Mustelus canis* at Portoferraio (Brian, 1906, pp. 55-6).

SOUTH-EAST ATLANTIC: on *Eulamia* sp. off coast of Angola (Nunes-Ruivo, 1956*); on *Galeorhinus* and *Carcharhinus* at Table Bay and False Bay, South Africa (Barnard, 1948, p. 249).

NORTH-WEST ATLANTIC: on smooth dogfish at Woods Hole, Mass. (Wilson, 1932, p. 436).

* From translations supplied by the Fisheries Research Board of Canada, original page numbers not retained.

INDIAN OCEAN: on a grey shark at Durban, South Africa (Barnard, 1955, pp. 257-8).

SOUTH-WEST PACIFIC: on a shark at Lord Howe Is., Java, on *Isurus glaucus* at Port Hacking, New South Wales, and on unnamed hosts at Port Jackson, New South Wales, Oyster Bay, Tasmania and Manouard Is., east coast of Tasmania (Heegaard, 1962, pp. 177-8).

From my records and those of other authors it seems that this species usually occurs in low numbers (five or less) on any one host specimen, although occasionally a single host may carry 30 or more.

Pandarus cranchii Leach, 1819

(Figs 141-8)

Pandarus cranchii Leach, 1819, p. 535.

Pandarus dentatus Milne-Edwards, 1840, p. 469, pl. 38, fig. 19.

Pandarus armatus Heller, 1865, pp. 202-5, pl. 19, fig. 4, 4a-4d.

? *Pandarus dentatus* Milne-Edwards. Thomson, 1899, p. 363.

Pandarus armatus, Heller. Thomson, 1889, pp. 363-5, pl. 27, figs 1a-1f.

Nogagus latreillii Leach. Thomson, 1889, p. 364.

MATERIAL: 43 females taken from the buccal cavity of *Galeorhinus australis* taken in Tory Channel by Professor J. A. F. Garrick in 1955; five females taken from the jaws and skin of *Isurus oxyrinchus* at Makara by Professor J. A. F. Garrick on 29 June 1955. Both sharks were also infested with other species of parasitic copepod.

DESCRIPTION

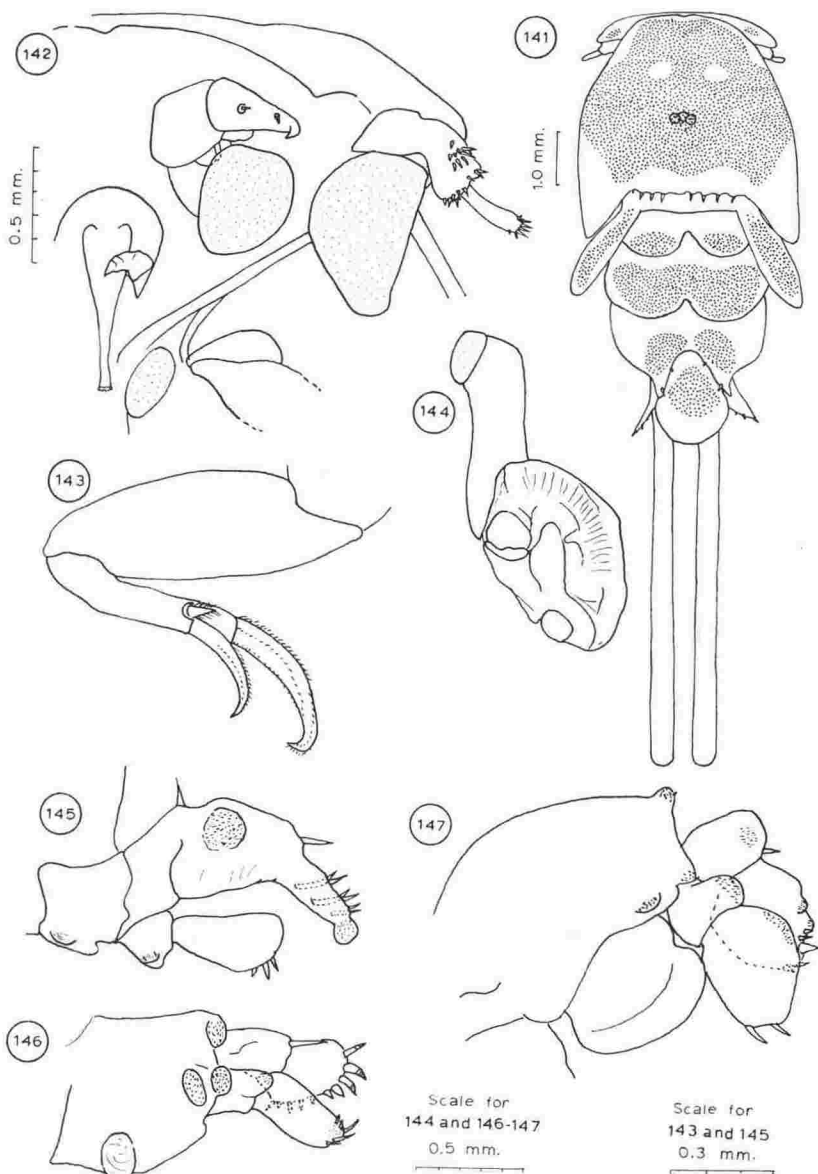
FEMALE only, overall length 7.7 mm-8.7 mm.

CARAPACE wider than long (3.3 mm-3.8 mm x 3.9 mm-4.6 mm); frontal plate three-quarters carapace width (3.1 mm-3.4 mm), greatest length one-eighth width, shorter medially, rounded laterally; postero-lateral angles of carapace extended posteriorly for a distance equal to two-sevenths length of carapace, rounded posteriorly, area between these extended angles sublinear, bearing about eight sharp posteriorly directed spines.

SECOND SEGMENT subrectangular, much wider than long (0.3 mm-0.5 mm x 2.2 mm-2.7 mm), carrying large plates laterally and directed posterolaterally which increase the size of the segment (1.7 mm-2.4 mm x 3.9 mm-4.4 mm) and are rounded distally.

THIRD SEGMENT, including plates, width twice length (0.9 mm-1.1 mm x 1.8 mm-2.6 mm), the plates being carried on the posterior margin, rounded posteriorly, with a v-shaped incision between them which is rounded at its anterior apex and extends for a distance equal to half length of plate.

FOURTH SEGMENT, including plates, width twice length (1.5 mm-1.8 mm x 2.9 mm-3.3 mm), plates attached to posterior margin, rounded posteriorly, with a small rectangular incision between them, rounded at its anterior apex, which extends for a distance equal to one-fifth length of segment.



FIGS 141-147—*Pandarus cranchii* Leach, female. Fig. 141—dorsal; 142—antennae and anterior mouth parts; 143—first maxilliped; 144—second maxilliped; 145—first pereopod; 146—second pereopod; 147—third pereopod.

GENITAL SEGMENT including posterior processes, one-fifth wider than long (2.2 mm–2.6 mm x 2.6 mm–3.2 mm), lateral margins rounded, posterolateral processes extending length of segment by a distance equal to two-sevenths total length, pointed posteriorly, with the margin between them an entire curve, two small spines borne medially on inner margin of processes.

ANAL PLATE longer than wide (1.6 mm–1.8 mm x 1.3 mm–1.5 mm), subovate, slightly narrower anteriorly than posteriorly.

ABDOMEN subrectangular, slightly wider than long (1.2 mm–1.3 mm x 1.3 mm–1.6 mm), caudal rami borne laterally.

CAUDAL RAMI 1.2 mm–1.3 mm in length, width at the base two-fifths length, narrowing to a point distally, with one spine terminally, one small spine on posterior margin and a small plumose seta just proximal to this spine, and two further spines on ventral surface near outer margin.

FIRST ANTENNA of two segments, first segment twice length of second, width two-fifths length, with about 16 setae on distal part of outer margin and distal margin; second segment, width one-third length, with about eight setae distally.

Immediately posterior to first antenna is a large adhesion pad which is one-seventh shorter than first antenna, suboval, outer margin sublinear, width two-thirds length.

SECOND ANTENNA of three segments, first segment associated with a large adhesion pad which in some specimens overlies part of antenna, which is three-quarters length of adhesion pad posterior to first antenna, subovate, only slightly wider than long; second segment two-thirds length of third, subrectangular, with a projection on inner margin which has an indentation making it appear bilobed in ventral view, but single lobed in dorsal view; second segment, width at the base two-fifths length, narrowing gradually to a sharp point distally, distal two-fifths sharply curved, with two spines each on a small raised boss on uncurved portion of segment.

MOUTH TUBE 0.7 mm in length, width at the base two-sevenths length, narrowing rapidly over proximal half.

SECOND MAXILLA placed lateral to base of mouth tube, spine-like, indistinctly segmented but at least two segments, narrowing steadily and ending in a sharp point.

FIRST MAXILLIPED of two segments, second segment a little longer than first; first segment, width one-third length; second segment, width one-eleventh length, branched distally, major branch constituting nearly half length of segment, smaller branch two-thirds length of major branch, both with longitudinal rows of very small spines, segment also has a short plumose seta near base of smaller branch.

SECOND MAXILLIPED of three segments, basal segment elongate and with a subovate adhesion pad anteriorly, which is two-thirds as long as that associated with base of second antenna, width half length, basal segment width one-quarter length for most of length; second segment as long as first, subovate, width two-thirds length, swollen in inner proximal region and bearing a pad, which is a silvery colour, against which third segment closes; third segment two-thirds length of second, distal width half length, a little narrower proximally, distal margin concave, distal angles rounded.

FIRST PEREIOPOD biramous, each ramus of two segments, endopod two-thirds length of exopod; basipod small, hardly exceeding half length of endopod, subrectangular, as wide as long, with a small subsemicircular ridged area near inner margin; first segment of exopod subrectangular, one-quarter length of second, length two-thirds width, with a spine on outer distal angle; second segment, width at the base half length, gradually narrowing for half its length and then suddenly narrowing to two-fifths basal width, with a rounded protrusion distally, a rounded area covered in fine spines near outer proximal angle, a spine just proximal to point at which joint suddenly narrows and three long and three short spines on inner and outer margins respectively of narrowed portion, rounded distal protrusion also covered in fine spines; first segment of endopod half length of second, subrectangular, as wide as long, inner margin slightly expanded and has a subsemicircular ridged area; second segment subovate, greatest width half length, narrowed to half this width at base, with three spines in inner distal region.

SECOND PEREIOPOD biramous, each ramus of two segments, exopod and endopod subequal in length, basipod a little longer than either, subrectangular, as wide as long, with a rounded ridged area medially on inner margin, and three raised rounded areas, covered in fine spines, near distal margin; first segment of exopod as long as second, subrectangular, width three-quarters length, with a spine on outer distal angle; second segment subovate, proximal margin sublinear, width two-thirds length, with three spines on distal margin which are ringed with very small spines, and seven further spines on distal three-quarters of inner margin; first segment of endopod two-thirds length of second, subrectangular, as wide as long, outer distal angle expanded to constitute one-third of total length, and rounded, covered in very fine spines; second segment subovate, anterior margin sublinear, width half length, with two long and three small spines on distal margin and numbers of very fine spines in the same area.

THIRD PEREIOPOD biramous, each ramus of two segments, rami subequal in length, basipod longer than either ramus, width two-thirds length, with three raised areas, covered in very small spines, near distal margin and a flange along posterior margin which is half as wide as basipod; first segment of exopod two-thirds as long as second, outer margin swollen, with a spine on outer distal angle and a group of very small spines near outer distal angle; second segment subovate, proximal margin linear, a little longer than wide, with five spines on distal

margin, a small raised area with very small spines on outer distal angle and a further similar area on outer margin two-sevenths distance from outer distal angle; first segment of endopod two-fifths length of second, length two-thirds width, outer margin swollen and covered in very short spines; third segment subovate, width three-quarters length, with a group of very small spines on proximal part of outer margin and two spines distally.

FOURTH PEREIOPOD biramous, each ramus of one segment, endopod three-quarters length of exopod, basipod twice length of exopod, as long as wide, outer margin and to lesser extent inner margin swollen, with patches of very small spines on outer and inner distal angles and a further patch on a small swollen area between points of attachment of rami, and a spine near outer distal angle; exopod subovate, width two-thirds length, with one large spine medially on outer margin, two large spines on distal margin, four small spines near outer distal angle, two small spines on inner margin proximal to larger spines, two patches

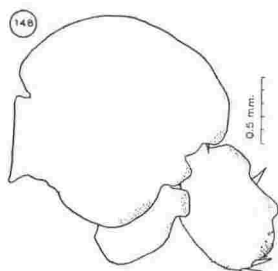
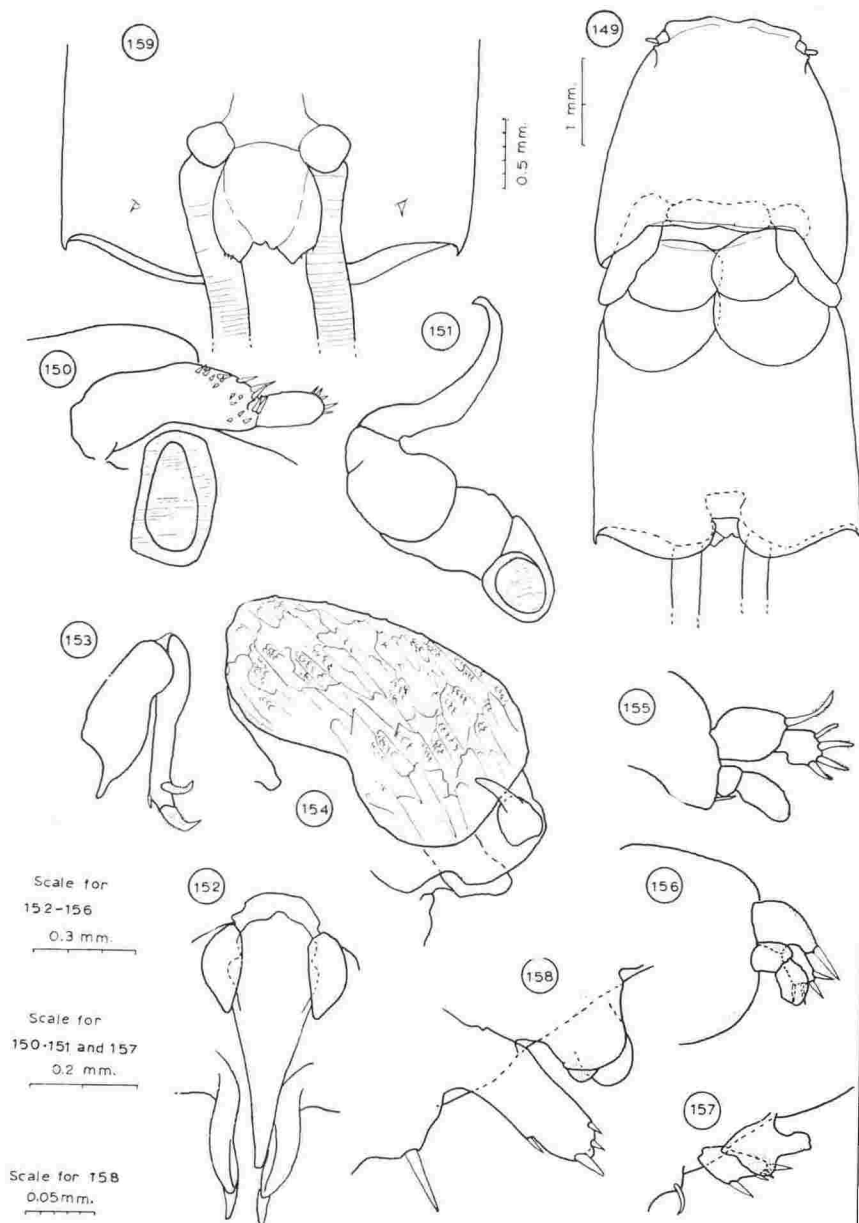


FIG. 148—*Pandarus cranchii* Leach, female; fourth pereopod.

of very short spines on outer margin between large spine and inner and outer proximal angles, and a further group of very small spines on outer distal angle; endopod subovate, width two-thirds length, with two groups of very small spines on proximal half of outer margin, the more proximal of the two groups carried on a subrectangular raised area with rounded angles, which increases the width of the endopod by one-fifth.

DISCUSSION

The females of *Pandarus cranchii* and *P. satyrus* have not so far been satisfactorily separated in the literature. Dana (1853, p. 1368) states that *P. satyrus* differs from *P. cranchii* in the form of the genital segment (which he calls the "first abdominal segment"), the acute points behind, the "stylets", and the "large cheliform legs". I have not seen Leach's original description but descriptions by later authors do not seem to bear out these differences. Wilson (1907, p. 395) separates the two species on the grounds that the plates on the third and fourth segments



FIGS 149-159—*Perissopus ~~communis~~ dentatus* Steenstrup and Lütken, female. Fig. 149—dorsal; 150—first antenna; 151—second antenna; 152—mouth tube and second maxillae; 153—first maxilliped; 154—second maxilliped; 155—first pereopod; 156—second pereopod; 157—third pereopod; 158—fourth pereopod; 159—abdomen and caudal rami.

are unequal in size in *P. satyrus* but subequal in *P. cranchii*. This difference is not even apparent in his own figures (1907, pl. 28, fig. 124, pl. 31, fig. 162). Shiino (1954, pp. 323-4) follows Wilson. Lewis (1966, p. 90) gives several differences which do not seem to be borne out by the present material. He states that the caudal rami are longer in *P. cranchii* than in *P. satyrus*. Dividing the average length of these structures as given by Lewis by the total length gives figures of 0.106 and 0.178 respectively, but in the present material the same calculation produces a figure of 0.143, which is midway between these two measurements. If the same calculation is made for Dana's specimen (1853, pl. 95, fig. 2a) the figure is about 0.2, which is proportionately greater than in Lewis's measurements for *P. cranchii*. Lewis states that the lobe on the second segment of the second antenna is bilobed in *P. satyrus* and single lobed in *P. cranchii*, but in the present material the structure of this lobe makes it appear bilobed in ventral view but single lobed in dorsal view. Lewis also gives the presence or absence of a clump of plumosities on the second segment of the first maxilliped as a character. In the present material there is a plumose seta present at this point, again distinguishing it from either type described by Lewis. The other characters described by Lewis as differing (setation of limbs, etc.) cannot be considered to be major characters considering their variability in other species of this family. It seems likely that a comparison of specimens from many different areas and hosts will be required before this problem is solved. In the meantime it does not seem profitable to discuss the distribution of this species when previous authors may well have been mistaken in their identification (see synonymies by Shiino, 1954, p. 312, and Lewis, 1966, pp. 81 and 91).

Of species previously recorded from the New Zealand region, *P. dentatus* Milne-Edwards has already been synonymised with the present species by Wilson (1907), and *P. brevicaudis* Dana (1853, p. 1368) is recorded from the male alone. *P. armatus* Heller appears to be a separate species, but if the basipod shown projecting on either side of the fourth segment (Heller, 1865, pl. 19, fig. 4) were really part of this segment then this species might also be *P. cranchii*.

Genus *Perissopus* Steenstrup and Lütken, 1861

Perissopus dentatus Steenstrup and Lütken, 1861 (Figs 149-59)

- Perissopus dentatus* St. and Lüt., 1861, p. 393, pl. 12, fig. 25.
Chlamys incisus van Beneden, 1892a, p. 227, pl. 2, figs 1-10.
Perissopus communis Rathbun, 1887, p. 560, pl. 29, figs 6-7, pl. 30, figs 1 and 6.
Perissopus dentatus St. and Lüt. Bassett-Smith, 1899, pp. 467-8.
Perissopus dentatus St. and Lüt. Brian, 1906, pp. 57-8.
Perissopus communis Rathbun. Wilson, 1907, pp. 354-61, pls. 17-18.
Perissopus communis Rathbun. Brian, 1924, pp. 394-5.
Perissopus crenatus Leigh-Sharpe, 1930, p. 7, pl. 5, figs 1-4, pl. 4, fig. 2.
Perissopus manuelensis Gnanamuthu, 1951b, pp. 9-12, figs 1-5, and 1951a, pp. 1252-5, figs 45-7.
Perissopus dentatus St. and Lüt. Capart, 1953, pp. 662-3.
Perissopus dentatus St. and Lüt. Barnard, 1955, pp. 260-1, fig. 15a.
Perissopus travancorensis Kurian, 1955, p. 108, figs 19-37 (*non vid.*). *Fide* Pillai. 1964.

Perissopus serratus Heegaard, 1962, pp. 175-6, figs 154-61.

Perissopus manuelensis Gnanamuthu. Pillai, 1964, pp. 67-9, figs 40-59.

Perissopus dentatus St. and Lüt. Kirtisinghe, 1964, pp. 92-3, fig. 123.

MATERIAL: One female specimen on a hammerhead shark taken at 36° 37' S, 175° 5' E (Hauraki Gulf, N.Z.) by the Marine Department vessel *Ikatere*, collected by Mr. L. J. Paul.

DESCRIPTION

FEMALE only, overall length 6.1 mm.

CARAPACE as long as wide (2.8 mm x 2.8 mm); frontal plate 1.5 mm in width, length one-sixth width; carapace widening gradually from frontal plate to gain its maximum width just anterior to posterior termination, posterolateral angles extended posteriorly to constitute one-fifth length of carapace, margin between them two-thirds carapace width, sublinear.

SECOND SEGMENT, width four times length (0.3 mm x 1.2 mm), largely hidden by carapace in dorsal view, bearing posterolaterally directed plates on lateral margins which are a little wider than segment is long, length four times width, narrowing slightly and rounded distally.

THIRD SEGMENT similar in length to second but somewhat wider, with large subovate plates which make its width twice length (0.8 mm x 1.9 mm), the plates overlapping in the midline so that there is little or no sinus between them.

FOURTH SEGMENT similar in structure to third but larger, size including plates, width nearly twice length (1.4 mm x 2.5 mm).

GENITAL SEGMENT as wide as long (2.9 mm x 3.0 mm), lateral margins sublinear and nearly parallel, posterolateral angles projecting slightly, median tenth of posterior margin incised to a depth equal to one-sixth length of carapace, sublinear anteriorly, with margins lateral to incision being entire convex curves; abdomen visible through incision.

ABDOMEN slightly longer than wide (0.8 mm x 0.6 mm), narrowing anteriorly to two-fifths posterior width, lateral margins entire curves.

CAUDAL RAMI attached along distal five-sixths of lateral margins of abdomen, length two-thirds width (0.2 mm x 0.3 mm), lateral margin curved and four times length of medial margin, medial and distal margins both sublinear, distal margin with three small spines.

EGG STRINGS 4.8 mm in length, somewhat damaged in the present specimen, one containing 67 eggs.

FIRST ANTENNA of two segments, first segment three times length of second, with five well developed spines and about 13 smaller spines on distal third of outer margin and on or near distal margin; second segment, width half length, rounded distally, with five small setae distally.

Immediately posterior to first antenna is a subovate adhesion pad with transverse striations, three-quarters length of first segment of first antenna, width five eighths length.

SECOND ANTENNA of four segments, first segment a little shorter than second, second as long as third and half length of fourth; first segment as wide as long, inner margin with a large subovate adhesion pad as long as segment; second segment subrectangular, width four-fifths length; third segment rounded proximally, width at the base three-quarters length, narrowing to half this width distally; fourth segment, width at the base one-fifth length, narrowing steadily to a sharp point distally, sharply curved.

MOUTH TUBE 0.8 mm in length, width at the base one-third length, narrowing steadily distally.

SECOND MAXILLA in the form of a heavy, blunt spine lateral to base of mouth tube, one-third length of mouth tube.

Two posteriorly directed spinous projections are situated on the ventral surface of carapace lateral to posterior end of mouth tube, each one-third length of mouth tube.

FIRST MAXILLIPED of two segments, first segment three-quarters length of second, width two-fifths length; second segment, width at the base one-seventh length, somewhat narrower distally, branched distally, major branch one-quarter length of segment, minor branch situated one-seventh closer to base, three-quarters length of major branch, both with longitudinal rows of very small spines, segment also has a small plumose seta near base of smaller branch.

SECOND MAXILLIPED of three segments, first segment a base upon which second rests; second segment with inner distal angle strongly expanded to form a pad against which third closes; this pad is six-sevenths total width of maxilliped, length half width, with a very rough surface and may itself act as an attachment device, as a result of friction set up by the rough surface; third segment much smaller than second, one-third its length, width at the base half length, narrowing rapidly over proximal two-fifths to half this width, and more slowly to end in a point distally.

FIRST PEREIOPOD biramous, each ramus of two segments; endopod two-thirds length of exopod; first segment of exopod subrectangular, width three-quarters length, with a long spine on outer distal angle which is bordered with small cirri over its distal half; second segment subovate, two-thirds length of first, width three-quarters length, with four spines distally, each armoured as first spine on first segment; first segment of endopod subrectangular, one-third length of second, length two-thirds width, angles somewhat rounded; second segment subovate, proximal margin sublinear, width half length, with very small spines around distal two-thirds of outer and distal margins.

SECOND PEREIOPOD biramous, each ramus of two segments; endopod two-thirds length of exopod; rami a little smaller than equivalent rami of first pereopod, but basipod almost twice the size of basipod of first pereopod, basipod subrectangular, angles rounded, with rows of very short spines on posterior margin; first segment of exopod three-quarters as wide as long, one-third of length the result of extension of outer distal angle, which bears a long spine, segment also has rows of very small spines on outer margin; second segment subrectangular, two-thirds length of first, width half length, with four spines on distal margin; first segment of endopod three-quarters length of second, subrectangular, as wide as long, with rows of very fine spines on outer margin; third segment subovate, proximal margin sublinear, width two-thirds length, with rows of very small spines on outer and distal margins.

THIRD PEREIOPOD biramous, each ramus of one segment; basipod much larger than that of second pereopod but rami further reduced in size; exopod as long as endopod, semicircular, as long as wide, with a projection two-thirds as long as width of segment just proximal to outer distal region, this projection covered in very small spines distally, segment covered in very small spines over inner distal region; endopod, median width half length, narrowing to half this width proximally and distally, outer margin sublinear, distal margin rounded, with one large spine and three smaller spines distally and a further large spine at widest point on inner margin.

FOURTH PEREIOPOD biramous, each ramus of one segment; basipod further expanded, rami smaller than those of third pereopod; exopod two-thirds length of endopod, length three-quarters basal width, subsemicircular, with a semioovate projection half as wide as basal width of segment, nearly as long as segment, and a further rounded projection covered in very small spines on inner distal region; endopod, width at the base half length, rounded distally, with two small spines and one larger spine on distal margin and a further small spine on midpoint of inner margin.

DISCUSSION

This species has been known by a number of specific names. Capart (1953), after comparison of abundant material from the region of Dakar with the type specimens, synonymised *Chlamys incisus* van Beneden, *Perissopus communis* Rathbun, and *P. crenatus* Leigh-Sharpe. These species had all been differentiated on their general body form and the extent of posterior denticulation of the posterior margin of the carapace and the posterior margins of the plates on the free segments, characters that Capart found to be very variable. Three other species have been described, *P. manuelensis* Gnanamuthu and *P. travencorensis* Kurian (this later being synonymised with the preceding species by Pillai (1964)) and *P. serratus* Heegaard. As Kirtisinghe (1964) points out, the distinguishing features attributed to these species are comparable

to those which were rejected by Capart because of their variability. Thus it seems that the genus *Perissopus* is monotypic, containing the one species, *P. dentatus*.

There is a slight possibility that *Pholidopus armatus* (Dana, 1853) (Dana, pp. 1372-4, pl. 95, figs 5, a-k; Wilson, 1907, pp. 347-8) is a second species since it resembles *Perissopus dentatus* in many respects, but differs in having a convexly rounded posterior margin to its genital segment.

P. dentatus is found in many parts of the world, chiefly in warmer waters, on a variety of hosts. Previous records include:

ATLANTIC: on *Carcharias* sp. (Steenstrup and Lütken, 1861, p. 393).

NORTH-EAST ATLANTIC: on *Mustelus asterias* at Mauritania (Brian, 1924, pp. 394-5); on an unnamed host at Senegal (van Beneden, 1892a, p. 227); on *Sphyrna diplana* and *Paragaleus gruveli* at Goree, Senegal, and on *Sphyrna diplana* at Joal, Senegal (Capart, 1953, p. 662); on *Mustelus mustelus* at Pulpito Bay, Rio de Oro (Sterkhoven, 1937, p. 12).

MEDITERRANEAN: on *Mustelus equestros* (Richiardi, 1880, p. 148); on *Mustelus canis* and *Carcharias lamia* at Genoa (Brian, 1906, pp. 57-8); on *Mustelus plebejus* and *Carcharhinus milberti* in the Adriatic (Heller, 1865, p. 32 and Valle, 1880, p. 61 [*vide* Brian, 1906, p. 58, *none vide*]).

NORTH-WEST ATLANTIC: on *Mustelus canis* at Woods Hole, Mass., and on *Scoliodon terraenovae* at Beaufort, Nth. Carolina (Wilson, 1907, p. 360); on *Carcharhinus obscurus* and *C. milberti* at Vineyard Sound, Mass., on *C. obscurus* at Noark Sound, Connecticut, on *Sphyrna tiburo* at St. Mary's River, Florida, on *Rhizoprionodon terraenovae* at Pensacola, Florida, and on an unnamed host at Great Egg Harbour, New Jersey (Rathbun, 1887, p. 560); on bay, dusky (*Carcharhinus obscurus*), shovelhead (*Sphyrna tiburo*?), sharpnosed (*Scoliodon terraenovae*) and smoothtooth (*Aprionodon isodon*) sharks at Lemon Bay, Gulf of Mexico (Bere, 1936, p. 595); on *Sphyrna tiburo* at Port Aransas, Texas (Pearse, 1952, p. 27); on *Carcharhinus limbatus* and *Rhizoprionodon terraenovae* at Port Aransas, Texas (Causey, 1953, p. 12); on *Carcharhinus limbatus* at the Dry Tortugas (Wilson, 1936, p. 335).

SOUTH-WEST ATLANTIC: on *Carcharhinus limbatus* at Praia Grande, Santos, Brazil (Carvalho, 1940, p. 277); on *Carcharhinus milberti* at Praia de Matinhos, Parana Province, Brazil (Carvalho, 1945, p. 110).

INDIAN OCEAN: on *Scoliodon* sp. at Durban (Barnard, 1955, p. 261); on a carcharhind shark at Rameshvaram, India (Gnanamuthu, 1951a, p. 1236); on *Scoliodon sorrakowah* at Quilon, Sth. India (Pillai, 1964, p. 67); on *Hemigaleus balfouri* and *Scoliodon* sp. bought in the Colombo market (Kirtisinghe, 1964, p. 92); on *Carcharhinus borneensis* at Java (Leigh-Sharpe, 1930, p. 7).

SOUTH-WEST PACIFIC: on a shark at Flinders Is., Nth. Queensland (Heegaard, 1962, p. 175).

This is thus only the second record of this parasite from the Pacific Ocean and it is the most southern record to date.

GENERAL CONCLUSIONS

The systematics of pandarid copepods are particularly difficult because of the profound morphological response to the environment. This is clearly illustrated by the measurements of total length in the present collection of *Dinematura latifolia*. Specimens from the same host specimen tend to be very similar, while specimens from another host of the same species may be significantly different. When parasites of the same species from different host species are compared, the differences may be even more striking, as in *D. producta*. These phenomena have led to the description of many species which later proved to be spurious. It is clear that in parasitic copepods sample size must be thought of in terms of numbers of hosts rather than numbers of parasites.

Of the ten species discussed five are very widely distributed. *Nesippus orientalis* and *Perisoppus communis* have been recorded mainly from the warmer waters of the world and in each species the only previous records from the Pacific are those by Heegaard (1962) from Northern Queensland, Australia. Other records of these species may well be obtained when the warmer waters of the Pacific are more thoroughly sampled. The only records of *Pandarus bicolor* from the Pacific are those by Heegaard (1962) from the S.W. Pacific. *Echthrogaleus braccatus* has previously been recorded only from Tongatabu and it may be restricted to a relatively small area of the Pacific. It is unfortunate that neither Heller nor the collector of the specimens described above were able to record the host fish. *Denoleus latus* has previously been recorded only from Japan, and may be restricted to the Pacific.

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MATERIAL

Material borrowed from the Marine Department, Wellington, the N.Z. Oceanographic Institute, Wellington, the Otago Museum, Dunedin, and Mr J. Graham, Oamaru, will be returned to the lenders. The material collected by Dr H. Manter is retained in the collection of the Zoology Department, Victoria University of Wellington. All the remaining specimens are deposited in the Dominion Museum, Wellington.

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ECHTHROGALEUS DENTICULATUS SMITH (COPEPODA, PANDARIDAE) IN NEW ZEALAND WATERS

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SUMMARY

Dinematura neozealanica Thomson, 1889 is shown to be a synonym of *Echthrogaleus denticulatus* Smith, 1874. The male recorded as *Pandarus armatus* Heller by Thomson (1889) is probably *E. denticulatus*. The latter species is redescribed from Thomson's specimens.

INTRODUCTION

A collection of parasitic Crustacea from the Otago Museum included a tube which held 91 females and 14 males of *Echthrogaleus denticulatus* Smith, 1874, and contained two labels, "*Dinematura neo-Zealandeus*, Dana, rect. from the Captain of the barque *Splendid*" and "G.M.T. coll. 1910". The second label, the identity of the collector, and the nature of the material leave little doubt that the specimens are those from which Professor G. M. Thomson described *Dinematura neozealanica* in 1889.

The total loss of the *Splendid* on 7 February 1890 (see discussion, p. 350) makes it most unlikely that the present material could have been a further collection made after Thomson presented his paper on 12 November 1889.

The label "*Dinematura neo-Zealandeus* Dana" presents a problem. Dana did not use this name for any of his species. However, in Thomson's workbook, there are drawings bearing the label *D. neozealanicus* which has been crossed out, then replaced by *D. braccatus* Dana, which in turn has been crossed out and *D. neozealanicus* rewritten. This change of mind in labelling the drawings may well account for the confused label on the collection tube.

Echthrogaleus denticulatus Smith, 1874.

Echthrogaleus denticulatus Smith, 1874, p. 282.

Dinematura neozealanica Thomson, 1889, pp. 359-60 (male and female).

Pandarus armatus Heller. Thomson, 1889, pp. 363-65 (male only).

Echthrogaleus neozealanicus (Thomson). Basset-Smith, 1899, p. 464.

Echthrogaleus denticulatus Smith. Wilson, 1907, pp. 369-71, pl. 20; Shiino, 1954, pp. 297-307, figs. 4-8, female only, *nec* male; Shiino, 1959, p. 352; Cressey, 1967, pp. 56-7, figs. 281-90.

DESCRIPTION

FEMALE (Figs 1-8) overall length 8.0 mm-8.8 mm (measurements from 10 females).

CARAPACE a little wider than long (4.2 mm-4.7 mm x 4.8 mm-5.2 mm); frontal plate three-fifths carapace width, very short, slightly convexly curved; median area three-fifths carapace width, bordered laterally for half its length by sub-parallel longitudinal ribs, and anteriorly by a further very short rib just posterior to first antenna; lateral areas extending beyond sublinear posterior margin of median area for a distance equal to one-third carapace length, divided by a transverse rib between posterior margin of median area and lateral margin near mid-point; posterior margin of lateral areas somewhat truncated; a flange bordering free margins of lateral areas is somewhat expanded medially.

SECOND AND THIRD SEGMENTS fused, total length 1.2 mm-1.4 mm, anterior width 1.9 mm-2.3 mm, width of posterior section 1.6 mm-1.8 mm; wider anterior area two-thirds length of posterior section, both sections with lateral margins rounded, anterior section with posterolaterally directed plates which are one-third as long as segment width, width two-thirds length, distal angles rounded, posterior margin with a narrow flange.

FOURTH SEGMENT including plates, length two-thirds width (2.7 mm-3.4 mm x 4.2 mm-4.7 mm), anterolateral angles expanded as spine-like projections, posterolateral angles rounded and projecting posteriorly for one-fifth segment length, incision between plates narrow and somewhat pointed anteriorly, extending for most of segment length, posterior and median margins armed with small spines, their number and size not constant.

