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by
C. PRABHA AND N. K. PILLAI

Issued by the Director
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INTRODUCTION

This is the fourth contribution in the series entitled 'Additions to the copepods parasitic on the marine fishes of India' In all, twenty six caligids belonging to the genera namely *Caligus, Sciaenophilus, Pseudopetalus. Lepeophtheirus, Hermilius, Anuretes* and *Pseudanuretes* are described. Ten species, which are new, are fully illustrated and described. In describing the known species emphasis has been placed on additional details observed by us and in correcting and supplementing earlier descriptions.

This paper is part of a thesis for which the first author was awarded the Ph. D. degree by the Kerala University.

The terminology adopted in this work, especially in the description of the second antenna, the second maxilla and the maxilliped. is that of Kabata (1979) who has introduced a few new terms.

Reg. no. of the type species is given at the end of the text.

TAXONOMIC ACCOUNT

Family CALIGIDAE

Genus Caligus Muller

Caligus amblygenitalis Pillai

(Figs. 1-11)

1961. *Caligus amblygenitalis* Pillai, *Bull Res. Inst. Univ. Keraly*, 8 : 98, Fig. 7.
1975. *Caligus amblygenitalis*, Margolis et al, *Bull. Fish. Res. Bd. Can.*, 192 13.
1980. *Caligus amblygenitalis*, Cressey & Cressey, *Smith. Contr. Zool.*, 311 : 36, Figs. 74c-g.

Material.—One ovigerous female from the gills of *Acanthocybium solandri* (Cuvier) examied at Trivandrum.

Female.—Cephalothorax oblong in outline ; thoracic area longer than cephalic ; marginal membrane narrow. Frontal plates projecting, with very narrow flange, lunules as wide as frontal plates. Postero-median lobe of cephalothorax three times as broad as lateral lobes and slightly extending beyond them. Posterior sinuses narrow, deep and fully open. Fourth leg-bearing segment short but broad. Genital complex longer than broad, nearly parallel-sided, antero-lateral borders slanting, postero-lateral parts produced into nearly rounded lobes. Abdomen one-segmented, twice as long as broad. Uropods rectangular, with four long and two short plumose setae.

Basal segment of first antenna slightly longer than distal. Posteriorly directed process on the second segment of second antenna wedge-shaped, third segment roughly rectangular, terminal claw strongly curved in the middle with an outer median spine. Post-antennary process a long, slightly curved sclerotised process, with three iong setae associated with its base. Dentiform process of first maxilla a long, apically blunt process, with roughly triangular base ; papilla composed of a low base carrying three dissimilar setae. There is another long, sharp, sclerotised process inner and posterior to the dentiform process. Second maxilla of the typical structure. Corpus maxilipedis more than twice as long as broad, with a proximal conical projection ; subchela short, nearly straight, divisible into a proximal shaft and a distal claw ; barb short. Sternal furca with broad, flat, diverging limbs.

Sympod of first leg with a conical sclerotised projection ; vestigial endopod a conical process ; terminal claws of exopod

bilaterally serrate, second and third with long accessory claws; spine-like seta similar to the claws but longer, plumose setae on the inner margin very long. First two claws on exopod of second leg directed inwards; first claw straight and stout, with narrow serrate flange on both sides; second claw stout but slightly curved, with an outer row of strong spines, third claw spine-like; first two setae modified. Outer border of endopod segments with several rows of sharp spines. Rami of third leg two-segmented, set wide apart, basal claw of exopod apically blunt. Sympod of fourth leg as long as exopod; latter two-segmented, with four rather slender claws. Fifth leg represented by a pair of short setae on the postero-lateral part of the genital complex.

Length.—3.1 mm.

Remarks.—The only detailed description of this species so far available is the original one. Cressey and Cressey's (1980) short account is solely based on Pillai's (1961) publication. As Pillai had only a single specimen it was difficult to make a detailed study of all the appendages. We have, therefore, given above a detailed description of this species. Certain additional features observed during the present study are the following. The corpus maxillipedis carries proximally a conical, sclerotised projection. An almost similar process is seen on the sympod of the first leg also. Pillai has shown a thin flange on the post-antennary process, the dentiform process of first maxilla and on the limbs of the sternal furca, This is absent in the present specimen. Similarly, the sympod of the fourth leg is subequal in length to the exopod and not longer as described by Pillai.

In the nature of the post-antennary process, maxilliped and legs 2 and 3 *C, amblygenitalis* shows some resemblance to *C. pomadasi* sp. nov. (*vide infra*) and *C. glandifer* Shiino (1954a). *C. amblygenitalis* shows very close resemblance to *C. planktonis* Pillai (1979) in the shape of the cephalothorax and the genital complex and even in the details of the appendages. But in *C. amblygenitalis* the sternal furca is slightly different in shape, the symped of the first leg has a triangular process instead of the patch of denticles seen in *C. planktonis*, and the second claw of the exopod of the second leg has a larger number of smaller teeth than in *C. planktonis*. The exopod of the fourth leg in *C. amblygenitalis* is two-segmented but only onesegmented in *C. planktonis*. Above all, in *C. planktonis* the sympod of the second leg has a

large process carrying a row of spines and a long seta which is a unique character hitherto not found in any other caligid. Pillai had only a single female of *C. planktonis* and hence it is not sure that this is not an abnormality. If it is a true character of the species this alone would be sufficient to distinguish *C. planktonis* from all the others.

Caligus callyodoni sp. nov.

(Figs. 12-24)

Material.—Five ovigerous females from the gills of *Callyodon guttatus* (Schneider) examined at Trivandrum.

Holotype.—female in the National Zoological Collection at Z.S.I.

Female.—Cephalothorax nearly equal in length and width, gradually narrowing forwards; narginal membrane comparatively narrow. Frontal plates projecting; lunules not wider than frontal plates. Thoracic area longer than cephalic. Posterolateral lobes of cephalothorax about one-third as broad as median lobe, latter extending far beyond the former. Posterior sinuses shallow and wide open. Faurth leg-bearing segment broader than long. Genital complex rather large, pyriform. Abdomen one-segmented and widening backwards. Uropods squarish, each with three long and three short setae.

Distal segment of first antenna shorter than basal ; both with setae of the usual caligid type. Second segment of second antenna with a slender straight process ; terminal claw curved in the middle ; with two short spine-like setae. Post-antennary process long, slender and curved ; its base associated with three long setae. Dentiform process of first maxilla slightly curved ; basal papilla small, with one long and two short setae, Second maxilla heavily built ; lacertus shorter and stouter than brachium flabellum shifted distalwards ; calanus one and a half times as long as canna. latter pectinate. Corpus maxillipedis nearly parallel-sided, devoid of myxa, subchela slender, with a sharp bent at the place of insertion of the barb. Sternal furca with large base ; limbs narrow, shorter than base and slightly curved inwards.

Vestigial endopod of first leg small ; first exopod segment

unusually large, outer distal spine placed away from the distal end ; second segment only one-fourth as long as the first ; outer terminal claw slender and weak ; second claw largest and curved, accessory process of the second and third claws not reaching the tip of the main claw ; inner plumose setae with characteristically stout base. First claw of exopod of second leg stout, straight, extending beyond the inner border of the segment ; second claw slender, slightly bent ; third claw small and spine-like ; first modified seta stout, bilaterally flanged ; second seta with outer flange and inner hairs. Endopod segments of second leg with outer hairy border. Rami of third leg two-segmented, placed wide apart , basal claw of exopod small, slightly curved. Sympod of fourth leg longer than exopod, latter two-segmented, with four long, rather weak claws, first claw nearly straight, terminal claws successively increasing in size. each with a large serrate membranous lobe at its base. Vestigial fifth leg represented by four setae arising postero-laterally from the genital complex.

Length.—3.0 mm.

Remarks.—*C. callyodoni* shows resemblance to several other species of *Caligus* in one important character or another. In the general shape of the body it resembles *C priacanthi* Pillai (1961) and *C. flexispina* Lewis (1964). In the shape of the maxilliped this species shows resemblance to *C. bifurcus* Shen (1958) and in the presence of long accessory claw on the exopod claws of first leg to *C. longipedis* Bassett-Smith (1898a), *C. gurnardi* Kroyer (1863), *C. macrovi* Gussev (1951), *C. clemensi* Parker and Margolis (1964) and *C. serratus* Shiino (1965). In the armature of the exopod of the second leg it resembles *C. quadratus* Shiino (1954b),*C. longiabdominis* Shiino (1965) and *C. buchlerae* Hewitt (1964) However, *C. callyodoni* differs from all the above mentioned species in the shape of the abdomen, the post-antennary process, the sternal furca and above all in the relative size of the exopod segments of the first leg.

Caligus constrictus Heller

(Figs. 25—27)

1865. *Caligus constrictus* Heller, *Novara Expedition 1857-'59, Zool. Teil,* 2 : 175, pl. 15, Fig. 5

1956. *Caligus constrictus,* Kirtisinghe, *Parasitology,* 46 : 14, Figs. 1—4.

1961. *Caligus constrictus,* Pillai, *Bull. Res. Inst. Univ. Kerala,* 8 : 93.

1964. *Caligus constrictus,* Kirtisinghe, *Bull. Fish. Res. Stn. Ceylon,* 17 : 54, Figs. 27—38.

1967. *Caligus constrictus*, Pillai, *Proc. Symposium on Crustacea, Cochin*. 15 : 1585.

1975. *Caligus constrictus*, Margolis et al., *Bull. Fish. Res. Bd. Can.*, 192 : 23.

Material.—Several ovigerous females and one male from the branchial chamber of *Carangoides malabaricus* (Bloch) examined at Trivandrum.

Male.—Cephalothorax elegantly rounded, nearly equal in length and width; lunules large and projecting. Fourth leg-bearing segment broader than long, fused with the genital complex. Genital complex with narrow anterior neck-like part, rest of the tagma perfectly oval. Abdomen two-segmented, septum between the two segments indistinct, basal segment shorter than distal, narrowing backwards, second segment broadening backwards.

Second and third segments of second antenna with broad adhesion pads, latter with an inner corrugated projection, distal claw strong and well curved, with two proximal setae, one of them very long. Corpus maxillipedis massive, myxa represented by a conical projection; subchela short, moderately curved, contacting the myxa when opposed.

Length.—5.1 mm.

Remarks.—Inspite of the fact that this species was created by Heller (1865) on a male specimen, a detailed and accurate description of the male is still lacking. We have not given a description of the female here because Pillai's (1961) description of the female of this species is complete and the specimens in our collection perfectly agree with it. Kirtisinghe (1956 & 1964) has described the male and female of *C. constrictus*. But his description is very brief. We have, therefore, described the male in detail.

The male described by Heller is so much like the male specimen in our collection especially in the shape of the genital complex and abdomen, that its identity is very clear. Compared to Kirtisinghe's (1956) description, the male has larger lunules and the second abdominal segment slightly widens backwards. More over, the septa between the genital complex and abdomen and the first and second abdominal segments are indistinct. The terminal claw of the second antenna, though strongly curved, is not lobed. In this character the male of *C. constrictus* rescmbles the male of *C. fortis* Kabata (1965), *C. priacanthi* Pillai (1961) and *C. kirtii* sp. nov. (*vide infra*).

Caligus elongatus Nordmann
(Figs. 28-37)

1832. *Caligus elongatus* Nordmann, *Micrographische Beitrag Zur Naturgeschichte der Wirbellosen*, Theire. Heft 2, I, 18.24.
1840. *Caligus kroyeri* Milne-Edwards, *Historie naturelle des crustaces*, Vol. 3. Ruret : Paris, p. 452.
1840. *Caligus rissonus* Milne-Edwards, *Historie naturelle des crustaces* Vol. 3. Ruret : Paris, p. 452.
1905. *Caligus latifrons* Wilson, *Proc. U.S. Natl. Mus.*, 28 : 587, Fig. 140.
1936. *Caligus rabidus* Leigh-Sharpe, *Parasitology*, 28 : 140. Figs. 1-2.
1965. *Caligus rapax*, Kabata, *Ann. Mag. nat. Hist.*, 8 (13). 120, Figs. 1 C,F.
1969. *Caligus elongatus*, Parker, *J. Fish. Res. Bd. Can*, 26 : 1013, Figs —1-21.
1971. *Caligus elongatus*, Hewitt, *Pacif. Sci.*, 25. (2) : 145, Figs. 73-78.
1979. *Caligus elongatus*, Kabata, Parasitic Copepoda of British Fishes, 152 : 179, Figs. 549-558.

Material.—One non-ovigerous female from the gills of *Platax teira* (Forskal), one ovigerous female from the eye of *Callyodon forstei* (Valenciennes) and one ovigerous female from the gills of *Xiphias gladius* (Broussonnet) all collected at Trivandrum.

Female.—Cephalothorax clearly longer than broad, slightly narrowing forwards, marginal membrane broad. Frontal plates projecting, with comparatively narrow flange, lunules as wide as frontal plates. Postero-median lobe of cephalothorax four times as broad as lateral lobes, clearly overreaching the latter, its posterior border trilobed and postero-lateral borders evenly curved. Posterior sinuses deep and wide open. Cephalic area subequal to thoracic in length. Fourth leg-bearing segment broader than long, slightly produced at the base of the fourth legs. Genital complex enlarged, nearly equal in length and width, widening backwards, postero-lateral parts rounded. Abdomen one-segmented, somewhat dorso-ventrally flattened, clearly longar than broad, slightly narrowing distalwards and constricted at its junction with the genital complex. Uropods large, rectangular, each with three long and three short plumose setae.

Basal segment of first antenna longer than distal, with comparatively long plumose setae. Second segment of antenna with a strong, sharp, conical process ; third segment nearly equal in length and width ; terminal claw large, distally curved, with slender outer median seta and a stout basal seta. Post-antennary process a large, straight,

apically blunt process, with an irregularly circular base and three low nodules, each carrying a pair of unusually long setae. Dentiform process of first maxilla well developed, triangular, with a broad base and long slightly curved claw ; basal papilla composed of one large and two very slender and short setae borne on a low base. Brachium of second maxilla slender and longer than lacertus ; terminal processes flattened, calanus one and a half times as long as canna. Corpus maxIIIipedis with smoothly curved outer border and nearly straight inner border, without any armature ; subchela strong, well curved, with a strong spine-like barb. Sternal furca remotely bracket-shaped ; its base transversely rectangular ; limbs apically blunt and set wide apart.

Terminal exopod segment of first leg less than half as long as basal, armed with three terminal claws, one long spine-like seta and three inner plumose setae ; spine-like seta longer than claws. Outer claw of first exopod segment of second leg straight, slightly over-reaching inner border of third segment ; second claw similar to first but only half the size of the latter, both with serrate flange , third claw modified into an inwardly curved, naked, setiform spine. First modified seta a laminate structure with narrow membranous flange : second seta with outer flange and inner hairs. Outer border of endopod segments armed with comparatively long, stiff hairs. Rami of third leg two-segmented , basal claw of exopod flattened, with round tip ; second endopod segment semicircular, with setae crowded at the distal border, rest of the border hirsute. Sympod of fourth leg subequal in length to exopod and nearly parallel-sided , exopod two-segmented, first segment with a long straight claw, terminal segment with three apical claws and another claw placed on the outer margin away from the tip, all claws barbed. Vestigial fifth leg represented by a pair of small nodules on each side of the genital complex, anterior nodule carrying a single seta and the posterior three setae.

Length.—2.8 mm.

Remarks.—Since the creation of this species by Nordmann (1832) it has been reported by several workers from widely distant areas and from quite unrelated hosts. But the inadequate original description created much confusion and several authors misidentified their material as *C. rapax* Milne-Edwards (1840). They even considered *C. elongatus* Nordmann as a synonym of *C. rapax* Milne-Edwards.

Recently, Parker (1969) studied the problem in detail and established the true identity of the species.

Paiker (1969) has given a summary of the information on the hosts and distribution of this species. Accoring to him this species infests 64 species of fish and is restricted to the temperate waters of botn hemispheres.

So far this species has not been recorded from tropical waters. When compared to the detailed description of the lectotype of this species by Parker (1969) some minor differences are observed. The genital complex is more swollen, with the proximal one-third narrow. The first two claws of the fourth leg overreach the base of the next and the basal claw of the exopod of the third leg is apically more rounded.

In the general shape of the body and in the structure of many of the appendages *C. elongatus* shows some resemblance to *C. longicornis* Heegaard (1962) but the structure of the exopod of the first leg is totally different in these two species.

Though the present record falls outside the known distributional range of this species there is no boubt about its identity. A careful study has show that it is clearly referrable to *C. elongatus, a* species which has the following important characterestic featuies. The postero-median lobe of the cephalothorax is four times as broad as the lateral lobes and the posterior sinuses are deep and wide open. The base of the post-antennary process is assoclated with three pairs of long setae. The base of the sternal furca is nearly squarish and the limbs are set wide apart. The first two claws on the exopod of the second leg are straight and strong and the third claw is curved and spine-like. The sympod of the fourth leg is subequal in length to the exopod and parallel sided.

Caligus fortis Kabata

(Figs. 38-52)

1965. *Caligus fortis* Kabata, *Ann. Mag. nat. Hist.*, 9 (13) : 114, Figs. 3-4.
1975. *Caligus fortis,* Margolis et al., *Bull. Fish Res. Bd. Can.,* 192 : 34.

Material.—Nine ovigerous females and one male from the nasal cavity of *Carənx* sp. collected at Trivandrum.

Female.—Cephalothorax equal in length and width. Frontal plates projecting ; lunules not as deep as frontal plates. Marginal membrane of cephalothorax comparatlvely narrow, that of frontal plates very narrow. Dorsal surface of cephalothorax with prominent longitudinal and transverse sutures, cephalic area longer than thoracic. Postero-lateral lobes of cephalothorax half as broad aa median lobe, former contacting the latter and thus closing the posterior sinuses. Postero-median lobe slightly overreaching lateral lobes, its posterior border trilobed. Fourth leg-bearing segment large, broader than long, expanded inta rounded lobes overlapping the base of fourth legs and incompletely fused with the genital complex. Genital complex swollen, nearly circular and connected to the fourth leg-bearing segment by a short neck. Postero-ventral part of genital complex with a median cleft, lateral parts of the cleft slightly produced in the form of a pair of lobes carrying the spermatophores and giving attachment to the egg tubes. Abdomen turgid, one-segmented, broader than long, proximallay bulged and distally narrowed. Uropods longer than broad, curving inwards, with four long and two short plumose setae.

Distal segment of first antenna twice as long as basal. Second segment of second antenna with a round process ; terminal claw long and distally curved at right angles, with two short setae. Post-antennary process well developed , claw apically blunt, base with an inner triangular accessory process and three projecting nodules carrying hairs. Dentiform process of first maxilla large, base broad, main process long and flattened, with an inner slender accessory process arising near the base; papilla with a projecting base carrying one long and two short setae. Flabellum of second maxilla well developed; terminal processes curved, calanus one and a half times as long as canna. Corpus maxilliped is proximally swollen and distally narrowed, subchela moderately curved. Base of sternal furca triangular, as long as limbs, latter stout and narrowing distalwards.

First exopod segment of first leg with two short outer distal spines; second segment with three terminal claws successively decreasing in size, each with a row of denticles and second and third with a weak terminal accessory claw; spine-like seta longer than the claws, inner plumose setae comparatively short; vestigial endopod swollen and two-segmented, ending in two apical spines. Claws on the exopod of second leg suceessively decreasing in size, with narrow serrate flange; first claw straight; second and third slightly curved; first modified seta with outer smooth and inner serrate flange: second

with outer flange and inner hairs. Basal endopod leg proximally sparsely hairy, distal part armed with spines; second segment externally hairy. Basal claw of exopod of third leg curved inwards. Sympod of fourth leg subequal to exopod in length; latter three-segmented, with five claws, middle claw of terminal segment slightly longer than abjacent ones. Vestigial fifth leg represented by three setae on the postero-lateral part of genital complex.

Length.—4.3 mm.

Male.—Cephalothorax roughly oblong; marginal membrane very narrow. Hind border of median lobe of cephalothorax convex. Fourth leg-bearing segment shorter than in female. Genital complex pyriform. Abdomen one-segmented, longer than broad, slightly constricted in the middle. Uropods as in female.

Sexual dimorphism evident in second antenna, dentiform process of first maxilla and maxilliped. Post-antennary process similar to that of female. Second segment of second antenna with one adhesion pad; third segment with outer corrugated margin and inner distal corrugated pad; terminal claw strongly curved, with two prominent setae. Dentiform process of first maxilla with an inner accessory process, outer middle part with prominent ridges. Corpus maxillipedis with a pair of conical projections in the middle and a small tubercle beyond; subchela moderately curved, its tip extending beyond the process on corpus maxillipedis.

Length.—3.2 mm.

Remarks.—*C. fortis* closely resembles several other species collected from carangids inhabiting widely distant localities. These parasites show remarkable uniformity in the general structure of the appendages and they can be distinguished only by the shape of the body and the finer details of the appendages.

Our collection forms the first record of this species from this locality and the specimens agree with those described by Kabata in every detail. However, certain comments are necessary. Kabata has shown the hind border of the posteromedian lobe of the cephalothorax as perfectly straight. This is clearly trilobed and very slightly projecting beyond the lateral lobes. Instead of the single seta shown by Kabata, the papilla of the first maxilla has the usual three setae

mounted on a projecting base. The subchela of the maxilliped is less curved than illustrated by Kabata.

Ho and Bashirullah (1977) included *C. fortis* in the group of species with only one outer element on the third exopod segment of the second leg. Kabata (1965) has observed on this segment one outer claw, one modified seta and five subsimilar setae. Obviously this made Ho and Bashirullah make the observation mentioned above. In our specimens this segment, as usual, carries one claw, two modified setae and five plumose setae.

Caligus kirtii sp. nov.
(Figs. 53-69)

1964. *Caligus curtus*, Kirtisinghe, *Bull. Fish. Res. Stn. Ceylon* 17 : 62 Figs. 49-50.

Holotype.—female and Allotype-male in the National Zoological Collection at Z.S.I.

Material.—Six ovigerous females and two males from the gills of *Lutianus* sp. examined at Trivandrum.

Female.—Cephalothorax nearly equal in length and width. Frontal plates projecting. Lunules as wide as frontal plates. Cephalic area subequal to thoracic in length. Postero-median lobe of cephalothorax about thrice as broad as lateral lobes and very slightly overreaching them. Posterior sinuses deep and wide open. Fourth leg-bearing segment broader than long. Genital complex broader than long, gradually widening backwards and postero-laterally produced into large rounded lobes. Abdomen one-segmented and somewhat dorso-ventrally flattened, more than half as long as genital complex, and demarcated from it by lateral incisions. Uropods comparatively large, with three long and three short plumose setae.

First antenna of the usual caligid type. Second segment of second antenna with a blunt process, terminal claw long and slender, with a proximal outer seta. Post-antennary process a moderately curved claw, its base associated with three nodules bearing a pair of hairs each. Dentiform process of first maxilla well developed and triangular. A small conical sclerotised process present inner and posterior to the first maxilla. Second maxilla of the usual caligid type. Inner border of corpus maxilliped is almost straight, without

any armature, subchela comparatively short but stout, distally curved, and with a median barb. Sternal furca with broad base and long, apically blunt, divergent limbs.

First leg of the usual structure ; vestigial endopod two-segmented, basal segment swollen, distal minute and tipped with a small spine, terminal claws on the distal exopod segment dentate, inner two with accessory claws ; spine-like seta very long ; inner plumose setae well developed. First two claws on the exopod of second leg directed inwards, first claw overreaching the inner margin of the segment ; second shorter ; third half as long as second ; first modified seta longer than the third claw, with serrate inner flange ; second seta with outer flange and inner hairs. Basal segment of endopod of second leg with an outer distal crest of strong spines and a proximal row of short hairs outer border of second segment with a marginal row of short but sharp spines. Rami of third leg two-segmented, basal claw of exopod moderately curved. Sympod of fourth leg as long as exopod ; exopod two-segmented, first segment with one claw and second with one outer median and three terminal claws, latter successively increasing in length ; all claws rather long and slender, with narrow flange on either side and large serrate membranous lobe at the base. Vestigial fifth legs represented by short plumose setae on the postero-lateral parts of genital complex.

Length.—5.0 mm.

Male.—Cephalothorax slightly longer than broad. Genital complex comparatively small, narrowing backwards , posterior half with a pair of lateral indentations housing vestigial fifth legs ; postero-lateral corners angular, carrying three setae on each side representing vestigial sixth legs. Abdomen similar to that of female but smaller.

Second and third segments of second antenna with marginal grooved pads ; terminal claw strongly curved, with two proximal spines. Dentiform process of first maxilla with a corrugated pad and a blunt accessory process in the distal region. Subchela of maxilliped more slender than in female and elegantly curved. Other appendages as in female.

Length.—4.0 mm

Remarks.—From the branchial chamber of *Pristipomoides* Kirtisinghe collected females and males of a copepod which he identified as *C. curtus* Muller (1785). As pointed out by Parker et al. (1968) this is certainly not *C. curtus*. The nature of the fourth leg alone is sufficient to come to this conclusion. Our specimens from *Lutianus* sp., a fish closely related to *Pristipomoides typus*, are undoubtedly the same as those of Kirtisinghe.

C. kirtii can be distinguished from all other *Caligus* spp. by the characteristic shape of the body, the genital complex of the female and male and of the female abdomen. The terminal claw of the second antenna of the male, like that of *C. constrictus* Heller (1865), *C. fortis* Kabata (1965) and *C. priacanthi* Pillai (1961) lacks accessory claws.

This species is named after Mr. P. Kirtisinghe, its discoverer.

Caligus pelagicus Kurian

(Figs. 70-87)

1955. *Caligus pelagicus* Kurian, *Bull. Res. Inst. Univ. Travancore*, 4 : 103, Fig. 1.

1967. *Caligus pelagicus*, Pillai, *Proc. Symposium on Crustacea. Cochin*, 15 : 1595, Fig. 82.

1975. *Caligus pelagicus*, Margolis et al., *Bull. Fish Res. Bd. Can.*, 192 : 59.

Material.—Several ovigerous females and males from the body surface of *Mugil subviridis* examined at Trivandrum.

Female.—Cephalothorax comparatively large, clearly longer than broad, with broad marginal membrane. Frontal plates fairly long and projecting, lunules as deep as frontal plates. Thoracic area of cephalothorax larger than cephalic. Postero-median lobe of cephalothorax clearly overreaching lateral lobes, former about four times as broad as latter and with straight posterior border. Posterior sinuses of moderate size. Fourth leg-bearing segment short and broad. Genital complex nearly parallel-sided, clearly broader than long, its width exceeding that of the median lobe of cephalothorax. Abdomen one-segmented, slightly more than half the length of genital complex. Uropods comparatively large and longer than broad.

Basal segment of first antenna large ; distal segment shorter than basal. Second segment of second antenna with a blunt process, terminal claw distally curved at right angles. Post-antennary process long and curved, with three long hair-like process associated with its base. Dentiform process of first maxilla roughly triangular, apically blunt, papilla composed of a low base carrying three setae. Second maxilla of the typical caligid structure. Corpus maxillipedis almost twice as long as broad, with nearly straight inner border ; subchela short but stout, very slightly curved, claw clearly delimited from the shaft and with a spine-like barb at its base. Base of sternal furca broad, as long as limbs ; limbs highly flattened and broadening distalwards.

Vestigial endopod of first leg a small conical process , terminal claws on exopod comparatively short, successively decreasing in length ; spine-like seta naked, much longer than claws, inner plumose setae large. First claw of exopod of second leg stout and straight, extending up to the inner margin of the ramus ; second claw similar to the first but shorter, both with outer flange ; third claw spine-like ; first modified seta stout and naked , second with outer flange and inner hairs ; second endopod segment with outer hairy border. Rami of third leg two-segmented basal claw of exopod well curved and bilaterally flanged. Sympod of fourth leg shorter than exopod ; latter two-segmented, uniformly broad, segmentation between first and second segments rather indistinct ; first segment with a long straight claw, distal segment with three terminal claws, outer two rather spine-like, inner claw almost twice as long as penultimate. Vestigial fifth leg represented by two small tubercles bearing setae on the postero-lateral corner of the genital complex.

Length.—2.8 mm.

Male.—Cephalothorax and fourth leg-bearing segment as in female. Genital complex smaller, about one and a half times as long as broad, with postero-lateral projection carrying vestigial fifth leg. Abdomen clearly two-segmented, basal segment very short, second segment longer than broad, very slightly widening backwards. Uropods as in female.

Sexual dimorphism evident in the structure of the second antenna, post-antennary process, dentiform process of first maxilla, maxilliped

and vestigial fifth leg. Second segment of second antenna fused with the cephalothorax, with marginal grooved pad ; third segment narrowing distalwards, carrying a distal adhesion pad ; terminal claw very short, curved, apically trifid and with a prominent spine-like seta. Post-antennary process more curved than in female, with narrow inner flange. Dentiform process with a circular grooved pad in the middle. Corpus maxillipedis of maxilliped massive, inner margin with a broad apically flattened process in the middle and a small tooth posterior to it ; subchela longer and more curved than in female, with an inner median barb. Vestigial fifth leg represented by two processes on the postero-lateral part of genital complex, anterior tubercular process carrying one seta and posterior conical process carrying two setae.

Length.—2.1 mm.

Remarks.—*C. pelagicus* closely resembles *C. epidemicus* Hewitt (1971), a parasite of *Mugil butchleri* in New Zealand waters. The similarity is particularly evident in the overall shape of the body and in the nature of the cephalic appendages and the fourth leg. But the shape of the sternal furca and the short spine-like seta of the first leg clearly distinguish *C. epidemicus*.

Hewitt (1971) compared *C. epidemicus* with *C. pageti* Russell (1925). All the characters of *C. pageti*, indirectly mentioned by Hewitt, apply to *C. pelagicus*. Hence there is strong possibility that *C. pelagicus* may be a synonym of *C. pageti*. We are unable to come to a conclusion as we do not have access to Russell's paper.

A casual examination would show that *C. pelagicus* is an inconspicuous member of the genus resembling many others. But the large cephalothorax, the short apically rounded limbs of the sternal furca, the large spine-like seta of the first leg, the armature of the second leg and the extremely elongated apical spine of the fourth leg and the maxilliped of the male make specific identification easy.

Caligus pomadasi sp. nov.

(Figs. 88-101)

Material.—Two ovigerous females from the gill filaments of *Pomadasys maculatus* (Bloch) examined at Trivandrum.

Holotype—female in the National Zoological Collection at Z. S. I. Reg. No.

Female.—Cephalothorax longer than broad, gradually narrowing forwards. Frontal plates moderately broad and strongly projecting, with narrow flange and fairly large lunules. This, together with the large basal segment of the first antenna preserves the even contour of the anterior part of the cephalothorax. Dorsal transverse suture of cephalothorax placed in the middle. Postero-median lobe of cephalothorax twice as broad as and slightly overreaching lateral lobes. Posterior sinuses deep, narrow and wide open. Fourth leg-bearing segment small, broader than long. Genital complex equal in length and width, antero-lateral borders slanting and postero-lateral perfectly rounded. Abdomen short, indistinctly two-segmented ; first segment slightly longer than second. Uropods of moderate size, longer than broad.

