STUDIES ON THE COPEPOD FISH PARASITES OF KERALA COAST

THESIS

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By

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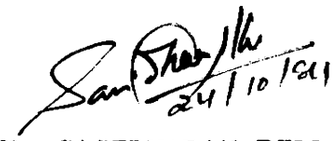
DECLARATION

I hereby declare that the findings provided in the thesis were not previously formed the basis of the award of any degree, diploma, associateship, fellowship or other similar title of recognition in any University or Institution.



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CERTIFICATE

This is to certify that this thesis is an authentic record of the work carried out by Shri. N.K. Sasidharan Pillai, M.Sc., under my supervision and guidance and that no part thereof has been submitted for any other degree.

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A C K N O W L E D G E M E N T

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C O N T E N T S

INTRODUCTION

The study of copepods parasitic on fishes was initiated by Linnaeus (1746) with a report on Lernaea. His study was succeeded by the work of Muller (1785) on Caligus. Earlier workers who had pioneered in the study of parasitic copepods were Herman (1804), De La Roch (1811), Oken (1815), Leach (1816), Blainville (1822), Lesuer (1824), Risso (1840) and Dana (1852). In the latter half of the nineteenth century study of this interesting group of animals was taken up by workers like Gestacker (1853), Steenstrup & Lutken (1861), Kroyer (1863), Heller (1865), Hesse (1871), Richards (1876), Bassett-Smith (1898) etc. During early twentieth century Normann (1903), Wilson (1907), T.Scott & A.Scott (1913) and Leach-Sharp (1935) contributed much in this field.

Later on Kirtisinghe (1932), Yu (1935), Yamaguti (1936), Heegaard (1940) and Shiino (1952) penetrated deep into the subject and published a large number of papers. Recent authors in this field like Kabata (1958-'83), Hewitt (1963-'71), Pillai (1961-'83), Cressey and Ho (1966-'83) etc. are worth mentioning.

Bassett-Smith (1898) started the study of parasitic copepods on the marine fishes of the Indian waters and reported thirty species collected from the Bombay coast and the Persian Gulf. For nearly a half a century, the study of the parasitic copepods of fishes of the Indian waters was not carried out. Afterwards Kirtisinghe (1933-'64) taken up the copepodal study mainly from the Ceylon waters. Ten papers brought out by him form a significant contribution in this field and his review in 1964 is very helpful to identify the parasites of this region.

Later, a number of Indian Scientists came forward to study the subject in deep. Gnanamuthu (1947-'60) made his collections from the Madras coast and Renganekar (1955-'63) examined the specimens of the Bombay coast. The twenty four papers describing thirty two species by Gnanamuthu and the thirty two species reported by Ranganekar form a remarkable contribution in this subject. Redkar (1949-'50), P.G. Ranganekar and Murti (1949), Rao (1950-'51),

Kurian (1950-'61), Tripathi (1960-'62), Pillai (1961-'83) and Hameed (1972-'77) are noteworthy for their contribution in the study of parasitic copepods.

Pillai's (1961-'83) study on the parasitic copepods of Indian waters is a milestone in the field. He has published fourty five papers describing more than two hundred species from the west coast of India and brought to the notice of the scientific world a good number of new species. The review brought out by Pillai (1965b) containing two hundred and fourty eight species is a ready reckoner to the beginners in this branch of study. Pillai (1962 b, 1968a, 1969, 1978) supplemented the earlier descriptions with detailed illustrations, which are worthmentioning. Apart from the Indian scientists, Wilson (1906), Heegaard (1943), Shiino (1958a), Cressey (1967c), Lewis (1969) and Kabata (1967-'83) also contributed to the study of parasitic copepods of the Indian region.

Those who are working in this field in the Indian region force to refer the literature of foreign authors, since the report of the same or

related species may be made from different oceans. In this regard, the contribution of C.B. Wilson (1905-'42) is significant. His collections were mainly from the North American waters, include several new species from that locality. The classification proposed by Wilson (1932) is even now valid in all respects.

Yamaguti (1936-'63) and Shiino (1942-'66) made collections from the Japanese waters and their reports include several new species and new records. Yamaguti (1963) proposed a classification and published all relevant available literature with illustrations but it is not fully accepted. The work " Parasitic Copepoda and Branchiura of Fishes" is a very helpful primer for referring the earlier literatures.

The copepods of the South African Museum were studied by Bernard (1955). Heegaard (1962) studied the copepods of the Australian region. Lewis (1963-'69) and Hewitt (1963-'61) investigated the copepods of the Hawaiian waters. Cressey's (1966-'83) extensive work on several aspects of the parasitic copepods, specially the host-parasite relationship

is unique. The studies on the copepods of the needle fishes by Cressey and Collette (1970) and that of Scombroid fishes by Cressey, Collette and Russo (1983) are of great value. Cressey's revision of the family Pandaridae (1967b) still remains as a valuable reference to those who concentrate on the parasitic copepods of Elasmobranchs.

Ho (1966-'83) made an extensive study of the copepod parasites of the American waters. He made a detail study of the family Chondracanthidae and set right the controversies and errors prevailed in the taxonomy of Chondracanthids (1970-'78).

The work of Kabata (1958-'83) is a valuable contribution in this field. He made collections mainly from the Pacific and Atlantic Oceans. His work on the parasitic copepods of the Australian fishes is substantial. Kabata's presentation of literature is a new trend in this field and it is widely accepted and adopted by recent investigators. He has corrected the errors and anomalies of the earlier descriptions. Kabata (1979) proposed a classification based on the primitive charactors of the copepods. His studies (1974a,b) on the functional morphology of the copepods are noteworthy.

Like other crustacean groups, study of the parasitic copepods of fishes have also undergone considerable refinement and improvement. The works of Kabata (1979), Cressey and Cressey (1979, 1980) emphasize the need for a revision of the earlier studies. A number of new species described by the earlier workers need revision based on the information gathered. This has been indicated by a large number of synonyms observed by Kabata (1979). Similar type of work was undertaken by Pillai (1962b), Vervoort (1969) and Ho (1970). Pillai (1969) re-described the type specimens deposited in the British Museum and supplemented it with the descriptions of Bassett-Smith (1898). Vervoort (1962, 1969) revised the Bomolochids and Ho (1970) made a revision of Chondracanthids.

Recent reviews rectifying the errors on the systematic position of the parasitic copepods needs special mention. Comprehensive reviews of Bomolochidae and Taeniacanthidae by Balaraman (1983a,b), Caligidae by Prabha (1983) and Lernanthropidae by Jayasree (1983) are of importance in this regard.

Earlier works on the copepods were mainly centered on the taxonomical studies. This trend has changed and several workers recently attempted to

study the functional morphology, anatomy, life-history and host-parasite relationship of the copepods. Notable among such works from Indian region are that of Natarajan and Nair (1971), John et al. (1971) and John and Nair (1973, 1976). Kannupandi's study (1975, 1976) on the cuticular adaptation of the copepod Pennella elegans is typical.

Lewis's (1969b) study on the structure of the cephalic appendages and the study of locomotory mechanism in Caligidae by Kabata and Hewitt (1971) and Kabata's (1974b) work on the mouth and mode of feeding in Caligidae are significant. The extensive studies on the development of this group of animals by Lewis (1963), Izawa (1969, 1973), Kabata (1972), Kabata and Cousens (1973) are worthmentioning.

Classification.

The order Copepoda has been re-classified by Yamaguti (1963), but authors in this field are not following this classification. Wilson's (1932) classification is accepted by almost all workers. Wilson (1932) divided the order Copepoda into eight suborders viz., Arguloida, Calanoida, Harpacticoida, Cyclopoida, Nothodelphoida, Monstrilloida, Caligoida and Lernaeopoida.

Yamaguti (1963) upgraded the status of order Copepoda to that of a class subsequently Wilson's suborders to orders. Thus he has divided the sub-class Copepoda into six orders viz., Cyclopidea, Caligidea, Philichthyidea, Andreinidea, Lernaeopodidea and Sarcotacidea.

Kabata (1979) further revised the classification of copepods based on the primary or primitive characters. These primitive characters are less susceptiable to parallelism and convergence. These include the morphological features inherited from the ancestors and recognisably retained by the later generations. Kabata observed that the structure of the mouth and the mouth parts remain without much changes in the evolutionary process. These reliable primitive characters give the basic clues to the phylogeny.

As per Kabata's (1979) proposed classi-fication the order Copepoda is divided into three suborders, viz., Poecilostomatoida, Siphnostomatoida and Cyclopoida. The suborder Poecilostomatoida is subdivided into five families, viz., (1) Bomolochidae (2) Taeniacanthidae (3) Ergasilidae (4) Chondracanthidae and (5) Philichthydae. The suborder Siphonostomatoida

is divided into fourteen families viz., (1) Caligidae (2) Euryphooridae (3) Trebiidae (4) Pandaridae (5) Cecropidae (6) Dichelesthiidae comb. nov. (7) Eudactylinidae comb. nov. (8) Kroyeriidae fam. nov. (9) Pseudocycnidae comb. nov. (10) Hatschekiidae fam. nov. (11) Lernanthropidae fam. nov. (12) Pennellidae (13) Sphyriidae and (14) Lernaeopodidae. Suborder Cyclopoida includes a single family, ie. Lernaeidae.

The family Bomolochidae and Taeniacanthidae included in the suborder Cyclopoida are transferred to newly created suborder Poecilostomatoida. Family Dichelesthiidae, Eudactylinidae and Pseudocycnidae are re-organised by removing few genera. Three new families are suggested, viz., Kroyeriidae, Pseudocycnidae and Lernanthropidae.

Though, Kabata's classification is easy to follow and have advantage over the classifications suggested by Wilson and Yamaguti, due to the limited acceptance of this, I intend to follow the classification of Wilson (1932), which was accepted by the copepodologists throughout the world. Wilson originally included family Chondracanthidae in the suborder Lernaeopodoida, but after detailed study several investigators proposed the transfer of this family

to the more related suborder Cyclopoida. For the present study this transfer is accepted and rest of the classification is the same as that of Wilson.

Terminology.

Homology of the cephalic appendages of copepods still remains as an unsettled problem. Heegaard (1947), Lang (1946) and Lewis (1963) studied in detail the homology of the mouth parts of copepods. But they could not come to an agreement. In the earlier works of Wilson the cephalic appendages were described as two pairs of antennae, one pair of mandible, two pairs of maxillae and two pairs of maxillipeds. Lewis's (1963) study on the development of Lepeophtherius dissimulatus Wilson revealed that what was still then described as first and second maxilla in Caligidae are not true appendages, but cuticularised processes. So he has renamed the first maxilla as postantennal (antennary) process and the second maxilla as postoral process. As a result, the first maxilliped became the maxilla and second maxilliped as simply maxilliped. Majority of the present day workers follow the terminology proposed by Lewis (1963). This method has some added advantage over the earlier ones.

According to Hewitt (1967) the postoral process of Pandarids is the second maxilla and the maxilla, the first maxilliped. Cressey (1967b) described the postoral process of Pandarids as the first maxilla and the first maxilliped described by Wilson and Hewitt as the second maxilla.

Kabata (1979) studied the homology of the appendages of the copepods and suggested a generalised pattern applicable to all groups. He considers the postoral process described by Lewis as first maxilla and maxilla as second maxilla. The postantennary process is not recognised as a true appendage by him.

For the present study the terminology proposed by Lewis is adopted for the cephalic appendages of Caligids, whereas for the remaining groups the terminology proposed by Wilson is followed. In Caligidae the postantennary process is invariably used as an important character. For the present study this character is also taken into account. The terminology used for the cephalic appendages of Caligids in the present study are first antenna, second antenna, postantennary process

(postantennal), post oral process, maxilla and maxilliped. For the rest of the groups the terminology followed is first antenna, second antenna, first maxilla (maxillules), second maxilla, first maxilliped and second maxilliped.

Materials.

The specimens described in the present study were collected by regular examination of the fishes landed at Cochin. The new species and new records in the present collections show that despite the detailed investigation by Pillai and Hameed there is considerable scope for further work. It was with this idea that this problem was taken up for the present investigation.

Present collection consists of seventy seven species of which fourteen are new species, two new records from the Indian waters and ten new host records. In the case of already known species descriptive notes are avoided. Short notes are added as remarks for those species already described. A few species are however, redescribed, since their

available descriptions are found to be inadequate in one way or other. All the new species are described in detail. Details regarding the types are not included in the text, will be brought out at the time of the publication of the thesis. Holotypes and allotypes will be deposited in the National Museum, Calcutta and paratypes will be deposited in the Museum of the Department of Industrial Fisheries, University of Cochin, Cochin.

CLASSIFIED LIST OF SPECIES

Order Copepoda

Suborder Cyclopoida

Family Taeniacanthidae

Genus Taeniacanthus Sumpf

Taeniacanthus lagocephali Pearse

Taeniacanthus longicaudus Pillai

Taeniacanthus indicus Pillai

Family Bomolochidae

Genus Bomolochus Nordmann

Bomolochus selaroides Pillai

Bomolochus megaceros Heller

Bomolochus decapteri Yamaguti

Genus Nothobomolochus Vervoort

Nothobomolochus multispinosus (Gnanamuthu)

Family Chondracanthidae

Genus Chondracanthus De La Roche

Chondracanthus trilobatus Pillai

Genus Protochondracanthus Kirtisinghe

Protochondracanthus alatus (Heller)

Genus Heterochondria Yu

Heterochondria Pillaii (Pillai)

Suborder Caligoida

Family Caligidae

Genus Caligus Muller

Caligus quadratus Shiino

Caligus seriolae Yamaguti

Caligus kanagurta Pillai

Caligus annularis Yamaguti

Caligus hamruri Pillai

Caligus phipsoni Bassett-Smith

Caligus cordyla Pillai

Caligus epinepheli Yamaguti

Caligus cybii Bassett-Smith

Caligus priacanthi Pillai

Caligus confusus Pillai

Caligus savala Gnanamuthu

Caligus infestans Heller

Caligus longicervicis Gnanamuthu

Caligus parapetalopsis Hameed & Pillai

Caligus arii Bassett-Smith

Caligus robustus Bassett-Smith

Caligus pelagicus Kurian

Caligus nautili sp. nov.

Caligus industri sp. nov.

Caligus kaloori sp. nov.

Genus Pseudocaligus A.Scott

Pseudocaligus indicus Hameed

Pseudocaligus fistulariae Pillai

Pseudocaligus lunari sp. nov.

Genus Parapetalus Step. & Lutk.

Parapetalus hirsutus (Bassett-Smith)

Parapetalus occidentalis Wilson

Parapetalus orientalis Step. & Lutk.

Parapetalus longipennatus Rangnekar

Parapetalus dewani sp. nov.

Genus Hermilius Heller

Hermilius helleri Pillai

Hermilius pyriventris Heller

Genus Lepeophtheirus Nordmann

Lepeophtheirus spinifer Kirtisinghe

Lepeophtheirus longipalpus Bassett-Smith

Family Euryphoridae

Genus Tuxophorus Wilson

Tuxophorus caligodes Wilson

Genus Gloiopotes Step. & Lutk.

Gloiopotes watsoni Kirtisinghe

Genus Euryphorus Milne-Edwards

Euryphorus nordmanni Milne-Edwards

Genus Alebion Kroyer

Alebion carchariae Kroyer

Family Trebidae

Genus Trebius Kroyer

Trebius exilis Wilson

Family Pandaridae

Genus Pandarus Leach

Pandarus cranchii Leach

Pandarus niger Kirtisinghe

Genus Pseudopandarus Kirtisinghe

Pseudopandarus longus (Gnanamuthu)

Family Anthosomatidae

Genus Lernanthropus Blainville

Lernanthropus trifoliatus Bassett-Smith

Lernanthropus cornutus Kirtisinghe

Lernanthropus otolithi Pillai

Lernanthropus indicus (Pillai)

Lernanthropus aneezi sp. nov.

Family Eudactylinidae

Genus Eudactylina Van Beneden

Eudactylina diaboli sp. nov.

Eudactylina eulamini sp. nov.

Genus Kroyeria Van Beneden

Kroyeria longicauda Cressey

Kroyeria elongata Pillai

Kroyeria melanopteri sp. nov.

Genus Nemesis Risso

Nemesis robusta (Van Beneden)

Family Dichelesthiidae

Genus Hatschekia

Hatschekia sphyraeni Pillai

Hatschekia gastri sp. nov.

Family Pseudocycnidae

Genus Pseudocycnus Heller

Pseudocycnus armatus (Bassett-Smith)

Pseudocycnus appendiculatus Heller

Family Lernaeidae

Genus Lernaeenicus Le Sueur

Lernaeenicus ramosus Kirtisinghe

Lernaeenicus hemirhamphi Kirtisinghe

Suborder Lernaeopodoida

Family Lernaeopodidae

Genus Thysanote Kroyer

Thysanote eleutheronema Rangnekar

Thysanote appendiculata (Step. & Lutk.)

Genus Clavella Oken

Clavella japoni sp. nov.

Genus Clavellopsis Wilson

Clavellopsis appendiculata Kirtisinghe

Genus Brachiella Cuvier

Brachiella trichiuri Gnanamuthu

Brachiella albida (Rangnekar)

Family Naobranchidae

Genus Naobranchia Hesse

Naobranchia theraponi sp. nov.

Naobranchia cochinensis sp. nov.

DESCRIPTION OF SPECIES

Order COPEPODA

Suborder CYCLOPOIDA

Family Taeniacanthidae

Genus *Taeniacanthus* Sumpf

Taeniacanthus lagocephali Pearse

Figs.1-7.

Taeniacanthus lagocephali Pearse, 1952, p.8, figs.1-4.

Irodes lagocephali Pillai, 1963c, p.124, fig.7.

Taeniacanthus lagocephali Ho, 1969, p.112, figs.1-5.

Material:

Fifteen females were collected from the gill filaments of *Gastrophysus lunaris* (Bloch) at Cochin.

Distribution:

Texas coast, West coast of India.

Total length, 2.8 mm.

Remarks:

Based on the close resemblance of

T. lagocephali Pearse (1952) with that of Irodes tetradontis Bassett-Smith (1898a), Pillai transferred this species to the genus Irodes and renamed it as Irodes lagocephali. But Ho (1969) studied the type specimen of Pearse and re-established its validity and affinity with the genus Taeniacanthus and transferred Irodes lagocephali to Taeniacanthus lagocephali. Pillai (1963) had given a detailed description of this species. Kabata (1979) also accepted the transfer and the remarks made by Ho (1969).

As observed by Pillai the setae on the basal segment of the first antenna are not hooked. It is observed that the setae are simple and plumose and other details of the species agree with the illustration of Pillai. The second antenna in the present specimen shows certain variations. The distal segment having a row of corrugated ridges and four stout distal spines. The structure of the maxilliped shown by Pillai is not agreeing with that of the present specimen. But it agrees with the illustration of Ho (1969). The distal segment of the maxilliped with a broad based distally pointed

claw having a basal bifurcation, apically denticulate and slender. Other details are same as that of Pillai and Ho.

The species can be identified by the general body shape, nature of the first antenna having highly plumose marginal setae and the nature of the maxilliped with a basal bifurcation.

Taeniacanthus longicaudus Pillai

Taeniacanthus longicaudus Pillai, 1963c, p.116, fig.3.

Material:

Twelve females were collected from the gills of Gymnura poecilura (Shaw) examined at Cochin.

Total length, 2.8 mm.

Distribution:

West coast of India.

Remarks:

Present collection agrees in all major

details with that of the original description by Pillai (1963). This species can be identified by the outer spines on the exopod and the modified spines on the endopod of the third leg.

Taeniacanthus indicus Pillai

Taeniacanthus indicus Pillai, 1963c, p.112, fig.1.

Material:

Twenty females from the buccal cavity of Sphyrna zygaena (Linnaeus) and five females from the gill of Scoliodon sorrakowah (Cuvier) were collected at Cochin.

Total length, 2.3 mm.

Distribution:

West and east coasts of India.

Remarks:

Pillai (1963) described this species in detail, the present specimen agrees in all major details with the description by Pillai. Minor variations observed are of less taxonomic importance. The rostral projection of the carapace in the present

specimen is less prominent, the genital segment is smaller and shorter than the first abdominal segment. The terminal segment of the exopod of the third leg bears one additional short pectinate spine near the base of the claw like spine.

Scoliodon sorrakowah and Sphyrna zygaena are new host records for this species.

Family Bomolochidae

Genus Bomolochus Nordmann

Bomolochus selaroides Pillai

Bomolochus selaroides Pillai, 1965a, p.47, fig.19.
Parabomolochus selaroides Pillai, 1965a, p.1565, fig.14.

Material:

Three females were collected from the gills of Carangoides malabaricus (Bloch) at Cochin. The parasites were found to be embedded in the mucus.

Total length, 1.9 mm.

Distribution:

West coast of India.

Remarks:

The present specimen of my collection agrees

in all major details with the original description of the species by Pillai (1965). In the present specimen the third trunk segment is found to be overlapping the fourth segment.

This species was originally described by Pillai (1965) under Bomolochus and later transferred to Parabomolochus Vervoort. As the validity of the genus Parabomolochus ceases, this species was again retransferred to Bomolochus, Vervoort (1969).

This species can be identified by the modified setae of the first antenna and the armature of legs. Carangoides malabaricus (Bloch) is a new host record for this species.

Bomolochus megaceros Heller

Bomolochus megaceros Heller, 1865, p.153, pl.13, fig.2; Bassett-Smith, 1898, p.358, pl.10, fig.1; Pillai, 1965a, p.43, fig.17.

Parabomolochus megaceros Vervoort, 1962, p.43.

Material:

Ten females from the branchial cavity of Parastromateus niger (Bloch) were collected at Cochin.

Total length, 2.5 mm.

Distribution:

Indian Ocean, Ceylon and South west coast of India.

Remarks:

The specimen of the present collection is similar to that of Pillai's (1965) description. Pillai in his remarks pointed out that Heller's description is defective and lacks the details of the appendages and gave a detailed description. Bomolochus megaceros Heller was later transferred by Vervoort (1962), creating a genus Parabomolochus. After detailed study of the family Bomolochidae Vervoort (1969) brought back this species to Bomolochus.

In the present specimen the fourth thoracic segment is found to be overlapped by the third segment. B. megaceros can be identified easily by the shape of the first antenna and peculiar spinulation of the second and third segment. The type host of the parasite remains to be Parastromateus niger (Bloch). By assessing the similarities of Bomolochus decapteri Shen (1957) with B. megaceros, Vervoort (1962) opined that both are similar and can be made synonymous.

Bomolochus decapteri Yamaguti

Figs.8-20.

Bomolochus decapteri Yamaguti, 1936a, p.4 & 5, figs.49-60.

Parabomolochus decapteri Vervoort, 1962, p.45.

Material:

Two ovegerous females were collected from the gill cavity of Atropus atropus (Bloch) examined at Cochin.

Distribution:

Japan, Pacific and West coast of India.

Female:

Cephalothorax roughly semicircular with the rostral plate visible completely. The 'V' shaped groove extend beyond the middle line. Posterior margin truncated, nearly two times broader than long, first thoracic segment fused with the head to form the cephalothorax. Free thoracic segments gradually narrow posteriorly. Fourth and fifth thoracic segments comparatively small. First free thoracic segment laterally overlapping the second free thoracic segment. Genital segment

laterally produced. Abdomen three segmented. Egg sac long and reaching beyond the caudal lamina. Caudal lamina one segmented with two median long and two short lateral plumose setae.

Basal part of the first antenna three segmented. Segments gradually narrowing towards the distal end and reinforced with chitinized plates. Outer margins of the segments with fourteen sensory plumose setae and chitinized finger like process extends to the plumose setae. Fourth seta highly modified, stout, robust and curved at the tip forming a strong hook. Third segment distally bears two sensory plumose setae of equal size. Distal flangellum three segmented. First segment with a circlet of naked setae at the distal end. Distal segment laterally plumose and distally with three large and four small naked setae.

Basal segment of the second antenna strong and stout, longer than the distal segment and free of armature. Second segment comparatively small forming the articulation basis for the distal segment. Third segment highly modified with two finger like processes distally and laterally it bears a row of lamillae. Distally the segment is having five long processes.

Mandible two segmented. Basal segment stout and strong, distally narrows and curved inwardly. Distal segment is modified into a claw. Maxillule is represented by a papilla bearing four plumose setae of roughly equal in length. Maxilla two segmented, basal segment stout and roughly squarish. Second segment comparatively slender elongated and narrows towards the distal end. Distally it bears two blunt claws of equal length. The claws are totally plumose and sclerotized. Maxiliped two segmented, basal segment stout and strong. Distally it bears two plumose setae on its outer margin, one is long and the other short. Second segment modified into a pointed sigmoid claw, sharply pointed and medially with an acute axillary claw. Base of the distal claw posseses a large plumose seta.

First leg biramous, basipod and rami highly flattened. Basipod two segmented. Basal segment large and about two times broader than long. Second segment very large. Exopod two segmented, basal segment distally bears a sharp spine. Second segment bears six roughly equal plumose setae and an outer spine. Endopod three segmented. First and second segments bear a single outer plumose seta and its inner margins lined with five setules. Distal segment armoured with six plumose setae.

Basipod of the second leg two segmented, basal segment fused with the body. Second segment comparatively large and transversely elongated. Rami three segmented. Exopod three segmented, basal segment with a sharp spine at its disto-lateral end. Second segment externally bears a spine and internally a plumose seta. Distal segment with five plumose setae and four outer spines. Spines of the second and third segments with denticles on either side and with flagellum distally. Outer margins of the segment close to the spine with patches of sharp denticles. Endopod segments flattened, basal segment internally bears a single plumose seta and second segment having two plumose setae. Base of these setae thickened and covered with spinules. Distal segment with three plumose setae and two sharp spine internally. Inner margin of all the segments lined with setules.

Third leg biramous, rami three segmented. Outer basal corner of the basal and second segment of exopod bears unilaterally denticulate sharp spines. Third segment with two spines and six plumose setae. The spines with sharp spinules at one side and with a flagellum distally. Outer quarter of the segment

with patches of spinules, irregularly arranged. Endopod comparatively flattened. Basal and the second segments bear a single plumose seta and two sharp spines.

Basipod of the fourth leg comparatively large. Rami three segmented. Outer margins of the exopodal segments with short but sharp spinules arranged in patches. First and second segment bears strong spine on its outer distal corner and the spines are denticulate on one side with distal flagellum. Second segment bears internally a plumose seta. Basal segment of endopod with a narrow base and broad distal end, bearing a single naked seta internally. Second segment nearly cylindrical with a naked seta at the disto-lateral corner. Third segment slightly elongated, distally bearing two lateral short spines, denticulate on one side and a median elongated naked seta.