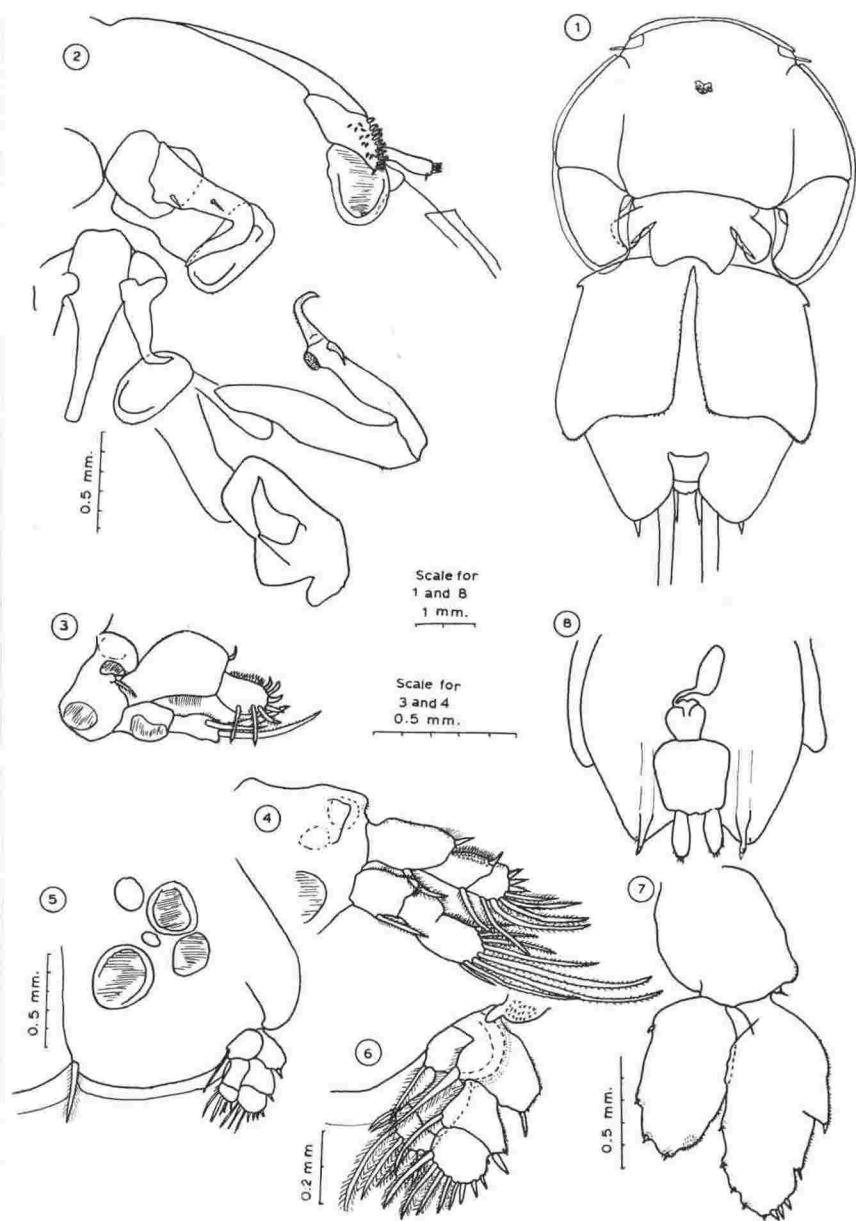
GENITAL SEGMENT as long as wide (3.7 mm-4.2 mm x 3.6 mm-4.0 mm), posterior processes accounting for one-third this length, margin between processes sublinear, one-fifth segment width, median margins of processes slightly expanded, posterior margin rounded.

ABDOMEN one segmented, as wide as long (1.2 mm-1.4 mm x 1.2 mm-1.5 mm), subrectangular, narrowing slightly posteriorly.

ANAL PLATE subsemicircular, as wide as long (0.6 mm x 0.6 mm).

CAUDAL RAMI borne laterally on posterior margin of abdomen, two-thirds abdomen length, width one-third length (0.8 mm x 0.3 mm), with three setae on somewhat rounded posterior margin, a further small seta lateral to these and a short tuft of cilia medial to these setae.

FIRST ANTENNA of two segments, second segment two-thirds length of first; first segment, width two-fifths length, with about 12 plumose setae on distal third of outer margin and distal margin, and about 12 small spines medial to these setae; second segment, width one-fifth length, rounded distally with several non-plumose setae distally and another small seta just proximal to inner distal angle.



FIGS 1-8—*Echthrogaleus denticulatus* female. Fig. 1—dorsal view; 2—antennae and mouth parts; 3—first pereopod; 4—second pereopod; 5—third pereopod; 6—rami of third pereopod further enlarged; 7—fourth pereopod; 8—genital segment and abdomen in ventral view.

A subovate adhesion pad borne just posterior to first antenna is as wide as second segment of first antenna is long, width two-thirds length, with transverse striations.

SECOND ANTENNA three segmented, first segment twice length of second, as long as third, with a subrectangular adhesion pad with rounded angles at its base, as long as adhesion pad associated with first antenna, width half length; second segment somewhat rounded, as wide as long; third segment, basal width two-sevenths length, narrowing steadily to end in a point distally, distal two-thirds sharply curved, a sharp spine near inner distal angle and a further sharp spine medially one-third of distance from base.

MOUTh TUBE a little more than 1 mm in length, width at base one-third length, narrowing rapidly to be slender for most of length.

FIRST MAXILLA immediately lateral to base of mouth tube, half length of mouth tube, width at base almost half length, narrowing steadily to a sharp point distally, curving laterally one-quarter of distance from end.

FIRST MAXILLIPED of two segments, first as long as second, width one-fifth length; second segment, width one-eighth length, distal third a narrowing branch covered in longitudinal rows of very short spines, with a smaller branch half its length near its base, and a rounded swelling covered in very short spines just lateral to minor branch.

SECOND MAXILLIPED of three segments, basal segment small and narrow, second segment twice length of third, width half length; third segment a sharp claw, width at base half length, narrowing rapidly distally, slightly curved.

Just lateral to tip of mouth tube is an adhesion pad similar in size and shape to that immediately posterior to first antenna.

FIRST PEREIOPOD biramous, rami two segmented, endopod as long as first segment of exopod; basipod two-fifths exopod length, length half width, with a plumose seta near base of exopod, a striated adhesion pad near this seta, and a further striated adhesion pad near inner margin; second segment of exopod half length of first, first segment width at midpoint two-thirds length, half this width at base, two-thirds this width distally, outer margin an entire curve, inner margin sublinear, with a curved spine on outer distal angle, and a row of cilia on median two-thirds of inner margin; second segment, width two-thirds length, rounded distally, a row of cirri on outer margin, four spines and three plumose setae on distal margin and distal half of inner margin; first segment of endopod as long as second, subrectangular, width three-quarters length, with a large striated adhesion area on distal two-thirds of inner margin; second segment subrectangular, width half length, with rows of short cilia on outer and distal margins, and three long setae with short cilia on or near distal margin.

SECOND PEREIOPOD biramous, rami subequal in length, exopod of three segments, endopod of two; basipod subrectangular, as long as exopod, with three or more, more or less distinct, striated adhesion areas, and a group of short spines on outer distal angle; first segment of exopod as long as other two together, third segment half length of second; first segment subrectangular, width half length, a spine on outer distal angle, a tuft of cilia just proximal to this spine, scattered very small spines along outer margin, a long plumose seta on inner margin, and a tuft of cilia between this seta and inner proximal angle; second segment subrectangular, width two-thirds length, narrower at base, a spine on outer distal angle, a row of cirri on outer margin, rows of short spines just medial to these cirri, and a long plumose seta on inner distal angle; third segment as wide as long, rounded distally, with very short spines on outer margin, three spines and five plumose setae on distal margin; first segment of endopod half length of second, subrectangular, width three-quarters length, with cilia on outer margin, cirri on expanded and rounded outer distal angle, and a plumose seta medially on inner margin; second segment subrectangular, rounded distally, width two-fifths length, outer margin suggests that this segment is the result of the fusion of two segments since the proximal two-fifths of margin is covered in cilia, the distal three-fifths in cirri, and there is a furrow between these two regions; segment also has seven plumose setae and one nonplumose seta on distal margin, those nearest inner distal angle being four times length of those nearest outer distal angle.

THIRD PEREIOPOD biramous, rami three segmented; basipod much expanded, united with other basipod to form a broad apron with about five striated adhesion areas; exopod as long as endopod, first segment of exopod as long as other two together, third segment as long as second; first segment, width three-quarters length, distal half of outer margin with short spines, outer distal angle with a well developed spine, inner margin with cilia and a long plumose seta; second segment, length three-quarters distal width, base width half distal width, very short spines along outer margin, a well developed spine on outer distal angle, cilia along inner margin, and a long plumose seta near inner distal angle; third segment subovate, length three-quarters width, outer part of margin with very short spines, distal part of margin with three well developed spines, one spine-like seta plumose on inner margin, four normal plumose setae; first segment of endopod as long as second, third half this length; first segment as wide as long, outer margin rounded and covered in cilia, inner margin one-quarter length of outer and bearing a long plumose seta; second segment subrectangular, width three-quarters length; third segment rounded distally, length half width, with four plumose setae and two much shorter non-plumose setae.

FOURTH PEREIOPOD biramous, each ramus of one segment, basipod as long as endopod, endopod two-thirds length of exopod; basipod as wide as long, with a small spine on outer distal angle, and a group of very small spines just proximal to this spine; exopod subovate, width two-fifths length, with very short spines along outer margin, two short spines on expansions on outer margin, three spines on outer

distal area, and five small spines along distal half of inner margin, with groups of very small spines associated with their bases; endopod subovate, width half length, a row of very short spines on outer margin, a subcircular group of very short spines on outer distal area, and four small spines on slight swellings of the outer and distal margins, each with an associated group of very small spines.

FIFTH PEREIOPOD a slender spine-like process from ventral surface of posterior processes of genital segment; 0.7 mm long with one terminal spine and a more slender subterminal spine.

DESCRIPTION

MALE (Figs 9-15) overall length 5.3 mm-5.9 mm (measurements from eight males).

CARAPACE as wide as long or a little wider (2.7 mm-2.9 mm x 2.8 mm-3.2 mm), frontal plate three-quarters carapace width, very short, slightly curved convexly; median area two-thirds carapace width, bordered laterally for half its length by longitudinal ribs which converge slightly anteriorly, and anteriorly by short ribs extending postero-medially from immediately posterior to first antennae; lateral areas extending beyond sublinear posterior margin of median area for a distance equal to one-quarter carapace length, divided by a transverse rib between posterior margin of median area and lateral margin two-thirds of distance from anterior carapace margin; posterior margin of lateral areas rounded, free margin of lateral areas bordered by a flange which is somewhat truncated posteriorly.

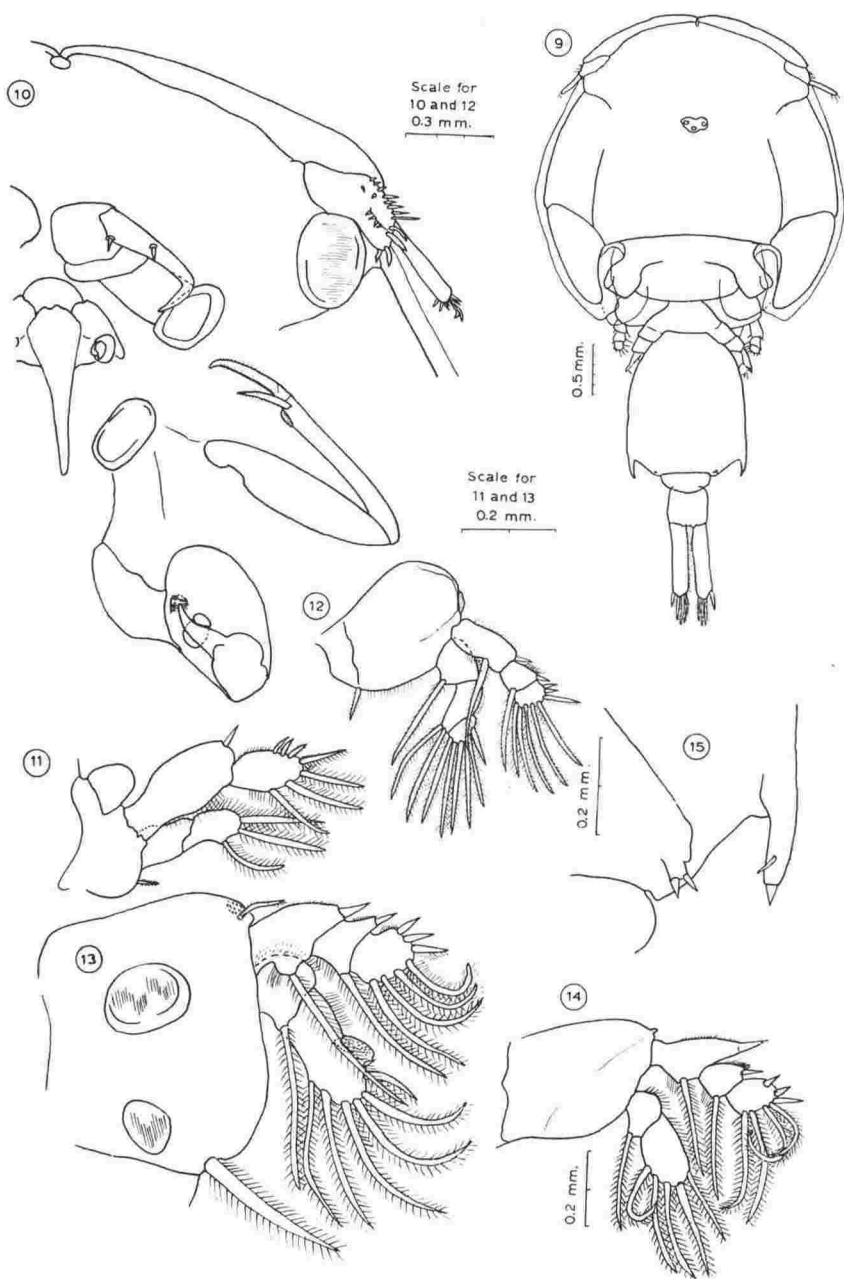
SECOND SEGMENT incompletely fused to third, width three times length (0.4 mm-0.5 mm x 1.2 mm-1.3 mm), with subrectangular plates extending from posterior angles, as long as segment, width three-quarters length, anterolateral angles swollen dorsally, their free margins surrounded by a broad flange.

THIRD SEGMENT, width twice length (0.5 mm-0.6 mm x 1.0 mm-1.1 mm), subovate.

FOURTH SEGMENT length half width (0.3 mm-0.4 mm x 0.7 mm-0.8 mm), width narrowing to half anteriorly, with small lateral subrectangular plates which increase width of segment by one-third and are as long as wide.

GENITAL SEGMENT a little longer than wide (1.3 mm-1.5 mm x 1.1 mm-1.2 mm), lateral margins parallel for two-thirds their length, narrowing anteriorly and posteriorly, these margins half segment width.

ABDOMEN of two segments; first segment, length two-fifths width (0.2 mm-0.3 mm x 0.5 mm-0.7 mm), anterior margin sublinear, lateral and posterior margins combined in an entire curve; second segment subrectangular, angles rounded, as wide as long (0.3 mm-0.4 mm x 0.3 mm-0.4 mm).



FIGS 9-15—*Echthrogaleus denticulatus* male. Fig. 9—dorsal view; 10—antennae and mouth parts; 11—first pereiopod; 12—second pereiopod; 13—third pereiopod; 14—fourth pereiopod; 15—fifth and sixth pereiopods.

CAUDAL RAMI much longer than abdomen (0.7 mm), width two-ninths length, lateral and inner margins sublinear and parallel, four plumose setae on rounded posterior margin, and cilia on inner margins.

FIRST AND SECOND ANTENNAE, MOUTH TUBE, SECOND MAXILLA, AND FIRST AND SECOND MAXILLIPEDS as in female.

FIRST PEREIOPOD biramous, each ramus of two segments, endopod four-sevenths length of exopod; basipod two-thirds length of endopod, length half width, with a flattened semicircular projection two-thirds basipod length on outer distal angle, and a short plumose seta on rounded inner distal angle; second segment of exopod half length of first, first segment subrectangular, width half length, a spine on rounded outer distal angle, and cilia along inner margin; second segment subovate, width half length, with three spines, a seta plumose along inner margin, and three fully plumose setae around rounded distal margin, cilia on inner and outer margins; first segment of endopod as long as second, both subrectangular, width in both two-thirds length; second segment has three long plumose setae on distal margin, cilia on outer margin.

SECOND PEREIOPOD biramous, each ramus of three segments, endopod as long as exopod; basipod as long as exopod; length four-fifths width, a row of cilia on posterior margin, and a group of spines on a small raised area on rounded outer distal angle; second and third segments of exopod together four-fifths length of first, third segment three-quarters length of second, first segment subrectangular, width half length, bearing cilia on both margins, a spine on outer distal angle and a plumose seta on inner margin; second segment as wide distally as long, two-thirds this width proximally, with cirri along outer margin, a spine on outer distal angle, and a plumose seta on inner distal angle; third segment subsemicircular, proximal margin sublinear, length three-quarters width, with two spines on outer distal area, a seta plumose only on inner margin, and five normal plumose setae around distal and inner margins; first segment of endopod as long as second, third half this length; first subrectangular, width three-quarters length, outer margin curved convexly, with cilia along outer margin and a long plumose seta medially on inner margin; second subrectangular, width half length, inner distal angle expanded to constitute one-third length of segment, with cilia along outer margin, and two long plumose setae on inner distal angle; third segment subsemicircular, proximal margin sublinear, length two-thirds width, with a tuft of cilia on outer margin and six long plumose setae on distal and inner margins.

THIRD PEREIOPOD biramous, rami subequal in length, exopod of three segments, endopod of two; basipod longer than exopod, width four-fifths length, with two subovate striated adhesion pads on midline, a group of very small spines on posterodistal angle and a plumose seta on this angle, rami borne distally on posterior margin; first segment of exopod as long as second and third combined, second two-thirds length of third; first segment with expanded outer distal angle, so that inner margin is two-thirds length of outer, width three-quarters length, cilia

on distal half of outer margin, a stout spine on outer distal angle, a long plumose seta and proximal tuft of cilia on expanded median third of inner margin; second segment, length two-thirds distal width, narrowing to two-thirds this width proximally, a row of cilia along outer margin, a spine on outer distal angle, a long plumose seta on inner distal angle, and long cilia along inner margin; third segment subovate, as wide as long, with cilia on outer region, two spines on outer distal region, a short seta plumose only on inner margin, and four long fully plumose setae on distal and inner distal regions; first segment of endopod half length of second, length four-fifths width, outer margin twice length of inner, with long cilia on outer margin and a long plumose seta on inner distal angle; second segment, width two-fifths length, rounded distally, with cilia along proximal three-fifths of outer margin, distal two-fifths occupied by an ovate projection covered in very small spines, with a small distally directed spine near its proximal base and a further small spine directed along its distal margin, rounded distal margin has one short seta plumose only on inner border, and five long fully plumose setae.

FOURTH PEREIOPOD biramous, exopod of three segments, endopod of two; basipod as long as exopod, subrectangular, width four-fifths length, inner distal angle rounded, a small subcircular protrusion from outer distal angle; second and third segments of exopod together two-thirds length of first, second as long as third; first segment with expanded spine-like outer distal angle constituting two-fifths length, medial width two-fifths length, narrowing to two-thirds this width proximally, with very small spines along outer margin, a plumose seta on inner margin and a short row of cilia just proximal to this seta; second segment as wide distally as long, half this width proximally with cilia along outer margin, a spine on outer distal angle, a long plumose seta on inner distal angle, and a row of long cilia just proximal to this seta; third segment subovate, as long as wide, with two spines on outer distal region, a non-plumose seta and four plumose setae on distal region; first segment of endopod half length of second, as wide as long, with long cilia on rounded outer margin, and a plumose seta on inner margin; second segment rounded distally, width half length, with cilia along outer margin and five long plumose setae on distal and inner distal areas.

FIFTH PEREIOPOD posteriorly directed, spine-like, borne on lateral margin of genital segment one-sixth distance from posterior margin, length one-sixth of segment length, width one-quarter length, tipped with a stout spine, and with a further slender spine just proximal to this.

SIXTH PEREIOPOD represented by a subrectangular protrusion just lateral and anterior to attachment of abdomen to genital segment, with a spine medially, and a non-plumose seta laterally on distal margin.

DISCUSSION

Following its original description by Thomson *Dinematura neozelanica* was transferred to the genus *Echthrogaleus* by Basset-Smith

(1899, p. 464) and recently synonymised with *E. denticulatus* Smith by Cressey (1967, p. 56). The morphological agreement of the present collection with previous descriptions of the species supports Cressey's action.

Cressey also suggests that the specimen described by Thomson as a male of *Pandarus armatus* Heller is really the male of *E. denticulatus*. I have previously pointed out (Hewitt 1967) that I believe the female described by Thomson as *P. armatus* is in reality *P. cranchii*, but I have not been able to locate Thomson's specimens. However, I support Cressey's suggestion since Thomson's descriptions of the males of "*Dinematura neozealanica*" and "*P. armatus*" are very similar and the apparent differences in the figures are made less significant by a drawing in Thomson's workbook labelled "*D. neozealanica*, male" which is intermediate between the two published drawings. This shows, for example, in the detail with which the dorsal plates are drawn.

Previous records of *E. denticulatus* include:

NORTH-WEST ATLANTIC—on *Carcharodon carcharias* at Vineyard Sound, Woods Hole, Mass. (Smith 1874, p. 282).

INDIAN OCEAN—on *Alopias vulpinus* at 6°13'N, 63°29'E, 7°17'N, 55°00'E, 9°24'N, 54°58'E; on *A. pelagicus* at Majunga, Madagascar; on *Carcharhinus falciformis* at 14°36'N, 55°23'E (Cressey 1967, p. 56).

NORTH-WEST PACIFIC—on *A. pelagicus*, *Prionace glauca* and *Isurus oxyrinchus* at Owase, Mie Prefecture, Japan; on *Sphyrna zygaena* at Hamajima, Mie Prefecture, Japan (Shiino 1954, p. 297, 1959, p. 352).

NORTH-EAST PACIFIC—on *A. vulpinus* at 11°15'N, 113°26'W; on *Carcharhinus falciformis* at 7°47'N, 102°37' W (Cressey 1967, p. 56).

It is unfortunate that the captain of the whaling barque *Splendid*, who collected Thomson's specimens of *E. denticulatus*, did not record the host, locality, or date. Presumably the specimens were collected sometime between Thomson's preliminary note on New Zealand parasitic Copepoda (1885, p. 455)—which contains no reference to specimens of "*Dinematura*"—and the wreck of the *Splendid* early in 1890.

At this time the *Splendid* is described as having been in the "inter-colonial" trade (Ingram and Wheatley 1960, p. 241) but her last runs were along the New Zealand coast and, since Thomson described "*D. neozealanica*" as one of several "Parasitic Copepods from New Zealand", one may assume the specimens were collected in New Zealand waters.

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THE CEPHALIC AND IMMEDIATELY
POSTCEPHALIC APPENDAGES OF CALIGOID COPEPODA

by

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ABSTRACT

Recent authors have applied a variety of names to the seven pairs of structures which are derived from the cephalon, or from immediately posterior to it; analogies with the external morphology of free-living copepods cannot be the sole criterion for homology of these structures; supporting evidence from anatomy and embryology is discussed; the first two pairs are antennae; the next pair maxillae or, more probably postantennal processes; the mandibles are derived from the mandibles of the nauplius; the structures lateral to the mouth tube are maxillae or mandibular palps, the author preferring the latter term; there is no evidence that the penultimate pair are other than maxillae; the final pair are true maxillipeds. There is need for further research to resolve the nature of the structures in doubt, and remove the confusing conflict of terminology at present in use.

There has been considerable discussion over the years as to the homologies of the cephalic and immediately postcephalic appendages of parasitic Copepoda. The appendages of these animals have been compared both within the group and with the appendages of various free-living forms. On this basis various authors have suggested various methods of naming these appendages.

Unfortunately this comparison has been chiefly of the external shape and segmentation of these appendages. It is now widely recognised that form and function in animal morphology are closely related, and that strong selection pressures can cause rapid evolutionary changes, at least in the alteration of structures already present. Parasitic Copepoda occur in a variety of environments, the mobile forms moving more or less rapidly over the outsides of fishes, while other forms are immovably fixed to a gill filament; similarly pelagic Copepoda have a wide range of environment (Wickstead, 1962, p. 547). Under such widely different conditions appendages must be put to many very different uses, and widely different variations be selected for. In addition, groups with previously divergent evolutionary histories on occasion adopt similar modes of life, as is seen in the parasitic copepods which are clearly polyphyletic. Under these circumstances it might be expected that different appendages might take on similar functions in different groups and thus undergo convergent evolution, while in other cases the same appendage might be used quite differently and thus under the pressure of quite different selective forces in closely related forms.

Under these circumstances arguments of analogy of appendages within the Copepoda need to be supported from other sources. In the absence of fossil material to indicate

the original condition of these appendages, the most obvious sources of additional evidence are embryological and anatomical studies.

I have been led to re-examine what evidence is available from these fields, so far as they effect the Caligoida, because of the wide range of terms in use by recent authors.

There are seven pairs of structures referred to as cephalic or immediately postcephalic appendages by various authors. The first two pairs are situated near the anterior margin of the cephalon, considerably anterior to the mouth tube. The first pair is filiform, the second usually subchelate and used to attach the parasite to its host. These are always referred to as the first and second antennae or antennules and antennae. These terms are directly equivalent and, since this terminology is established I do not intend to discuss them further.

The following five pairs of structures are hereafter referred to by number to avoid confusion. They are:

1. A spine (e. g. Caligidae), adhesion pad (Pandaridae), possibly a stout suboval chitinous structure (Anthosoma crassum), situated posterior or posterolateral to the second antenna.
2. The long narrow biting structure contained within the mouth tube.

3. The structure immediately lateral to the mouth tube, which may be spinous (e. g. Caligidae) or apparently segmented (e. g. some Dichelesthidae) and possibly a seta-like structure in some Anthosomidae (Hewitt, 1968, in press) and Lernaeidae (Kabata, 1963, p. 314).
4. and 5. Two pairs of uniramous and usually two-segmented appendages situated posterior to the mouth tube; the second usually a subchelate appendage with which the parasite grips the host.

Names used for these structures by recent authors include:

Author	1	2	3	4	5
Cressey (1967)	postantennal process	mandible	first maxilla	second maxilla	maxilliped
Heegaard (1962)	first maxilla	"	second maxilla	first maxilliped	second maxilliped
Hewitt (1967)	"	"	"	"	"
Ho(1966)	postantennal process	"	first maxilla	second maxilla	maxilliped
Kabata (1966)	"	"	postoral process	maxilla	"
Lewis (1966)	"	"	"	"	"
Parker (1965)	first maxilla	"	second maxilla	first maxilliped	second maxilliped
Shiino and Izawa (1966)	"	"	"	"	"

The contemporary use of three different terminologies for these structures is unfortunate. Heegaard (1947a), Lang (1946) and Bocquet and Stock (1963) have reviewed the discussion of the homologies and analogies of these structures. It is my intention here to summarise the evidence which I consider is not based too strongly on analogy.

1. This structure was called the first maxilla by Scott (1902, p.197) "with some doubt", because its nerve from the suboesophageal ganglion has its origin close to that of structure 3, which he refers to as the second maxilla. Heegaard (1947a, p.204) supports Scott's findings, but the findings of both Scott and Heegaard are strongly doubted by Lang (1946, p.6, 1948, p.30) who states that he can find no sign of such innervation.

Wilson (1905, p.543; 1911, p.323), Gurney (1947, p.494), Lang (1946, p.7) and Lewis (1963, p.222) all agree that this process is formed later in development than the other mouthparts. Heegaard (1947a, p.205) states that this is because the structure has become rudimentary and quotes other examples of rudimentary appendages appearing late in development.

In the very earliest stages of its development (Heegaard, 1947a, p.205, and Lewis, 1963, p.222) this structure appears to be two segmented or spinous with two setule bearing nodules. From the drawings by these two

authors it appears that even at this stage it could be interpreted as a spine bearing seta.

Obviously, further evidence is required before it can finally be said that this structure is a maxilla or a process. Until that time I prefer the use of the term post antennal process or pad on the grounds that this describes accurately the position and adult form of this structure.

2. So far as I am aware, nobody has seriously doubted that the biting structure within the mouth tube of caligoid copepods is the mandible. Lang (1946, p.18) argues that there is no mandible in the peocilostome Cyclopoida, but Bocquet and Stock (1963, p.261) present arguments that a true mandible is present in this group also, with the possible exception of the Mytilicolidae.
3. The structure beside the mouth tube, although it appears spinous in adult caligids and some other groups, is clearly very like an appendage in some caligoids, even to having an apparently biramous structure. The difficulty arises in deciding which appendage it is. Most recent authors have referred to it as a maxilla. However, it seems that the view of Oakley (1930), and other authors of this era, that this is actually a mandibular palp, cannot be entirely dismissed. The evidence in favour of this view is that this structure is often closely associated with the mandible,

as is clearly seen in species of Nemesis when the mouth tube is removed (see plates A and B) and in Lernaeocera is actually inside the mouth tube with the mandible (Kabata, 1962, fig. 4a). Heegaard (1947a, p. 200) opposes the view that this structure is a mandibular palp on the grounds that it is not of the form to be expected if it were formed from the mandibular exopod, as would be required if his view that the mandible in this group is formed from the protopodite and the endopodite of the nauplius mandible were accepted. He further argues that in some Chondracanthidae (Cyclopoida) it is well separated from the mandible. However, the change in these associated structures from the nauplius, which has a mandible and palp to the copepodite with a "naked" mandible and more or less closely associated appendage takes place in one moult (Gurney, 1934; Lewis, 1963). Under these circumstances there is, as yet, no direct evidence on the structure of the mandible, (though Gurney, 1947, p. 499 believes it is developed from the coxa) nor its relationship to the associated appendage. Nor is evidence from anatomy available to inform us whether this is a mandibular palp or maxilla. The significance of the slight separation between the mandible and the other structure is open to conjecture in the absence of other evidence, but does not seem sufficient in itself to exclude the possibility that this is a mandibular palp.

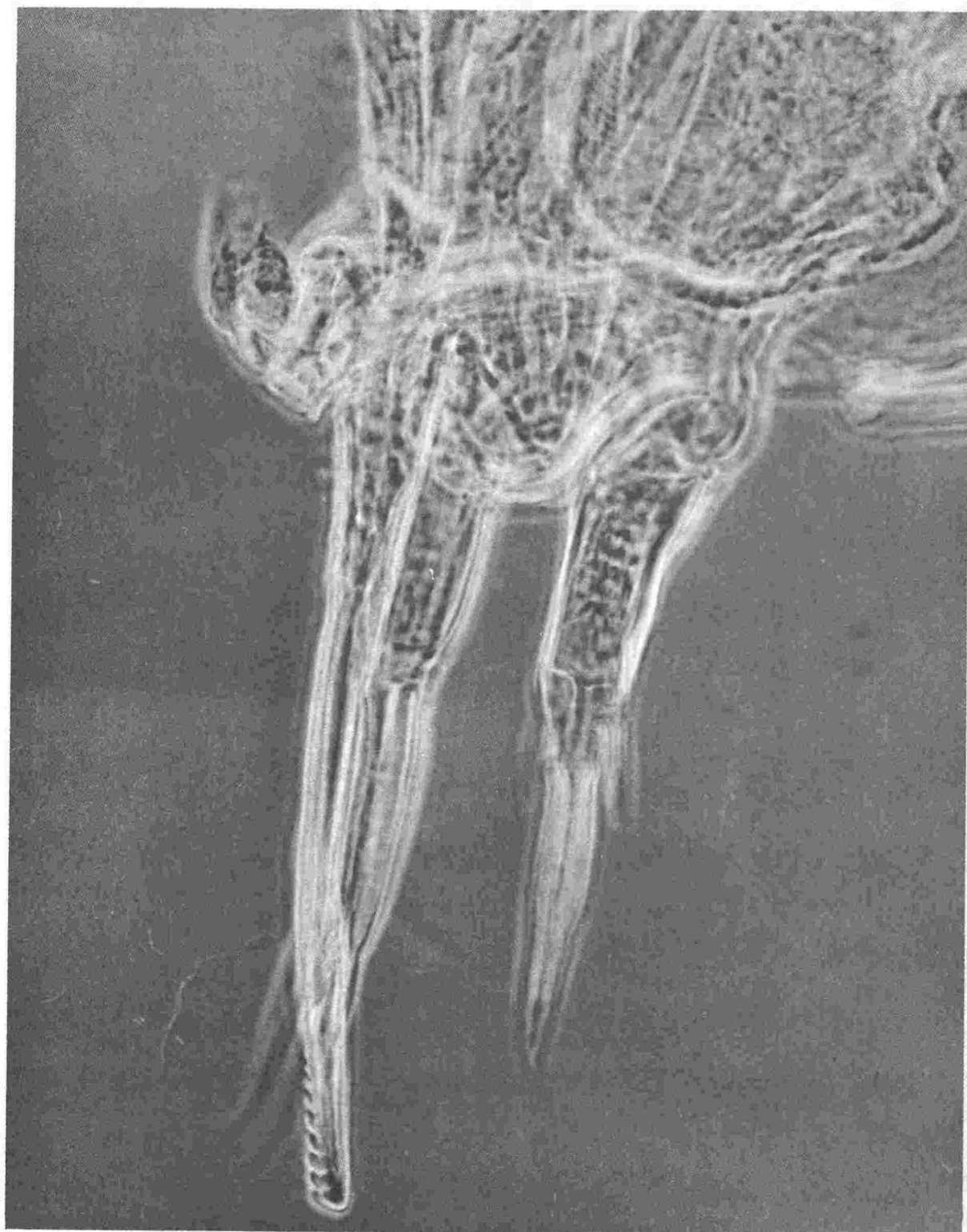
Caption for Plate A.

Plate A

Nemesis lamna Risso - female:

mandible and associated appendage.

PLATE A



0.05 mm.



Caption for Plate B

Plate B

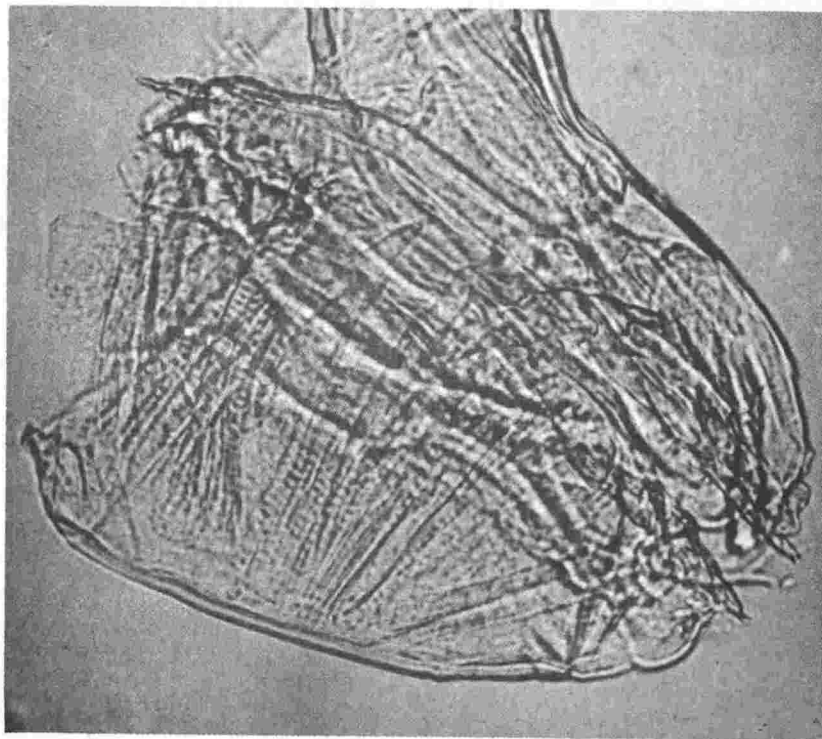
Nemesis robusta (van Beneden) male:

1 - mouth tube

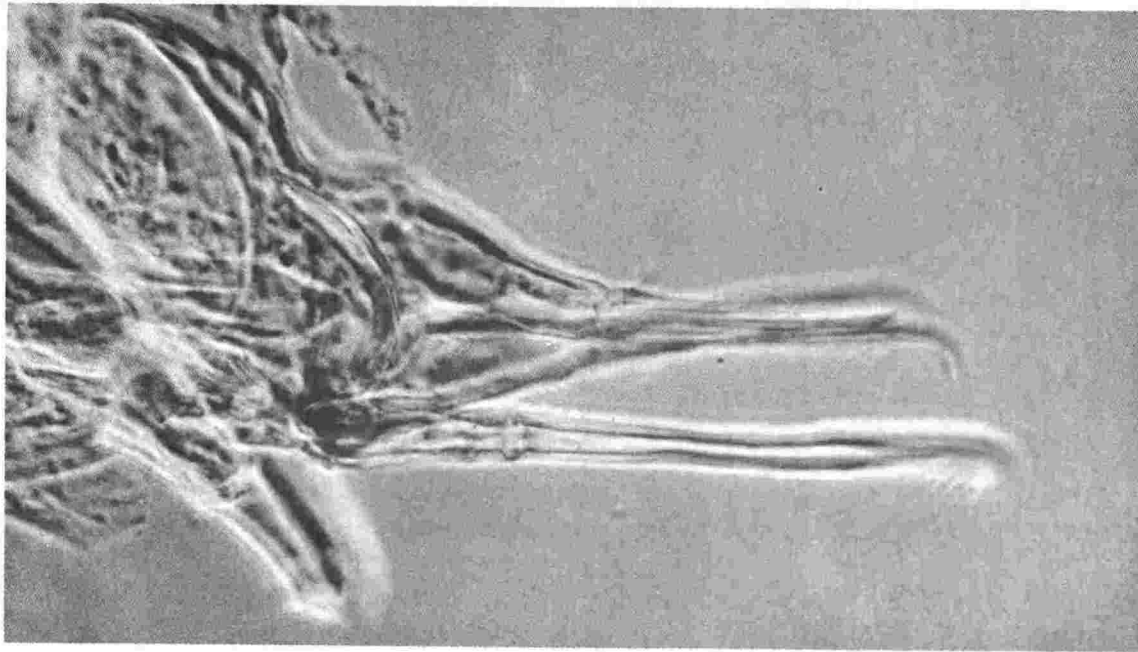
2 - mandible and associated appendage.

PLATE B

①



②



0.1 mm.

Again, further evidence is required. Until it is available I prefer the term mandibular palp as indicating the position of the structure and its difference in form from other cephalic appendages which have been referred to as maxillae.