Basal segment of first antenna large ; distal segment shorter than basal. Second segment of second antenna with an apically rounded large process ; distal claw very long, double curved, with an inner and outer small seta. Post-antennary process moderately long and slightly curved, with outer flange and carrying three whip-like setae instead of the usual three bunches of hairs on its base. Inner to the dentiform process is a small but sharp, sclerotised conical process. Second maxilla very characteristic, lacertus stout, shorter than brachium ; proximal half of brachium narrow, distal half suddenly broadened, distal part of the outer border with narrow serrate flange ; flabellum small, placed in the distal half of brachium ; terminal process comparatively short but stout : calanus winged ; canna feebly pectinate. Maxilliped of average size, corpus maxillipedis devoid of myxa ; subchela short, slender and nearly straight, divisible into a proximal shaft and terminal claw ; barb at the base of terminal claw spine-like. Base of sternal furca as long as limbs, latter flat, bracket-shaped and externally flanged.

Sympod of first leg with a large patch of spinules, vestigial endopod conical, surmounted by a small spine; distal exopod segment with three rather dissimilar naked claws ; spine-like seta exactly like the claws but longer ; inner plumose setae well developed. First claw of exopod of second leg short but stout and straight, bilaterally flanged , second claw smaller, slightly curved, with very

broad crenate outer flange ; third claw slender and curved , first modified seta stout ; outer border of endopod segments armed with several rows of stiff hairs. Rami of third leg two-segmented, basal claw of exopod slightly curved and blunt, with narrow outer flange ; distal endopod segment oblong. Exopod of fourth leg two-segmented, with four long, slender, pectinate claws successively increasing in length. Vestigial fifth leg represented by three small plumose setae on postero-lateral part of genital complex.

Length.—2.6 mm.

Remarks.—In the general shape of the body and in the structure of the cephalic appendages, except the second maxilla *C. pomadasi* shows some resemblance to *C. glandifer* Shiino (1954a) and *C. punctatus* Shiino (1955). But this species can be distinguished by the peculiar shape of the second maxilla and of the claws on the exopod of the second leg.

In the structure of the claws on the exopod of the first leg, which is different from the usual type, *C. pomadasi* resembles *C laticaudus* Shiino (1960), *C. longiabdominis* Shiino (1965), *C. flexispina* Lewis (1964) and *C. pseudokalumi* Lewis (1968). The latter two species show further resemblance to *C. pomadasi* in the shape of the dentiform process, the maxilliped, the sternal furca and in the structure of the claws on the exopod of the second and fourth legs. But in *C. pomadasi* the shape of the body, particularly of the post-cephalothoracic part, is clearly different from that of all the others and the postero-median lobe of the cephalothorax is not very much produced backwards.

Caligus priacanthi Pillai
(Figs. 102-106)

1961. *Caligus priacanthi* Pillai, *Bull. Res. Inst. Univ. Kerala,* 8 : 104, Fig. 11.

1967. *Caligus priacanthi* Pillai, *Proc. Symposium on Crustacea Cochin,* 15 : 1575, Fig. 33.

1975. *Caligus priacanthi,* Margolis et al., *Bull. Fish. Res. Bd. Can.,* 192 : 63.

Material.—Several ovigerous females and males from the inner surface of the opercle of *Priacanthus hamrur* (Forskal) examined at Trivandrum.

Allotype.—male in the National Zoological Collection at Z. S. I. Reg. No.

Male.—Postero-lateral parts of cephalothorax slightly more curving inwards than in female. Genital complex nearly equal in length and width, steadily widening backwards, with very prominent postero-lateral lobes carrying vestigial legs. Abdomen two-segmented, basal segment clearly broader than distal and constituting one-third of the total length of the tagma. Uropods large.

Second segment of second antenna rather indistinct ; third segment with very small adhesion pad ; proximal part of terminal claw with a short spine-like seta and a backwardly directed, wedge-shaped, strong process, distal part strongly bent and apically acute. Post-antennary process more curved than in female. Dentiform process of first maxilla similar to that of female. Maxilliped large, corpus maxillipedis massive, myxa consisting of a pair of inner conical projections placed one behind the other in the middle ; subchela moderately curved and when folded contacting the inner distal process on the corpus maxillipedis.

Length.—2.1 mm.

Remarks.—Pillai (1961) described the female of this species in detail. The male is described for the first time. As ovserved earlier, the structure of the second antenna of the male is different from the usual type. Generally in *Caligus* spp. it is very short and three to five-lobed. But in this species the claw is as in the female but has a proximal accessory claw and the distal part is strongly curved. Sexual dimorphism is seen in the structure of the maxilliped also.

Caligus spinosus Yamaguti

(Figs. 107-117)

1939. *Caligus spinosus* Yamaguti, *Vol. Jubil. Prof. Yoshida,* 2 : 445, 445, pl. 14, Figs. 4-8.

1956. *Caligus spinosus,* Markewitch, *Izd. Akad. Nauk. Ukr. SSR. Kiev,* 193, Fig. 63 (1).

1960. *Caligus spinosus,* Shiino, *Rep Fac. Fish. Pref. Univ. Mie,* 3 (3) : 476, Figs. 3 & 4.

1963. *Caligus spinosus*, Yamaguti, *Parasitii Copepoda and Branchiura of Fishes*. 60, pl. 74, Fig. 2.

1963. nec. *Caligus spinosus*, Pillai, *J. Mar. Biol. Ass. India*, 5 : 76, Fig. 6.

1969. *Caligus spinosus*, Izawa, *Rep. Fac. Fish. Pref. Univ. Mie*, 6 : 127, Figs. 18-20.

1975. *Caligus spinosus*, Margolis et al., *Bull. Fish. Res. Bd. Can.*, 192 : 76.

Material.—One ovigerous female from the gills of *Pellona ditchella* Valenciennes examined at Trivandrum.

Female.—Cephalothorax perfectly circular with broad marginal membrane, frontal plates narrow , lunules very large and projecting Transverse and longitudinal sutures on the dorsal surface of cephalothorax not prominent, former shifted backwards up to the level of the posterior sinuses. Postero-median lobe of cephalothorax only slightly broader than lateral lobes, not extending beyond the latter. Postero-lateral lobes curving inwards and contacting the median lobe, thus closing the posterior sinuses. Fourth leg-bearing segment large, broader than long, genital complex longer than broad, connected to the fourth leg-bearing segment by a neck-like part. Abdomen short, slightly broader than long, two-segmented, partition between the segments incomplete. Uropods very small, with three long and three short setae.

First antenna with the distal segment longer than the basal. Second segment of second antenna with a round posteriorly directed process ; terminal claw remarkably long, slender, strongly falcate, with two setae. Post-antennary process well developed, its base with an inner triangular accessory process ; main claw slightly curved and bilaterally flanged. Dentiform process of first maxilla with a broad base carrying a small prominence towards its inner side and a stout apically flanged claw with an inner accessory process, papilla composed of a raised base carrying one long and two short setae. Second maxilla of the usual caligid type, brachium broadening distalwards, flabellum large, calanus about twice as long as canna. Corpus-maxillipedis narrowing towards the distal end, with three small projections in the middle ; subchela long, slender and strongly falcate, barb prominent. Base of sternal furea large, limbs stout, long, apically flanged and curving inwards.

Sympod of first leg with a circular patch of spinules, exopod long and narrow, basal segment about three times as long as distal, latter with the usual armature ; spine-like seta longer than the third claw and placed at the inner distal corner. Interpodal bar of second leg with a toothed sclerotised process at either end ; sympod with a patch of teeth basal endopod segment armed with outer marginal spines ; outer border of second segment hairy ; first claw of exopod straight and apically pointed, second claw curved, third smaller than second and overreaching it, first two modified setae with outer flanged and inner hairy borders. Apron of third leg strongly armed, with an inner longitudinal apically projecting and bifid sclerotised bar, a patch of strong teeth in line with the endopod, a longitudinal row of spines in line with the exopod and an outer proximal adhesion pad. Rami of third leg two-segmented, basal claw of exopod strong, well curved ; third spine-like seta of distal exopod segment much longer than the other two ; velum well developed, partly covering the claw. Sympod of fourth leg almost as long as, but stouter than, exopod ; latter three-segmented ; claws strong and straight, first two claws subsimilar, claws on terminal segment successively increasing in length. Vestigial fifth leg represented by four setae at the postero-lateral corner of genital complex.

Length.—2.3 mm.

Remarks.—Yamaguti's original description of this species is somewhat inadequate. Shiino (1960) described both sexes in detail and Izawa (1969) while describing its life history described the adult female and male.

When compared with the descriptions by earlier authors our specimen shows differences in certain characters. However, intra-specific variation can, to a certain extent, account for the differences observed in the present study and one can be reasonably certain that the present specimen belongs to *C. spinosus*.

According to Shiino (1960) the postero-median lobe of the cephalothorax is fused with the succeeding segment but in our specimen the posterior limit is well defined. This should be so since to our knowledge the cephalothorax in all caligids is free from the following segment. Shiino described the abdomen as less than half as long as the genital complex and indistinctly two-segmented, second segment being very short. Izawa illustrated it as half as

long as the genital complex and one-segmented in the female and two-segmented in the male. In our specimen the abdomen is only one-fourth as long as the genital complex. It is indistinctly two-segmented and the segments are subequal in length. The post-antennary process has a prominent inner accessory process as described by Izawa. Shiino obviously did not notice this. The latter author has shown a single tubercle on the corpus maxillipedis. Izawa reported a similar process on the corpus maxillipedis of the male which, according to him, is absent in the female. The corpus maxillipedis in the female actually carries three small tubercles. The tiny spinule reported by Shiino at the base of the second claw of the exopod of the first leg is not found in our specimen. Indeed all the claws have at their base a membranous lobe as illustrated by Izawa. The sympod of the first leg has a patch of spinules and the intercoxal bar has a pair of dentate processes. Izawa has shown the last two claws on the fourth leg as subequal in length but the penultimate claw is slightly shorter than the last.

C. spinosus exhibits several features peculiar to caligids parasitic on carangids. They include the structure of the post-antennary process, the dentiform process of the first maxilla and the armature of the first three pairs of legs. However, this species can be distinguished by its smaller size, indistinctly two-segmented abdomen, presence of small prominences on the corpus maxillipedis and the characteristic shape of the sternal furca.

Genus **Sciaenophilus** van Beneden

Sciaenophilus tenuis van Beneden

(Figs. 118-127)

1852. *Sciaenophilus tenuis* van Beneden, *Bull. Acad. Roy. Belg.*, 19 : 464.

1898. *Caligus benedeni* Bassett-Smith, *Ann. Mag. nat. Hist.*, 1 (7) : 8, pl. 4, Fig. 3.

1913. *Sciaenophilus tenuis*, Scott, T & A., *The british parasitic copepoda Vol. I & II.*

1961. *Sciaenophilus tenuis*, Pillai, *Bull. Res. Inst. Univ. Kerala*, 8 : 115, Fig. 16.

1963. *Sciaenophilus tenuis* Yamaguti, *Parasitic Copepoda and Branchiura of Fishes*, 66, pl. 85, Fig. 2.

1963. *Sciaenophilus benedeni* Yamaguti, *Parasitic Copepoda and Branchiura of Fishes*, 66.

1964. *Caligus benedeni*, Kulasinghe, *Bull. Fish. Res. Stn. Ceylon*, 17 : 64.

1979. *Sciaenophilus tenuis*, Kabata, *Parasitic Copepoda of British fishes*, 152 : 188, Figs. 713-721.

Material.—Five ovigerous females and one male from the gills of *Johnius maculatus* Bloch and Schneider examined at Trivandrum.

Female.—Cephalothorax slightly broader than long, frontal plates broad and projecting ; lunules as wide as frontal plates. Cephalic area longer than thoracic ; postero-median lobe twice as broad as lateral lobes, gradually narrowing backwards and overreaching lateral lobes. Posterior sinuses shallow, wide open. Fourth leg-bearing segment broader than long, incompletely fused with the succeeding tagma. Genital complex gradually widening backwards, about four times as long as the cephalothorax and with small, rounded postero-lateral lobes. Abdomen longer than the rest of the body, rear end slightly narrowed and constricted demarcating a second segment. Uropods, laminate, each with six short plumose setae.

First antenna of the typical caligid structure. Second antenna four-segmented ; second segment without any processes ; terminal claw moderately curved. Dentiform process of first maxilla with broad base, slightly curved and narrowing distalwards basal papilla consisting of a highly projecting base carrying three comparatively short setae. Second maxilla of the usual structure. Maxilliped large, inner margin of corpus maxillipedis straight, with a proximal spine-like projection ; subchela strongly curved, with a small barb. Sternal furca absent.

Terminal claws on the exopod of first leg simple and naked, successively increasing in length ; spine-like seta subsimilar to the inner claw ; inner plumose setae normally developed. Exopod of second leg with three barbed claws, successively decreasing in size, first modified seta short, stout and naked ; second seta with outer flange and inner hairs, endopod segments with outer hairy border. Rami of third leg two-segmented, basal claw of exopod slightly curved. Exopod of fourth leg three-segmented, with five claws. Fifth and sixth legs could not be observed.

Length.—17 mm.

Male.—Cephalothorax nearly equal in length and width, more steadily widening backwards ; posterior sinuses moderately deep. Fourth leg-bearing segment nearly twice as broad as long, clearly demarcated from the genital complex. Genital complex comparatively

small, pyriform, with a pair of median lateral indentations housing the vestigial fifth leg and a pair of small postero-lateral lobe-like projections bearing setae representing the vestigial sixth legs. Abdomen shorter than cephalothorax, distinctly two-segmented, basal segment half as long as distal. Uropods comparatively longer than in female.

Third segment of second antenna with marginal and distal grooved pads ; terminal claw short, strongly curved, with a basal backwardly directed strong accessory claw. Post-antennary process more slender and narrow than in female. Dentiform process of first maxilla with a short median process. Corpus maxillipedis with an inner proximal distally dentate projection, subchela less curved than in female, with a long barb.

Length.—3.3 mm.

Remarks.—Sciaenophilus tenuis, though more than a century old, remained poorly known till Pillai (1961) published a detailed description of both sexes. Recently, Kabata (1979) redescribed this species and made *S. benedeni* (Bassett-Smith, 1898b) a synonym of *S. tenuis*.

The material described by Kabata differs from those described by Pillai (1961) and the present collection in certain relevant characters. According to Kabata the hind border of the genital complex is truncate but in our specimens the genital complex has small postero-lateral lobes. This difference can be attributed to the difference in the stage of maturity of the reproductive organs. The dentiform process of the first maxilla in our specimens is slightly curved in contrast to the straight process described by Kabata. The most important difference is seen in the shape and structure of the maxilliped. In Kabata's material the inner border of the corpus maxillipedis is concave and lacks the proximal spine-like process. We could not observe the fine serrations illustrated by him on the outer margin of the second and third claws of the exopod of the first leg. According to Kabata the exopod of the fourth leg is two-segmented and the distal segment is formed by the complete fusion of the two segments. But in the specimen we have studied, the line of demarcation between the two segments

is distinct. These differences reopen the question whether *S. tenuis* and *S. benedeni* are synonymous as suggested by Kabata.

Genus Pseudopetalus Pillai

Pseudopetalus caudatus (Gnanamuthu)

(Figs. 128-141)

1950. *Parapetalus caudatus* Gnanamuthu, *Proc. Ind. Acad. Sci.*, 31 : 125, Fig. I.

1957. *Caligus biseriodentatus* Shen, *Acta Zool. Sinica,* 9 : 375, pl. 9.

1962. *Pseudopetalus caudatus,* Pillai, *Crustaceana,* 3 : 299, Fig. 6.

1963. *Caligus biseriodentatus,* Yamaguti, *Parasitic Copepoda and Branchiura of Fishes* 50, pl. 54, Fig. 2.

1975. *Caligus biseriodentatus,* Margolis et al., *Bull. Fish. Res. Bd. Can.*, 192 : 18 (immature female).

Material.—Fourteen ovigerous females from the gills of *Dussumieria hasselti* Bleeker and three juvenile females from the gills of *Cybium commersoni* (Lacepede) examined at Trivandrum.

Juvenile female.—Cephalothorax slightly longer than broad, gradually widening backwards. Frontal plates very wide and projecting, with large circular lunules. Marginal membrane of cephalothorax and frontal plates very narrow. Cephalic area longer than thoracic. Postero-median lobe of cephalothorax three times as broad as lateral lobes, clearly overreaching the latter. Posterior sinuses wide open. Fourth leg-bearing segment clearly broader than long, very distinct. Genital complex narrow, about twice as long as broad and very slightly broadening backwards. Abdomen slightly shorter and narrower than genital complex, one-segmented. Uropods roughly squarish, each with three long and three short setae.

Basal segment of first antenna longer than distal, with comparatively long plumose setae. Second antenna of average size, second segment with a sharp, medium-sized posterior process, third segment apparently rectangular ; terminal claw distally curved at right angles, with a small median spine-like seta and a basal short fleshy seta. Post-antennary process a sharp curved claw. Inner to the post-antennary process there is a triangular sclerotised projection. Dentiform process of first maxilla roughly triangular distally curved outwards, papilla consisting of a projecting base carrying one

long and two short setae. Lacertus of second maxilla shorter and stouter than brachium; flabellum very small, terminal processes only slightly differing in size. Maxilliped large, corpus maxillipedis swollen, with two sharp projecting spines on the inner margin and a median circular pad; subchela robust, well curved, with a small barb. Base of sternal furca widening backwards, longer than limbs; limbs nearly straight, narrowing distalwards and apically acute.

Sympod of first leg with a large circular patch of spinules; vestigial endopod a conical process tipped with a spine inner border of first exopod segment with a row of short spines instead of the usual hairs; terminal claws on distal exopod segment comparatively short but strong, second and third with accessory process; spine-like seta long and plumose; inner setae represented by small spine-like structures. Claws on exopod of second leg successively decreasing in size, all directed inwards and reaching the inner margin of the ramus; first two setae modified; first endopod segment with an outer distal crest of spines, outer margin of second segment with two rows of prominent teeth. Apron of third leg large, armed with a circular patch of spines in line with the endopod, a longitudinal row of spines in line with the exopod and an outer proximal corrugated pad, rami two-segmented, basal claw of exopod slightly curved and apically acute. Sympod of fourth leg subcylindrical, longer than exopod, exopod two-segmented, with five sharp claws, first segment with a single claw, second segment with one subterminal and three terminal claws. Vestigial fifth leg represented by a pair of plumose setae placed postero-laterally on the genital complex.

Length.—3.0 mm.

Remarks.—The genus *Pseudopetalus* Pillai (1962a) was created to include two species namely, *P. caudatus* (Gnanamuthu, 1950) and *P. formicoides* Redkar et al. (1949) which till then remained in the genus *Parapetalus* Stp. & Lutk. Pillai published detailed descriptions of the female of both species. Therefore, we have not attempted a description of the mature female here.

From the gills of *Cybium commersoni* we obtained specimens identical to those described by Shen (1957) as *Caligus biserioden-tatus*. We have given above a detailed account of them and we

are absolutely sure that they are juveniles of *Pseudopetalus caudatus*. It is surprising that Shen failed to recognise them as immature females of some caligid. Cressey and Cressey (1980) even went to the extent of relegating *C. auxisi* Pillai (1963) to the synonymy of *C. biseriodentatus*. According to them *C. auxisi* represents the adult form of the immature female described by Shen. The illustration of the adult, female and immature female given by Cressey and Cressey are obviously reproductions of figures published by Pillai and Shen respectively. Hence we have to take into consideration the details of the appendages. On the distal segment of the first leg of *C. biseriodentatus*, Shen has shown three small inner teeth but in *C. auxisi* there are three short plumose setae. The claws on the exopod of the fourth leg of *C. biseriodentatus* decrease in length distalwards but it is just the opposite in *C. auxisi*. This difference in the nature of the fourth leg cannot be attributed to immaturity.

On the other hand there are ample reasons to consider *C. biseriodentatus* as the juvenile of *P. caudatus*. Except for the difference in the shape of the genital complex and abdomen, which can be attributed to sexual immaturity all other distinguishing characters of the adult are present in the juvenile specimen. This resemblance is evident in the structure of the second antenna and the postantennary process, in the presence of a sclerotised conical projection inner to the base of the post-antennary process, in the presence of two sharp spines representing the myxa on the corpus maxillipedis, in the general structure of the first leg, in the presence of two rows of prominent teeth on the second endopod segment of the second leg and in the structure of the fourth leg. We have therefore, no doubt that *C. bisericdentatus* Shen represents the juvenile female of *Pseudopetalus caudatus* and not of *C. auxisi* Pillai.

On detailed examination of the adult females in the present collection we could notice a few additional features and minor differences from the specimens described earlier (Pillai, 1962a). They are the following. The abdomen in *P. caudatus* does not form a deep postero-median sinus and the postero-lateral lobes of the abdomen do not overreach the uropods. Inner to the base of the post-antennary process there is a small sclerotised conical process.

Pseudopetatus dussumieri (Rangnekar)

(Figs. 142-149)

1957. *Caligus dussumeri* Rangnekar, *J. Univ. Bombay*, 25 : 18, Fig. 2.

1963. *Caligus dussumieri*, Yamaguti, *Parasitic Copepoda and Branchiura of Fishes*, 52.

1968. *Pseudopetalus dussumieri*, Pillai, *Parasitology*, 58 : 13, Fig. 3.

1975. *Caligus dussumieri*, Margolis et al. *Bull. Fish. Res. Bd. Can.*, 192 : 31.

Material.—One ovigerous female and two juvenile females from the gills of *Dussumieria hasselti* Bleeker examined at Trivandrum.

Remarks.—At the time of its creation genus *Pseudopetalus* Pillai comprised only two species. Later (Pillai, 1968), *Caligus dussumieri* Rangnekar was transferred to this genus and was redescribed in detail giving accurate information about the sternal furca and the structure of the legs which exhibit several interesting features. But due to dearth of material the cephalic appendages could not be studied in detail. The important characteristic features exhibited by the cephalic appendages are, therefore, mentioned below. The third segment of the second antenna has a blunt process on its dorsal aspect. This is an interesting feature since the third segment of the female second antenna among caligids generally does not possess any armature *(Caligus phipsoni* Bassett-Smith, 1898b and *Parechetus carangis* (Bassett-Smith, 1898a) are exceptions). The inner margin of the corpus maxillipedis is rather irregular and has low proximal projection. Towards the outer margin of this segment there is a very small prominence.

In addition to the mature female our collection includes two juvenile females of this species. In the juvenile female the genital complex and the abdomen are not enlarged. The blunt process on the third segment of the second antenna is more clearly visible and the subchela of the maxilliped is less curved. Instead of the short spines found in the mature female the outer border of the second endopod segment of the second leg possesses circular sclerotized areas. Nevertheless, the resemblance to the adult is unmistakable.

The three species of *Pseudopetalus* so far discovered can be distinguished from one another by the structure of their maxilliped. In *P. caudatus* the myxa on the corpus maxillipedis is represented

by two teeth placed one behind the other and slightly apart. In *P. dussumieri* the corpus maxillipedis has irregular inner margin carrying a low proximal projection. This segment also has a small prominence towards the outer margin. In *P. formicoides* Redkar et al. (1949) the corpus maxillipedis has on its inner margin two spines placed very close to each other. This segment also carries a median corrugated pad. The subchela has a short spine at the base of the barb.

Genus **Lepeophtheirus** Nordmann

Lepeophtheirus anguilli Hameed

(Figs. 150-160)

1976. *Lepeophtheirus anguilli* Hameed, *Hydrobiologia*, 50 (2) : 161, Figs. 1-20.

Material.—One ovigerous female from the inner surface of the opercle of *Plotosus* sp. examined at Trivandrum.

Female.—Cephalothorax broadest behind, gradually narrowing forwards. Frontal plates slightly projecting ; marginal membrane of cephalothorax and frontal plates comparatively narrow. Dorsal transverse and longitudinal sutures well developed, cephalic area subequal to thoracic in length. Postero-lateral lobes of cephalothorax one-third as broad as median lobe ; latter clearly overreaching the former. Posterior sinuses wide open. Fourth leg-bearing segment well developed, fully exposed, broader than long. Genital complex swollen, nearly circular in outline, with a pair of short, horn-like postero-lateral projections representing the vestigial fifth legs. Abdomen short, fused with the genital complex. Uropods subcircular.

Basal segment of first antenna large, inner distal part produced into an apically bifid lobe, outer setae short ; second segment stumpy, shorter than basal, one of its apical setae very stout. Second segment of second antenna with a stout process ; third segment narrowing distalwards ; terminal claw fairly long, distally curved, with two well developed setae. Post-antennary process with roughly triangular base and exceptionally slender, flanged claw. Dentiform process of first maxilla with nearly rectangular base carrying two blunt processes, outer shorter than inner. Basal papilla placed close to the dentiform process and consisting of a low base carrying two short and one long setae. Second maxilla comparatively large ;

brachium longer than lacertus, stout and fleshy ; calanus winged, twice as long as canna, latter rod-like ; with broad, prominently pectinate flange. Myxa on corpus maxillipedis a low step-like projection , subchela stout and well curved, its sharp tip contacting myxa when closed, limbs of sternal furca longer than base, slightly diverging and bilaterally flanged.

Vestigial endopod of first leg a small tapering process ; distal segment of exopod armed with the usual three claws, a long plumose spine-like seta a placed at the inner distal corner and three well developed inner plumose setae. First claw of exopod of second leg stout and straight ; second and third claws subsimilar, shorter than first ; first modified seta claw-like, with outer flange, endopod segments with hairy outer border. Exopod of third leg three-segmented, first segment with an inner plumose seta , second segment with inner plumose seta and an outer stout spine-like seta , third segment with three outer spine-like setae and four inner plumose setae, base of the claw expanded, claw proper lancet-like, with outer flange broken into two parts ; endopod two-segmented, velum represented by a small lobe overlapping the exopod. Sympod of fourth leg very stout ; exopod three-segmented, with five claws , claws of first segment very small, second segment with one claw, third segment with three terminal claws successively increasing in length, innermost claw remarkably long and curved, all claws finely pectinate and with broad membranous lobe at their base. Vestigial fifth leg represented by a conspicuous process bearing two distal and one outer median setae.

Length.—2.5 mm.

Remarks.—Compared to the original description by Hameed (1976) certain differences, especially in the structure of the appendages are evident. The distal segment of the first antenna is much thicker and the basal segment has a bilobed process at its inner distal corner. The corpus maxillipedis has a low inner proximal projection. The limbs of the sternal furca are more diverging and apically blunt. The structure of the rami of the third leg is quite different from that shown by Hameed. The exopod is three-segmented and the basal segment carries an inner plumose seta. Hameed has shown the velum as a separate lobe but it is actually an extension of the basal segment of the endopod.

As observed by Hameed *L. anguilli* shows close resemblance to *L. plotosi* Barnard (1948) in the shape of the genital complex. But further comparison is not possible as Barnard's account of *L. plotosi* lacks details.

The more important distinguishing features of *L. anguilli* are the shape of the cephalothorax and sternal furca and the structure of the fourth and fifth legs. Hameed's illustrations lack details and hence we have given a nearly full description to facilitate future comparison with *L. plotosi*.

Lepeophtheirus kabatai Ho & Dojiri

(Figs. 161—182)

1968. *Lepeophtheirus plectropomi*, Lewis, *Proc. U. S. natl. Mus.*, 125. 36, Figs. 16-18.

1977. *Lepeophtheirus kabatai* Ho & Dojiri, *Publ. Seto Mar. Biol. Lab.*, XXIV (1/3), 89, Figs. 7A. F.

Material.—Nine ovigerous females and three males from the branchial cavity of *Plectropomus maculatus* (Bloch) examined at Trivandrum.

Female.—Cephalothorax comparatively large, equal in length and width ; marginal membrane narrow. Cephalic area subequal to thoracic. Frontal plates slightly projecting, with very narrow flange. Postero-lateral lobes of cephalothorax nearly one-third as broad as median lobe, latter clearly overreaching former. Posterior sinuses shallow and wide open. Fourth leg-bearing segment fully exposed and prominently produced laterally. Genital complex swollen, with nearly straight lateral margins. Abdomen one-segmented, nearly equal in length and width, proximally narrow, widest in the middle. Uropods small, each with four long and two short setae.

Basal segment of first antenna large, with a bifid process at the inner distal corner. Second segment of second antenna with a short cylindrical process ; distal claw heavily built, strongly curved, with slender median and stout but short basal setae. Post-antennary process with a broad triangular base and nearly straight, sharp, short claw, the three bunches of hairs mounted on highly projecting nodules. Dentiform process of first maxilla large and bifid tines parallel, outer slightly longer than inner. Second maxilla slender ;

flabellum placed in the middle of brachium, the segment suddenly narrowed in front of the flabellum. Corpus maxillipedis with a small inner distal patch of spinules, subchela short but stout. Base of sternal furca with lateral projection ; limbs as long as base, diverging and narrowing distalwards.

First leg of the usual structure, vestigial endopod a small conical projection carrying a pair of apical spines ; spine-like seta on the distal exopod segment placed at the inner distal corner. Endopod segments of second leg with hairy outer border, outer three claws of exopod stout and straight, second slightly shorter than others, first modified seta claw-like. Exopod of third leg three-segmented, basal claw stout ; endopod two-segmented, overlapping exopod. Sympod of fourth leg remarkably stout , exopod long and slender, three-segmented, with spine-like claws, first claw minute, second, third and fourth claws subsimilar, only slightly differing in length, fifth claw twice as long as the fourth, outer border of last two segments with finely serrate flange. Fifth leg represented by a small tubercle carrying a single seta and a triangular sclerotised process carrying three setae.

Length.—5.0 mm.

Male.—Cephalothorax nearly circular. Fourth leg bearing segment less produced laterally than in female. Genital complex barrel-shaped. Abdomen one-segmented, nearly as long as broad. Uropods large, with very long setae.

Second antenna highly modified, second segment with two adhesion pads, third segment large, with several adhesion pads and two distal long curved claws, one inner and the other outer ; distal claw stout, curved, apically bifid, with inner median spine-like seta and a small tooth. Post-antennary process stout and more curved than in female. Dentiform process of first maxilla smaller, consisting of an apically blunt process carrying a short subapical, flexible, spine-like process. Corpus maxillipedis with a small inner distal triangular projection ; subchela longer and less curved than in female with an inner proximal tooth in addition to the barb. Vestigial fifth leg a sclerotised cylindrical process carrying four setae, sixth leg a conical projection carrying three setae.

Length.—2.2 mm.

Remarks.—Lewis (1968) collected a few specimens from *Epinephelus fuscoguttatus* and *Epinephelus kohleri* which he identified as *Lepeophtheirus plectropomi.* Recently Ho and Dojiri (1977) showed that what Lewis described as *L. plectropomi* actually belongs to a new species which they named as *L. kabatai.* Even though our material shows some difference in detail we assign them to *L. kabatai.*

Contrary to the description by Lewis the flabellum on the second maxilla is not broken into two parts and the corpus maxillipedis has a distal patch of spinules. The basal segment of the first antenna is produced into a bifid process in both sexex. Ho and Dojiri (1977) have described a sclerotised accessory process on the dentiform process of the first maxilla of the male. But in our specimens the accessory process is highly flexible. Lewis apparently failed to observe the sexual dimorphism in the maxillipeds.

L. kabatai so closely resembles *L. plectropomi* that only very careful examination will reveal their difference. As observed by Ho and Dojiri they differ in the shape of the sternal furca, shape of the abdomen, second endopod segment of the third leg and in the nature of the claws on the fourth leg. The males can be distinguished by the difference in the second antenna and the dentiform process.