Fifth leg uniramous, rami two segmented, basal segment short longer than broad, distal segment elongated broader at the middle. Inner margin lined with rows of fine plumules, distally it bears three naked setae. Median seta comparatively long and a submedian seta on its outer margin.

Anal lamina one segmented broader at the base and narrowing towards the distal end. Distally it bears two long and two small naked setae and an outer median seta.

Total length, 1.8 mm.

Remarks:

The present specimen agrees with Bomolochus decapteri Yamaguti (1936) in all major details. But present collection of this species from the gills of Atropus atropus (Bloch) is a new host record. The fourth modified seta on the basal segment of the first antenna appears to be more stout in the present specimen. Distal segment of the second antenna having two flat processes of equal in size and breadth in the present specimen, whereas in Yamaguti's collection the inner process is comparatively thinner than the outer process. Vervoort (1962) included this species in the newly created genus Parabomolochus. Vervoort (1969) retransferred the same back to the genus Bomolochus.

This species can be identified by the first antenna having its fourth seta modified into a strong and robust hook and the distal segment of second antenna

bearing two pairs of processes and lamillate inner margin of the third segment.

Genus Nothobomolochus Vervoort

Nothobomolochus multispinosus (Gnanamuthu)

Figs.21-35.

Bomolochus multispinosus Gnanamuthu, 1947, p.309, figs.1-5.

Bomolochus multispinosus Pillai, 1965a, p.45, fig.18.

Nothobomolochus multispinosus Vervoort, 1962, p.68.

Material:

Six females were collected from the gills of Dussumieria acuta Valenciennes examined at Cochin.

Distribution:

West and East coasts of India.

Female:

Cephalothorax broader than long, anteriorly rounded with its posterior margin inwardly curved, median rostral plates visible. Anterior 'V' shaped groove converges medially and extends upto the middle of the carapace. Second and third thoracic segments sub equal

in size, about two times the width of length, laterally rounded with nearly truncated posterior margin. Fourth segment small, and broader than long. Fifth segment laterally produced into conical lobe. Genital segment barrel shaped, abdomen three segmented, segments roughly squarish and subequal in length. Caudal lamina elongated and posteriorly narrowing with one long and two short setae.

First antenna with three segmented basal part and three segmented distal flagellum. Basal segment broader than long, second and third segments distally narrowing. Outer margin of the basal segment having twelve normal plumose setae. Third, fourth and fifth setae modified, more than three times the length of the normal setae, apically curved and pointed. Sclerotized processes extend upto the tip of the modified setae. Second segment with two very long slender setae of plumose nature. First and second segments of the distal flagellum cylindrical, subequal in length. First segment having a median and a distal seta and second segment with three naked setae. Distal segment slender rounded at the tip and having a tuft of setae.

Second antenna four segmented, first segment long and roughly cylindrical. Second segment small with a distal spine. Third segment comparatively long with rows of denticles arranged on its entire length, distally having a patch of lamillar process. Fourth segment short having an outer lining of lamellae and five nonplumose slender elongated processes curved distally.

Mandible two segmented, basal segment broad and distal segment long bearing two claws of equal size. First maxilla having a basal papilla bearing two long and two short plumose setae. Second maxilla two segmented, basal segment large and distal segment short having two claws of subequal length. The claws are plumose on either side. Maxilliped two segmented, first segment broader at the base and distally narrowing and having a large plumose seta apically. Distal claw with a sigmoid curve sharply pointed with a short basal seta.

First leg biramous, basipod two segmented and basal segment with a distal thick plumose process. Second segment transversly elongated. Exopod two segmented, first segment internally bears two plumose setae and distal segment with four stout plumose setae. Endopod broad, flattened and three segmented. First

and second segments with one plumose seta each at its inner margin.

Second leg biramous, basipod two segmented and transversly elongated. Exopod three segmented, basal segment having an external spine with distal flagellum. Second segment broader than long with an outer spine and an inner seta. Endopod three segmented, segments broad and flattened, basal segment comparatively short with an elongated seta on the inner margin. Second segment broader than long having two inner plumose setae. Distal segment bears three plumose setae and two small blunt spines.

The basipod of the third leg broad and rami three segmented. Basal segment of the exopod with a distal spine. Second segment with an inner plumose seta and an outer spine. Distal segment with two spines and five plumose setae. Endopod three segmented, first segment with a plumose seta. Second segment longer than broad having two plumose setae. Distal segment roughly squarish with two plumose setae and two modified small spines.

The basipod of fourth leg is same as that of the third leg. Rami three segmented. Basal segment

of the exopod narrow at the base and distally broader having a single spine with flagellum. Second segment comparatively long with six plumose setae and two spines. First and second segment of the endopod with a single plumose seta each and the distal segment with two short apical spines and one long plumose seta.

Fifth leg two segmented, basal segment short and the distal segment more than three times the length of basal segment and having three naked setae. Anal lamina longer than broad narrowing towards the distal end. Distal seta highly elongated and plumose in nature. Laterally it bears two naked spines.

Total length, 1.8 mm.

Remarks:

The present specimen agrees in structural details with Nothobomolochus multispinosus (Granamuthu, 1947). But Gnanamuthu's diagrams are vague and difficult to compare the details. Vervoort (1962) in his review of the Bomolochidae commented that the description of Gnanamuthu is not sufficient and illustrations are not in detail. Pillai (1965a) provided a detailed description of the species. The modified third, fourth and fifth setae

of the first antenna in the present specimen is of almost equal in length, where as the third seta is found to be smaller in Pillai's illustration. As observed by Pillai in the present specimen the first maxilla posses four plumose setae instead of three described by Gnanamuthu. As observed by Gnanamuthu, the maxilliped in the present specimen possesses only two setae. All the leg endopods are three segmented in the present specimen and not four segmented as observed by Gnanamuthu.

This species can be easily identified by the modified third, fourth and fifth setae of the first antenna. Third segment of second antenna having rows of spinules and a distal circlet of the lamellar processes.

Family Chondracanthidae

Genus Chondracanthus De La Roche

Chondracanthus trilobatus Pillai

Chondracanthus trilobatus Pillai, 1964a, p.78, figs.121-132.

Material:

Two females were collected from the gills of Psettodes erumei (Bloch) caught at Cochin.

Total length, 4 mm.

Distribution:

West coast of India.

Remarks:

This specimen shows close resemblance with the original description of Chondracanthus trilobatus Pillai (1964 a) in all major details. The present specimen shows certain variations with that of the original description. It is observed that the outer margin of the maxilla of the present specimen is with a serrated flange and the basal segment of the maxilliped stout and large, whereas in the original diagram the maxilla having only a distal serration and the basal segment of maxilliped slender. In the present specimen the anal lamina is clearly two segmented whereas in the original description the segmentation indistinct. Apart from these variations all other characters are similar to that of the original description. This specimen closely resembles P. alatus (Heller) in several details. But in the shape of the cephalon and nature of the neck and body process it differs from P. alatus. In P. trilobatus the anterior trunk process is smaller than that of P. alatus. The variations found are enough to treat this as a separate specis.

This species can be identified by the posteriorly narrowing trunk with a pair of slender lateral process and comparatively long anal lamina.

Genus Protochondracanthus Kirtisinghe

Protochondracanthus alatus (Heller)

Chondracanthus alatus Heller, 1865, p.175; Bassett-Smith, 1898a, p.13; Kirtisinghe, 1956, p.20; 1964, p.48, figs.7-9; Pillai, 1964a, p.76, figs.109-120.

Protochondracanthus psettodes Kirtisinghe, 1950, p.85, figs.44-51.

Protochondracanthus alatus Yamaguti, 1963, p.291; Ho, 1970, p.186-187.

Material:

Twelve females along with males were collected from the gills of Psettodes erumei (Bloch) examined at Cochin.

Total length, female 4.3 mm.

Distribution:

Singapore, Ceylon and West coast of India.

Remarks:

This species had been adequately described by the previous authors and it is observed that my specimen agrees in all major details with the previous descriptions. Kirtisinghe (1950) proposed the new genus Protochondracanthus, but later he has withdrawn his original proposal of the genus, later Yamaguti (1963) restored its status. Ho (1970) made a careful study of the description of Heller (1865), Kirtisinghe (1950) and Pillai (1964a) found that they have described the species having two pairs of legs, the first pair being modified into a lobate structure. But Ho observed that what these authors described as first leg is actually the usual body process and the unmodified second pair of leg is the true first leg. He proposed this character i.e., the possession of only one pair of leg as the main variation of the genus Protochondracanthus from Chondracanthus. He further opined that the character proposed by Yamaguti (1963), i.e. all the pedigerous segments fused into an unsegmented trunk cannot be used as the valid character for the identification of the genus. Detailed observation of the present specimen shows that Ho's opinions regarding the structure of the legs appears

correct and thus I assign my specimen as Protochondracanthus alatus (Heller).

Genus Heterochondria Yu

Heterochondria pillaii (Pillai)

Pseudochondracanthus longitruncus Pillai, 1964a, p.79, figs.133-148.

Material:

Three females were collected from the gills of Pseudorhombus arsius (Hamilton-Buchanan) caught at Cochin.

Total length, 2.4 mm.

Distribution:

West coast of India.

Remarks:

The present specimen agrees with the description of Pseudochondracanthus longitruncus Yamaguti which as redescribed by Pillai (1964a). Except for the structure of the legs and structure of the first antenna, Pillai's specimen found to be agreeable to Yamaguti's description.

Ho (1970) in his revision of the family Chondracanthidae, suggested the removal of Yamaguti's P. longitruncus from Pseudochondracanthus and included it in Ceratochondria Yu (1935). He observed that the specimen described by Pillai as Pseudochondracanthus longitruncus is apparently differing from Yamaguti's original description. As Pillai's specimen possesses only unilobate legs it cannot be included in the genus Ceratochondria which possesses bilobate legs. Ho included Pillai's specimen in the genus Heterochondria and renamed it as Heterochondria pillaii.

In major details the present specimen agrees with Pillai's original diagrams and description of Pseudochondracanthus longitruncus. Hence I assign my specimen along with renamed Heterochondria pillaii.

This species can be identified by the nature of the comparatively elongated curved second antenna with distal half having grooved ridges and the unilobate nature of the legs.

Suborder CALIGOIDA

Family Caligidae

Genus Caligus Muller

Caligus quadratus Shiino

Figs.36-43.

Caligus quadratus Shiino, 1954b, p.26; 1959b, p.8, figs.3-5; Pillai, 1964a, p.61; Lewis, 1967, p.109, figs.41-43.

Caligus coryphaenae Yamaguti, 1936b, p.5, pl.41, figs.160-170.

Material:

Seven females were collected from the gills of Coryphaena hippurus Linnaeus examined at Cochin.

Total length, 5.6 mm.

Distribution:

Japan, Pacific and Indian Ocean.

Remarks:

Present specimen is found to be similar in almost all details with the descriptions of Shiino (1956b) and that of Pillai (1964a). Shiino described the sternal

fork having distally truncated tines, but in the present specimen it is pointed and flanged. The distal spine on the third segment of the exopod of the second leg is bilaterally barbed in Shiino's illustration, whereas it is not barbed in the present specimen. In the original description the marginal spines on the distal segment of exopod of third leg is shown to be curved in the middle with partial separation. But in the present specimen the spines are almost straight and segmentation is not clear. Lewis (1967) observed variations in the structural details of specimens collected from different geographical areas. These variations make C. quadratus difficult to differentiate from C. bonito Wilson and C. productus Dana. Lewis found that the Hawaiian specimens have a break on the inner margin of the first segment of the exopod of the first leg. But in the present specimen such a break is not observed. The major identifying character of C. quadratus from that of C. productus and C. bonito is the presence of stiff plumosites on the second segment of the endopod of second leg.

Caligus seriolae Yamaguti

Caligus seriolae Yamaguti, 1936b, p.2, pl.1, figs.1-3; Shiino, 1959c, p.336, fig.1.

Material:

Two females were collected from the gills of Alectis indica (Ruppell) at Cochin.

Total length, 2.8 mm.

Distribution:

Japan, West coast of India.

Remarks:

Present collection of this species is the second record from the West coast of India. This species shows close resemblance to the original description by Yamaguti (1936b), in all major details. But slight variations are observed. Yamaguti described the abdomen of this species as indistinctly two segmented. As observed by Shiino (1959c) the present specimen is with distinctly segmented abdomen. The basal claw of the exopod of the third leg is pointed and unflanged in the present specimen, but Yamaguti observed it as unflanged and blunt ended.

This species can be identified by the nearly cylindrical abdomen, the small sternal fork with its tines narrow and flanged on either side, apically rounded and comparatively stout fourth leg with elongated spines at the distal end.

Caligus kanagurta Pillai

Caligus kanagurta Pillai, 1961, p.100, fig.8.

Material:

Four females were collected from the branchial cavity of Rastrelliger kanagurta (Cuvier) at Cochin.

Total length, 4.2 mm.

Distribution:

West coast of India.

Remarks:

Present specimen agrees with the original description of Pillai (1961) in all the major details. But few variations are observed, which are of less taxonomic importance. Pillai has shown that the distal claws of the exopod of second leg as unflanged. But in the present specimen the distal claws are flanged. The

structure of the fourth leg in the present specimen is same as that of the original description.

Present specimen can be identified by the peculiarities of the fourth thoracic leg and postero-laterally produced genital segment and comparatively rounded basal claw of the third thoracic leg.

Caligus annularis Yamaguti

Caligus annularis Yamaguti, 1954, p.385, figs.33-34; Pillai, 1966, p.126, fig.3.

Material:

Two females and one male were collected from the gills of Johnius argentatus (Houttuyn) and two females from the gills of Otolithus maculatus (Cuvier) at Cochin.

Total length, female 2.4 mm; male 1.9 mm.

Distribution:

Celebes, Japan and West coast of India.

Remarks:

This species has been adequately described by Pillai (1966) giving detailed illustration of the

appendages. Present specimen agrees with the description and illustrations of Pillai. The species can be easily distinguished by the absence of plumose setae on the lower broader of the distal segment of the first leg and shape of the genital segment and abdomen.

Caligus hamruri Pillai

Figs.44-47.

Caligus hamruri Pillai, 1964a, p.61, figs.1-33.

Material:

Seven females were collected from the branchial cavity of Priacanthus hamrur (Forskal) at Cochin.

Total length, 2.9 mm.

Distribution:

West coast of India.

Remarks:

Abdomen of the present specimen is narrowing anteriorly and getting broader posteriorly, but in the original description the abdomen is almost cylindrical with roughly parallel margins. The postero-median lobe

of the carapace in the present specimen nearly equal in length to that of lateral lobes, but it is extending well beyond the lateral lobes in the illustration given by Pillai. Rest of the characters are found to similar to that of the original description.

This species can be identified by the posterolaterally rounded genital segment with an anterior neck, comparatively long distal claw of the first and fourth legs.

Caligus phipsoni Bassett-Smith

Caligus phipsoni Bassett-Smith, 1898b, p.6, pl.3, figs.3-4; Pillai, 1963, p.68, fig.1.

Material:

Four females and two males were collected from the gills of Polynemus plebeius (Broussonet) at Cochin.

Total length, female 4.4 mm.; male 1.9 mm.

Distribution:

West coast of India.

Remarks:

Bassett-Smith (1898) has given a short description of the species and lacks major details. Pillai (1963) reported and supplemented the details of the same species with illustrations. Pillai's observation revealed that the postero-median lobe of the carapace extending beyond the lateral lobes, whereas in the present specimen the postero-lateral lobes are equal in length with the median lobe. Bassett-Smith stated that the tines of the sternal fork are parallel, but in the present specimen the tines are diverging as observed by Pillai. The abdominal segmentation in the male is less prominent in the present specimen, whereas it is prominent in the description given by Pillai.

Caligus phipsoni can easily be identified by the nature of the strong denticles arranged in three rows on the second segment of the endopod of second leg and by the nature of the pear shaped genital segment.

Caligus cordyla Pillai

Caligus cordyla Pillai, 1963b, p.82, fig. 10.

Material:

Twelve females were collected from the gills of Megalaspis cordyla (Linnaeus) caught at Cochin.

Total length, 3.2 mm.

Distribution:

West coast of India.

Remarks:

Apart from the few variations, the present specimen shows close similarity with the description and illustrations of C. cordyla (Pillai, 1963b). In the present specimen the abdomen appears one segmented and rest of the body shape same as that of the original description. Basal part of thesternal fork not bulged as shown by Pillai and also posseses two lateral collars at the base, the rami are found to be diverging and flanged at the distal end. Apron of the third leg carries a patch of spines above the endopod.

This species can be identified by the comparatively elongated and slender distal segment of the first antenna, highly elongated slender and curved distal claw of the second antenna, second segment of the first leg

with flanged distal spines and by the presence of the serrated flange on the inner margin of the basalsegment of the endopod of the second leg.

Caligus epinepheli Yamaguti

Caligus epinepheli Yamaguti, 1936b, p.4, pl.3, figs.27-39; Shiino, 1952, p.80, figs.1-2; Pillai, 1963b, p.75, fig.5; Kirtisinghe, 1964, p.57, fig.32; Kabata, 1965, p.112. fig.2c.

Caligus cossackii Rangnekar & Murti, 1959, p.78.

Material:

Nine females were collected from the gill rakers of Chorinemus tala Cuvier at Cochin.

Total length, 4.5 mm.

Distribution:

Japan, India and Ceylon.

Remarks:

This species has been adequately described by several authors. The present specimen is found to be similar in every details with the descriptions of Yamaguti (1936b) and Pillai (1963b), but lacks minor

details. Yamaguti in his original description has not mentioned about the denticular patch on the apron of the third leg. The present specimen has a patch of denticles above the endopod and long rows of denticles above the exopod. As Kabata (1965) observed, a well developed layer of radially arranged muscle fibres were found in the present specimen along the lateral margin of the carapace.

This species can be distinguished by the apically blunt process on the basal segment of the second antenna, rows of strong spines on the enodopod of the second leg and absence of setae on the lower broader of the distal exopod segment of the first leg.

Caligus cybii Bassett-Smith

Caligus cybii Bassett-Smith, 1898a, p.6, pl.2, fig.3; Pillai, 1969, p.156, figs.35-47; Kirtisinghe, 1964, p.58, figs.33-34.

Caligus brevicornis Pillai, 1961, p.87, fig.1.

Material:

Eight female and two males were collected from the gills of Cybium commersoni (Lacepede) caught at Cochin.

Total length, female 5.3 mm.; male 2.1 mm.

Distribution:

West coast of India.

Remarks:

The original description of Bassett-Smith (1898) and the description of Kirtisinghe (1964) lack several major details. But Pillai (1969) has given a detailed redescription of the species based on the paratype of Bassett-Smith. Specimens of the present collection are found to be similar in all major details with that of the description given by Pillai, but it lacks minor details. Base of the sternal fork longer and produced backwardly in the present specimen, but it is small and nearly squarish in the illustration given by Pillai. Distal claws of the first leg are with a small denticular lining in the present specimen, which is not shown by Pillai.

This species can be identified by the nature of the nearly squarish genital segment, comparatively large and posteriorly narrowing abdomen, denticulated claw of the exopod and spinulation on the second segment of the endopod of the second leg.

Caligus priacanthi Pillai

Figs.48-52.

Caligus priacanthi Pillai, 1961, p.104, fig.11.

Material:

Four females were collected from the gill filaments of Priacanthus hamrur (Forskal) caught at Cochin.

Distribution:

West coast of India.

Total length, 2.9 mm.

Remarks:

The present specimen appear to be similar, in almost every major details to the original description of Caligus priacanthi by Pillai (1961). In the original illustration the genital segment is subtriangular and the abdomen fused with the genital segment, but in the present specimen the genital segment is more rounded and the abdomen is separated from the genital segment. It is found that the tuft of setules at the base of the claw of the fourth leg shown in the original description is lacking in the present specimen.

C. priacanthi and C. hamruri are roughly similar in the general body shape, but can easily be identified by the toothed nature of the maxillary claw, denticulated distal process of the maxilla, elongated and subequal sized distal claws of the second segment of the first leg and the distal claws of the first and second segment of the exopod of the second leg with an outer row of sharp strong denticles which remains to be a unique character of the species.

Caligus confusus Pillai

Figs.53-64.

Caligus confusus Pillai, 1961, p.104, fig.10;
Kirtisinghe, 1964, p.68, figs.70-71;
Lewis, 1968, p.53, figs.22-23.

Caligus constrictus Wilson, 1937, p.25, pl.3, fig.3a;
Shiino, 1959c, p.285, figs.9-10; Pillai, 1961,
p.104, fig.10.

Caligus alalongae Kirtisinghe, 1937, p.435, figs.1-14;
Yamaguti, 1954, p.379, pl.2, fig.19; pl.3,
fig.21.

Material:

Six females and one male were collected from the gills of Caranx carangus (Bloch) caught at Cochin.

Total length, female 3.2 mm.; male 2.2 mm.

Distribution:

Ceylon, Panama, Galapagos, Celebes, Japan and East and West coasts of India.

Remarks:

Present specimen is found to be agreeing with the earlier description in all major details, but posses certain variations. In the nature of the genital segment and the structure of the sternal fork the present specimen is found to be similar to that of Shiino (1959c). But Pillai found that the genital segment is narrow anteriorly and gradually widening backwards, and the sternal fork nearly straight and apically pointed. But in the present specimen the tines of sternal fork are diverging and apically rounded. Lewis (1968) opined that the membraneous flange of the distal claw of the postoral process shown by Pillai (1961) is not a separate membrane, but only the transparent tip of the process. But in the present specimen it is clearly found that it is a membraneous flange as observed by Pillai. Present specimen also posses a blunt secondary projection on the proximal inner margin of the postoral process, which is absent in Lewis description.

Lewis (1968) discussed in detail the synonymy and distinctive characters of this species. Accordingly to Lewis, there are differences in the morophology of these species referred by Pillai to C. confusus. Lewis found that the size variations should be treated as pronounced character.

The length of the female specimens described by Shiino (1959c) Wilson (1937), and Kirtisinghe (1964) are 3.75 mm., 5 mm. and 4.5 mm. respectively. But Pillai's specimen is only 2.9 mm. Because of these differences in size, Lewis stated that it is difficult to assign all these collections to C. confusus. In my collection the female is 3.2 mm. and the male 2.2 mm. long; nearly the same size to that of Pillai observed and is found to be similar in all structural details with that of the earlier description. The size variation with in the species may be due to the effect of the host and cannot be taken as valid character as observed by Lewis.

Caligus savala Gnanamuthu

Caligus savala Gnanamuthu, 1948, p.591, figs.1-8;
Pillai, 1969, p.164, figs.81-101.
Caligus affinis Kurian, 1961, p.70, figs.37-45.
Caligus acutus Kirtisinghe, 1964, p.64, figs.58-67.

Material:

Two females were collected from the body surface of Trichiurus savala Cuvier caught at Cochin.

Total length, 3.4 mm.

Distribution:

West and East coasts of India and Ceylon.

Remarks:

The present specimen agrees in every details with the description of Gnanamuthu (1948) and Pillai (1969). Pillai described the first and second claws on the exopod of the second leg as subequal in length. The present specimen shows that the Pillai's description is correct.

This species can be identified by the postero-laterally drawn out membraneous flange of carapace, the basal segment of the second antenna, which is produced into a large spine and by the shape of the sternal fork.

Caligus infestans Heller

Caligus infestans Heller, p.167, pl.14, figs.3-4; Kirtisinghe, 1964, p.52, figs.22-24; Kabata, 1965, p.119, figs.2a & b; Pillai, 1969, p.158,

Material:

Two females were collected from the gills of Cybium commersoni (Lacepede) at Cochin.

Total length, 5 mm.

Distribution:

Indian Ocean, Madagascar, Queensland, Ceylon and West coast of India.

Remarks:

This species has been described in detail by several authors and the present specimen is found to be similar in all major details with the earlier descriptions. As observed by Kabata (1965) and Pillai (1969), the fourth thoracic segment is laterally produced at the base of the legs. Postero-lateral lobes of the genital segment produced into two large lobes reaching beyond the first abdominal segment. The distal claws on the exopod of the second leg is comparatively stout and flanged second segment of the endopod of the second leg with three rows of spines.

This species can be identified by the postero-laterally produced genital segment, the arrangement of the spines on the endopod of the second leg and the

characteristic inner projection on the second segment of the fourth thoracic leg.

Caligus longicervicis Gnanamuthu

Caligus longicervicis Gnanamuthu, 1950b, p.115, figs.31-46; Kirtisinghe, 1964, p.65, fig.65; Pillai, 1966, p.125, fig.25.

Caligus cunicephalus Pillai, 1963b, p.77. fig.7.

Material:

Two females and one male were collected from the branchial cavity of Trichiurus savala Cuvier at Cochin.

Total length, female 3.5 mm.; male 2.1 mm.

Distribution:

India and Ceylon.

Remarks:

As observed by Pillai, the fourth thoracic segment is much shorter and not so long as described by Gnanamuthu and Kirtisinghe. The shape of the genital segment varies slightly and the anterior and posterior broaders of the segment are nearly truncated, but it

is rounded in Pillai's description. Shape of the abdomen also shows slight variations in the present specimen. It is posteriorly narrowing in the present specimen, whereas in the original description the abdomen is nearly parallel. The cephalic appendages appears to be shifted towards the anterior and there exist a gap between the cephalic and thoracic appendages and that may be due to the absence of the sternal fork. The peculiar nature of the maxilla, distal claws of the first and second legs, the structure of the fourth leg in the present specimen are found to be similar to that of the descriptions given by Pillai and the original descriptions of Gnanamuthu.

This species can be identified by the absence of the sternal fork, the peculiar nature of the claw of the distal segment of the first leg and the comparatively large serrated first claw on the exopod of the second leg.

Caligus parapetalopsis Hameed & Pillai

Caligus parapetalopsis Hameed & Pillai, 1973a, p.114-118, figs.1-21.

Material:

Thirty four females and five males were collected from the buccal cavity and buccal floor of the Naucrates ductor (Linnaeus) at Cochin.

Total length, female 4.2 mm.; male 2.6 mm.

Distribution:

West coast of India.

Remarks:

The present collection of the parasites agrees with the description of Caligus parapetalopsis, by Hameed & Pillai (1973 a) in the major characters, but lacks some minor details. The extreme expansion of the abdomen and genital segment brings these parasite close to the genus Parapetalus. The tines of the sternal fork in the present specimen is diverging whereas it is almost parallel and with rounded tips in the original description. The basal claw of the third leg in the present specimen is found to be partially separated near the base and the distal segment of the exopod posses three spines, whereas in the original description, it is shown as with two spines. Rest of the characters appear to be quite similar and identical with that of the original description.