4. and Those previous authors who have called the structures
5. 1. and 3. (above) the first and second maxillae have had to assume that these two appendages were both maxillipeds. Evidence from embryology (e.g. Lewis, 1963, p.199) suggests that the second of these appendages is formed from the fusion of a thoracic segment with the cephalon, following the copepodite stage and is thus a true maxilliped. There is no evidence that this is true of the first. So long as there is doubt as to the nature of the structures 1 and 3 (above), the need to assume that caligoid copepods differ from all free-living copepods, in having two pairs of maxillipeds rather than one, does not exist. Under these circumstances it seems preferable that the first of these two pairs of appendages should be recognised, in the meantime, as a maxilla.

In summary, I suggest the use of the terms first and second antennae, postantennal process, mandibular palp, maxilla and maxilliped for the six paired structures of the cephalon of caligoid copepods (recognising that the last pair are thoracic in origin). It seems probable that when further evidence is

available the postantennal process or the structure I have called a mandibular palp will prove to be a further maxilla, or else it will be shown that one maxilla has been lost in the evolution of the group.

It is not expected that the names suggested in this paper for the paired cephalic structures will be accepted by all other students of the Caligoida. It is rather my hope that this discussion may encourage further studies, particularly of comparative anatomy and embryology, which may finally decide this issue.

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CECROPS LATREILLII LEACH
(CECROPIDAE, COPEPODA) ON MOLA MOLA
IN NEW ZEALAND WATERS

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ABSTRACT

Cecrops latreilli is redescribed from material from a stranded Mola mola in Wellington Harbour. Previous records from localities and hosts elsewhere are discussed. Mola mola seems to be the normal host although Rhombus maximus and Thunnus thunnus have also been recorded. Despite its wide distribution Cecrops latreilli exhibits little morphological variation.

Introduction

Although there have been many records of the sunfish, Mola mola, in New Zealand waters (McCann, 1961) there have been only two records of the parasite Cecrops latreillii Leach which has so frequently been recorded from it overseas (see Discussion below). The first record (Thomson, 1889, p.362) was from Mola mola taken in Otago Harbour. The second record (McCann, 1961, p.17) is from a Mola mola stranded in Wellington Harbour, about a mile and a half beyond the Eastbourne Bus Terminus, on 9 June 1951.

Thomson gives some figures of the female of Cecrops latreillii, and McCann gives photographs of both male and female. However, no complete description of Cecrops latreilli from the South Pacific has been published. It is the purpose of this paper to provide such a description. The author is most grateful to the Dominion Museum, Wellington, for placing at his disposal the three male and three female specimens (Dom. Mus. No. ZG619) collected by McCann. Two of the male specimens were attached to females.

Cecrops latreillii Leach 1816

C. latreillii Leach 1816, p.405, pl. 20.

C. latreillii Leach, Thomson, 1889, p.362 - 3, pl. 26, figs 3, a-f.

C. latreillii Leach (?), McCann, 1961, p.17, Ipl.

The name of this species has been variously spelt as C. latreillii and C. latreillei. Leach presumably made the ending -ii by Latinizing Latreille, substituting -ius for -e, thus making the genitive -ii. While this procedure is not recommended by the International Code of Zoological Nomenclature, 1961 (Appendix D III 16 (b)), it is not prohibited, and therefore Leach's name must be considered a "correct original spelling" (Article 32(a)).

Description

Colour

In life the colour is mostly ivory with the plates of the abdominal region a pale iridescent green-blue (according to McCann, 1961). In alcohol the specimens are yellow-brown with dark brown tips to the second antennae and maxillipeds.

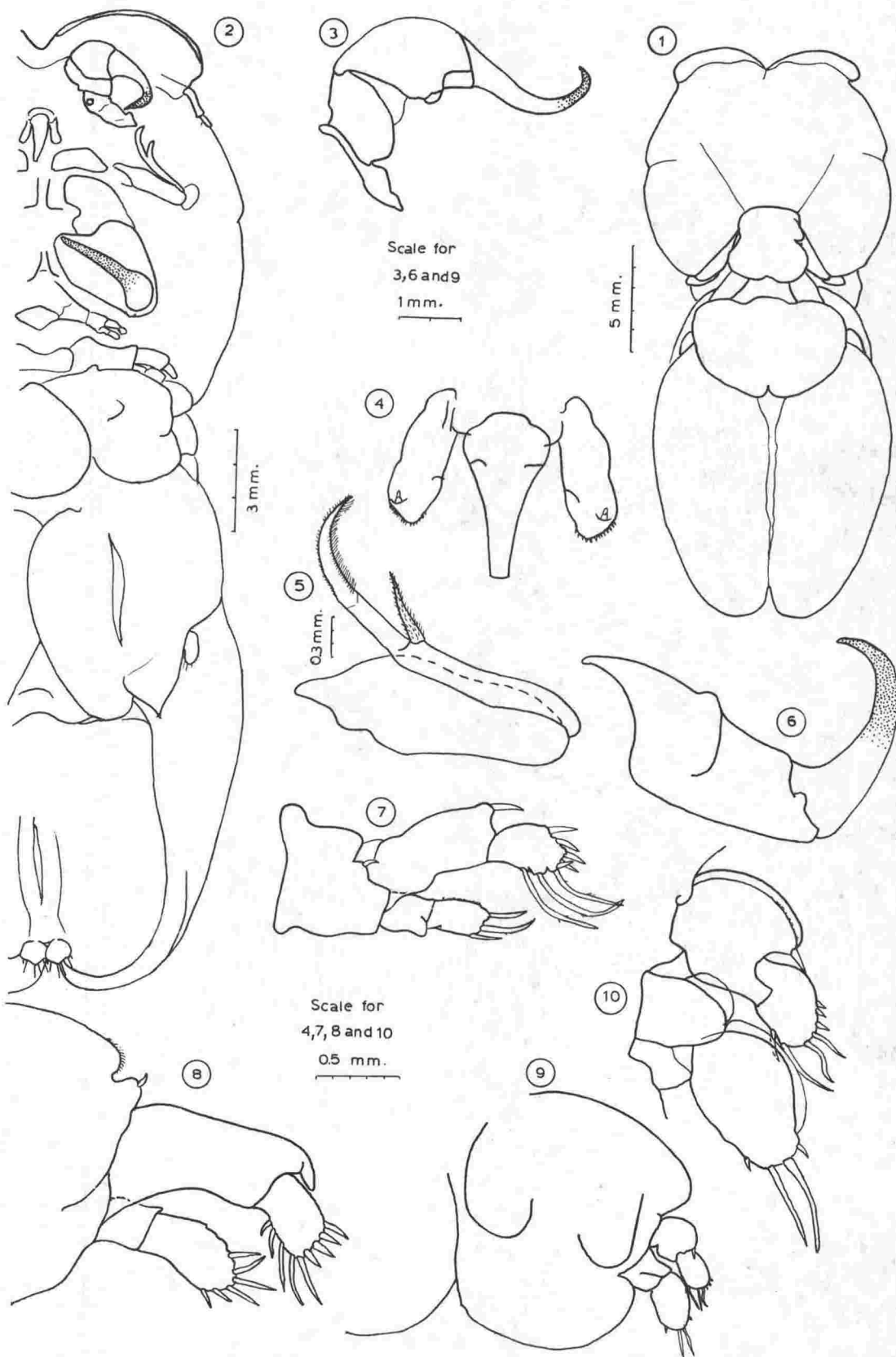
Female (figs 1-11)

Overall length 26.2 mm - 28.3 mm.

Cephalothorax subovate, as wide as long (11.1 mm - 11.3 mm x 10.3 mm - 11.2 mm); frontal plate three-quarters carapace width (8.3 mm - 8.8 mm), length one-tenth width, much shorter medially, both halves curved forward, lateral margins curved out beyond anterior termination of lateral areas; lateral margin of lateral areas an entire curve except that a slight indentation marks the origin of a short transverse rib one-third distance from anterior of margin; posterior lobes extend beyond median posterior margin for almost one-third length of cephalothorax; median posterior margin sublinear, one-quarter cephalothorax width, with anterolateral ribs extending from its outer angles for a distance equal to one-third cephalothorax length.

Second and third thoracic segments incompletely fused, wider than long (3.3 mm - 3.4 mm x 3.3 mm - 3.9 mm); anterior width three-quarters posterior width, angles rounded, somewhat narrowed medially.

Cecrops latreillii Leach 1816. Female. 1: dorsal; 2 : ventral;
3 : second antenna; 4 : mouth tube and mandibular palps; 5 :
maxilla; 6 : maxilliped; 7 : first pereopod; 8 : second pereopod;
9 : third pereopod; 10 : rami of third pereopod (detail).



Fourth thoracic segment subovate, wider than long (4.9 mm - 5.6 mm x 7.3 mm - 8.3 mm), posterior margin with a shallow median incision.

Genital segment longer than wide (12.4 mm - 12.7 mm x 10.5 mm - 11.8 mm), subovate, lateral and posterior margin forming an entire curve except for a posterior median incision one-ninth length of segment.

Abdomen hidden in dorsal view by overlapping genital segment, subrectangular, longer than wide (7.0 mm - 7.2 mm x 6.0 mm - 6.7 mm), posterior angles rounded.

Caudal laminae near midline of posterior margin of abdomen, subrectangular, longer than wide (0.8 mm x 0.7 mm); distal margin slightly pointed medially, with four long setae and with single small setae lateral and medial to these four.

Egg strings coiled between the broad flattened abdomen and the posterior projection of the genital segment.

First antenna two segmented, first segment twice length of second, four times as long as wide; second segment about twice as long as wide, rounded distally; setae present on both segments but damaged.

Second antenna, first segment two-thirds length of second, two-fifths length of third, subrectangular; second segment longer than wide, slightly curved; third segment strongly curved, basal width one-third length, distal two-fifths darkly pigmented.

Mouthtube 1 mm in length, basal width half length, narrowing to one-quarter this width distally.

Mandibular palp little shorter than mouthtube, three segmented, basal segment one-third as wide as long, irregularly rounded distally, with a row of spines on distal margin; second and third segments together one-ninth first segment length, subequal in length, situated near outer distal angle, and directed proximally.

A solid chitinous swelling immediately posterior to palp is as wide as mouthtube is long, half as long as wide.

Maxilla, two segmented, first segment three-quarters length of second, width one-third length, distal margin rounded; second segment narrow, width one-fourteenth length, with a ciliated branch which narrows steadily to a sharp point situated medially on outer margin, distal half of segment narrowing gradually to a point, with rows of cilia on distal two-fifths of its length.

Maxilliped of two segments, segments subequal in length, first segment subrectangular, width one-third length, bearing a transverse swelling medially against which second segment closes; second segment a powerful claw, basal width one-third length, narrowing steadily to a sharp point distally, strongly curved, distal half darkly pigmented.

First pereopod biramous, each ramus of two segments; basipod half length of exopod, subrectangular, as wide as long, with a small seta near base of exopod; first exopod segment twice length of second subrectangular, width half length, with a spine on outer distal angle; second segment subovate, width two-thirds length,

with five spines on outer distal and distal margins, and three sparsely plumose setae on inner distal region; first segment of endopod a little shorter than second, as wide as long, with a swelling on inner distal angle; second segment subrectangular, distal margin rounded, width half length, with a row of very short spines on outer margin and three sparsely plumose setae distally.

Second pereopod biramous, each ramus two segmented; basipod one and one-half times exopod length, subrectangular, width two-thirds length, with a row of short cilia on outer distal angle and a very short seta on a projection near base of exopod; first exopod segment subrectangular, basal width two-thirds length, narrowing distally, with a stout spine on outer distal angle; second segment two-fifths length of first, subrectangular, distal angles rounded, width two-thirds length, with four spines on distal margin and five setae on outer and outer distal regions; first endopod segment half length of second, subrectangular, as wide as long; second segment subrectangular, rounded distally, width half length, bearing six setae on distal region.

Third pereopod biramous, each ramus two segmented; basipod three times exopod length, subrectangular, angles rounded, as wide as long; first exopod segment subequal in length to second, as wide as long, outer margin rounded, with a spine on outer distal angle; second segment subovate, width two-thirds length, with three spines on outer distal region and three setae on inner distal region; first endopod segment two-thirds length of second, subrectangular, as wide as long; second segment subovate, width two-thirds length,

with two long setae and two short setae which are placed on either side of the longer setae.

Fourth pereopod biramous, each ramus of one segment, the endopod fused with the basipod; basipod five times exopod length, subovate, a little longer than wide, terminating distally in two lobes, the medial lobe rounded, the lateral lobe which includes endopod pointed, the rami attached lateral to the pointed lobe, the basipod bulging dorsally for half its length, to produce a narrow longitudinal hollow when viewed from the ventral aspect and a tortuous dorsal fold; exopod segment subovate, width half length, with three spines on outer distal margin and three setae on inner distal margin; a further seta is carried on the basipod lateral to the ramus; endopod reduced to a pointed lobe fused to basipod and with two small setae near distal point.

Male (figs 12 - 23)

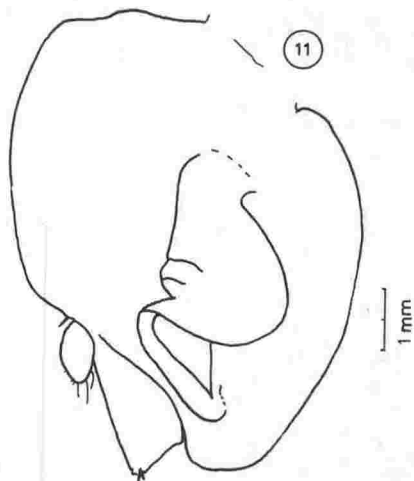
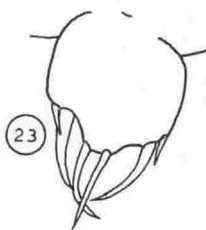
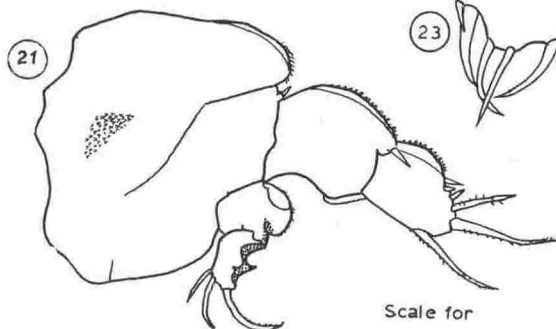
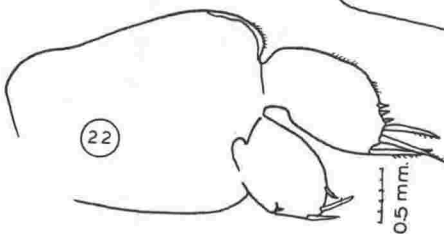
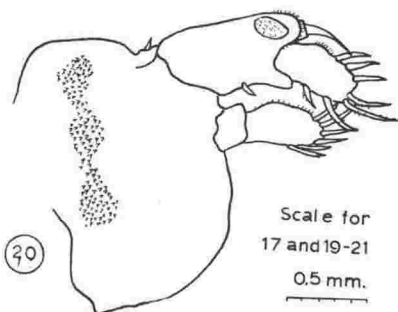
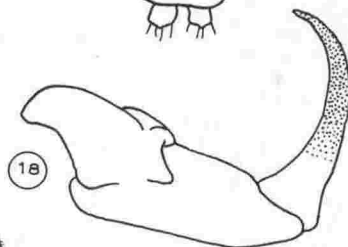
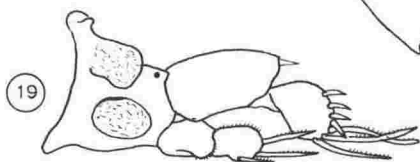
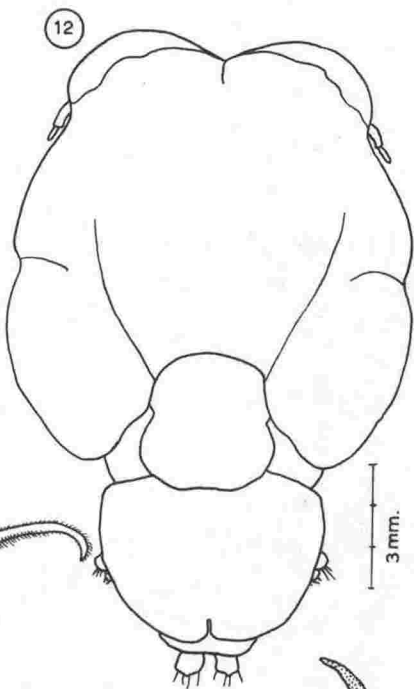
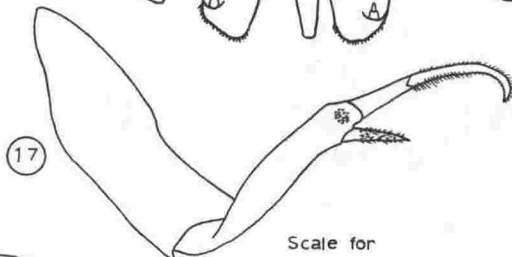
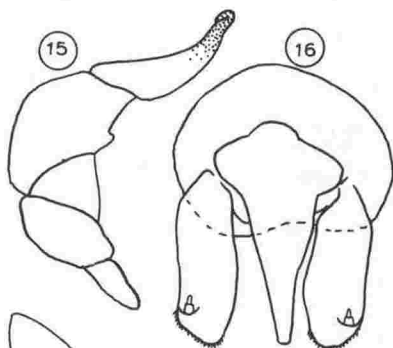
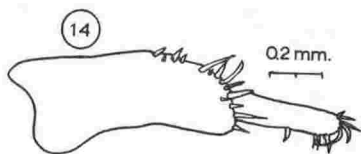
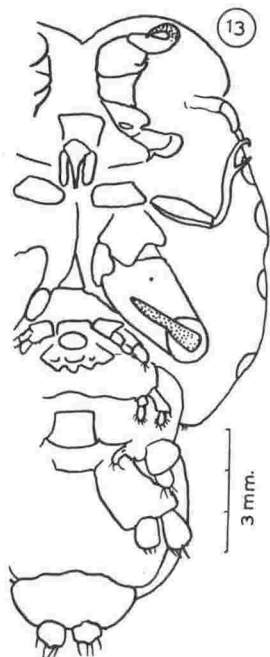
Overall length 11.5 mm - 14.8 mm.

Cephalothorax subovate, wider than long (7.8 mm - 8.8 mm x 8.3 mm - 9.5 mm); similar in form to that of female.

Second and third thoracic segments fused as in female, wider than long (2.3 mm - 3.0 mm x 2.8 mm - 3.3 mm); form similar to that of female.

Fourth thoracic segment wider than long (3.2 mm - 3.7 mm x 4.6 mm - 5.4 mm), anterior margin slightly curved, lateral and posterior margins forming an entire curve except for a median incision in the posterior margin which forms a narrow sinus one-eighth length of segment.

Cecrops latreillii Leach 1816. Female. 11 : fourth pereopod; ventral aspect. Male. 12 : dorsal; 13: ventral; 14: first antenna; 15: second antenna; 16: mouth tube and mandibular palps; 17: maxilla; 18: maxilliped; 19: first pereopod; 20 : second pereopod; 21: third pereopod; 22 : fourth pereopod; 23 : caudal lamina.



Genital segment wider than long (2.0 mm 2.8 mm x 3.0 mm - 4.2mm), subrectangular, posterior angles sharp, anterior angles more rounded, entirely covered in dorsal view by the posterior extension of the fourth segment.

Abdomen wider than long (1.3 mm - 1.3 mm x 2.3 mm - 3.0 mm), narrowing somewhat posteriorly, angles rounded.

Caudal laminae as in female

First antenna as in female; setae in this case still present; first segment with ten setae on distal and outer distal regions, with several associated small spines; second segment with about eight setae on rounded distal and inner distal margins, and a further seta on midpoint of inner margin.

Second antenna, mouthtube, mandibular palp, maxilla and maxilliped as in female.

First pereopod as in female except that the seta on the basipod is missing, and there are four spines instead of five on the second exopod segment; the basipod bears two raised areas covered in small spines, the outer margin of the second endopod segment and the curved inner distal angle of the first endopod segment bears very short spines.

Second pereopod as in female except that there is a raised spinous area near outer distal angle of first exopod segment, outer distal angle of exopod segment is covered in short spines and bears a longer and sharper spine than the female, there is a row of very short spines on outer margin of second exopod segment, there are only

three spines and four sparsely plumose setae on second exopod segment, and the outer margin of the second endopod segment bears a row of short spines.

Third pereopod as in female except that there is a short spine near outer distal angle of basipod, outer distal angle of basipod bears a row of short spines as do outer margins of both segments of exopod, first segment of endopod has a swollen outer margin bearing a row of fine spines, outer margin of second segment with a deep semicircular incision, the area about it heavily pigmented, this pigmentation extending on to the unswollen distal portion of first segment, second segment with three sparsely plumose setae distally.

Fourth pereopod biramous, each ramus one segmented, basipod much smaller than in equivalent limb of female, subrectangular, angles rounded, width three-quarters length, distal outer angle with a row of very short spines; exopod half length of basipod, subovate, width two-thirds length, with rows of very short spines on outer margin, three spines on outer distal region, and four sparsely plumose setae on distal margin; endopod four-fifths length of exopod, subovate, width two-thirds length, with a short seta on outer distal angle, two larger setae distally, and a short spine near margin in inner distal region.

Discussion

Cecrops latreillii is an unusually large (female ca 27 mm in length, male ca 13 mm) and distinctive fish parasite.

Only three other species have been described as belonging to the genus Cecrops. Of these C. achantiivulgaris Hesse (1883, p. 26, pl. 5, figs 15 - 20) is very poorly illustrated but, so far as it is possible to tell from these drawings, I am inclined to agree with Wilson (1907, p. 467) that this species does not belong in the genus Cecrops. Wilson (1923, p. 1) mentions another species, C. desmaresti Risso, which he states cannot be a species of Cecrops since Risso states that the legs are uniramous. I have been unable to trace Risso's original description.

The only species besides C. latreillii which can definitely be referred to Cecrops is C. exiguus Wilson 1923 (p. 1, figs 1 - 15). This species can easily be distinguished from C. latreillii by its small size (female 10 mm - 12 mm in length, male 5.3 mm - 6.3 mm); in the female the plate on the fourth segment overlaps the genital segment for about half its length while in C. latreillii it covers only about one-quarter of the dorsal surface of this segment; in the male the fused second and third segment is about twice as wide as long while in C. latreillii it is only slightly wider than long. Wilson recorded this species from the gills of a "large shark" off the south-east coast of Florida and it has since been recorded by Shiino (1965), p. 381) on Mola mola taken at Kuki, Mie Prefecture, Japan.

C. latreillii seems to be much more common than C. exiguus.

Previous records of C. latreillii include:

No locality given: no host recorded (Leach, 1816, p. 405);

on Thunnus thunnus (Milne Edwards, 1840, p. 474).

Atlantic: on Thunnus sp. (Heegaard, 1943, p. 26).

Northwest Atlantic: on Mola mola, Irish and English Coast (Baird, 1850, pp. 289-292);

Firth of Forth and 14 miles E. of Lerwick,

Scotland (Scott, T., 1900, p. 157);

Mallaig, West Coast of Scotland and

Glenluce Bay, Solway Firth, Scotland

(Scott, T., 1901, p. 126);

British Isles and Southern Ireland

(Scott and Scott, 1913, p. 98);

Coast of Lanquedoc, France (van Beneden, 1855, p. 520)

Brest, France (Hesse, 1888, p. 349);

51°19'N, 2°56'E (Stekhoven, 1936, p. 9);

Belgium (van Beneden, 1890, p. 86);

Kattegat (Olsson, 1868, p. 22);

Innriholmur, Iceland (Stephenson, 1940, p. 6).

Mediterranean: on unrecorded host, Portoferraio (Brian, 1906, p. 54).

on Mola mola, (Bassett-Smith, 1899, p. 465);

(Lucas, 1887, p. xxxi);

Genova (Brian, 1898, p. 212);

Naples (Brian, 1906, p. 54).

Adriatic (Valle, 1880, p. 60).

on Rhombus maximus, (Leach, 1819, p. 554);
(Brian, 1912, non vide, after Yamaguti, 1963, p. 89).

on Thunnus thunnus, Adriatic (Heller, 1866, p. 754);
Adriatic (Valle, 1880, p. 60,);
(Lucas, 1887, p. xxxi).

Northeast Atlantic: on Mola mola, Guy's Head, Mass.

(Rathbun, 1884, p. 489);

Woods Hole, Mass. (Wilson, 1907, p. 471);

Martha's Vineyard, Mass. (Wilson, 1932, p. 442).

Southwest Atlantic: on Mola mola, Banana, Congo (Darteville, 1950,
p. 38);

the Cape, South Africa (Barnard, 1955, p. 268).

Northeast Pacific: on Mola mola, coast of California

(Baird, 1850, p. 292);

Pacific coast of the United States (Wilson, 1907,
p. 471).

Northwest Pacific: on Mola mola, Japan (Shishido, 1898, non vide, after
Shiino, 1959, p. 354);

Shirahama, Wakayawa, Japan (Shiino, 1959, p. 354);

Japan (Yamaguti, 1936, p. 10).

Southwest Pacific: on Mola mola, Otago Harbour, New Zealand

(Thomson, 1889, -p. 363);

Wellington Harbour, New Zealand

(McCann, 1961, p. 10).

Why Cecrops latreillii should occur on three such different hosts as Mola mola (the sunfish), Thunnus thunnus (the tunny) and Rhombus maximus (the turbot) is problematical. The only obvious factor in common among these hosts is their size. However, postulating some kind of "size specificity" leaves the question of why this very distinctive parasite has not been found on other species of large fish.

Despite the many records of this species, few authors have given full descriptions or figures. Leach (1816, pl. 20) figures both male and female and gives indications of the structures of some appendages. Desmarest (1825, pl. 50) gives similar figures which may have been taken from Leach. Figures showing most of the appendages are given by Hesse (1888, pl. 14, figs. 1-25) but these are poorly drawn and almost unrecognisable.

The only authors available to me who show or describe details of appendages are van Beneden (1855, opp. p. 527) who gives a dorsal view of the female, ventral views of the female and male, and outline drawings of most appendages, Thomson (1889, pl. 26, figs 3a - f) who gives dorsal and ventral views of the female and detail of the female's pereopods, Wilson (1907, pls. 38 - 39) who describes both male and female and figures some anterior appendages and the pereopods of both sexes, Scott and Scott (1913, pl. 21, figs. 3-4, pl. 27, figs 9-10, pl. 28, figs 1 - 7) who give figures of male and female and most of the appendages of the female, and Yamaguti (1936, pl. 6, figs 62 - 66) who figures the female and shows the

structure of the female pereopods in detail. Yamaguti (1963, pl. 113, figs 1a- f) reproduces the drawings of the female from his earlier paper together with a dorsal view of the male by Wilson (1907).

Although all these figures are from parasites from Mola mola they represent specimens taken from widely separated geographical areas. The only notable differences shown are slight variations in the number of small spines on some of the pereopods, seldom involving more than a single spine, and in the exopod of the second pereopod of Scott and Scott's figures which is shown with two more setae than in drawings by other authors.

Few authors give measurements but those given are all within the range 24 mm - 30 mm for female total length and 10 - 17 for male total length.

One would not be surprised to find variation on this scale in a single geographical area and it seems that, despite its wide distribution, Cecrops latreillii is morphologically an unusually constant species.

ACKNOWLEDGMENTS

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SOME NEW ZEALAND PARASITIC
COPEPODA OF THE FAMILY EUDACTYLINIDAE

by

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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; 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.

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-vide); 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.

Nemesis lamna lamna

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.

Second thoracic segment subrectangular, length free-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.

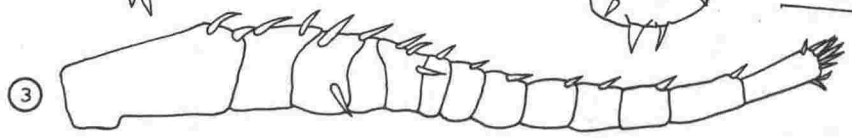
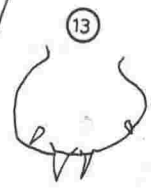
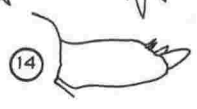
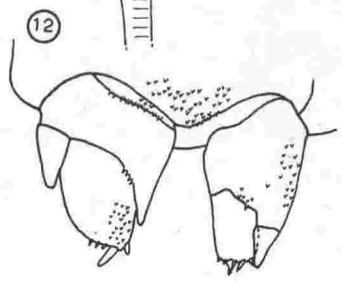
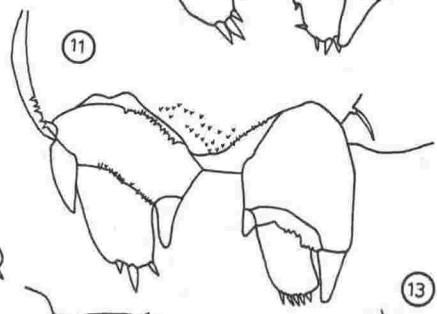
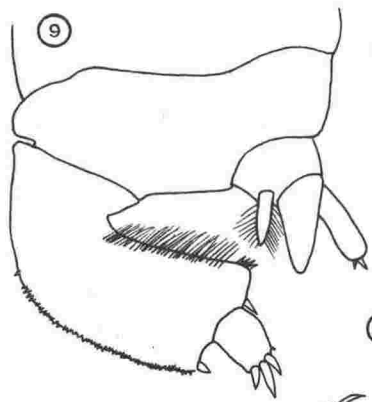
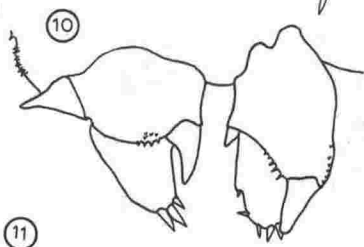
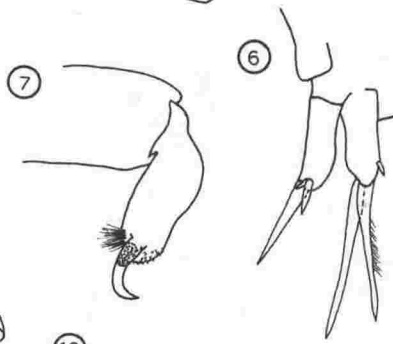
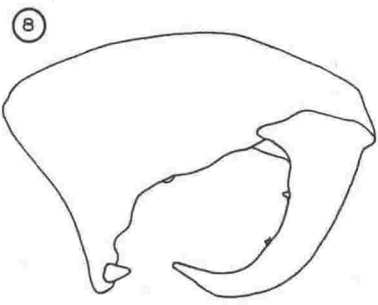
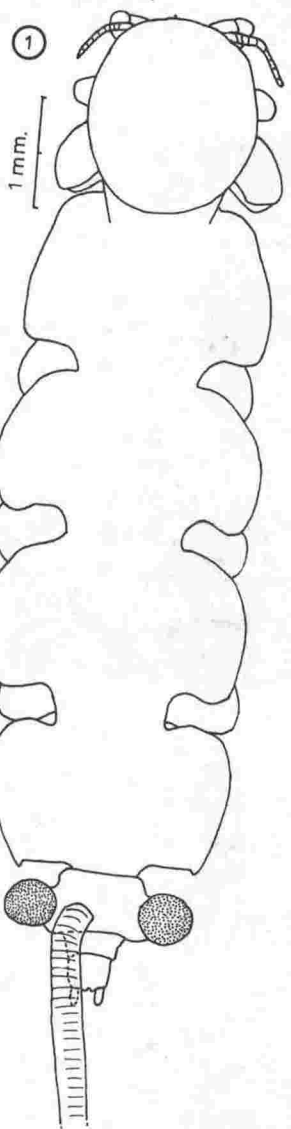
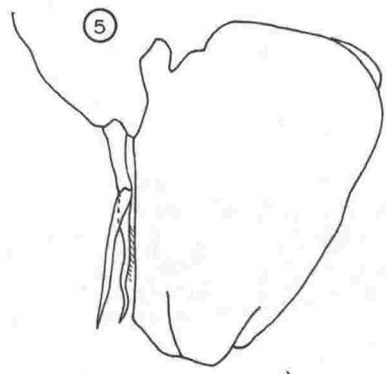
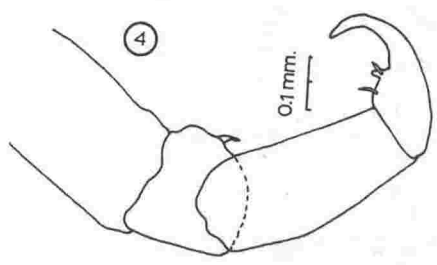
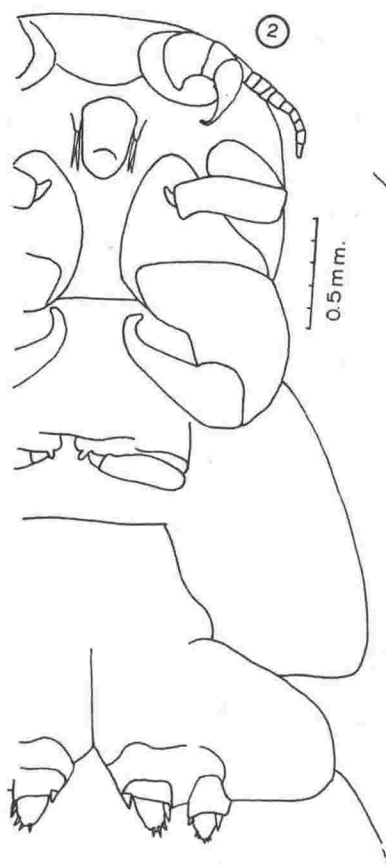
Third thoracic segment subovate, length three-fifths width (1.2 mm - 1.5 mm x 2.2 mm - 2.6 mm) anterior angles broadly rounded, posterior angles rounded and swollen slightly posteriorly; the swelling of the posterior angles, of both second and third segments, is generally more pronounced in specimens 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.

Caption for figs. 1-14.

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.



Scales for
7 - 8
0.5 mm.
9 - 12
0.2 mm.
3, 5, 6, 13 and 14
0.2 mm.

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, 31mm - 43mm., 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, sub-
rectangular, 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 pereopod 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 pereopod biramous, each ramus of two segments; basipod of two segments, much larger than basipod of first pereopod, 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 pereopod 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 pereopod 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 pereopod 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.

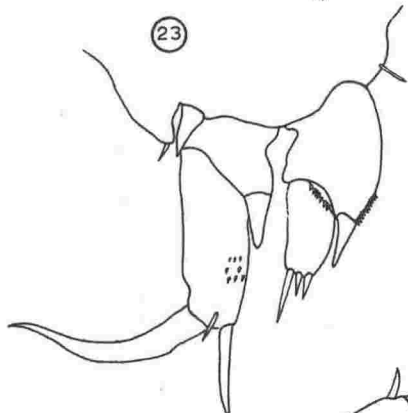
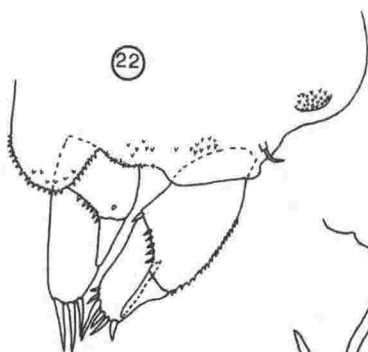
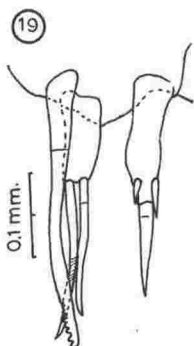
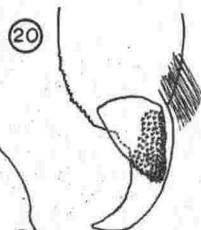
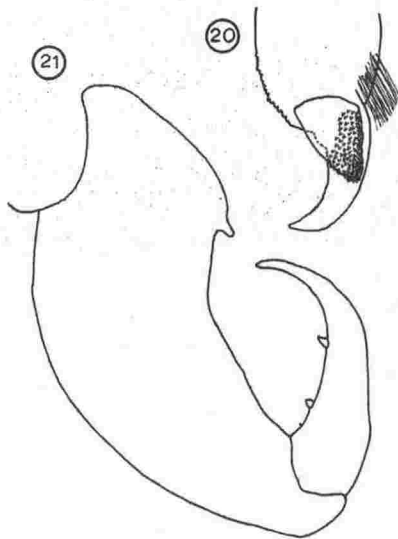
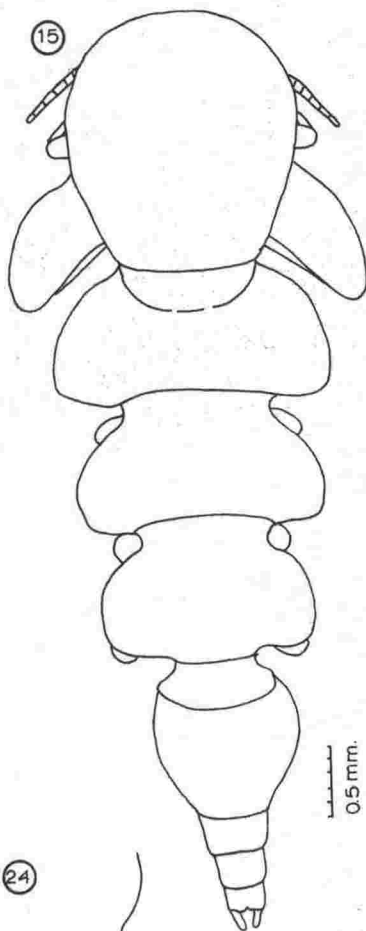
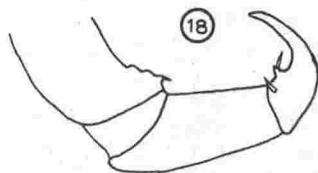
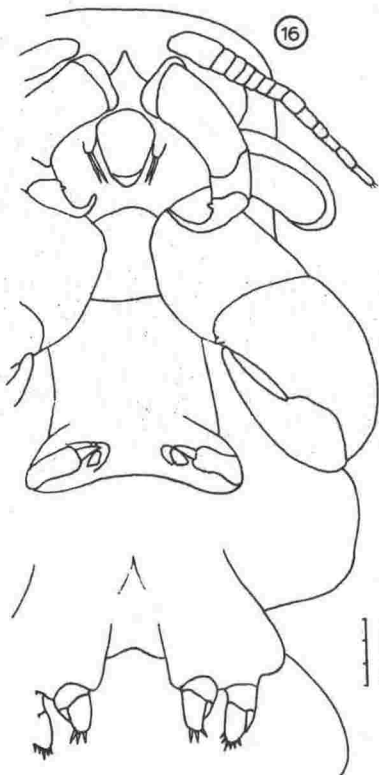
Cephalothorax shaped as in female, as wide as long (1.6 mm - 1.8 mm x 1.4 mm - 1.8 mm).