L. kabatai resembles *L. bifidus* Fraser (1920) in the nature of the claws on the fourth leg and *L. hapalogenyos* Yamaguti (1954) in the shape of the second maxilla. It shows close similarity to *L. epinepheli* Ho and Dojiri (1977) in the structure of the first antenna, the sternal furca and the first three pairs of legs. But *L. kabatai* can be distinguished by the two-pronged dentiform process of the first maxilla, the post-antennary process with an acute tip, the maxilliped with an inner distal patch of spinules on the corpus maxillipedis and by the vestigial fifth leg represented by a small projection carrying a single seta and a sclerotised conical projection carrying three plumose setae.

The male of this species can be distinguished from the male of *L. epinepheli* by the structure of the second antenna.

Lepeophtheirus shiinoi sp. nov.

(Figs. 183-202)

Material.—Six ovigerous females and two males from the inner surface of the opercle of *Epinephelus* sp. examined at Trivandrum.

Holotype—female and Allotype-male in the National Zoological Collection at Z. S. I.

Female.—Cephalothorax nearly circular, frontal plates projecting, dorsal transverse suture placed in the middle. Postero-median lobe of cephalothorax twice as broad as lateral lobes and clearly overreaching them. Fourth leg-bearing segment fully exposed and prominently produced laterally. Genital complex swollen, slightly broader than long. Abdomen one-segmented, squarish, with a slight lateral bulge at the base. Uropods with four long and two short setae. Egg tubes stout, shorter than the body.

Basal segment of first antenna massive, inner distal part produced into a bifid process. Second segment of second antenna with a stout digitiform process ; third segment small ; terminal claw relatively large, stout and distally curved, with median spine-like seta and small basal seta. Post-antennary process slightly curved, spine-like. Dentiform process of first maxilla straight, sharp and with a small inner accessory process , basal papilla projecting. Second maxilla slender, brachium broadest in the middle where the flabellum is placed, latter small, divided into two separate parts. Maxilliped feeble ; corpus maxillipedis slender, parallel-sided ; subchela smoothly curved, with slender median barb. Base of sternal furca as long as limbs , latter flat, slightly diverging, with blunt tip and very narrow outer flange.

First leg with a small, conical vestigial endopod surmounted by two small spines ; distal exopod segment armed with three terminal claws of the usual type spine-like seta placed at the inner distal corner ; inner setae well developed. Claws on exopod of second leg strong and straight, first longest and second shortest, all directed outwards , first modified seta large, curved and externally flanged ; second seta longer than first curved in the opposite direction and provided with outer flange and inner hairs. Outer border of endopod segments with a single row of long hairs. Exopod of third leg three-segmented, basal claw slightly curved, apically acute , endopod two-segmented; velum overlapping exopod. Exopod of fourth leg three-segmented ; outer border of last two segments with finely serrate flange ; claws modified into barbed spines, first highly reduced and hook-like, second and third subsimilar ; fourth claw very long, last claw similar to the penultimate but slightly shorter. Fifth leg represented by a conspicuous process bearing three setae placed postero-laterally on the genital complex.

Length.—3.9 mm

Male.—Cephalothorax similar to that of female ; frontal plates comparatively less projecting. Genital complex small, equal in length and width, steadily widening up to the level of the vestigial fifth leg, latter represented by a small process, carrying three terminal and one basal setae. Distal one-fourth of genital complex narrowing backwards, postero-lateral corners carrying vestigial sixth leg consisting of a small process surmounted by three setae. Hind border of genital complex subtruncate. Abdomen one-segmented and rectangular, broader than long. Uropods similar to those of female.

Second antenna highly modified, with elaborate armature , second segment with marginal corrugated pad ; inner margin of third segment with two hook-like claws, a sharp triangular process present at the base of the claws and a small inner distal adhesion pad and a less curved outer distal claw ; terminal claw distally constricted and bent into a sharp claw super imposed by a similar but smaller claw originating at the level of the bend, inner border of terminal claw with a median seta and a small tooth arising close to its base. Accessory process of dentiform process arising from outer margin. An elliptical raised adhesion pad present inner to the dentiform process. Carpus maxillipedis with an inner distal crest of small spinules subchela strong and more curved.

Length.—2.8 mm

Remarks.—A study of the litrature on parasitic copepods reveals that there are several species of *Lepeophtheirus* parasitic on fishes of the family Serranidae and all of them show close similarity in the general shape of the body and in the structure of the first antenna, the post-antennary process, the first maxilla, the maxilliped and the first three pairs of legs. The present species is closest to *L. epinepheli* Ho and Dojiri (1977). Both have identical first and second maxillae, maxillipeds and swimming legs. However, they can be distinguished by the following characters. The genital complex in the present species is swollen and clearly broader than long whereas in *L. epinepheli* it gradually widens backwards and is almost equal in length and width. In *L. epinepheli* the abdomen is half as long as the genital complex but in *L. Shiinoi* it is only one-third as long as genital complex. In addition to the inner distal process, the basal segment of the first antenna of *L. shiinoi* has a small spine-like projection

on the proximal margin. The post-antennary process is more curved than in *L. epinepheli*. The sternal furca of the female of *L. epinepheli* has slightly incurved limbs whereas in the present species the limbs of the sternal furca are slightly diverging.

In the male of *L. epinepheli* the corpus maxillipedis is shown to possess two distal patches of spinules. But in the present species only one patch of spinules is present. In *L. epinepheli* the sternal furca exhibits sexual dimorphism. In the female it is bracket-shaped and in the male the limbs are divergent. The sternal furca in this species does not exhibit sexual dimorphism.

In the overall shape of the body *L. shiinoi* resembles *L. dissimulatus* Wilson (1905) parasitic on *Epinephelus* and *L. rotundiventris* collected and described by Bassett-Smith from the branchial cavity of *Serranus* sp. But *L. shiinoi* can be distinguished from *L. dissimulatus* by the presence of a well developed spine on the first exopod segment of the fourth leg. A detailed comparison of *L. shiinoi* with *L. rotundiventris* is not possible due to lack of detailed information on the latter species.

Genus Hermilius Heller

Hermilius ariodi sp. nov.

(Figs. 203—221)

Material.—Four ovigerous females, one juvenile female and two males from the gills of *Ariodes dussumieri* examined at Trivandrum.

Holotype—female and Allotype-male in the National Zoological Collection at Z.S.I.

Female.—Cephalothorax twice as broad as long when spread out. Frontal plates shallow, projecting, devoid of marginal membrane. Posterior sinuses shallow, wide open. Fourth leg-bearing segment narrow, fully exposed, with a constriction in front of the point of origin of fourth legs. Genital complex dorso-ventrally flattened. Abdomen short, one-segmented, proximally bulged and distally narrow Uropods longer than broad, each with three long and three short plumose setae.

Distal segment of first antenna shorter than basal, latter with a spine at the inner distal corner. Second antenna four segmented ; second segment small , third segment longer than second ; terminal

claw long, distally curved, with a large accessory claw and a proximal tubule carrying small seta. The position of the post-antennary process indicated by three bunches of short hairs. Dentiform process of first maxilla a long apically blunt sclerotised process ; papilla consisting of a moderately projecting base carrying one long and two short setae. Second maxilla very small, two-segmented, segments subequal, brachium comparatively stout, calanus large and feebly pectinate, canna reduced to a short, triangular process continuous with the segment. Maxilliped slender ; corpus maxillipedis parallel-sided, longer than subchela ; subchela straight, distalwards and divisible into a shaft and a claw ; shaft distally carrying a barb and a small tooth. Sternal furca normally developed, limbs proximally broad and diverging, with very broad flange.

Vestigial endopod of first leg an oval spiny lobe terminal claws on exopod long, with inner flange, first claw as long as the exopod itself ; spine-like seta reduced to a short tooth-like process ; inner seta normally developed. Outer claws on exopod of second leg successively increasing in length, first two setae only slightly modified ; first endopod segment with outer distal row of spines, outer border of second and third segments with ventral rows of small spines. Apron of third leg with an outer distal patch of spinules, rami overlapping, basal claw of exopod moderately curved with narrow outer flange ; exopod oblong, one-segmented with outer long seta indicating the line of fusion of the segments, distal end of the ramus with four comparatively short plumose setae ; endopod two-segmented. Sympod of fourth leg slightly longer than exopod, exopod one-segmented with four spine-like claws successively in length, last claw slightly more than half the length of the exopod.

Length:—4.2 mm.

Male.—Cephalothorax not folded, clearly broader than long, with narrow marginal membrane. Postero-median lobe of cephalothorax almost as broad as lateral lobes, slightly overreaching the latter. Fourth leg-bearing segment broader than long, with convex sides. Genital complex nearly elliptical, twice as long as broad. Abdomen one-segmented, longer than broad. Uropod larger than in female.

First antenna as in female. Third segment of second antenna with a proximal transverse and an inner distal projecting adhesion

pad, distal claw strongly falcate; accessory claw strong, shifted towards the proximal part, a spine-like seta present near the base of the accessory claw. Maxilliped stouter than in female, with irregular inner proximal margin, barb at the distal end of the shaft of subchela longer than in female. Sternal furca very much different from that of female, with circular base and long, straight, diverging limbs. A pair of sclerotised processes present in front of and lateral to the sternal furca. Sympod of first leg spiny; terminal outer claw of exopod shorter than ramus; spine-like seta comparatively longer. Exopod of third leg not as broad as in female, basal claw long and slender. Sympod of fourth leg shorter than exopod; first claw over-reaching the base of the second, last claw longer than exopod.

Length.—2.0 mm.

Remarks.—Genus *Hermilius* already contains five valid species, viz. *H. helleri* Pillai (1962b), *H. longicornis* Bassett-Smith (1898c), H. *pyriventris* Heller (1865), *H. tachysuri* Pillai & Natarajan (1977) and *H. youngi* Kabata (1964). The discovery of the present species raises the total number to six. These species fall into two groups. One characterised by the presence of a false joint on the terminal claw of the second antenna and the presence of modified seta on the uropod, and the second, with the terminal claw of the second antenna devoid of a false joint and the uropods carrying unmodified plumose seta. *H. ariodi* falls in the second group along with *H. youngi* Kabata (1964) and *H. longicornis* Bassett-Smith (1898c).

H. ariodi differs from *H. youngi* in the armature of the second maxilla and maxilliped and in the shape of the sternal furca. Further, in *H. youngi* the fourth-leg bearing segment is hidden in the dorsal view by the anterolateral expansions of the genital complex whereas in *H. ariodi* there are no such expansions and the fourth leg-bearing segment is fully exposed. Kabata (1964) has described the rami of the second leg of *H. youngi* as two-segmented. In view of the fact that in all other species this leg has three-segmented rami, it is worth-while to reexamine this limb. The armature of the exopod of the third leg is very different in these two species. Kabata was unable to study the fourth leg but observen that it is one-segmented. In *H. ariodi* it is two-segmented.

H. ariodi differs from *H. longicornis* in the structure of the first antenna, sternal furca, exopod of the third leg and in the armature of the fourth leg.

Rangnekar (1963) described a specimen as *H. longicornis* Bassett-Smith (1898c). Her description generally applies to *H. ariodi* and is much different from that of *H. longicornis* given by pillai (1962). It is likely that her specimen belongs to *H. ariodi*.

Fishes of the family Aridae harbour several species of copepod parasites like, *Hermilius* spp., *Caligus arii* Bassett-Smith (1898c), *C. distortus* Pillai and Natarajan (1977) and *Lepeophtheirus longipalpus* Bassett-Smith (1898c). Though these species belong to three different genera there is surprising similarity in the detailed structure of the legs, especially of the first pair. In all these species the claws on the distal exopod segment of the first leg carry thin inner flange, the like of which is not found in any other caligid. In all, the setae arming the basal segment of the first antenna and the legs are hirsute rather than plumose. All these species exhibit atypical features in many of the appendages, for eg., the extremely slender maxilliped of *C arii* and very peculiar claws on the fourth leg of *L. longipalpus*. Though it is difficult to explain this identity of characters, there is no doubt that the similarity is induced by some character of the host, thus constituting an instance of convergent evolution.

Hermilius helleri Pillai

Figs. 222—231

1962. *Hermilius helleri* Pillai, *J. Zool. Soc. India*, 14 : 187. Fig. 3.

Material.—Fourteen ovigerous females from the gills of *Pseudarius jatius* (Hamilton-Buchanan) examined at Trivandrum.

Female.—Cephalothorax longer than broad, with conspicuous sclerotised ridges on the dorsal surface. Frontal plates narrow, slanting towards the midpoint. Posterior sinuses comparatively deep, wide open. Fourth leg-bearing segment broader than long, visible in the dorsal view. Genital complex swollen, about one and a half times as long as broad, abruptly narrowed at the distal one-third. Abdomen short, two-segmented, segments almost subsimilar. Uropods with the middle three setae modified into claws.

Basal segment of first antenna about twice as long as broad, with short outer setae and a spine at the inner distal corner. Second antenna four-segmented, terminal claw long, curved, with a false joint and carrying an outer proximal seta and a distal accessory claw ; latter carrying a well developed seta at its tip. Position of post-antennary process indicated by three bunches of hairs. Dentiform process of first maxilla a long straight sclerotised process ; papilla composed of a low base carrying three dissimilar setae. Second maxilla short and stout, with subequal segments, calanus stout ; canna small. Subchela of maxilliped indistinctly divided into shaft and claw, former carrying distally a barb and two teeth, latter with a subapical tooth. Limbs of sternal furca parallel, narrowing distalwards and with moderately developed flange.

First leg of the typical structure, sympod spiny. Rami of third leg two-segmented, basal claw of exopod reaching up to the middle of the ramus, apically blunt, with outer flange broken into two parts. Sympod of fourth leg slightly longer than exopod, latter two-segmented, first segment with one and second with three terminal claws successively increasing in length , all the claws apically acute. Fifth sixth legs could not be observed.

Length —3.0 mm.

Remarks.—This species is known from the original description only. From the shape of the genital complex and sternal furca and from the structure of the subchela of the maxilliped and the armature of the fourth leg it is quite clear that the specimens in the present cellectien belong to *H. helleri*. But they differ from the original description in the following characters. The sympod of the fourth leg is slightly longer than the modified setae on the uropods are naked. Another interesting feature noticed in the specimens described here is that the basal segment of the first antenna possesses an inner distal spine. The accessory claw of the second antenna carries an apical setiform process as in *H. longicornis*.

As noted earlier *H. hellari*, *H. pyriventris* Heller (1865) and *H. tachysuri* Pillai & Natarajan (1977) are characterised by the presence of a false joint on the terminal claw of the second antenna and by the presence of modified setae on the uropod, However, *H. helleri* can be distinguished from the other two species by the general shape of the body and by the presence of two teeth on the shaft of the subchela of the maxilliped.

Genus **Anuretes** Heller

Anuretes chelatus sp. nov.

(Figs. 232—243)

Material.—Three ovigerous females from the gills of *Pomacanthodes imperator* (Bloch) examined at Trivandrum.

Holotype—female in the National Zoological Collection at Z. S. I.

Female.—Cephalothorax comparatively large, nearly circular, with a pair of shallow antero-lateral incisions; marginal membrane fairly broad. Frontal plates moderately broad and projecting, with narrow marginal membrane. Longitudinal sutures on the dorsal shield distinct, broken in the middle, transverse suture absent. Postero-lateral lobes hardly one-fourth as broad as median lobe, latter with nearly straight hind border and overreaching the former. Posterior sinuses wide open. Fourth leg-bearing segment normally developed but almost completely overlapped by the postero-median lobe of cephalothorax in front and genital complex behind. Genital complex transversely oblong and slightly broader than postero-median lobe of cephalothorax. Abdomen absent. Uropods small and circular.

Basal segment of first antenna oblong, distal segment shorter than basal. Second segment of second antenna with a conical process bordered by a remarkably broad flange perforated by numerous pores; terminal claw long, slender, distally broadly curved and with a prominent basal seta, a slender spine-like seta and inner proximal accessory process mounted on a prominent projection. Post-antennary process absent, its position indicated by a squarish sclerotised area carrying three bunches of small hairs. First maxilla without dentiform process; basal papilla carrying three setae. Second maxilla of the usual caligid type, brachium slender, longer than lacertus, flabellum normally developed, placed at three-fourths distance from the base; calanus long, jointed near the base and twice as long as canna. Maxillary whip represented by a highly muscular, finger-like, apically blunt process. Maxilliped very large, proximal part of corpus maxillipedis highly swollen, distal part narrow, myxa represented by a shelf-like projection; subchela rather short and stout, moderately curved and with a stout median seta. Sternal furca with a circular base and short, flat, diverging, apically spatulate limbs.

First leg of the typical structure ; vestigial endopod narrow and three-segmented ; spine-like seta on distal segment of exopod placed between second and third claws. First exopod segment of second leg with a huge outer claw , claw of second segment slightly curved and smaller than first, both extending far beyond the third segment ; third claw minute ; first modified seta stout and claw-like , second seta externally flanged and internally hairy. Rami of third leg one-segmented but unlike as is usual placed apart. Exopod with a medium sized straight basal claw outer three setae spine.like, subsimilar, fourth seta very long ; velum represented by a circular lobe. Sympod of fourth leg shorter than exopod, latter one-segmented, narrowing distalwards and carrying three long, barbed, spine-like claws, first claw placed at three-fourths distance from the base, inner terminal claw equal in length to the ramus and swollen at its base. Fifth leg represented by three setae on the postero-lateral part of genital complex.

Length.—2.4 mm

Male.—Cephalothorax similar to that of female. Genital complex small. Abdomen one-segmented, projecting beyond the genital complex.

Second segment of second antenna without posteriorly directed process ; third segment nearly rectangular, with a distal crescentic projection ; terminal claw short, not lobed, with stout basal part and slender curved distal claw carrying an outer median spine-like seta. Myxa on corpus maxillipedis nearly triangular, more sharp and projecting than in female. Vestiges of fifth and sixth legs represented by one short and five long plumose setae on the postero-lateral part of the genital complex. Other appendages as in female.

Length.—2.0 mm

Remarks.—In the general shape of the body this species resembles. *A. anomalus* Pillai (1967b) but is different in practically every other character of importance.

The presence of an accessory claw on the terminal claw of the second antenna is unusual in *Anuretes* but characteristic of *Pseudanuretes.* In addition to this charactor, the shape of the terminal claw of the second antenna as well as the posteriorly directed process on its second segment, the absence of the post-antennars process and the

dentiform process of the first maxilla, the shape of the maxillary whip, the shape of the limbs of the sternal furca. presence of stout claws on the exopod of the second leg, the widely separated rami of the third leg and the two-segmented fourth leg distinguish this species frcm its congeners. *A. rotundus* Prabha & Pillai (1983) and *A. chelatus* sp. nov. are both parasites of *Pomacanthodes imperator* (Bloch), the former inhabiting the nasal cavities and the latter the gill filaments. The wide difference in the external morphology of these two species is obviously dependent on the difference in the habitat.

Anuretes hoi sp. nov.
(Figs. 244-254)

Material—Eleven ovigerous females from the gill filaments of *Spilotichthys pictus* (Thunburg) examined at Trivandrum.

Holotype—female in the National Zoological Collection at Z. S. I.

Female.—Cephalothorax nearly circular, with a pair of antero-lateral indentations continuous with the dorsal longitudinal sutures, transverse suture distinet ; cephalic area subequal to thoracic in length. Postero-median lobe of cephalothorax more than twice as broad as lateral lobes and slightly overreaching them. Posterior sinuses wide open. Fourth leg-bearing segment broader than long, clearly visible in the dorsal view. Genital complex small and globular. Abdomen visible as a small bilobed projection on the postero-median part of genital complex. Uropods small, broader than long with six plumose setae of varying length and a long fleshy non-plumose seta placed in the middle.

Basal segment of first antenna enormous, more than twice as long as distal, distal segment roughly elliptical and slightly swollen at the tip. Second segment of second antenna with a sharp posteriorly directed process, third segment longer than broad, terminal claw strongly curved, with well developed median and basal setae. Post-antennary process curved and blunt with three bunches of short hairs associated with its base. Dentiform process of first maxilla slender, straight, basal papilla composed of a nodule carrying the usual three setae. Lacertus of sccond maxilla stout, subequal to brachium in length, latter slender, with a characteristic hump at two-thirds its distance from the proximal end, flabellum small, calanus two and a half times as long as canna ; former with a basal joint, latter pectinate

Maxillary palp a long, apically bifid, fleshy process. Corpus maxillipedis massive, myxa represented by a sharp conical process ; subchela short but stout, with sharp grooved tip. Sternal furca with semicircular base and slightly diverging, apically rounded limbs.

Vestigial endopod of first leg comparatively long, narrowing distalwards, with hairy outer border and an apical spine, distal segment of exopod armed with three terminal claws, a spine-like seta and three stout setae on the inner border. First exopod segment of second leg with a stout claw overreaching the third segment ; second segment short, only half the size of the third segment, with rather straight outer claw, latter slightly constricted at the distal one-third and extending clearly beyond the first claw , third claw minute ; first modified seta naked, with swollen base and curved pointed tip, second seta externally flanged, outer border of second endopod segment with a single row of spinules. Rami of third leg one-segmented, basal claw of exopod slender, straight, exopod broader than long, with three outer spine-like setae and four inner setae, third spine-like seta very long and whip-like ; endopod one-segmented, velum small. Sympod of fourth leg shorter but broader than exopod ; exopod two-segmented, with four strong claws successively increasing in length. Fifth leg represented by a single seta. Sixth leg a large, dorso-ventrally flattened lobe carrying one inner dorsal plumose seta, two outer plumose setae and a non plumose elongated stout process placed at the outer distal corner.

Length.—2.1 mm

Remarks.—In the general shape of the body and in the overall structure of the appendages the three species of *Anuretes* namely *A. hoi*, *A. plectorhynchi* Yamaguti (1936) and *A. yamagutii* sp. nov. *(vide infra)*, parasitic on *Spilotichthys pictus* (Thumburg) show close resemblance. However, *A. hoi* can be distinguished from the other two species by the globular shape of the genital complex, the non-plumose seta on the uropod and vestigial sixth leg and by the elongate apically bifid, maxillary whip.

Anuretes plataxi sp. nov.

(Figs. 255-267)

Material.—Three ovigerous females from the nasal cavity of *Platax teira* (Forskal) examined at Trivandrum.

Holotype—female in the National Zoological Collection at Z. S. I.

Female.—Cephalothorax large, longer than broad and gradually widening backwards. Its antero-lateral regions with a pair of incisions continued inwards as a pair of longitudinal ridges ; dorsal transverse ridge incomplete. Frontal plates moderately broad and projecting, marginal membrane of cephalothorax and frontal plates of average width. Posterior sinuses shallow and wide open. Postero-median lobe of cephalothorax twice as broad as and clearly overreaching lateral lobes ; its posterior border straight, slightly overlapping the anterior margin of genital complex and hiding the fourth leg-bearing segment completely in dorsal view. Genital complex comparatively small, transversely oblong. Abdomen fused with the genital complex, visible postero-dorsally as a distally bilobed conical projection. Uropods with two long and three short setae.

Basal segment of first antenna large, almost squarish, with a blunt, finger-like inner distal spine ; distal segment short and stumpy Posteriorly directed sclerotised process on second segment of second antenna strong and sharp ; third segment as long as broad ; terminal claw strong, distally curved at right angles, with a small median spine-like seta. Post-antennary process absent but three bunches of hairs present. Dentiform process of first maxilla triangular, with broad base and pointed tip basal papilla shifted a little anteriorwards. Second maxilla with slender subequal segments, brachium unusually slender, calanus almost twice as long as canna, latter short and pectinate, originating far behind the former. Corpus maxillipedis gradually narrowing distalwards, with nearly straight inner border, subchela short, moderately curved, with weak barb. Base of sternal furca broad, roughly semicircular, limbs very slightly diverging, flattened and apically rounded.

Vestigial endopod of first leg three-segmented, swollen at the base and narrowing distalwards and with a pair of spinules at the junction of the first and second segments ; exopod without any special feature. First claw on the exopod of second leg stout and barbed, overreaching third segment claw on second segment shorter, slightly curved and reaching the tip of the first ; third claw stout, first modified seta claw-like, with outer membranous flange and inner hairs ; endopod segments with hairy outer border. Rami of third leg overlapping, exopod large, one-segmented, with seven setae, fourth seta

comparatively very long, basal claw unusually stout, endopod two-segmented, second segment with four plumose setae. Sympod of fourth leg longer than exopod, latter two-segmented ; claw modified into slender curved spines, each with a basal joint ; first four spines successively increasing in length, last twice as long as the penultimate claw. Vestigial fifth leg represented by a small process carrying a single seta and a larger conical projection carrying three setae.

Length.—3.0 mm.

Remarks.—*A. rotundus* Prabha and Pillai (1983) is the only species of *Anuretes* so far known to inhabit the nasal fossae of fishes. In the general morphology, *A. rotundus* differs from the typical conditions but surprisingly, *A. plataxi* shows no such transformation. *A. plataxi* can be casily distinguished by the median lobe of its cephalothorax which overlaps the genital complex, the stout basal segment of the first antenna the slender distal segment of the second maxilla and the shape of the exopod of the third leg, particularly its very stout basal claw.

Anuretes plectorhynchi Yamaguti

(Figs. 268—276)

1936. *Anuretes plectorhynchi* Yamaguti, Private publication, 15, Figs. 172-185.

1963. *Anuretes plectorhynchi* Yamaguti, *Parasitic Copepoda and Branchiura of Fishes*, 68, Fig. 5.

Material.—Nine ovigerous females from the gills of *Spilotichthys pictus* (Thunburg) examined at Trivandrum.

Female.—Cephalothorax slightly broader than long, with subtruncate hind border, antero-lateral margin with a pair of indentations continuous with the dorsal longitudinal sutures, transverse suture incomplete. Postero-median lobe of cephalothorax twice as broad as lateral lobes and overreaching them. Postero-lateral lobes curving inwards but not closing the posterior sinuses. Fourth leg-bearing segment well developed, almost completely hidden by the postero-median lobe of cephalothorax and the genital complex. Genital complex swollen transversely elliptic, abdomen represented by a small postero-dorsal projection, not extending beyond the genital complex. Uropods with three long and three short plumose setae.

Basal segment of first antenna large, more than twice as long as distal ; distal segment short and stumpy. Second segment of second antenna with a sharp, wedge-shaped process ; third segment squarish, terminal claw slender, distally bent at right angles, with a median, slender spine-like seta. Post-antennary process an evenly curved claw, with three bunches of hairs associated with its base. Dentiform process of first maxilla well developed, triangular with broad base and rather straight, sharp process with a sclerotised conical process behind ; basal papilla of the usual type. Brachium of second maxilla longer and more slender than lacertus ; flabellum small, placed at two-thirds distance from the proximal end ; calanus twice as long as canna, former proximally broad, latter shifted backwards. Maxillary whip a stout, fleshy, conical process carrying a pair of setiform processes, two-thirds as long as base. Corpus maxillipedis steadily narrowing distalwards, myxa represented by a step-like projection, the border beyond myxa concave, subchele unusually short, heavily sclerotised and apically acute, with a median barb. Limbs of sternal furca slightly divergent and apically spatulate.

Sympod of first leg with a long outer distal plumose seta vestigial endopod a thin elongated lamina with an apical spine and hairy lateral margin , first segment of exopod less than half as broad as long, second segment with three terminal claws, one spine-like seta placed between second and third claws and three inner plumose setae. Outer claw of first exopod segment of second leg very stout and nearly straight, extending beyond the third segment , second claw reaching the tip of the first, slightly constricted at one-third distance from base, the portion beyond constriction slender and more curved ; claw of third segment reduced to a spine ; first modified seta stout, wedge-shaped and bilaterally flanged ; outer border of endopod segments hairy. Apron of third leg broad, rami small, placed close to each other, basal claw of exopod straight, segment proper somewhat rectangular, with three outer spine-like setae, third spine-like seta very long ; endopod one-segmented , velum very slightly overlapping exopod. Sympod of fourth leg shorter but stouter than exoped ; latter two-segmented, with four spine-like claws. Fifth leg represented by a single seta situated postero-laterally on the genital complex. The process representing sixth leg larger than exopod, flat ane roughly rectangular, carrying three plumose setae and a long fleshy, non-plumose seta.

Length.—1.8 mm

Remarks.—The present material was collected from the type host, namely, *Spilotichthys pictus* (Thunburg) (= *Plectorhynchus pictus* Thunburg). In the overall shape of the body it agrees so perfectly with Yamaguti's original description that there is no doubt about the identity of the species. But Yamaguti's description lacks several interesting features observed in the detailed structure of the appendages. Yamaguti has shown the cephalothorax an steadily narrowing forwards. In our material it is nearly circular. Yamaguti has shown the abdomen as projecting beyond the genital complex. In our specimens it does not project. Yamaguti failed to locate the maxillary whip which in this species is of a very characteristic shape. Yamaguti also failed to detect the conical, sclerotised process situated posterior to the dentiform process of the first maxilla. The maxilliped also is very much different in shape from that Yamaguti illustrated. The spine-like seta on the distal exopod segment of the first leg is shorter. Instead of a rudimentary spine the sixth leg has a long fleshy naked seta.

Since there are two more species of *Anuretes* parasitic on the same host and showing very close similarity to *A. plectorhynchi* in the shape of the body and in the detailed structure of the appendages, information about the fine structure of the appendages is necessary to make specific identification possible.

The diagnostic features of the species are the shape of the cephalothorax, the presence of a conical selerotised process posterior to the dentiform process of the first maxilla, the structure of the maxilliped and the presence of a non-plumose, fleshy seta on the vestigial sixth leg.

Anuretes rutundus Prabha and Pillai

(Figs. 277-280)

1983. *Anuretes rotundus* Prabha and Pillai, *Rec. Zool. Survey of India*, 46 : 26, Figs. 133-144.

Material.—Two females and two males from the nasal lamallae of *Pomacanthodes imperator* (Bloch) examined at Trivandrum.

Allotype —male in the National Zoological Collection at Z. S. I.

Male.—Cephalothorax similar to that of female, its submarginal ventral part with a row of transversely placed short selerotised ribs. Genital complex transversely oval. Abdomen more projecting than in female.

Second segment of second antenna more clearly defined, with an adhesion pad ; third segment with major part of its ventral side covered with broad adhesion pads, inner margin with two sets of closely packed strong teeth. Dentiform process of first maxilla poorly developed, represented by a triangular sclerotised plate carrying a flange on one side. Vestigial fifth leg represented by four setae, one of them placed far in front of the others ; sixth leg represented by two setae, shorter than those of fifth.

Length:—1.2 mm

Remarks.—The female of this species has been described in detail by Prabha and Pillai (1983) It exhibits several peculiarities not found in any other member of the genus. This is certainly due to the effect of its special habitat.

An interesting feature found in the male of this species is the presence of transverse sclerotised ribs at the submarginal ventral part of the cephalothorax. The second antenna is also very characteristic. The rows of teeth found on the third segment of the second antenna are unique. Something even remotely resembling this has not been observed in any other caligid except perhaps in the males of *Lepeophtheirus* spp.

Anuretes serratus Shiino

(Figs. 281-287)

1954. *Anuretes serratus* Shiino, *Rep. Fac. Fish. Pref. Univ. Mie,* 1 : 260, Figs. 1 & 2.

1964. *Anuretes serratus,* Lewis, *Proc. U. S. natl. Mus.*, 115 : 188, Figs. 13a-n, 14a-f.

Material.—One ovigerous female from the body surface of *Siganus javus* (Linnaeus) examined at Trivandrum.