Based on the similarity of these species with the members of the genus Parapetalus, Hameed opined that the validity of the genus Parapetalus needs re-examination. This species can be identified by the

winged genital segment and externally flattened abdomen which directly joins with the genital segment without a neck like formation.

Naucrates ductor (Linnaeus) is a new host for this species.

Caligus arii Bassett-Smith

Figs.65-70

Caligus arii Bassett-Smith, 1898b, p.82, pl.4, fig.1; Bernard, 1955, p.248, figs.10a & b; Pillai, 1963b, p.71, fig.3; 1969, p.154, figs.24-34.

Material:

Eight females from the gills of Arius dussumieri Cuvier & Valenciennes and six females from Pseudarius jatius (Hamilton & Buchanan) were collected at Cochin.

Total length, 5.1 mm.

Distribution:

Ceylon, South Africa and West coast of India.

Remarks:

Pillai (1969) described with detailed illustration of this species and explained its peculiarities. The present specimen is found to be similar in all major details with that of Pillai's description, but certain variations were observed. The distal segment of the first antenna is comparatively slender and of equal length with that of basal segment in the present specimen. Pillai's illustration shows that it is only half the length of the basal segment. The tines of the sternal fork longer than the base in the present specimen, but it is shorter in Pillai's illustration. In the present specimen claws of the distal segment of first leg are comparatively stout with a narrow distal spine and an accessory spine. But Pillai had shown that it is slender, elongated and without the sensory spine. The present specimen appears to be remarkable with pronounced characters. These characters are found to be shared by other unrelated species parasitizing the same hosts. This convergence of characters may be due to the effect of the host.

This species can be recognized by the nature of the distal segment of the second antenna, comparatively developed endopod of first leg, modified and flattened basal segment of the exopod of third leg, slender

and roughly cylindrical two segmented abdomen.

Caligus robustus Bassett-Smith

Caligus robustus Bassett-Smith, 1898c, p.361, pl.2, figs.1-2; Pillai, 1963b, p.73, fig.4; Kirtisinghe, 1964, p.55, figs.29-30.

Material:

Twelve females and two males were collected from the gills of Chorinemus tala Cuvier and Mugil cephalus (Linnaeus) examined at Cochin.

Total length, female 3.3 mm.; male 2.1 mm.

Distribution:

West coast of India and Ceylon.

Remarks:

Chorinemus tala Cuvier and Mugil cephalus Linnaeus are new hosts for this species. This species was formerly collected from Caranx sansun (Forskal), C. melamphygus (Cuvier) and C. leptolepis Cuvier and Valenciennes. The present specimen shows certain variations with the description by Pillai (1963b). As stated by Pillai a false partition in the postoral

process is found to be lacking in the present specimen. The postantennal process in the present specimen is found to be more pointed and curved distally, whereas it is shown as broader in Pillai's illustration. Further, the stout and robust postoral process shown by Pillai appears to be more slender and elongated in the present specimen. It is found that the shape of the genital segment varies considerably from the members of these species and it may be due to the relative abundance of the eggs inside the segment. In Pillai's illustration the anterior end of the genital segment modified into a prominent neck, but in the present specimen the neck is not much prominent as shown by Pillai. The species can be identified by the nearly squarish genital segment, the spinulose distal claws of the second segment of the first leg and the thick patches of setules arranged on the outer margin of the second and third segment of the endopod of the second leg.

Caligus pelagicus Kurian

Figs.71-94.

Caligus pelagicus Kurian, 1955, p.103, fig.1.

Material:

Eight females and two males were collected

from the body surface of Liza parsia (Hamilton-Buchanan) and two females from body surface of Mugil cephalus Linnaeus at Cochin.

Female:

Carapace slightly longer than broad, gradually broadening backwards. Lunules large and ovoid, median cephalic ridges shifted anteriorly, lateral lobes narrow, postero-median lobe more than four times broader than lateral lobes and posteriorly truncated, lateral margins of carapace fringed with marginal membranes. Posterior sinuses oblique and open. Fourth thoracic segment broader than long fused with the genital segment, transversly eliptical. Genital segment roughly eliptical with rounded lateral margins, postero-lateral side of the genital segment with two setae representing the fifth and the sixth legs. Abdomen almost cylindrical, longer than broad, one segmented, fused with the genital segment. Anal lamina longer than broad with three long and three very small plumose setae.

First antenna two segmented, basal segment stout with a row of plumose setae on the outer margin, the distal segment short and slender with a tuft of slender setae at the distal end.

Second antenna three segmented, basal segment short with a backwardly projected process at the base. Second segment stout, broader than long, third segment claw like, sharply curved with a pointed distal end.

Postantennal process with a broad base and a curved distal claw. Postoral process having a broad base and gradually tapering bluntly ending distal claw. Basal papilla bearing one short and two long naked setae. Maxilla two segmented, basal segment stout and distal segment slender and longer than basal segment. The inner margin of the distal segment having a membraneous flap and distally bearing two process of unequal length, larger one with membraneous flange at the tip. Maxilliped two segmented, basal segment robust with more than two times the length of the distal segment. Distal segment partially separated in the middle with a spine and sharply pointed distal claw. Base of the sternal fork roughly squarish with lateral wing like extensions, tines unflanged, spatulate and slightly diverging.

First leg uniramous, rami three segmented, basal segment stout with a median seta and rudimentary endopod distally. Second segment comparatively slender, longer than broad with a distal spine. Third segment short with

three sharply curved distal claws and a very long naked seta. The second and third claw having accessory spines. Inner margin with three plumose setae. Second leg biramous, basal segment large, and stout. Exopod three segmented. First and second segments with inwardly directing stout dist claws. Third segment comparatively long with a stout small distal claw and seven plumose setae. Endopod three segmented, first and second with a plumose seta. Inner margin of the second segment fringed with a row of setules. Third segment with seven plumose setae. Apron of the third leg roughly semicircular. Exopod three segmented. Basal claw strong, slightly curved and flanged. Second segment large with an outer spine and an inner plumose seta. Distal segment with three naked spine and four plumose setae. Endopod two segmented, basal segment fused with the apron and bearing a single inner seta. Distal segment with six plumose setae. Fourth leg uniramous, three segmented, basal segment strong and stout with a short seta at the distal end. Second segment short with a distal claw. Third segment having three distal claws of subequal length. The claws unflanged. Fifth and sixth legs are represented by two small naked setae at the postero-lateral margins of the genital segment. Caudal ramus longer than broad, with three long and three very short plumose setae.

Total length, 3.2 mm.

Male:

Structure of the cephalothorax same as that of the female, genital segment as long as broad, barrel shaped. Postero-lateral sides with setae representing the fifth and sixth legs. Abdomen two segmented, first segment comparatively shorter than the second. Second antenna very stout and differs considerably from that of the female. Basal segment much longer and without backwardly directing process. Middle segment large and stout having four patches of corrugated pads. Third segment is short with two flat distal claws. The base of outer claw with a small spine. Postoral process having a constriction and corrugated ridges in the middle. Basal segment of the maxilliped stout with a boss on the middle of the inner margin.

Total length, 2.7 mm.

Remarks:

The specimen agrees with the original description of Caligus pelagicus Kurian in major characters, but shows several variations. Kurian's description (1955) of this species is mainly based on the male,

whereas the present study gives a detailed account of the male and female. Though Kurian collected both male and female from the plankton collections of Travancore-Cochin waters, he has not described the female in detail. The present collection of the specimens from the host fishes confirmed the identity of the hosts.

Kurian in his original description of Caligus pelagicus stated that the appendages of the male and female are similar, but I could observe prominent structural variations as usual in male and female. Kurian failed to observe the details of the second antenna of the male. In the present specimen the second antenna of the male is comparatively stout and large. The basal segment stout, second segment with four patches of corrugated ridges, distal segment short with two flat denticulated claws and a strong spine. In the present specimen the shape of the maxilliped of male and female are different, but Kurian stated that it is similar in both male and female. Kurian's description of the postoral process of male lacks an important structural detail. He stated that it is almost straight and pointed, whereas the postoral process of the present specimen having a median corrugated pad and distally blunt. Kurian in his

description has not mentioned about the accessory claw present on the distal segment of the first leg, whereas in the present specimen the distal spines on the first leg are with accessory claws. In the present specimen both in the male and female, the basal claw of the third leg is stout and flanged.

Caligus nautili sp. nov.

Figs.95-107.

Material:

Two females were collected from the branchial cavity of Caranx sp. at Cochin.

Female:

Cephalothorax nearly circular with well developed frontal plate. Lunules comparatively large, oval in shape and projecting out of the frontal plates. Postero-lateral lobes inwardly curved and rounded having half the width of the median lobe. Posterior margin of the median lobe truncated and laterally rounded. Posterior sinuses large, oval and closed. Fourth thoracic segment broader than long and laterally produced into lobes. Genital segment apple shaped. Abdomen short, narrowing posteriorly and caudal rami small.

First antenna two segmented, basal segment comparatively stout with a row of plumose setae at the

outer margin. Distal segment very long and slender with a tuft of setae at the distal end. Second antenna three segmented, basal segment transversly elongated, second segment stout and broader at the base, third segment distally narrowed to a sharply pointed claw and curved at the distal end.

Postantennary process well developed with a broad base having a blunt claw flanged at the tip. Postoral process stout, narrowing distally with a median curve and ends in a blunt claw flanged on either side. Close to the median curve it bears a well developed accessory claw. Basal papilla bearing one long and two small naked setae. Maxilla two segmented. Basal segment stout and strong, distal segment slender bearing two elongated subequal flanged claws at the distal end. Maxilliped two segmented, basal segment stout and strong, distal segment modified as a claw, basally the segment bears a small spine. Base of the sternal fork rounded and the tines are parallel and comparatively narrow, pointed distally with flange on either side.

First leg uniramous, rami two segmented, basal segment stout and strong with a distal sharp spine, inner margin of the segment lined with a row of fine plumose

setae. Second segment nearly quadrangular with three large claws at the distal end. Second and third claws bear an accessory spine reaching beyond the distal end of the main claw. Inner margin of the second and third claws bear an accessory spine reaching beyond the distal end of the main claw. Inner margin of the second and third claw with rows of small setules from the base to the tip of the claw. Inner margin of the segment with a distal elongated naked spine and three plumose setae.

Second leg biramous. Exopod three segmented. First and second segments distally with a strong nearly straight inwardly directed flanged claw. Third segment with one small and one large claw, large distal claw flanged on either side and the segment bears six plumose setae. Endopod also three segmented. Basal segment enlarged nearly circular with its outer margin lined with serrated membraneous flange. Second segment modified, comparatively long and slender about twice longer than the distal segment with a row of fine setules on the inner margin. Third segment short and bears six plumose setae.

Apron of the third leg well developed with a row of sharp denticles at the base of the exopod and a small patch of denticles inner to the base of the

exopod. Exopod two segmented, basal claw of the exopod highly elongated, curved and distally blunt. Basal segment of the exopod flattened and subequal in length with a distal spine. Distal segment bearing three spines, of which one is comparatively longer and distally with five plumose setae. Endopod two segmented, basal segment short and fused with the apron, second segment comparatively large with six plumose setae at its margin.

Fourth leg four segmented. Basal segment stout and long. Second and third segments bear one distal flanged claw each at the outer disto-lateral end. Distal segment bears three flanged claws of subequal length. Fifth and sixth legs are represented by three and one plumose setae respectively at the postero-lateral corner of the genital segment.

Total length, 2.1 mm.

Remarks:

In the general morphological features Caligus nautili sp. nov. closely resembles Caligus platurus Kirtisinghe (1964) and Caligus djedabae Rangnekar (1956). The postoral process in the present species having very prominent accessory claw, whereas in C. platurus the

accessory claw is very small. In C. platurus the sternal fork is having comparatively very short tines with a bulged base, whereas in C. nautili sp. nov. the tines are longer, flanged on either side. Base of the distal claws on the distal segment of the first leg having serrated membraneous flange in C. platurus, but it is absent in the present species. Moreover, the plumose lining on the inner margin of the second and third claws is found to be absent in C. platurus. First and second segments of the endopod of the second leg are modified from the usual Caligid structure in the new species, whereas in C. platurus such a modification is not observed.

Caligus nautili sp. nov. varies from all other known species of Caligus by the shape and armature of the first and second segments of the endopod of second leg. It is very peculiar to note that the second segment devoid of any setae from the usual Caligoid nature. The shape of the genital segment and setules lining on the second and third claws of the distal segment of the first leg are also different from all other Caligus species.

Caligus industri sp. nov.

Figs.108-132.

Material:

Five females and three males were collected from branchial cavity of Eleutheronema tetradactylum (Shaw) caught at Cochin.

Female:

Cephalothorax roughly oval shaped, frontal plates well developed with a median notch. Lunules very large, lateral margin of the cephalothorax fringed with a marginal membrane. Postero-median lobe is more than twice the width of the lateral lobes. Postero-lateral corners of the lateral lobes curved inwardly, thus reducing the opening of the posterior sinuses. Median transverse ridge shifted slightly to the posterior thus reducing the size of the posterior half. Fourth thoracic segment joins with the cephalothorax through a neck, segment broader than long, laterally produced and forming the attaching base for fourth thoracic leg. Genital segment elongated but swollen, anteriorly it narrows and joins with the fourth thoracic segment through a collar like formation. Posterior margin nearly truncated. Abdomen cylindrical with slightly swollen

at the posterior end and fused with the genital segment. Anal laminae short one segmented, longer than broad with three long and three short plumose setae at the distal end.

First antenna two segmented, basal segment roughly conical and stout. Outer margin of the segment with a row of stout and short plumose setae. Distal segment elongated, but comparatively stout and apically the segment armoured with a tuft of naked setae. Second antenna three segmented, basal segment stout, transversely elongated and fused with the cephalothorax. Second segment stout and longer than broad. Distal segment slender and ends in a sharply pointed claw. Postantennal process greatly reduced and is represented by three setiferous papillae. Postoral process having roughly triangular base with a distally narrowed blunt process. Base of the process with three papillae. Basal segment of maxilla stout and strong, about thrice the length of breadth. Distal segment long and slender with two terminal claws and a subterminal membraneous flap, inner claw large and outer claw small, both flanged on either side. Maxilliped three segmented, the basal segment large and strong, thrice the length of breadth. Outer margin of the segment

close to the distal end with transverse rows of corrugated ridges. Distal segment roughly one-third of the second segment, and it ends in a sharp claw. The claw is partially separated near the base and bears a small accessory spine. Base of the sternal fork squarish with a slight neck like constriction close to the origin of the tines. The tines are well developed, elongated and slightly diverging, blunt at the tip and with narrow flange.

First leg uniramous, basipod short, stout and almost squarish in shape. First segment stout and large with roughly squarish distal end, the outer distal end having a short spine and inner margin lined with plumules. Second segment short, nearly rectangular in shape and distal end with three sharply pointed strong claws of subequal length. Second leg biramous, basal segment strong and stout, almost the equal breadth as that of length. Outer distal end having a small spine and inner margin with row of setules. Exopod three segmented, basal segment elongated with a distal sharp claw on the outer margin. The claw is winged on either side. Second segment comparatively small, only one third length of the first segment. Disto-laterally it bears a claw, sharp, strong and winged on both sides.

Inner margin of the segment with an elongated plumose seta. Distal segment more than one and a half times longer than the second segment and on the outer margin it bears a small spine. Distally it bears a claw which is winged on either side. Next to the claw is a plumose seta flanged on its outer margin. Inner margin with five elongated plumose setae. Endopod three segmented, first segment roughly barrel shaped almost equal in length as that of breadth. Inner margin with a plumose seta and outer margin with a row of setules. Second segment elongated and with curved margins. The entire length of the outer margin with three rows of denticles which are well developed and sharply pointed. Inner margin with a row of setules and two plumose setae, at the distal end. Terminal segment with six spiniform setules and rest with normal setules. Apron of the third leg broad, exopod three segmented. Basal segment short and stout with a strong unflanged claw. Second segment broader than long. Outer margin with a row of setules. Inner margin almost straight and distally with a large plumose seta and outer distal corner with a stout spine. Third segment comparatively small with three short distal spine and four large plumose setae. Endopod two segmented, basal segment very short and bears a large plumose seta internally. Distal segment large having

six plumose setae. Lower margin the apron is limited by an obliquely running ridge and a large plumose seta.

Fourth leg uniramous, three segmented, basal segment elongated and distally posses a long spine. Second segment distally with a winged claw, base of the claw with a tuft of fine setules. Third segment with four flanged claws on its distal end. One is much elongated and the rest are subequal in length. Fifth and sixth legs are represented by setae at the postero-lateral side of the genital segment. Anal lamina one segmented, elongated with three long and three short plumose setae. Inner margin lined with setules.

Total length, 4.8 mm.

Male:

Cephalothorax large and nearly of the same shape as that of the female. Almost the same width as that of length. Frontal plates well developed with large lumules. Postero-median lobe about twice the width of the lateral lobes and is more convex than that of female. Posterior sinus wide open and slightly oblique. Median transverse ridge almost in the middle. Fourth thoracic segment wider than long, genital segment roughly barrel shaped and joins with the thoracic segment

through a neck. Abdomen barrel shaped with an anterior partial segmentation. Anal lamina squarish with a row of plumose setae at its distal end.

The structure and the nature of the first antenna is same as that of the female. But the second antenna shows marked differences from that of the female. Basal segment much elongated, second segment stout and large. Distal segment with two flat oppossing distal claws and a basal sharp spine. Postantennal process elongated and well developed.

Maxilliped shows marked variation from that of female. Basal segment somewhat conical, second very much enlarged and stout. Inner margin produced into three sharp bosses at the middle region. Distal segment elongated and ends as sharply curved claw with an accessory claw having nearly half the length of the original claw. Endopod of the second leg shows variations from that of the female. There is only one row of outwardly directing denticles on the outer margin of the second segment. The denticles are sharp but flattened at the base. Rest of structures are same as that of the female.

Total length, 2.7 mm.

Remarks:

In the general body shape Caligus industri sp. nov. lacks close resemblance with any of the species in this genus. But it has got certain similarity with Caligus lagocephali Pillai (1961). The carapace and genital segment of C. lagocephali are different from that of the new species. In C. lagocephali the median lateral part of the carapace with a deep channel extending dorsalwards to the longitudinal ribs, whereas such a channel is absent in C. industri sp. nov. In C. lagocephali the abdomen is clearly two segmented but in the new species it is unsegmented. Postantennal process is lacking in the present species, but in C. lagocephali it is well developed. The first segment of the second antenna with a backwardly directed basal process, which is absent in the new species. Base of the sternal fork in the new species is comparatively large, tines elongated and distally flanged, but in C. lagocephali the base and tines of the sternal fork are short and the tines unflanged. In C. industri sp. nov. outer margin of the second segment of the endopod carries three rows of inwardly directed denticles,

are comparatively small and arranged in several rows. Second to fifth setae of the distal segment of the endopod of the second leg with swollen base having strong spiniform setules in C. industri but in C. lagocephali the setae are normal.

Caligus industri sp. nov. can be identified from all other known species by the absence of the postantennal process, spinulation on the second segment of the endopod of second leg, unusual nature of the plumule modification on the setae of the distal segment of the endopod of second leg and the nature of the sternal fork with highly elongated tines.

Caligus kaloori sp. nov.

Figs.133-154

Material:

Twelve females and five males were collected from the branchial cavity of Polynemus plebeius (Broussonet) landed at Cochin.

Female:

Carapace nearly circular, with well developed frontal plates, lunules very large and circular. Postero-lateral lobes curved inwardly, cephalic ridges almost medially placed, postero-median lobe about twice the width of the lateral lobes, posterior sinuses narrow and straight. Fourth thoracic segment short, broader than long and produced laterally. Genital segment long, pear shaped and laterally produced, anteriorly the segment form a small neck to join with the fourth thoracic segment. Abdomen one segmented roughly about two times longer than broad, cylindrical having a constriction at the middle. Anal lamina small longer than broad with three long and two small setae.

First antenna two segmented, stout with a marginal row of plumose setae, distal segment comparatively long having a tuft of naked setae at the distal end and a single submedian seta. Second antenna three segmented, basal and second segments stout and subequal in length. Distal segment very long elongated curved claw. Postantennary process reduced and represented by a small triangular pad, bearing three small setose papillae. Postoral process well developed with a broad base and narrowed into a distal flanged claw.

Basal papillae with three setae. Maxilla two segmented, basal segment stout and long, distal segment slender elongated with one long and short distal claws of flanged nature. Mxilliped two segmented, basal segment stout and strong, distal segment modified to a strong claw sharply curved with a median accessory spine. Base of the sternal fork long and narrow, tines are distally pointed, slightly curved and flanged on either side.

First leg three segmented, basal segment stout and fully covered with denticles bearing the vestigeal endopod as a one segmented cylindrical process. Exopod two segmented basal segment about twice the length of the distal segment. Distal segment narrow at the base and broader distally and bears three claws of subequal length and a slender elongated distal spine. Second and third claws bearing accessory claws and inner margin of the segment with three plumose setae. Second leg biramous, exopod three segmented, basal segment large and distally having a pointed inwardly directed flanged claw. Second segment short, broader than long also bears distal flanged claw and an inner plumose seta. Basal segment of endopod stout with five unusual naked setae on the distal corner. Second segment large with patches of small denticles on the outer margin arranged on several rows. Distal segment short with six plumose setae.

Apron of the third leg well developed having two patches of denticles. Exopod two segmented basal claw very large, curved and reaches upto the inner margin of the distal segment of exopod. Claw is partially segmented. Basal segment of the exopod bears a sharp spine at the outer disto-lateral end. Distal segment short bears three claws and four plumose setae. Basal segment of the endopod short, bearing a plumose seta and distal segment with five plumose setae. Fourth leg three segmented basal segment long and stout with a subapical spine on the outer margin. Second and third segments subequal in length, second segment with a distal flanged claw. Distal segment with four flanged claws, three in equal length and the fourth one comparatively long. The segment bears a small spine on the distal end. Fifth and sixth legs are represented by plumose setae on the postero-lateral sides of the genital segment.

Total length, 3.1 mm.

Male:

Carapace nearly of the same shape as that of female. The postero-median lobe extends beyond the lateral lobes considerably. Posterior sinuses open but slightly

oblique. Fourth thoracic segment broader than long and laterally produced. Genital segment roughly barrel shaped, anteriorly narrowed with two small constrictions. Abdomen clearly two segmented, first segment small and second segment twice longer than first. Anal laminae elongated but equal in length as that of the distal abdominal segment and distally bears three highly elongated plumose setae and two small lateral spines.

Postantennal process very much elongated and sharply curved, distally pointed into a claw. Base of the process swollen with three sets of setose papillae. Second antenna modified, the second segment with rows of corrugated ridges and distal segment modified into a trifid claw. Basal segment of the maxilliped stout with two well developed bosess on the inner margin. Distal claw elongated curved and oppossing with the bosses of the basal segment. Submedially it bears an accessory spine. Armature of the legs are same as that of the female.

Total length, 1.9 mm.

Remarks:

Present new species Caligus kaloori sp. nov. shows resemblance with Caligus phipsoni Bassett-Smith (1898b) in the shape of the genital segment and abdomen.

In the shape of genital segment the new species appears similar to Caligus annularis Yamaguti (1954), Caligus epinephelii Yamaguti (1936) and Caligus arii Bassett-Smith (1898b). Eventhough the new species Caligus kaloori shows certain superficial resemblance with Caligus phipsoni, it varies considerably. In C. phipsoni the carapace with more truncated lateral margins and is posteriorly widening whereas in the present specimen the carapace is roughly circular. More variations are observed in the structure of appendages in these two species. The sternal fork in the present specimen with an elongated narrow base, and parallel tines, whereas in C. phipsoni the base of the sternal fork is broader and tines diverging slightly. Basal segment of the first leg of the present specimen with patches of sharp denticles, but it is absent in C. phipsoni. The basal segment of the endopod of the second segment distally bears five spines in the present specimen which are absent in C. phipsoni. The inner margins of the second segment of the endopod of the second leg of C. phipsoni with three rows of sharp teeth, whereas in C. kaloori sp. nov. the outer margin of the segment with a patch of several rows of small denticles. The apron of the third leg in the present specimen with two patches of small denticles, whereas it is found to be absent in C.phipsoni.

Moreover, the basal claw of the exopod of the third leg is highly enlarged in the present specimen.

The present species resembles with C. epinepheli and C. annularis in the shape of the genital segment, but considerably varying in several other characters. The new species varies considerably from the other two species in the shape of the sternal fork and the nature of armature on the outer margin of the basal and second segments of the endopod of second leg.

The new species differs from all other species of Caligus from the shape of the genital segment, structure of the sternal fork, spines on the disto-lateral margin of the first segment of the endopod of the second leg and the armature of spines on the outer margin of the distal segment of the exopod of third leg.

Genus Pseudocaligus

Pseudocaligus indicus Hameed

Pseudocaligus indicus Hameed, 1977, p.61, figs.1-19.

Material:

Two females were collected from the body surface of Triacanthus strigilifer (Cantor) at Cochin.

Total length, 3.7 mm.

Distribution:

West coast of India.

Remarks:

The original description of this species by Hameed (1977) agrees with present specimen in all major characters. The original collection was made from the body surface of Dactyloptena orientalis (Cuvier) examined at Trivandrum. In the present specimen the basal segment of the second antenna shows a backwardly directing pointed process, whereas it is not shown in the original description. In the original specimen the base of the sternal fork is roughly rounded with slightly diverging blunt tines, but in the present specimen the base of the sternal fork narrows posteriorly and the tines are pointed at the tip. Basal claw on the exopod of the third leg is found to be stout and strongly curved and flanged on either side. Fourth leg is a small knob, slightly elongated with a naked seta.

This species can be easily identified by the small knob of fourth leg with a single seta, the nature of the armature on the distal segment of first thoracic leg with much reduced distal claw and quite an unusual

character of the hairy lining on the inner margins of the distal segment of first leg and the nature of the maxilliped. Triacanthus strigilifer (Cantor) is a new host for this species.

Pseudocaligus fistulariae Pillai

Pseudocaligus fistulariae Pillai, 1961, p.112, figs.14.
Pseudocaligus tenuicauda Shiino, 1964b, p.249, figs.3-4.
Pseudocaligus similis Lewis, 1968, p.48, figs.19-21.