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.

Caption for figs. 15-26

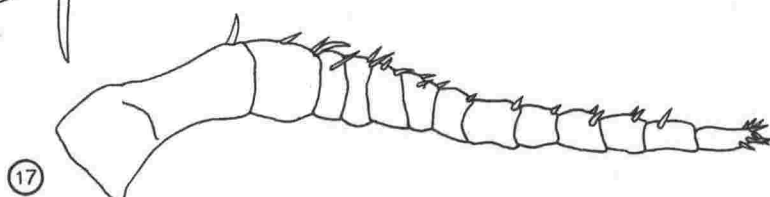
Nemesis lamna lamna Risso, 1826 from Isurus oxyrinchus.

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.



Scale for
18 and 21
0.3 mm.

Scale for
17, 20 and 22-26
0.2 mm.



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 two setae each on outer distal angle, twelfth segment has one seta proximal to midpoint of outer margin, thirteenth segment has nien 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 pereopod as in female.

Second pereopod 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 pereopod 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 pereopod 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 midpoint.

Fifth pereopod 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. 280; 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.

Nemesis lamna vermi

Description

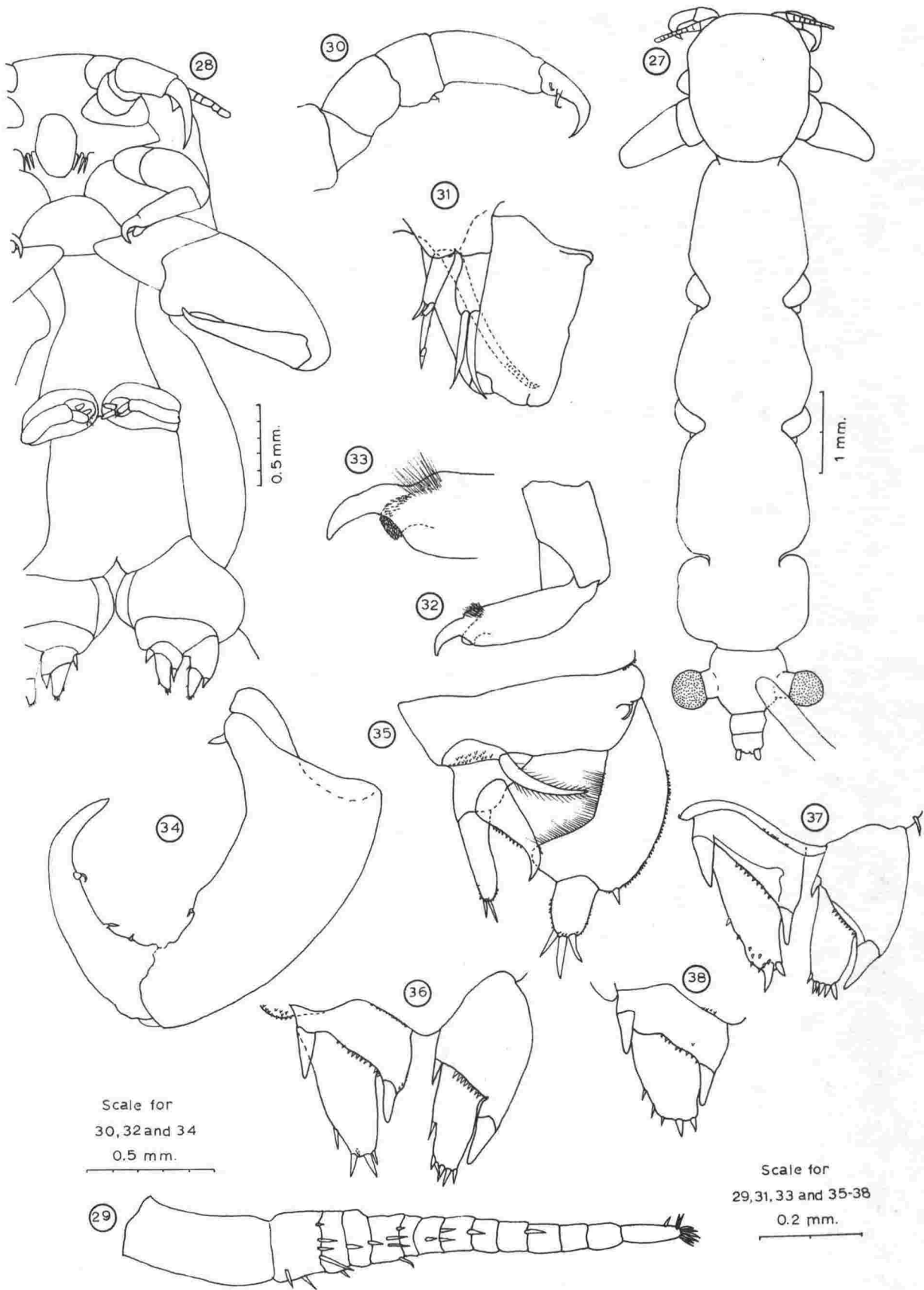
Female (figs. 27 - 38).

Overall length 8.4 mm - 9.3 mm.

Caption for figs. 27-38.

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.



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.

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. 1. lamna, except that the maxilliped appears to have one small additional seta on inner margin of claw-like second segment.

Second pereopod as in N. 1. 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 pereopod 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 pereopod similar to second except that spines of endopod second segment are spaced slightly further apart.

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).

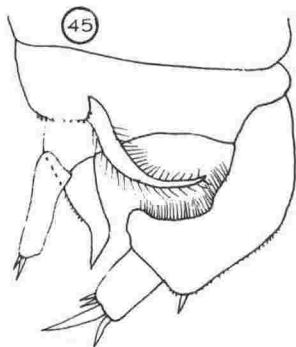
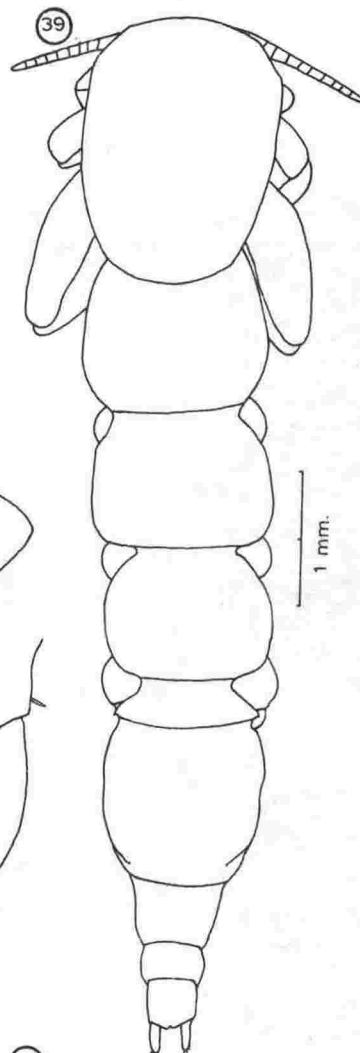
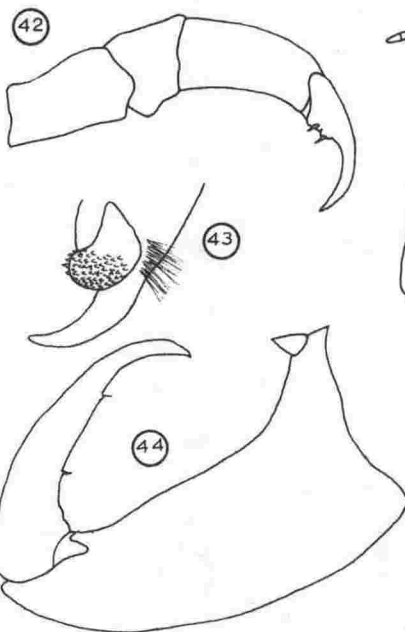
Third thoracic segment similar in shape to first, except shorter, length four-fifths width (0.9 mm - 1.0 mm x 1.2 mm - 1.3 mm).

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).

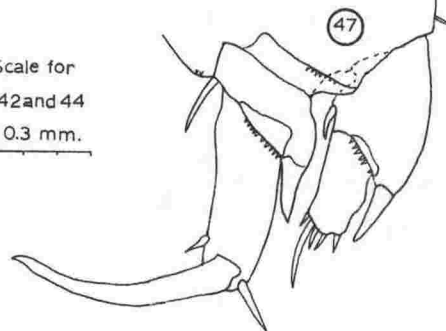
Caption for figs. 39-50.

Nemesis lamna vermi Scott, 1929 from Cetorhinus maximus.

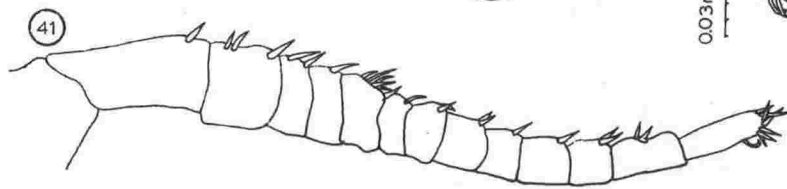
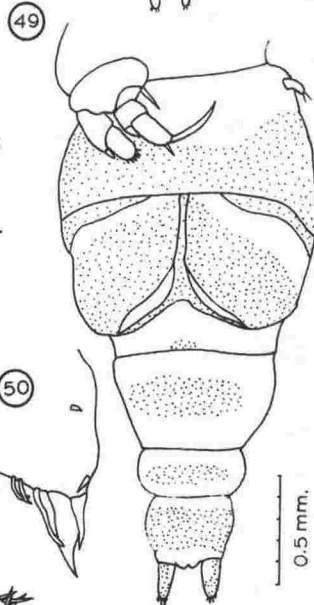
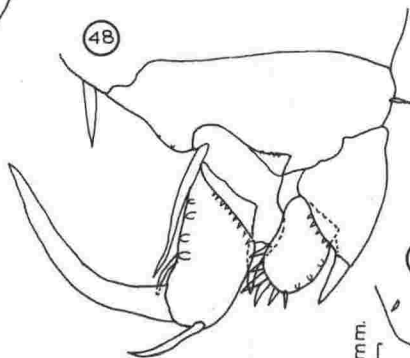
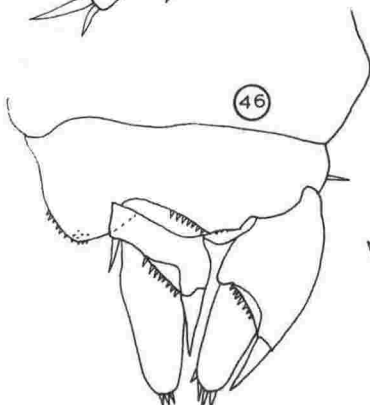
Male. fig. 39: dorsal view; fig. 40: anterior, ventral view;
fig. 41: first antenna; fig. 42: second antenna; fig. 43: tip of
maxilla; fig. 44: maxilliped; fig. 45: first pereopod; fig. 46:
second pereopod; fig. 47: third pereopod; fig. 48: fourth
pereopod; fig. 49: genital segment and abdomen, ventral view;
fig. 50: tip of caudal lamina.



Scale for
42 and 44
0.3 mm.



Scale for
41, 43 and 45-48
0.2 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 pereopod all as in female.

Second pereopod 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 pereopod 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 pereopod 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, opp. p.26) 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)^x 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

^x 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.

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)
Yamaguti	1939	<u>Cetorhinus maximus</u>	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	<u>Carcharodon carcharias</u>	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	<u>Lamna nasus</u>	1.41	1.41	1.47	1.39	0.53	0.27	8-10
Brian	1906	Either <u>Carcharodon carcharias</u> or <u>Isurus oxyrinchus</u>	1.49	1.59	1.56	1.45	0.45	0.32	9

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

TABLE 2

Present material (females)

Host	Area	Seg. 2	Seg. 3	Seg. 4	Seg. 5	Gen. Seg.	Abd. 1	Total Length (mm)
<u>Cetorhinus maximus</u>	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
<u>Carcharodon carcharias</u>	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
<u>Isurus oxyrinchus</u>	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
<u>Isurus oxyrinchus</u>	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, fide Delamare Deboutteville and Nunes-Ruivo, 1953, p. 213.

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 fide Brian, 1906); Palavas (Delamare Deboutteville and Nunes-Ruivo, 1953, 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 fide Brian, 1906).

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

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

on Lichia amia: (Richiardi, 1880, p. 150 fide
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).

Northwest Pacific - on Carcharodon carcharias: Simizu,
Siznoka Prefecture, Japan (Yamaguti, 1939, p. 455.)

Southwest Pacific - on unnamed shark: Port Jackson, N.S.W.,
Australia (Heegaard, 1962, p. 184).

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 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.

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 -

Caption for Plate A

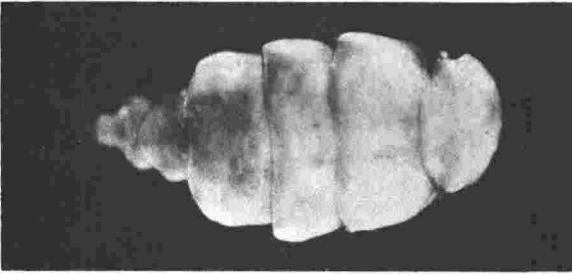
Nemesis robusta (van Beneden) Female.

1 - 2 contracted females.

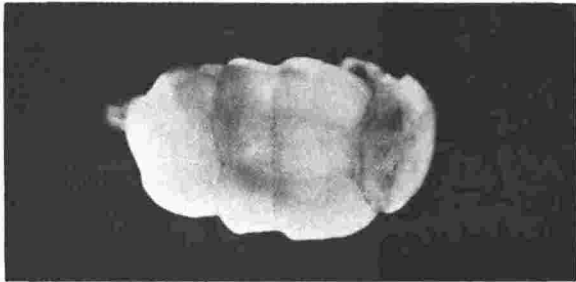
3 - 5 extended females.

PLATE A

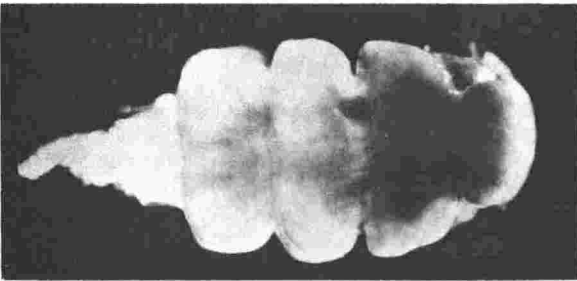
①



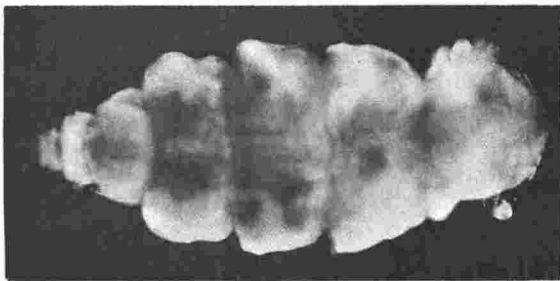
②



③



④



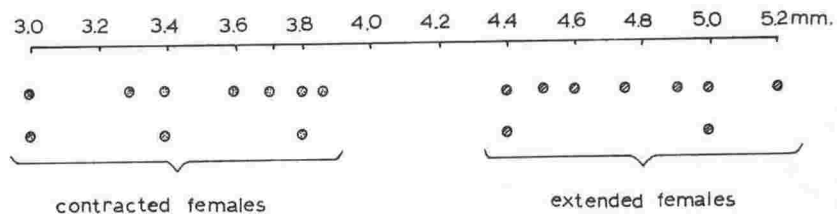
⑤



2 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

Graph 1



short neck (see Plate A figs. 3- 5). Of 19 individuals, 10 were contracted, the other nine extended, see Graph 1 above.

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).

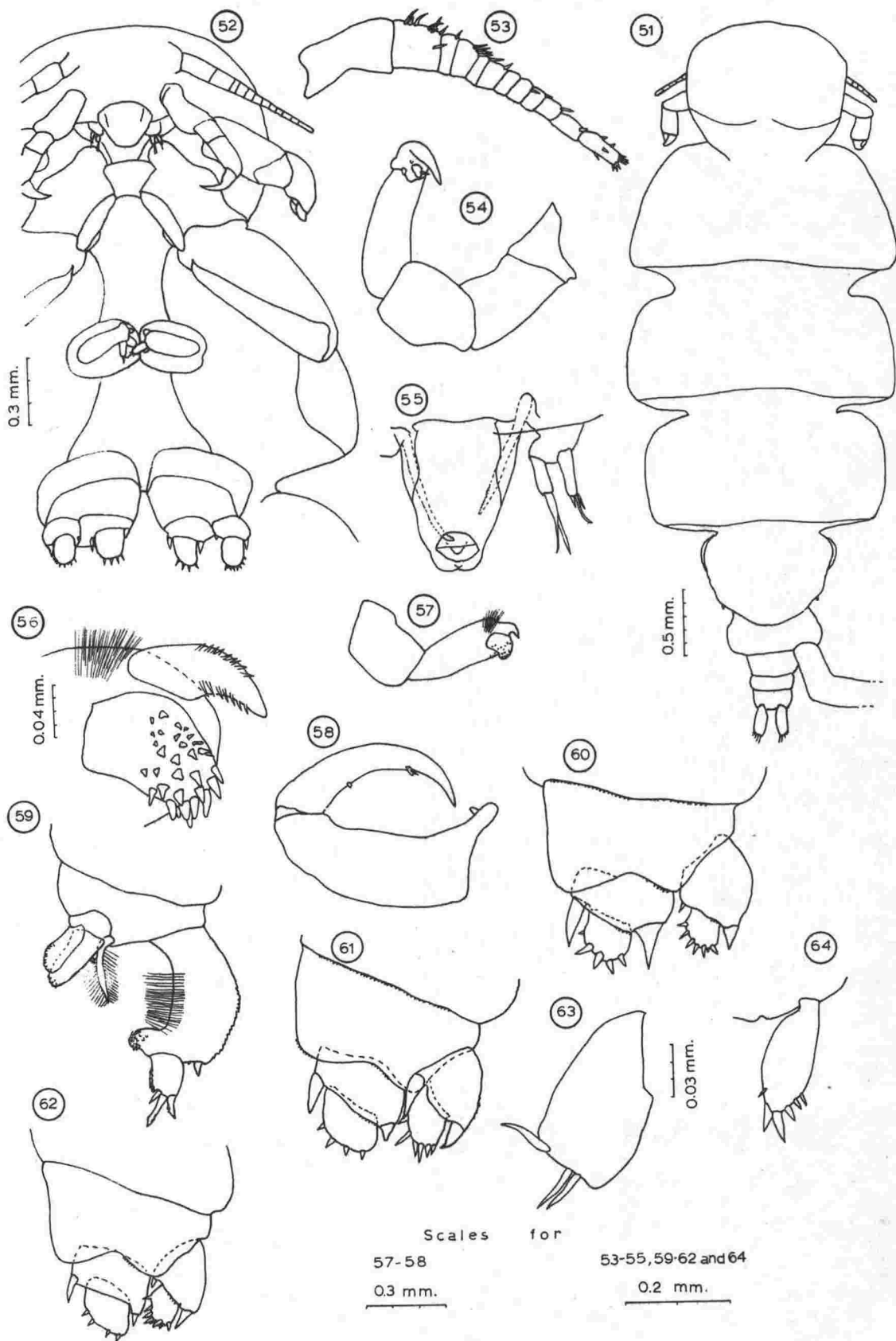
Second thoracic segment, length half width (0.75 mm - 1.05 mm x 1.6 mm - 1.85 mm), anterior angled broadly rounded, posterior angles less broadly rounded, segment widest posteriorly, narrowing by almost one-third anteriorly, separated from third thoracic segment in extended specimens by a short neck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

Caption figs. 51-64.

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.



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; third segment subrectangular, width one-third length; 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 pereopod 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 pereopod 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 pereopod; 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 pereopod biramous, each ramus of two segments, the basipod and segments similar in shape and size to those of second pereopod, 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 one 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 pereopod similar in form to second, but a little smaller; endopod first segment armed as in second pereopod, second segment with six to eight small spines on distal margin; first endopod segment armed as in second pereopod except that spines on distal angles are a little smaller, second endopod segment with three to six spines on distal margin.

Fifth pereopod 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.

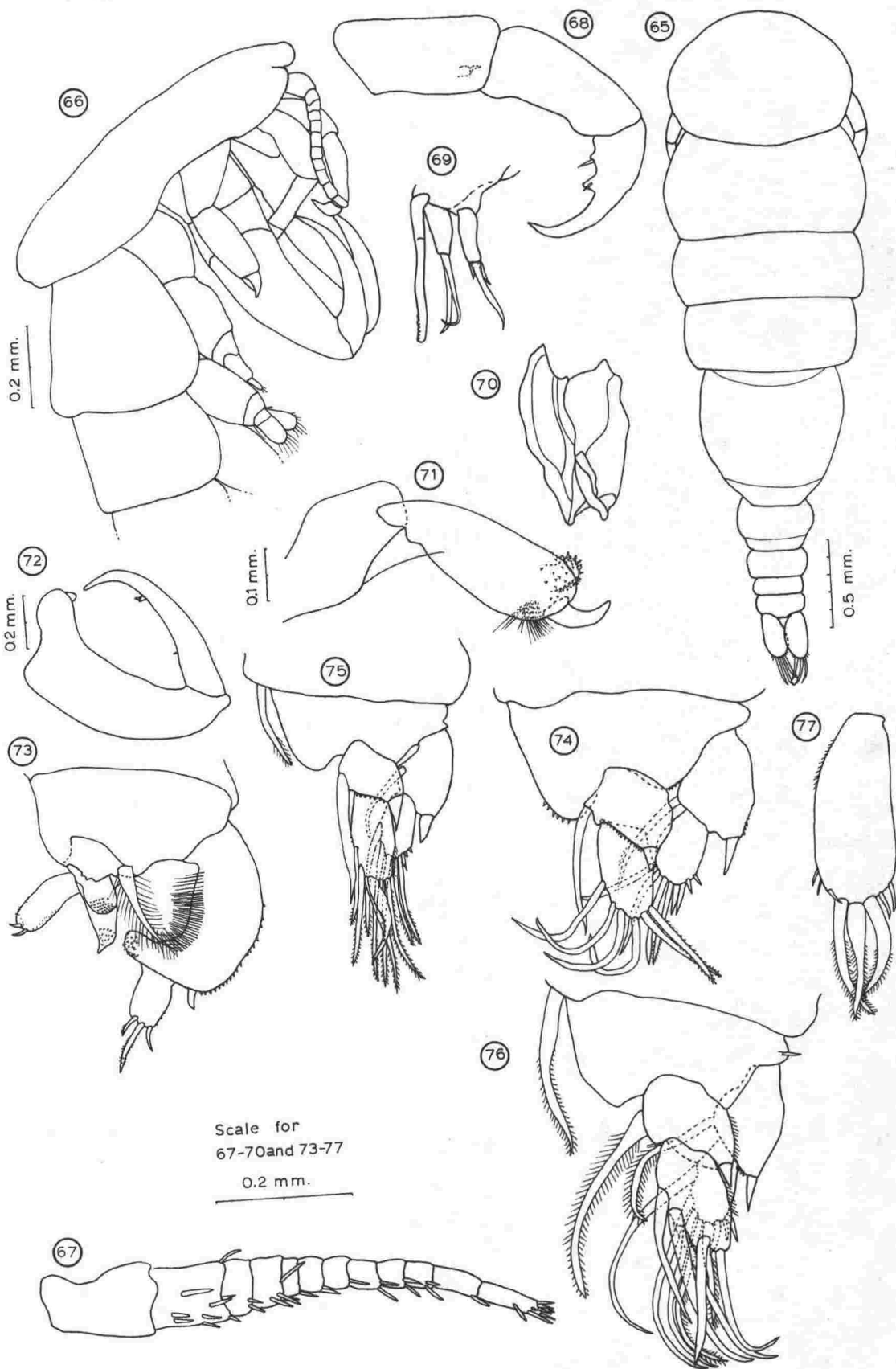
Second abdominal segment subrectangular, angles rounded, length one-third to two-thirds width (0.11 mm - 0.24 mm x 0.31 mm - 0.33 mm).

Third abdominal segment subrectangular, angles rounded, length two-fifths width (0.10 mm - 0.12 mm x 0.26 mm - 0.27 mm).

Caption for figs. 65-77.

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 pereopod; fig. 74:
second pereopod; fig. 75: third pereopod; fig. 76: fourth
pereopod; fig. 77: caudal lamina.



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 pereopod 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.

Second pereopod 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, subrectangular, 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 pereopod 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 pereopod 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.

TABLE 3

Previous records (females)

Species	Author	Year	Host (if only one specified)	Seg. 2	Seg. 3	Seg. 4	Seg. 5	Gen. Seg.	Abd. 1	Total Length (mm)
<u>N. atlantica</u>	Wilson	1922	<u>Scoliodon terrae-novae</u>	1.22	1.33	1.22	0.77	0.68	0.33	5
<u>N. macrocephalus</u>	Shiino	1957	<u>Carcharinus melanopterus</u>	1.28	1.22	0.97	0.71	0.39	0.29	3.14
<u>N. pilosus</u>	Pearse	1951	<u>Carcharias littoralis</u>	1.47	1.47	1.14	0.80	0.50	0.31	3.0
<u>N. versicolor</u>	Wilson	1913	<u>Sphyrna zygaena</u>	1.54	1.49	1.33	0.72	0.53	0.30	3.1
<u>N. pallida</u>	Wilson	1932	Several species (type from <u>Vulpecula marina</u>)	1.49	1.52	1.33	0.95	0.65	0.30	4.5-5
<u>N. pallida</u> Wilson	Barnard	1955	<u>Alopias</u> sp.	1.56	1.61	1.33	0.94	0.62	0.44	4.5
<u>N. robusta</u> (van Ben.)	Delamare Deboutteville and Nunes-Ruivo	1953	<u>Carcharias glaucus</u>	1.59	1.64	1.56	0.72	0.54	0.28	3.8
<u>N. tiburo</u>	Pearse	1952	<u>Sphyrna tiburo</u>	1.79	1.79	1.56	0.79	0.61	0.31	2.7
<u>N. robusta</u> (van Ben.)	Brian	1906	-	2.17	2.17	1.96	1.28	1.0	0.55	5

TABLE 4

Present material (females)

Host	Area	Seg. 2	Seg. 3	Seg. 4	Seg. 5	Gen. Seg.	Abd. 1	Total Length (mm)
<u>Alopias vulpinus</u>	Probably Cooks Strait	1.39	1.35	1.22	0.74	0.55	0.31	3.0
		1.47	1.56	1.39	0.69	0.54	0.29	4.6
		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.

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).

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).

Southeast Atlantic - on Sphyrna zygaena and Mustelus sp.:

Angola (Nunes Ruivo, 1956^x).

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

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.

^xfrom a translation, original page numbers not retained.

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.

Third thoracic segment similar in shape and size to second (0.25 mm - 0.38 mm x 0.57 mm - 0.64 mm).

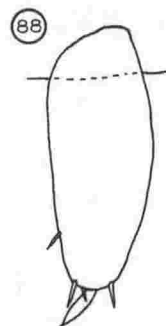
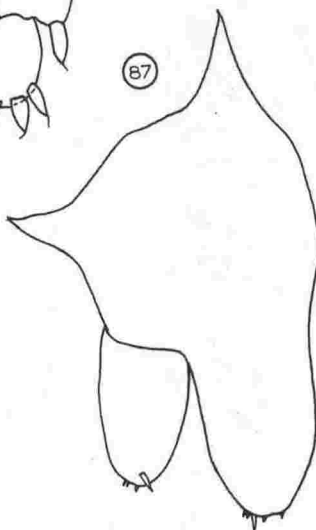
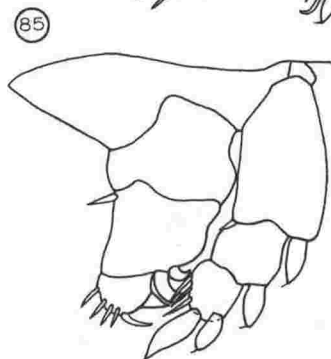
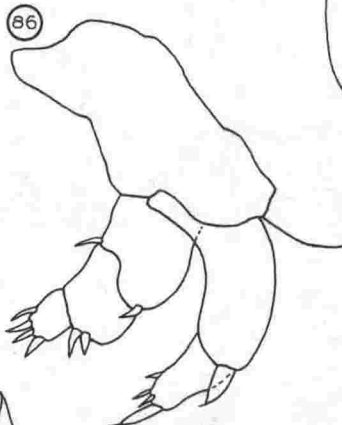
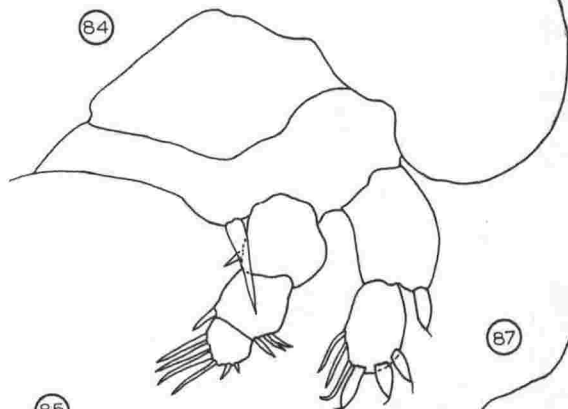
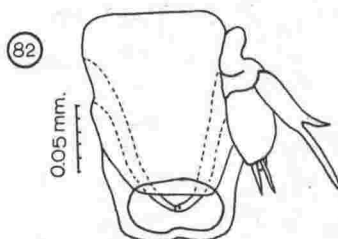
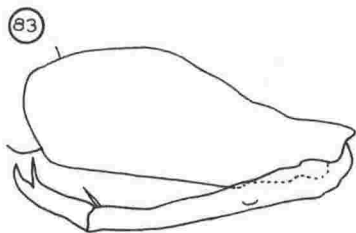
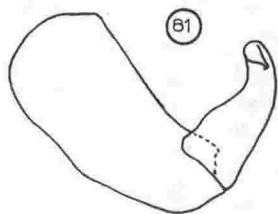
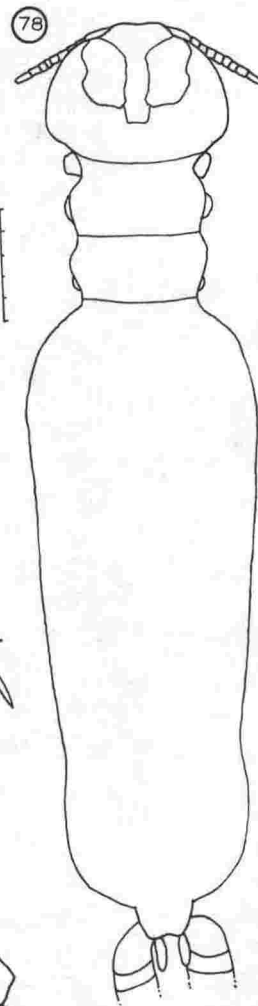
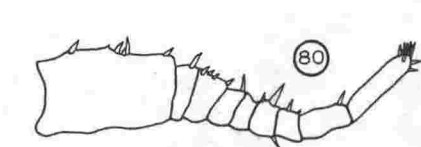
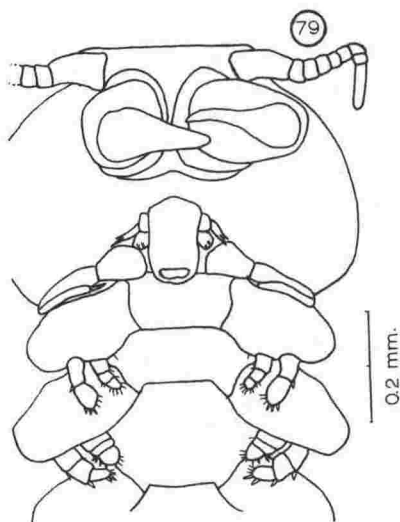
Fourth thoracic segment fused with genital segment to form a trunk, although in some specimens this trunk narrows slightly one-quarter to one-fifth of distance from anterior margin, and this slightly more swollen anterior region appears to mark the limit of the fourth segment.

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).

Caption for figs. 78-88

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.



Scales for
 80-81
 0.1 mm.
 87-88
 0.05 mm.
 83-86
 0.04 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 pereopod 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 pereopod 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 pereopod 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 pereopod 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.

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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PSEUDOCYCNUS APPENDICULATUS HELLER, 1868

(COPEPODA, DICHELESTHIIDAE) IN NEW ZEALAND

WATERS

by

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of Wellington.

ABSTRACT

Pseudocycnus appendiculatus is described and recorded, for the first time from New Zealand, on Thunnus alalunga. Pseudocycnus spinosus Pearse, 1951 and P. thynnus Brandes, 1955 are thought to be synonyms of P. appendiculatus. Other species previously placed in the genus are discussed and the action of Yamaguti (1963) in removing them to other genera supported. It is suggested that the family Pseudocycnidae Yamaguti, 1963 cannot be differentiated from the family Dichelesthidae Bassett Smith, 1898.

INTRODUCTION

I have been fortunate in receiving specimens of Pseudocycnus appendiculatus Heller, 1868 from P. E. Roberts, a postgraduate student in the Zoology Department, Victoria University of Wellington.

Although this species has previously been described in some detail, including material from the relatively close Loyalty Is. (Stebbing, 1900, p.672), I consider it necessary to describe my specimens in some detail because of the complications which have arisen in the systematics.

Pseudocycnus Heller, 1868

Pseudocycnus appendiculatus Heller, 1868

P. appendiculatus Heller, 1868, p.218; Bassett-Smith, 1899, p.475; Stebbing, 1900, p.3; Brian, 1906, p.76; Wilson, 1922, p.75, 1932, p.474; Leigh-Sharpe, 1930, p.3; Kirtisinghe, 1935, p.336, 1964, p.102; Legendre, 1940, p.285; Carvalho, 1951, p.141; Pearse, 1951, p.364; Brandes, 1955, p.192; Nunes-Ruivo, 1956, p.20; Delamare Deboutteville and Nunes-Ruivo, 1958, p.224; Shiino, 1959a, p.325, 1959b, p.356; Stuardo and Fagetti, 1961, p.78; Yamaguti, 1963, p.169; Pillae, 1964, p.73.

P. spinosus Pearse, 1952, p.30; Brandes, 1955, p.192.

P. thynnus Brandes, 1955, p.190.

Material

on Thunnus alalunga (albacore tuna): four females collected at Arial Reef, Gisborne by P. E. Roberts on 17 February, 1967.

Description

Female (figs. 1-11).

Colour, anterior quarter of ventral length bright red, rest of body yellow-brown, the red pigment persistent in alcohol for at least several months.

Overall length 13.7 mm - 15.6 mm.

Cephalothorax subovate, posterior margin sublinear, as wide as long (1.2 mm - 1.3 mm x 1.2 mm), greatest width a little posterior to midpoint.