Female.—Cephalothorax elliptical, with two pairs of long lateral marginal setae, membranous flange broad. Frontal plates moderately broad and projecting, with narrow flange. Dorsal transverse and

longitudinal sutures of cephalothorax inconspicuous, cephalic area longer than thoracie. Postero-median lobe of cephalothorax more than twice as broad as lateral lobes and slightly overreaching them, latter curving inwards but not closing the posterior sinuses, fourth legbearing segment broad, partially concealed by the median lobe of cephalothorax. Genital complex transversely oblong. Abdomen short, fused with the genital complex but not projecting. Uropods very large, pyriform, with four long and two short plumose setae.

Basal segment of first antenna broad, with sparsely setose outer margin. Second segment antenna with a triangular process, third segment longer than broad, terminal claw suddenly constricted in the middle and distally curved forming a hook. Postantennary process short, roughly triangular, with three bunches of hairs associated with its base. Dentiform process of first maxilla asymmetrically bifid, papilla very small, with short setae mounted on a small tubercle. Second maxilla long and slender ; lacertus feeble, flabellum very small, placed in the middle, calanus twice as long as canna, latter placed a little behind the former. Maxilliped comparatively feeble, corpus maxillipedis slender, subchela with very small barb. Sternal furca absent.

First leg normally developed ; first terminal claw of exopod serrate on inner margin, second and third claws bilaterally dentate , spine-like seta placed at the inner distall corner ; inner plumose setae short. First claw of exopod of second leg stout and curved, with four strong outer accessory claws ; second claw simple and stout, third similar to second but shorter ; first modified seta short and laminate ; second seta long, with outer flange and inner hairs. Rami of third leg one-segmented and overlapping, basal claw of exopod exoped large, not strongly sclerotised , outer three setae jointed and spine-like, fourth seta very large, inner four setae very short , endopcd with five setae ; velum overlapping exopod. Fourth leg very characteristic, sympod slender , exopod two-segmented, first segment, first segment with a strong straight claw, second segment distally broadened, with four terminal claws, outer three claws short, last claw very long, with a basal joint. Fifth leg represented by two small tubercles, proximal carrying one and distal three setae.

Length.—1.7 mm.

Remarks—Fishes of the family Acanthuridae alone are known to harbour this species and this is the first record of this species from this locality.

A. serratus has been described in detail by Shiino (1954c) and Lewis (1964). According to Lewis the papilla of the first maxilla consists of a pair of nodules, each bearing several setules. But in our specimen the papilla is normal, consisting of a single nodule bearing three setae as shown by Shiino. Earlier descriptions do not give an accurate picture of the post-antennary process. It is a triangular process with broad base and pointed tip. We could not observe the accessary process at the base of the subchela of the maxilliped described by carlier authors. According to Lewis the subchela lacks the spinule reported by Shiino but its distal portion carries minute denticulations. In our specimen the spinule is present but the denticles are absent. Shiino has illustrated seven accessary spines on the first exopod claw of the second leg. According to Lewis there are six spines in the female and eight in the male. In our female specimen this claw carries only four accessory spines.

Generally the abdomen in *Aruretes* spp. is highly reduced. But this tagma of the body shows maximum development in *A. serratus*.

In the structure of the exopod of the second leg and in the shape of the uropods this species resembles *A. shiinoi* Prabha and Pillai (1983). The diagnostic features of *A. serratus* include the general shape of the body, the peculiar structure of the claws on the exopod of the first and second legs, the structure of the fourth leg and the shape of the uropod.

Anuretes yamagutii sp. nov.

(Figs. 288-297)

Material.—Five ovigerous females from the gills of *Spilotichthys pictus* (Thunburg) examined at Trivandrum.

Holotype.—female in the National Zoological Collection at Z. S. I.

Female.—Cephalothorax elliptical, with indistinct antero-lateral incisions. Dorsal longitudinal sutures distinct, transverse suture indistinct ; cephalic area longer than thoracic. Postero-median lobe of cephalothorax twice as broad as lateral lobes, both extending upto the same level. Posterior sinuses open. Fourth leg-bearing

segment partly hidden by the adjacent tagmata. Genital complex transversely oblong, two-thirds as broad as cephalothorax. Abdomen extremely short and fused with the genital complex but projecting. Uropods small, with six plumose setae. Egg tubes short and stout.

Basal segment of first antenna massive, longer than broad, outer distal setae reaching the tip of the distal segment, distal segment short and cylindrical. Second segment of second antenna with a straight, blunt and bilaterally flanged process, third segment longer than broad, distally narrowed; terminal claw slender and distally curved, with a basal and a median seta. Post-antennary process curved, apically blunt, with three bunches of minute hairs on its base. Dentiform process of first maxilla well developed, straight and narrowing distalwards, basal papilla far removed from the dentiform process, consisting of a small base carrying three slender setae. Second maxilla with stout lacertus, brachium slender, suddenly narrowed beyond the flabellum. Maxillary whip situated away from the base of the second maxilla, composed of a conical stout base and two identical setae, shorter than the base Corpus maxillipedis massive, with rather straight inner margin, subchela modified into a strong falcate claw. Sternal furca with broad base and slightly divergent, saptulate limbs.

Vestigial endopod of first leg slender and two-segmented, first segment with hairy margin; first segment of exopod with a slight dorsal hump, second and third claws on distal segment lacking accessory spine, flanged along the inner border, spine-like seta situated between second and third claws. First claw on exopod of second leg enormously developed, with broad serrate flange, almost reaching the distal margin of third segment; second segment broader than long, its claw similar to the preceding one but shorter, third segment longer than broad, with a spine-like claw first modified seta laminate, flanged, with unusually broad base and pointed tip; second seta with outer flange and inner hairs, second endopod segment of second leg about twice as long as third, it's outer border with a single row of minute hairs. Rami of third leg one-segmented, placed close to each other; basal claw of exopod comparatively strong and sharp, exopod broad, carrying four outer spine-like setae and five inner setae, endopod nearly circular, carrying the usual six setae, velum small. Sympod of fourth leg shorter than exopod, exopod two-segmented, with four barbed

spine-like claws, first claw overreaching the base of the second, last claw one and a half times as long as the penultimate. Fifth leg represented by a single plumose seta arising from the postero-lateral border of the genital complex. Sixth leg composed of a flattened process carrying three plumose setae.

Length.—2.1 mm.

Remarks.—As noted earlier *A. yamagutii* shows very close resemblance to *A. hoi* sp. nov. and *A. plectorhynchi* Yamaguti. But it differs from *A. hoi* in the shape of the genital complex, in the absence of non-plumose setae on vestigial sixth leg and uropod, in the structure of the maxillary whip and in the absence of myxa on corpus maxillipedis.

A. yamagutii can be distinguished from *A. plectorhynchi* by the shape of the body and by the absence of certain structures like, sclerotised process posterior to the dentiform process of the first maxilla, myxa on corpus maxillipedis and non-plumose setae on vestigial sixth leg.

Genus **Pseudanuretes** yamaguti

Pseudanuretes indicus sp. nov.

(Figs. 298-306)

Material.—One ovigerous female from the gills of *Pomacanthodes imperator* (Bloch) examined at Trivandrum.

Holotype.—female in the National Zoological Collection of Z. S. I.

Female.—Cephalothorax oblong in outline, posteriorly truncate, marginal membrane narrow. Frontal plates shallow, not projecting, with broad membranous flange. Dorsal transverse and longitudinal sutures inconspicuous. Postero-median lobe of cephalothorax broad, lateral lobes very narrow, former overreaching latter. Posterior sinuses nearly absent. Fourth leg-bearing segment and part of genital complex concealed by the postero-median lobe of cephalothorax. Genital complex very small, broader than long, its distal ventral part with three pairs of non-plumose setae and patches of spinules placed inner to the point of attachment of egg tubes. Egg tubes comparatively short and stout.

Distal segment of first antenna slightly shorter than basal, latter with slender outer seta. Second segment of second antenna with a large, curved, apically blunt process ; third segment longer than broad, terminal claw apically curved into a hook and with a strong inner proximal accessory claw. Post-antennary process absent, its position indicated by four bunches of short hairs. First maxilla without dentiform process ; basal papilla consisting of a projecting base carrying three setae. Second maxilla with subequal segments, lacertus stouter than brachium, flabellum absent, terminal processes naked, calanus twice as long as canna. Maxillary whip long and tapering. Maxilliped massive, corpus maxillipedis large, without any armature, subchela short and distally curved, with an inner proximal barb. Sternal furca absent.

First leg with the usual armature, distal exopod segment with three terminal claws, a spine-like seta placed between second and third claws and three inner plumose setae, vestigial endopod an elongated process carrying an apical spine. First exopod claw of second leg stout and straight, overreaching third segment , second claw shorter and slightly curved, both claws feebly pectinate ; third claw not observed , first modified seta claw-like, shorter than the claw of second segment, second modified seta with outer flange and inner hairs, outer border of endopod segments hairy. Rami of third leg one segmented, basal claw of exopod sharp and straight, outer two setae on exopod jointed, third seta much longer. Fourth leg stout, sympod subequal to exopod in length, latter one-segmented with two terminal and one subterminal spine-like claws. Vestigial fifth leg represented by a single plumose seta and sixth leg by three plumose setae on the postero-ventral part of genital complex.

Length.—1 1 mm.

Remarks.—This species can be distinguished from the remaining four species of *Pseudanuretes* by the presence of a curved apically blunt process on the second segment of the second antenna and by the comparatively well developed fourth leg possessing one subterminal and two terminal spine-like claws on the exopod.

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REG. NOS. OF THE TYPE SPECIES

1 *Caligus callyodoni* n. sp. Regd. No. ZSI, Calcutta C3636/2

2. *C. Kirtii* n. sp. Regd. No. ZSI, Calcutta C3637/2—C3638/2

3. *C. pomadasi* sp. nov. Regd. No. ZSI, Calcutta C3639/2

4. *Lepeophtheirus shiinoi* sp. nov. Regd. No. ZSI, Calcutta C3642/2

5. *Hermilius ariodi* sp. nov. Regd. No. ZSI, Calcutta C3643/2

6. *Anuretes chelatus* sp. nov. Regd. No. ZSI, Calcutta C3645/2

7. *A. hoi* sp. nov. Regd. No. ZSI, Calcutta C3647/2

8. *A. plataxi* sp. nov. Regd. No. ZSI, Calcutta C3648/2

9. *A. rotundus* sp. nov. Regd. No. ZSI, Calcutta C2898/2

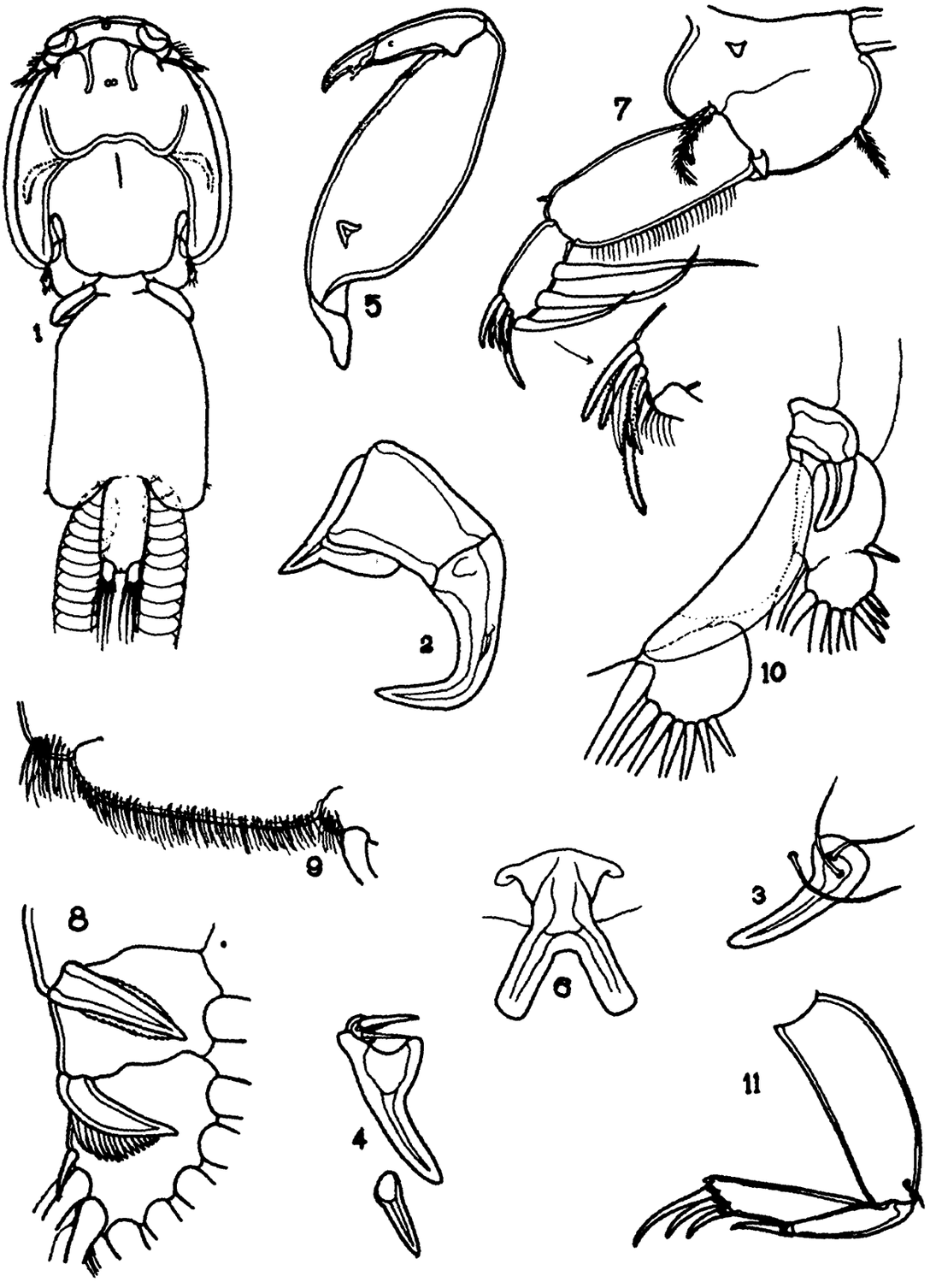
10. *A. yamagutii* sp. nov. Regd. No. ZSI, Calcutta C3650/2

11 *Pseudanuretes indicus* sp. nov. Regd. No. ZSI, Calcutta C3651/2

FIGURES

Figs. 1-11. *Caligus amblygenitalis* Pillai. Female.

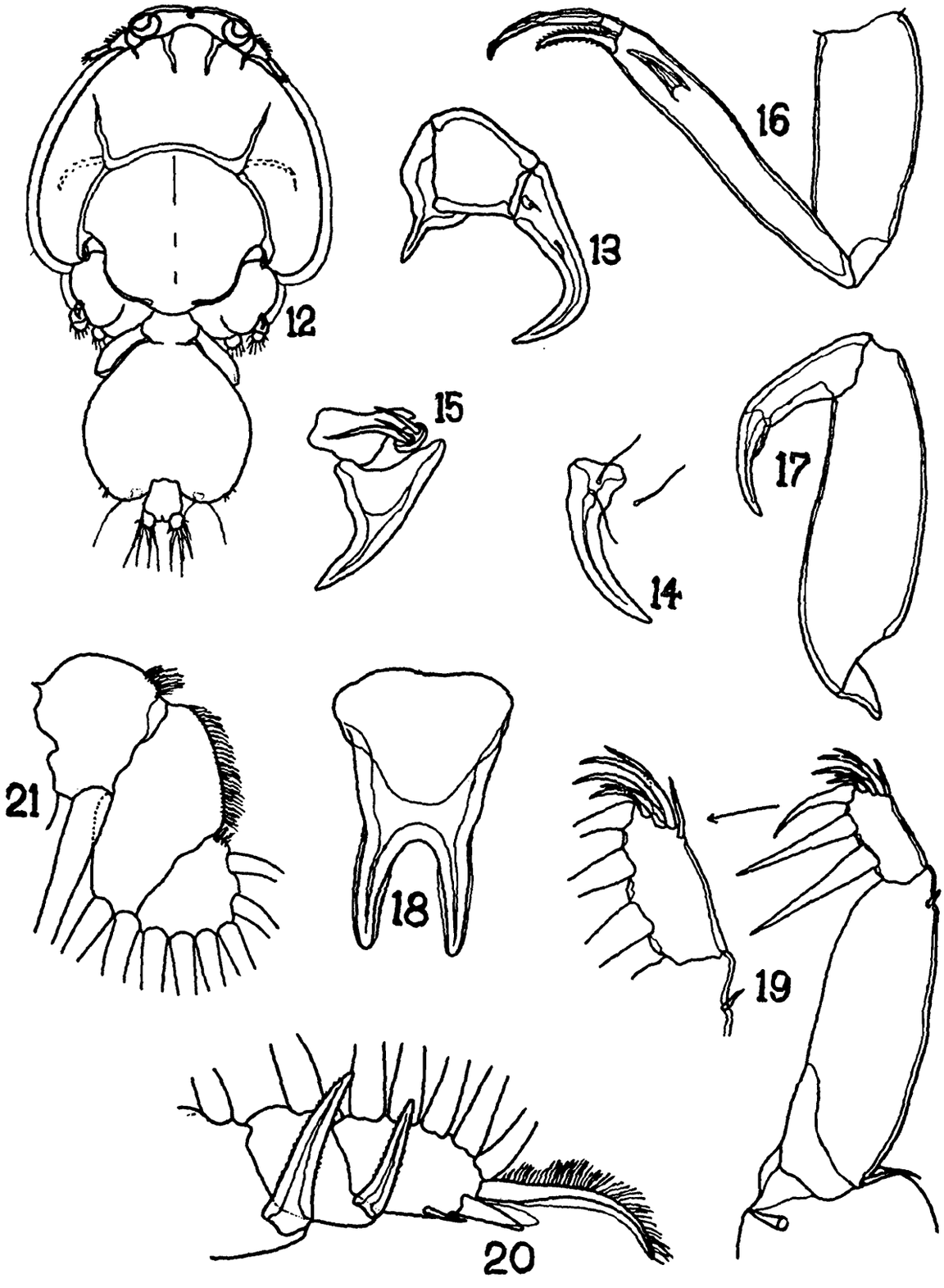
1. Female, dorsal view ; 2. Second antenna ; 3. Postantennary process ; 4. First maxilla and sclerotised process ; 5. Maxilliped ; 6. Sternal furca ; 7. Legi ; 8. Leg 2 ; 9. exopod ; 9. Same, endopod ; 10. Leg 3 ; 11. Leg 4.



Figs. 1-11

Figs. 12-21 *Caligus callyodoni* sp. nov. Female.

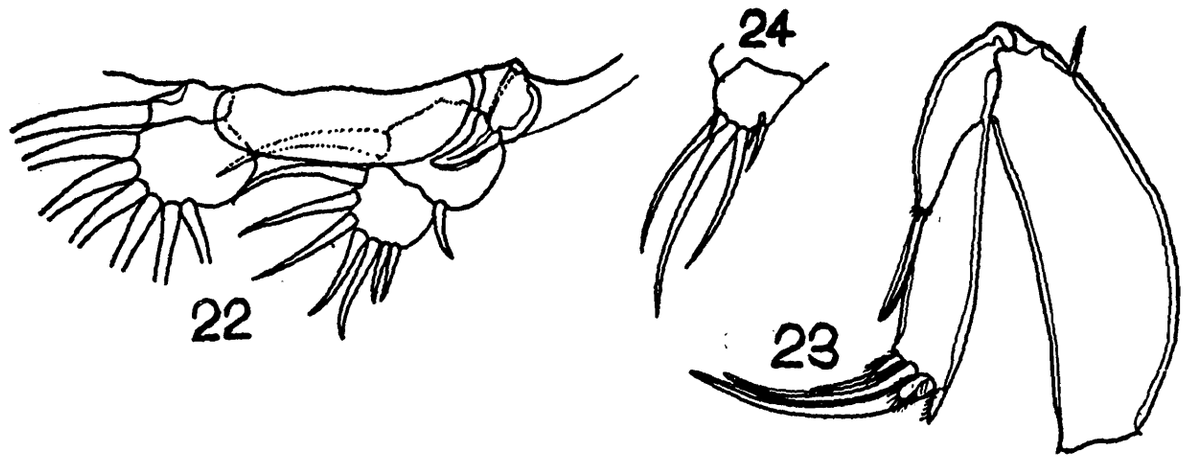
12. Female, dorsal view ; 13. Second antenna ;
14. Postantennary process ; 15. First maxilla ;
16. Second maxilla ; 17. Maxilliped ; 18. Sternal furca ;
19. Leg 1 ; 20. Leg 2; exopod ; 21. Same, endopod.



Figs. 12-21

Figs. 22-24 *Caligus cailyodoni* sp. nov. Female.

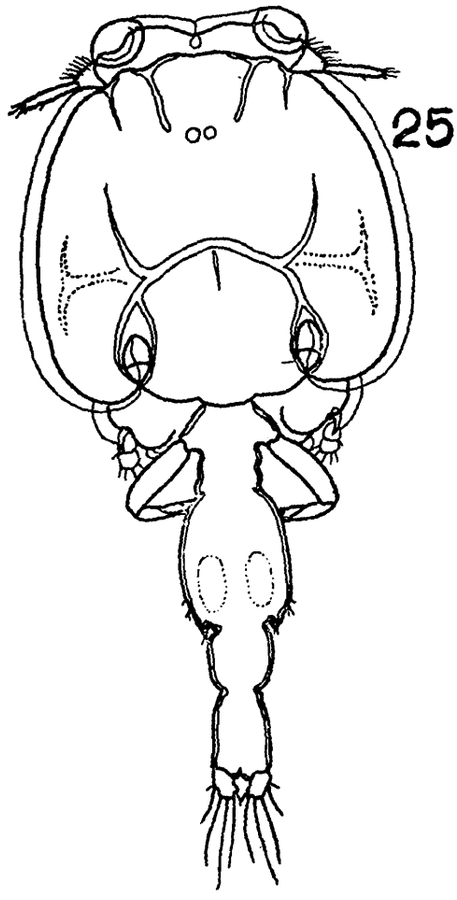
22. Leg 3 ; 23. Leg 4 ; 24. Uropod.

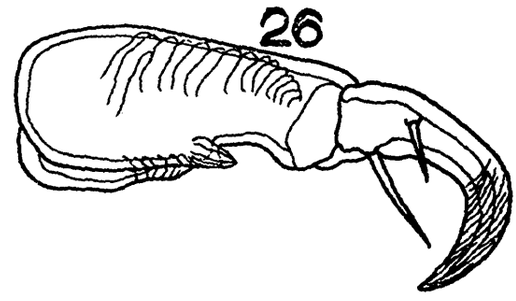


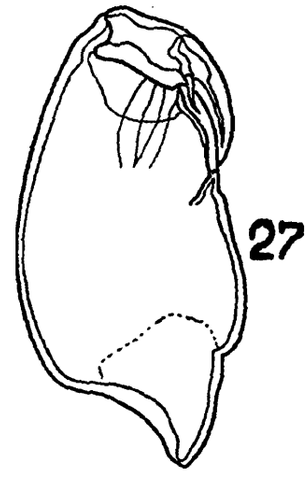
Figs. 22-24

Figs. 25-27. *Caligus constrictus* Heller. Male,

25. Male, dorsal view ; 26. Second antenna ;
27. Maxilliped ;



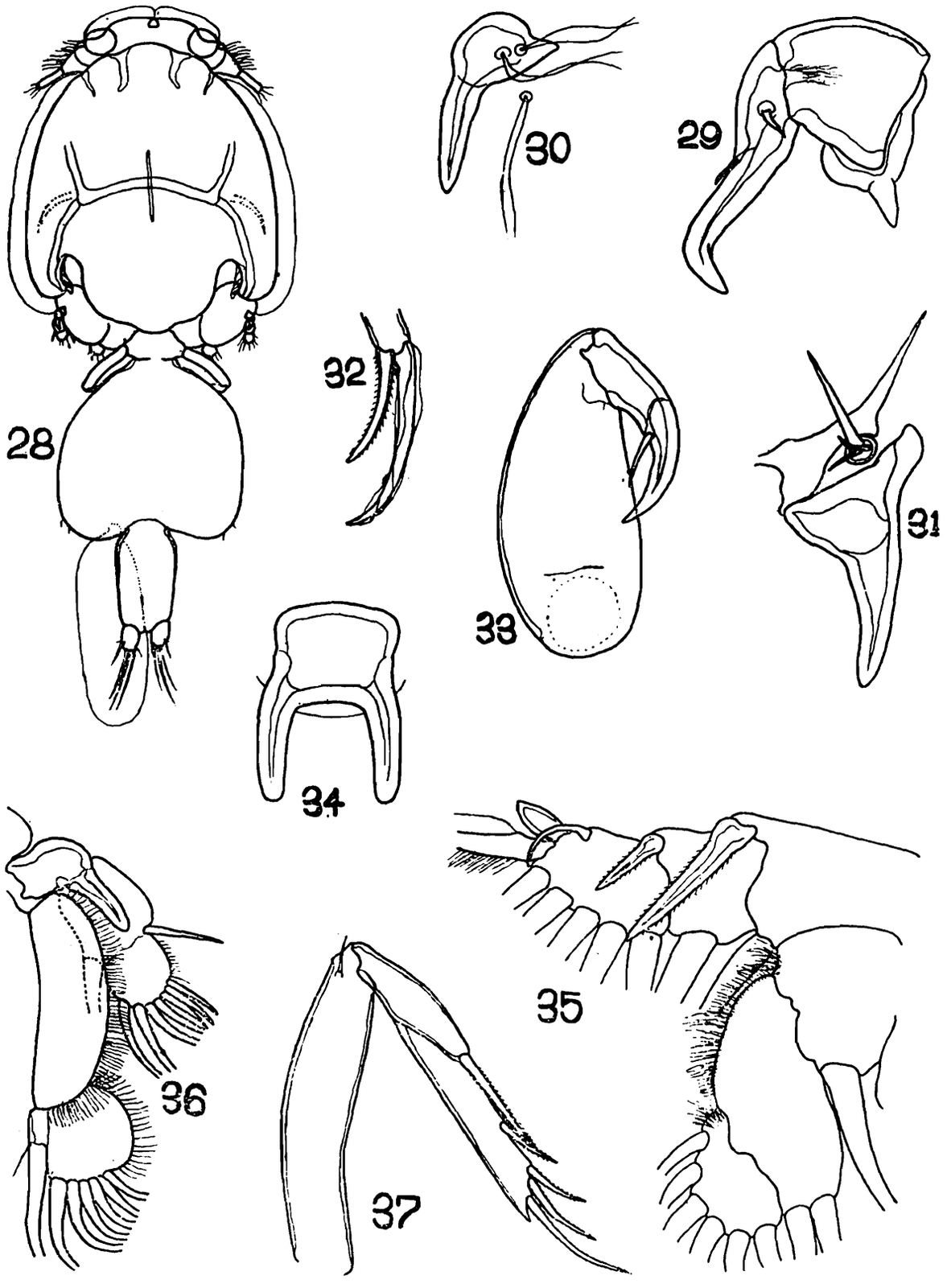




Figs. 25-27

Figs. 28-37 *Caligus elongatus* Nordmann. Female.

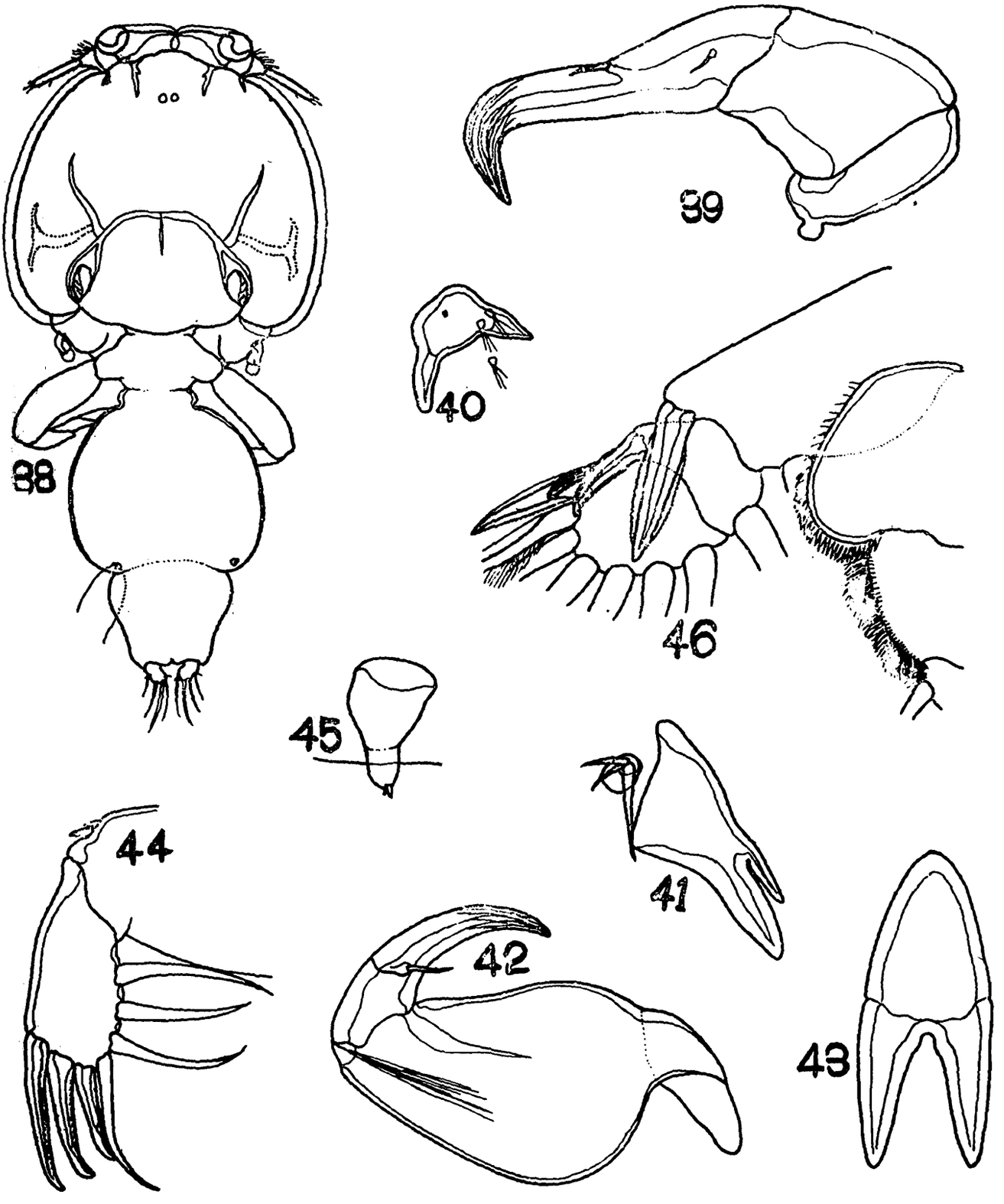
28. Female, dorsal view ; 29. Second antenna ; 30. Postantennary process ; 31. First maxilla ; 32. Tip of second maxilla ; 33. Maxilliped ; 34. Sternal furca ; 35. Leg. 2 ; 36. Leg 3 ; 37. Leg 4.



Figs. 28-37

Figs. 38-46. *Caligus fortis* Kabata. Female.