Material:

Eighteen females and two males were collected from the buccal cavity and inner sides of the probosis of Fistularia villosa Kluzinger caught at Cochin.

Total length, female 3.9 mm.; male 2.8 mm.

Distribution:

West coast of India and Japan.

Remarks:

The present specimen agrees with the original description given by Pillai (1961), but certain variations are observed. Pillai described the fourth thoracic leg two segmented, whereas in the present specimen the segmentation is not clear and is having a distal knob bearing

a plumose seta and distally with two spines. It is found that the basal claw of the third leg is flanged on either side in the present specimen which is lacking in Pillai's illustration. Hameed (1977) observed that the fourth leg of the specimen collected by him is only one segmented like that of Pseudocaligus tenuicauda Shiino (1964b) and P. similis Lewis (1968). Hence these species were made synonymous to P. fistulariae Pillai (1961).

This species can easily be identified by the comparatively stout fourth leg, the distal exopod segment of the first leg which is devoid of plumose setae and the sternal fork with nearly parallel and apically rounded rami.

Pseudocaligus lunari sp. nov.

Figs.155-170.

Material:

Two females were collected from the gills of Gastrophysus lunaris (Bloch) caught at Cochin.

Female:

The carapace longer than broad with narrow frontal plate, lunules small and ovoid, postero-lateral lobes of the carapace curved inwardly, posterior sinuses

wide open and slightly oblique. Fourth thoracic segment fused with the genital segment, genital segment squarish and postero-laterally rounded, abdomen one segmented longer than broad, anal lamina small with three long and two small plumose setae at the distal end.

First antenna two segmented, basal segment long and stout with a row of plumose setae on its outer margin. Distal segment short with a tuft of naked setae at the distal end and a single non-plumose seta at the middle of the segment. Second antenna three segmented, basal segment with a backwardly directing pointed process and second segment roughly squarish. Distal segment long, slender and strongly curved apically with a naked seta on the base. Postantennal process with a swollen base narrowing distally into a slightly curved claw. Postoral process having a broad base, distally narrowing to a blunt claw having a submedian accessory claw.

Maxilla two segmented, basal segment short and stout. Distal segment long and slender having one long and one short distal claw. Inner margin of the short claw with serrated flange. Maxilliped two segmented, basal segment strong and stout having an inner basal process; distal segment base swollen, partially segmented in the middle and the distal claw sharply curved with a submedian accessory spine.

First leg uniramous, basipod having an inner papilla representing the vestigial endopod. Exopod two segmented, basal segment long with a distal spine and inner margin lined with plumules. Distal segment about half the length of the basal segment and nearly quadrangular with three distal claws, median claw longer than the rest two. Second and third claw having accessory spines and inner margin bears four stout plumose setae.

Second leg biramous, exopod three segmented, first segment longer than broad and distally bears a strong inwardly directed unflanged claw. Second segment short, broader than long, distally with an unflanged claw. Distal segment bears two small spines and six plumose setae. Endopod three segmented, basal segment bears one plumose seta and second and distal segment bear two and six plumose setae respectively.

Apron of third leg flattened, exopod two segmented, basal claw of the exopod strong, stout and curved distally flanged on either side. Basal segment bears a distal elongated spine and distal segment with three spines of equal length. Endopod two segmented, basal segment short with a single plumose seta and distal segment with six plumose setae.

Fourth leg is greatly reduced and represented by a small papilla bearing two small setae. Fifth and sixth legs are represented by two and one plumose setae respectively at the postero-lateral boarder of the genital segment.

Total length, 2.1 mm.

Remarks:

Pseudocaligus lunari sp. nov. shows close resemblance to Pseudocaligus subparvus Hameed (1977) in the general body shape. Both the species show close resemblance in the structure of the genital segment. In P. subparvus, the genital segment is having a neck anteriorly, whereas it is lacking in the present one. The abdomen of P. subparvus is not separated from the genital segment, whereas in P. lunari sp. nov. the abdomen is clearly separated from the genital segment. In P. subparvus the abdomen is longer than broad and gradually narrows posteriorly, whereas in P. lunari sp. nov. the abdomen is nearly equal in length and breadth and slightly produced laterally. The sternal fork of the present new species is totally different from that of P. subparvus. The base of the sternal fork is stout and tines are comparatively short and diverging in P. lunari sp. nov., whereas

in P. subparvus the base of the sternal fork is short and the tines are longer than base. In P. subparvus the maxilliped is highly modified and the claw like process of the first segment closes with the distal segment forming a circle, whereas in P. lunari sp. nov. the basal segment of the maxilliped lacks the strong claw but on the base there is a comparatively small pointed process. In the present specimen the base of the distal segment produced on the inner side, but in P. subparvus the distal segment has not modifications.

Genus Parapetalus Steenstrup & Lutken

Parapetalus hirsutus (Bassett-Smith)

Caligus hirsutus Bassett-Smith, 1898a, p.5, pl.3, figs.1-2; Shen, 1957, p.373, pl.8.

Parapetalus hirsutus Kirtisinghe, 1950, p.77, figs.1-4; Pillai, 1962, p.228, fig.1.

Material:

Six females from the branchial cavity of Polynemus plebius (Broussonet) and fifteen females and three males from Eleutheronema tetradactylum (Shaw) caught at Cochin. The parasites are found to be embedded in the mucus of the branchial cavity.

Total length, female 7.5 mm.; male 4.2 mm.

Remarks:

The present specimen agrees with the original description of the species P. hirsutus (Bassett-Smith) and those of illustrations given by Pillai (1962b). As observed by Pillai the shape of the abdomen appears to be roughly pear shaped and flattened. Bassett-Smith (1898) described it as oblong and Kirtisinghe (1950) observed it having polygonal shape. The general external morphology is found to be varying from that of the description given by Kirtisinghe. The genital wings extending upto the middle of the abdomen and the abdomen more rounded than the orginal description. The sternal fork of the present specimen also found to be slightly varying from the original description. Tines are nearly parallel and the wings are comparatively narrow in the present specimen. Rest of the characters are found to be similar to that of the original description.

The species P. hirsutus can be identified by the roughly pear shaped abdomen, the spinulose nature of the distal claws on the second segment of the first leg and by the highly modified fourth leg.

Parapetalus occidentalis Wilson

Parapetalus occidentalis, Wilson, 1908, p.606, pl.53; Pearse, 1952, p.24, figs.87-93; Pillai, 1962b, p.293, fig.3.

Material:

Twelve females and three males were collected from the gill cavity of the host fish Rachycentron canadus (Linnaeus). The parasites were found to be in the gill cavity embedded within the mucus.

Total length, female, 5.7 mm.; male 2.1 mm.

Distribution:

North America, West coast of India.

Remarks:

Present specimen is found to be similar in almost all major details and agrees with the description of Pillai (1962b). But a few minor variations are noticed, the claw of the basal segment of the exopod of third leg is more stout and larger in the present specimen.

Pillai (1962b) in his revision of the genus Parapetalus observed that P. occidentalis Wilson (1908) and P. gunteri Pearse (1952) are closely similar.

Prabha (1983) observed that P. gunteri is synonymous with P. occidentalis. Pillai in his revision described and illustrated in details two types of males, one for P. occidentalis and another for P. gunteri. If these two species were same, one of the male described may be of different species. In the present study I have collected P. occidentalis, P. dewani sp. nov., and the two different males described by Pillai. So one of the male is that of P. occidentalis and the other may be that of P. dewani sp. nov.

This species can be identified by the ventrally curved abdominal wings forming a tube enclosing the egg strings, the sternal fork with strongly diverging unflanged claw and the basal segment of the exopod of the second leg having an outer row of spines.

Parapetalus orientalis Steenstrup & Lutken

Figs.171-175

Parapetalus orientalis Steenstrup & Lutken, 1861, p.365, fig.10; Pillai 1962b, p.290, fig.2.

Material:

Twelve females were collected from the gill and gill chamber of the fish Alectis ciliaris (Bloch) at Cochin.

Total length, female 2.7 mm.

Distribution:

East Indies and Indian Ocean.

Remarks:

Present specimen agrees in the structural details with Parapetalus orientalis Steenstrup and Lutken (1861) and also the description given by Pillai (1962b) except a few variations. Pillai made his collection from the host Alectis indicus (Ruppell). The posterior margin of the carapace is rather truncated in Pillai's illustration, whereas it is almost rounded and inwardly curved in the present specimen.

The shape of the postoral process differs from that given by Pillai. In the present specimen it is comparatively elongated and distally narrowing, whereas it is atout and roughly conical in Pillai's illustration. Pillai in his revision opined that the extremely short description given by Steenstrup & Lutken (1861) makes the specimen difficult to compare. Steenstrup and Lutken observed that the first leg posses five spines on its distal segment. But as observed by Pillai the present specimen having four spines, three long and one slender. In the present specimen the abdominal wings are found to be overlapping the genital wings.

The apron of the third leg having a distinct ridge running from the base of the exopod in the present specimen but it is found to be lacking in Pillai's illustration.

P. orientalis can easily be identified from other members of the genus by the nature of the genital segment and the abdominal wings.

Parapetalus longipennatus Rangnekar
Figs.176-197.

Parapetalus longipinnatus Rangnekar, 1956b, p.46, figs.a-p; Hameed & Pillai, 1972, p.329.

Material:

Six females and two males were collected from the bucal cavity of Carangoides chrysophrys (Cuvier).

Female:

Carapace broader than long, frontal plates well developed, lunules roughly ovoid and small. Lateral lobes of the cephalothorax less than half the width of the postero-median lobe. Posterior sinuses wide open and comparatively shallow. Postero-lateral lobes curved inwardly. Dorsal cephalic ridge shifted posteriorly extending the area of anterior cephalic region. Fourth

thoracic segment comparatively small, broader than long. Genital segment with a small neck like part that joins with the fourth thoracic segment. Genital segment anteriorly rounded and posteriorly extending as two conical lobes.

Abdomen clearly separated from the genital segment through a narrow neck. Abdomen swollen and roughly circular, postero-laterally produced into nearly rounded lobes. Caudal lamina short and not extending beyond the posterior margin of the abdomen.

First antenna two segmented, basal segment comparatively strong with its outer margin having a row of plumose setae. Distal segment slender slightly curved, subapically there is a single spinous seta and distally with a row of naked setae. Second antenna three segmented, basal segment stout and short, second segment strong and stout more than two times longer than the first segment, distal segment large, with a swollen base ending distally into a sharp claw, with a median partial separation. Postantennal process with broad base having a basal pointed process, distally narrows to an unflanged claw. Postoral process having a broad base,distally narrowing to a pointed flanged claw with a subterminal accessory claw. Maxilla two segmented. Basal segment stout and strong, slightly

narrowing towards the distal end. Terminal segment comparatively slender, having two elongated flanged claws distally. Maxilliped two segmented, basal segment strong and stout,narrowing towards the distal end. Distal segment more than half the length of the basal segment and ends in a sharp claw. Sternal fork comparatively small in size. Basal part not distincly separated from the tines. Tines are parallel and winged on either side.

First leg uniramous, ramus three segmented, basal segment comparatively small almost the same length as width. Inner margin of the segment covered with spinules. Second segment more than twice the length of the first segment, longer than broad and inner margin with a row of fine setules. Distal segment small about twice the length of breadth. Distally it bears three strong claws and a long spine. The claws are of subequal length, the second and third claw with an accessory spine. Inner margin having three plumose setae.

Second leg biramous, basipod stout and large, longer than broad. Inner margin of the segment with a row of fine setules. Exopod three segmented. First segment large, about four times the length of the second segment, distally with a strong inwardly directed

claw reaching the middle of the inner margin of the distal segment. Second segment broader than long, roughly sqarish, outer margin with a slightly curving strong claw. Outer margin of the distal segment with two small claws of subequal length and a long spine, inner margin with five plumose setae. Endopod three segmented, basal segment longer than broad and outer margin is denticulated upto the middle with an inner large plumose seta. Second segment broader than long having a row of spinules on the inner margin. Third segment roughly conical with six plumose setae.

Apron of the third leg broad, with a covering of fine setules on its outer margin. An oval patch of denticles at the lower half of the apron and above the ridge, running from the base of the endopod. Rami well developed, exopod three segmented, basal segment short with a strong sharply curved claw reaching almost at the distal end of the second segment. Second segment having a plumose seta at the distal end. Third segment equal length of breadth. Distally it has three strong spines of subequal length and four plumose setae on the inner margin. Endopod two segmented, basal segment short having a large plumose seta. Distal segment roughly oval with six plumose setae.

Fourth leg four segmented, first segment large and stout, second and third segments roughly conical, each with a strong claw on its distal end. Fourth segment roughly quadrangular, distally with three claws of sub-equal length. The claws unflanged and sharply pointed.

Fifth and sixth legs are represented by papillae bearing setae on the inner margin of the genital segment. Anal lamina small, unsegmented, squarish and is enclosed in the posterior sinus formed by the lateral elongation of the abdomen.

Total length, 3.3 mm.

Male:

Cephalothorax roughly ovoid, frontal plate developed as in female. Lunules large and roughly circular. Posterior sinuses deep, open and slightly oblique. Postero-lateral lobes about half the width of the median lobe. Posterior margin of the median lobe is roughly squarish. Fourth thoracic segment broader than long. Genital segment roughly pear shaped with an anterior constriction, postero-laterally produced into small lobes. Abdomen two segmented. Segments almost fused showing partial separation. First segment

comparatively larger than the second. Both the segments are roughly barrel shaped. Second segment with lateral lobes. Caudal laminae unsegmented, small and posteriorly with five plumose setae.

First antenna is similar to that of female. Second antenna shows slight variations. The basal segment is short, second segment much elongated and the third segment is comparatively shorter than that of female. The postantennal process has almost the same shape as that of female, but in male the main branch is flanged at the tip. Postoral process comparatively simple with a broad base and a tappering distal end without accessory process. Maxilla same as that of the female. Maxilliped three segmented, basal segment short and pointed. Second segment strong and stout with broad base. Third segment with a strong curving stout claw, submedially at the inner margin there is a small seta. Sternal fork shows slight variations from that of the female. The basal part is distally squarish and backwardly narrowing. Tines are roughly parallel and flanged at the distal end.

First leg is uniramous. The basal segment with an oval base. Inner margin of the basal segment with a few rows of denticles and also having a plumose seta at its disto-lateral end. Second segment about twice the length of the basal segment and third segment roughly

squarish in nature, with the armature as that of the female. Second leg not showing much difference to that of the female. The apron of the third leg lacks the denticulated patch. Fourth leg is also similar in structure but the claws are more sharply pointed and straight than the female. Fifth and sixth legs are represented by setiferous papillae bearing three and two setae respectively.

Total length, 1.8 mm.

Remarks:

Present specimen agrees in major details with that given by Rangnekar (1956), but certain variations are observed. Hameed and Pillai (1972) redescribed the species in detail and present specimen is found to be similar in all major details with their description. In the present specimen the frontal plates are projecting and well developed and not narrow as described by Rangnekar. The posterior sinus are wider compared to Rangnekar's illustrations. Rangnekar discribed the fourth thoracic segment as long and nearly two third the median length of the genital segment. But in the present specimen the segment is almost the same length as that of breadth and anteriorly elongated as a neck

like extension. Rangnekar described the second antenna two jointed, but it is clearly three segmented in the present specimen. The distal claws of the third segment of first leg are found to be unflanged in the presen specimen and also having an accessory claw. Rangnekar has shown that the distal segment of the first leg with two conical process, one large and theother small. But in the present specimen the conical process is lacking and the distal claws are with accessory spines. Rangnekar reported it as flanged. The lateral margin of the genita segment in present specimen reaches nearly in line with that of abdominal wings. Rangnekar treated the abdomen proper as distinct from the lateral wing. But in the present specimen it appears as a single flattened laminae Rangnekar described the sternal fork as rudimentary. Compared with her illustration in the present specimen it is well developed. This is the first time male specimens are collected. I could collect two males along with the females. Cephalic appendages of male and female show variations. Postoral process in the male lacks the accessory claw of the distal end and further the main claw is unflanged. The second segment of the second antenna is found to be more stout and elongated in the male than that of the female. Inner margin of the

maxilliped basal segment with a prominent boss to which the distal claw opposes. In the female it is nearly smooth. Tines of the sternal fork is comparatively narrow and longer than the female.

Parapetalus dewani sp. nov.

Figs.198-216.

Material:

Eighteen females were collected from the opercular cavity of Rachycentron canadus (Linnaeus) caught at Cochin.

Female:

Cephalothorax broader than long, subcircular, lateral margin fringed with membranes having a distinct notch anteriorly, frontal plates comparatively narrow, lunules small and ovoid in shape. Posterior sinuses oblique and open, cephalic ridges far behind the median line. Lateral lobes inwardly curved with a round posterior border. Postero-median lobe is about twice the width of lateral lobes. Fourth thoracic segment broader than long, fused with the genital segment. Genital segment swollen, laterally winged, the wings are extending beyond the middle of abdomen. Abdomen apple-shaped, joined with the genital segment through a neck, broader

than long with almost truncated anterior margin and tapering posteriorly with two postero-lateral lobes. Anal lamina short, not extending beyond the abdominal lobes and having six setae.

First antenna two segmented; basal segment stout, slightly inwardly curved, outer margin with a row of plumose setae. Distal segment slender, narrow with a tuft of distal setae, a single naked seta present on the inner margin. Second antenna three segmented, basal segment short with an inwardly directing process, second segment stout, broader than long, third segment long, distally curved with a pointed claw. Postantennal process roughly triangular with a broad base and having a prominent subterminal outgrowth. Postoral process with a broad base tapering into a blunt claw having basal palp with two small and one long setae. Maxilla two segmented; basal segment stout with a narrowing base, distal segment elongated, equal in length with basal segment, having two setiferous processes of subequal length and subterminally with a flap like extension from the inner margin of the distal segment. Maxilliped three segmented, basal segment short and fused with the cephalothorax. Second segment stout, broader than long, roughly conical in shape and third segment ends in a sharply curved claw.

sternal fork well developed, base with two backwardly directed wings, tines are elongated, unflanged and diverging.

First leg uniramous, basipod with a rudimentary endopod on its inner margin. Exopod three segmented, basal segment short, stout and inner margin with a papilla like out growth. Second segment longer than broad, comparatively stout, inner margin fringed with a row of hair like setae, Third segment short, less than half the length of the second segment and distal it bears three claw like spines of subequal length. Second and third claws with accessory spine. Inner margin of the segment with three plumose setae and the distolateral corner having a naked seta. Inner margins of the second and third claws armoured with small teethy serrations.

Second leg biramous, basal segment stout, broader than long, inner margin with marginal membrane, posteriorly the inner margin bears large plumose setae and with a short naked seta submedially. Exopod three segmented, first segment elongate, outer margin covered with a membraneous flange. The segment bears a stout and comparatively long inwardly curved claw on the

disto-lateral end, the claw flanged with serrated membranes. Second segment short, broader than long, distally with a strong claw having serrated membrane. Third segment small with a short claw. Endopod three segmented, basal segment stout and the outer margin fringed with a row of denticles upto the middle and the rest lined with fine setules. Second segment broader than long, with an inner plumose seta. Distal segment roughly triangular and bearing seven plumose setae.

Apron of the third leg broad with a circular patch of denticles at the lower half. Rami well developed, exopod three segmented. Basal claw of the first segment strong curved and not winged. Disto-lateral corner of the second segment bears a sharp stout claw like spine. Distal segment with three unusually stout claw-like spines of which the third spine is very stout and strong. Inner margin with five plumose setae. Endopod two segmented, basal segment very short with a plumose seta, distal segment longer than broad having six plumose setae.

Fourth leg four segmented, basal segment long and stout, distally it bears one spine. Second and third segments on its disto-lateral side bear a strong claw. The claws are winged, its base with a

tuft of fine setae. Distal segment with three distal unflanged claws. Fifth and sixth legs are represented by two small plumose setae on the disto-lateral corner of the genital segment. Caudal ramus small with three comparatively long plumose and three short naked setae.

Total length, 5.2 mm.

Remarks:

Parapetalus dewani sp. nov. shows resemblance with Parapetalus occidentalis Wilson (1908) in general appearance, but differs in some important characters. P. dewani mainly differs from P. occidentalis in the structure and shape of the abdomen. In P. dewani the abdomen is apple shaped, bulging on the antero-lateral margins and posteriorly narrowing. But in P. occidentalis the abdomen is longer than the genital segment, produced into lateral wings curled ventrally and the posterior margin nearly truncated. In P. dewani the lateral wings are not curled ventrally and the posterior border rounded. In P. dewani the post-antennal process with a subterminal outgrowth. The corrugated patch present on the anterior border of the third leg of P. occidentalis is lacking in P. dewani. Outer marginal spines on the third segment of the exopod of

the third leg in P. dewani are unusually stout and claw like, whereas the spines on P. occidentalis are slender. P. dewani differs from all other members of the genus by the shape and structure of the abdomen, nature of the post-antennal process and the presence of claw like spines on the exopod of the third leg.

Members of the genus Parapetalus except P. hirsutus (Bassett-Smith, 1898a) are found to be host specific, parasitizing the fishes of the family Carangidae and Rachycentridae coming under the order Perciformes. All the species, including the new species P. dewani, show certain identical character combinations having the distal segment of the first antenna slender and elongated, second antenna with a strong falcate distal claw, first segment of the enodpod of the second leg with a circular row of denticles on its outer margin, apron of the third leg with patches of denticles. This convergence of characters may be due to the host specificity of this genus. Two other species P. formicoides (Redkar et al. 1949) and P. caudatus (Gnanamuthu, 1950c) formerly included in the genus was transferred by Pillai (1962b) by creating a new genus Pseudopetalus. These two species were collected from the fishes of the order Clupeiformes. It is interesting to note

that these two species having contasting characters with the other members of the genus Parapetalus. So this transfer established the host specificity of the genus Parapetalus with fishes of the family Carangidae and Rachicentridae.

Pillai (1962b) in the revision of the genus Parapetalus discussed in detail the validity of the genus. He observed that there is not much variation between the genus Caligus Muller and Parapetalus Steenstrup and Lutken, except the wing like genital segment and abdomen. Hameed and Pillai (1973a) proposed to re-examine the validity of the genus while describing a new species Caligus parapetalopsis, a species resembling Parapetalus. I could observe that the C. parapetalopsis lacks a major structural similarity with Parapetalus. In all the known species of the genus Parapetalus the abdomen joins with the genital segment through a neck like formation and the abdominal wings overlapping the genital wings. But in C. parapetalopsis the abdomen fused with the genital segment without a neck and not overlapping the genital wings. Detailed observation of the members of the genus Parapetalus revealed that the abdomen joins with the genital segment through a

neck-like formation and the abdominal wings overlapping the genital wings. Based on this character the genus Parapetalus can easily be identified. Pillai (1962b) revised the genus with the same features, so I agree with Pillai's identifying characters as the valid generic characters.

Genus Hermilius Heller

Hermilius helleri Pillai

Hermilius helleri Pillai, 1962c, p.185, fig.3.

Material:

Five females were collected from the gills of Pseudarius jatius (Hamilton & Buchanan).

Total length, 4.8 mm.

Distribution:

West coast of India.

Reamrks:

Present specimen is found to be similar in all major details to the original description by Pillai (1962c). In the present specimen the genital segment

is gradually narrowing towards the posterior and the abdomen clearly two segmented. But in Pillai's illustration anterior half of the genital segment nearly truncated. In the present specimen the caudal lamina with stout setae, whereas Pillai observed normal setae on the caudal lamina. The base of the sternal fork in the present specimen is nearly squarish, but Pillai observed it as nearly rounded. Rest of the characters are found to be identical with that of the original description.

Hermilius helleri can be identified by the conical shaped genital segment, comparatively reduced fourth leg and the caudal lamina with three stout spines.

Hermilius pyriventris Heller

Hermilius pyriventris Heller, 1865, p.187, pl.18, fig.1; Pillai, 1962c, p.181, fig.1; Cressey, 1974, p.235-244, figs.1-46.

Material:

Five females were collected from the gills of Aroides dussumieri (Valenciennes) examined at Cochin.

Total length, 2.8 mm.

Distribution:

Indian Ocean, West coast of India, Jawa, Mauritiana and South Africa.

Remarks:

The original description of this species by Heller (1868) lacks details. Pillai (1962c) described this species in details and supplemented the original description. Recently Cressey (1974) provided a detailed description and illustration of the species. Present specimen is found to be exactly similar to those earlier descriptions except for few minor details. Pillai described the genital segment pyriform and slightly narrowing towards the posterior. But in the present specimen the genital segment is nearly conical, gradually narrowing towards posterior.

This species can be easily distinguished by its four segmented second antenna, two segmented abdomen and two segmented fourth thoracic leg.

Genus Lepeophtheirus Nordmann

Lepeophtheirus spinifer Kirtisinghe

Lepeophtheirus spinifer Kirtisinghe, 1937, p.441, Figs.41-58; Rangnekar, 1959a, p.51, fig.4; Pillai, 1961, p.128, fig.23; Pillai, 1966, p.133, fig.7.

Material:

Five females were collected from the body surface of Rachycentron canadus (Linnaeus) caught at Cochin.

Total length, 5.8 mm.

Distribution:

Ceylon, West coast of India.

Remarks:

Present specimen is found to be agreeing in all major details with the earlier description of Kirtisinghe (1937) and Pillai (1961). Pillai (1966) in his revision discussed in detail the affinity of this species with genus Dentigryps. Lewis (1964) discussed the affinity of this species with the genus Dentigryps and has opined that this species might have belonged to the genus Dentigryps. But Pillai in his description made clear that Lepeophtheirus spinifer possess enough valid characters to be treated as a seperate species and the proposed transfer by Lewis may cause much confusion. So he suggested that Dentigryps species can be made synonymous with that of

Lepeophtheirus. Prabha (1983) suggested that Dentigryps should definitely be treated as synonymous of Lepeophtheir

No commentable variations are observed in the present specimen with that of earlier descriptions. This species can be identified by the strongly chitinized process of fifth leg reaching far beyond the anal laminae.

Lepeophtheirus longipalpus Bassett-Smith

Figs.217-229.

Lepeophtheirus longipalpus Bassett-Smith, 1898b, p.86, pl.5, fig.2.

Indocaligus echinus Pillai, 1961, pl.127, fig.22.

Lepeophtheirus longipalpus Pillai, 1963b, p.92.

Material:

Seven females were collected from the gills of Pseudarius jatius (Hamilton and Buchanan) at Cochin.

Distribution:

Ceylon and West coast of India.

Female:

Carapace roughly equal length as that of breadth. Frontal plates well developed, lunules absent.