Pseudocycnus appendiculatus Heller, 1868. female:

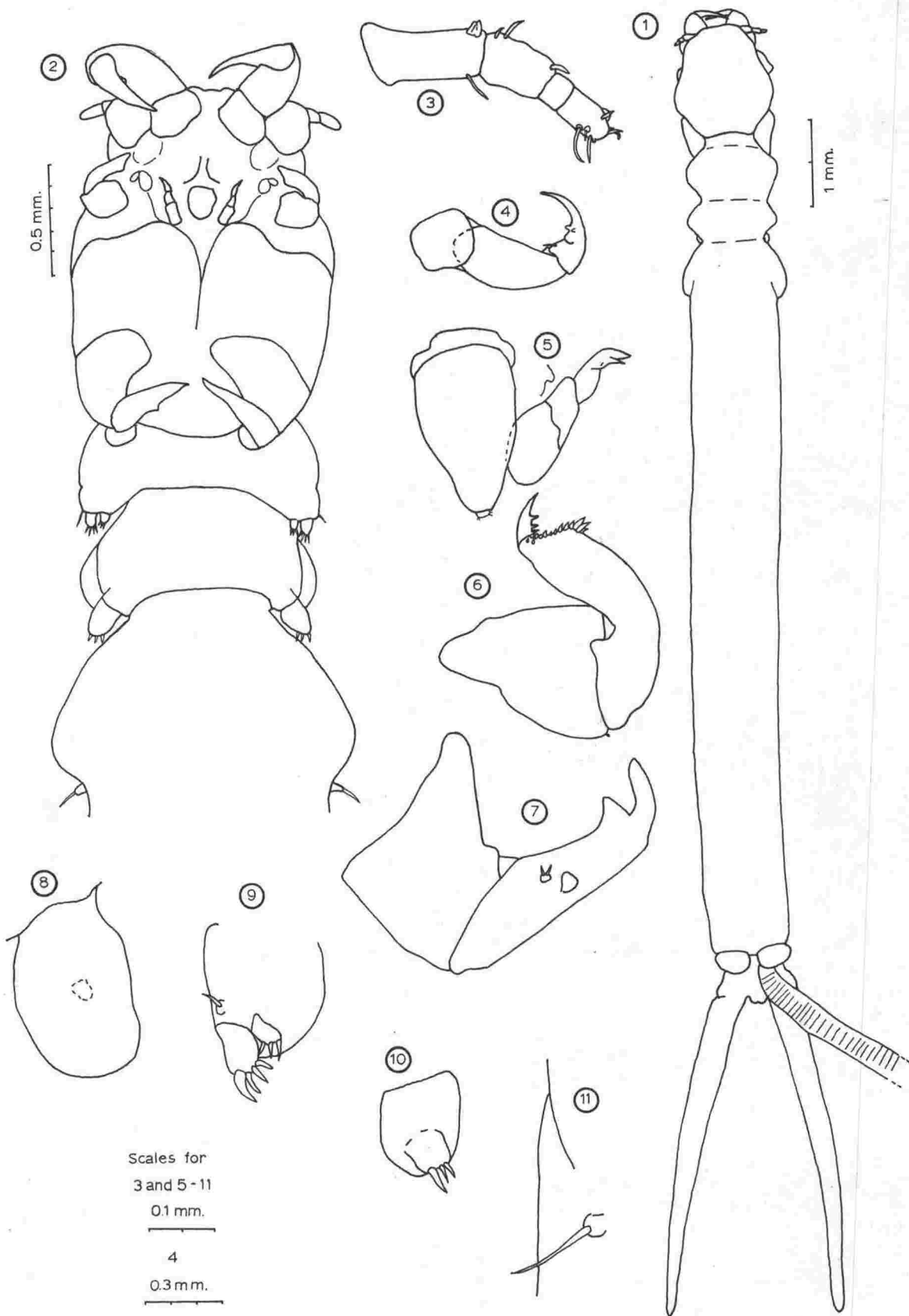
fig. 1: dorsal view; fig. 2: anterior ventral view;

fig. 3: first antenna; fig. 4: second antenna; fig. 5:

mouth tube and mandibular palp; fig. 6: maxilla; fig. 7:

maxilliped; fig. 8: first pereopod; fig. 9: second pereopod;

fig. 10: third pereopod; fig. 11: fourth pereopod.



Scales for
3 and 5-11

0.1 mm.

4

0.3 mm.

Second thoracic segment subovate, length two-thirds width (0.6 mm - 0.8 mm x 1.1 mm).

Third thoracic segment subovate, subequal in width to second, length half width (0.5 mm - 0.6 mm x 1.0 mm - 1.2 mm).

Fourth thoracic segment fused with genital segment to form an elongate trunk, but distinguishable by anterior lateral swellings which bear the reduced fourth pereopods posterolaterally; subovate, length half width (0.7 mm x 1.2 mm - 1.3 mm).

Trunk excluding the anterior swollen portion, cylindrical, length more than six times width (6.6 mm - 7.9 mm x 1.0 mm - 1.1 mm), lateral margins parallel, with two plate-like subsemicircular dorsal projections, two-fifths trunk width, length two-thirds width, carried laterally on posterior margin.

Abdomen, length two-thirds width (0.6 mm - 0.7 mm x 0.9 mm - 1.0 mm), widest posteriorly, narrowing anteriorly to two-thirds posterior width, angles slightly rounded.

Caudal laminae borne laterally on posterior margin of abdomen, length twelve times basal width (3.4 mm - 3.8 mm x 0.3 mm - 0.4 mm), narrowing slightly posteriorly, posterior margin rounded.

Egg strings extending from posterior margin of trunk, beneath plate-like projections dorsal to abdomen, present on only one specimen, subequal in length to body, eggs uniserial, length 13.7 mm, posterior half of egg strings empty of eggs in this individual.

First antenna of four subrectangular segments, ratios of lengths 8:5:2:4; first segment width half length, with a blunt process on outer distal angle, and a long seta on inner distal angle; second segment width two-thirds length, with two setae on outer margin near outer proximal angle, and one seta on outer distal angle; third segment as long as wide, indistinctly separated from fourth segment; fourth segment, width two-thirds length, rounded distally, with five long and three short setae on or near distal margin.

Second antenna subchelate, of three segments, first segment a subcircular base, as long as wide; second segment twice length of first, basal width two-fifths length, narrowing and rounded distally; third segment a little shorter than second, basal width one-third length, narrowing distally to a sharp point, distal half slender, with one spine near inner distal angle, and two spines near midpoint of inner margin.

Mouth tube small (0.28 mm in length), basal width half length, narrowing gradually distally, distal margin rounded.

Mandibular palp indistinctly three-segmented, basal segment subrectangular, as long as wide, second segment subrectangular, two-thirds length of first, as long as wide, third segment basal width two-thirds second segment width, basal width one-third length, narrowing distally, distal third bifid, each branch sharply pointed, segment sharply curved near midpoint.

Maxilla of two segments, basal segment as wide at the base as long, narrowing and rounded distally, second segment subequal in length to first, basal width two-fifths length, curved, narrowing so suddenly to its inner margin as to appear almost truncated distally, distal margin with 15-19 spines which are very variable in size, one on inner distal angle one-third segment length, itself with four or five smaller spines.

Maxilliped subchelate, of two segments, basal segment as wide at the base as long, narrowing and rounded distally; second segment, basal width two-fifths length, narrowing distally, distal quarter bifid, inner branch half length of outer, basal widths subequal, both branches ending in sharp points, segment curved, particularly over distal third, with a stout blunt spine near midpoint of outer margin, and two setae on a raised boss near dorsal midline, one-quarter distance from base.

First pereopod very small (0.26 mm in length), consisting of a flattened subovate basipod, proximal margin sublinear, width two-thirds length, with a small second segment, presumably representing a ramus, near its midpoint; ramus one-seventh width of basipod, subsemicircular, as wide as long.

Second pereopod biramous, each ramus of one segment; basipod subsemicircular, as wide as basipod of first pereopod, a little longer than wide, outer margin slightly straightened, with a seta on a raised boss near proximal outer angle of exopod; exopod two-thirds basipod length, width two-thirds length, rounded distally, with four spines on distal margin, the outer spine being

stouter than the other three; endopod two-thirds length of exopod, width half length, rounded distally, with three spines on outer distal region.

Third pereopod uniramous, ramus of one segment; basipod two-thirds length of basipod of second pereopod, subsemiovalate, proximal margin sublinear, a little longer than wide; ramus subrectangular, angles rounded, two-fifths length of basipod, as long as wide, with three spines on distal margin, the outermost being slightly larger than the other two.

Fourth pereopod represented by a seta on a raised boss, the seta being as long as the third pereopod, situated laterally on the most posterior extremity of the swollen anterior part of trunk.

Fifth pereopod similar to fourth, situated on the lateral trunk margin just anterior to the posterior angles of the trunk.

Discussion

Seven species have been placed in Pseudocycnus since it was first proposed by Heller (1868, p.218).

Three of these species, P. appendiculatus Heller, P. spinosus Pearse (1952, p.30), and P. thynnus Brandes (1955, p.190) are obviously similar. Brandes (1955, p.192) compares the described differences between these three species and concludes that they are sufficient to make them distinct. Yamaguti (1963, p.170) suggests in a footnote without further comment, that it seems likely that these species are identical.

Shiino (1959a, p. 328) discusses the differences between P. appendiculatus and P. thynnus, and concludes that they could well be attributed to individual variation or mistaken descriptions by previous authors.

The main characters used by Brandes in separating the three species are:

1. the number of segments in the first antennae, which have been variously described as three and four. All drawings however show an appendage of the same shape and it seems that some authors have not recognised the indistinct joint between the third and fourth segments.
2. the number of spines on the various appendages. These structures are notoriously variable and in addition prone to damage and misinterpretation. However, the three spines on the distal margin of the maxilla in P. spinosus look most unusual (Pearse, 1952, fig. 117) and may be a distinguishing feature.
3. the presence or absence of the fifth pereopods. These structures are very small and placed near the posterior end of the body so that they could easily be overlooked. The structure figured and described by Pearse (1952, fig. 115) is almost certainly not a vestigial pereopod.
4. differences in body proportions. Shiino (1959a, p. 330) has already stated that the differences in these proportions given by Brandes (1955, p. 195) are insufficient to separate P. thynnus from P. appendiculatus. It must also be doubted if they are sufficient to separate P. spinosus from P. appendiculatus.

since: P. spinosus is known from a single specimen.

P. appendiculatus is known to be very variable in total lengths, e.g. 6.7 mm (Pillae, 1964, p.73), 10 mm (Kirktisinghe, 1935, p.336), 12 mm - 16 mm (Wilson, 1932, p.474), 16.4 mm - 24.4 mm (Brandes, 1955, p.195), and in body proportions as is strikingly shown by Legendre (1940, fig. 70).

It is doubtful if the spination of the maxilla, should it be confirmed in other material, is enough to differentiate P. spinosus as any more than a subspecies of P. appendiculatus.

In the absence of further evidence I consider both P. thynnus and P. spinosus to be synonyms of P. appendiculatus.

Yamaguti (1963, p.169-173) places P. scromberomori Yamaguti, 1939 and P. armatus Bassett-Smith, 1898 in a new genus Pseudocycnoides since the first and second pairs of pereopods are biramous and the third are uniramous, while in Pseudocycnus appendiculatus Heller, 1868, the first and third pereopods are uniramous and the second biramous. He places P. buccatus Wilson, 1922 in a new genus Pseudocynopsis on the grounds that the pereopods are all rudimentary in this species, without the one-segmented rami found in P. appendiculatus.

The nature of the pereopods has been used in many families to separate genera, and in my view Yamaguti is perfectly justified in using them also in these cases, even though, in this particular situation, the pereopods are rather small.

Whether Yamaguti is justified in separating out this group from the remainder of the family Dichelesthidae Bassett-Smith, 1899, as a separate family is less certain. The major difference between the Dichelesthidae and members of the family Pseudocycninae lies in the lack of a fourth pereopod in the former - yet in several of the Pseudocyninae (e. g. Pseudocycnus) this limb is very rudimentary, and in Pseudocycnoides it is lacking.

I therefore prefer to regard the Pseudocycninae Wilson, 1922 and Dichelesthidae, at most, as subfamilies of the same family, Dichelesthidae Bassett-Smith, 1899.

Cybicola Bassett-Smith, 1898 is so similar to the Pseudocycnines just discussed that Tripathi (1962, p. 213) considers that Cybicola and Pseudocycnus should be included as subgenera in the same genus, and Shiino (1959a, p. 329) considers them one genus.

While the differences in the pereopods of Cybicola and Pseudocycnus are sufficient, in my view, for them to be considered separate genera I consider that other similarities place Cybicola within the subfamily Pseudocycninae. With this reduction to subfamily level the author would accept the diagnosis of these groups as given by Yamaguti (1963, p. 132 and p. 168). The strict application of these diagnoses places Cybicola with the Pseudocycninae, as recommended above.

Undoubtedly further revision of the taxonomic status of the groupings within the group called Dichelesthiidae by Wilson, 1922 is required.

Pseudocycnus appendiculatus has been reported by many authors. Previous records include:

Northeast Atlantic - on Coryphaena sp.: (Heller, 1868, p.218).

on Thunnus thynnus: White Bank and Dogger Bank, North Sea (Brandes, 1955, p.190).

on T. alalunga: Gulf of Gascoyne (Legendre, 1940, p.285).

Mediterranean - on Katsuwonus pelamis: (Brian, 1906, p.76).

on T. thynnus: sète (Delamare Deboutteville and Nunes-Ruivo, 1958, p.224); Piana (Brian, 1906, p.76).

Southeast Atlantic - on T. albacares, T. obesus and Katsuwonus pelamis: Angola (Nunes-Ruivo, 1956).

Northwest Atlantic - on T. alalunga: 100 miles South of Marthas Vineyard, Mass. (Wilson, 1922, p.75);

Marthas Vineyard, Mass. (Wilson, 1932, p.474).

on Sarda sarda: Texas Coast (Pearse, 1952, p.30); Bemini, Bahama Is. (Pearse, 1951, p.364).

Southwest Atlantic - on Euthynnus alletterata: S. Sebastião, North of the state of S. Paulo (Carvalho, 1951, p.141).

Northeast Pacific - on T. albacares: $18^{\circ}24'N.$, $104^{\circ}38'W.$
(Shiino, 1959a, p. 325).

Southeast Pacific - on T. alalunga: Valparaiso (Stuardo
and Fagetti, 1961, p. 78).

Southwest Pacific - on E. yaito: North of Misoöl (Leigh-Sharpe,
1930, p. 3).
on "bonito": Uvea, Loyalty Is. (Stebbing,
1900, p. 672).

Indian Ocean - on Coryphaena sp., T. albacares and E.
alletterata: Aden (Bassett-Smith, 1899, p. 475).
on T. albacares: $77^{\circ}20'E.$, $5^{\circ}40'S.$ and
 $81^{\circ}E.$, $11^{\circ}45'N$ (Shiino, 1959b, p. 356); Vizhingom,
India (Pillae, 1964, p. 73).

on E. affinis: Trivandrum, India (Pillae, 1964,
p. 73), Ceylon (Kirtisinghe, 1964, p. 102).

on E. alletterata: Ceylon (Kirtisinghe, 1935,
p. 336).

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TWO NEW SPECIES OF HATSCHEKIA

(COPEPODA, DICHELESTHIIDAE) IN NEW

ZEALAND WATERS

by

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of Wellington.

ABSTRACT

Two new species of Hatschekia are described from New Zealand specimens of Allomycterus jaculiferus and Lepidopus caudatus respectively. Comment is made on the need for revision within the genus Hatschekia.

INTRODUCTION

In the course of work on several collections of New Zealand parasitic Copepoda I have come across two species of Hatschekia. Members of this genus are found on numerous species of teleosts, many of which are of restricted occurrence. Normal evolutionary principles would suggest that under these conditions there would be considerable speciation, and many species have, in fact, been described. However the descriptions of most of these species are not particularly full or detailed. Also, the members of this group have a relatively simple body form with relatively few taxonomically useful characters. The combination of these circumstances increases the difficulty of identification. Despite this, the specimens available to me appear quite distinct from previously described species.

Hatschekia Poche, 1902

Hatschekia quadrata n. sp.

Material

on Allomycterus jaculiferus: three females (including the type specimen) collected by H. Manter, presumably in the Wellington region, in 1951; forty-seven females collected by M. Howell at Shelly Bay, Wellington Harbour, 18 January 1964.

Description

Female only (figs. 1 - 11)

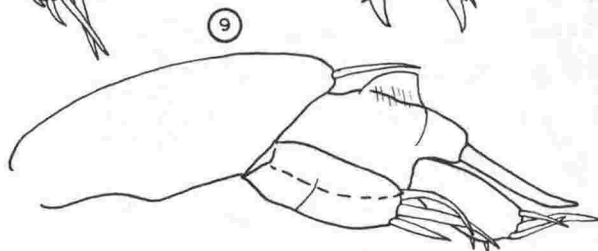
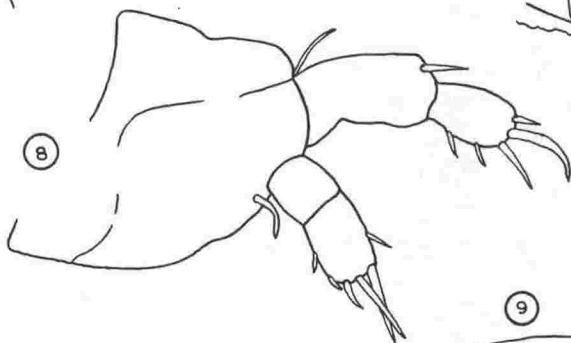
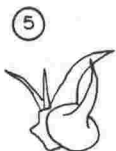
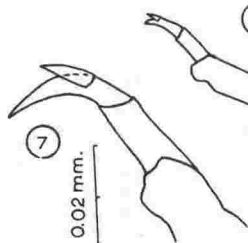
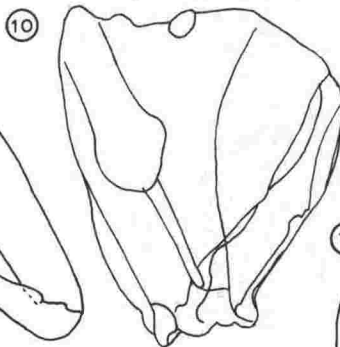
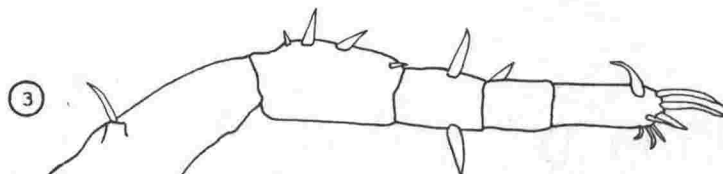
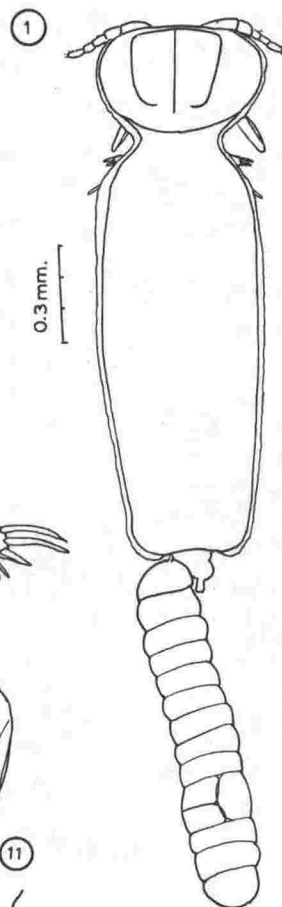
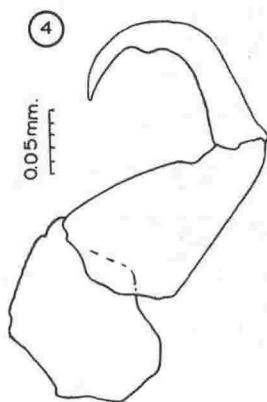
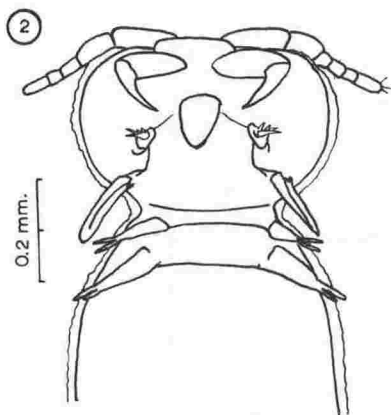
Overall length (11 specimens) 1.58 mm - 1.92 mm.

Cephalothorax subovate, length two-thirds width (0.32 mm - 0.39 mm x 0.48 mm - 0.54 mm), the anterior margin a little less curved than the posterior, the dorsum of the cephalothorax with a subrectangular marking, half length of cephalothorax, as wide as long, posterior margin broken, divided medially by a longitudinal line; the cephalothorax separated from the trunk by a short neck which is half as wide as the cephalothorax (0.23 mm - 0.28).

Trunk consisting of fused second, third and fourth thoracic segments and genital segment; subrectangular, length one-third width (0.93 mm - 1.43 mm x 0.39 mm - 0.58 mm), anterior

Caption for figs. 1-11.

Hatschekia quadrata n. sp., female. fig. 1: dorsal view;
fig. 2: anterior, ventral view; fig. 3: first antenna; fig. 4:
second antenna; fig. 5: mandibular palp; fig. 6: maxilla;
fig. 7: tip of maxilla, detail; fig. 8: first pereopod,
fig. 9: second pereopod; fig. 10: mouth tube, lateral
view; fig. 11: abdomen and caudal laminae.



Scale for
3,5,6 and 10-11
0.05 mm.

Scale for
8 and 9
0.05 mm.

angles broadly rounded, posterior angles rounded, posterior margin sublinear or slightly concave.

Abdomen subovate, length three-fifths width (0.063 mm - 0.073 mm x 0.112 mm - 0.132 mm), separated from the trunk by a short neck, five-sixths width of abdomen; caudal laminae carried laterally on posterior margin.

Caudal laminae, width three-fifths length, rounded distally, with three setae on distal half of outer margin, one flattened seta and one other seta distally, and a further seta just proximal to these two.

Egg strings 1.23 mm - 1.53 mm in length, eggs uniseriate, except that in some specimens short sections of the egg string may have the eggs less regularly arranged (see fig. 1), 14 - 17 eggs per egg string.

First antenna of five segments, the relative lengths of the segments given by the ratio - 8:4:2:2:3; first segment width one-third length, narrowing to half this width distally, with one seta on outer margin; second segment width half length, with four setae on outer margin; third segment width two-thirds length, with a large seta on each of inner and outer margins; fourth segment width two-thirds length, with a large seta on outer margin near base; distal segment width two-fifths length, rounded distally, with four large and four small setae on distal margin.

Second antenna subchelate, of two segments, arising from a stout base, first segment width two-thirds length, narrowing to two-fifths this width distally, rounded distally; second segment basal width one-fifth length, narrowing gradually to a point distally, distal two-thirds sharply curved.

Mouth tube 1.5 mm in length, basal width two-thirds length, narrowing distally, distal margin slightly rounded.

Mandibular palp consisting of a seta-like process on a round raised boss, with a further seta of equivalent size on an irregularly shaped base beside it, two smaller setae also arising from this irregularly shaped basal part.

Maxilla of two segments, second segment a little longer than first, first segment width one-quarter length, narrowing slightly distally, distal margin rounded; second segment width one-tenth length, distal quarter a somewhat narrowed process, apparently divided transversely two-fifths distance from its base, distal portion narrowing to a sharp point distally, with a further branch one-third its length, arising one-third of distance from base, also ending in a sharp point.

First pereopod biramous, each ramus of two segments, basipod subrectangular, length three-quarters width, with a long seta near outer proximal angle of exopod and another near inner proximal angle of endopod; first segment of exopod two-thirds basipod length, subrectangular, width half length, slightly

curved, with a seta on outer distal angle; second exopod segment subovate, proximal margin sublinear, width two-thirds length, with three setae on distal margin and two on inner margin; first segment of endopod subrectangular, as wide as long; second segment subrectangular, width two-thirds length, distal angles somewhat rounded, with three setae on distal margin one small seta on outer margin and two small setae on inner margin.

Second pereopod biramous, each ramus of two segments, basipod width half length, with a long seta on rounded outer distal angle; first segment of exopod subrectangular, width two-thirds length, outer distal angle swollen to constitute one-quarter length of segment, bearing a long seta, medial third of outer margin carrying a small flange; second exopod segment width half length, rounded distally, with three long setae on distal margin and two short setae on inner margin; exopod much shorter than endopod, first segment subrectangular, indistinctly separated from second segment as wide as long; second segment one-third longer than first, width three-quarters length, rounded distally, with three long setae on distal margin.

Discussion

In determining the present material I have examined descriptions and/or figures of 84 species assigned to the genus Hatschekia. It is clear that this genus is in urgent need of revision. Many species cannot satisfactorily be separated using the information previous authors have given. The name H. elongata has been applied to three quite distinct species, none of which was described in any detail (Redkar, Rangnekar and Murti. 1950, p. 35; Capart, 1953, p. 649; Heegaard. 1962, p. 185), although Heegaard subsequently renamed his species H. thomsoni (Heegaard, 1964, p. 320).

In the absence of any data by previous authors on variation in this genus, or even as to whether individual specimens are capable of contraction, and in view of the small size of the present samples, determination has been rather difficult.

Ultimately the method used consisted of dividing head width (assumed to be the body measurement subject to least variation) into head length, trunk length, and trunk width. For the present material this gave the following ranges (11 specimens) 0.62 mm - 0.70 mm, 1.75 mm - 2.80 mm and 0.75 mm - 1.14 mm respectively.

Specimens figured in the literature were then measured and those that came within the ranges 0.50 mm - 0.80 mm, 1.4 mm - 3.2 mm and 0.5 mm - 1.4 mm for these three

respective measurements were examined in more detail, except in a few cases where the body form of the figured specimens was so different from the present material as to make further comparison unnecessary.

Those examined in detail were:

H. crenilabris (Hesse, 1878, fide Yamaguti, 1963, pl. 179, fig. 5) which has the anterior part of the lateral margin of the cephalothorax swollen, and the trunk narrowed posteriorly; in the present material the cephalothorax has its lateral margins as entire curves, and the lateral margins of the trunk are subparallel. H. crenilabris is almost certainly synonymous with H. labracus (van Beneden, 1870, pl. 1, fig. 4) and H. richiardii Goggio (1905, p. 222, pl. 13, fig. 4), which have a similar swelling of the cephalothorax and a similarly narrowed trunk.

H. labrimixti (Hesse, 1878, fide Yamaguti, 1963, pl. 179, fig. 5) also differs from H. quadrata in that it has a lateral swelling of the cephalothorax. Yamaguti has accidentally recorded this species as H. labrimixti (Heller, 1878) but his earlier listing (p. 138), the date of authorship and the style of drawing all confirm that the original author was Hesse.

H. pygmaea Scott, 1909 (fide Scott and Scott, 1913, p. 119, pl. 35, figs. 3-7, pl. 36, figs. 6-9) in which the second and third thoracic segments clearly are separated from the remainder of the trunk by grooves visible in dorsal view; no such separation occurs in my specimens.

H. quadriabdominalis Yu (1933, p.127, pl. 5, figs. 2-6, pl. 6, figs. 1-2) has posterolateral processes, which bifurcate distally, carried on the trunk; no such processes occur in the present material.

H. longibrachium Yamaguti (1939, p.465, pl. 24, figs. 103-107) has a subtriangular abdomen and a six-segmented first antenna; in the present material the abdomen is rounded and the first antennae five-segmented.

H. monacanthi Yamaguti (1939, p.468, pl. 26, figs. 119-125) has the abdomen almost lacking.

H. doiodontis Yamaguti (1953, p.225, pl. 4, figs. 29-34) has its trunk narrowed and rounded posteriorly; in the present species the posterior narrowing is slight and the posterior margin is sublinear or concave.

H. ostracii Yamaguti (1953, p.228, pl. 5, figs. 45-48) has the lateral margins of its trunk convexly curved so that the anterior and posterior widths are less than two-thirds the medial width; in my specimens the lateral margins of the trunk are sublinear.

H. prionoti Pearse (1947, p.10, figs. 41-44) has its trunk divided by several transverse grooves; no similar grooves occur in the present material.

H. modesta Kabata (1965, p.8, pl. 3, figs. 22-32) has its abdomen indistinctly separated from the trunk as an increase

in its posterior narrowing; in the present species the abdomen is separated from the trunk by a short "neck".

On the basis of the above comments the present material, therefore, appears to be distinct from previously described species of Hatschekia.

H. crenata n. sp.

Material

on Lepidopus caudatus: two collections, one of one female, one of 10 females, by H. Manter, presumably from the Wellington region, in 1951.

Description

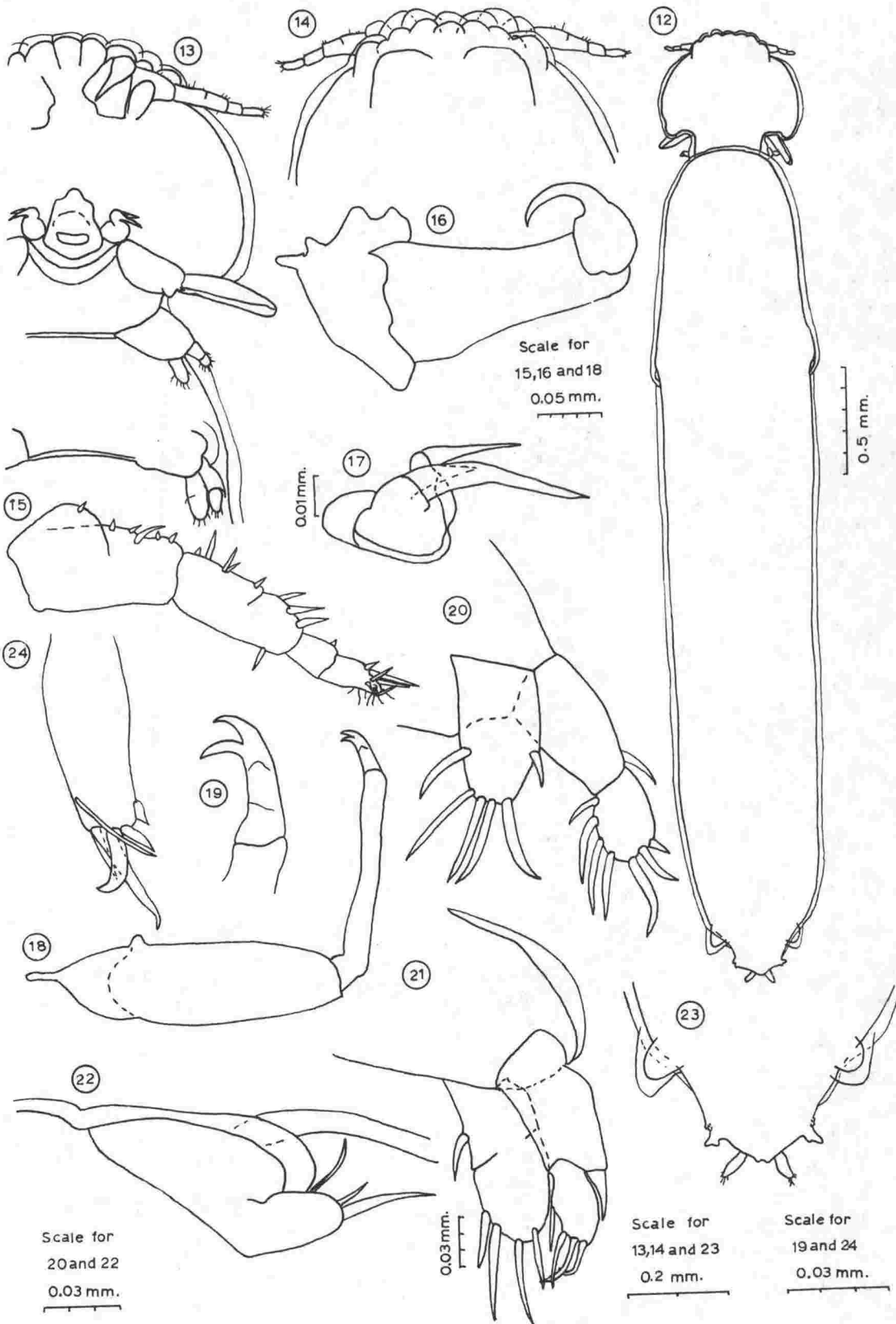
Female only (figs. 12-24).

Overall length (eight specimens) 3.87 mm - 4.62 mm.

Cephalothorax subovate, length two-thirds width (0.43 mm - 0.52 mm x 0.64 mm - 0.72 mm), posterior margin sublinear, postero-lateral angles rounded and slightly swollen posteriorly, a short frontal area, half cephalothorax width, has a complexly crenate frontal margin, divided into nine small semicircular

Caption for figs. 12-23.

Hatschekia crenata n. sp., female. fig. 12: dorsal view; fig. 13: anterior, ventral view; fig. 14: anterior margin, detail, dorsal view; fig. 15: first antenna; fig. 16: second antenna; fig. 17: mandibular palp; fig. 18: maxilla; fig. 19: tip of maxilla, detail; fig. 20: first pereopod; fig. 21: second pereopod; fig. 22: third pereopod; fig. 23: posterior of trunk, abdomen, caudal laminae.



lobes; cephalothorax separated from trunk by a short neck, half cephalothorax width (0.31 mm - 0.37 mm).

Trunk cylindrical, rounded anteriorly and posteriorly, length $3\frac{1}{2}$ - $5\frac{1}{2}$ times width (3.34 mm - 4.02 mm x 0.71 mm - 0.94 mm), a slight lateral swelling two-sevenths distance from anterior margin marks the position of rudimentary third pereopods, and small sub-acute processes, about 0.1 mm in length project from posterolateral region.

Abdomen fused with trunk, some indication given by a dorsal groove, partly hidden by a posterodorsal bulge in the trunk; the abdomen presumably contributes most of the narrowing area posterior to the trunk posterolateral processes, this area a little wider than long (0.15 mm - 0.22 mm x 0.22 mm - 0.25 mm), narrowing to two-thirds this width posteriorly, the posterior margin which bears the caudal laminae, in the form of a shallow V, with very short distally bifurcate processes where it meets the lateral margins, these processes about 0.04 mm in length, bifurcate for half their length, the outer branch being the longer.

Caudal laminae subrectangular, distal angles rounded, width two-fifths length (0.061 mm - 0.071 mm x 0.023 mm x 0.028 mm), with four setae on distal margin, one small seta on outer distal angle, and one long thin seta just proximal to inner distal angle.

Egg strings intact in only one specimen, length in this case 5.9 mm, with about 110 eggs per string.

First antenna of four segments, their proportionate lengths being given by the following ratio - 7:7:2:3; first segment subrectangular, distal half swollen to three-quarters length, narrowing distally to two-thirds this width, outer margin with one normal seta, and five very short setae; second segment subrectangular, rounded distally, width two-fifths length, partially divided by a groove in its anterior margin near the mid-point, with three setae on distal half of outer margin, two setae and three small setae on proximal half of outer margin, and one seta near inner proximal angle; third segment as long as wide, with one small seta near outer distal angle; distal segment rounded distally, width half length, with four setae and two very small setae on distal margin, and about seven very fine hairs on distal half of inner margin.

Second antenna of two segments, set on a stout base, first segment basal width half length, narrowing distally to two-thirds this width and rounded; second segment basal width two-fifths length, narrowing rapidly over the proximal third to half this width, and then more gradually to a sharp point distally, the distal two-thirds strongly curved.

Mouth tube 0.17 mm in length, basal width two-thirds length, narrowing to two-thirds this width distally, distal margin slightly rounded.

Mandibular palp a raised boss, as long as wide, with two short distal branches, one bearing two setae, one as long as the boss, the other twice this length, the other with a single seta as long as the boss.

Maxilla two segmented, segments subequal in length, first segment width one-third length, narrowing distally to two-thirds this width, rounded proximally and distally; second segment width one-tenth length, distal fifth a process with its distal two-sevenths bifurcate, and the branches narrowing to sharp points, the process divided into thirds by indistinct transverse markings.

First pereopod biramous, exopod of two segments, endopod of one segment or indistinctly two segmented, basipod subrectangular, as wide as long, somewhat rounded distally, twice length of endopod, which is two-thirds length of exopod; first segment of exopod subrectangular, basal width two-thirds length, narrowing slightly posteriorly, with a seta on outer distal angle; second segment subovate, half length of first segment, width two-thirds length, with seven setae on inner and distal regions of margin; endopod width a little more than half length, rounded distally, with four setae on distal margin, one seta on outer margin three-fifths distance from base, and one on inner margin two-thirds distance from base, these two latter setae possibly marking the distal angles of an indistinct first segment.

Second pereopod biramous, each ramus of two segments, the

segmentation of the endopod indistinct, basipod similar to that of first pereopod; exopod first segment subrectangular, width half length, outer distal angle slightly extended and with a stout seta.

Third pereopod rudimentary, about 0.1 mm in length, width two-thirds length, distal third a lobe half this width, rounded distally, with two setae on distal region and one on outer margin.

Discussion

In comparing H. crenata with described species the same type of measurements were employed as in the previously discussed species, H. quadrata, i. e. head width was divided into head length, trunk length, and trunk width. Ranges for these figures in the present material (eight specimens) were: 0.61 mm - 0.77 mm, 5.14mm - 6.11 mm and 1.03 mm - 1.43 mm, respectively.

Specimens figured in the literature were measured and those that came within the ranges 0.5 mm - 0.9 mm, 4.6 mm - 6.7 mm, and 0.8 mm - 1.7 mm for the three measurements were examined in more detail, except in a few cases where the body form of the figured specimens was so different from the present material as to make further comparison unnecessary.

Those examined in detail were as follows:

H. hippoglossi (Krøyer, 1837, p.205, pl. 2, figs. 3-3a) has broadly rounded posterolateral lobes on the trunk, which reach or nearly reach the posterior of the abdomen; in my specimens these lobes are smaller, more acute, and do not extend to the midpoint of the abdomen.

H. mulli (van Beneden, 1851, p.99, pl. 3, figs. 3-4, dorsal view; Scott and Scott, 1913, pl. 32, fig. 1) has its posterolateral lobes extending to the posterior end of the abdomen which in this species, is poorly developed compared to the present material.

H. linearis Wilson (1913, p.246, pl. 44, figs. 240-246) has the third thoracic segment clearly distinct from the trunk, unlike the present species.

H. conifera Yamaguti (1939, p.458, pl. 20, figs. 59-66) has long, pointed posterolateral processes on the trunk, again reaching well beyond the abdomen, hence distinct from the present species.