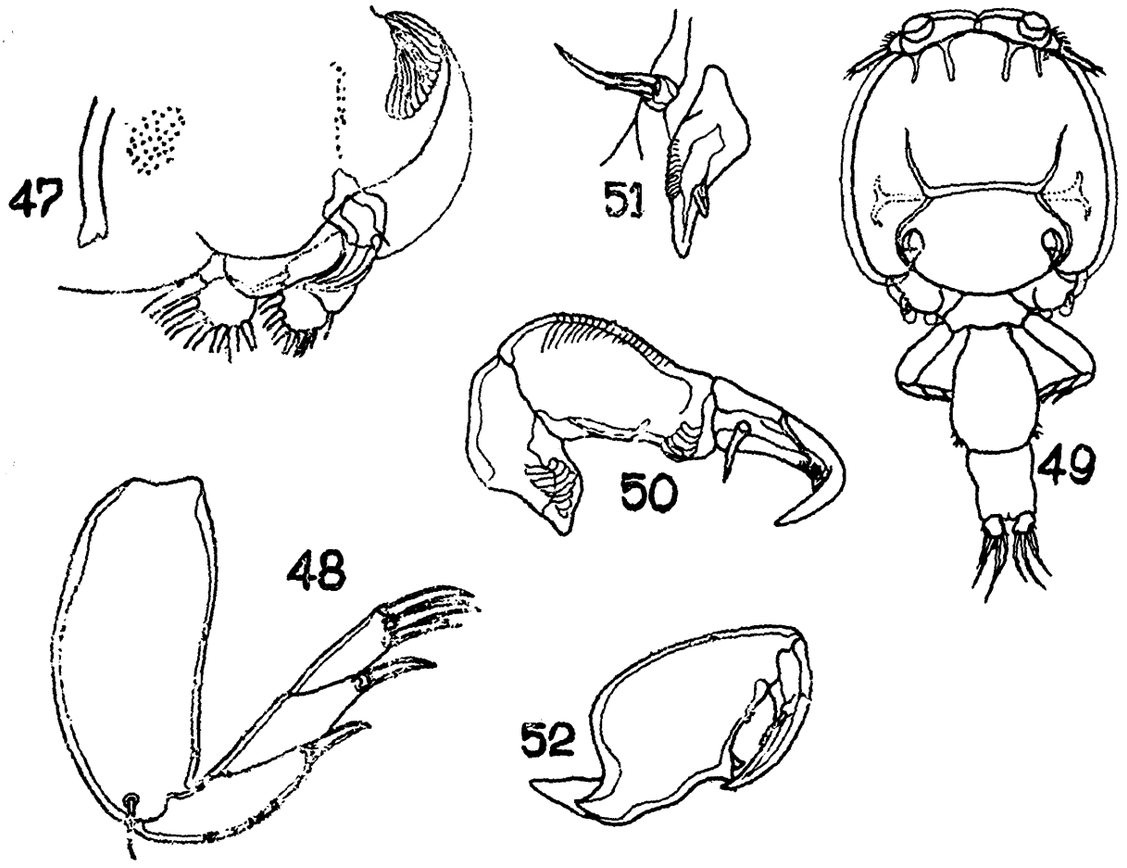
38. Female, dorsal view ; 39. Second antenna ; 40. Postantennary process ; 41. First maxilla ; 42. Maxilliped, 43. Sternal furca ; 44. Leg 1, tip of exopod ; 45. Same, endopod, 46. Leg. 2.



Figs. 38-46

Figs. 47-52. *Caligus fortis* Kabata. 48. Female ; 49-52. Male.

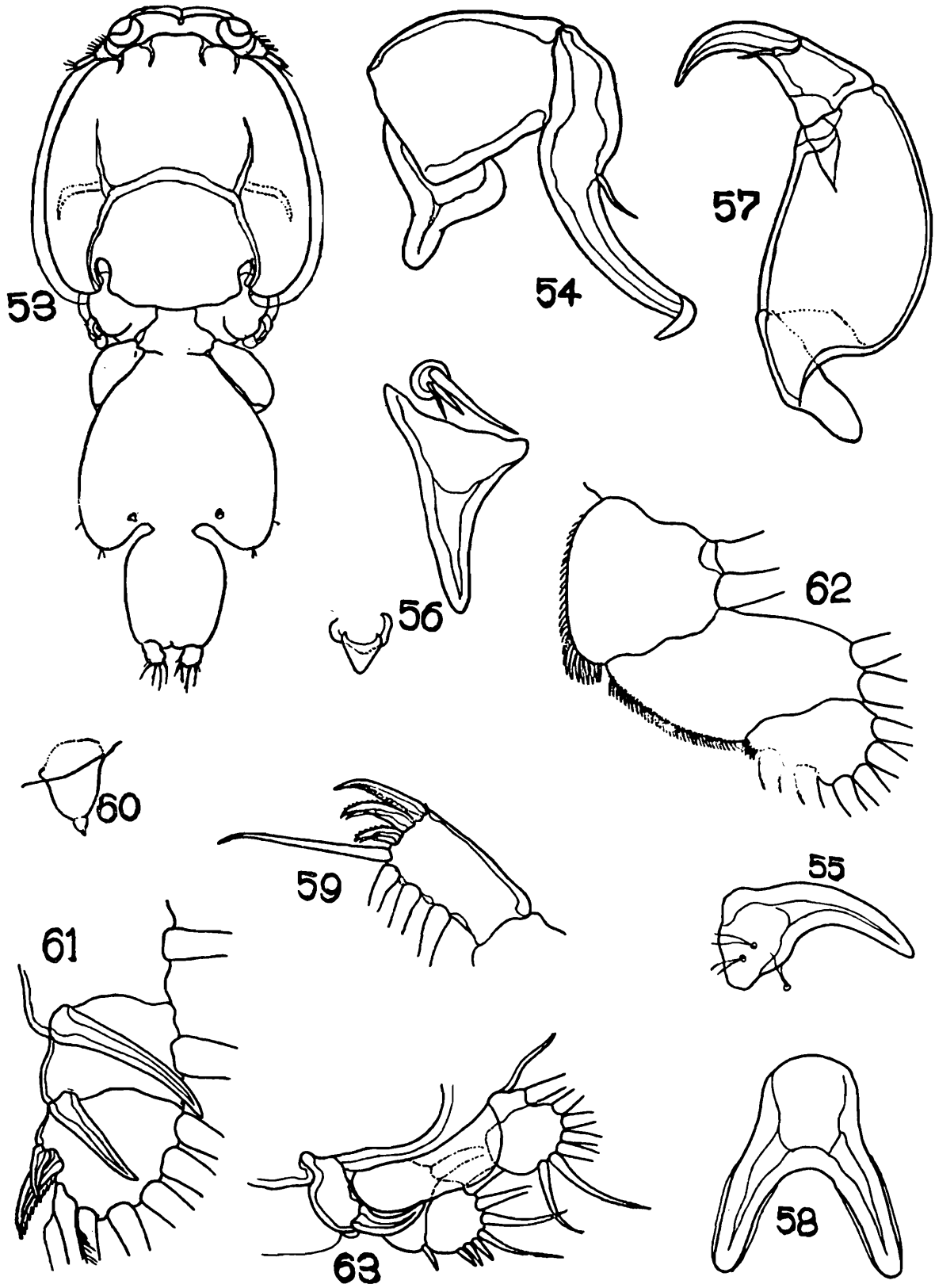
47. Leg 3 ; 48. Leg. 4 ; 49. Male, dorsal view ;
50. Second antenna ; 51. First maxilla.
52. Maxilliped.



Figs. 47-52

Figs. 53-63. *Caligus kirtii* sp. nov. Female.

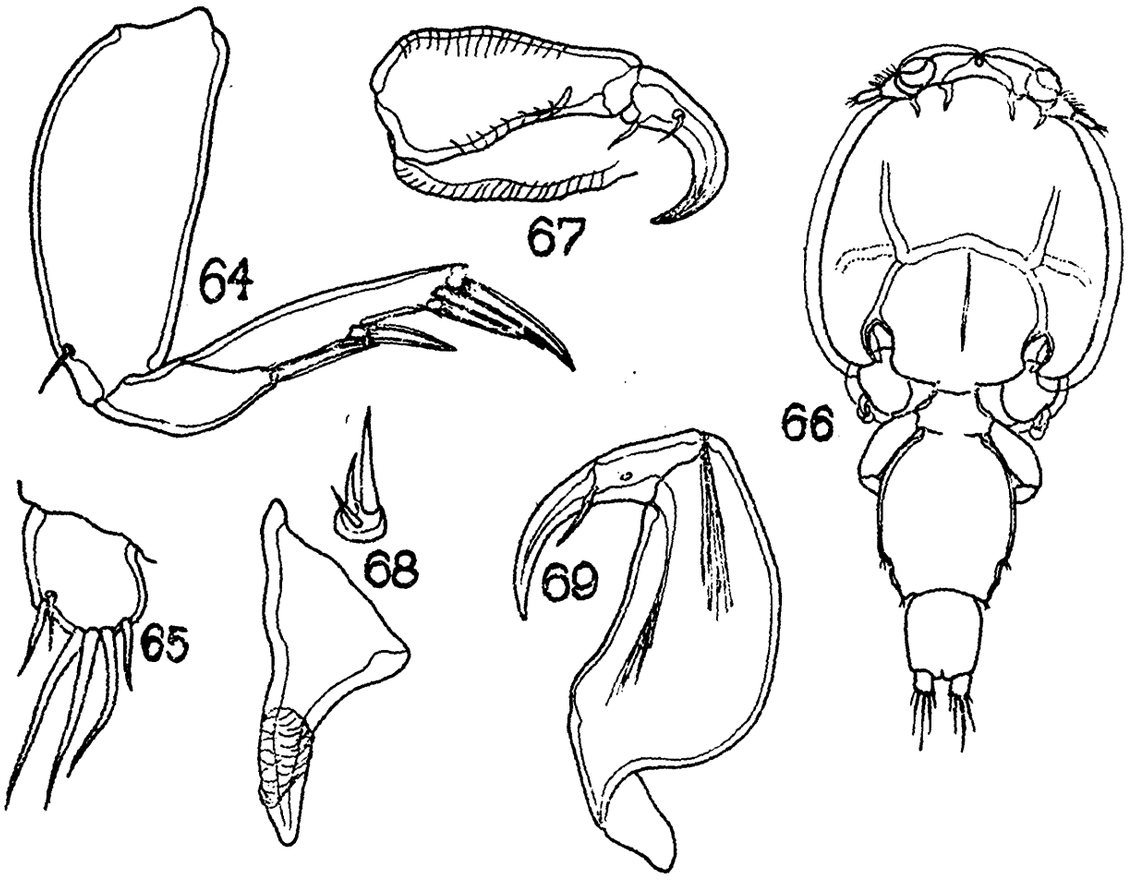
53. Female, dorsal view ; 54. Second antenna ; 55. Postantennary process ; 56. First maxilla and sclerotised process ; 57. Maxilliped ; 58. Sternal furca ; 59. Leg 1, tip of exopod enlarged ; 60. same, endopod ; 61. Leg 2, exopod ; 62. Same, endopod ; 63. Leg. 3.



Figs. 53-63

Figs. 64-69. *Caligus kirtii* sp. nov. 64 & 65 Female ; 66-69 Male.

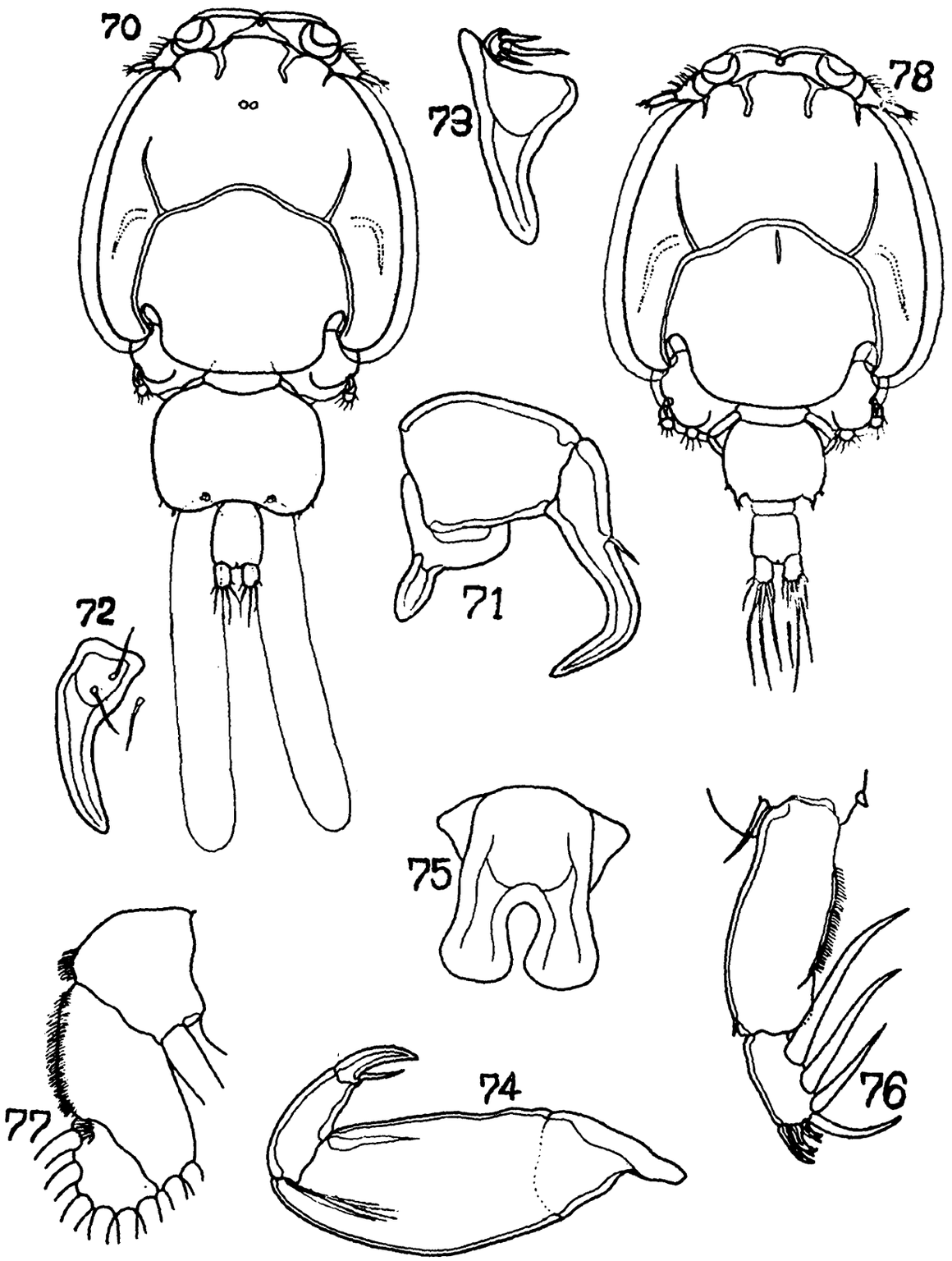
64. Leg 4 ; 65. Uropod ; 66. Male, dorsal view, 67. Second antenna, 68. First maxilla, 69. Maxilliped.



Figs. 64-69

Figs. 70-78. *Caligus pelagicus* Kurian. 70-77 Female ; 78. Male.

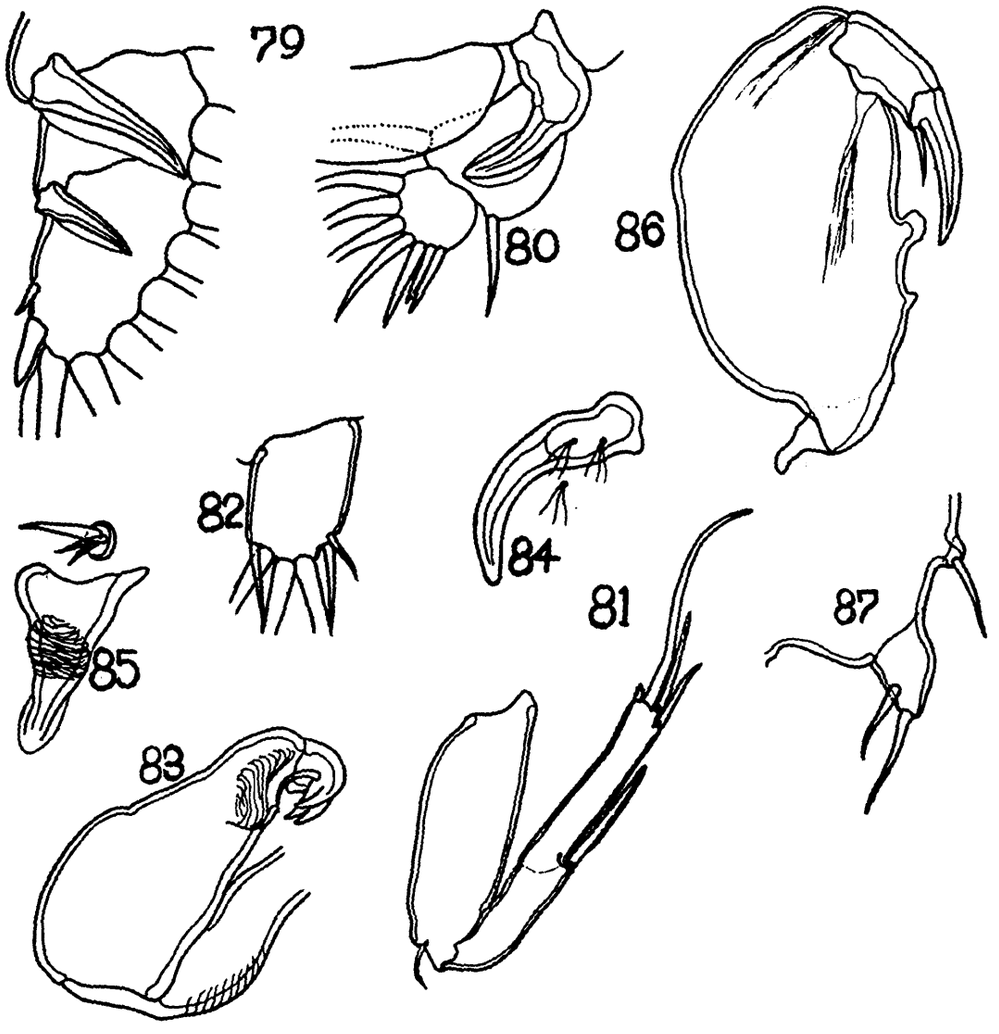
70. Female ; dorsal view ; 71. Second antenna ; 72. Postantennary process ; 73. First maxilla ; 74. Maxilliped ; 75. Sternal furca ; 76. Leg 1 ; 77. Leg. 2. endopod ; 78. Male, dorsal view.



Figs. 70-78

Figs. 79-87. *Caligus pelagicus* Kurian. 79-82 Female, 83-87 Male.

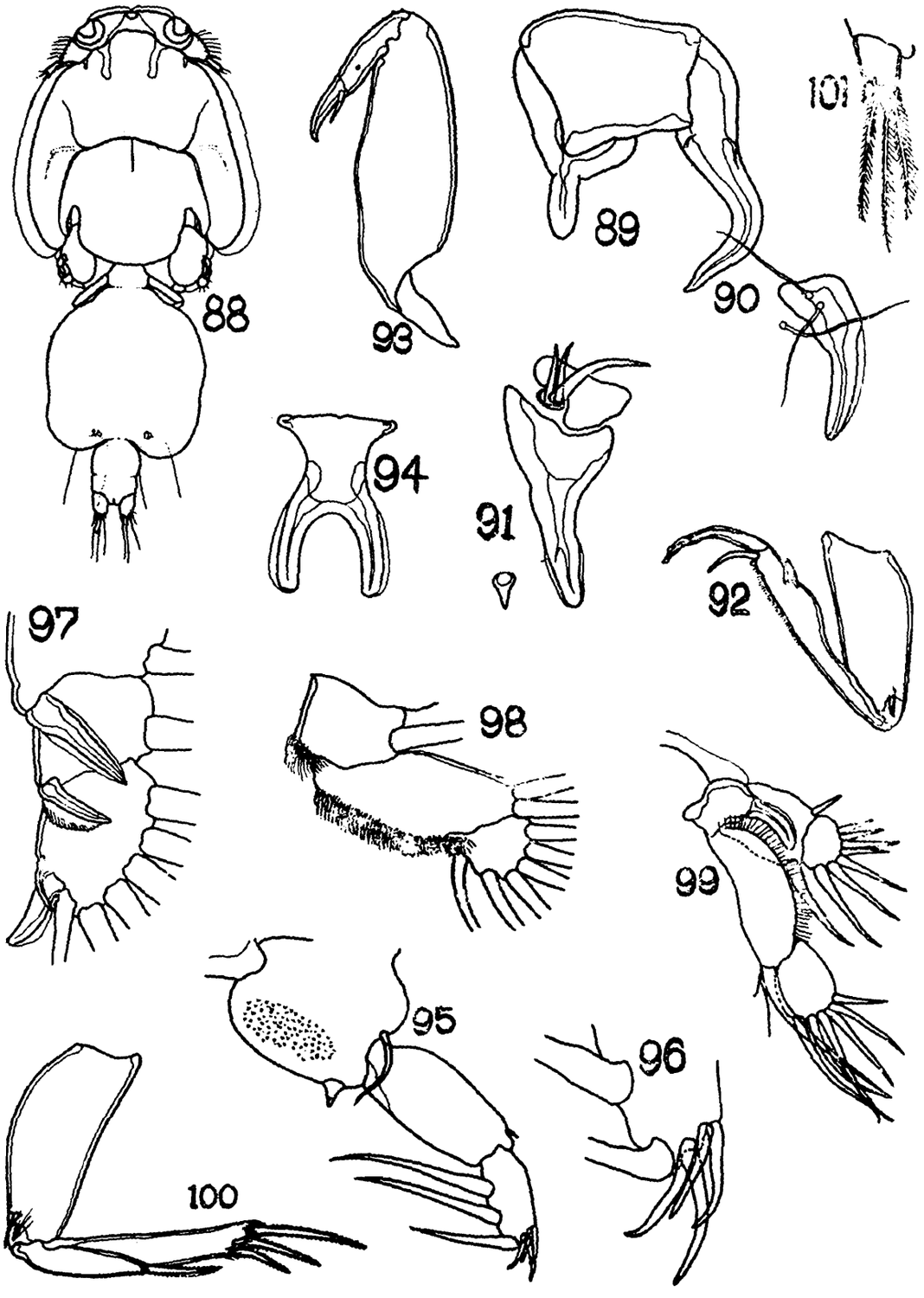
79. Leg 2 ; exopod, 80. Leg 3, exopod ; 81. Leg. 4 ; 82. Urepod ; 83. Second antenna ; 84. Postantennary process ; 85. First maxilla ; 86. Maxilliped ; 87. Leg 5 and 6.



Figs. 79-87

Figs. 88-101. *Caligus pomadasi* sp. nov. Female.

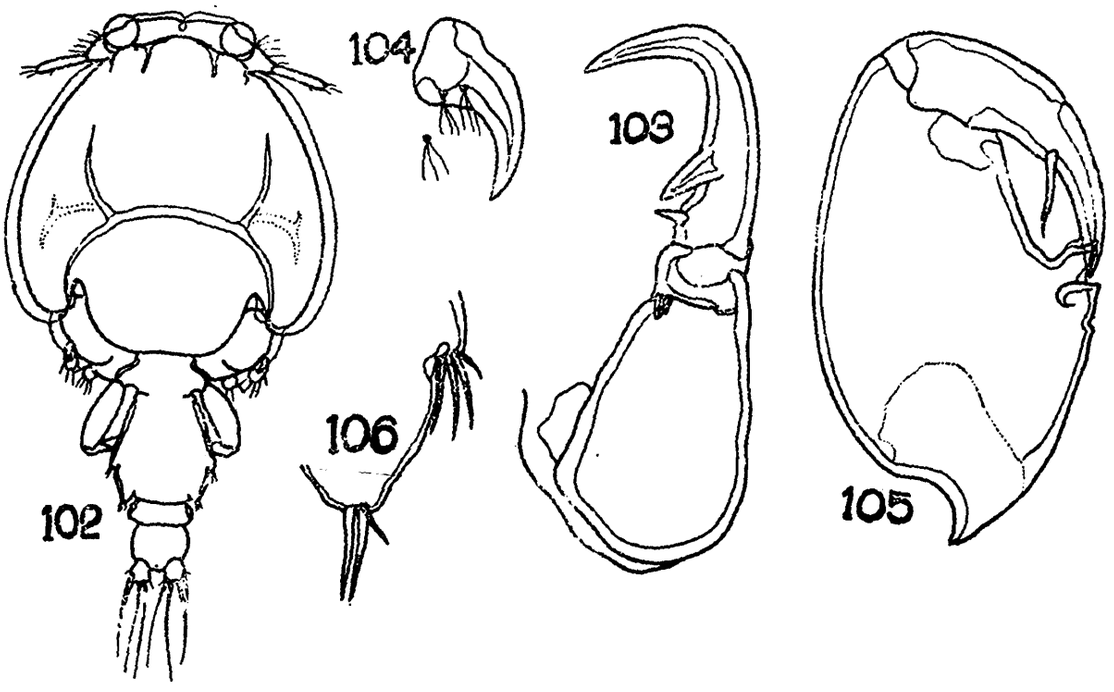
88. Female, dorsal view; 89. Second antenna; 90. Postantennary process; 91. First maxilla and chitinized process; 92. Second maxilla; 93. Maxilliped; 94. Sternal furca; 95. Leg 1; 96. Same, tip of exopod enlarged; 97. Leg 2, exopod; 98. Same, endopod; 99. Leg 3; 100. Leg 4; 101. Uropod.



Figs. 88-101

Figs. 102-106. *Caligus priacanthi* Pillai. Male.

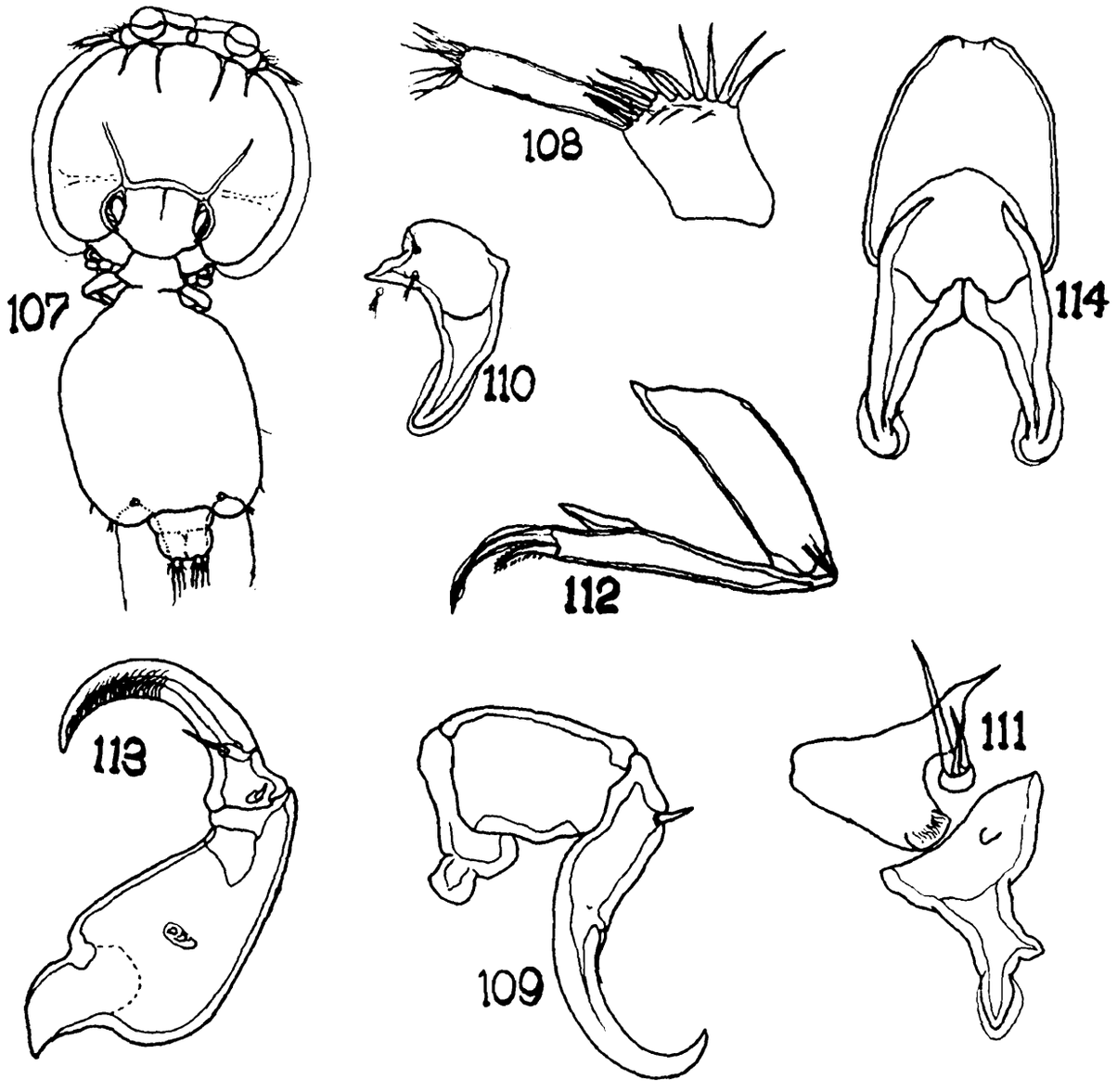
102. Male, dorsal view ; 103. Second antenna, 104. Postantennary process ; 105. Maxilliped, 106. Legs. 5 & 6.



Figs. 102-106

Figs. 107-114. *Caligus spinosus* Yamaguti. Female.

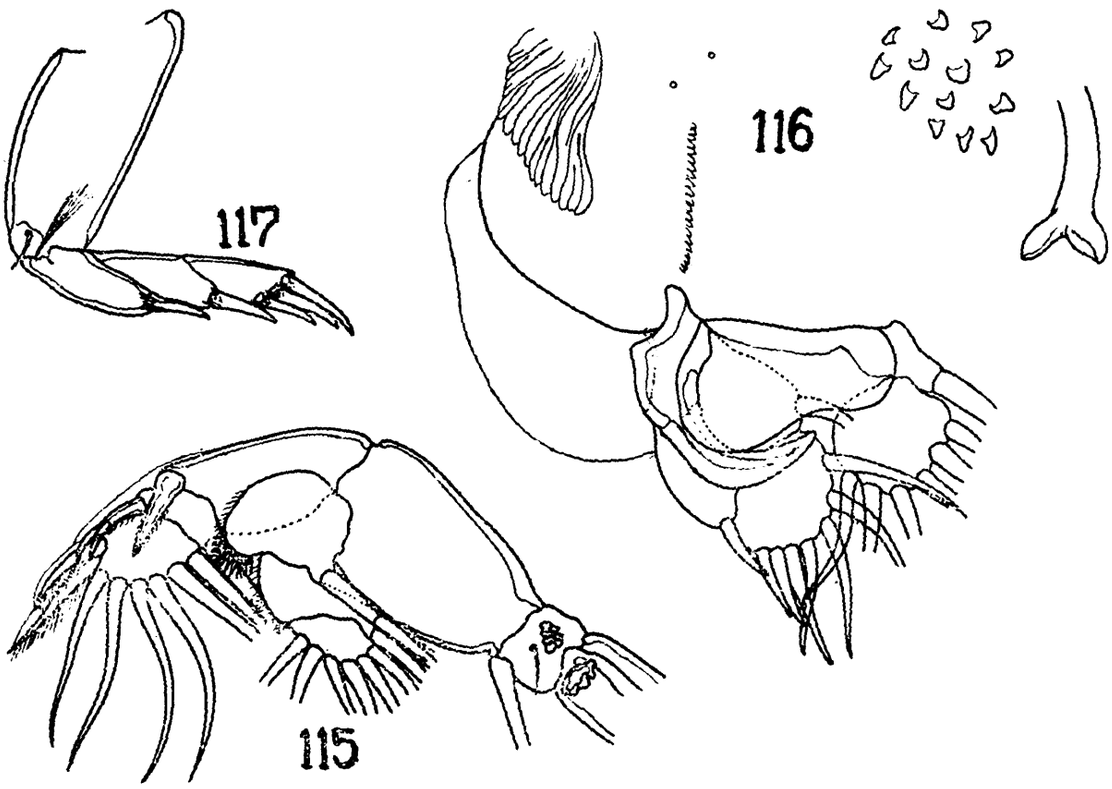
107. Female, dorsal view; 108. First antenna; 109. Second antenna; 110. Postantennary process; 111. First maxilla; 112. Second maxilla; 113. Maxilliped; 114. Sternal furca.