Postero-median lobe about twice the breadth of the lateral lobes and nearly truncated. Lateral lobes posteriorly rounded and curved inwardly. Fourth thoracic segment broader than long, laterally produced but rounded and anteriorly neck like. Genital segment roughly pear shaped, about one and a half times the length of breadth and antero-laterally produced into two lateral lobes and the segment postero-laterally rounded. Abdomen two segmented. First segment about four times longer than broad, roughly cylindrical. Distal segment short and with equal width as that of length. Caudal ramus small, broader than long with three distal plumose setae and two lateral naked spines.

First antenna two segmented, basal segment stout and strong with an outer row of short plumose setae, distal segment short and stout with a tuft of distal plumose setae. Second antenna three segmented, first segment transversely elongated with an elongated basal process flanged on either side. Second segment longer than broad, distally narrowing and third segmentt modified into sharply curved claw. Postantennal process represented by three small papilla with small spinules. Postoral process well developed with comparatively broad base, with the basal papilla bearing two short spines. Distally it is elongated into a sharp pointed claw.

Maxilla two segmented, basal segment long and stout. Distal segment slender, apically having two process of plumose nature. Maxilliped two segmented, basal segment modified into sharply curved distal claw. Base of the sternal fork nearly squarish, with roughly parallel tines. The tines are winged on either side.

Basipod of the first leg two segmented, basal segment fused with the cephalon and distal segment longer than broad. Exopod two segmented with a distal stout spine and an inner patch of spinules. Distal segment short, with four distal claws and three stout inner plumose setae with a circlet of setules at its base. Endopod represented by a unsegmented club shaped outgrowth fully covered with spinules.

Second leg biramous. Basipod two segmented, basal segment fused with the cephalon. Second segment longer than broad. Exopod three segmented, basal segment large, more than two times longer than broad with a distal claw of plumose nature and an inner seta. Second segment broader than long, with a claw of plumose nature and third segment longer than broad with two distal spines and six plumose setae. Endopod three segmented, basal segment broader than long with an inner seta and an outer patch of sharp denticles,

second segment comparatively large with outer patch of spinules and an inner plumose seta. Distal segment with seven plumose setae and an outer patch of spinules.

Apron of the third leg highly enlarged, rami two segmented. Basal claw of exopod short and spine like and flanged on either side. First segment of endopod flattened with an outer patch of sharp denticles and a distal strong spine, second segment comparatively small with an outer patch of small denticles and two spines. The segment distally bears three spines. Endopod two segmented, basal segment short with an outer plumose seta. Second segment flattened with an outer patch of sharp denticles and six plumose setae.

Fourth leg four segmented, basal segment strong and stout, comparatively elongated. Second and third segment longer than broad, each with a distal claw. Distal segment apically having three claws and a short spine. The claws of second, third and fourth segments flanged with membrane strengthened by ribs and base of the claw with a tuft of setules. Fifth and sixth legs are represented by plumose setae at the postero-lateral margin of the genital segment. Caudal rami one segmented, comparatively small with three long plumose setae and two short lateral spines.

Total length, 4.8 mm.

Remarks:

Structural details of the present specimen agrees with the descriptions given by Pillai (1961 & 1963b). But a few variations are observed in the present specimen. The genital segment roughly conical, narrow anteriorly and broadening gradually towards the distal end. But in the present specimen the genital segment is roughly pear shaped. The relative length of the genital segment in Pillai's illustrations found to be equal in length of the cephalothorax, whereas in the present specimen the genital segment is shorter than the cephalothorax. The backwardly directing process from the basal segment of the second antenna in the present specimen is large compared to that given by Pillai. The setae on the first segment of the first antenna are hirsute and the postantennal process absent in the present specimen.

It is found Lepeophtheirus longipalpus (Bassett-Smith) shares certain similar characters with other species like Caligus arii (Bassett-Smith) and Hermilius longicornis (Bassett-Smith) which are parasitizing the same host. It is found that the appendages

of these parasites posses patches of bristles and spinules of identical nature inorder to get a firm grip on the mucus covered body surface and the gills of the host.

Family Euryphoridae

Genus Tuxophorus Wilson

Tuxophorus caligodes Wilson

Tuxophorus caligodes Wilson, 1908, p.617, pl.55-56; Heegaard, 1946, p.451, fig.8; Rangnekar, 1959b, p.20, fig.1-2; Pillai, 1961, p.120, fig.19.

Material:

Nine females and ten males were collected from the body surface of Rachycentron canadus (Linnaeus) caught at Cochin.

Total length, female 6.5 mm.; male 3.8 mm.

Distribution:

North America, East Africa and West coast of India.

Remarks:

This species was adequately described and it

is found that the present specimen agrees with the earlier description in all major details. In the present specimen the genital segment is roughly squarish with nearly parallel lateral sides, whereas it is rounded in Pillai's illustrations. As Pillai (1961) and Rangnekar (1959b) observed, the abdomen is clearly two segmented. In the present specimen the basal claw on the third leg is more stout and winged externally, the claws on the basal and distal segments of the exopod are distally sharp with stout base. As observed by Pillai, the distal segment of the first leg bears four claws, the fourth one comparatively small and slender. The claws arming the exopod of the second leg are found to be stout and flanged. Other structures are found to be identical with that of the original description.

Ragnekar's description regarding the male is found to be similar in all major aspects. Rangnekar has illustrated the sternal fork with nearly pointed tines, but in the present specimen, even though it is smaller in size, it is same as that of female, ie. the tines with squarish tip. The postoral process in the present specimen is found to be comparatively narrow than that described by Rangnekar. So far four species

of this genus are recorded from the marine teleost fishes. This species can be identified by the nature of the sternal fork and the structure of the genital segment.

Genus Gloiopotes Steenstrup & Lutken

Gloiopotes watsoni Kirtisinghe

Figs.230-234

Gloiopotes watsoni Kirtisinghe, 1934, p.167, figs.1-17; Kurian, 1955, p.108; Cressey, 1967a, p.7; Shiino, 1954a, p.274, figs.1-2; 1959, p.348; Hewitt, 1964, p.95.

Gloiopotes auriculatus Bernard, 1957, p.11

Gloiopotes huttoni Lewis, 1967, p.57.

Material:

Four females and six males were collected from the body surface of Histiophorus gladius (Broussonet) caught at Cochin. The parasites were found to be embedded in the mucus at the base of the dorsal fin.

Distribution:

It is almost cosmopolitian in distribution with a fairly wide range of host fishes. In India it

was reported from Makaira indica (Cuvier), Tetrapturus brevirostris (Playfair) and Histiophorus gladius (Broussonett).

Total length, female, 12.6 mm; male, 9 mm.

Remarks:

As this species was being adequately described by various authors, further detailed description is avoided. Revision of the genus Gloiopotes by Hewitt (1964), Lewis (1967) and Cressey (1967a) made to bring out the interesting factors regarding the intraspecific variations and affinities of this genus. Cressey (1967a) observed that the length of the cephalon is getting reduced with the increase in total length of the species. Cressey opined that these variations may be due to relative abundance of the egg production and egg migration. Further he observed that the size of the female is found to be varying with different host species. He opined that the dorsal thoracic plates of the female and the structure of the postantennal process cannot be used as valid characters. Lewis (1967) made G. watsoni Kirtisinghe as synoymous with G. huttoni (Thomas) but Cressey (1967a) listed enough variations between these two species to be treated as separate one.

Present specimen agrees with the description and illustration given by Cressey, specially in the shape of the dorsal plates and the relative length and structure of the fifth leg. According to Pillai, the dorsal plate of the fourth segment pointed posteriorly, whereas in the present specimen its posterior end is rounded. Rest of the characters, the present specimen is similar to that described by Cressey (1967a).

This species can easily be identified by the posteriorly rounded dorsal plate of the fourth segment, bifurcated postantennal process, the claws on the first leg and having an accessory claw on the third leg.

Genus Euryphorus Milne-Edwards

Euryphorus nordmanni Milne-Edwards

Euryphorus nordmanni Milne-Edwards, 1840, p.462, pl.39, fig.1; Bassett-Smith, 1899, p.461; Kirtisinghe, 1937, p.445, figs.74-87; Yamaguti, 1963, p.98; Lewis, 1967, p.32, figs.12-15.

Euryphorus nympha Steenstrup & Lutken, 1861, p.365, pl.6, fig.12; Bassett-Smith, 1899, p.461; Wilson, 1913, p.225; Shiino, 1954a, p.284,

figs.5-6; 1959, p.350; Yamaguti, 1963, p.99; Kirtisinghe, 1964, p.88; Pillai, 1964a, p.64, fig.16.

Euryphorus coryphaenae Kroyer, 1863, p.161, pl.10, fig.4a-h; Wilson, 1913, p.225; Yamaguti, 1939, p.2, pl.1, figs.1-17; Bennet, 1948, p.7;

Material:

Six females and three males were collected from the branchial cavity of Coryphaena hippurus (Linnaeus) caught at Cochin.

Total length, female 9.2 mm.; male 4.2 mm.

Remarks:

Present specimen agrees in almost all details with that of the descritpion given by Pillai, but a few variations are observed. In the present specimen the carapace is more rounded laterally than the truncated nature shown by Pillai. The genital segment in the present specimen is not produced postero-laterally into prominent lobes, but the lobes are prominent in Pillai's illustration.

This species can be identified by the dorsal plates on the fourth segment, postero-laterally rounded

genital segment and extremely flat and apically narrowed abdominal wings which are extending beyond the caudal rami.

Genus Alebion Kroyer

Alebion carchariae Kroyer

Alebion carchariae Kroyer, 1863, p.165, pl.119, fig.1; Heegaard, 1955, p.49; Yamaguti, 1963, p.99; Cressey, 1970, p.4; 1972, p.3, figs.1-28.

Alebion difficilis Yamaguti, 1963, p.100.

Alebion gracilis Lewis, 1966a, p.136; Cressey, 1967c, p.5.

Material:

Eleven females and two males were collected from the body surface of Sphyrna zygaena (Linnaeus) caught at Cochin. These parasites were collected along with Pandarus cranchii Leach.

Total length, female 9 mm.; male 7.2 mm.

Distribution:

This parasite is found to be collected from different parts of the world.

Remarks:

This is the first record of this species from the West coast of India. This species has been described by several previous authors after its first report by Kroyer (1863). Cressey (1972) revised the genus Alebion and opined that there are eight valid species in the genus. Present collection agrees with the illustration and description given by Cressey (1972) in practically all details. The specimen of the present collection is larger than that described by Cressey. This may be due to the relative size of the host fish and geographical variations. In all my specimens the attached spermatophores are found to be either with a closed sinus or kept at nearly parallel distance with anterior end. The identifying character suggested by Cressey seems to be valid for the identification of this genus.

Family Trebidae

Genus Trebius Kroyer

Trebius exilis Wilson

Trebius exilis Wilson, 1906, p.194, pl.2, figs.20-23; Kirtisinghe, 1964, p.77; Hameed & Pillai, 1973b, p.461-475, figs.1-14.

Material:

Three females were collected from the body surface of Rhinoptera javanica Muller & Henle examined at Cochin.

Total length, 5.2 mm.

Distribution:

Ceylon and West coast of India.

Remarks:

Till 1973 this species has not been recorded from anywhere after its original discription of Wilson (1906). Hameed (1973b) collected a single female from the type host caught at Cochin and redescribed with detailed illustrations. Hameed and Pillai's description of this species agrees practically in every details with that of the present specimen. As Hameed and Pillai observed the abdomen of the present sepecimen is two segmented, whereas Wilson (1906) described it one segmented. The anterior segment of the abdomen longer than the posterior and the genital segment joins with the fourth thoracic segment through a neck. The fifth and sixth legs are clearly visible on the postero-lateral sides of the genital segment which Wilson failed to observe.

The postoral process is found to be only one segmented as observed by Hameed and Pillai. The structure of the legs in the present specimen is found to be same as that of Hameed and Pillai's description and the variations they observed with Wilson's descritpion are found to be correct.

This species can be identified by the two segmented abdomen having the first segment longer than second, well developed two segmented endopod of first leg and the nearly oblong genital segment with an anterior neck.

Family Pandaridae

Genus Pandarus Leach

Pandarus cranchii Leach

Figs.235-259.

Pandarus cranchii Leach, 1819, p.535; Wilson, 1907, p.403; Heegaard, 1943, p.27; Cressey, 1967b, p.9, figs.27-33; Hewitt, 1967, p.249, figs.141-148.

Pandarus armatus Heller, 1865, p.202; Bassett-Smith, 1899, p.467; Wilson, 1907, p.448; Barnard, 1955, p.258.

Material:

More than hundred females and six males were

collected from a number of hammer headed shark Sphyraena zygaena (Linnaeus). The parasites were found to be firmly attached on the body surface, mainly colonised on the ventral side of the head and head lobes.

Female:

Dorsal shield of the carapace caligiform, lateral margins diverging with narrow strips of membrane. Postero-lateral margins inwardly curved and the posterior margin nearly truncated. The carapace submedially and posteriorly posses two rows of sharp, small spines. First leg bearing segment fused with the cephalon. Dorsal plate of the second segment large, wing-like and reaching nearly upto the posterior margin of the dorsal plates of the fourth leg bearing segment. Dorsal plate of third segment less prominent, roughly semicircular with deep posterior sinus. Dorsal plates of the fourth segment well separated by a deep sinus and the wings are nearly semicircular. Genital segment barrel shaped. Posterior margin with a median lobe and postero-laterally produced. Abdomen one segmented, pear shaped, dorsal plate roughly semicircular and anteriorly narrowing. Caudal ramus reaching beyond the dorsal plate of the abdomen and posteriorly diverging with sharply pointed distal spine and two prominent submedian spines.

First antenna two segmented, basal segment stout more than twice the length of the distal segment, distally swollen bearing a number of stout plumose setae. Distal segment comparatively slender and bears a tuft of distal naked setae. Second antenna three segmented, basal segment stout nearly squarish and unarmoured at its base bearing a large flat adhesive pad. Second segment large, with bulbous scelrotized protuberence. Distal segment long apically produced to a claw bearing two submedian sharp spines on the middle. First maxilliped two segmented, basal segment unarmoured, stout and strong. Second segment slender and short with three claws. Inner claw strong and short, flanged with serrated membrane, outer claws also flanged, one is small and the other about twice the length of the first having sharply curved tips. Second maxilliped two segmented basal segment very stout and roughly squarish with well developed adhesion pad. Second segment broader at the base and narrows towards the distal end, modified into a claw. Inner surface of the claw flat and sclerotized and opposes the basal adhesion pad.

First leg biramous, basipod two segmented, basal segment short and fused with the interpodal bar, second segment spinulose on the inner margin. Exopod

two segmented. First segment roughly squarish with an outer flanged long spine. Distal segment broader at the base and narrows gradually. Basal half of the segment heavily spinulose and distally the segment modified into a knob armoured with spinules. Outer margin with three toothed, curved spines and inner margin with three plumose setae. Endopod two segmented, basal segment short with an inner naked seta. Distal segment long, oval shaped and inner margin with three rugose spines.

Second leg biramous, rami distincly two segmented. Basipod flat and indistincly separated. Distal corner of the basipod with a bulbous outgrowith with spinules. Exopod two segmented, basal segment short with a distal spine. Second segment stout with three strong apical claws having spinules at the distal half and a short bulbous claw heavily armoured with spinules. Inner margin with six naked sharp spines. First segment of the endopod short with patches of spinules on the inner margin. Second segment comparatively long and distally bears three long and two small spines. Outer margins of the segment with patches of spinules.

Third leg basipod two segmented, basal segment transversely flat and distally bears a naked seta and

distal corner with spinules. Second segment flat and modified as a pad. Rami two segmented. Basal segment of the exopod with a distally placed naked spine and the outer margin with spinules. Second segment bears six naked spines. Third and fourth spines strong and stout. Endopod small and two segmented. Basal segment unarmoured with rows of spinules on the inner margin. Second segment distally bears two naked spines, inner margin of both segments with patches of spinules.

Basipod of the fourth leg two segmented, basal segment flat with a distal small spine. Exopod two segmented, first segment with an outer distal spine and second segment with five naked spines, the inner second spine stout and modified. Outer margin with spinules. Endopod one segmented with a single naked seta at the distal end. Outer margin with a patch of spinules.

Caudal rami extends well beyond the posterior broader of the dorsal abdominal plate and diverging. Distally it ends with a sharply pointed claw and inner margin with two naked spines of subequal in length and a flat conical process.

Total length, 8 mm.

Male:

Morphological features of the adult male is same as that of the typical Pandarid male. The cephalothorax semicircular with prominent frontal plates. Posterior sinuses deep and open. First thoracic segment fused with the cephalon. Second segment about four times broader than long, postero-laterally produced, distally truncated and extends upto the postero-lateral margins of the third segment. Third segment two times broader than long and laterally rounded. Fourth segment roughly oval, anteriorly produced into a neck. Dorsal plates are absent on third and fourth segments. Genital segment antero-laterally rounded with submedian lateral conical projections on either side carrying fifth leg, postero-lateral corners produced into prominent lobes. Abdomen two segmented, first segment broader than long and laterally rounded. Second segment also broader than long about two times the length of the first segment. Caudal rami comparatively long and distally bears four long and stout plumose setae.

First antenna same as that of the female. Second antenna three segmented and lacks the sclerotized protruberances found in the female. Structure of the first maxilliped similar to that of female. The distal

segment of second maxilliped apically flat and opposes the adhesion pad.

First leg biramous, basipod two segmented. Basal segment fused, second segment with an inner spine and an outer spinulose outgrowth. Rami two segmented. First segment of exopod about twice longer than the second segment, disto-laterally bears a spine and inner margin lined with plumules. Second segment short, bears three inner plumose setae and four distal flanged claws gradually reducing in length. Endopod two segmented, subequal in length, basal segment having its inner margin lined with plumules. Second segment with three plumose setae.

Second leg biramous, basipod two segmented and basal segment with a row of sharp denticles at its disto-lateral end. Second segment transversely elongated. Exopod two segmented, first segment more than twice the length of the second segment. having a sharp claw on its distal corner and internally with a plumose seta. Second segment with six plumose setae and four flanged claws gradually decreasing in length. Endopod two segmented. First segment broader than long and the second segment about twice the length of the first segment with eight plumose setae distally. Both the

segments of endopod externally lined with a row of fine setules.

Structural details of third and fourth legs are similar, basipod very stout, transversely elongated and a row of sharp denticles at the distal end. Rami two segmented, first segment of the exopod with an outer distal flanged claw and an inner plumose seta. Outer margin of the first segment of exopod produced into two prominent ridges, one at the middle and the other near to the distal claw with a row of sharp denticles. Distal segment with five plumose setae and four flanged claws gradually decreasing in length, the outer margin with a row of sharp denticles. Endopod two segmented, basal segment broader than long with a plumose seta. Distal segment longer than broad having six plumose setae. Inner margin of the segments lined with setules. Fifth leg one segmented, rami distally with a large and two small spines. Sixth leg is represented by a papilla bearing a distal naked seta.

Remarks:

Present specimen is found to be closely similar in all major details with that of the description and illustration given by Cressey (1967b), but minor variations were observed. Cressey observed that spine and setal formula of the first to fourth legs are same

as that of P. satyrus. But variations are observed in the present specimen. The setal formula shows that the basal segment of enodopod of first leg is unarmed, whereas the present specimen having an elongated spine distally and the second segment of exopod having four spines instead of three observed by Cressey. The distal segment of the endopod of second leg with five setae instead of eight given by Cressey. Variations are observed in the setal formula of third and fourth legs also. Caudal rami in the present specimen is found to be diverging, whereas it is almost straight in Cressey's illustration.

Cressey (1967b) in his revision of the family Pandaridae described and discussed in detail the affinity of the species with Pandarus satyrus Dana (1852) and observed that variations between these two are comparatively less. Due to the close similarity in the structure and morophology of this species with P. satyrus, Shiino (1954c) placed it in synoymy with P. satyrus. But Cressey after careful examination of a large number of both of these species established the validity of these two species. It is found that Pandarus cranchii Leach is closely related to P. satyrus Dana. But it has been separated by the difference in the length of the caudal ramus. It is also related to P. zygaena

Brady (1883) in the development of the dorsal plates of the thoracic segments, but differs in the structure of the caudal ramus.

Present specimen can be identified by the wing like dorsal plate of second segment extending up to the posterior broader of the dorsal plates of fourth segment and comparatively elongated caudal ramus, which extends beyond posterior margins of the dorsal abdominal plates.

Pandarus niger Kirtisinghe

Figs.260-268.

Pandarus niger Kirtisinghe, 1950, p.83, figs.13-28; 1964, p.83, figs.97-98; Cressey, 1967b, p.22, figs.109-118.

Material:

Two females were collected from the body surface of Sphyrna zygaena (Linnaeus) examined at Cochin.

Distribution:

Ceylon and West coast of India.

Female:

Dorsal shield of the cephalothorax roughly triangular, narrow anteriorly and without any armature. Frontal plates well separated. Posterior margin of the dorsal shield with two pairs of laterally placed denticles. Dorsal plates of second and third leg bearing segments are of equal size and fused at the base. Fourth segment with a lateral sclerotized ridge with three sharp denticles. Posterior sinus shallow and the dorsal plates are less prominent. Genital segment smaller than the fourth leg bearing segment, postero-laterally produced into conical lobes. Abdomen unsegmented. Dorsal plate semicircular with a neck anteriorly. Caudal lamina about twice the length of the dorsal abdominal plate with two sharp spines on the middle and a distal spine.

First antenna two segmented, basal segment stout and more than twice the length of the distal segment. Distal half of the outer margin of the basal segment with rows of twelve to fifteen strong and stout setae. Distal segment roughly cylindrical with a median stout seta and a tuft of distal naked setae. Second antenna stout, strong and four segmented. First segment stout and strong with a well developed adhesive pad at the base. Second segment longer than broad with two spines, one in the middle and

the other on the disto-median position. Third segment roughly squarish and comparatively small. Distal segment with a strong claw, slightly curved and blunt at the tip. First maxilliped two segmented, basal segment strong, stout and unarmoured. Distal segment slender and stout, bearing three claws, the basal short one with plumose setules and the other two claws are lined with membraneous flanges of which the terminal claw is twice the length of the other. Basal segment of the second maxilliped roughly squarish and highly muscular with two sclerotized distal chelae. One of the chelae flat with strong ridges and the other pointed and sharp.

First leg biramous, basipod one segmented and the inner and outer distal margin armed with two sharp distal spines. Endopod two segmented and subequal in length. Basal segment unarmed, distal segment bearing three distal spines. Exopod two segmented, basal segment comparatively short and squarish, bearing a distal naked outer spine. Distal segment long, slightly curved inwardly, basal half bulged, unarmed and distal end modified bearing three pairs of strong spines on either side of the segment and apically it ends in a blunt claw.

Second leg biramous, basipod two segmented. Segments transversely elongated. Outer distal corner of

the basal segment with an oval shaped papilla armed with spinules. Exopod two segmented and the segments subequal in length. Outer margin of the basal segment with a chitinized plate fully covered with rows of fine denticles and distally with a naked seta. Distal segment with ten spines on the inner and distal margins. Outer margin with few rows of spinules. Endopod two segmented, basal segment comparatively small and unarmed. Distal segment more than two times the length of the basal segment, curved inwardly, inner and the distal margins with six short naked spines.

Third leg biramous, basipod comparatively large, flat and two segmented. Outer distal margin of the basal segment of the exopod highly bulged with a sharp spine and few rows of spinules. Distal segment roughly squarish, nearly one and a half times longer than the basal segment and bears seven spine apically. Fourth spine modified in to a conical shaped claw. Endopod two segmented, basal segment very short and unarmed, distal segment long with three naked slender spine at the distal margin.

Fourth leg basipod two segmented, flat and large. Disto-lateral corner of the distal segment having a small bulge bearing spinules and a slender spine. Rami unsegmented and flattened, exopod and endopod are

subequal in length. Outer margin of the exopod with rows of spinules and armoured with seven spines. Outer third spine modified into a conical shaped claw. Inner margin of the endopod with three spines, outer without spinules.

Total length, 5.5 mm.

Remarks:

Pandarus niger Kirtisinghe (1950) has so far been described from Ceylon and Formosa (Cressey, 1967b). So far this species was not collected from the Indian waters. I was able to collect two females from the body surface of hammer headed shark. Sphyrna zygaena (Linnaeus) along with Pandarus cranchii Leach (1819). Cressey (1967b) in his revision of the pandarid copepods described the taxonomically important features of the species and has given the principal variations among the related species. I could observe certain variations in the present specimen when compared with the illustrations and description given by Kirtisinghe (1950) and Cressey (1967b). The median sinuses of the dorsal plates of third and fourth segments in the present specimen are more deep and prominent, wherea they are shallow in the illustration given by Kirtisinghe and Cressey.

The lateral margins of fourth segment in the present specimen is with a marginal ridge which is not observed by Kirtisinghe. The distal spine of the caudal ramus in the present specimen is sclerotized and partially separated from the caudal lamina proper. But such a separation is not observed by Kirtisinghe and Cressey. The spines and setal formula of the present specimen is found to be identical with that of the earlier descriptions. Distribution of this species is restricted to Indian Ocean and Western Pacific. Earlier collections were made from carcharinid shark (Kirtisinghe, 1950) and Galeorhinus sp. (Cressey, 1967b). The present collection of the specimen is from Sphyrna zygaena.

Pandarus niger can be identified by the reduced dorsal plates of the second and third segment, posteriorly truncated dorsal plate of the fourth segment and comparatively long caudal ramus with two spines.

Genus Pseudopandarus Kirtisinghe

Pseudopandarus longus (Gnanamuthu)

Pandarus longus Gnanamuthu, 1951a, p.1245, figs.23-44;
Kurian, 1955, p.114, fig.38.

Pseudopandarus longus Pillai, 1964a, p.65, figs.17-19;
Cressey, 1967b, p.31, figs.151-161.

Material:

Twenty five females and two males were collected from the body surface of the shark, Scoliodon sorrakowah (Cuvier) collected at Cochin.

Total length, female 4 mm.; male 2.4 mm.

Distribution:

West and East coasts of India.

Remarks:

Present specimen is agreeing with the original description in all major details. This genus Pseudopandarus created by Kirtisinghe (1950) differs from the Pandarus mainly by the nature of the dorsal plates on the thoracic segment. So far this species was collected from the body surface of the carcharinid sharks. This copepod was first described by Gnanamuthu (1951a) as Pandarus longus. Kurian (1955) had also reported the same. Cressey on comparison with Pseudopandarus gracilis Kirtisinghe (1950) placed along with the genus Pseudopandarus.