H. acuta Barnard (1948, p.250, fig. 7) differs from the present material in having lateral grooves in the trunk, one-tenth of the distance from its anterior margin, which appears to separate the third thoracic segment from the remainder of the trunk.

H. teuthedis Yamaguti (1954, p.392, pl. 6, figs. 53-55) lacks posterolateral processes on the trunk.

H. longigenitalis Yamaguti (1954, p. 394, pl. 6, figs. 59-61) has no posterolateral processes, and the trunk is narrowed steadily anteriorly from the midpoint so that as it approaches the cephalothorax its width is only half its greatest width; there is little tendency for anterior narrowing in the trunk in my material.

H. fusiformis Shiino (1957, p. 398, fig. 3) is without posterolateral processes on the trunk.

In addition, none of the above species appears to have the complexly lobate anterior margin of the cephalothorax found in H. crenata.

Type Material

The type specimens are deposited in the collection of the Zoology Department, Victoria University of Wellington, Wellington, New Zealand.

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SOME NEW ZEALAND PARASITIC
COPEPODA OF THE FAMILY ANTHOSOMIDAE

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ABSTRACT

The relationship between the genera Lernanthropus Blainville, Sagum Wilson, Pseudolernanthropus Yamaguti and Aethon Krøyer is considered. The genus Pseudolernanthropus is redefined and a new species of this genus described from Thyrsites atun and Jordanidia solandri; a new species of Lernanthropus is described from Seriolella brama; Aethon is redefined and Lernanthropus percis Thomson is redescribed and transferred to this genus; two new species of Aethon are described from Cheilodactylus macropterus and Latridopsis ciliaris respectively; Anthosoma crassum (Abildgaard) is redescribed from New Zealand material and previous records are discussed.

INTRODUCTION

Members of the family Anthosomidae include one widely distributed species (Anthosoma crassum) parasitic on sharks, and a large number of other species, mostly belonging to the genus Lernanthropus but also assigned to several other genera, which are found as parasites on teleosts and, in general, have a much more restricted distribution than Anthosoma crassum.

The collection described here contains six species belonging to the family.

Anthosomidae Yamaguti 1963.

This family as defined by Yamaguti (1963, p.142) contained eight genera. Of these Anthosoma Leach, 1816, Epachthes Nordmann, 1832, Norion Nordmann, 1864, Caetrodes Wilson, 1906 and Lernanthropodes Bere, 1936, are all clearly distinguishable, and each is represented by a single species. Of these only Anthosoma crassum is represented in the present collection.

The remaining genera, Lernanthropus Blainville, 1822, Sagum Wilson, 1913 and Pseudolernanthropus Yamaguti, 1960, together with Aethon Kroyer, 1836, which is described below, are all, clearly, closely related. Whether all should be united in the single genus Lernanthropus must be largely a subjective decision, but since this genus already contains some 90 species I feel that any unequivocal character which can be used to separate some members of the group should be accepted. In a group with, as yet, no records of its fossil history and very little obvious evidence of its phylogeny some recourse to utility in taxonomy is, I feel, acceptable.

I would, therefore, suggest the following separation of the females of these related genera.

1. Egg strings trailing from body, sublinear - Lernanthropus Blainville, 1822.
2. Egg strings coiled and concealed by dorsal plate of fourth segment. -----3.
3. Third thoracic segment expanded into wing-like posterolateral plates which fuse with fourth segment plates - Sagum Wilson, 1913^x.

^x The genus Sagum is not represented in the present collection.

4. Plates of third segment absent, or where present, not fused with plate of fourth segment. -----5.
5. Second pereopod biramous, each ramus one-jointed; fourth pereopod wall developed, visible in dorsal view - Pseudolernanthropus Yamaguti and Yamasu, 1960.
6. Second pereopod bifurcate but lacking joints; fourth pereopod small, hidden by third pereopods. - Aethon, Krøyer, 1836.

The males of Sagum and Aethon are unknown. I am unable to separate, at the generic level, the male of Pseudolernanthropus described below, from described males of Lernanthropus.

Pseudolernanthropus Yamaguti and Yamasu, 1960^{*}

Anthosomidae, Female: Head fused with first thoracic segment, lateral margin of carapace expanded laterally or ventrally; remaining thoracic segments fused together, the fourth with a large plate extending posteriorly to cover the genital and abdominal segments, the caudal laminae, the egg strings and most of the fourth pereopods; genital segment and abdomen both small; caudal laminae flattened dorso-ventrally and tapering posteriorly; first antennae small, 1 or 7 segmented with a few small setae; second antennae subchelate; mandibular palp with a divided base, each part bearing small processes or setae; maxilla with a variously toothed distal process; maxilliped subchelate; first four pairs of legs

^{*} Modified to include the following species)

biramous; first two pairs with one-segmented rami; third and fourth pairs visible in ventral view as laminate rami extending posteriorly; fifth leg uniramous, rudimentary.

Male: Head fused with first segment, margins entire; remaining segments fused into a trunk without dorsal plates; abdomen one-segmented, visible in dorsal view; caudal rami subcircular in cross section, slightly tapering posteriorly; appendages as in the female except third and fourth pereopods which are subcircular in cross section and fused to trunk, and fifth pereopods which are lacking. Parasitic on marine teleosts.

Type species: P. epinephali Yamaguti and Yamasu, 1960.

Pseudolernanthropus normalus n. sp.

Material Examined

From: Thyrsites atun - two lots of eight females, collected near Poor Knights Is. by A.N. Baker, January, 1964; three females and two males and another lot of two females collected, presumably in the region of Wellington, by H. Manter, 1951; seven females from Otago, no other data; nine females collected July, 1959, no other data.

From Jordanidia solandri - 10 females collected off Cape Terakirae, Cooks Strait, by the author, 20 October, 1960; one female (head missing) collected, presumably in the region of Wellington, by H. Manter, 1951.

Description

Female (figs 1 - 13)

Overall length 6.5 mm - 6.8 mm.

Cephalothorax as wide as long (1.27 mm - 1.73 mm x 1.37 mm - 1.80 mm), narrowing anteriorly to three-quarters this width, anterior margin curved, with a small medial bulge; antennae colaterally on a frontal area, one-sixth length of cephalothorax, which is marked by a transverse groove; posterior margin of cephalothorax marked by a dorsal ridge which is highest medially, posterolateral angles of cephalothorax rounded. Cephalothorax separated from remaining thoracic segments by a very short neck.

Second and third thoracic segments fused, their junction marked by a groove; second segment four-fifths width of third, combined length three-quarters third segment width (second segment width 1.75 mm - 1.90 mm, third segment width 1.95 mm - 2.47 mm, combined length 1.20 mm - 2.26 mm), both segments rounded laterally.

Fourth thoracic segment partially fused with third, but separated by deep lateral grooves, a little longer than wide (3.42 mm - 4.16 mm x 2.89 mm - 4.40 mm), widest just before rounded posterior margin, narrowing to less than half this width anteriorly, posterior margin with a very shallow V-shaped notch medially. Segment slightly less than half length of combined plate and segment, largely hidden in ventral view by the lamellar fourth pereopods.

Genital segment subovate, length three-fifths width (0.34 mm - 0.61 mm x 0.78 mm - 0.95 mm), entirely hidden in dorsal view by the plate of the fourth segment, and in ventral view by the fourth pereopod.

Abdomen subrectangular, angles broadly rounded, as wide as long (0.41 mm - 0.45 mm x 0.33 mm - 0.52 mm), bearing the caudal rami posterolaterally.

Caudal rami with rounded proximal margin, narrowing to a point distally, width two-fifths length (0.72 mm - 0.88 mm x 0.29 mm - 0.35 mm), plate of fourth thoracic segment reaching beyond caudal rami for a distance approximately equal to their length.

Egg strings many times length of animal, eggs uniserial, egg strings complexly coiled between plate of fourth thoracic segment and fourth pereopod.

First antenna without obvious segmentation, basal width two-fifths length, extending laterally, distal third at right-angles to basal portion, extending posteriorly, proximal width of this section one-third basal width, narrowing distally to a point, with setae over distal fifth; outer margin of this section with four setae, three sparsely plumose, inner margin with two setae, and a further three setae on blunt tip.

Second antenna of two segments, segments subequal in length, first segment, basal width two-thirds length, narrowing to two-thirds this width distally, with a small seta on outer margin near outer distal angle; second segment a sharply curved claw, basal width half length, narrowing steadily to a sharp point.

Pseudolernanthropus normalus n. sp. female:

fig. 1: dorsal view; fig. 2: lateral view; fig. 3: ventral view;
fig. 4: first antenna; fig. 5: distal end of first antenna further
magnified; fig. 6: seta found between first and second antennae;
fig. 7: second antenna; fig. 8: mandibular palp; fig. 9: maxilla;
fig. 10: distal process of maxilla further magnified; fig. 11:
maxilliped; fig. 12: first pereopod; fig. 13: second pereopod.



A small seta (0.2 mm in length) situated on a raised boss is found between the bases of the first and second antennae, and may correspond to the chitinised lappet in Anthosoma crassum.

Mouth tube small and very narrow distally.

Mandibular palp in two parts, medial part half length of lateral part, width half length, with a distal process one-third its length, width half length, rounded distally, with a seta near its base (hidden by distal protuberance in fig. 8); lateral part rising from a broad subrectangular base, width half length, rounded distally, with one heavy spine, one slender seta, and one blunt spine or small protuberance borne distally.

Maxilla of two segments, second half length of first, width of first two-sevenths length, rounded distally, width of second one-third length, rounded distally; second segment bears distally a small subsemicircular projection, one-eighth segment length, outer margin straight and dentate, a small flange surrounding part of its base.

Maxilliped of two segments, second segment three-quarters length of first, first segment half as wide at the base as long, narrowing and rounded distally, with a raised area near midpoint of inner margin against which claw-like second segment closes; second segment, basal width two-fifths length, curving, particularly near base and tip, narrowing gradually to a sharp distal point.

First pereopod biramous, each ramus of one segment; basipod swollen, subovate, width twice length, rami situated near inner distal angle, exopod half basipod length, endopod two-thirds exopod length; exopod a little longer than wide, outer margin a little longer than inner, with five flattened spines on distal margin; endopod as wide as long, rounded distally, bearing a single distal seta.

Second pereopod biramous, each ramus of one segment, basipod swollen, semicircular, length half width, with a single seta on a raised boss near outer distal angle, rami borne on inner part of distal margin; rami subequal in length, half basipod length; exopod rounded distally, width two-thirds length, with about seven very small spines around distal margin; endopod with basal width subequal to length, narrowing and rounded distally, with several small spines and one larger spine on distal region.

Third pereopod without rami, a flattened lamina, curved into a semicircle so that lateral margins are directed posteriorly, so that total length is about one-fifth body length, rounded anterior margin raised from body by a sublinear margin two-thirds anterodistal length of appendage.

Fourth pereopod flattened lamellae, three-quarters body length, two-fifths as wide as long, one-third this width basally, distal half bifurcate, each branch narrowing distally to a point, outer branch a little longer than inner; the fourth pereopods overlap in the midline so as to hide in ventral view much of the fourth thoracic segment, all of the genital and abdominal segments, and the egg strings.

Male (figs 14 - 24).

Overall length 3.20 mm and 4.82 mm.

Cephalothorax, width four-fifths length (1.45 mm and 1.48 mm - 1.23 mm and 1.17 mm), subovate, antennae borne laterally on a frontal area, marked by dorsal grooves, anterolateral angles rounded, two-fifths cephalothorax length, four-fifths as wide as long, shorter ventrally; posterior margin of cephalothorax an entire curve.

All remaining segments fused but second and third segments distinguished by lateral grooves, posterior margin of third segment by posterior termination of pereopods, posterior termination of fourth segment by termination of fourth pereopod and by lateral grooves, posterior margin of genital segment by slight grooves and by the disparity in width between the genital segment and abdomen.

Second thoracic segment subovate, length one-tenth width (0.08 mm and 0.09 mm x 0.75 mm and 0.82 mm).

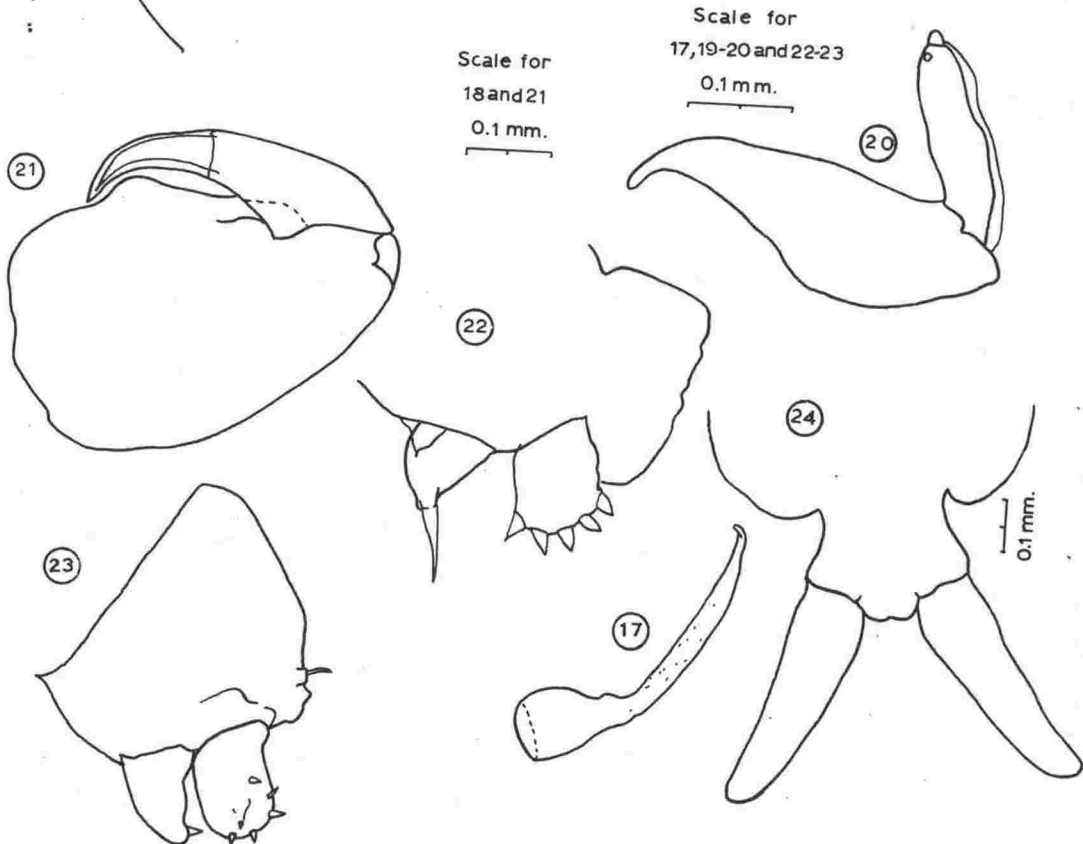
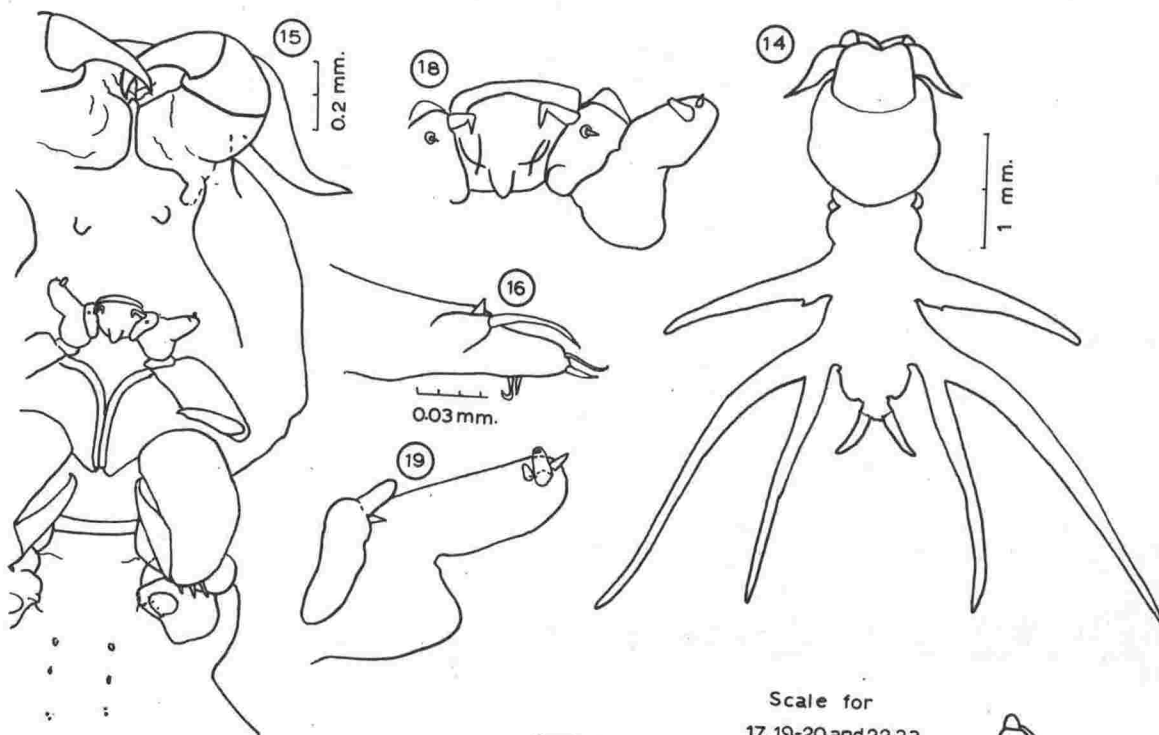
Third thoracic segment subrectangular, the lateral margin between the base of the pereopod and the second segment bulging laterally and curved, as long as wide (0.83 mm and 0.80 mm x 0.81 mm and 0.92 mm).

Fourth thoracic segment subrectangular, length half width (0.57 mm and 0.54 mm x 0.86 mm and 0.95 mm).

Genital segment subrectangular, posterolateral angles rounded, length half width (0.33 mm and 0.28 mm x 0.61 mm and 0.58 mm).

Pseudolernanthropus normalus n. sp. male:

fig. 14: dorsal view; fig. 15: ventral view of cephalothorax,
second and third thoracic segments; fig. 16: tip of first antenna;
fig. 17: seta from between first and second antennae; fig. 18:
mouth tube and mandibular palp; fig. 19: mandibular palp;
fig. 20: maxilla; fig. 21: maxilliped; fig. 22: first pereopod;
fig. 23: second pereopod; fig. 24: genital segment, abdomen and
caudal rami.



Abdomen subrectangular, length three-quarters width (0.22 mm and 0.17 mm x 0.29 mm and 0.22 mm), slightly narrower anteriorly.

Caudal rami attached to lateral part of posterior margin of abdomen, basal width one-third length (0.45 mm and 0.40 mm x 0.12 mm and 0.13 mm), narrowing slightly distally, distal margin rounded, not pointed as in female.

Appendages as in female except that the maxilla bears a flange along outer margin of second segment, and a second smaller process on inner margin near distal process, the spines on the exopod of the second pereopod are better developed than in the female, and the third and fourth pereopods are transformed into laterally projecting cylindrical processes fused to their respective thoracic segments.

Third pereopod projecting laterally from posterior half of third thoracic segment, length two-fifths body length, basal width one-quarter length, narrowing distally, distal margin rounded, posterior margin with a small pointed branch, one-seventh distance from base, which may represent the endopod.

Fourth pereopod almost as long as body, extending posterolaterally from fourth thoracic segment, basal width one-ninth length, dividing one-seventh distance from base into two branches, inner branch two-thirds length of outer branch, both branches tapering gradually to a blunt point.

Discussion

There seem to be no differences between the specimens from Thysites atun and Jordanidia solandri except that the combined second and third thoracic segments are longer in the latter (1.43 mm - 1.67 mm) than in the former (1.72 mm - 2.26 mm).

The genus Pseudolernanthropus was erected by Yamaguti and Yamasu (1960, p.146) who made P. epinephali the type species. They suggest that Lernanthropus petersi van Beneden, 1857 should be transferred to this new genus. Later, Yamaguti (1963, p.153-154) expanded the genus to include P. posteli (Delamare-Deboutville and Nunes-Ruivo, 1954), transferred from Sagum, P. angulatus (Krøyer, 1863, p.270) which Wilson (1922, p.28) had transferred from Lernanthropus to Sagum, and P. texanus (Pearse, 1952, p.32) transferred from Sagum.

Yamaguti gives no discussion of his reasons for transferring these species to Pseudolernanthropus. Descriptions of these species (in the case of P. petersi, (van Beneden) the original description was not available and figures by Yamaguti (1963, pl. 168, fig.6) and Barnard (1955, fig.19) were consulted) make it clear that in all cases (1) the eggs are coiled up between the fourth pereopods and plate of the fourth segment, (2) except in Lernanthropus angulatus, the fourth pereopods are clearly visible in ventral view, and (3) posterolateral extensions of the third and fourth thoracic segments are not fused with the exopod of the third pereopod; on these criteria I accept these species as belonging to Pseudolernanthropus as defined in this paper.

Krøyer in his description of L. angulatus, however, suggests that the third pereopod ("Femte Fodpar") is fused in part to the thorax and further, that the fourth pereopod ("Sjette Fodpar") has a soft flagellum as later described by Wilson for Sagum flagellatum. Krøyer queries the function of these structures, as did Wilson fifty-nine years later. It is clear that the soft flagellum is not just a sudden narrowing of the lamellar ramus as found in most species of Pseudolernanthropus. I therefore agree with Wilson (1922, p. 28) that L. angulatus is referable to Sagum and should be Sagum angulatus (Kroyer).

The present species, P. normalus, is quite unlike any of the species of Pseudolernanthropus previously described. It differs from P. epinephali, P. posteli and P. texanus in lacking the sudden narrowing of the fourth pereopods. In P. normalus and P. petersi these pereopods narrow gradually towards the posterior tip. P. normalus differs from P. petersi in having broadly laminate fourth pereopods (width about half length) and a long fourth thoracic segment plate (more than half body length) while in P. petersi the length of the fourth pereopods are many times their width and the fourth thoracic segment plate is much less than half body length,.

In some characters, e. g. the longer body shape and form of the fourth pereopods, P. normalus resembles members of the genus Lernanthropus to a greater extent than do most other species of Pseudolernanthropus.

Lernanthropus Blainville, 1822

Anthosomidae. Female: Head fused with first thoracic segment, cephalothorax margins turned down ventrally; second and third thoracic segments fused; fourth thoracic segment fused to second and third, rarely free, covered by a dorsal plate which extends posteriorly to cover the genital segment, and sometimes the abdomen and caudal rami, in dorsal view; genital segment small, rounded; abdomen one-or two-segmented; caudal rami present, flattened or subcircular in cross section, usually tapering posteriorly; eggs uniseriate, flattened; egg strings usually long, trailing posteriorly from genital segment; first antenna with segments more or less fused, sometimes distinct; second antenna subchelate; mandibular palp present; maxilla two-segmented; maxilliped subchelate; first four pereopods biramous; rami of first and second pairs rudimentary, one-segmented; those of third pair lamellar, fused, projecting at right angles or diagonally from ventral surface; rami of fourth pereopods usually separate, lamellar, extending posteriorly; fifth pereopods uniramous, rudimentary or lacking. Male as for Pseudolernanthropus. Parasitic on marine teleosts.

Type species: L. musca Blainville, 1822.

Lernanthropus microlamini n. sp.

Material

From Seriolella brama, one female, collected by H. Manter in 1951, presumably in the region of Wellington.

Description

Female (figs 25 - 36).

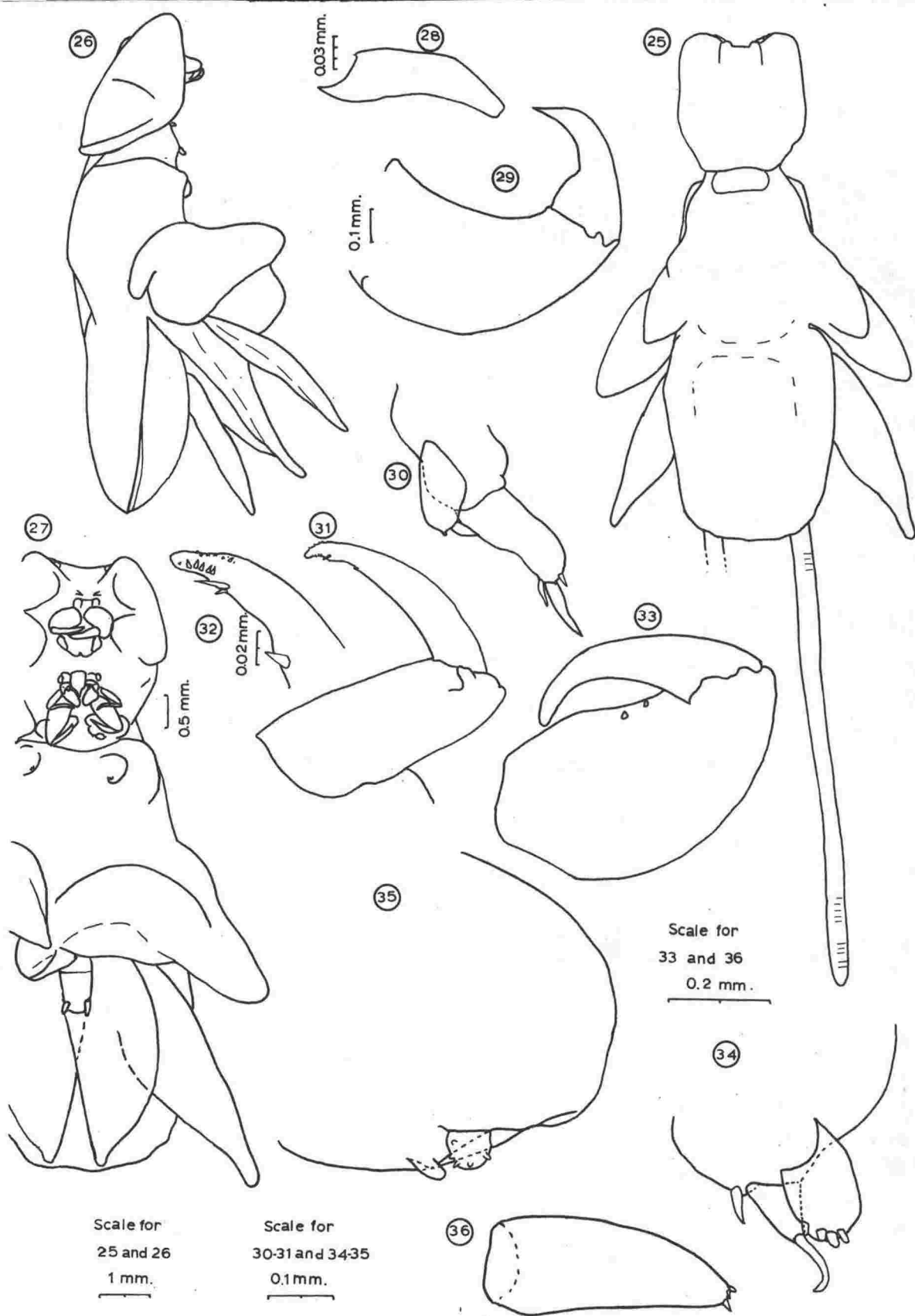
Overall length 9.92 mm.

Cephalothorax subrectangular, angles rounded, little longer than wide, (2.67 mm x 2.52 mm), anterior three-quarters of lateral margins parallel, cephalothorax narrowing slightly posteriorly; antennae borne on anterolateral bulges of a frontal area which is one-third cephalothorax width and one-seventh cephalothorax length, marked laterally by grooves, its sublinear anterior margin forming a dip in the anterior margin of cephalothorax, remainder of anterior margin of cephalothorax an entire curve on either side of frontal region.

Second and third thoracic segments fused, as wide as long (3.20 mm x 3.35 mm), widest posteriorly, narrowing anteriorly to half this width, projections on the posterior two-fifths of the lateral margin extend over part of surface of third pereopod, and increase this width by two-sevenths.

Fourth thoracic segment, including plate, subrectangular, angles rounded, four-fifths as wide as long (4.27 mm x 3.39 mm) narrowing to three-quarters this width posteriorly; actual segment very short.

Lernanthropus microlamini n. sp. female: fig. 25: dorsal view; fig. 26: lateral view; fig. 27: ventral view; fig. 27a: first antenna; fig. 28: spine from between first and second antennae; fig. 29: second antenna; fig. 30: mandibular palp; fig. 31: maxilla; fig. 32: tip of maxilla; fig. 33: maxilliped; fig. 34: first pereopod; fig. 35: second pereopod; fig. 36: caudal lamina.



Genital segment very small, subovate, partly hidden in ventral view by third pereopods, which were not dissected off to reveal this segment.

Abdomen subrectangular, posterior angles rounded, width half length (0.65 mm x 0.49 mm), narrowing slightly posteriorly.

Caudal rami, width two-fifths length (0.45 mm - 0.19 mm), widest at base, narrowing slightly distally, distal margin rounded, three small spines borne distally.

Egg strings 13.00 mm in length, eggs uniserial, egg strings trailing behind body.

First antenna of seven segments, basal segment half length, second and third segments subequal in length, together half basal segment length, remaining segments progressively shorter; basal segment, basal width two-thirds length, narrowing to half this width distally, with two setae on outer margin and one on inner margin; second segment as wide as long, subovate; third segment as wide at the base as second, narrowing to two-thirds this width distally, with one seta on outer margin; fourth segment subovate, four-fifths as wide as long, with one seta on outer margin; fifth segment two-thirds as wide as long, with two setae near distal margin; terminal segment, width two-thirds length, rounded distally, with five setae on inner distal region, and three small spines near outer distal region.

Second antenna of two segments, subchelate; first segment, basal width two-thirds length, narrowing to nearly half this width distally, curving slightly; second segment three-quarters length of first, basal width half length, narrowing suddenly to half this width one-third distance from base, then narrowing slowly to a sharp point distally, distal two-thirds sharply curved.

Mouth tube small (0.4 mm in length), and sharply pointed distally.

Mandibular palp biramous, rami borne on subrectangular base, outer ramus, width half length, rounded distally; inner ramus as wide as outer, two-thirds its length, both rami with one large and two small spines distally.

Maxilla of two segments, segments subequal in length, first segment subrectangular, half as wide as long; second segment basal width one-quarter length, narrowing gradually to a blunt tip, with a spine on inner margin two-sevenths distance from tip, two spines one-seventh distance from tip, and two rows each of about seven very small spines between these two and the tip.

Maxilliped of two segments, subchelate; basal segment swollen, basal width half length, narrowing to two-thirds this width distally, outer margin strongly curved, inner margin with two small spines; second segment three-quarters length of first, basal width two-fifths length, narrowing to a point distally, sharply curved, particularly over distal half.

First pereopod biramous, each ramus of one segment; basipod swollen, subsemicircular, half as long as wide, with a spine near base of endopod; rami subequal in length, a little shorter than basipod; exopod, width three-quarters length, rounded distally, with four blunt flattened spines on distal margin; endopod subtriangular, as wide as long, with a seta subequal in length to segment on distal apex.

Second pereopod biramous, each ramus of one segment; basipod swollen, almost three times length of basipod of first pereopod, similar in shape except that it swells more strongly laterally than does basipod of first pereopod; exopod one-seventh basipod length, subsemicircular, proximal margin straight, as wide as long, with five small flattened blunt spines on distal and inner margins; endopod three-quarters length of exopod, width two-thirds length, rounded distally, with no setae.

Third pereopod laminate, rami fused or lost, laminae a little wider than plate on fourth thoracic segment, lying transversely across body, overlapping slightly in the midline, and extending posterolaterally from the body for almost one-third their length, slightly curved, standing out at right angles from the body for a distance equal to one-fifth body length.

Fourth pereopod biramous, rami flattened lamellae separated almost to their base, exopod, width one-quarter length, narrowing gradually to one-quarter this width distally and then rounded, extending posterolaterally beyond plate of fourth segment for more than half its length; endopod five-sevenths length of exopod, two-fifths as wide as long, inner

margin sublinear, outer margin curved over distal three-fifths of its length to reduce width to one-eighth basal width, lamella then rounded distally.

Discussion

L. microlamini seems to be most closely related to a group of species or subspecies recorded from many parts of the world on Caranx spp. Initially these were described as L. giganteus by Krøyer (1863, p.280, pl. 8, fig. 1) from Brazil, then Wilson recorded specimens from the West Indies (1913, p.227, pl. 33, figs 148 - 150, pl. 35) under the same name, although Wilson's figures differ from those by Krøyer in the length of the plate of the thoracic segment (40% of total length in Krøyer's figure, 30% in Wilson's), as well as in the shape of this plate; Kirtisinghe (1956, p.18, fig. 11) recorded specimens from Colombo under the name L. trifoliatus Bassett-Smith but later (1964, p.98, figs. 132 - 137) gave further records from the Gulf of Mannar area, now placing these and his previous records as L. giganteus; meanwhile Pillai (1964, p.48, fig. 9) recorded specimens from the same host genus from nearby Trivandrum as L. carangis Pillai (nec L. carangis Hesse, 1878 which was removed from the genus Lernanthropus by Wilson, 1922, p.46); these Indian Ocean specimens differ from those of Wilson and Krøyer in having a broadly laminate fifth pereopod while the latter show their specimens as having filiform fifth pereopods.

The present material can readily be distinguished by the third pereopods which extend little beyond the plate of the fourth thoracic segment, while in the above records these appendages project beyond

the plate for one-third its length, and also by the lack of fifth pereopods which are well developed in the above records.

The present species is also very similar to L. trifolius Bassett-Smith (1898, p.12, pl. 7, fig. 1) but differs in having the plate of the fourth thoracic segment narrowed posteriorly while in L. trifolius it becomes wider and then broadly rounded posteriorly, and again in the lack of the fifth pereopods which are particularly well developed in L. trifolius.

It seems possible that the present species and L. trifolius are closely related to the specimens recorded from Caranx spp. but, until such time as larger collections from a variety of geographical localities makes revision of this group possible, there is no way of deciding the extent of this relationship.

Aethon, Krøyer, 1836

Anthosomidae. Male probably unknown. Female: Head fused with first thoracic segment, cephalothorax usually with lateral wing-like expansions; second and third thoracic segments fused but with separate dorsal plates, and with lateral expansions which extend slightly posterolaterally but do not fuse with plate of fourth segment; fourth segment covered by a dorsal plate which extends posteriorly to hide the posterior part of the body and all or most of the egg strings in dorsal view; genital segment small, abdomen small and rounded; caudal laminae small, irregular in outline with a lateral spine-bearing projection and further spines posteriorly; eggs uniseriate, flattened; egg strings long, coiled between third pereopods and plate of fourth thoracic segment; first antenna with six or seven segments, several with short setae; second antenna subchelate; mandibular palp with two rami, at least one with spines; maxilla of two segments usually with rows of spines distally; maxilliped subchelate; first four pereopods biramous; first pereopods with rudimentary one-segmented rami; second pereopods held at right angles to body, rami fused with basipod; third pereopods large, thickened lamellae with endopod covering egg strings in ventral view and exopod hiding them in lateral view; fourth pereopods lamellar, divided nearly to base, about half length of third pereopods, which completely hide them in ventral view; fifth pereopods uniramous, rudimentary. Parasites on marine teleosts.

Type species: Aethon quadratus Krøyer, 1836.

Aethon percis (Thomson, 1889)

Lernanthropus percis Thomson, 1889, p. 366-7, pl. 27, figs 2a-j

nec " " " Wilson, 1936, p. 340.

Material

From gills of Parapercis colias (blue cod):

One female, collected at the northern end of Kapiti Is., by the author, 4 February 1967; three females from the collection of the Otago Museum in a tube containing three labels "Lernanthropus percis - gills of blue cod", "G.M.T. dep. 1910" and "label on outside of tube - from gills of blue cod 23/10/79" (there is now no label on outside of tube).

One of these latter specimens had been dissected and may be the specimen from which Thomson made his original description and drawings.