Figs. 107-114

Figs. 115-117. *Caligus spinosus* Yamaguti. Female.

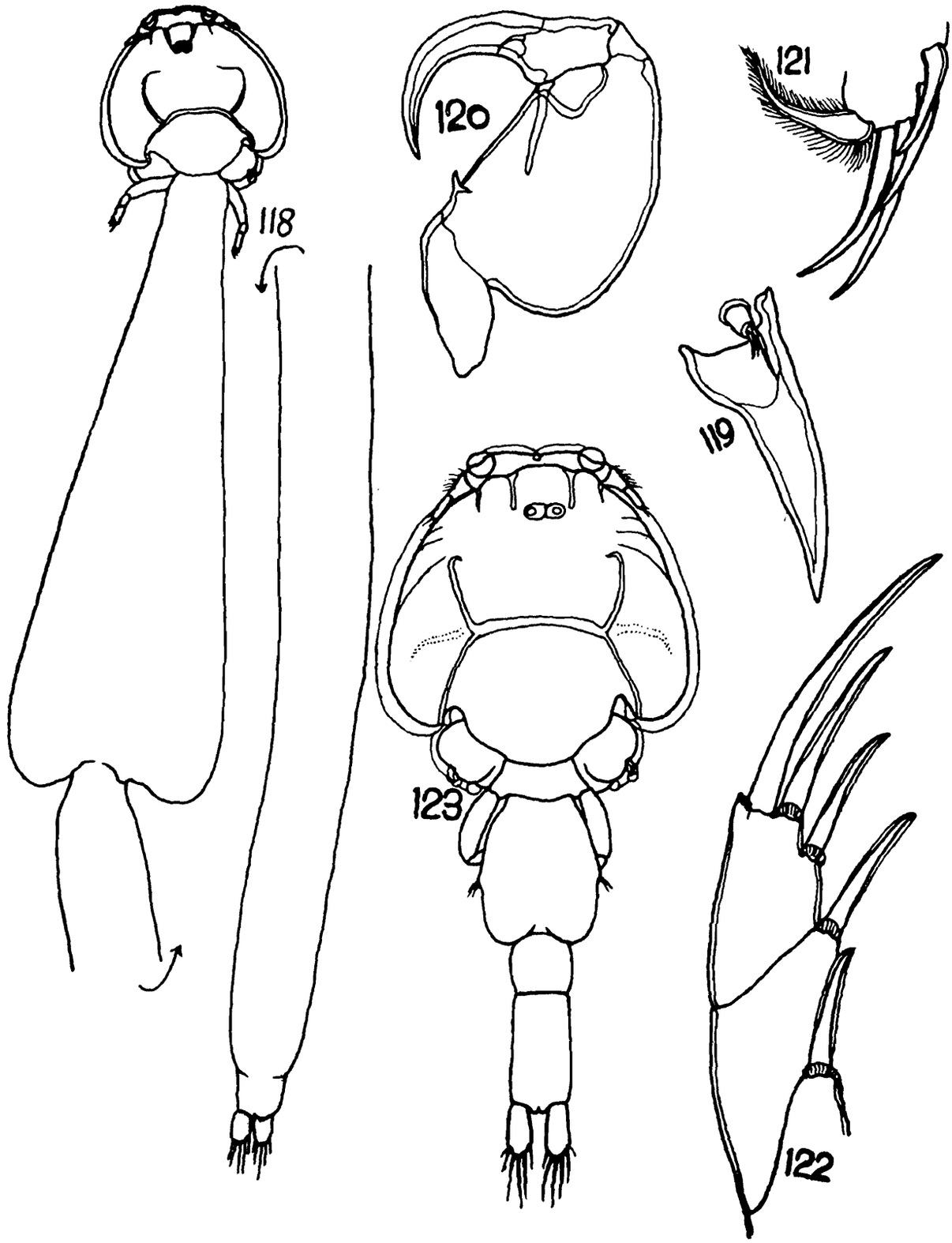
115. Leg. 2. 116. Leg. 3 ; 117. Leg. 4.



Figs. 115-117

Figs. 118-123. *Sciaenophilus tenuis* van Beneden.

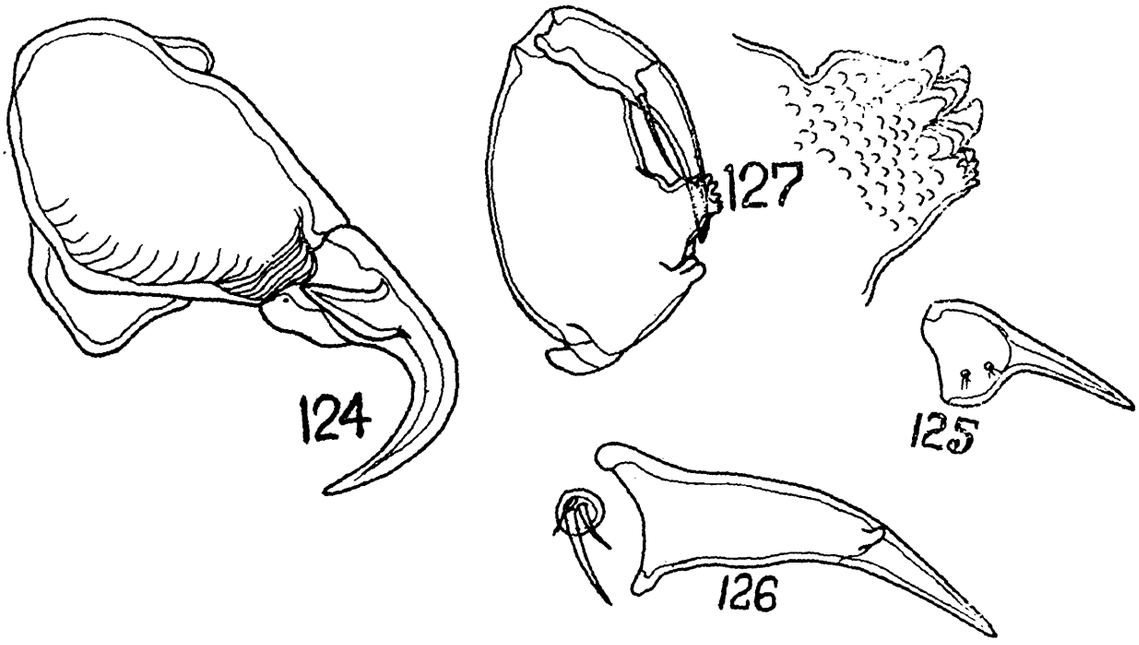
118-122. Female; 128. male.
118. Female, dorsal view ; 119. First maxilla ;
120. Maxilliped ; 121. Leg. 1, tip enlarged ;
122. Leg 4, exopod ; 123. Male, dorsal view.



Figs. 118-123

Figs. 124-127. *Sciaenophilus tenuis* van Beneden. Male.

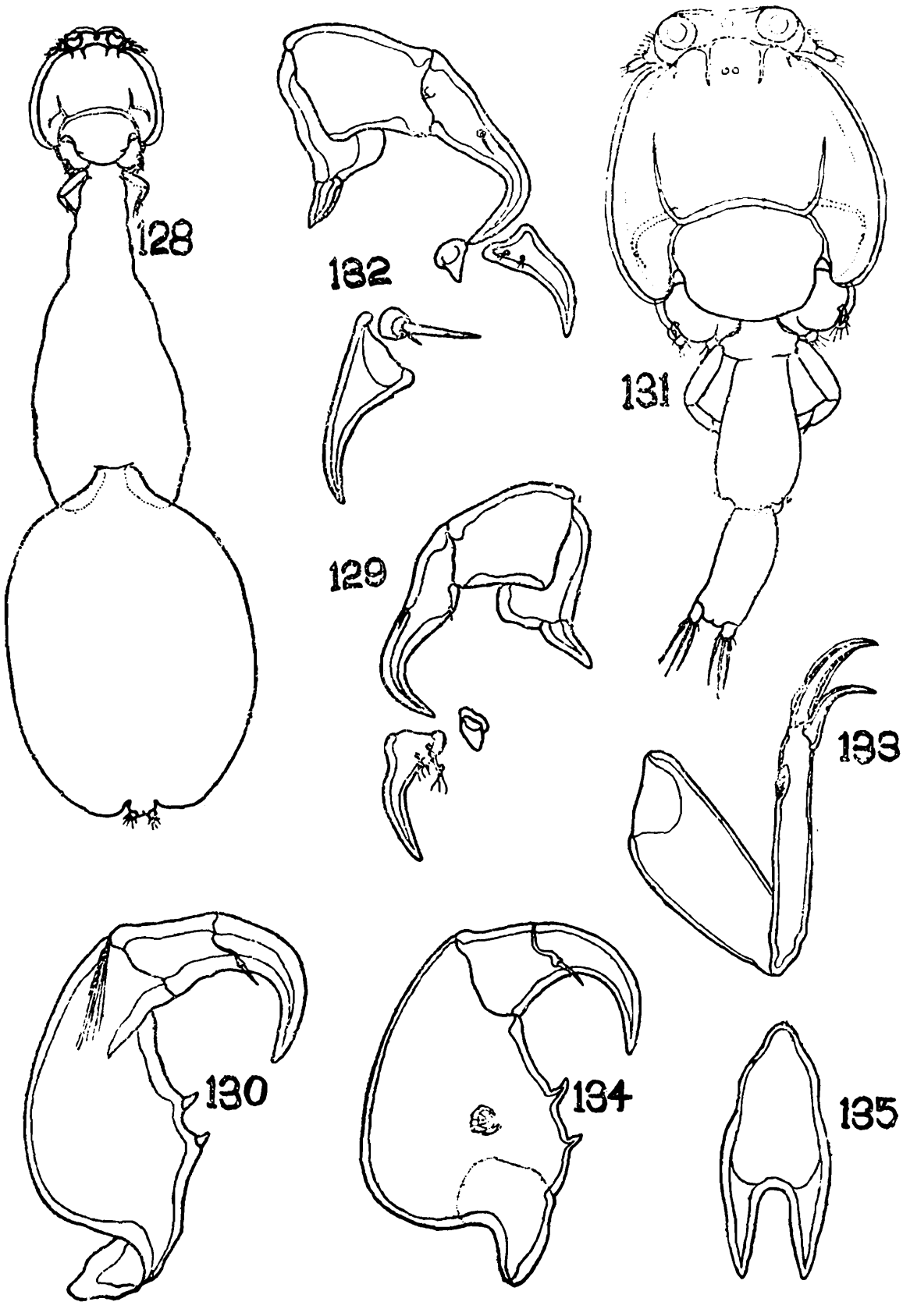
124. Second antenna ; 125. Postantennary process ; 126. First maxilla ; 127. Maxilliped ; & myra enlarged.



Figs. 124-127

Figs. 128-135. *Pseudopetalus caudatus* (Gnanamuthu) 128-130. Adult female ; 131-135. Juvenile female.

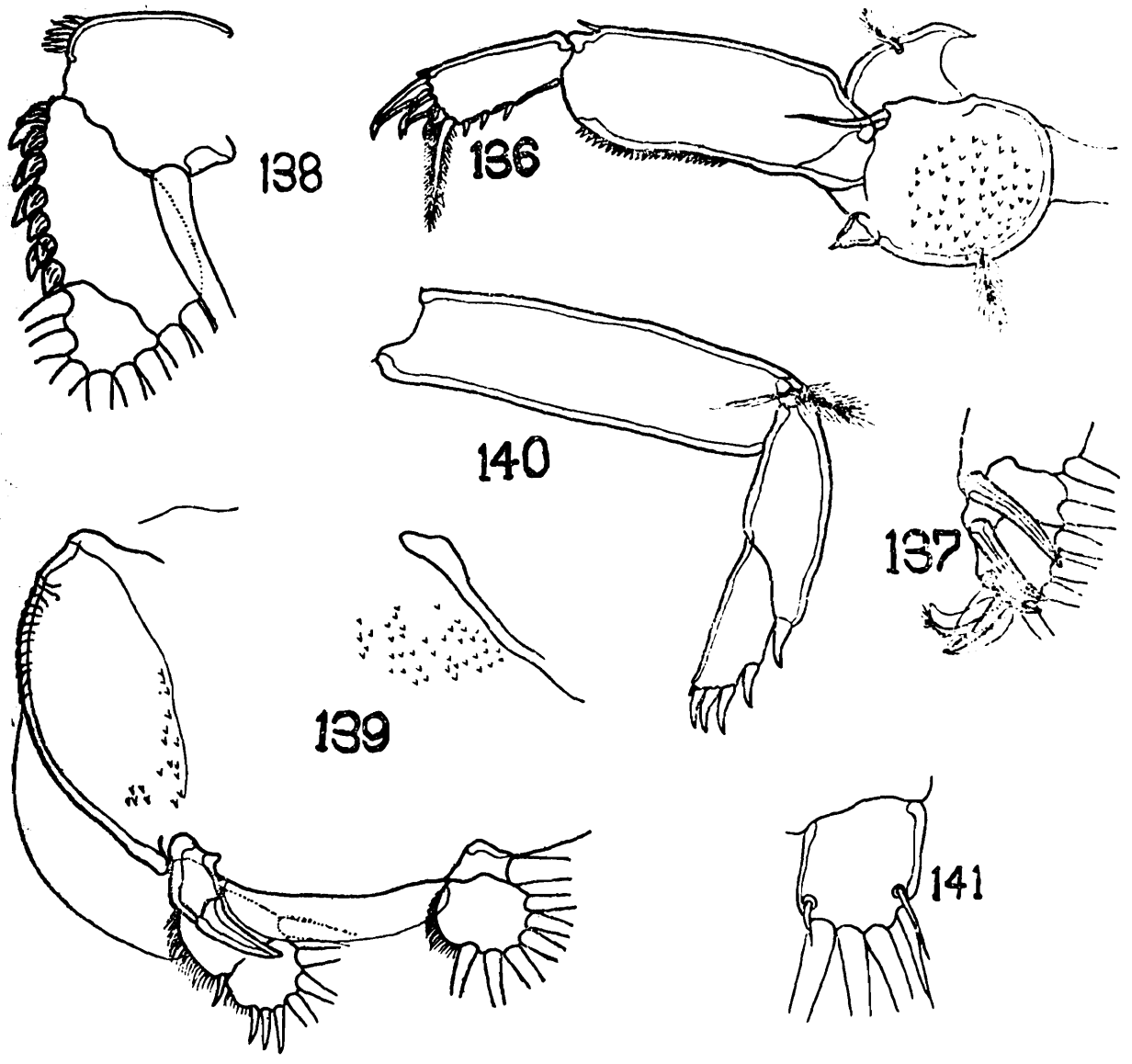
128. Adult female, dorsal view ; 129. Second antenna and postantennary process ; 130 Maxilliped ; 131. Juvenile female, dorsal view ; 132. Second antenna, postantennary process and first maxilla ; 133. Second maxilla ; 134. Maxilliped ; 135. Sternal furca.



Figs. 128-135

Figs. 136-141 *Pseudopetalus caudatus* (Gnanamuthu). Juvenile female ;

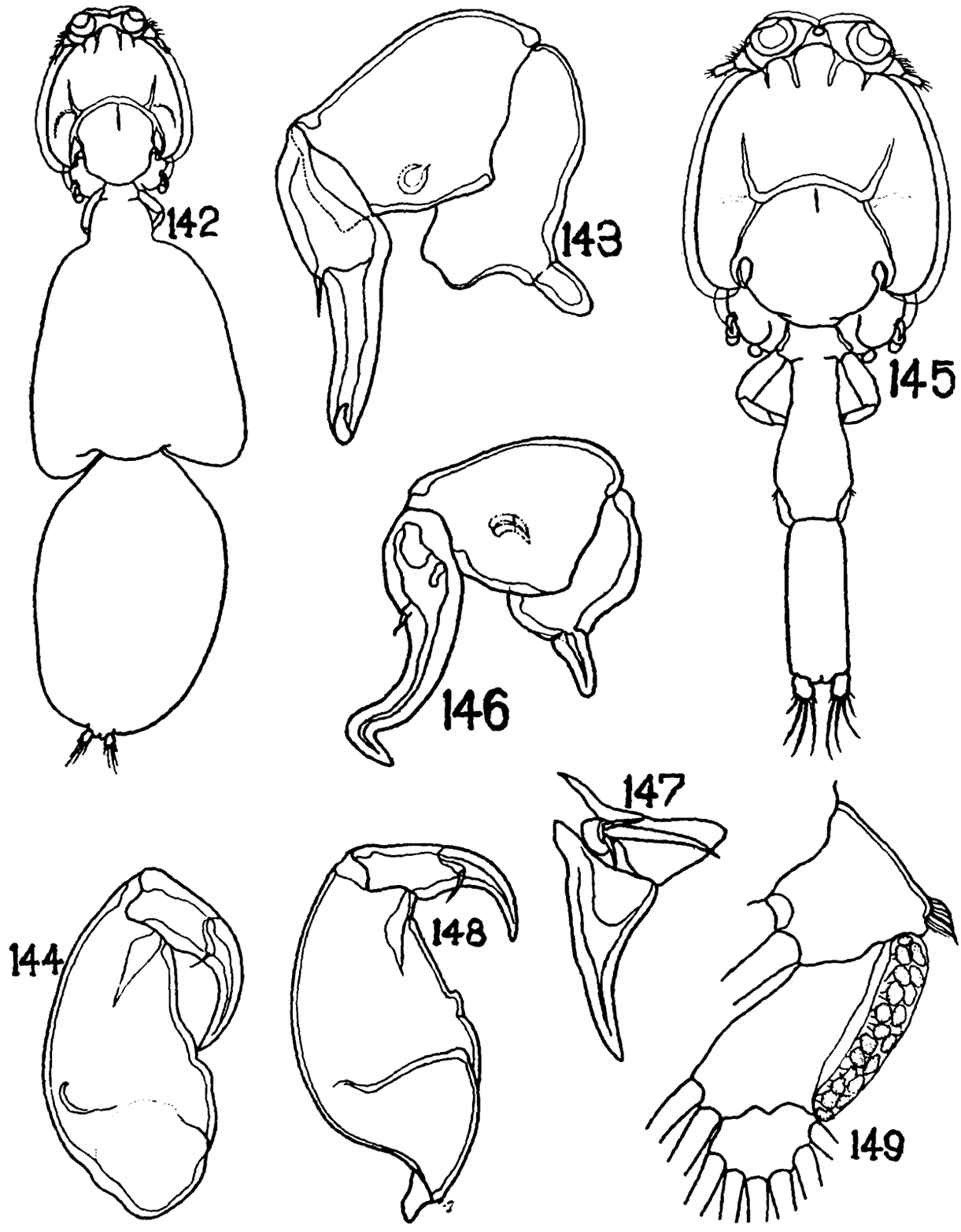
136. Leg 1 ; 137. Leg 2, exopod ; 138. Same, endopod ;
139. Leg 3 ; 140. Leg 4 ; 141. uropod.



Figs. 136-141

Figs. 142-149. *Pseudopetalus dussumieri* (Rangnekar).
142-144. Adult female, 145-149 Juvenile female.

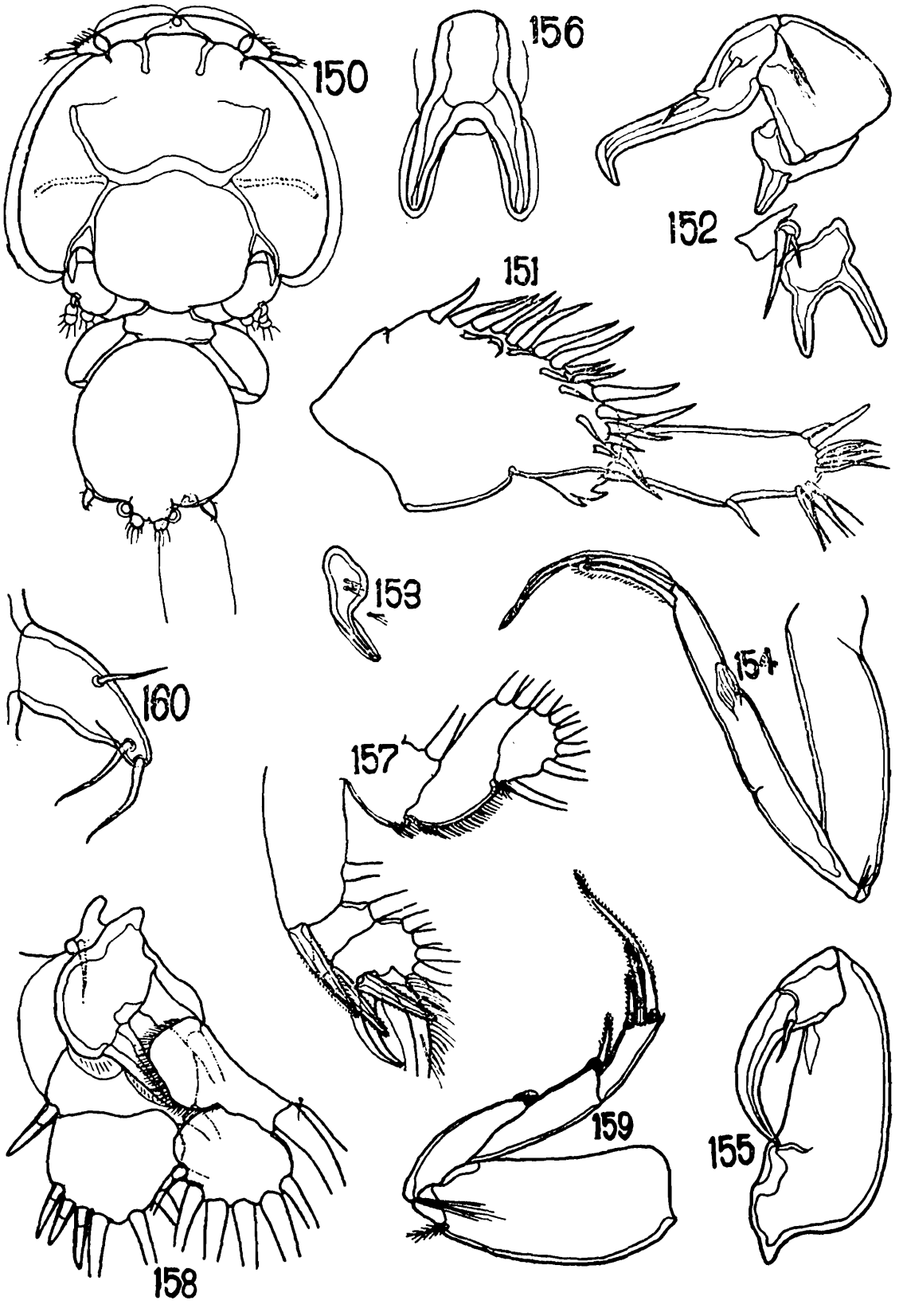
142. Adult female, dorsal view ; 143. Second antenna ;
144. Maxilliped ; 145. Juvenile female, dorsal view ;
146. Second antenna ; 147. First maxilla ;
148. Maxilliped ; 149. Leg 2, endopod.



Figs. 142-149

Figs. 150-160. *Lepeophtheirus anguilli* Hammed. Female.

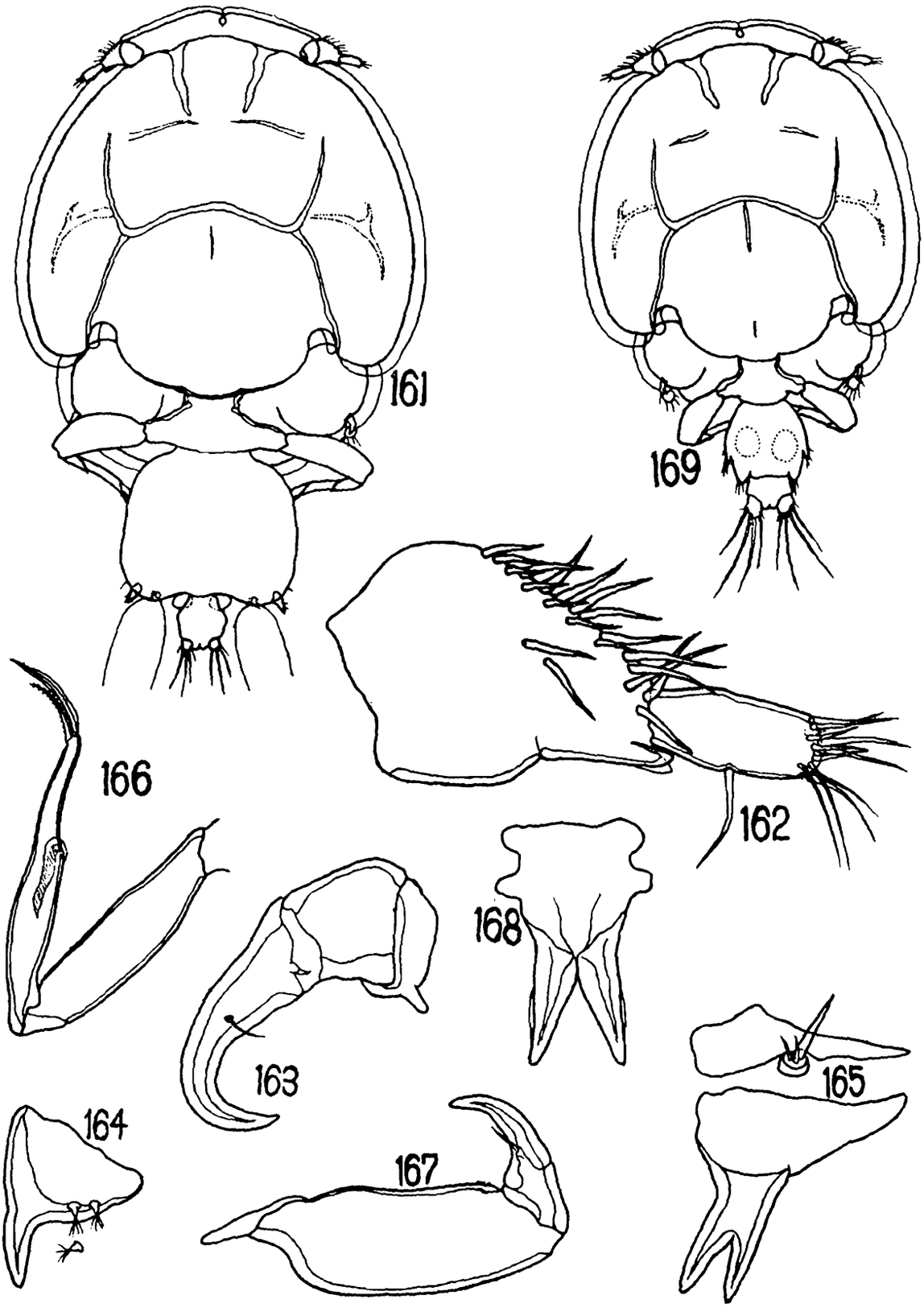
150. Female, dorsal view ; 151. First antenna ;
152. Second antenna and first maxilla ; 153. Postantennary process ; 154. Second maxilla ; 155. Maxilliped ;
156. Sternal furca ; 157. Leg 2, 158. Leg. 3 ;
159. Leg 4 ; 160. Leg 5.



Figs. 150-160

Figs. 161-169. *Lepeophtheirus kabatai* Ho & Dojiri. 161-168. Female ; 169. Male.

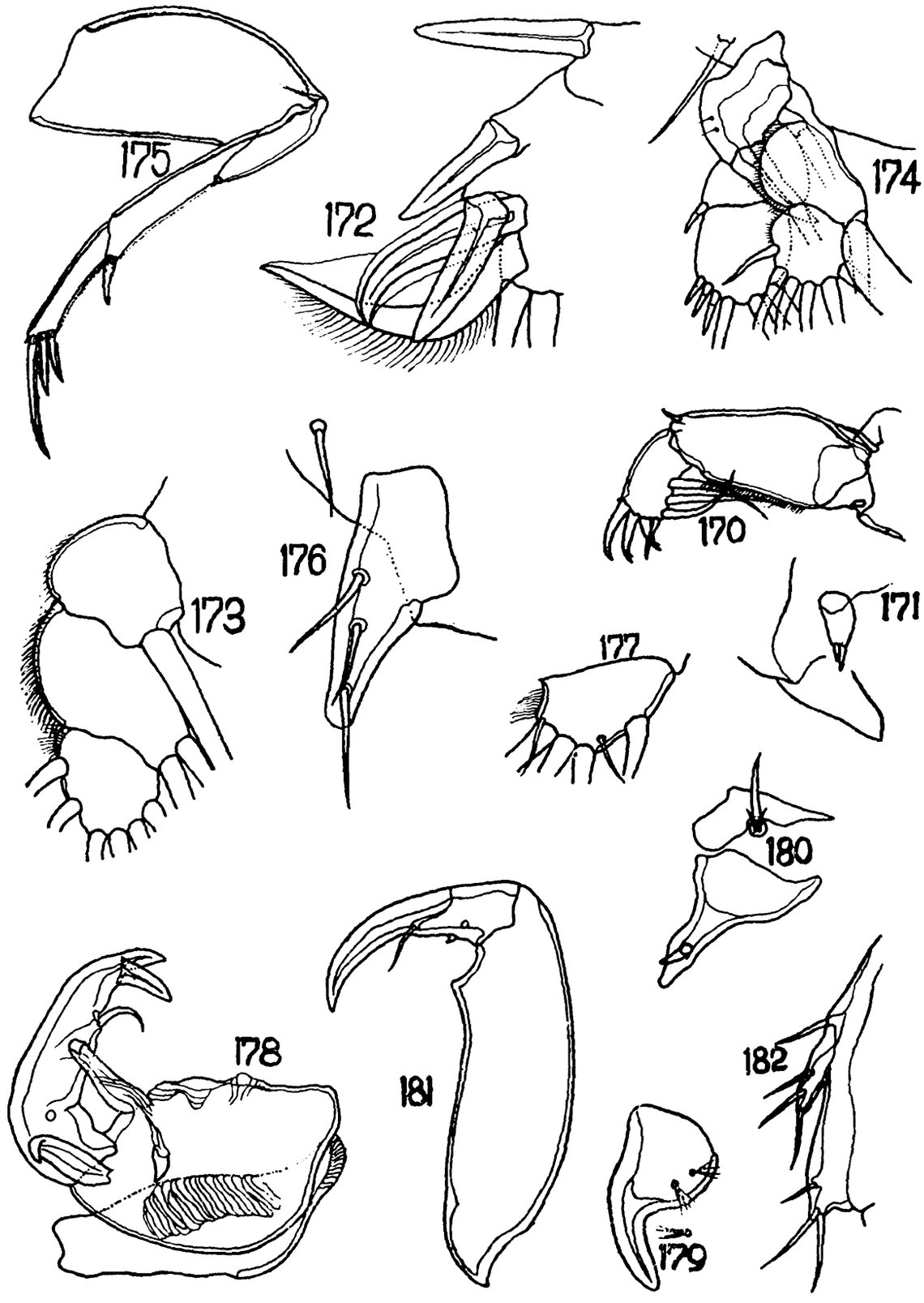
161. Female, dorsal view ; 162. First antenna ;
163. Second antenna ; 164. Postantennary process ;
165. First maxilla ; 166. Second maxilla ; 167. Maxilliped ;
168. Sternal furca ; 169. Male, dorsal view.