This species can be easily identified by the elongated nature of the genital segment and the comparative size of the dorsal plates of second free thoracic segment

to that of third. The plates on second segment never extend beyond that of third segment.

Family Anthosomatidae

Genus Lernanthropus Blainville

Lernanthropus trifoliatus Bassett-Smith

Lernanthropus trifoliatus Bassett-Smith, 1898a, p.11, pl.7, fig.3; Kirtisinghe, 1956, p.18, fig.11; Pillai, 1963a, p.655, fig.1.

Material:

Two females and four males were collected from the gills of Polynemus plebeius (Broussonet) and two males and two females from the gills of Eleutheronema tetradactylum (Shaw).

Total length, female 5.3 mm.; male 0.9 mm.

Distribution:

West coast of India and Ceylon.

Remarks:

Pillai (1963a) described the species in detail and comparison of the present specimen with the description of Pillai shows prominent variations. The carapace is nearly

of equal length and breadth and postero-lateral lobes of the carapace are not prominent and is nearly truncated in the present specimen, whereas Pillai described it as longer than broad and postero-laterally produced into lobes. Distal segment of second antenna of the female with an accessory spine, whereas it is found to be lacking in the present specimen. The endopod of the first and second legs are comparatively elongated and with a prominent median constriction separating a basal portion and nearly rounded distal part, whereas Pillai's illustration shows that it is nearly ovate without any median constriction.

The structural details of the male specimen also show variations. The cephalothorax is nearly rounded and the rest of the body segments fused together, lacking the demarcation of the segments. Rami of the third and fourth legs fully covered with setules.

Pillai (1963a) observed that the species shows size and structural changes with variation of the host species. The exopod of the fourth pair of legs in female collected from Polynemus plebeius (Broussonet) is club shaped and stout, whereas the specimens collected from hosts other than Polynemus plebeius is found to be narrow and with uneven margins. Present collection of L. trifoliatus from P. plebeius shows that what Pillai observed

is correct. The exopod of the fourth leg is club shaped and with even margin having spinules arranged regularly on the inner side.

The specimen collected from Eleutheronema tetradactylum (Shaw)is varying considerably in the structure of the fourth leg from those collected from P. plebeius. This structural variation within the same species is definitely due to the effectof host or the structural variation aquired in relation to the variation of the host species.

This species can be identified by the nature of the fourth leg with marginal rows of spinules and posteriorly rounded and anteriorly narrowing dorsal plate.

Lernanthropus cornutus Kirtisinghe

Lernanthropus cornutus Kirtisinghe, 1937, p.448, figs.88-98; Pillai, 1963a, p.658, fig.2; Shiino, 1965a, p.375, figs.1-2.

Material:

Six females and two males were collected from the gills of Tylosurus leiurus (Bleeker) and two females from Ablennes hians (Valenciennes) caught at Cochin.

Total length, female 2.8 mm.; male 1.4 mm.

Distribution:

Ceylon, Senegal, Gilbert island, Japan and West coast of India.

Remarks:

General shape and structural details of the present species remain the same as that of original description and less variations are observed. Male specimen is found to be varying in its general body shape and structure of the third and fourth legs. The posterior broader of the cephalothorax is found to be modified with a constriction in the original description, whereas it is found to be nearly truncated in the present specimen. Moreover, the rami of the third and fourth legs are broad and short respectively in the present specimen. Rami gradually narrow distally, bifurcated and bear a small tuft of setae at each lobe.

In the female the abdomen is more elongated and rectangular in shape with caudal lamina nearly the same size as that of the abdomen. Rest of the characters are found to be identical with that of the original description.

In the present specimen, as Pillai observed all the appendages and leg rami remain within the posterior limit of the dorsal abdominal plate. From the earlier report it is clear that the species shows pronounced size variation which may be due to the variation in the size and age of the parasite and the host fish.

This species can be identified by the membraneous nature of the dorsal abdominal plates and postero-laterally produced processes of the cephalothorax.

Lernanthropus otolithi Pillai

Lernanthropus otolothi Pillai, 1963a, p.664, fig.5.

Material:

Three females were collected from the gills of Johnius argentatus (Houttuyn) at Cochin.

Total length, 4.7 mm.

Distribution:

West coast of India.

Remarks:

Present specimen is found to be similar in all

details with the original description of Pillai (1963a), but a few variations are observed. The postero-lateral borders of the carapace in the present specimen is laterally produced and rounded, whereas it is inwardly curved in Pillai's illustration. The anterior trunk segment in the present specimen widened posteriorly, whereas it is nearly parallel in Pillai's illustration. Dorsal plate of the present specimen is nearly circular in outline as observed by Pillai. The abdomen in the present specimen is elongated and two segmented, whereas it is broader in the original description. Structure of the legs also show variation. Exopods of the second and third legs in the present specimen are found to be elongated and slender, whereas it is comparatively broader in Pillai's specimen. Rest of the characters are found to be similar to that of the original descritpion.

This species can be identified by the nearly circular carapace, large and nearly circular dorsal plate and the long and slender anal lamina.

Lernanthropus indicus (Pillai)

Figs.269-285

Lernanthropus indicus Pillai, 1965, p.1630, fig.159.

Lernanthropus carangus Pillai, 1964b, p.48, fig.9.

Material:

Four females and one male were collected from the gills of Pampus chinensis (Euphrasen) caught at Cochin.

Female:

Cephalothorax longer than broad, anteriorly narrowing with two prominent lateral projections. Postero-lateral margin rounded with posterior margin slightly curved. Trunk segment comparatively large with roughly of equal length as that breadth with two postero-lateral projections and a deep sinus. Dorsal plates roughly pear shaped, anteriorly broader, posterior margin with a shallow sinus. Abdomen comparatively small, having postero-laterally rounded margins. Caudal ramus longer than broad and distally narrowing bearing one short distal spine.

First antenna seven segmented, segments distinctly separated and gradually narrows towards the distal end. Basal segment large and stout, longer than broad and free of any armature. Second segment roughly squarish with an outer and an inner naked spine. Segments three to six, subequal in size and each one with naked

seta on their outer margin. Distal segment comparatively short and distally with five naked spines.

Second antenna three segmented, basal segment short and fused with the cephalon. Second segment comparatively stout. Third segment modified into a strong and stout claw, apically curved with its distal half nearly chitinized. First maxilliped two segmented, basal segment strong, about two times longer than broad. Second segment slender, more than half the length of the basal segment and distally bears a sharp claw having a row of sharp denticles on either side of the claw. Second maxilliped two segmentd, first segment very stout and strong, longer than broad; second segment modified into strong claw slightly curved at the tip and ends bluntly.

First thoracic segment biramous. Basipod indistinctly separated from the body. Exopod large, about two times longer than broad, distally flattened with four sharp distal spines. Endopod unsegmented, roughly oval shaped with its outer margin fully covered with short spinules and close to the inner base of the endopod with a sharp stout spine. Second leg also biramous, exopod longer than broad with four distal spines. Endopod nearly of the same shape as that of

the exopod, distally bears a sharp spine and marginal row of denticles. Third leg uniramous, rami large and broad modified into foliacious process and distally narrow. Fourth leg biramous, rami well developed and of subequal length. Rami broader at the base and distally narrowing. Fifth leg uniramous, rami slender and elongated, about half the length of the exopod of the third leg. Sixth leg found to be absent. Caudal ramus well developed, roughly conical with a large naked submedian spine and a short distal spine.

Total length, 3.5 mm.

Male:

Pillai had not described the male of this species. Cephalothorax barrel shaped. First thoracic segment fused with the cephalon. Second, third and fourth thoracic segments are separated by an indistinct septum. Fifth thoracic segment and the genital segment fused together. Abdomen unsegmented with rounded lateral margin. Caudal lamina distinctly separated, distally pointed and slightly diverging.

First antenna seven segmented, outer broader of the segment with chitinized thickenings and distal segment with a tuft of setae. Second antenna three

segmented. Basal segment short and stout, second segment stout and curved inwardly. Third segment modified into a sharply pointed claw close to the base having sharp accessory spine. First maxilliped same as that of the female and distal claw with two rows of sharp denticles. Second maxilliped two segmented, basal segment stout and strong, distal segment modified to a claw opposing the basal segment.

First leg biramous, structure same as that of female. Exopod flat and bears five sharp teeth and endopod with an elongated distal spine. Second leg also biramous, rami unsegmented. As that of the first leg the endopod bears distally an elongated sharp spine. Third leg highly developed, biramous, exopod modified into an elongated process, distally narrowing, both covered with irregularly arranged spinules. Fourth leg comparatively large modified into two elongated processes, rami subequal in length, and covered with spinules. Fifth and sixth legs are found to be absent.

Total length, 1.6 mm.

Remarks:

Present specimen shows close similarity in all major details with that of Pillai's (1964b) descriptio

But certain minor variations are observed. The distal segment of the second antenna more stout and with chitinized grooves apically, whereas in the original description these characters are not mentioned. Basal segment of the second maxilliped is comparatively stout and the distal segment lacks the partial separation shown by Pillai.

The original collection of this species is from Caranx sansun (Forskal) at Trivandrum. Present collection of this species is from Pampus chinensis (Euphrasen) is a new host record. For the first time the male of this species was collected and described in detail.

This species can be identified by the shape of the lateral trunk process, basal segment of the first antenna and structure of the dorsal trunk plate.

Lernanthropus aneezi sp. nov.

Figs.286-294

Material:

Two females were collected from the gills of Chirocentrus dorab (Forskal) caught at Cochin.

Female:

The carapace broader than long, antero-laterally produced into two prominent lateral lobes and with a deep median notch. Carapace widens beyond the middle forming two postero-lateral lobes. Posterior part narrow, roughly rounded and slightly overlapping the trunk. Trunk broader than long and antero-laterally rounded. Rest of the body is covered with dorsal plate. Dorsal plate about equal length as that of breadth. Abdomen is covered with dorsal plate. Abdomen short, widens posteriorly, longer than broad with postero-lateral margin rounded. Caudal rami more than two times longer than broad and narrowing distally. First antenna seven segmented, each segment is separated by sclerotized lateral ribs and are free of armature. Distal segment with a tuft of short naked setae. Second antenna prehensile, strong, modified and three segmented, first segment nearly quadrangular and broader than long with two basal projections at the basal corner Second segment stout, about three times longer than the basl segment and slightly narrows distally. Distal segment with a nearly quadrangular base, bearing a strong and stout apical claw. A prominent accessory claw arising from the inner base of the main claw. The main cla with deep grooves on its entire length.

Maxilla with a slightly curved elongated base, narrowing distally. Apically it bears a stout large process and a small spine. The process is having a partition on the middle. First maxilliped two segmented, basal segment comparatively stout and strong, about three times longer than broad, broader at the base and narrows distally. Second segment slender, distally pointed and slightly curved. Second maxilliped three segmented, firs segment short and conical in shape, second segment stout, strong and about two and a half times longer than broad with patches of short denticles above the base. Distal segment slender and claw like, sharply pointed at the distal end with a small accessory spine submedially.

First leg biramous. Basipod flat and unsegmented, with an outer marginal row of sharp spinules. Exopod two segmented, basal segment fused with the basipod. Second segment roughly squarish, longer than broad, slightly broader at the distal end. Distally it bears five sharp claws toothed on either side. Endopod unsegmented, segment roughly conical, narrows distally and lateral margins of the segment lined with rows of fine spinules. Distally the segment bears an elongated naked spine. Second leg biramous, basipod indistinct, fused with the body. Exopod unsegmented, segments

longer than broad and roughly barrel shaped with three slender spine lined with setules. Both the margin of the segments lined with a row of setules. Endopod one segmented, nearly conical in shape with an elongated naked distal slender spine. Both the margin lined with setules. Third leg uniramous, roughly oval in shape, distally bearing a slender elongated spine. Lateral margins lined with setules. Fourth leg biramous modified into very long foliacious structure. Rami roughly of equal length broader at the base and narrows distally. Fifth and sixth legs are found to be absent.

Total length, 5.1 mm.

Remarks:

Lernanthropus aneezi sp. nov. shows resemblance with Lernanthropus atrox Heller (1865) in the general shape of the body. In the present new species first antenna is clearly segmented and segmentation distinct through the sclerotized ribs of the segment, whereas in L. atrox the segmentation of the first antenna is not distinct. In the present specimen the second antenna with a prominent accessory claw and the main claw distinctly grooved. But in L. atrox the accessory claw absent and the main claw free of any grooves. Moreover, the endopod of the first and second legs of the new species having highly elongated distal spine and

the exopod spines are toothed on either side, but in L. atrox the spines are free of denticles and the distal spine of the endopod is very small.

L. aneezi sp. nov. differs from all other members of the genus by the shape of the dorsal plate, the structure of the second antenna with a prominent accessory claw on its distal segment and the sclerotized grooves on the main claw. Maxilla of this new species is large with a stout distal process having a partition on the middle.

Lernanthropus carangoidi sp. nov.

Figs.295-310

Material:

Four females and two males were collected from the branchial cavity of Carangoides malabaricus (Bloch) landed at Cochin.

Female:

The carapace anteriorly narrow and postero-laterally rounded with the antero-lateral borders produced into two lateral lobes. Trunk about two times broader than long and postero-laterally produced. Dorsal plate

nearly semicircular with the anterior half granulated. Abdomen fused with the genital segment, posteriorly rounded and medially with a deep sinus. Anal lamina longer than broad, narrows distally and ends bluntly.

First antenna seven segmented, basal segment large and the segments gradually getting reduced in size towards the distal end. Each segment bears a spine on its outer margin. Sixth segment with four spines and the distal segment with seven marginal spines and two basal spines. All the segments are found to be sclerotized on its either margin. Basal segment of the second antenna stout and strong, slightly curved at the inner distal end, distal claw strong and sharply curved without any accessory claw. First maxilliped two segmented, basal segment large and stout, narrow towards the distal end. Distal segment slender and distally bears one large claw, margins of the claw fringed with serrated membranes and the base of the claw having a circlet of setules. Second maxilliped strong and stout and of typical caligid type. Basal segment stout and second segment distally curved bearing strong sharply pointed claw.

First leg biramous. Exopod broader, distally with five strong teeth. Endopod small conical in shape

with a distal long spine. Second segment also biramous and the shape of the rami similar to that of the first leg. The exopod distally bears four teeth. Endopod distally rounded with a spine having marginal setules. Third leg reduced, conical in shape, uniramous and close to the lateral margins of the trunk segment. The rami of the fourth leg is enlarged and are of subequal length. Endopod nearly two times the length of the exopod and distally pointed. Exopod broader at the base and narrows distally. Fifth leg uniramous, comparatively small and close to the base of the fourth leg. Sixth leg found to be absent.

Total length, 4 mm.

Male:

Carapace anteriorly narrowed with two lateral lobes, posterior part nearly circular. The trunk and abdominal segments fused together. Trunk segments are covered with scutes. Genital segment and abdomen fused. Abdomen nearly rounded with short caudal rami diverging each other. These segments are also armed with denticles. First antenna same as that of the female. Second antenna highly modified. Basal segment strong and stout with outer distal grooves. Distal segment is a strong claw with a

basal accessory process. Maxilla having a strong and stout, distally narrowing base with two apical processes. The larger process medially separated into a nearly cylindrical basal and sharply pointed distal part. Basal segment of the first maxilliped stout, second segment slender, long and distally bears an accessory claw along with the main claw. Both the claws denticulated. The first segment of the second maxilliped with a prominent boss at its inner margin and distal claw without accessory spines.

First leg biramous, basipod flattened and segmentation indistinct with an elongated slender spine close to the outer base of the exopod. Exopod unsegmented, stout, longer than broad bearing five stout spines at the distal end. Endopod also unsegmented, longer than broad, distally narrowing with rows of sharp denticles. Base of the exopod with a distally pointed claw like process and denticulate on either side.

Second leg also biramous and rami unsegmented. Exopod longer than broad with a prominent distal bulging fully covered with sharp denticles and three short spines. Endopod unsegmented with roughly oval shape, narrows distally and having rows of sharp denticles on either

margin. Distally it bears an elongated comparatively stout spine with the distal half lined with two rows of sharp denticles.

Third leg biramous and rami modified. Exopod of the third leg highly enlarged, elongated and distally rounded. Endopod comparatively small both rami covered with sharp denticles. Fourth leg modified as that of the third leg. Exopod comparatively long and slender. Endopod more than half the length of the exopod, both the rami lined with sharp denticles. Fifth and sixth legs are found to be absent.

Total length, 2.3 mm.

Remarks:

Lernanthropus carangoidi sp. nov. shows similarity in the structure of the dorsal plates and general body shape to L. opisthopteri Pillai (1964b) and L. shishidoi Chin (1948). In L. opisthopteri the cephalothorax is anteriorly squarish in nature and posteriorly joins with the thorax through a neck, whereas in the new species the cephalothorax broader at the posterior end and joins directly with the posterior trunk. Moreover, in the present specimen the anterior trunk is medially divided into two equal halves and the dorsal plate roughly semicircular and granulated anteriorly.

But in L. opisthopteri the dorsal plate is laterally produced and roughly truncated in the posterior end. In L. opisthopteri the abdomen is comparatively slender and clearly two segmented, but in the present specimen the abdomen is broader and segmentation indistinct. Moreover the structure of the legs and appendages also show variation. In the present specimen the exopod of the third leg is small and nearly half the length of the endopod, whereas in L. opisthopteri they are roughly of equal length. In this present species the distal claw of the first maxilliped is lined with a broad serrated membraneous flange and a circlet of fine spinules at the base of the distal claw, which is found to be absent in L. opisthopteri.

In the shape of the dorsal plates present specimen shows resemblances to L. shishidoi Chin (1948). But in L. shishidoi the carapace is roughly squarish with laterally produced margins, whereas in the new species the cephalothorax anteriorly narrow and the postero-lateral margin rounded.

The new species Lernanthropus carangoidi differs from other members of this group by the nearly circular nature of the dorsal thoracic plate, the distal claw of second maxilla with a basal circlet of spines and the

anteriorly narrow cephalothorax with prominent lateral projections.

Family Eudactylinidae

Genus Eudactylina Van Beneden

Eudactylina diaboli sp. nov.

Figs.311-322.

Material:

Two females were collected from the gills of Mobula diabolus (Shaw) examined at Cochin.

Female:

Cephalothorax longer than broad, shield like and anteriorly with two conical processes on either side. First throcic segment fused with the cephalon, laterally rounded and the posterior margin nearly truncated. Second segment broader than long and laterally rounded. Third segment nearly rounded. Fourth segment very stout and pot like. Fifth segment gradually increasing posteriorly and the lateral margins on the posterior side rounded with two prominent lateral sinuses. Genital segment narrows backwardly with a median patch of sharp denticles. Abdomen two segmented, basal segment about twice longer than the

distal segment. Distal segment comparatively narrow. Caudal ramus one segmented and the margins lined with small denticles.

First antenna six segmented, basal segment fused with cephalon. Second segment nearly squarish, stout and strong. Third segment also squarish with two outer spines. Distal claw of the third segment very large and sharply curved. Fourth segment longer than broad, distally narrowing and the outer margin with three short spines and a long claw. Fifth segment comparatively small, the outer margin having a row of sharp spines. Distal segment long and slender with a tuft of naked setae at the apical end. Second antenna four segmented, first segment elongated, second segment broader at the base, third segment two times longer than broad, fourth segment swollen at the base and distally narrowing into a sharp claw without any accessory spine.

Maxilla very small with two apical plumose subequal spines. First maxilliped two segmented, segments subequal in length, first segment long and stout, distal segment comparatively slender bearing a sharp distal claw, setose on either side. Second maxilliped chelate and three segmented. First segment stout, strong

and fused with cephalon. Second segment modified with stout roughly squarish base and produced into an arm, pointed at the tip with an inner membraneous flap to receive the oppossing arm of the chela. Third segment curved, distally narrowing and apically having two sharp small inner spines and a strong outer spine.

First leg biramous, basipod two segmented, basal segment broader than long, stout and with a two segmented papilla fully spinulose in nature. Basal segment of the pailla stout. Distal segment small, longer than broad and armed with spinules. Second segment broader at the base and roughly conical. Exopod two segmented first segment longer than broad with the lateral margins having row of sharp denticles. Second segment about two and a half times longer than the basal segment. Its lateral margin lined with sharp spinules. The segment distally bears one median long plumose seta and two lateral spines. Endopod three segmented, segment comparatively long, modified into a pointed curved claw.

Second leg biramous, basipod transversely elongated, basal segment comparatively long, about two times the length of the second segment. Exopod modified,

first segment long, slightly curved at the base with a small spine distally. Second segment small, longer than broad having five small spines on its inner margin. Third segment modified into a distal strong spine. Endopod three segmented, first segment stout and strong, longer than broad and on the lateral margins arranged with sharp denticles. Second segment short about half the length of the basal segment. Third segment slender more than one and a half times longer than the second segment, distally it bears one large and two short spines.

Third leg biramous, basipod two segmented, segments flattened, transversely elongated and subequal in size. Exopod three segmented, segments nearly cylindrical, first segment highly elongated, equal to the combined length of second and third segments. Outer distal margin of the segment with a sharp spine and lateral margins covered with spinules. Second segment about half the length of the basal segment having a sharp distal spine and the lateral margins lined with spinules. Distal segment comparatively slender with four apical spines, one large and three small. Lateral margins of the segment lined with setules. Endopod also three segmented, first segment stout, about two times longer

than broad, inner and outer margins lined with sharp spinules. There is a partition on the middle of the segment longitudinally. Second segment small, roughly oval in shape, lateral margins with a row of denticles. Third segment slender, more than twice the length of the second segment, inner margin curved with three distal spines, median spine long.

Basipod of the fourth leg two segmented, basal segment long and stout, distal segment short about the half the length of the basal segment. Exopod three segmented, first segment more than twice the length of the second segment, nearly cylindrical with a sharp distal spine. Second segment also cylindrical with a distal spine. Third segment comparatively small with three distal spines. Lateral margins of the segments lined with sharp spinules. Endopod three segmented, basal segment about two times longer than broad having a longitudinal partition on the middle. Second segment small, roughly oval and distally narrowing. Third segment slender with three distal spines. Lateral margins of the segments lined with sharp spinules. Fifth leg one segmented, roughly conical, about two times longer than broad with three sharp spines and its lateral margins lined with spinules. Caudal ramus one segmented, narrowing towards the distal end and fully covered with small spinules.

Total length, 3.6 mm.

Remarks:

The new species Eudactylina diaboli shows resemblance to Eudactylina oliveri Leubier (1968) in its morphological structures. Leubier has shown that the anterior broader of the cephalothorax perfectly rounded, but in the present specimen the cephalothorax is anteriorly narrow with two lateral projections. In E. oliveri the second thoracic segment is constricted in the middle, but in the present specimen the segment is transversely elongated with rounded lateral margins. The fourth and fifth segments of the present specimen is very much different from that of E. oliveri. Fourth segment is comparatively elongated and posteriorly narrowing in E. oliveri. But in the present specimen the segment with clearly rounded posterior margin with a prominent anterior neck.

In E. oliveri the base of the distal claw of the second antenna bearing three spines, but it is absent in the present specimen. Exopod of the first leg in E. oliveri is three segmented and elongate, but in the present specimen exopod two segmented and segments short and stout. Second and third segments of the exopod of second leg modified, second segment with five small spine and the distal segment carries a

sharp spine apically. But in E. oliveri the segments are not modified. In the first segment of the endopod of the second, third and fourth legs in E. diaboli having a partition in the middle longitudinally, whereas in E. oliveri such a partition is lacking.

This new species can be identified from all other known species by the shield like anteriorly elongated cephalothorax, the nearly round third and fourth thoracic segments and the basal segment of the endopod of second, third and fourth legs having a median longitudinal partition.

Eudactylina eulamini sp. nov.

Figs.323-348.

Material:

Ten females and six males were collected from the gills of Eulamia melanoptera (Quoy & Gaimard) at Cochin.

Female:

Carapace longer than broad, anteriorly narrowing. Postero-lateral margin rounded with slightly curved posterior margins and antero-laterally having two prominent notches. Lateral margins covered with two sharp denticles. First thoracic segment fused with the cephalon. Second thoracic segment more than three

times broader than long, laterally produced and rounded with patches of sharp denticles. Posterior margin slightly curved inwardly. Third segment longer than the first with nearly of equal in length and breadth as that of the second segment with slightly inwardly curved posterior margin. Lateral margins with patches of denticles. Fourth thoracic segment about two and a half times the breadth of length, laterally rounded with row of sharp denticles. Fifth segment conical in shape, posteriorly produced into lobes and connected with the genital segment by a neck. Genital segment roughly circular. Abdomen two segmented. First segment large about two times the breadth of length. Second segment small, broader than long. Caudal ramus unsegmented.

First antenna seven segmented with a geniculate flexion between the third and fourth segment. First segment short and fused with the cephalon. Second segment nearly two times broader than long and stout with an outer distal spine. Third segment stout and broad at the outer margin with two prominent ridges bearing two spines and a distal stout and strong claw sharply curved and apically acute. Fourth segment nearly rectangular with two lateral and one distal spine,

subapically having a strong and stout spine with denticulated lateral margin. Fifth segment roughly cylindrical with a subdistal spine. Sixth segment longer than broad with a distal elongated spine. Distal segment small, rounded apically and bearing a tuft of naked setae at the distal end. Second antenna five segmented. First segment short and fused with the cephalon. Second segment more than two times longer than broad and roughly quadrangular. Third segment stout and roughly of equal length and breadth with a stout claw at the distal end and outer margin with a row of denticles. Fourth segment elongated and broader at the base. The distal segment modfied into a sharply curved claw having a basal accessory claw and a short spine.

Maxilla distally narrowing with patches of sharp denticles at the basal and distal margins. Distally it bears two elongated spines of subequal length. First maxilliped two segmented, basal segment very stout and roughly quadrangular. Second segment narrow at the base and distally truncated with a sharp and strong claw and a circlet of spinules distally. Outer margin of the segment with three rows of sharp denticles. Second maxilliped chelate. Basal segment strong, stout and longer than broad. Second segment with broad base,

about one and a half times broader than long, distally produced into a strong arm of chela, apically having a membraneous cup for receiving the opposing arm of the chela. Basal part having a patch of sharp denticles medially. Third segment elongated, curved inwardly forming the oppossing arm of the chela and having a partial separation subdistally. Distally it ends in a sharply pointed stout forked strong claw with a membraneous flap. Inner margin submedially bears a short spine.