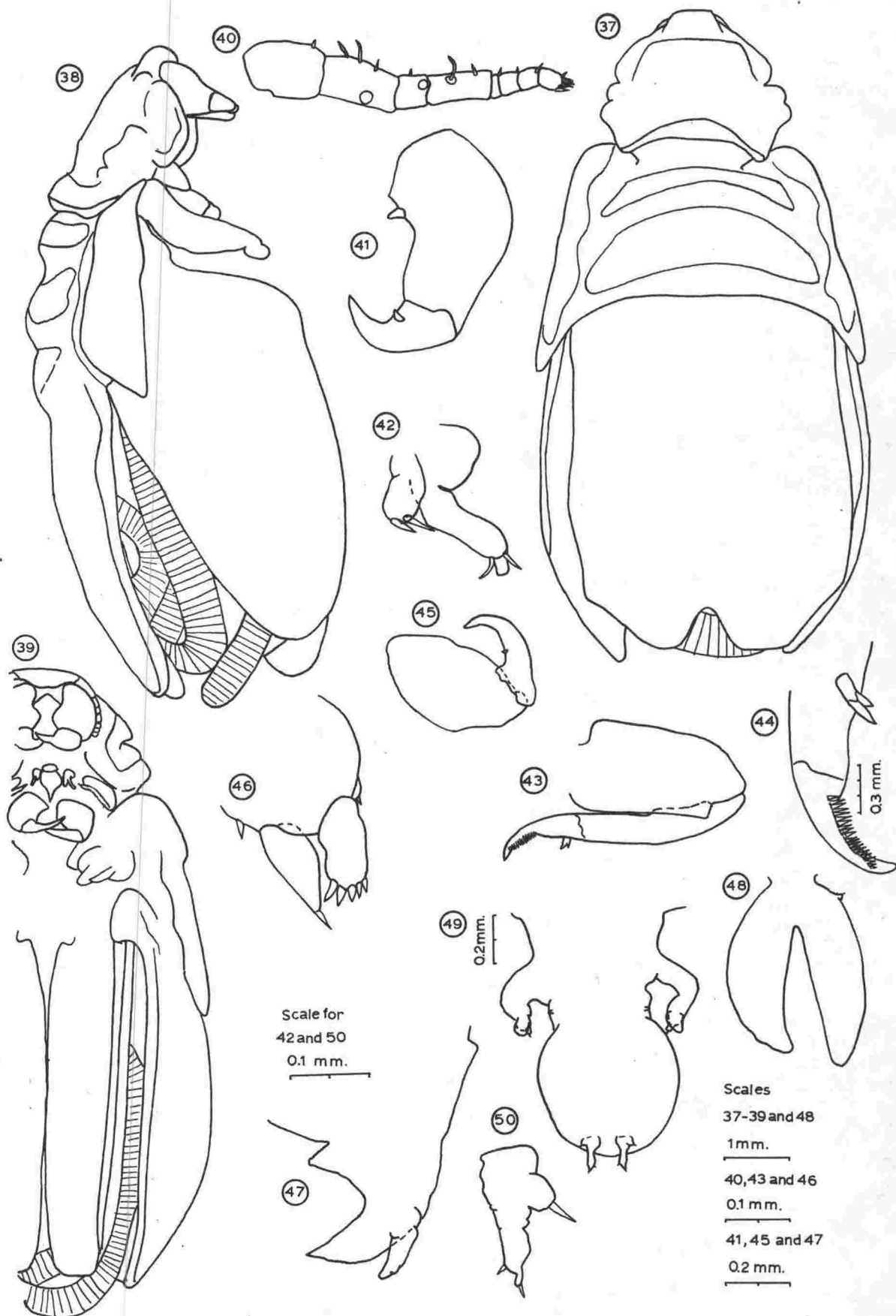
Description

Female (figs 37 - 50).

Overall length (5.15 mm - 5.73 mm).

Cephalothorax, width four-fifths length (1.63 mm - 1.95 mm x 1.18 mm - 1.47 mm), subovate, posterior margin sublinear, raised in a ridge; antennae borne laterally on a short anterior area, one-third carapace width posteriorly, narrowing to two-thirds this width anteriorly, anterior margin straight, marked off from carapace by lateral grooves, extending a little beyond anterior margin of remainder of cephalothorax; lateral margin of carapace expanded as two lobes, each half length of margin, anterior lobe bulging posterolaterally, posterior lobe bulging antero-laterally, posterior lobe slightly bifid distally in some specimens,

Aethon percis (Thomson, 1889): fig. 37: dorsal view;
fig. 38: lateral view; fig. 39: ventral view; fig. 40: first
antenna; fig. 41: second antenna; fig. 42: mandibular palp;
fig. 43: maxilla; fig. 44: tip of maxilla; fig. 45:
maxilliped; fig. 46: first pereopod; fig. 47: second pereopod;
fig. 48: fourth pereopod; fig. 49: genital segment, abdomen
and caudal laminae; fig. 50: caudal lamina.



posterior lobe sometimes unequally developed (see fig 37 in which right hand lobe is larger than left).

Second and third thoracic segments fused, but distinguished by a groove which runs dorsally and laterally; combined length three-quarters width, second segment four-fifths width of third (combined length 1.05 mm - 1.21 mm, second segment width 1.13 mm - 1.39 mm, third segment width 1.44 mm - 1.67 mm), second and third segments each with most of dorsal surface covered by a poorly developed plate; lateral margin of combined second and third thoracic segments extend laterally as wing-like expansions, which increase the width by up to one-fifth, lateral margins of expansions sublinear, anterior angles rounded, posterior angles extended posterolaterally for a distance equal to two-fifths combined segments length, narrowing and rounded distally, not fused with plate of fourth segment.

Fourth thoracic segment including plates, slightly longer than wide (2.43 mm - 3.32 mm x 2.47 mm - 2.87 mm), lateral margins sublinear and parallel for the anterior four-fifths of their length, then slightly angled, posterior margin an entire curve except for a concave invagination medially which is one-sixth plate width, and one-eighth length of plate; actual segment short, length one-third width (0.72 mm - 0.80 mm x 2.11 mm - 2.53 mm), subrectangular, angles rounded.

Genital segment subrectangular, a little wider than long (0.42 mm x 0.49 mm), widest anteriorly, narrowing to two-thirds this width distally.

Abdomen subovate, as wide as long (0.55 mm x 0.53mm), fused to genital segment anteriorly, bearing caudal laminae posterolaterally.

Caudal laminae very small, length twice width (0.18 mm x 0.09 mm), subtriangular, lateral margins irregular, with a lateral projection one-quarter distance from base, one-fifth as long as lamina, a little wider than long, and tipped with a sharp spine; lamina with a further sharp spine at the distal apex, and further spine on medial margin near the apex.

Egg strings long, complexly coiled and hidden in dorsal view by the plate of the fourth thoracic segment, in ventral view by the third pereopods.

First antenna of seven subrectangular segments, ratio of lengths from the basal segment outwards being approximately 3:3:2:3:1:1:1; first segment width two-thirds length, with a small spine on outer margin, second segment width four-sevenths length, with three setae on outer margin, third segment as wide as long, with a small seta on outer margin, fourth segment width half length, with one long and one short seta on outer margin (fig 40 shows fourth segment joined to fifth by a short membrane which could be a thinly chitinated segment), fifth segment as wide as long, with two small setae on outer margin, sixth segment as wide as long, with one small seta on outer distal angle, seventh segment rounded distally, width three-quarters length, with six setae on distal margin.

Second antenna of two segments, subchelate; first segment, basal width half length, narrowing to three-quarters this width distally, curved, with a stout spine on inner margin near base; second segment basal width half length, narrowing steadily to a sharp point distally, strongly curved, with a stout spine near inner margin one-quarter of distance from base.

Mouth tube small (0.5 mm in length), sharply pointed distally.

Mandibular palp, with two rami on a flattened subrectangular base; outer ramus, width two-fifths length, rounded distally, with two setae and one subrectangular process distally; inner ramus half length of outer, width two-thirds length, rounded distally, with two setae distally.

Maxilla of two segments, segments subequal in length; first segment, basal width half length, narrowing slightly distally, distal margin rounded; second segment basal width one-tenth length, narrowing gradually distally except that distal seventh narrows suddenly and bears a longitudinal row of small spines reaching almost to the slightly blunted tip, a small process, one-third length of narrowed distal region, width half length, is situated near inner margin one-quarter distance from tip, and bears two setae distally, the larger seta subequal in length to process, the other a little smaller.

Maxilliped of two segments, subchelate; first segment, basal width two-thirds length, narrowing slightly distally, distal margin rounded; second segment basal width half length, narrowing gradually to a distal point, sharply curved over distal two-thirds, with a small spine on inner margin one-third distance from base.

First pereiopod biramous, each ramus of one segment; basipod swollen, subsemicircular, length two-thirds width, with one small spine medial to endopod and another on a raised boss lateral to exopod; exopod subovate, subequal in length to basipod, width half length, with five flattened spines on distal margin; endopod subtriangular, subequal in length to exopod, basal width half length, distal apex bearing a spine.

Second pereiopod biramous, the rami fused to the basipod, length including rami more than twice length of first pereiopod, as long as basal width, narrowing steadily distally, to end in a sharp point, the terminal section presumed to include the endopod, distal portion curving sharply medially and posteriorly away from the body, inner margin with a well developed subtriangular expansion one-third distance from base, and a further process on outer margin two-thirds distance from base is assumed to be the reduced exopod; exopod one-quarter length of combined basipod and endopod, basal width half length, narrowing gradually for three-quarters its length then more suddenly to one-third basal width, tip rounded.

Third pereiopod very large, two-thirds length of body, biramous, the rami lamellar, directed posteriorly and separated but fused with base which is one-fifth length of subequal rami; exopod a flattened subsemiovate lamella, basal width two-thirds length, narrowing slightly distally, distal margin rounded, hiding the egg strings in lateral view; the endopod is folded almost into a right angle in cross section, the inner portion lying flat against egg strings, the outer portion turned ventrally, involving one-quarter width of endopod

distally, less proximally, the ventrally turned portion lying almost parallel to exopod, endopod if flattened would be subrectangular, width one-quarter length, posterior angles rounded.

Fourth pereiopod biramous, total length half total length of third pereiopod, rami fused with basipod which is one-quarter length of exopod and narrows towards its base so that its lateral margins form entire curves with outer margin of exopod and inner margin of endopod; exopod one-quarter as wide at the base as long, narrowing and rounded distally, outer margin a convex curve, inner margin sublinear, with a very small spine on a raised boss on outer margin near junction with basipod; endopod three-quarters exopod length, width at midpoint half length, narrowed slightly proximally, more narrowed distally, rounded distally, outer margin an entire curve, inner margin sublinear.

Fifth pereiopod borne near midpoint of genital segment lateral margin, almost as long as genital segment, width one-quarter length, rounded distally, bent into a right angle, directed laterally, then posteriorly, with a small seta on a well developed projection near distal margin.

Discussion

The material on hand agrees well with Thomson's description and figures (1889, p. 366-7, pl. 27, figs. 2a-j); this could be expected in the case of the Otago Museum material since it had been identified as L. percis by Thomson himself.

Wilson (1936, p. 340) claimed to have found this species on Promicrops itaira at the Dry Tortugas. The only description

he gives is that the first antennae "prove to be six-segmented, with no setae except two minute ones at the tip of the end segment". Since in A. percis the antenna is seven segmented with setae on every segment it seems that Wilson's record is of yet another species of Aethon.

A. percis resembles A. quadratus Krøyer in its general form and in its possession of forked, unsegmented, second pereopods, and in the development of the third pereopods, but it can be separated from A. quadratus in that the latter has the posterior lateral lobe of the cephalothorax extending out well beyond the anterior (which may even be missing; Krøyer does not make this clear) while in A. percis the posterior lobe is only slightly longer than the anterior. Further, A. quadratus has a well developed neck region, almost entirely missing in A. percis.

Aethon garricki n. sp.

Material

From gills of Cheilodactylus macropterus: One female collected by the author from Somes Island, Wellington Harbour, 28 April, 1961.

Description

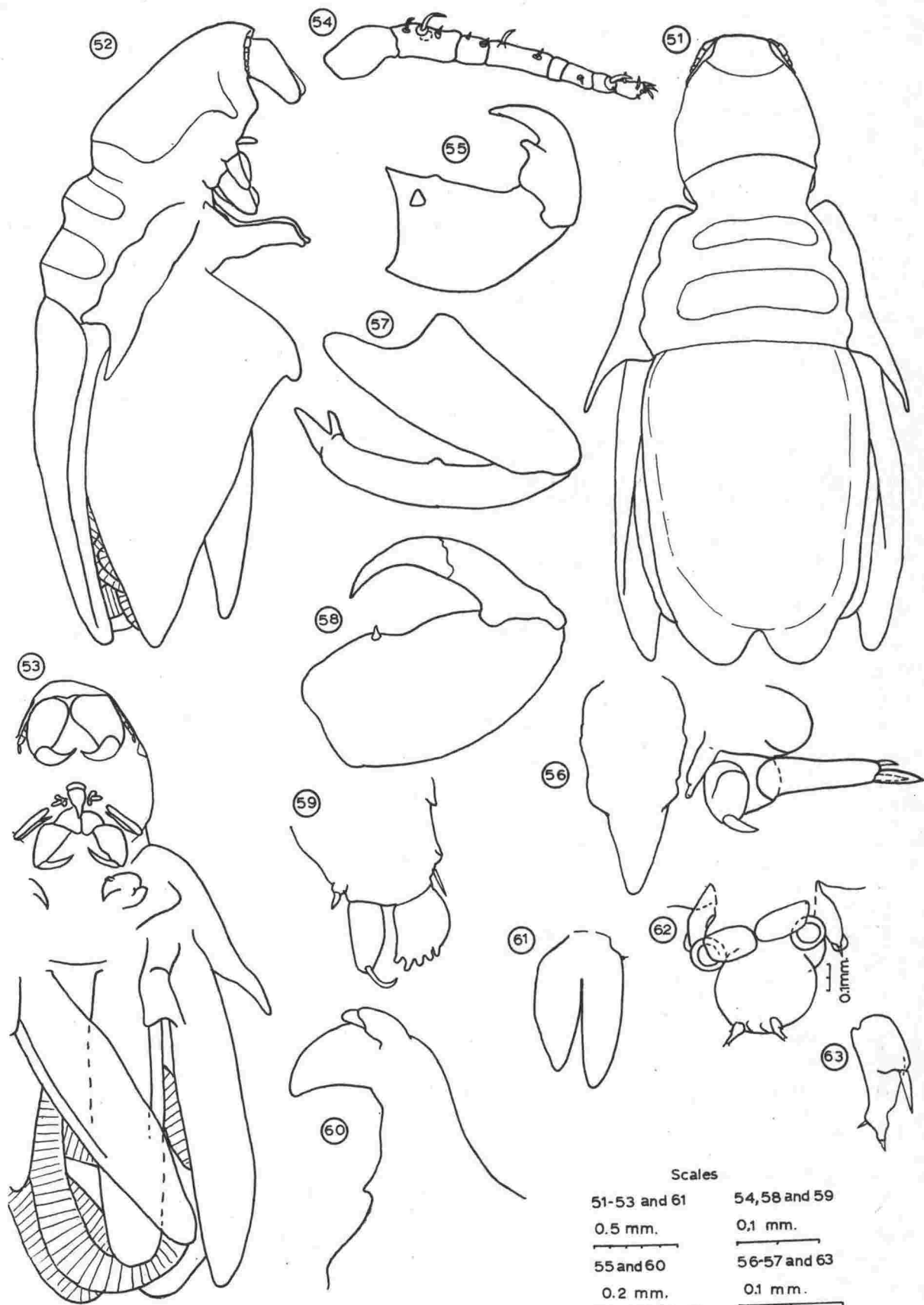
Female (figs 51 - 63).

Overall length 3.82 mm.

Cephalothorax subovate, width two-thirds length (1.22 mm x 0.86 mm), anterior and posterior margins sublinear, lateral margins entire convex curves, anterior margin half cephalothorax width, posterior margin three-quarters cephalothorax width; antennae carried laterally on an anterior area one-quarter cephalothorax length, half cephalothorax width posteriorly, slightly narrower anteriorly, distinguished by very faint grooves; cephalothorax without lateral expansions.

Second and third thoracic segments fused, distinguishable by a dorsal and lateral transverse groove, combined length two-thirds width, width of second segment four-fifths width of third (combined length 0.81 mm, width of second thoracic segment 1.04 mm, width of third thoracic segment 1.24 mm); two poorly developed dorsal plates which are rounded laterally, cover much of the dorsum of each segment; lateral margins of these segments are extended in wing like projections which increase in width of segments by up to one-third,

Aethon garricki n. sp. female: fig. 51: dorsal view;
fig. 52: lateral view; fig. 53: ventral view; fig. 54: first
antenna; fig. 55: second antenna; fig. 56: mouth tube and mandibular
palp; fig. 57: maxilla; fig. 58: maxilliped; fig. 59: first pereopod;
fig. 60: second pereopod; fig. 61: fourth pereopod; fig. 62:
genital segment, abdomen and caudal laminae; fig. 63: caudal
lamina.



the extensions rounded anteriorly, extended posterolaterally for a distance equal to half length of combined second and third thoracic segments; this extension narrowing rapidly and ending in a blunt point, this extension well separated from the plate of the fourth thoracic segment.

Fourth thoracic segment, including plate, subovate, anterior margin sublinear, width two-thirds length (1.96 mm x 1.36 mm), lateral margins forming an entire curve with posterior margin except that posterior margin has a median convex invagination, one-ninth segment length, one-fifth segment width. The segment is entirely covered by the plate indorsal view and the single specimen was not dissected so that the segment itself was not seen.

Genital segment subrectangular, slightly swollen posteriorly, length three-quarters width (0.33 mm x 0.46 mm).

Abdomen subcircular, length four-fifths width (0.32 mm x 0.39 mm), anal laminae borne posteroventrally.

Caudal laminae width two-fifths length (0.12 mm x 0.05 mm), subtriangular, lateral margins irregular, with a lateral projection one-quarter distance from base, one-fifth as long as lamina, a little wider than long, and tipped with a sharp spine; lamina with a further sharp spine at the distal apex, and a further spine on medial margin near the apex.

Egg strings long, complexly coiled and hidden in dorsal view by the plate of the fourth thoracic segment, in ventral view by the third pereopods.

First antenna of seven subrectangular segments, ratio of lengths from the basal segment outwards being approximately 3:3:2:3:1:1:1; first segment width two-thirds length, second segment width four-sevenths length, with three setae on outer margin, third segment as wide as long, with two small setae on outer margin, fourth segment width half length, with one long and one short seta on outer margin, fifth segment as wide as long, with one small seta on outer margin, sixth segment as wide as long, with one small and one large seta on outer distal angle, seventh segment rounded distally, width three-quarters length, with one small seta on outer margin and six setae on distal margin.

Second antenna of two segments, subchelate; first segment, basal width two-thirds length, narrowing to three-quarters this width distally, curved, with a stout spine on inner margin near base; second segment basal width half length, narrowing steadily to a sharp point distally, strongly curved, with a stout spine near inner margin one-third of distance from base.

Mouth tube small (0.2 mm in length), sharply pointed distally.

Mandibular palp, with two rami on a flattened subrectangular base; outer ramus, width one-third length, rounded distally, with two small and one large setae distally; inner ramus half length of outer, width two-thirds length, rounded distally, with one seta distally.

Maxilla of two segments, segments subequal in length; first segment, basal width two-fifths length, narrowing slightly distally, distal margin rounded; second segment basal width one-seventh length, narrowing gradually distally except that distal seventh narrows suddenly; a small process, half length of narrowed distal region is situated on inner margin at base of this region.

Maxilliped of two segments, subchelate; first segment, basal width half length, narrowing slightly distally, distal margin rounded, with a small spine one-third of distance from base; second segment basal width two-fifths length, narrowing gradually to a distal point, sharply curved over distal half.

First pereopod biramous, each ramus of one segment; basipod swollen, subsemicircular, length two-thirds width, with one small spine medial to endopod and another on a raised boss lateral to exopod; exopod subovate, subequal in length to basipod, width half length, with five flattened spines on distal margin; endopod subtriangular, subequal in length to exopod, basal width half length, distal apex bearing a spine.

Second pereopod biramous, the rami fused to the basipod, length including rami more than twice length of first pereopod, as long as basal width, narrowing steadily distally, to end in a sharp point, the terminal section presumed to include the endopod, distal portion curving sharply medially and posteriorly away from the body, inner margin with a well developed subtriangular expansion one-third distance from base, and a process on outer margin two-thirds distance from base is assumed to be the reduced exopod;

exopod one-quarter length of combined basipod and endopod, basal width half length, narrowing gradually for three-quarters its length then more suddenly to one-third basal width, tip rounded.

Third pereiopod very large, half length of body, biramous, the rami lamellar, directed posteriorly and separate but fused with base which is one-fifth length of subequal rami; exopod a flattened subsemiovate lamella, basal width two-thirds length, narrowing slightly distally, distal margin rounded, hiding the egg strings in lateral view; endopod with a sharply curved section near outer margin, the inner portion lying flat against egg strings, the outer portion turned ventrally, to form a shallow ridge which lies parallel to the exopod, endopod if flattened would be subrectangular, width one-quarter length, posterior angles rounded.

Fourth pereiopod biramous, total length half total length of third pereiopod, rami fused with basipod which is one-quarter length of exopod and narrows towards its base so that its lateral margins form entire curves with outer margin of exopod and inner margin of endopod; exopod one-quarter as wide at the base as long, narrowing and rounded distally, outer margin a convex curve, inner margin sublinear, with a very small spine on a raised boss on outer margin near junction with basipod; endopod three-quarters exopod length, width at midpoint half length, narrowed slightly proximally, more narrowed distally, rounded distally, outer margin an entire curve, inner margin sublinear.

Fifth pereopod borne near midpoint of genital segment lateral margin, almost as long as genital segment, width two-fifths length, rounded distally, bent so as to be directed posterolaterally, then posteriorly, with a small seta on a well developed projection near distal margin.

Discussion

A. garricki can be separated from A. quadratus Krøyer, 1836 and A. percis (Thomson, 1889) by the lateral margins of the cephalothorax which are entire curves, without the well developed lateral lobes found in the other species.

Aethon morelandi n. sp.

Material

On the gills of Latridopsis ciliaris (moki) - three females from Ngaraunga, Wellington, collected by W. Heaphy on 7 August, 1951 (Dominion Museum collection).

Description

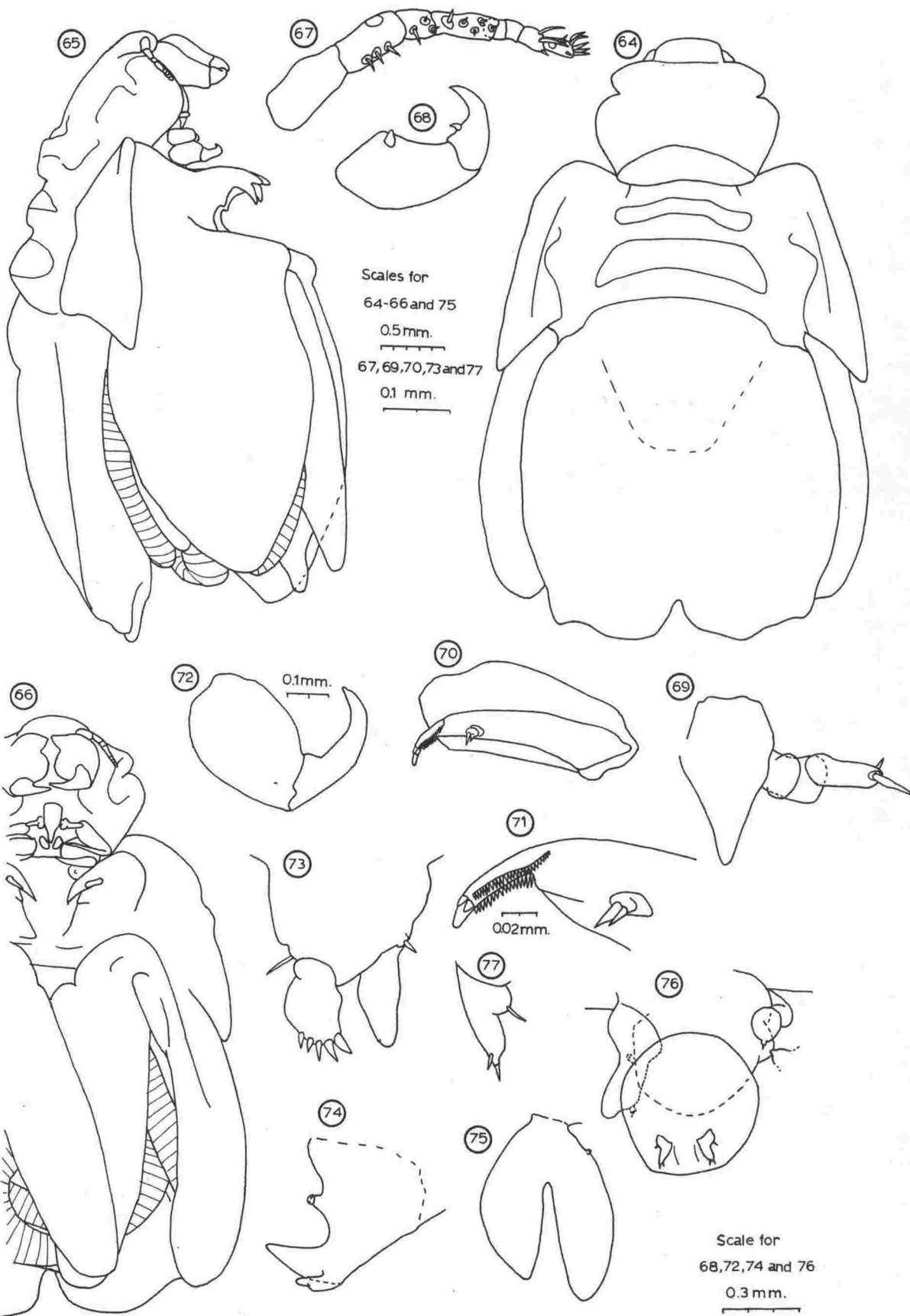
Female (figs 64 - 77).

Overall length 4.45 mm - 4.71 mm.

Cephalothorax, length nine-tenths width (1.25 mm - 1.33 mm x 1.36 mm - 1.46 mm) anterior and posterior margins sublinear, antennae carried laterally on an anterior area which is two-fifths cephalothorax length, one-quarter cephalothorax width, and which is marked off laterally by shallow grooves, and extends anteriorly a little beyond remainder of anterior margin of cephalothorax, anterior margin of anterior area very slightly curved; anterior quarter and posterior three-quarters of lateral margin expanded as two rounded lateral lobes, the anterior one directed laterally, posterior one directed anterolaterally.

Second and third thoracic segments fused, the junction between them marked by a transverse groove running dorsally and laterally, second segment nine-tenths width of third, overall length six-tenths width of third (second segment width 1.12 mm - 1.41 mm, third segment width 1.31 mm - 1.61 mm, overall length 0.77 mm - 0.85 mm); the combined segments are extended laterally as wing-like projections, which may increase width of segment by up to two-fifths, lateral

Aethon morelandi n. sp. female: fig. 64: dorsal view;
fig. 65: lateral view; fig. 66: ventral view; fig. 67: first
antenna; fig. 68: second antenna; fig. 69: mouth tube and
mandibular palp; fig. 70: maxilla; fig. 71: tip of maxilla;
fig. 72: maxilliped; fig. 73: first pereopod (dorsal view);
fig. 74: second pereopod; fig. 75: fourth pereopod;
fig. 76: genital segment, abdomen and caudal laminae;
fig. 77: caudal lamina.



margins sublinear, anterior angles rounded, posterior angles extended posterolaterally for a distance equal to two-fifths segment length, free margins slightly serrate.

Fourth thoracic segment including plate, width nine-tenths length (2.32 mm - 2.61 mm x 2.17 mm - 2.46 mm), subovate, with slightly developed blunt posterolateral angles, posterior margin divided into two entire curves by a median concave invagination which is one-tenth segment length, one-eighth segment width, margin of plate slightly serrated. Fourth segment completely covered by plate, a little narrower than plate, but less than one-third its length (0.6 mm).

Genital segment subovate, length three-fifths width (0.39 mm x 0.65 mm).

Abdomen subcircular, as long as wide (0.56 mm x 0.55 mm), caudal laminae carried posteroventrally.

Caudal laminae very small, length twice width, (0.18 mm x 0.09 mm), subtriangular, lateral margins irregular, with a lateral projection one-quarter distance from base, one-fifth as long as lamina, a little wider than long, and tipped with a sharp spine; lamina with a further sharp spine at the distal apex, and a further spine on medial margin near the apex.

Egg strings long, complexly coiled and hidden in dorsal view by the plate of the fourth thoracic segment, in ventral view by the third pereopods.

First antenna of seven subrectangular segments, ratio of lengths from the basal segment outwards being approximately 3:3:2:3:1:1:1; first segment width two-thirds length, second segment width four-sevenths length, with three setae on outer margin, third segment as wide as long, with three setae on outer margin, fourth segment width half length, with five setae on outer margin, fifth segment as wide as long, sixth segment as wide as long, with two long setae on outer distal angle and one small seta on distal margin, seventh segment rounded distally, width three-quarters length, with one small seta on outer margin and six setae distally.

Second antenna of two segments, subchelate; first segment, basal width half length, narrowing to three-quarters this width distally, curved, with a stout spine on inner margin near base; second segment, basal width half length, narrowing steadily to a sharp point distally, strongly curved, with a stout spine near inner margin one-quarter of distance from base.

Mouth tube small (0.25 mm in length), sharply pointed distally.

Mandibular palp, with two rami on a flattened subrectangular base; outer ramus width two-fifths length, rounded distally, with one long and one short seta distally; inner ramus half length of outer, width two-thirds length, rounded distally.

Maxilla of two segments, segments subequal in length; first segment basal width two-fifths length, narrowing slightly distally, distal margin rounded; second segment basal width one-fifth length, narrowing gradually distally except that distal one-fifth narrows

suddenly and bears two longitudinal rows of small spines reaching almost to the slightly blunted tip, with two flattened spines lying transversely at distal end of rows; a small process, one-third length of narrowed distal region, width half length, is situated near inner margin one-third distance from tip, and bears two setae distally, the larger seta subequal in length to process, the other a little smaller.

Maxilliped of two segments, subchelate; first segment, basal width two-thirds length, narrowing slightly distally, distal margin rounded; second segment basal width half length, narrowing gradually to a distal point, sharply curved over distal two-thirds.

First pereopod biramous, each ramus of one segment; basipod swollen, subsemicircular, length two-thirds width, with one small spine medial to endopod and another on a raised boss lateral to exopod; exopod subovate, subequal in length to basipod, width two-thirds length, with five flattened spines on distal margin; endopod subtriangular, subequal in length to exopod, basal width half length, without spine, but spine may have been lost.

Second pereopod biramous, the rami fused to the basipod, length including rami more than twice length of first pereopod, as long as basal width, narrowing steadily distally, to end in a sharp point, the terminal section presumed to include the endopod, distal portion curving sharply medially and posteriorly away from the body, inner margin with a well developed subtriangular expansion one-third distance from base which is tipped with a flattened

disc-shaped process, and a process on outer margin two-thirds distance from base is assumed to be the reduced exopod; exopod one-quarter length of combined basipod and endopod, basal width half length, narrowing gradually for three-quarters its length then more suddenly to one-third basal width, tip rounded.

Third pereopod very large, two-thirds length of body, biramous, the rami lamellar, directed posteriorly and separate but fused with base which is one-fifth length of subequal rami; exopod a flattened subsemiovate lamella, basal width two-thirds length, narrowing slightly distally, distal margin rounded, hiding the egg strings in lateral view; the endopod is folded almost into a right angle in cross section, the inner portion lying flat against egg strings, the outer portion turned ventrally, involving one-quarter width of endopod distally, less proximally, the ventrally turned portion lying almost parallel to exopod, endopod if flattened would be subrectangular, width one-third length, posterior angles rounded.

Fourth pereopod biramous, total length half total length of third pereopod, rami fused with basipod which is one-quarter length of exopod and narrows towards its base so that its lateral margins form entire curves with outer margin of exopod and inner margin of endopod; exopod one-quarter as wide at the base as long, narrowing and rounded distally, outer margin a convex curve, inner margin sublinear, with a very small spine on a raised boss on outer margin near junction with basipod; endopod three-quarters exopod length, width at midpoint half length, narrowed slightly proximally, more narrowed distally, rounded distally, outer margin an entire curve,

inner margin sublinear.

Fifth pereopod borne near midpoint of genital segment lateral margin, almost as long as genital segment, width half length, rounded distally, bent into a right angle, directed laterally, then posteriorly, with a small seta on a raised boss near distal margin.

Discussion

A. morelandi can be separated from A. garricki since its cephalothorax possesses lateral lobes which are lacking in the latter. A. morelandi lacks the well developed neck found in A. quadratus and also has the posterior lateral lobe of the cephalothorax less well developed.

A. morelandi most closely resembles A. percis but can be distinguished from it by the anterior lobe of the cephalothorax which projects laterally, not posterolaterally as in A. percis, by the posterior margin of the fourth thoracic segment plate which is not as strongly curved as in A. percis and has more clearly defined posterolateral angles.

Anthosoma Leach, 1816

Anthosoma crassum (Abildgaard, 1794)

Caligus crassum Abildgaard, 1794, p. 46, pl. 5, figs. 1-3 (non vide)

Anthosoma smithii Leach, 1816, p. 406, pl. 20, figs. 1-6

Anthosoma smithii Leach, Kirk, 1888, p. 31.

Anthosoma crassum (Abildgaard) Thomson, 1889, p. 365.

Material

On Lamna nasus: from Cook Strait, 20 females and one juvenile female, nine males and one juvenile male, collected by the author, 23 August, 1960; no data, 17 females and eight males, Dominion Museum collection; from between Cape Campbell and Kaikoura, 11 females and five males, collected by A. Dickinson, 21 November, 1963, Dominion Museum Collection; from Kaikoura, five females, one juvenile female and one male, collected by R. Baxter, 30 November, 1955; from Napier (?; label damaged), two females, three males and one juvenile male, collected by A. Hamilton, - November, 1837, Otago Museum collection, deposited by G. M. Thomson, 1910.

On Isurus oxyrinchus: from Bay of Islands, three females and two males, Dominion Museum collection, 14 March, 1957; from Paraparaumu, one female and four males, collected by J. M. Moreland, 23 April, 1953, Dominion Museum collection; from Makara, one juvenile male, collected by J. Garrick, 29 June, 1955; from Marnoo Bank, four females collected by

the Fisheries Laboratory, Marine Department, 30 November, 1964; from Kaikoura, four females, collected by T. Garbes, forwarded by Dr. J. Grieve, 23 April, 1964.

On Carcharodon carcharias: from Chatham Is., two females, collected by F. Abernethy, 1 August, 1949, Dominion Museum collection; from South Bay, Kaikoura, one female, collected by H. G. Upston, forwarded by Dr. J. Grieve, 9 January, 1965.

On Galeorhinus galeus: from Tory Channel Whaling Station, 21 females and seven males, collected by J. Garrick, 1955.

Description

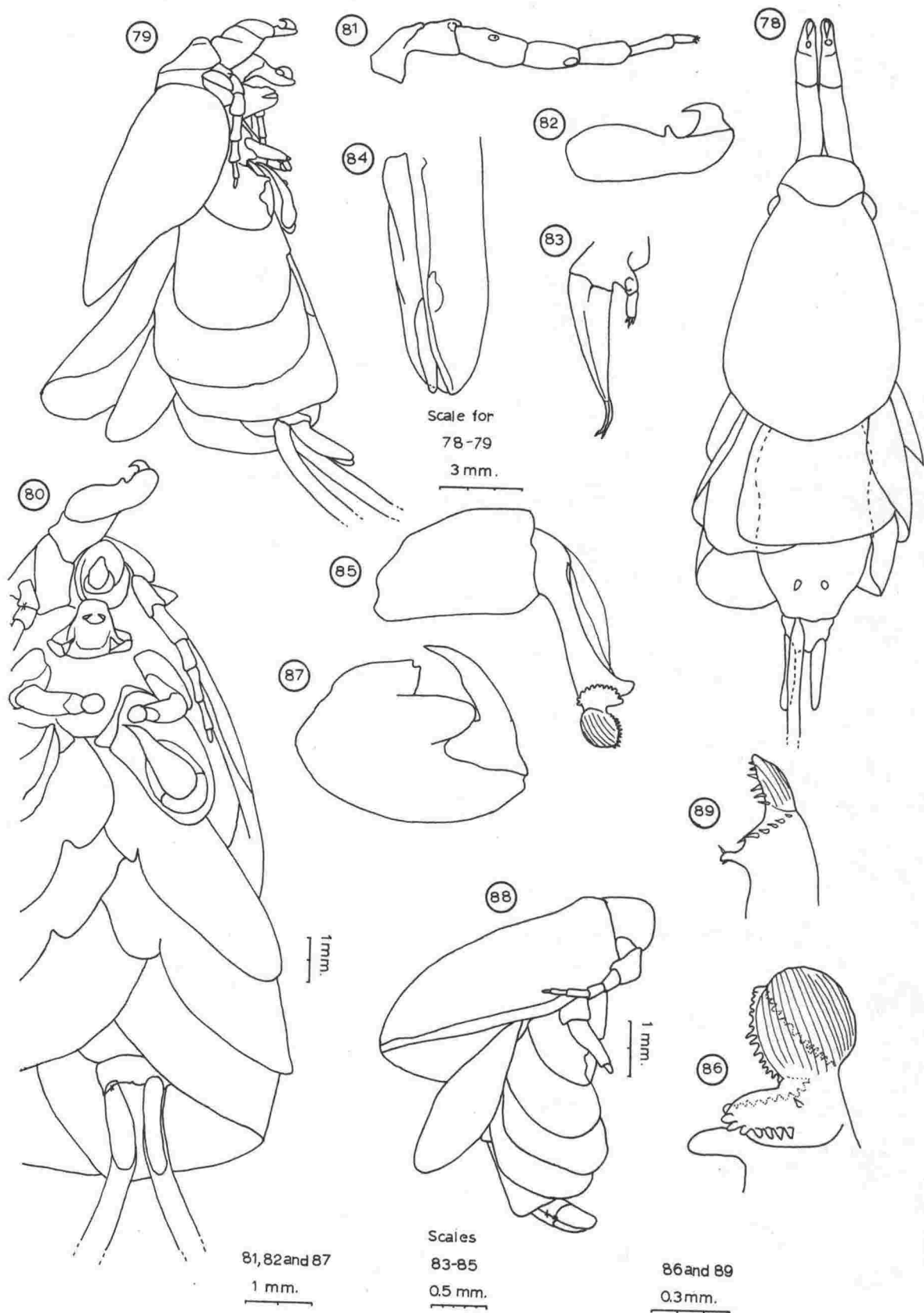
Female (figs 78 - 89)

Overall length 11.2 mm - 16.1 mm (14.1 mm).