Figs. 161-169

Figs. 170-182. *Lepeophtheirus kabatai* Ho & Dojiri.
170-177. Female ; 178-182. Male.

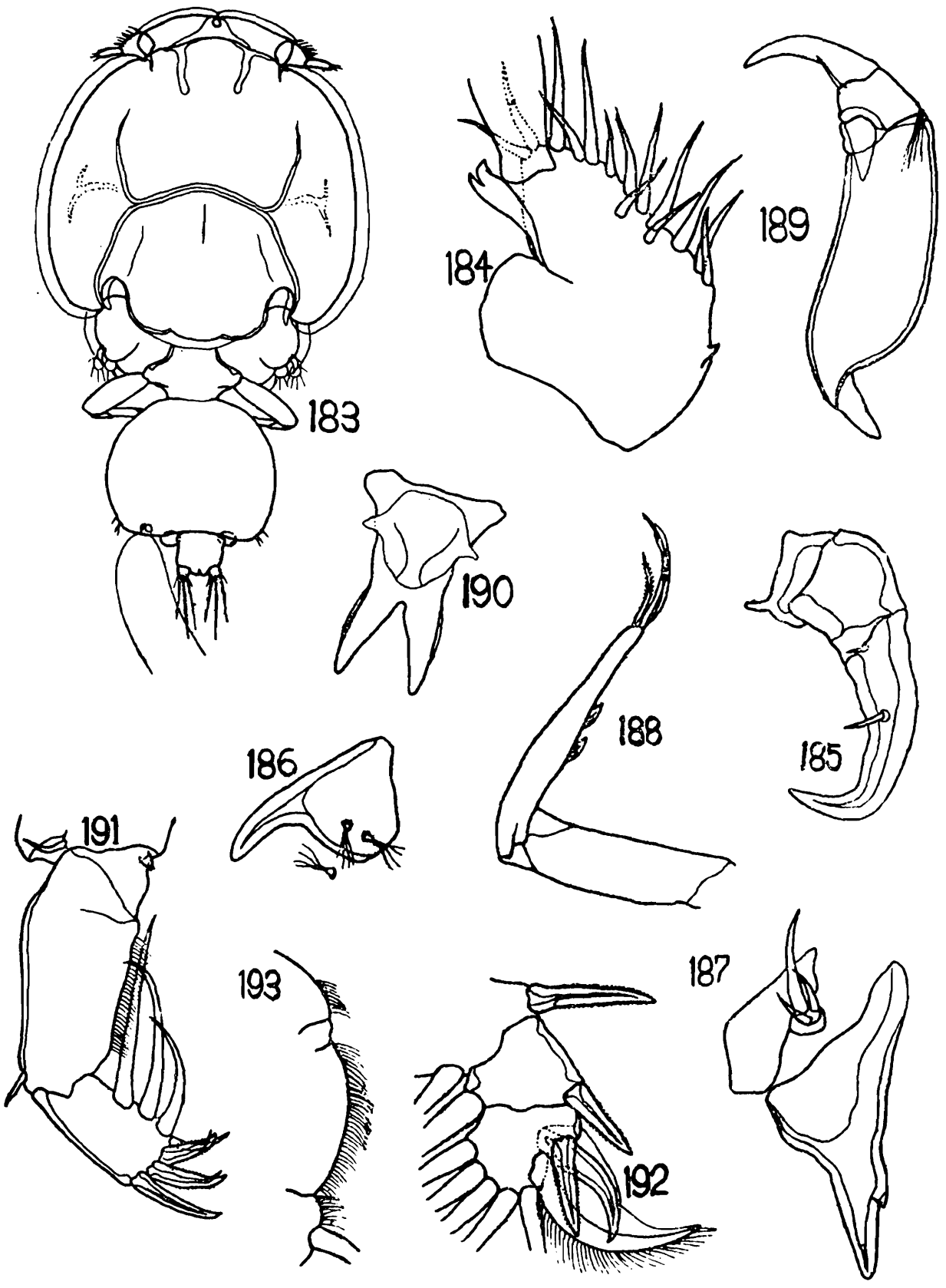
170. Leg 1 ; 171. Same, endopod enlarged ;
172. Leg 2, exopod ; 173. Same, endoped ;
174. Leg. 3 ; 175. Leg 4 ; 176. Leg 5 ; 177. Uropod ;
178. Second antenna ; 179. Postantennary process ;
180. First maxilla ; 181. Maxilliped ; 182. Legs 5 & 6.



Figs. 170-182

Figs. 183-193. *Lepeophtheirus shiinoi* sp. nov. Female.

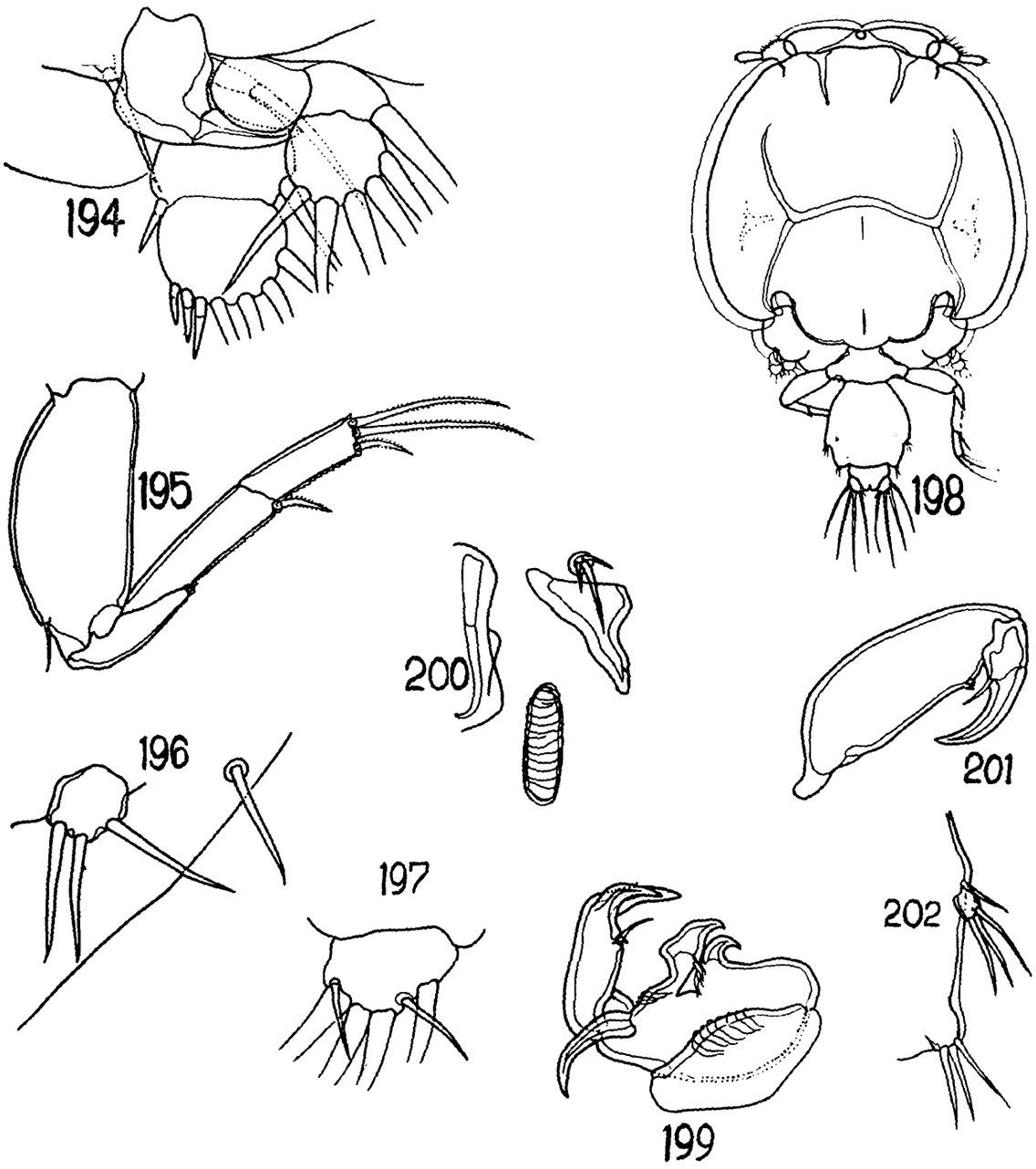
183. Female, dorsal view; 184. First antenna, basal segment; 185. Second antenna; 186. Postantennary process; 187. First maxilla; 188. Second maxilla; 189. Maxilliped; 190. Sternal furca, 191. Leg 1; 192. Leg 2; 193. Same, endopod.



Figs. 183-19.

Figs. 194-202. *Lepeophtheirus shiinoi* sp. nov.
194-197. Female ; 198-202 Male.

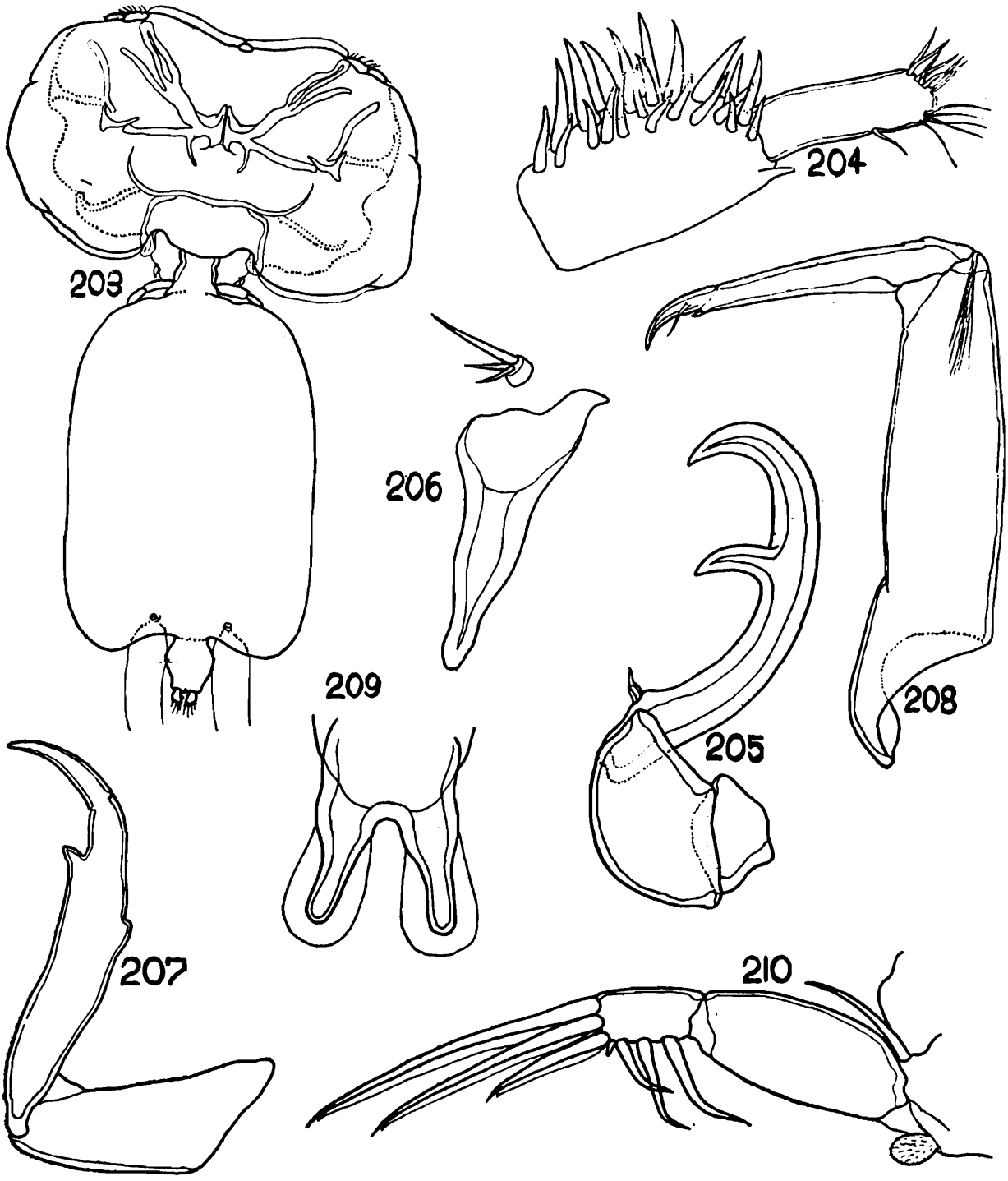
194. Leg 3 ; 195. Leg 4 ; 196. Leg 5 ; 197. Uropod ;
198. Male, dorsal view ; 199. Second antenna ;
200. First maxilla and corrugated pad ; 201. Maxilliped ;
202. Legs 5 & 6.



Figs. 194-202

Figs. 203-210. *Hermilius ariodi* sp. nov. Female.

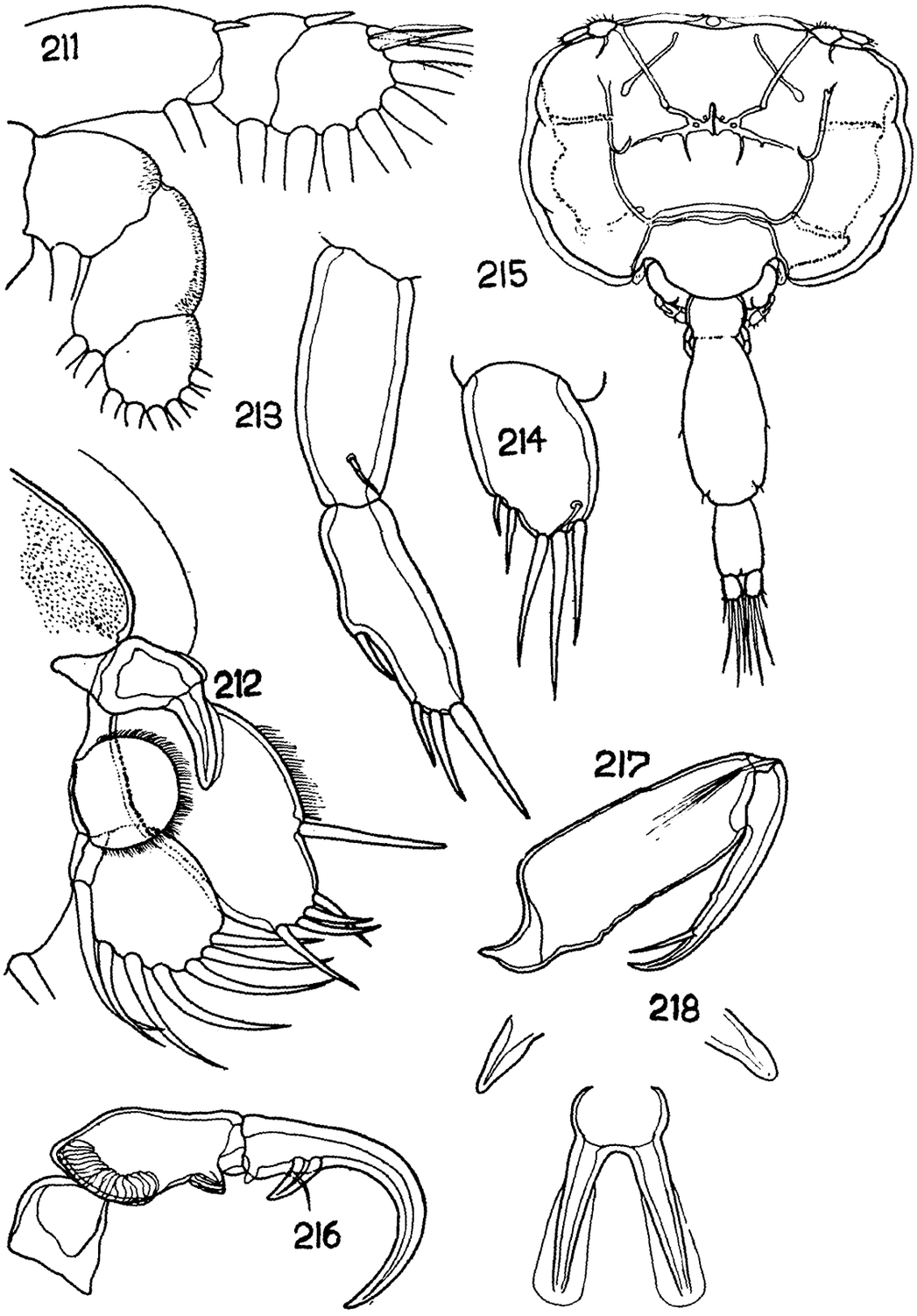
203. Female, dorsal view ; 204. First antenna ;
205. Second antenna ; 206. First maxilla ;
207. Second maxilla ; 208. Maxilliped ;
209. Sternal furca, 210. Leg. 1.



Figs. 203-210

Figs. 211-218. *Hermilius ariodi* sp. nov. 211-214. Female, 215-218 Male.

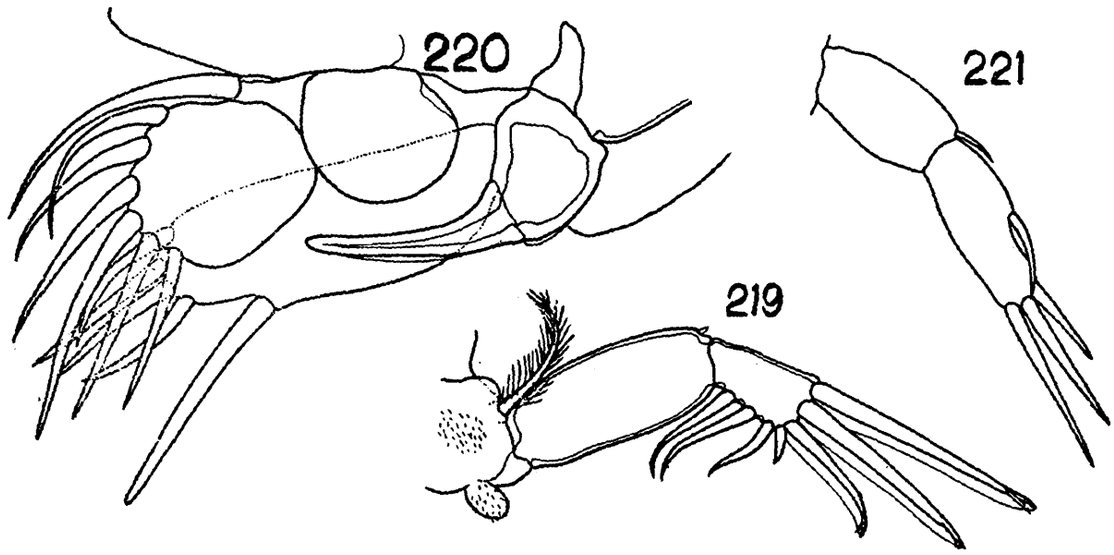
211. Leg 2 ; 212. Leg 3 ; 213. Leg 4 ; 214. Uropod ;
215. Male, dorsal view ; 216. Second antenna ;
217. Maxilliped ; 218. Sternal furca.



Figs. 211-218

Figs. 219-221. *Hermilius ariodi* sp. nov. Male.

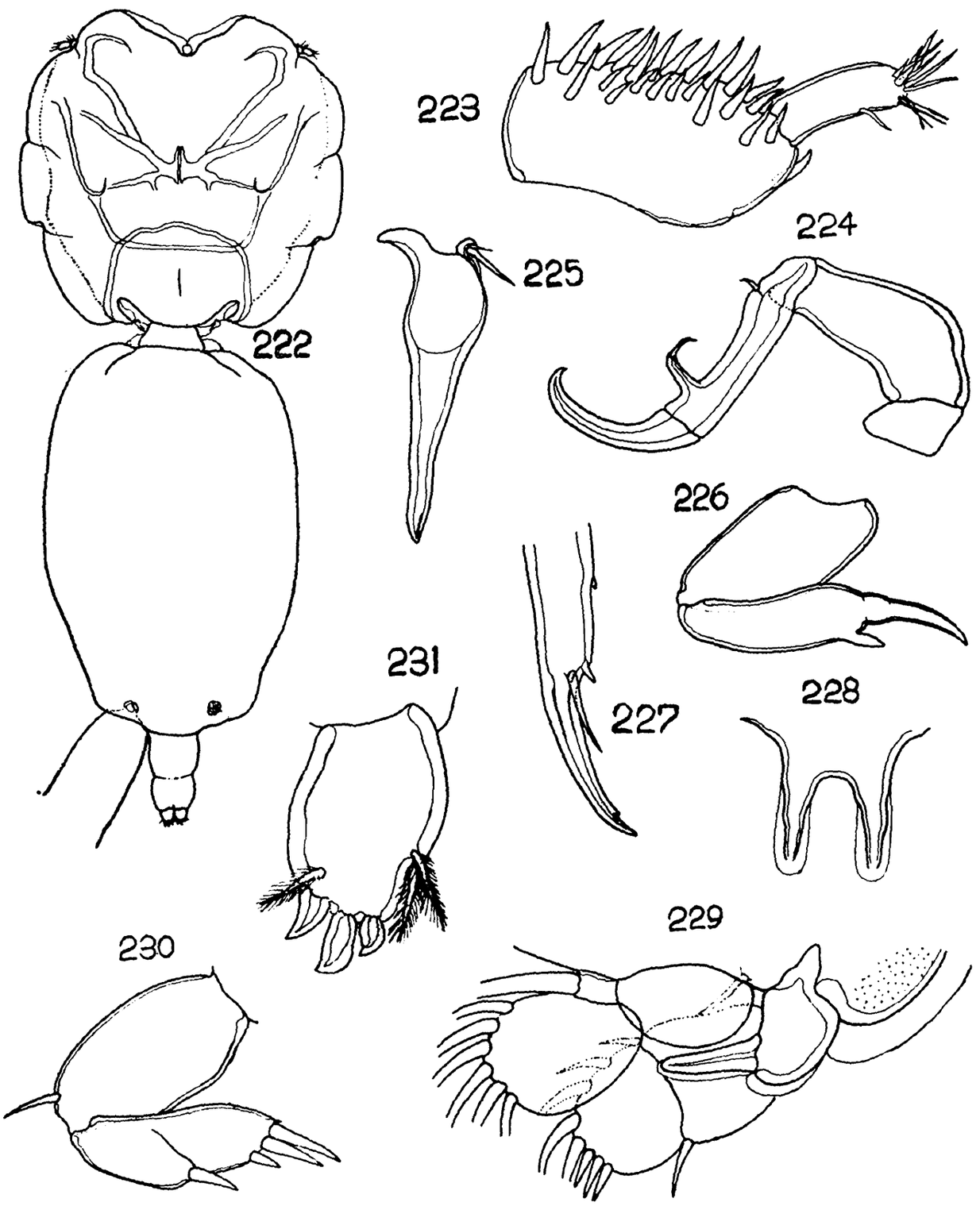
219. Leg 1; 220. Leg 3; 221. Leg. 4.



Figs. 219-221

Figs. 222-231. *Hermilius helfferi* Pillai. Female.

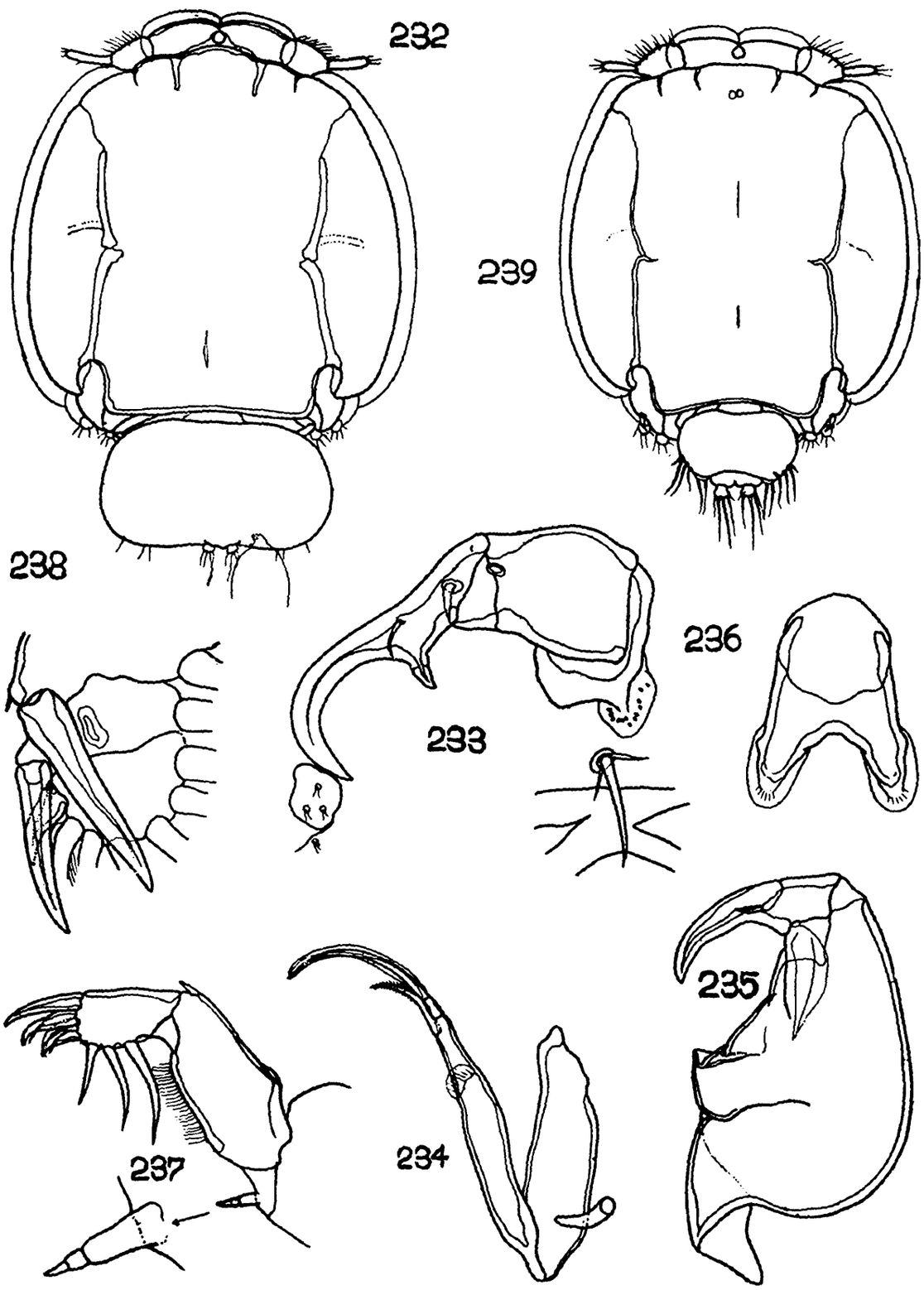
222. Female, dorsal view ; 223. First antenna ;
224. Second antenna ; 225. First maxilla,
226. Second maxilla, 227. Subchela of maxilliped ;
228. Sternal furca, 229. Leg 3 ; 230. Leg 4 ;
231. Uropod.



Figs. 222-231

Figs. 232-239. *Anuretes chelatus* sp. nov. 232-238. Female. 239. Male.

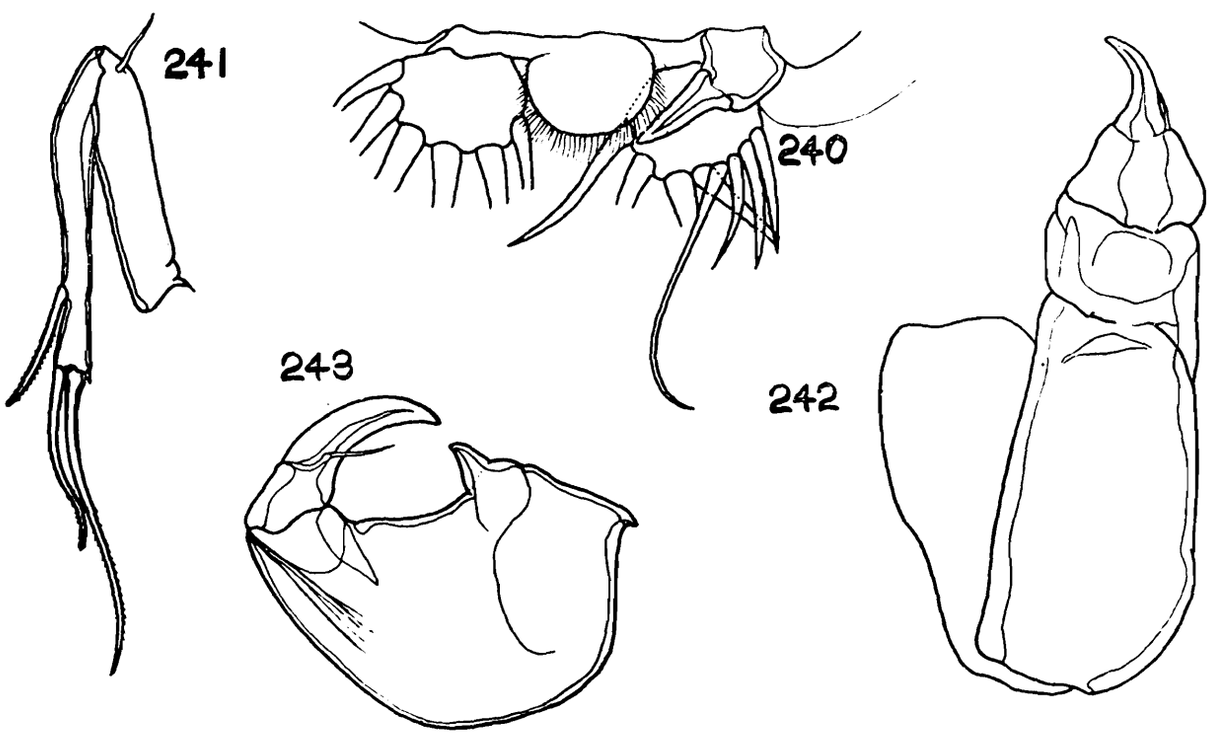
232. Female, dorsal view; 233. Second antenna and basal papilla of first maxilla; 234. Second maxilla and maxillary whip; 235. Maxilliped; 236. Sternal furca; 237. Leg 1; 238. Leg 2, exopod;
239. Male, dorsal view.



Figs. 232-239

Figs. 240-243. *Anuretes chelatus* sp. nov.
240 & 241. Female ; 242 & 243 Male.