First leg biramous, basipod two segmented, basal segment flattened and fully covered with sharp denticles, Second segment braoder than long. Rami three segmented. First segment of exopod comparatively large, broader than long with sharp spinulation on either side. Second segment small, narrows towards the distal end and distal segment nearly conical. Lateral margin of the segments lined with sharp denticles. Third segment bears an elongated spine, distally armed with a row of denticles. Structure of the endopod same as that of the exopod, but segments are comparatively small. The distal spine of the third segment free of denticles.

Second leg highly modified. Basipod two segmented, basal segment large, flat and the distal half covered with denticles. Second segment flat, but comparatively short, externally bears a sharp spine and completely covered with short spinules. Exopod three segmented. Basal segment highly enlarged, elongated and almost cylindrical, outer margin with a row of spinules, inner distal corner produced into a blunt tubercle. Second segment very short and almost fused with the distal segment. Third segment spatulate at the distal end with a strong spine at the inner margin and a circlet of short spines at its base. Endopod three segmented. Basal segment comparatively large with patches of denticles. Second segment roughly squarish with a row of outer marginal denticles. Third segment narrows towards the distal end with an apical spine. All segments are covered with thick patches of denticles.

Basipod of the third leg two segmented, basal segment flat and covered with a patch of fine spinules. Second segment longer than broad, inner margin with a papilla bearing a naked seta. The papilla and segment covered with denticles. Exopod three segmented. Basal segment comparatively stout and large, inwardly produced

with a distal claw and inner half of the segment covered with sharp spinules. Second segment shorter than first with a slightly curving unflanged claw at the distal end. Third segment comparatively short with three strong distal spines, middle one very long and the rest two nearly half the length of the middle with two short spines laterally. All segments are covered with spinules. Exopod also three segmented. Segments show gradual decrease in size towards the distal end. First and second segment free of spines, but fully covered with spinules. The distal segment with a strong and elongated spine at the distal end.

The structure of the fourth leg same as that of the third leg. Basipod two segmented and covered with spinules. Second segment bears a papilla and a naked seta at the inner margin. Exopod three segmented. First and second segment with a slightly curved distal claw. Distal segment comparatively narrow, but bears three distal claw and two small stout spines. One of the claws larger than the rest. All segments covered with row of spinules. Endopod three segmented, first segment narrow at the base and gradually increasing in size towards the distal end. Second segment roughly cylindrical and third segment conical, bearing a strong

distal claw. All the segments are covered with patches of fine denticles.

Fifth leg two segmented, basal segment flat nearly squarish with a distally bulging spinulose outgrowth, having two stout distal spines. Second segment small with rounded distal end having four spines at the outer distal margin and fully covered with spinules. Anal lamina one segmented, longer than broad, distally it bears three stout blunt claws. Medially the segment bears a row of sharp spinules.

Total length, 4.9 mm.

Male:

Male comparatively smaller than the female, having pronounced sexual dimorphism. Carapace shield like with two prominent lateral notches, postero-laterally rounded, having patches of sharp spinules. First segment fused with the cephalon. Second segment more than three times broader than long, laterally rounded and with patches of spinules. Third segment nearly the same size as that of the second with laterally rounded margins. Fourth segment posteriorly narrowing and laterally rounded. Fifth segment comparatively very small with rounded lateral margins. Genital segment barrel shaped and distally

truncated. Abdomen four segmented, segments gradually narrowing towards the distal end. First segment narrow anteriorly, second, third and fourth segments squarish. Caudal ramus elongated cylindrical with four distal spines with a row of sharp denticles in the middle.

First antenna multisegmented having a geniculate flexion between the third and fourth segment. First and second segment free of armature. Third segment roughly squarish with four spines at the outer margin and bears a strong sharply curved spine at the disto-lateral margin. Fifth segment comparatively large, almost cylindrical and lateral margins lined with naked setae. Sixth segment smaller with a basal stout spine and a lateral seta. Distal segment narrow and elongated, sub distally it is constricted and bears a large naked seta and distally with four setae. Second antenna almost similar to that of the female, but comparatively slender than female. Five segmented, first and second segments without any armature. Third segment roughly squarish with an inwardly directing strong spine. Fourth segment comparatively large and narrows towards the distal end, bearing a strong median

spine. Distal segment strongly curved with a sharply pointed claw having an accessory claw.

First maxilliped two segmented, basal segment strong and stout, second segment comparatively slender covered with strong spinules at its entire surface and distally bears two claws, one is large and the other small, both flanged on either side. Second maxilliped four segmented, basal segment longer than broad and fused with the cephalon. Second segment large and stout, distally narrowing with a basal papilla bearing a strong spine. Third segment slender with a sub-distal spine. Fourth segment modified into a sharp claw having a median accessory spine.

First leg similar to that of the female, basipod two segmented, first segment large and flat and second segment comparatively small with a lateral naked seta. Exopod three segmented, inner margin of each segment with a row of spinules. First and second segment at their disto-lateral corner having a small spine. Third segment distally bears two very long naked setae and two small spines. Endopod three segmented, the distal segment with two equal sized naked setae.

Second and third legs are almost of similar structure. Basal segment flat, but comparatively narrow in the second leg than in the third. Exopod three segmented, outer margin of the segment lined with rows of spinules. Outer distal corner of each segment bears strong claws of flanged nature outwardly and a single seta inwardly. Third segment bears a flanged claw, a long naked spine and five plumose setae. Inner margin of the first and second segment with long plumose setae. Endopod three segmented, inner margin of the first and second segment lined with setules. Outer margin of the first and second segments bear an elongated plumose seta and the distal segment with four plumose setae.

Basipod of the fourth leg two segmented, segments transversely elongated. Exopod three segmented. First segment longer than broad with a distal flanged claw and a row of sharp spinules on the outer margin. Second segment longer than broad with an inner plumose seta and an outer enlarged claw curved distally. Third segment longer than broad with two outer long spines and five plumose setae. Endopod three segmented, segments roughly squarish successively reduced in size towards the distal end. First and second segments with

an outer seta and an inner row of sharp denticles. Third segment distally bears two plumose setae and a sharp spine and a row of sharp denticles.

Fifth leg two segmented, basal segment stout, distal segment small and nearly squarish with a median spine and three distal setae. Sixth leg is represented by two naked setae at the lateral corner of the genital segment. Caudal ramous unsegmented, cylindrical, inner margin lined with a row of fine setules, distal end with two setae and two naked spines. A naked seta is also present subdistally.

Total length, 3.7 mm.

Remarks:

Eudactylina eulamini sp. nov. shows close resemblance to Eudactylina pusilla Cressey (1967c) and E. aspera Heller (1865) in its general body shape and structure of the appendages. In E. pusilla the carapace is broader than long and conical postero-laterally with the posterior margin curved inwardly. But in the present specimen the carapace is longer than broad with postero-lateral margins rounded. In E. pusilla the

second, third and fourth segments are having prominent neck like inter-segmental space, which is absent in the present new species and the segments directly joins with each other. The distal segment of the first maxilliped in the present specimen having a circlet of sharp spines around the base of the distal claw, which is found to be absent in E. pusilla. The third segment of the second maxilliped in the new species is distally bifurcated to form two nearly equal sized claws and the segment having a partial separation sub distally, whereas in E. pusilla the distal segment is not bifurcated and the partial separation is lacking. The distal segment of the exopod of second leg in the new species is spatulate with a basal ring of short spines, which is absent in E. pusilla. The fifth leg in the present new species is clearly two segmented, basal segment with two stout spines. But in E. pusilla it is described as a broad lobe with three distal spines.

Eudactylina eulamini sp. nov. shows close resemblance to E. aspera Heller (1865) in general body shape. In the present specimen the fourth thoracic segment modified having its sides produced laterally,

whereas in E. aspera the fourth thoracic segment same as that of other segments. In E. eulamini sp. nov. the genital segment is ovoid, but it is barrel shaped in E. aspera. The present new species can be identified by the nature of the carapace, laterally produced genital segment, the second segment of the second maxilla with a distal circlet of spines and by the spinulation on the body and legs.

Genus Kroyeria Van Beneden

Kroyeria longicauda Cressey

Kroyeria longicauda Cressey, 1970, p.19, figs.64-77.

Material:

Eight females were collected from the gills of Eulamia melanoptera (Quoy and Gaimard) caught at Cochin.

Total length, 3.8 mm.

Distribution:

Florida and the West coast of India.

Remarks:

The present specimen agrees in all major details with the original description of Cressey (1970). Apart from very few minor variations the present specimen agrees with the details of the original description.

This species can be identified by the presence of a lateral branch on the cephalic process, the peculiar armature on the endopod of the legs and the membraneous outer border of the anal lamina.

Kroyeria elongata Pillai

Kroyeria elongata Pillai, 1967, p.286, figs.12-24.

Material:

Fifteen females from the gills of Scoliodon walbeehmi (Bleeker) and two females and two males were collected from the gills of Scoliodon sorrakowah (Cuvier) caught at Cochin.

Total length, female 6.2 mm., male 2.8 mm.

Distribution:

West coast of India.

Remarks:

Pillai (1967) made the original description with full details, but minor variations are observed in the present specimen. The variation observed in the present specimen, from that of original description is the comparative length of the cephalic stylets. In the present collection the cephalic process over reaches the middle of the third thoracic segment, whereas in the original description the cephalic process are rather short and extend just beyond the distal border of the third thoracic segment. Validity regarding the use of the relative length of the dorsal stylets alone as a taxonamic character was questioned by Dellamare Deboutte Ville and Nuneo-Ruivo (1953). Kabata (1979) agrees with this opinion and stated that the armature of the thoracic legs are a reliable character in the identification of this group of parasites.

Kabata (1979) raised a point of confusion existing in the nomenclature of the species Kroyeria elongata Pillai. He proposed to change the name of Kroyeria elongata Pillai to avoid confusion as another valid species Kroyeria elongatus Fukui (1965) was pre-occupied.

Apart from the variations in the relative length of the dorsal stylets the specimens of the present collection agree in all details with that of Pillai's original description.

Kroyeria elongata Pillai can be identified by the distally flattened dorsal stylets reaching beyond the posterior broader of the second free thoracic segment and the rows of sharp denticles on the second segment of the endopod of all the first four pairs of legs.

Kroyeria melanopteri sp. nov.

Figs.349-365

Material:

Twenty females and ten males were collected from the gills of Eulamia melanoptera (Quoy and Gaimard) landed at Cochin.

Females:

Cephalathorax transversely ovate, cephalon broader than long. First thoracic segment fused with the cephalon. Posterior cephalic process extends upto the middle of the second free thoracic segment. Base of the process broad and sharply pointed at the distal

end. The free thoracic segments are broader than long, laterally rounded and gradually decreasing posteriorly. Segments having an antero-median ridge reaching beyond the middle. Fourth thoracic segment not separated from the genital segment. Genital segment about twice the length of the combined length of the cephalothorax and the free thoracic segments, roughly cylindrical and narrowing on either side. Abdomen longer than broad and unsegmented slightly narrowing towards the posterior. Caudal ramus slender and long, inner margin with setose lining.

First antenna seven segmented, segmentation indistinct, but sclerotized ridges on the inner margin separates the segment. Basal segment comparatively stout and long, other segments subequal in length carrying a total number of ten naked setae and distal segment with a tuft of naked setae. Margin of the segments irregular. Second antenna three segmented, chelate, basal segment longer than broad. Second segment modified with a broad roughly squarish base with a distally pointed claw of the chela, inner distal margin of the claw flat as a disc to receive the opposing arm of the chela. Third segment modified as a sharp fully chitinized strong claw of the chela with an inner submedian spine.

Maxilla elongated, nearly cylindrical with two apical processes of subequal length. First maxilliped two segmented, basal segment stout, longer than broad. Second segment narrow at the base and swollen at the distal end. Outer distal end of the segment with a tuft of fine setae and inner side densely packed with denticles. Distal claw slightly curved with a partial separation near to the base and the claw flanged on either side. Second maxilliped two segmented, sub-chelate and basal segment with an inwardly projected prominent ridge. Distal segment comparatively slender elongate and ends in a sharply curved distal claw. The claw opposes with the basal segment.

First four pairs of legs are almost identical in structure. Basipod of first leg two segmented, first segment flat and transversely elongated. Second segment distally having a sharp spine on its outer margin and an inner spine on the inner margin of the segment. The inner margin of the second segment lined with plumules. Exopod three segmented, first segment longer than broad with an outer distal flanged spine and distal half of the segment lined with thin membraneous flange. Second segment comparatively smaller than basal with an inner plumose seta and an outer flanged spine, distal segment longer than broad with two distal flanged spine and four

plumose setae. Outer margin of the second and third segment with broad membraneous flange. Endopod three segmented and the segments are subequal in length. First segment longer than broad with an inner plumose seta and an outer marginal membrane. Second segment longer than broad having two outer plumose setae and an inner marginal membrane. Distal segment having six plumose setae at its distal end.

Second leg identical in nature to that of first leg. Second segment of the basipod lacks the distal spine and inner seta. Third segment of exopod posses five plumose setae and two spines, instead of four in the first leg. Structure of the endopod identical to that of first leg. Third leg is similar in almost all details with that of second leg. But the distal segment of the endopod having four plumose setae, a short seta flanged on the one side and with two short flanged spines. Fourth leg identical in all structural details with that of the third leg. The segments are comparatively larger than the third leg.

Caudal ramus roughly cylindrical about two times longer than broad, distally having two plumose setae, of which one is very stout and long and the other is short. Inner margin lined with plumules.

Total length, 10.7 mm.

Male:

Carapace nearly the same shape as that of the female, but laterally more pointed. First thoracic segment fused with the cephalon. Posterior cephalic process with broad base and reaches upto the middle of the second free thoracic segment. Second thoracic segment rounded anteriorly and nearly truncated posteriorly. Third segment transversely ovate about two times broader than long. Fourth segment longer than broad. Genital segment gradually narrowing posteriorly, about two and a half times longer than broad. Abdomen three segmented, segments gradually narrowing posteriorly and decreasing in length and size towards the distal end. Caudal ramus elongated and distally having two plumose setae and two naked setae.

The structure of the cephalic and thoracic appendages are similar to that of the female, but found to be comparatively smaller in size. Basal segment of the second antenna stouter than that of female. Basal segment of the second maxilliped comparatively long and inner projection not prominent as that of the female.

Total length, 5.8 mm.

Remarks:

Kroyeria melanopteri sp. nov. shows resemblance in the general body shape and in the structure of the appendages to Kroyeria echinatus Rangnekar (1956), K. sphyrnae Rangnekar (1957), Kroyeria elongata Pillai (1967) and K. carchariae glauci Shiino (1957). But the new species shows very close resemblance to K. echinatus Rangnekar. The cephalothorax of the K. echinatus is longer than broad, whereas in the present new species the cephalothorax is broader than long. In K. echinatus the dorsal stylets extend upto the posterior broader of the first free thoracic segment, but in the present new species it extend beyond the middle of the second free thoracic segment. First maxilliped in K. echinatus is four segmented and flanged on the inner side, whereas in the present specimen it is two segmented and without any flange. Moreover, the distinct patches of spinules present on the second segment of the first maxilliped is absent in K. echinatus. All the segments on the legs externally flanged in K. melanopteri sp. nov., but are unflanged in K. echinatus. Shape and size of the caudal ramus is also varying considerably.

K. sphyrnae Rangnekar (1957) appears closely similar in the structure of the cephalothorax and abdomen

with the present new species. But the dorsal stylet in K. sphyrnae is comparatively slender and extends upto or beyond the posterior margin of the third free thoracic segment, whereas in the present specimen it reaches only upto the middle of the second free thoracic segment. In K. sphyrnae second, third and fourth thoracic legs with prominent inter coxal processes, which is absent in the present specimen.

K. elongata Pillai (1966) appears similar to the present new species in the structure of the cephalothorax and legs. But in K. elongata the dorsal stylets reach beyond the second free thoracic segment and the tip of the process flattened. In the new species it reaches only upto the middle of the second free thoracic segment and the process sharply pointed. Though the shape of the cephalothorax in the present specimen shows resemblance to K. carchariae glaucie Shiino, varies in the structure of the abdomen. The abdomen is unsegmented in the new species, whereas in K. carchariae glaucie the abdomen is three segmented.

Kroyeria melanopteri sp. nov. can be identified from other species by the relative length of the dorsal stylet which extends upto the middle of the second free thoracic segment, transversly elongated cephalothorax,

and the second, third and fourth thoracic legs without inter coxal process.

Genus Nemesis Risso

Nemesis robusta (Van Benedan)

Figs.366-376

Nemesis robusta Cressey, 1967c, p.6; Hewitt, 1969a, p.14, figs.51-77.

Material:

Eleven females were collected from the gills of Eulamia melanoptera (Quoy and Gaimard) examined at Cochin.

Distribution:

Madagascar, West coast of India.

Female:

Cephalothorax roughly circular, first segment fused with cephalon. Second thoracic segment free, broader than long, anteriorly rounded and lateral margins slightly curved with truncated posterior margin. Third and fourth thoracic segments are almost of the same size and shape

and both sides with chitinized plates. Fifth thoracic segment without chitinous plate, anteriorly narrowed, lateraly produced and posteriorly bulged. Genital segment comparatively small and laterly produced. Abdomen three segmented, segments gradually decreasing in size towards the posterior end. Segments broader than long and laterally rounded. Caudal lamina small and cylindrical with five spines.

First antenna multisegmented, basal segment long and roughly cylindrical. Second segment armed with two naked setae. Rest of the segments show gradual decrease in size towards the distal end, each bearing a single spine at the disto-lateral margin. Distal segment comparatively large, armed with a tuft of naked setae and a large apically rounded process. Second antenna five segmented, basal segment short and fused with the carapace. Second segment longer than broad roughly quadrangular. Third segment about the same size of the second segment. Fourth segment comparatively slender, elongated and slightly curved at the distal end. Distal segment modified into a curved claw with a submedian spine.

First maxilliped two segmented, basal segment robust and roughly rectangular. Second segment comparatively

slender, distally bears a stout claw and a pad. Outer claw is comparatively large and curved at the distal end. It bears five longitudianl rows of denticles. Inner pad is stout and strong, fully covered with denticles. Just behind the claw near the outer margin a tuft of long setules, appears to be arising from a single base. Second maxilliped two segmented, first segment very strong, stout and gradually decreasing anteriorly. Distal segment modified into a claw, inner surface of the claw bears two small spines.

First leg remarkably modified, having prehensile nature. Basipod two segmented, basal segment broad and large covered with fine setules. Second segment comparatively small and flattened. Both the segments are elaborately covered with spinules. Exopod two segmented. First segment highly modified with a sharp inward curve and fully covered with sharp denticles. Inner margin having a row of fine long setules, outer margin with a row of denticles and a stout spine. The segment distally rounded with a row of denticles and a tuft of fine setules. Second segment arising from the subdistal position. Segment cylindrical, longer than broad with its inner margin having a row of sharp denticles. Distally the segment bears three spines, median one comparatively very stout. Endopod two

segmented. First segment short and stout with a basal row of sharp denticles and an elongated plumose seta. Distally the segment having a well developed conical process, slightly curved at the distal end. The process fully covered with denticles. Second segment roughly cylindrical in shape and about three times longer than the basal segment. Distally it bears a long and a short spine.

Second leg biramous. Basipod two segmented, basal segment broader than long and very stout, with a row of sharp denticles at its distal margin. Second segment also of the same size as that of the first segment having a disto-lateral outgrowth fully covered with denticles. Exopod two segmented. Basl segment nearly squarish with one inner and an outer strong stout spine. Second segment having six spines. Endopod also two segmented, basal segment longer than broad having an outer an an inner stout spine. Second segment roughly squarish with five stout spines distally. All the segments fully covered with sharp denticles.

Third and fourth legs are nearly of the same structure of second leg. Fifth leg is reduced into a single segmented papilla bearing two elongated naked setae and is fully covered with fine setules. Caudal ramus one

segmented, subcylindrical, bearing five curved spines at the distal end and is found to be free of denticular patches.

Total length, 4 mm.

Remarks:

This species has been recorded by several authors from different oceans. Present record of this species is the third from the Indian waters and its distribution is wide and global. This species shows marked variations in the structure of the body and nature of the appendages according to the age and species variation of the hosts. This makes the identification of the species difficult. The relative length of the segment cannot be used as a satisfactory systematic character, as the segments are capable of contraction. Moreover, the setal formula also cannot be used as a valid criteria for the identification because the armature of the species varies from one specimen to other. Cressey (1967c) used the spinulation of the second antenna as a valid character, whereas Hewitt (1969a) observed it as unreliable due to variation within the species.

Hewitt studied the morphometric characters in detail and found that N. robusta is closely related to

species N. pallida Wilson (1932) and N. aggregatus Cressey (1967c) and are placed in synonymy with N. robusta. Specimen of the present collection shows close resemblance with those given by Hewitt, but few variations are observed. The cephalothorax in the present specimen is comparatively longer. The lateral sides of the fourth free thoracic segment is produced as a wing, whereas it is gradually narrowing towards the distal end in Hewitt's description. In Hewitt's specimen the genital segment is broadest at the posterior end, whereas in the present specimen it is broader in the middle. Anal lamina posses six spines, as observed by Hewitt.

Hewitt separated the species of the genus Nemesis into two groups. One with the fifth thoracic segment significantly narrower than the rest of the segments and abdomen three segmented. In the other group the fifth thoracic segment is not narrower than the rest of the segments and the abdomen two segmented. N. robusta is placed along with the first group.

Family Dicheleschiidae

Genus Hatschekia Boche

Hatschekia sphyraeni Pillai

Hatschekia sphyraeni Pillai, 1964a, p.72, figs.74-82.

Material:

Five females were collected from the gill filaments of Sphyraena acutipinnis Day caught at Cochin.

Total length, 1.2 mm.

Distribution:

West coast of India.

Remarks:

Major details of the present specimen show close resemblance to the original descritpion by Pillai (1964a). As observed by Pillai the body is nearly oblong and about three times longer than broad. The trunk demarcated from the carapace through a deep lateral groove. The abdomen in the present specimen is more prominent and nearly circular in shape.

This species can be identified by the nature of the first antenna, the absence of the third and fourth legs and the armature of the first and second legs, elonga oblong body with the abdomen indistinctly fused and the maxilliped comparatively strong with bifurcated distal claw.

Hatschekia gastri. sp. nov.

Figs.377-383

Material:

Seven females were collected from the gills of Gastrophysus lunaris (Bloch).

Female:

Carapace roughly oval in shape, transversely elongated, wider than long, laterally rounded and anteriorly with a prominent bulging. First and second segments fused but indicated by slight lateral constrictions, rest of the segments completely fused. Trunk oblong and rounded posteriorly. Abdomen nearly circular with anal lamina partially hidden in it.

First antenna long, basal segment short and fused with the second segment. Second segment elongated with two naked setae at the base. Third segment about half the length of the second segment with three naked setae at the outer margin. Fourth, fifth, and sixth segments are subequal in length. Fourth segment with three spines and distal segment with a tuft of setae apically. Basal segment of second antenna short and fused with cephalon. Second segment stout and large. Distal segment apically with sharp denticles. Maxilla

four segmented, basal segment short and fused with the cephalon. Second segment long and stout, two times longer than broad. Third segment slender, about equal length as that of the second segment and with a distal spine. Distal segment short and apically bifid.

First leg biramous, basipod longer than broad. Inner distal margins with a prominent bulge having two spines and a single spine close to the base. Outer disto-lateral corner with an elongated spine. Exopod indistinctly two segmented, basal segment long, broader at the base and distal segment short oval at the distal end. Apically it bears one large median and two small lateral spines. Endopod one segmented, longer than broad with a distal elongated seta.

Second leg also biramous basipod indistinctly two segmented, first segment broader at the base, with an outer short spine and second segment narrows towards the distal end. Exopod indistinctly two segmented, segments subequal in size, distal segment with an outer stout spine and an inner conical process with a distal flagellum. Endopod one segmented and longer than broad with a distal stout spine. Third, fourth, fifth and sixth legs are found to be absent. Anal lamina longer than broad, with one long and two short spines.

Total length, 1.2 mm.

Remarks:

In the general shape of the body Hatschekia gastri sp. nov. shows resemblance to Hatschekia sphyraeni Pillai (1964a) and H. pinguis Wilson (1922). The shape of the cephalon and trunk of H. piguis is very much like that of the present specimen. But in this species the endopod of the first leg is one segmented while it is indistincly two segmented in H. pinguis. Moreover, the legs of these two species show clear differences.

H. gastri sp. nov. can be distinguished from H. sphyraeni by the shape of the trunk which gradually broadening backwards, whereas it is broadest in the middle in H. sphyraeni. The structure of the first antenna of the new species considerably varies from that of H. sphyraeni. In H. sphyraeni the first antenna indistinctly segmented and having a membraneous flap on its outer margin, whereas in the present specimen the segmentation is distinct and membraneous flap absent. The basipod of the first leg in the new species having a prominent bulge with two strong spines which is absent in H. sphyraeni. The nature of the second leg varies considerably in these two species. The distal spine of the exopod of second leg is large

and stout, whereas it is small and slender in H. sphyraeni H. gastri sp. nov. can be identified by the shape of the trunk and structure of the first and second legs.

Family Pseudocycnidae

Genus Pseudocycnus Heller

Pseudocycnus armatus (Bassett-Smith)

Pseudocycnus armatus Bassett-Smith, 1898c, p.371; Kirtisinghe, 1935, p.453, figs.1-111; Gnanamuthu, 1950a, p.276, figs.9-18; Pillai, 1964a, p.75, figs.95-108; Silas & Ummerkutty, 1967, p.428, figs.15-29; Kurian, 1961, p.75, figs.46-48; Pillai, 1978, p.27, figs.20-36.

Helleria armata Bassett-Smith, 1898c, p.9, pl.5, figs.1-2.

Cybicola armata Bassett-Smith, 1898, p.371; Yamaguti, 1963, p.135, pl.171, fig.1.

Pseudocycnoides armatus Yamaguti, 1963, p.172, pl.196, fig.2.

Paracycnus lobosus Heegaard, 1962, p.182, figs.182-199 Kabata, 1970, p.171.

Material:

Fourteen females were collected from the gill

filaments of Indocybium guttatum (Bloch & Schneider) at Cochin.

Total length, 7.1 mm.

Distribution:

Ceylon, East and West coastsof India.

Remarks:

This species has been described by several authors. The present specimen is found to be similar in all details with the earlier descriptions. Silas & Ummerkutty (1967) reported that this species shows pronounced variation in size. They attributed this variation in size differences may be due to the host fish. This species can be easily identified by the nature of the cephalothorax and comparatively smaller size of the caudal ramus.