Cephalothorax three-quarters as wide as long (7.4 mm - 10.2 mm x 5.7 mm - 7.3 mm), subovate, widest posteriorly, the margin entire except for a shallow groove one-sixth distance from anterior margin, which is associated with a ridge running across dorsum of cephalothorax, dorsum otherwise smooth. Posterior margin of cephalothorax overlying remaining thoracic segments and anterior part of genital segment.

Second thoracic segment disc-like, five times as wide as long, (2.3 mm - 2.7 mm x 0.4 mm - 0.8 mm), with a pair of broad, flattened, dorsal plates, one-fifth length of body, each as wide as the carapace, overlapping in the midline and curved down

Anthosoma crassum (Abildgaard, 1794) female: fig. 78: dorsal view, specimen unusually extended so that genital segment is visible; fig. 79: lateral view, specimen with post-cephalothoracic region normally flexed; fig. 80: ventral view; fig. 81: first antenna; fig. 82: second antenna, two distal segments; fig. 83: mandibular palp; fig. 84: mouth tube, dorsolateral view; fig. 85: maxilla; fig. 86: maxilla, detail of distal part of second segment; fig. 87: maxilliped; fig. 88: juvenile female, lateral view; fig. 89: maxilla of juvenile female, detail of distal part of second segment.



around the body laterally; these plates have the same membranous structure as the basipods of the pereopods and are similar to them in texture.

Third thoracic segment similar to second but slightly longer and narrower (1.9 mm - 2.4 mm x 0.5 mm - 1.2 mm), and lacking plates.

Fourth thoracic segment difficult to discern. Shiino (1955 p. 54) states that it is fused with the genital segment. Lewis (1966, p. 69) says it is indistinctly fused and similar to two preceding segments although partly or completely covered by the swollen genital segment. In the specimens I have examined it appears to be very reduced and totally concealed by the genital segment in dorsal view although there is a small subtriangular area ventral to the anterior part of the genital segment indicating the position of this segment.

Genital segment subovate, width two-thirds length (4.7 mm - 7.7 mm x 3.8 mm - 4.7 mm), with a slight narrowing at its midpoint.

Abdomen, length half width (0.6 mm - 1.0 mm x 1.3 mm - 1.6 mm) narrowing slightly posteriorly, with caudal rami on posterolateral angles.

Caudal rami subovate, width four-tenths length (1.4 mm - 1.8 mm x 0.45 mm - 0.75 mm), with scattered very small spines irregularly over surface.

Egg string 35 mm - 68 mm in length.

First antenna of six segments, third and fourth segments subequal in length, otherwise segments becoming shorter distally so that distal segment is one-quarter basal segment length, basal segment partially divided by a groove running medially and proximally along the outer margin; second and third segments each with single setae, distal segment with several very small setae.

Second antenna of four segments, proximal half capable of being withdrawn into carapace (as noted by Lewis, 1966, p. 70) the proximal half a flexible membrane, first and third segments subequal in length, second segment a little shorter, distal segment one-third length of third segment, claw-like, sharply curved, closing against a projection near midpoint of third segment.

Associated with the bases of the antennae is a suboval, chitinated structure (1.2 mm x 1.1 mm) which projects, lappet-like, beyond the cephalothorax. Lewis (1966, p. 72) suggests that these may be homologous with the adhesion pads of pandarids and the processes of trebiids, euryphorids and caligids which are found in an approximately analogous position.

Mouth tube 2.0 mm in length, 0.9 mm in basal width, rounded distally.

Mandibular palp biramous, exopod one-segmented, one-quarter endopod length, borne on an extension of the basipod, with three small spines distally; endopod subtriangular in cross section, basal width two-fifths length, narrowing almost to a point distally, with two setae two-fifths segment length borne distally.

Maxilla of two segments, first segment three-quarters length of second, subrectangular, two-thirds as wide as long; second segment one-fifth as wide as long, with two parallel flanges near outer margin, for three-fifths segment length, terminating on an outer spur-like projection of outer margin, distal fifth of segment rounded, with longitudinal striations, and a longitudinal semicircular denticulate ridge running longitudinally around it, associated with a further semicircular denticulate ridge around outer portion of its base; these denticulate ridges are derived from rows of spines clearly seen in juvenile specimens, in which this distal portion of segment is smaller, narrower and more pointed distally.

Maxilliped of two segments, basal segment, two-thirds as wide as long, somewhat rounded distally, outer margin rounded, inner margin swollen medially and proximally, the second claw-like segment closing against and between these swellings; second segment two-thirds length of first, basal width half length, pointed distally, moderately curved.

First second and third pereopods with basipod greatly enlarged and flattened, in each case overlapping in the ventral midline, and extending laterally to hide much of the genital segment in lateral view, the second pereopod partly overlying the plates on the second thoracic segment, and these plates partly overlying the basipod of the third pereopod which extends further around the body than do the other two; the basipods of the pereopods and the plates of the second segment between them envelope much

of the body, hiding from view the three thoracic segments and much of the genital segment; first and second pereopods each with a mediodistal notch, in the apex of which are faint signs of degenerate rami, third pereopod with no notch and no signs of rami.

Male (figs 90 - 101)

Overall length 9.0 mm - 16.7 mm (smaller specimens may be less mature males).

Carapace similar in form to that of female, two-thirds as wide as long (5.2 mm - 9.5 mm x 4.0 mm - 7.3 mm).

Second thoracic segment disc-shaped, length one-third width (0.6 mm - 1.4 mm x 2.8 mm - 3.5 mm), lacking the dorsal plates found in the female.

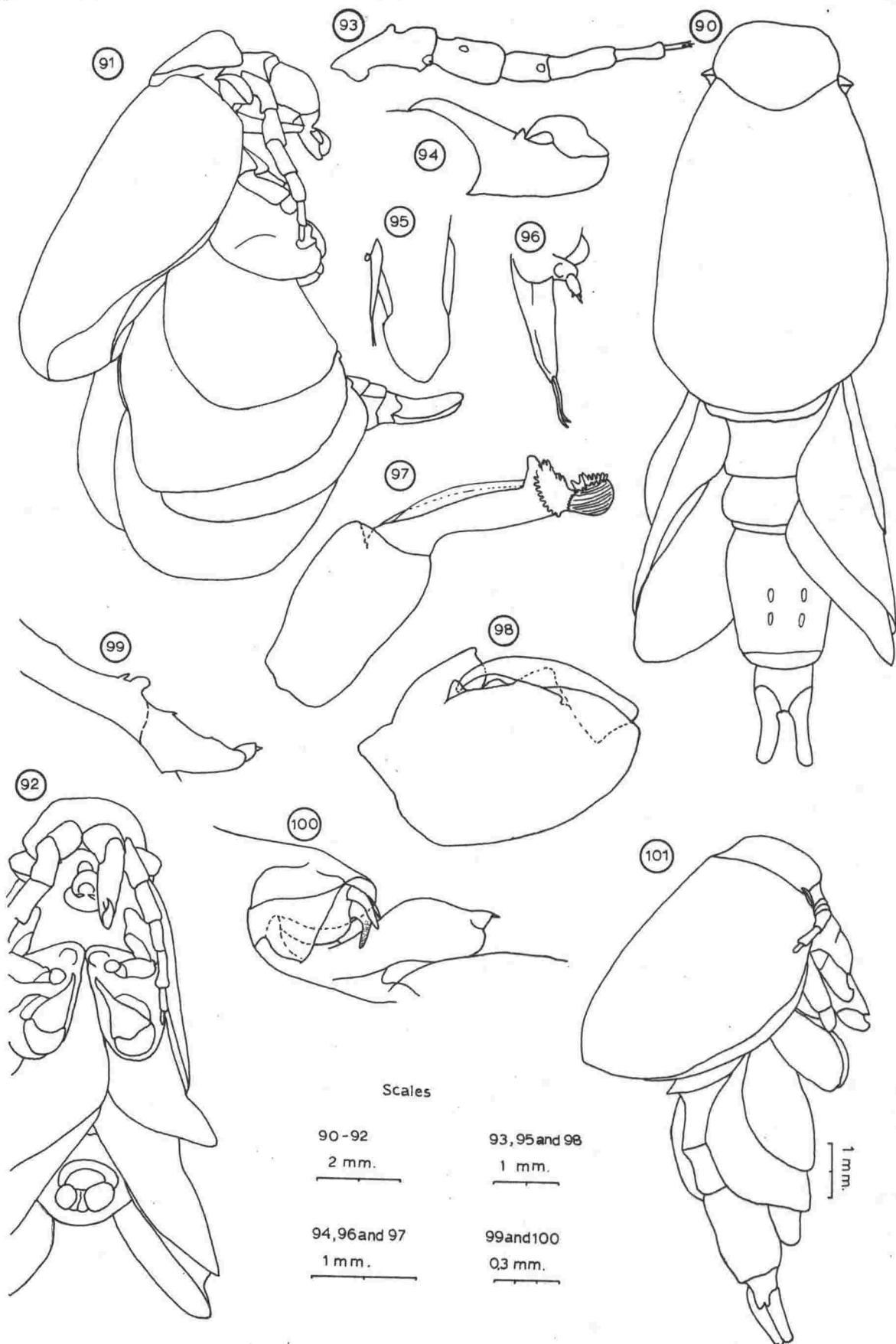
Third thoracic segment similar in form to second, length half width (1.1 mm - 2.5 mm x 1.9 mm - 4.3 mm).

Genital segment subrectangular, angles rounded, slightly wider anteriorly, a little longer than wide (2.0 mm - 3.3 mm x 1.5 mm - 3.2 mm), with two plate-like ventral extensions of posterior margin covering much of ventral surface of abdomen, the extensions separated by a narrow V-shaped sinus; two small semicircular projections from the base of these extensions could perhaps be degenerate fifth pereopods.

Abdomen subrectangular, two-thirds as long as wide (0.4 mm - 1.2 mm x 0.8 mm - 1.8 mm), the caudal rami carried on posterolateral angles.

Anthosoma crassum (Abildgaard, 1794) male.

fig. 90: dorsal view, specimen mechanically extended;
fig. 91: lateral view, specimen naturally flexed; fig. 92:
ventral view; fig. 93: first antenna; fig. 94: second
antenna, two distal segments; fig. 95: mouth tube; fig. 96:
mandibular palp; fig. 97: maxilla; fig. 98: maxilliped;
fig. 99: rami of first pereopod; fig. 100: rami of second
pereopod; fig. 101: juvenile male.



Scales

90-92

2 mm.

93, 95 and 98

1 mm.

94, 96 and 97

1 mm.

99 and 100

0.3 mm.

1 mm.

Caudal rami of similar form to those in female, width one-third length (0.9 mm - 1.8 mm x 0.3 mm - 0.7 mm).

Appendages as in female, except that in the first and second pereopods the notch in the basipod is shallow and the degenerate rami are slightly better developed; in the first pereopod each ramus is of one segment, lying against margin of pereopod, each subrectangular, endopod slightly narrowed distally, each with several small spines and one broader spine along outer and distal margins; rami of second pereopod more complex, exopod subcircular, with two setae and one heavy spine distally, the spine with pigmentation over distal half, the whole ramus almost hidden by a thin hood extending around it from the basipod, endopod similar to rami on first pereopod but broader.

Juvenile specimens (female, fig. 88, male, fig. 101) very similar to adults, but can be recognized by their smaller size, their relatively smaller genital segment and the nature of the maxilla (see above).

Discussion

Anthosoma crassum has been recorded from many parts of the world and on a number of host species, the most frequent being members of the family Lamnidae. Previous records include:

North-East Atlantic: on Lamna nasus - Aberdeen (Scott and Scott.

1913, p.109); Exmouth, Dartshire (Baird, 1850, p.299 and Leach, 1816, p.406 refer to same specimens); Devonshire (Leach, 1819, p.533); Øresund (Steenstrup and Lütken, 1861, p.397; Olssen, 1868, p.23); Hornbaek, Kattegat (Krøyer, 1838, p.295); Belgium (van Beneden, 1870, p.8)

on Cetorhinus maximus - Newlyn, England (Birkett and Burd, 1952, p.392).

on a shark, in the collection of the British Museum (Milne Edwards, 1840, p.483; Bassett Smith, 1899, p.468).

on Mustelus mustelus - Belgium (van Beneden, 1870, p.5).

Mediterranean: on Isurus oxyrinchus - Palavas, France (Delamare Deboutville and Nunes-Ruivo, 1953, p.205); Genoa (Brian, 1902, p.7); Portoferraio (Brian, 1902, p.7); Adriatic (Valle, 1880, p.62).

North-West Atlantic: on I. oxyrinchus^{*}, L. nasus, Carcharinus obscurus, and Odontaspis taurus - Martha's Vineyard and Woods Hole, Mass. (Wilson, 1922, p.23, 1932, p.446).

^{*} I. tigris and I. punctatus = I. oxyrinchus (?).

on Carcharodon carcharias - Woods Hole, Mass.

(Wilson, 1924, p.12); Padre Is., Texas (Pearse, 1952, p.28).

South-East Atlantic: on I. oxyrinchus - Angola (Nunes-Ruivo, 1956^{xx});

South Africa (Heegaard, 1962, p.181).

on Carcharias sp. and L. nasus - Table Bay and False

Bay, South Africa (Barnard, 1955, p.272).

Indian Ocean: on Carcharias sp. and L. nasus - Durban (Barnard, 1955, p.272).

on unnamed host - Port Natal, Durban (Wilson, 1923, p.13).

South-West Atlantic: on L. nasus - Mar del Plata (Brian, 1944, p.208).

on Cetorhinus maximus - Mar del Plata (Fontes, 1949, p.185).

North-East Pacific: on an unnamed host - Vancouver Is., and Californian Coast (Wilson, 1932, p.446).

probably on I. oxyrinchus - 45°11' N, 174°54' W (Lewis, 1966, p.67).

on Carcharodon carcharias - Pokai Bay, Hawaii (Lewis, 1966, p.67).

North-West Pacific: on L. nasus - Toyama Bay, Japan (Yamaguti, 1936, p.12); Kesennuma, Japan (Shiino, 1955, p.50).

on L. ditropis - Kesennuma, Japan (Shiino, 1957, p.370).

on Prionace glauca - Tyôsi, Japan,

on I. oxyrinchus - Owase, Japan,

^{xx} from translation as supplied by the Fisheries Research Board of Canada, original page numbers not retained.

on Heptranchias perlo - Kannoura, Japan (Shiino, 1955, p. 50).

on an unnamed host - Japan (Wilson, 1932, p. 446).

South-East Pacific: on an unnamed host - Concepción, Chile (Brian, 1944, p. 208).

South-West Pacific: on Isurus oxyrinchus - Long Reef, nr. Port Jackson, New South Wales and French Pass, Cook Strait, New Zealand (Heegaard, 1962, p. 181).

on L. nasus - Napier, New Zealand (Thomson, 1889, p. 366); Otago, New Zealand (Kirk, 1888, p. 31).

on Carcharias sp. - probably New South Wales and on an unnamed host - Port Jackson, New South Wales (Heegaard, 1962, p. 181).

As well as its almost complete latitudinal distribution, Anthosoma crassum has been taken from Aberdeen, Scotland (59°9'N.) to Otago, New Zealand (45°45' S).

Despite the numerous records of this species there have been few detailed descriptions or figures given. Those available (the fullest being those by Wilson 1922, p. 23, pl. 1 figs. 1-9, Shiino, 1955, p. 50, figs. 1-2, and Lewis 1966, p. 67, figs. 4-6) suggest there is little variation except in size. Minor morphological variations shown or described could well be due to variations in optical equipment available to the various authors, with the possible exception of the female specimen figured by Brian (1944, fig. 44), which appears to have notches in the third pereopod and plate of the second thoracic segment, as well as in the first and second pereopods.

Size as measured by total length varies considerably e.g. Yamaguti (1936) gives 8.8 mm - 11.0 mm for the female compared with Brian (1944) who gives 15.3 mm - 18.0 mm for this measurement, while Wilson (1922) gives the male as 8 mm - 10 mm compared with Brian (1944) who gives 12 mm - 13 mm. However when the range in the specimens available to me is considered (9.9 mm - 18.0 mm for the female, 9.0 mm - 16.7 mm for the male) the above apparent differences can be understood as individual variation. There is some suggestion of a host specific influence on size in my material but the numbers are not sufficient for statistical analysis and it would not be surprising if geographical factors, the site of attachment and the intensity of infection were also involved.

There appears to be considerable variation in the intensity of infection. Wilson (1922, p.25) states that this species "never occurs in any number on a host, but is more often solitary, although occasionally the two sexes are associated upon the same fish". Birkett and Bund (1952, p.392) on the other hand state that their specimens were numerous and did considerable damage to the host. In the present collection the author obtained one lot of 31 specimens from a single host which had been severely damaged, particularly on the dorsal surface of the tongue, which appeared to be partly hollowed out, while other collectors reported both single and multiple infections (see Material above).

Type Material

Type specimens are deposited with the Dominion Museum, Wellington, except the possible type and paratypes of Aethon percis (Thomson), which are returned to the Otago Museum.

Acknowledgements

I am grateful to Professor J. A. F. Garrick for information on the hosts of Anthosoma crassum and for helpful criticism of the text.

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NOTE

Paper 13 - Anthosomidae

After this thesis had been typed a xerox copy of a paper by Goggio (1905) was received from an overseas library.

This paper contains the only adequate description and figures of Lernanthropus foliaceus Richiardi, 1878. The figure given by Goggio (pl. 2, fig. 1) of this species agrees in the nature of the third and fourth pereopods, first antenna and general body form with Pseudolernanthropus normalus described as new in this thesis. There are no obvious differences between Goggio's figures and the latter species. In my opinion the local species is identical with Richiardi's species and should be known as Pseudolernanthropus foliaceus (Richiardi).

The only previous records of this species are those by Richiardi and Goggio from the gills of Thyrsites pretiosus in the Mediterranean.

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HOST SPECIFICITY AND BIOGEOGRAPHICAL
RELATIONSHIPS OF SOME NEW ZEALAND
CALIGOID COPEPODS.

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ABSTRACT

Thirty eight species of New Zealand caligoid copepods are considered. Of these, 13 are widely distributed parasites found on sharks and rays and two have so far been recorded only from sharks in the Western Pacific; none of the species recorded from elasmobranchs is new; of those parasitic on teleosts, seven have so far been recorded as having a widespread distribution, mostly on medium to large pelagic fishes; two species have previously been recorded only from Japan and may represent part of an Indopacific distribution and one has previously been found only from South America and may represent part of a Southern distribution; 14 species have so far been recorded only from New Zealand, but, considering that only one of the host species (Parapercis coilius) is restricted to New Zealand and that all of the species are members of families with wide distributions, at least in the Southern Hemisphere, it must be expected that the known distributions of many of these species will later be shown to be much wider. It is considered that shark parasites in this sample are generally restricted to shark hosts or shark and ray hosts but show no specificity beyond this, while the parasites of teleosts are in some cases specific to particular genera, or to one or more related families, or, in one case, to separate families which have some ecological similarity.

INTRODUCTION

In the course of work on the caligoid copepod fauna found parasitic on New Zealand marine fishes, I have so far had the opportunity to study 38 species. In previous papers (papers 1-7 and 9-13 of this thesis) I have described the morphology (except Lepeophtheirus erecsoni Thomson of which only damaged specimens were available), systematic relationships, their local hosts, and their occurrence as previously recorded.

This paper is an attempt to draw this material together in an examination of such information on the distribution and host specificity of the local parasitic copepods as can so far be inferred.

For a number of reasons this must be considered a preliminary study of these topics, in particular because:

1. The present specimens were taken from only 23 species of teleost and 12 species of shark; although a number of other species of both teleosts and shark were examined without result it cannot be presumed that these species are not parasitized since the incidence of some parasites is often low. The number of specimens of any one species examined by the author has generally been low, and in the absence of negative records by other collectors whose material has contributed to these studies no reliable estimate of the frequency of infection among New Zealand fish species is possible. However, considering that Richardson and

Garrick (1953, p.23) recognised only 29 species of shark recorded from New Zealand and Moreland (1959, p.28) gave the then currently accepted number of teleost fish species as 413, it would be surprising if the present study encompassed more than 5% - 30% of the caligoid copepod fauna from New Zealand fishes.

2. The parasitic Copepoda have been little studied in many areas, particularly in the southern Pacific and southern Atlantic, as is well illustrated by the recorded distribution of apparently widespread species parasitic on sharks (see Table 1 below).

It might well be supposed that this study is unnecessary since the distribution of these parasites might be expected to be a function of their hosts' distribution. However, it will be shown below that distribution is also a function of specificity, and that this varies considerably with different species of copepod. There is also some slight evidence that some parasites may be restricted in their distribution by factors that do not influence their possible hosts.

Since there are dramatic differences in the distribution patterns and degree of host specificity in those species parasitic on sharks and those parasitic on teleosts these groups will be discussed separately.

TABLE 1: Distribution of species on elasmobranch hosts

Species	Pacific						Atlantic				Medi- -erran- -ean	Ind- ian Ocean
	N. Z.	Aust.	Other S. W.	N. W.	S. E.	N. E.	N. W.	S. W.	N. E.	S. E.		
<u>Nesippus orientalis</u> Heller	X	X					X	X	X		X	X
<u>N. borealis</u> (St. and Lüt.)	X	X		X	X	X	X	X	X		X	X
<u>Dinemoura latifolia</u> St. and Lüt.	X	?		X		X	X	X	X		X	X
<u>D. producta</u> (Müller)	X			X								
<u>Demoleus latus</u> Shiino	X			X								
<u>Echthrogaleus braccatus</u> (Dana)	X		X									
<u>E. coleoptratus</u> (Guérin)	X	X		X	X	X	X	X	X	X	X	X
<u>E. denticulatus</u> Smith	X			X								X
<u>Phyllothyreus cornutus</u> (M.-E.)	X		X	X								X
<u>Pandarus bicolor</u> Leach	X	X	X									X
<u>P. cranchii</u> Leach	X		X									X
<u>Perissopus dentatus</u> St. and Lüt.	X	X					X	X	X	X	X	X
<u>Nemesis lamna</u> Risso	X	X					X	X	X	X	X	X
<u>N. robusta</u> van Beneden	X	X		X		X	X	X	X	X	X	X
<u>Anthosoma crassum</u> (Abildgaard)	X	X		X	X	X	X	X	X	X	X	X
Number of these species recorded in each geographical area.	15	8(?)	3	9	3	6	11	8	11	4	10	9

* Cressey (1967, p. 48) also records this species from Cape Trawler (Discovery collections); I have been unable to trace this locality.

** In my opinion this species and *P. satyrus* Dana have not satisfactorily been separated in the literature, and the distribution of this species is not discussed further although Cressey (1967, p. 10) regards it also as having a wide distribution.

Note: Some new locality and host records by Cressey (1967) have been included in this table together with previous records that I have summarised in earlier papers.

TABLE 2: Elasmobranch hosts

<u>Species</u>	<u>Local hosts</u>	<u>Overseas hosts</u>
<u>Nesippus orientalis</u>	<u>Mustelus antarcticus</u> <u>Notorhynchus pectorosus</u>	<u>Mustelus antarcticus</u> <u>M. mustelus</u> <u>M. asterias</u> <u>M. schmitti</u> <u>Carcharhinus obscurus</u> <u>C. milberti</u> <u>C. menisorrh</u> <u>C. maculipinnis</u> <u>C. leucas</u> <u>Sphyrna zygaena</u> <u>S. lewini</u> <u>S. tiburo</u> <u>Alopias vulpinus</u> <u>Carcharodon carcharias</u> <u>Galyocerdo cuvieri</u> <u>Ginglymostoma cirratum</u> <u>Odontaspis taurus</u> <u>Rhizoprionodon terraenovae</u> <u>Scoliodon laticaudus</u>
<u>N. borealis</u>	<u>Isurus oxyrinchus</u>	planktonic only
<u>Dinemoura latifolia</u>	<u>Carcharodon carcharias</u> <u>Isurus oxyrinchus</u> <u>Galeorhinus australis</u>	<u>Carcharodon carcharias</u> <u>Isurus oxyrinchus</u> <u>I. glaucus</u> <u>Lamna ditropis</u> <u>L. nasus</u>

TABLE 2: Elasmobranch hosts (contd.)

<u>Species</u>	<u>Local hosts</u>	<u>Overseas hosts</u>
<u>Dinemoura latifolia</u>		<u>Prionace glauca</u>
<u>D. producta</u>	<u>Cetorhinus maximus</u> <u>Carcharodon carcharias</u>	<u>Cetorhinus maximus</u> <u>Carcharodon carcharias</u> <u>Isurus glaucus</u> <u>I. oxyrinchus</u> <u>Lamna ditropis</u> <u>L. nasus</u> <u>Alopias vulpinus</u>
<u>Demoleus latus</u>	<u>Squalus acanthias</u>	<u>Squalus blainvillei</u> <u>Deania calcea</u>
<u>Echthrogaleus braccatus</u>	?	?
<u>E. coleoptratus</u>	<u>Prionace glauca</u> <u>Lamna nasus</u>	<u>Prionace glauca</u> <u>Lamna nasus</u> <u>L. ditropis</u> <u>Carcharhinus milberti</u> <u>Carcharodon carcharias</u> <u>Centrophorus granulosus</u> <u>Isurus oxyrinchus</u> <u>Squalus acanthias</u> <u>Mola mola</u> (?), a teleost

TABLE 2: Elasmobranch hosts (contd.)

<u>Species</u>	<u>Local hosts</u>	<u>Overseas hosts</u>
<u>E. denticulatus</u>	?	<u>Alopias pelagicus</u> <u>A. vulpinus</u> <u>Carcharhinus falciformis</u> <u>Carcharodon carcharias</u> <u>Isurus oxyrinchus</u> <u>Prionace glauca</u> <u>Sphyrna zygaena</u>
<u>Phyllothyreus cornutus</u>	<u>Isurus oxyrinchus</u>	<u>Isurus oxyrinchus</u> <u>Carcharhinus milberti</u> <u>Lamna nasus</u> <u>Prionace glauca</u>
<u>Pandarus bicolor</u>	<u>Squalus acanthias</u> <u>Galeorhinus australis</u> <u>Cyprilumus sp.</u> <u>Notorhynchus pectorosus</u>	<u>Squalus acanthias</u> <u>Galeorhinus galeus</u> <u>Carcharhinus sp.</u> <u>Carcharhinus sp.</u> <u>Mustelus canis</u> <u>M. mustelus</u> <u>Prionace glauca</u> <u>Scyliorhinus catulus</u>
<u>P. cranchii</u>	<u>Galeorhinus australis</u> <u>Isurus oxyrinchus</u>	doubtful (see footnote to table 1)

TABLE 2: Elasmobranch hosts (contd.)

<u>Species</u>	<u>Local hosts</u>	<u>Overseas hosts</u>
<u>Perissopus dentatus</u>	hammerhead	<u>Carcharias</u> sp. <u>C. lamia</u> <u>Carcharhinus milberti</u> <u>C. obscurus</u> <u>C. limbatus</u> <u>C. borneensis</u> <u>C. maculipinnis</u> <u>Hemigaleus balfouri</u> <u>Mustelus</u> sp. <u>M. asterias</u> <u>M. canis</u> <u>M. equestros</u> <u>M. mustelus</u> <u>M. plebjus</u> <u>Rhizoprionodon</u> <u>terraenovae</u> <u>Scoliodon laticaudus</u> <u>Sphyrna diplana</u>
<u>Anthosoma crassum</u>	<u>Carcharodon carcharias</u> <u>Isurus oxyrinchus</u> <u>Lamna nasus</u> <u>Galeorhinus galeus</u>	<u>Carcharodon carcharias</u> <u>Isurus oxyrinchus</u> <u>Lamna nasus</u> <u>Carcharias</u> sp. <u>Carcharhinus obscurus</u> <u>Cetorhinus maximus</u> <u>Heptranchias perlo</u> <u>Mustelus mustelus</u> <u>Odontaspis taurus</u> <u>Prionace glauca</u>

TABLE 2: Elasmobranch hosts (contd.)

<u>Species</u>	<u>Local hosts</u>	<u>Overseas hosts</u>
<u>Nemesis lamna</u>	<u>Carcharodon carcharias</u> <u>Cetorhinus maximus</u> <u>Isurus oxyrinchus</u>	<u>Carcharodon carcharias</u> <u>Cetorhinus maximus</u> <u>Isurus oxyrinchus</u> <u>Alopias vulpinus</u> <u>Lamna nasus</u> <u>Odontaspis ferox</u> <u>Lichia amia</u> (?), a teleost.
<u>N. robusta</u>	<u>Alopias vulpinus</u>	<u>Alopias vulpinus</u> <u>Aprionodon isodon</u> (?) <u>Carcharhinus limbatus</u> <u>C. milberti</u> <u>C. obscurus</u> <u>Carcharodon carcharias</u> <u>Dasyatis pastinaca</u> <u>D. aspersa</u> <u>Galeocerdo cuvieri</u> <u>Hexanchus griseus</u> <u>Mustelus</u> sp. <u>M. mustelus</u> <u>Negaprion brevirostris</u> <u>Odontaspis taurus</u> <u>Prionace glauca</u> <u>Raja macrorhynchus</u> <u>R. oxyrincha</u>

TABLE 2: Elasmobranch hosts (contd.)

<u>Species</u>	<u>Local hosts</u>	<u>Overseas hosts</u>
		<u>Rhizoprionodon</u> <u>terraenovae</u>
		<u>Sphyrna</u> sp.
		<u>S. tiburo</u>
		<u>S. zygaena</u>

The data show that:

1. All but three of these species have very wide distributions.
2. Of the three that may have restricted distributions -
 - (a) Nesippus borealis has previously been taken only from the plankton in areas fed by the Gulf Stream. The present record indicates a much wider distribution, perhaps in the warmer waters only.
 - (b) Demoleus latus has been reported from two species of Squalus and there is nothing about the distribution of the host genus which would suggest a restricted distribution; if this species should prove to be restricted to the Western Pacific this would then suggest that the parasite is limited by ecological factors other than those that limit distribution of the host genera.
 - (c) Echthrogaleus braccatus has so far been recorded only from the Southwest Pacific but may have been confused in other areas with E. coleoptratus which it closely resembles.

3. More of these species have been recorded from the Mediterranean and both sides of the Northern Atlantic than from Australia or other areas in the South Pacific. This is certainly not a true reflection of the distribution of these animals and illustrates the need for further work on copepod parasites in this region.
4. Only two doubtful records exist of any of these species occurring on teleosts, and they thus seem highly specific for elasmobranchs.
5. All except the three species mentioned in 2. above have been found from a wide range of elasmobranch hosts, probably an important factor in their achievement of such wide distributions.

Caligoida parasitic on teleost hosts

TABLE 3: Distribution of species on teleost hosts

Species	Pacific						Atlantic				Mediterranean	Indian Ocean
	N.Z.	Aust.	Other S.W.	N.W.	S.E.	N.E.	N.W.	S.W.	N.E.	S.E.		
<u>Caligus brevis</u> Shiino	X			X								
<u>C. aesopus</u> Wilson	X				X							
<u>C. pelamydis</u> Krøyer	X						X				X	
<u>Lepeophtheirus scutiger</u> Shiino	X			X								
<u>L. insignis</u> Wilson	X					X				X		
<u>Gloiopotes huttoni</u> (Thomson)	X			X								X
<u>Elytrophora brachyptera</u> Gerstaecker	X			X			X		X		X	X
<u>Cecrops latreilli</u> Leach	X			X		X	X	X			X	
<u>Congericola pallidus</u> van Beneden	X						X		X		X	
<u>Pseudocycnus appendiculatus</u> Heller	X		X		X	X	X	X			X	X
	10	0	1	5	2	3	4	2	4	3	5	3

The following species have, as yet, been recorded solely from New Zealand: Lepeophtheirus erecsoni Thomson, L. polyprioni Hewitt, L. heegaardi Hewitt, L. distinctus Hewitt, L. argentus Hewitt, Caligus buechlerae Hewitt^{*}; Hatschekia quadrata Hewitt, H. crenata Hewitt; Lernanthropus microlamini Hewitt, Pseudolernanthropus normalus Hewitt, Aethon percis (Thomson), A. garricki Hewitt, A. morelandi Hewitt.

TABLE 4: Parasites found on more than one host family

Species	New Zealand host	New Zealand family	Overseas family(ies)	Relationship
<u>Caligus pelamydis</u>	<u>Thyrsites atun</u>	Gempylidae	Thynnidae (several genera)	families are taxonomically
<u>Lepeophtheirus scutiger</u>	<u>Pseudolabrus</u> spp.	Labridae	Hexagrammidae (two genera)	families ecologically similar
<u>Gloiopotes huttoni</u>	<u>Makaira mitsukurii</u> <u>M. marlina</u>	Istiophoridae	Istiophoridae Xiphiidae	families are close taxonomically
<u>Cecrops latreillii</u>	<u>Mola mola</u>	Molidae	Molidae (<u>Mola mola</u>) Bothidae Thynnidae	no apparent relationship except that hosts are all large fishes
<u>Pseudocycnus appendiculatus</u>	<u>Thunnus alalunga</u>	Thynnidae	Thynnidae (including <u>T. alalunga</u>) Coryphaenidae	families are related taxonomically

^{*} this species was originally misspelt C. buechlerae; it is corrected in accordance with articles 27 and 32 (c)(i) of the International Code of Zoological Nomenclature 1961.

TABLE 5: Parasites found on more than one host species within the same family

Species	New Zealand host(s)	Overseas host(s)	Family
<u>Caligus brevis</u>	<u>Pseudolabrus pittensis</u> <u>P. miles</u> <u>P. celadotus</u>	<u>Pseudolabrus japonicus</u> <u>Duymaeria flagellifera</u> <u>Halichoeres poecilopterus</u>	Labridae
<u>C. aesopus</u>	<u>Seriola grandis</u>	<u>Seriola peruana</u> (?)	Carangidae
<u>Lepeophtheirus polyprioni</u>	<u>Polyprion oxygenios</u> <u>P. moeone</u>	-	Epinephelidae
<u>Elytrophora brachyptera</u>	<u>Thunnus alalunga</u> <u>T. maccoyi</u>	<u>Thunnus spp.</u> (including <u>T. alalunga</u>)	Thynnidae
<u>Congericola pallidus</u>	<u>Conger vereauxi</u>	<u>Conger vulgaris</u> <u>C. conger</u>	Congridae
<u>Pseudolernanthropus normalus</u>	<u>Thyrsites atun</u> <u>Jordanidia solandri</u>	-	Thynnidae

TABLE 6: Species recorded as parasitic on a single host species

Species	Host
<u>Caligus buechlerae</u>	<u>Tripterygion sp.</u>
<u>Lepeophtheirus erecsoni</u>	<u>Latridopsis ciliaris</u>
<u>L. argentus</u>	<u>Hyperoglyphe porosa</u>
<u>L. heegaardi</u>	<u>Lepidopus caudatus</u>
<u>L. distinctus</u>	<u>Genypterus blacodes</u>
<u>L. insignis</u>	<u>Mola mola</u>
<u>Hatschekia quadrata</u>	<u>Allomycterus jaculiferus</u>
<u>H. crenata</u>	<u>Lepidopus caudatus</u>
<u>Lernanthropus microlamini</u>	<u>Seriotelella brama</u>
<u>Aethon percis</u>	<u>Parapercis coelias</u>
<u>A. garricki</u>	<u>Cheilodactylus macropterus</u>
<u>A. morelandi</u>	<u>Latridopsis ciliaris</u>

These teleost parasites seem divisible into three groups:

- (A) those with widespread distributions (seven species) all found on medium to large pelagic fishes, except for Congericola pallidus which is found on three widespread and closely related species of Conger.
- (B) those reported from New Zealand and either Japan (two species) or South America (one species). These may represent elements of distinct Indopacific and Southern Pacific faunas but could easily be shown to have a wider distribution when further investigations are carried out. Both the species shared with Japan are on rocky shore or shelf fishes, whereas the species shared with South America are on a pelagic, shelf genus.
- (C) those so far recorded only from New Zealand (13 species). These may prove to be endemic, but this seems unlikely. Only one species is restricted to a host fish (Parapercis coilias) which is endemic, most of the other parasites having at least one host found also in Southern and/or Eastern Australian waters, and all belonging to quite widespread families. The high number of new species must be considered a consequence of lack of investigation in adjacent regions rather than any peculiarity of the very impoverished New Zealand fish fauna. Most of these species are from bottom-dwelling or midwater shelf species.

Table 4 (above) suggests a wide range of host specificities,

- (i) reported from only one host species: ten species, one widespread.
- (ii) reported from only one host genus: four species, one widespread.
- (iii) reported from only one host family: two species, one widespread.
- (iv) reported from two related families: three species, all widespread.
- (v) reported from two ecologically related but taxonomically more distant families (Lepeophtheirus scutiger on Labridae and Hexagrammidae), one species.
- (vi) reported from three quite different host species (Cecrops latreilli on Mola, Thunnus and Rhombus), one species.

Undoubtedly many of these species will be recorded from other hosts in the future, but the fact that widely reported species occur in all but category (v) suggests that these categories, at least, are valid.

The usually more restricted ability of these parasites of teleosts to parasitise a range of hosts, compared to the species parasitic on elasmobranchs, helps to explain why their distribution will certainly be more restricted in many cases. The resultant geographical restriction in turn helps to show how, as a result of more restricted gene flow and more localised selection pressures, some genera parasitic on teleosts have been able to speciate to a much greater extent than genera found on elasmobranchs.

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