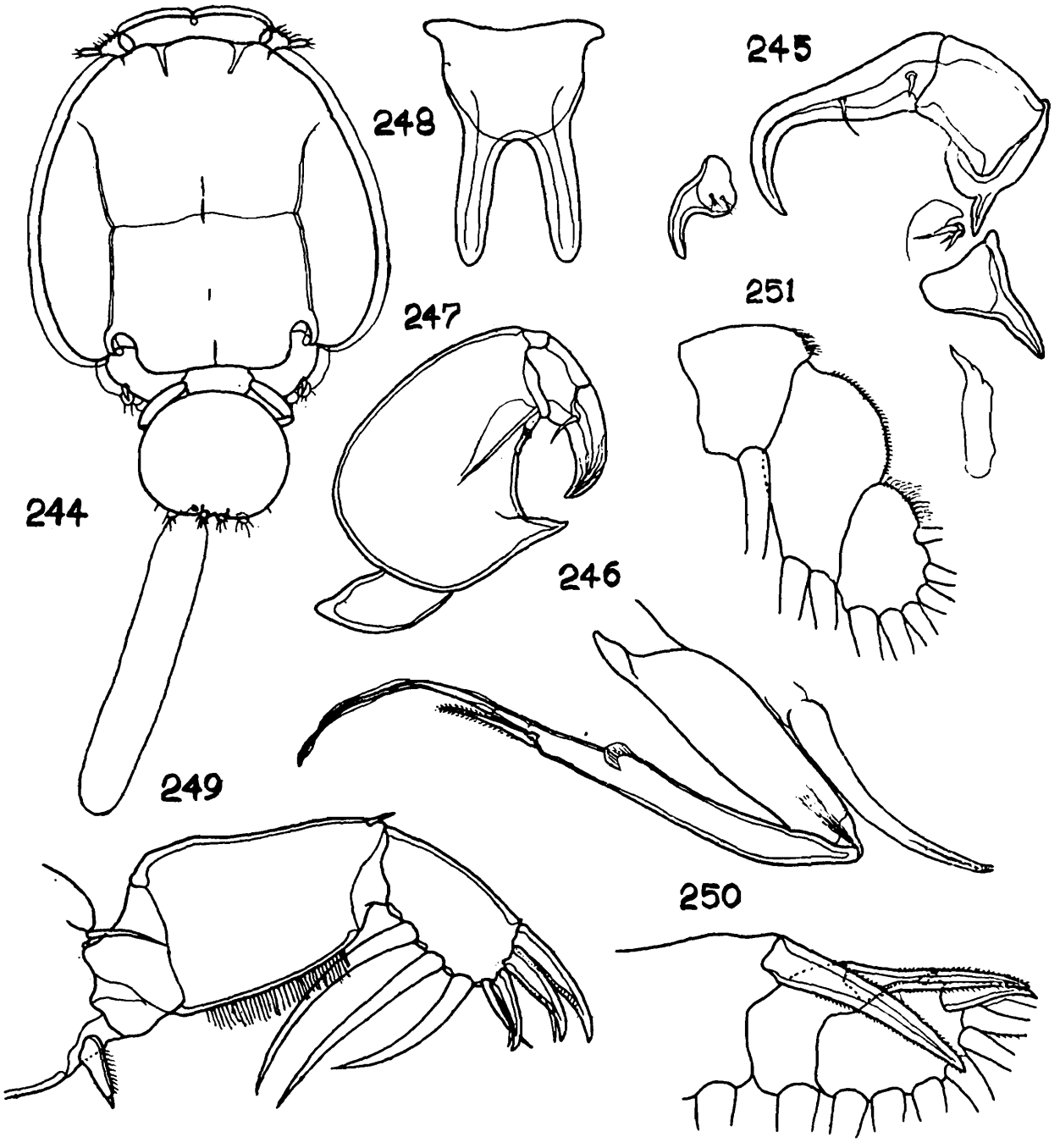
240. Leg 3, 241. Leg 4 ; 242. Second antenna ;
243. Maxilliped.



Figs. 240-243

Figs. 244-251. *Anuretes hoi* sp. nov. Female.

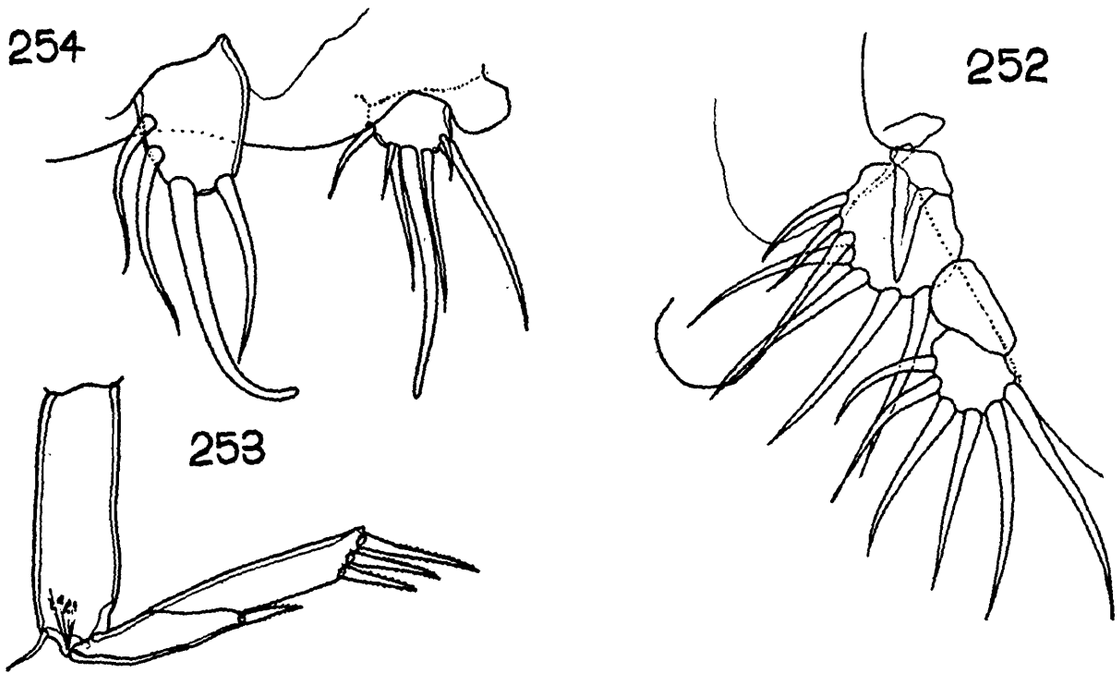
244. Female, dorsal view, 245. Second antenna, postantennary process and first maxilla, 246. Second maxilla and maxillary whip ; 247. Maxilliped, 248. Sternal furca ; 249. Leg 1, 250. Leg 2, exopod ; 251. Same, endopod.



Figs. 244-251

Figs. 252-254. *Anuretes hoi* sp. nov. Female.

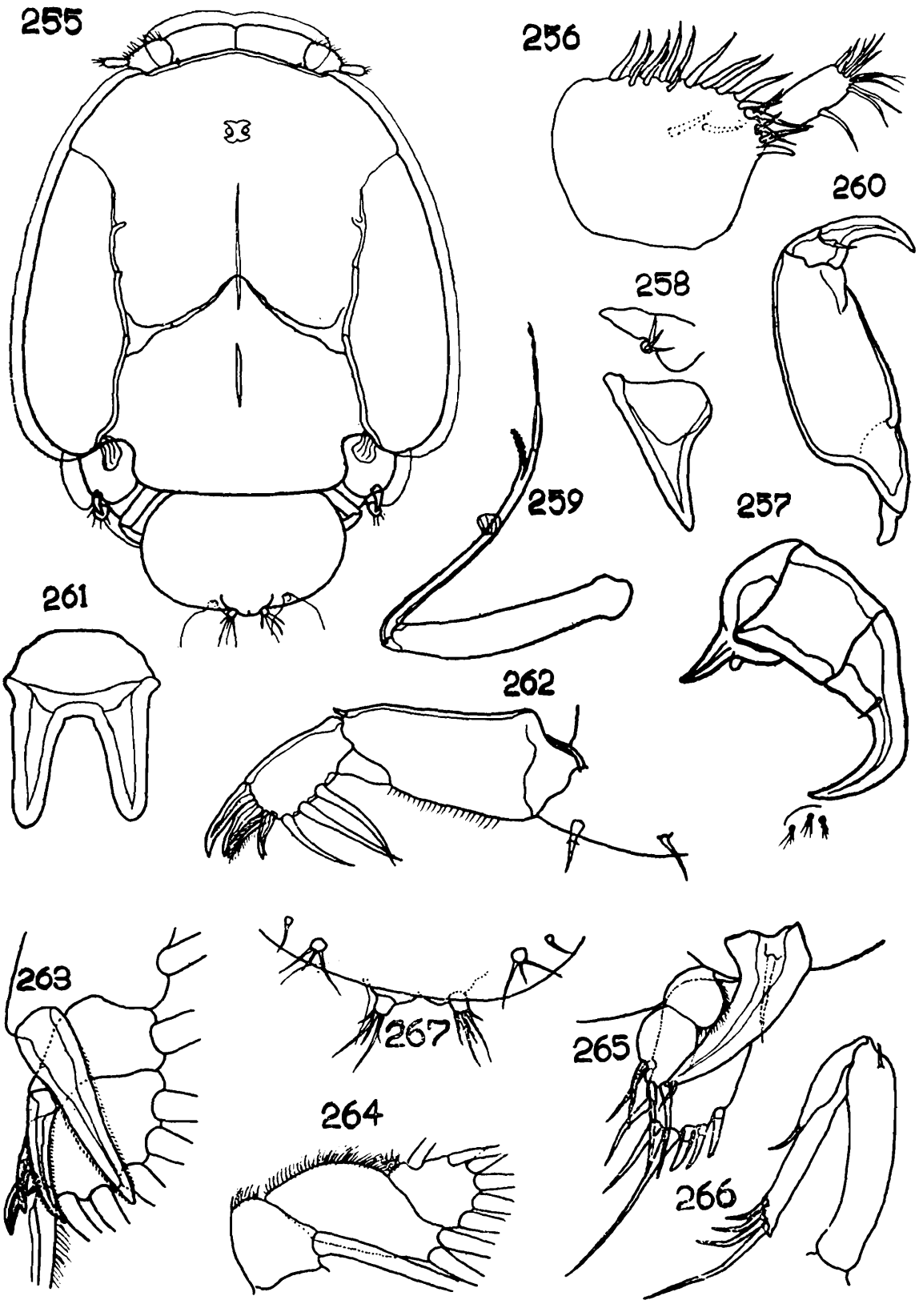
252. Leg 3 ; 253. Leg 4 ; 254. Vestigial legs and uropod on genital complex, Ventral view.



Figs. 252-254

Figs. 255-267. *Anuretes plataxi* sp. nov. Female.

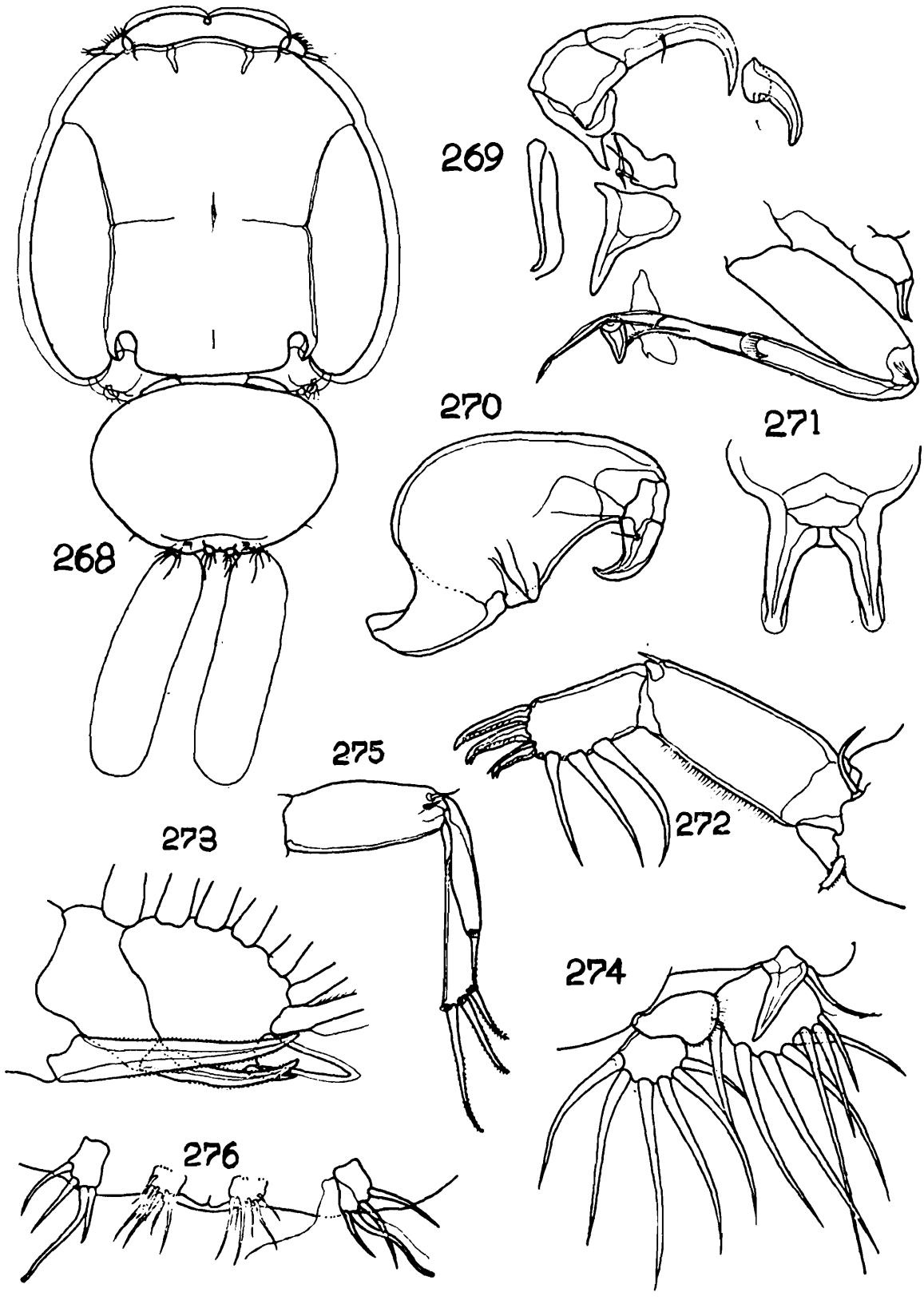
255. Female, dorsal view ; 256. First antenna ; 257. Second antenna, 258. First maxilla ; 259. Second maxilla ; 260. Maxilliped ; 261. Sternal furca ; 262. Leg 1 ; 263. Leg 2, exopod, 264. Same, endopod, 265. Leg 3 ; 266. Leg 4, 267. Vestigial legs and uropod on genital complex, ventral view.



Figs. 255-267

Figs. 268-276. *Anuretes plectorhynchi* Yamaguti. Female

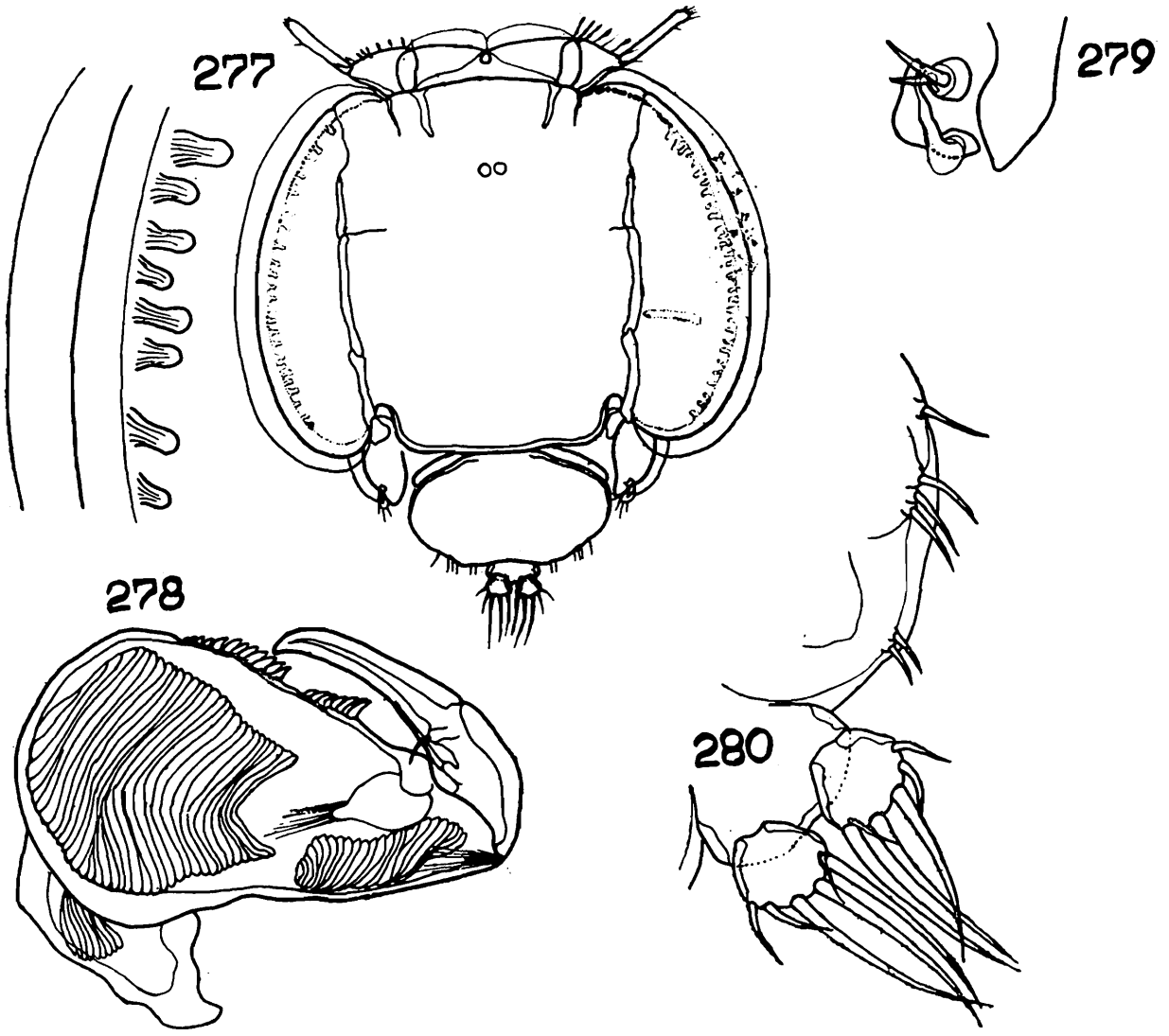
268. Female, dorsal view; 269. Second antenna; postantennary process, first maxilla, second maxilla and maxillary whip; 270. Maxilliped; 271. Sternal furca; 272. Leg 1; 273. Leg 2, exopod; 274. Leg 3; 275. Leg 4; 276. Genital complex with vestigial legs and uropod.



Figs. 268-276

Figs. 277-280. *Anuretes rotundus* sp. nov. Male.

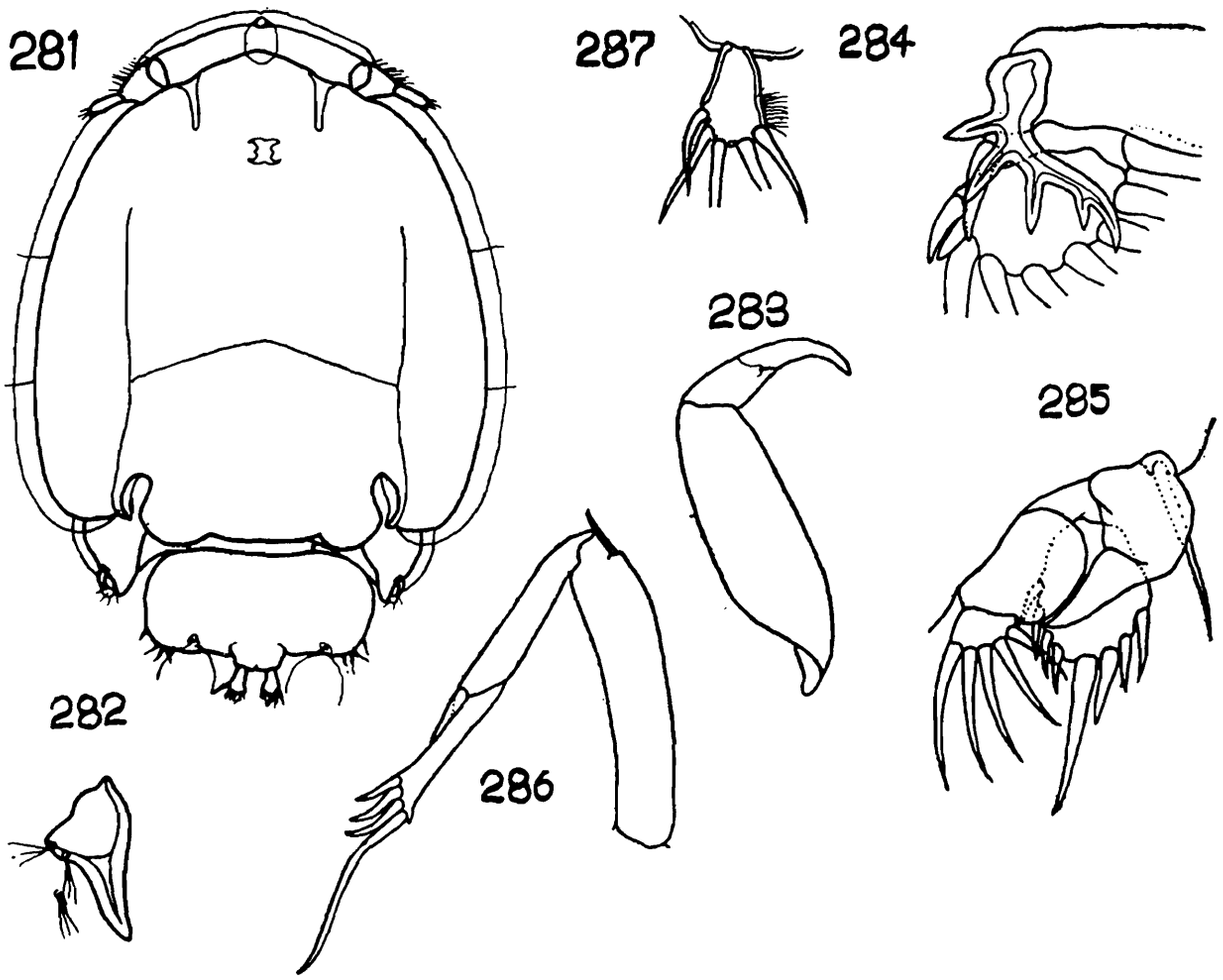
277. Male, dorsal view ; 278. Second antenna, 279. First maxilla ; 280. Distal part of genital complex, ventral view shoring vestigial legs, abdomen and uropods.



Figs. 277-280

Figs. 281-287. *Anuretes serratus* Shiino. Female.

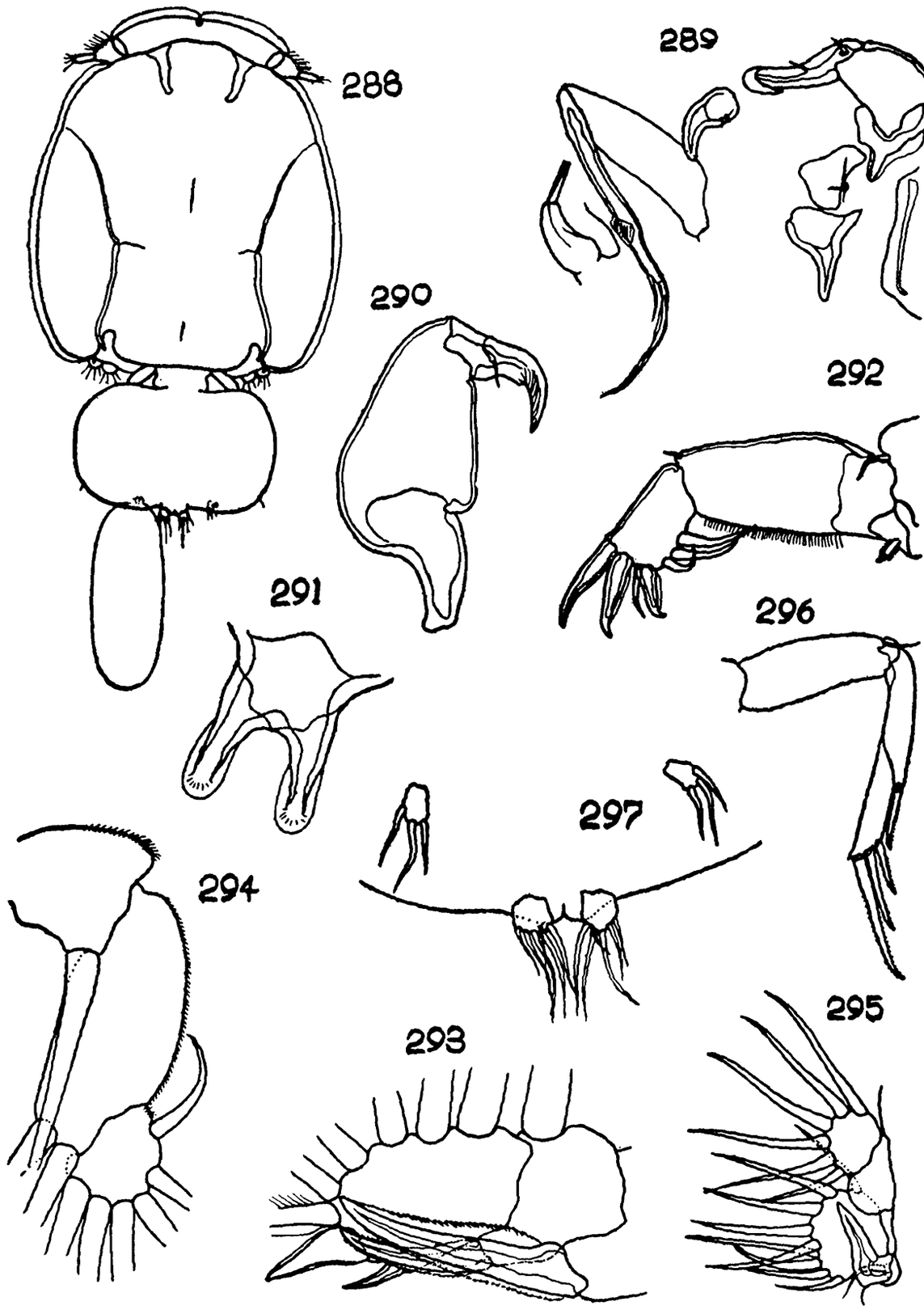
281. Female, dorsal view ; 282. Postantennary process ; 283. Maxilliped ; 284. Leg 2, exopod ; 285. Leg 3 ; 286. Leg 4 ; 287. Uropod.



Figs 281-287

Figs. 288-297. *Anuretes yamagutii* sp. nov. Female.

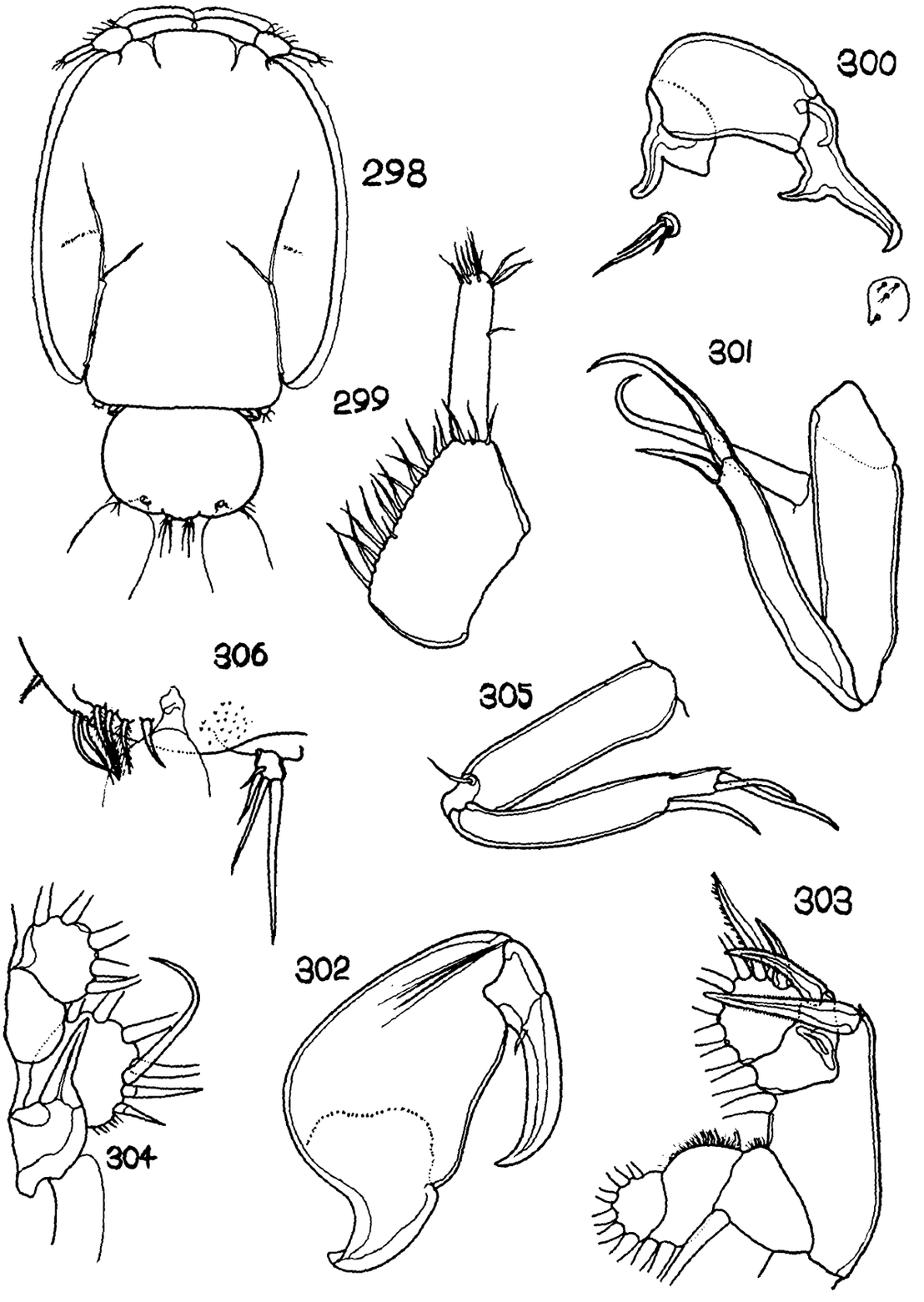
288. Female, dorsal view ; 289. Second antenna, postantennary process, first maxilla, second maxilla and maxillary whip. 290. Maxilliped ; 291. Sternal furca ; 292. Leg 1, 293. Leg 2, exopod ; 294. Same, endopod ; 295. Leg 3 296. Leg 4 ; 297. Distal part of genital complex, ventral view showing vestigial legs and uropods.



Figs. 288-297

Figs. 298-306. *Pseudanuretes indicus* sp. nov. Female.

298. Female, dorsal view ; 299. First antenna ; 300. Second antenna and basal papilla of first maxilla. 301. Second maxilla and maxillary whip ; 302. Maxilliped ; 303. Leg 2 ; Leg 3, 305. Leg 4 ; 306. Distal part of genital comp'ex, ventral view.



Figs. 298-306