Pseudocycnus appendiculatus Heller

Pseudocycnus appendiculatus Heller, 1865, p.218, p.22, fig.7; Wilson, 1922, p.75, pl.2, figs.87-96; Bassett-Smith, 1898c, p.368; Kirtisinghe, 1935, p.339, figs.10-28; Shiino, 1959a, p.325, figs.24-25

Yamaguti, 1963, p.197, figs.2; Pillai, 1964a, p.73, figs.83-94; Silas & Ummerkutty, 1967, p.925, fig.29; Hewitt, 1969b, p.169, figs.1-11; Kabata, 1970, p.170; Pillai, 1978, p.23, figs.1-19.

Pseudocycnus spinosus Pearse, 1952, p.30, figs.109-118

Pseudocycnus thynus Brandes, 1955, p.190.

Material:

Four females were collected from the gills of Indocybium guttatum (Bloch & Schneider) at Cochin.

Total length, 8.3 mm.

Distribution:

Atlantic, Mediteranian, Indian Ocean, East and West coasts of America.

Remarks:

This species has been adequately described by several authors. Pillai (1978) made a detailed study of the family Pseudocycnidae. He discussed in detail the affinity of the species to other related species. Present collection made from Indocybium guttatum (Bloch & Schneider) is a new host for this species.

This species can be identified by the relatively larger size of the posterior processes and the nature of

the cephalic and thoracic plates.

Family Lernaeidae

Genus Lernaeenicus Le Sueur

Lernaeenicus ramosus Kirtisinghe

Lernaeenicus ramousus Kirtisinghe, 1956, p.20, figs.12-14; Shiino, 1958c, p.84, figs.5-7; Rangnekar, 1961, p.196, fig.2; Kirtisinghe, 1964, p.109, fig.151.

Material:

Fifteen females were collected from the body surface of Nemipterus japonicus (Bloch) caught at Cochin. The parasites are found to be attached near the head and above the stomach penetrating the body and firmly attached to the host.

Total length, 19.8 mm.

Distribution:

Ceylon, Japan and West coast of India.

Remarks:

Shiino (1958c) had given a detailed description of the species by studying different collections and comparing the variations. But he failed to give an account

of the cephalic appendages. Rangnekar (1961) made a detailed study of the species and described the appendages and supplemented the study of Shiino. Present specimen collected from the host Nemipterus japonicus shows all similarities with the original description of Kirtisinghe (1956) and further those of Shiino (1958c) and Rangnekar (1961). They observed that the cephalic processes are arranged in two rows and the length of the processes appears to be varying from one specimen to the other.

This species can be identified by the extremely elongated ramose cephalic processes arranged in two rows, comparatively short neck and nearly cylindrical trunk with rounded distal end.

Lernaeenicus hemirhamphi Kirtisinghe

Lernaeenicus hemirhamphi Kirtisinghe, 1933, p.550, figs.4-7; Gnanamuthu, 1953, p.1, figs.1-8; Kirtisinghe, 1964, figs.1-2; Sebastian, 1966, p.21.

Material:

Two females were collected from the body surface of Hemirhamphus xanthopterus (Valenciennes) caught at Cochin.

Total length, 46.4 mm.

Distribution:

Ceylon, East and West coasts of India and Hawaii.

Reamrks:

Present specimen agrees in all details with that of the original description and also the description of Shiino (1956b). This species can be identified by the short horns which are placed roughly in right angle to each other, comparatively very long cylindrical neck and nearly cylindrical abdomen.

Suborder LERNAEOPODOIDA

Family Lernaeopodidae

Genus Thysanote Kroyer

Thysanote eleutheronema Rangnekar

Thysanote eleutheronema Rangnekar, 1961, p.202, fig.5;
Thysanote decemfimbriata Pillai, 1962a, p.63, fig.4.

Material:

Three females and two males were collected from the branchial cavity of Polynemus plebeius (Broussonet) at Cochin.

Total length, female 5.9 mm; male 1 mm.

Distribution:

West coast of India.

Remarks:

The present specimen shows close resemblance to Thysanote eleutheronema Rangnekar (1961) in almost all major details. In the present specimen there are only eight pairs of fimbriate processes at the base of the maxilliped and five pairs of posterior trunk processes as observed by Rangnekar (1961). But Pillai (1965) observed

ten pairs of fimbriate processes and only four pairs of posterior trunk processes including anal lamina. The present specimen shows prominent variation from the species Thysanote decemfimbriata Pillai (1962a). Pillai (1965) made T. decemfimbriata synonymous with T. eleutheronema. Comparisons of the present specimen with T. decemfimbriata Pillai (1962a) shows that the variations are prominent and agrees fully with the descriptions of Rangnekar (1961). If the number of the fimbriate processes and posterior trunk processes are the valid taxonomic features, the validity of the species T. decemfimbriata Pillai (1962a) can be re-established.

The present specimen can be identified by the dichotonomously branched fimbriate process on the maxilliped and five pairs of the posterior trunk processes including the anal lamina.

Thysanote appendiculata (Steenstrup and Lutken)

Branchiella appendiculata Stp. & Lutk., 1861, p.419, pl.15, fig.35.

Branchiella appendiculata Bassett - Smith, 1898a, p.14, pl.6, figs.1-3.

Thysanote appendiculata Wilson, 1915, p.650; Kirtisinghe, 1935, p.343; Gnanamuthu, 1950d, p.259, figs.1-3; Pillai, 1962a, p.60, fig.2; Kirtisinghe, 1964, p.114, figs.160-161.

Material:

Two females were collected from the gill cavity of Pampus chinensis (Euphrasen) at Cochin.

Total length, 4.2 mm.

Distribution:

India and Ceylon.

Remarks:

Since its description by Steenstrup and Lutken (1861) several authors have described it in detail. Gnanamuthu (1950) and Pillai (1962a) gave a detailed account of this species. The previous record of this is made from Parastromateus niger (Bloch). But present collection was made from the host Pampus chinensis (Euphrasen) and this is a new host record to this species. Present specimen agrees in all major details with original description and no more details need to be added to the earlier description.

This species can be identified by the first maxilliped with a mushroom shaped bulla and each maxilliped with two pairs of digitiform process originating from the middle of its ventral side and postero-lateral part of the trunk with two pairs of processes.

Genus Clavella Oken

Clavella japoni sp. nov.

Fig.384-390

Material:

Five females were collected from the gills of Nemipterus japonicus (Bloch) at Cochin.

Female:

Cephalothorax much longer than trunk, cylindrical and enveloped in loose chitinized covering. Head not enlarged but dorsally covered by a carapace. Trunk swollen, pear shaped and regularly broadening backwards. No trace of the genital process, but just above the middle of the posterior margin of the trunk a short groove is present. Egg sacs longer than the trunk, stout, elongate and oblong.

First antenna indistinctly five segmented,

distal segment apically with three spines. Second antenna indistinctly demarcated into three segments with a subapical spine. Mandible short and with four large teeth, apical tooth much larger than the others. Maxilla with two stout unequal spines and a very small third outer spine, palp with two slender unequal spines. First maxilliped separate but enclosed in a common covering, making them appear fully fused. Each maxilliped apically demarcated into three lobes, one proximal and two distal. Bulla wine glass shaped and ringed, with prominent diverging channels that profusely branch near the rim of the bulla. Basal segment of second maxilliped very stout, with a row of sharp denticles beyond the middle of the inner broader, distal segment of claw comparatively small with a spine near its base dorsally. Lower distal part of the maxilliped with a row of rather large teeth ending in a secondary unguis; unguis large and apically slightly curved.

Total length, 2.2 mm.

Remarks:

Clavella japoni sp. nov. resembles C. levis Wilson (1913), C. ovata Yamaguti (1939) and C. bowmani

Kabata (1963). In C. levis the trunk is rather eliptic, broadest in the middle, whereas in the present specimen the trunk is broadest at the posterior border. Moreover C. japoni has a comparatively longer cephalothorax.

The resemblance of the present specimen to C. ovata is rather close. In both these species the structure of the maxilla and maxilliped has a proximal spine. But in C. ovata the trunk is perfectly oval but it differs in the present specimen. The cephalothorax of Clavella japoni sp. nov. is longer and more curved.

Clavella japoni sp. nov. like C. bowmani has a postero-ventral longitudinal groove and the armature of the second maxilliped is also similar. But in C. bowmani trunk is comparatively shorter than that of Clavella japoni sp. nov. The two species show pronounced difference in the maxilla and mandible and also in the antenna.

This species can be easily identified from all other known species of this genus by the trunk which is broadest at the posterior end, long cephalothorax curved inwardly and the peculiar armature of the second maxilliped.

Genus *Clavellopsis* Wilson

Clavellopsis appendiculata Kirtisinghe

Clavellopsis appendiculata Kirtisinghe, 1950, p.84, fig.40-43; Pillai, 1962a, p.70, figs.8-9; Pillai, 1968a, p.126, figs.7-8.

Isobranchia ceylonensis Yamaguti, 1963, p.26.

Material:

Four females were collected from the gill arches of *Chirocentrus dorab* (Forskal) caught at Cochin. Total length, 4 mm.

Distribution:

Ceylon and West coast of India.

Remarks:

This species has been adequately described. Present specimens are found to be practically similar in all major details with that described by Pillai (1968a). In the light of the creation of the genus *Isobranchia* by Yamaguti (1963) this species was included in that

genus. Subsequently Pillai (1968a) retransferred the same into Clavellopsis.

This species can be identified by the nature of the posterior trunk process, the flat depressed pear shaped trunk and nature of the basal segment of the maxilliped.

Genus Brachiella Cuvier

Brachiella trichiuri Gnanamuthu

Brachiella trichiuri Gnanmuthu, 1951b, p.13, fig.1; Pillai, 1962a, p.83, fig.17; 1968a, p.119, figs.1-2; Yamaguti, 1963, p.249; 1964, p.121.

Material:

Eight females with attached males were collected from the branchial cavity of Trichiurus savala Cuvier caught at Cochin.

Total length, 4.3 mm.

Distribution:

East and West coasts of India and Ceylon.

Remarks:

This species after its original description by Gnanamuthu (1951b), Pillai (1962a & 1968a) had described and discussed in detail its affinity with other species. Present specimen agrees practically in all details with the description by Pillai. Gnanmuthu had not shown the sclerotized ribs on the cephalic appendages. The segmentation of the first antenna is indistinct and the segmentation is obscured by a loose outer covering. The first antenna in the present specimen appears five segmented, due to the sclerotized process. Other appendages of the present specimen appears to be practically similar in the illustration of Pillai.

This species can be identified by the posteriorly flattened trunk having nearly equal sized posterior trunk process and modified second antenna.

Brachiella albida (Rangnekar)

Charopinus albidus Rangnekar, 1956, p.62;
Brachiella albida Pillai, 1962a, p.86, fig.19.
Charopinopsis albida Kabata, 1964, p.106.

Material:

Five females with males were collected from the gills of Otolithus ruber (Schneider) caught at Cochin.

Total length, female 3.3 mm., male 0.2 mm.

Distribution:

West coast of India.

Remarks:

This species has been adequately described by Pillai (1962a) and discussed its affinity with other members to place it in this genus. Present collection agrees with the description of Pillai in practically every details. Few variations observed are found to be of less taxonomic importance. Pillai observed that the trunk and the maxilliped are in line with each other, but in the present specimen it appears to be positioned in an angle to each other. The posterior trunk process is comparatively long and stout in the present specimen.

This species is placed under Charopinopsis Yamaguti by Kabata with the notion that it posses two pairs of posterior trunk processes ventral to the egg sac. But in the present specimen, as Pillai observed, has only one pair of trunk process ventral to the egg sac. The larger pair of the processes are found to be dorsal to

that of the egg sac. The other characters are also found to be in identity with the members of the genus Brachiella. Hence this specimen is placed along with Brachiella.

This species can be identified by the nature of the posterior trunk processes one pair ventral and the other dorsal to the egg sacs, distally jointed maxilla and posteriorly rounded trunk segment.

Family Naobranchidae

Genus Naobranchia Hesse

Nabranchia theraponi sp. nov.

Figs.391-397.

Material:

Two females were collected from the branchial cavity of Therapon jarbua (Forskal) at Cochin.

Female:

Body demarcated into a cephalothorax and trunk. Cephalothorax is shorter than trunk, roughly cylindrical and almost of same width throughout its length. Demarcation of the head not distinct. The cephalic appendages

are grouped at the tip of the cylindrical trunk. The trunk is roughly circular with the egg sac encircling it. Abdomen is greatly reduced and represented by a small outgrowth from the posterior median position of the trunk. At the median position of the trunk there is a foot like outgrowth, which appears from the dorsal side as a shield.

First antenna small appears to be multisegmented, segmentation indistinct. Second antenna bifurcated, basal segment stout and strong with a distal spine. Rami reduced into two unsegmented flattened lobes. Mandible with a broad base and a distal unflanged claw. Basal segment of maxilla short, distal segment long broader at the base and narrows distally, bears two claws of equal length. Maxilliped two segmented, basal segment stout and strong, distal segment submedially partially separated and distally modified into a sharp claw. The distal segment also bears a small spine at the inner side. Legs are found to be lacking in the specimen.

Total length, 4.5 mm.

Remarks:

The specimen shows resemblance to Naobranchia variabilis Brain (1924) in its general body shape and structure. But in N. variabilis the cephalothorax

gradually narrows towards the tip and the head is clearly demarcated from the cylindrical cephalothorax. Moreover, the egg sac surrounding the trunk is strengthened by three pairs of ribs, but these structures are absent in this new species. In N. variabilis abdomen is not distinctly visible, but in the present specimen the abdomen is visible as a separate lobe from the postero-median position of the trunk. The second antenna in N. variabilis with a two segmented distal lobe bearing a distal spine, whereas in N. theraponi sp. nov. it is unsegmented and flattened.

The new species can be identified by the nature of the trunk, the egg sacs, the nearly circular abdomen and the second antenna with distal flat lobes.

Naobranchia cochinensis sp. nov.

Figs.398-403

Material:

Two females with two males were collected from the gills of Polynemus plebeius (Broussonet) at Cochin.

Female:

Body demarcated into an elongated cephalothorax

and a flatened trunk with a small abdomen. The cephalothorax is narrow and nearly equal length as that of the trunk. Distally the cephalothorax having two lateral circular disc which appears as a sucker. Cephalothorax widens when it join with the trunk and laterally bulged. The trunk is elongated, flattened at the anterior end and narrows posteriorly. The eggs sac cover the entire length on both sides. Abdomen slightly visible, posterior to the egg sac. Appendages are greatly reduced.

First antenna multisegmented but the segmentation indistinct. Second antenna two segmented, basal segment stout and strong slightly produced on the inner side and distal segment modified as a strong curved claw. Maxilliped comparatively small two segmented, basal segment stout and strong and distal segment a strongly curved claw. Legs are absent.

Total length, 4.7 mm.

Remarks:

In the general appearance Naobranchia cochinensis sp. nov. has no close resemblance with any other known species. It has some resemblance with N. auriculata Shiino (1958). In the present species the egg sacs nearly encircle the entire length of the trunk, whereas

in N. auriculata the egg sacs are limited to the posterior half of the trunk. The cephalothorax of N. auriculata widens towards the trunk, whereas in the present species it is slender and bulged at the anterior end. In N. cochinensis sp. nov. there are two sucker like circular discs on the anterior end of the cephalothorax which is absent in N. auriculata. The narrow cephalothorax with two circular discs on the anterior end is found to be the unique structure of the new species.

LIST OF HOSTS AND THEIR PARASITES

Ablennes hians (Valenciennes)

Lernanthropus cornutus Kirtisinghe

Alectis cillaris (Bloch)

Parapetalus orientalis Wilson

Alectis indica (Ruppell)

Caligus seriolae Yamaguti

Arius sp.

Hermilius pyriventris Heller

Aroides dussumieri (Valenciennes)

Caligus arii Bassett-Smith

Atropus atropus (Bloch)

Bomolochus decapteri Yamaguti

Caranx sp.

Caligus nautili sp. nov.

Carangoides malabaricus (Bloch)

Lernanthropus carangoidi sp. nov.

Bomolochus selaroides Pillai

Caranx carangus (Bloch)

Caligus confusus Pillai

Chirocentrus dorab (Forskal)

Lernanthropus aneezi sp. nov.

Clavellopsis appendiculata Kirtisinghe

Chorinemus tala Cuvier

Caligus epinepheli Ymaguti

Caligus robustus Bassett-Smith

Coryphaena hippurus Linnaeus

Caligus quadratus Shiino

Euryphorus nordmanni Milne-Edwards

Cybium commersoni (Lacepede)

Caligus infestans Heller

Caligus cybii Bassett-Smith

Dussumieria acuta Valenciennes

Nothobomolochus multispinosus (Gnanamuthu)

Echeneis naucrates Linnaeus

Tuxophorus caligodes Wilson

Eleutheronema tetradactylum (Shaw)

Caligus industri sp. nov.

Parapetalus hirsutus (Bassett-Smith)

Lernanthropus trifoliatus Bassett-Smith

Eulamia melanoptera (Quoy and Gaimard)

Nemesis robusta (Van Beneden)

Kroyeria melanopteri sp. nov.

Eudactylina eulamini sp. nov.

Fistularia villosa Klunzinger

Pseudocaligus fistulariae Pillai

Gastrophysus lunaris (Bloch)

Taeniacanthus lagocephali Pearse

Pseudocaligus lunari sp. nov.

Hatschekia gastri sp. nov.

Gymnura poecilura (Shaw)

Taeniacanthus longicaudus Pillai

Hemirhamphus xanthopterus (Valenciennes)

Larnaeenicus hemirhamiphi Kirtisinghe

Histiophorus gladius (Broussonnet)

Gloiopotes watsoni Kirtisinghe

Indocybium guttatum (Bloch and Schneider)

Pseudocycnus appendiculatus Heller

Pseudocycnus armatus (Bassett-Smith)

Johnius argentatus (Houttuyn)

Caligus annularis Yamaguti

Lernanthropus otolithi Pillai

Liza parsia (Hamilton-Buchanan)

Caligus pelagicus Kurian

Megalaspis cordyla (Linnaeus)

Caligus cordyla Pillai

Mobula diabolus (Shaw)

Eudactylina diaboli sp. nov.

Mugil cephalus Linnaeus

Caligus pelagicus Kurian

Caligus robustus Bassett-Smith

Naucrates ductor (Linnaeus)

Caligus parapetalopsis Hameed & Pillai

Nemipterus japonicus (Bloch)

Clavella japoni sp. nov.

Lernaeenicus ramosus Kirtisinghe

Otolithus maculatus (Cuvier)

Caligus annularis Yamaguti

Otolithus ruber (Schneider)

Brachiella albida (Rangnekar)

Pampus chinensis (Euphrasen)

Lernanthropus indicus (Pillai)

Thysanote appendiculata (Stp. & Lutk.)

Parastromateus niger (Bloch)

Bomolochus megoceros Heller

Thysanote appendiculata (Stp. & Lutk.)

Polynemus plebeius (Broussonet)

Thysanote eleutheronema Rangnekar

Caligus kaloori sp. nov.

Caligus phipsoni Bassett-Smith

Naobranchia cochinensis sp. nov.

Lernanthropus trifoliatus Bassett-Smith

Parapetalus hirsutus (Bassett-Smith)

Priacanthus hamrur (Forskal)

Caligus hamruri Pillai

Caligus priacanthi Pillai

Psettodes erumei (Bloch)

Chondracanthus trilobatus Pillai

Protochondracanthus alatus (Heller)

Pseudarius jatius (Hamilton-Buchanan)

Caligus arii Bassett-Smith

Hermilius helleri Pillai

Lepeophtheirus longipalpus Bassett-Smith

Pseudorhombus arsius (Hamilton-Buchanan)

Heterochondria pillaii (Pillai)

Rachycentron canadus (Linnaeus)

Lepeophtheirus spinifer Kirtisinghe

Parapetalus occidentalis Wilson

Parapetalus dewani sp. nov.

Tuxophorus caligodes Wilson

Rastrelliger kanagurta (Cuvier)

Caligus kanagurta Pillai

Rhinoptera javanica Muller and Henle

Trebius exilis Wilson

Scoliodon sorrakowah (Cuvier)

Kroyeria elongata Pillai

Pseudopandarus longus (Gnanamuthu)

Taeniacanthus indicus Pillai

Scoliodon walbeehmi

Kroyeria elongata Pillai

Sphyraena acutipinnis Day

Hatschekia sphyraeni Pillai

Sphyrna zygaena (Linnaeus)

Alebion carchariae Kroyer

Pandarus cranchii Leach

Pandarus niger Kirtisinghe

Therapon jarbua (Forskal)

Naobranchia theraponi sp. nov.

Triacanthus strigilifer (Cantor)

Pseudocaligus indicus Hameed

Trichiurus savala Cuvier

Caligus longicervicis Gnanamuthu

Caligus savala Gnanamuthu

Brachiella trichiuri Gnanamuthu

Tylosurus leiurus (Bleeker)

Lernanthropus cornutus Kirtisinghe

GENERAL OBSERVATIONS

The study of the copepods parasitic on fishes is a broad and diversified field with many branches of equal importance. Earlier works are mainly centered on the taxonomy of this group. This trend has changed recently and several workers have taken up investigation on various aspects of this interesting parasites. Parasitic copepods as a whole exceed any other group of parasites in number and abundance. Copepods are widely distributed and are found to be parasitising in almost all types of fishes. They show varying grades of adaptive modifications in the structural and functional morphology. These range from the mere closeness with their free living relatives to the extreme modification which leads to the loss of all prominent identifying characters.

Copepods parasitic on fishes mainly belong to three groups viz., Cyclopoida, Caligoida and Lernaeopodoida. From Cyclopoids to Lernaeopodoids, one could find a gradual transition on the body structure. The mophological features of these three groups show that the Cyclopoids are the least modified. Most of the members of Cyclopoids show close resemblance to free living copepods.

It is found that the number of free thoracic segments get reduced from Cyclopoids to Lernaeopodoids. Among the Cyclopoids, Taeniacanthids and Bomolochids have their first free thoracic segment fused with the cephalon, whereas Caligoids have the first three thoracic segments fused with the cephalon. Trends in reduction of appendages is also observed among the members of this group. In the genus Caligus Muller, fifth and sixth legs are represented by one or two simple plumose setae, whereas in Pseudocaligus Scott even the fourth leg is reduced to a simple lobe, bearing one or two setae. Lernaeopodoids are the most modified among the three groups and show comparatively higher reduction of the body segmentation and appendages. Most of the members are permanently attached on the host fishes.

It is difficult to find any convincing explanation for the way in which parasitic copepods find their host and the method of getting attached to the preferred location on the host. So one can only speculate that the infection of copepod may occur at certain age or size of the host accessible to the infective stages of the parasite. Chemoreception is considered to be a possible way of finding a specific host. Frayer (1966) observed that once a host is infested with a parasite, it may have

a tendency to acquire more parasites. He explained that a chemical attractant produced by the initally attached parasite may attract more parasites to the same host. Kabata (1974b) reported a chemoreceptive organ situated in the middle of the anterior margin of the dorsal shield in Caligus clemensi and similar organs in C. curtus Muller and Lepeophtheirus salmonis. Cressey and Cressey (1979 reported the presence of such structures in the Caligid genus Abasia Wilson. They described a 'rugose area', which appears similar to that described by Kabata. This shows that all Caligids probably possess such a receptive organ which may help to find the host and the specific site of attachment. Several authors suggested the role of tactile sensation as a possible way to find the host by the parasites. But, this is also a conjecture, for any report on direct observation in this regard is lacking.

Parasitic copepods are host specific with high site specificity. Majority of the species are ectoparasites. Collections of the present study show that Caligus prefer the mucus covered body surface and gill cavity. Members of Bomolochids and Taeniacanthids are found to be attached on the branchial cavity and body surface. Chondracanthids also show preference to the gill filaments for their attachment. Members of Lernaeids are

found permanently attached on the body surface. During the present study, collections of Lernaeenicus ramosus Kirtisinghe are made from the antero-ventral part of the body, whereas a related member Lernaeenicus hemirhamphi Kirtisinghe was collected from the middle half of the beak of the host fish. Members of the genus Hermilius Heller and Lernanthropus Blainville are found to be exclusively gill parasites. Pandarids as a whole are parasitic on the body surface. Certain groups of parasites are found to prefer specific sites like the nasal cavity, the underside of the adipose eyelids etc. It is interesting to note that Caligus parapetalopsis Hameed and Pillai colonising on the entire posterior half of the buccal floor of the host Naucrates ductor (Linnaeus).

It is observed in the present study that irrespective of the host fishes, same species of parasites are attached on a particular site of the host. Collections of Caligus pelagicus Kurian from the body surface of Mugil cephalus Linnaeus and Liza parsia (Hamilton), Caligus robustus Bassett-Smith from the gill filaments of Chorinemus tala Cuvier and Mugil cephalus Linnaeus, Taeniacanthus longicaudus Pillai from the gills of Sphyrna zygaena (Linnaeus) and Scolidon sorrakowah (Cuvier)

and Caligus arii Bassett-Smith from the branchial cavity of Pseudarius jatius (Hamilton & Buchanan), Aroides dussumieri (Valenciennes) are a few examples to support the site specificity of the copepods.

Another observation regarding selection of host is that old and large fish species often have larger number of parasites. Collection of a number of Pandarus cranchii Leach from large sized Sphryna zygaena (Linnaeus) and Kroyeria melanopteri sp. nov. from well grown Eulamia melanoptra (Quoy & Gaimard) supports this observation. Cressey and Collette (1970) found that specialized groups of parasites permanently attached on the host increase in number with the increase in the size of the host. This may be due to the increase in attachment area with the increasing size of the host. Heavy infestation may also be due to the adaptability of the free living larval stages of the parasites to the habitat of the host as suggested by Boxshall (1974).

Parasitic copepods show profound structural modifications. The present study shows that the specific site of attachment and nature of the host's body may be the major influencing factors for these modifications. Both Taeniacanthids and Bomolochids have their carapace

more or less sucker shaped. But Taeniacanthids attaching on the body surface have perfectly sucker shaped carapace with marginal membraneous flange, whereas those parasitising on the gill filaments have flat carapace and lacks marginal membrane. This variation is due to the different sites of attachment. The parasites on the body surface are more exposed to the external environment and effective attachment is attained by the peculiar structure of the carapace. Similar development is observed in Caligus parasitizing the body surface of the host.

Members of the genus Caligus Muller possess sucker shaped cephalothorax with a circular sucking disc called lunules on their frontal plates. This structure acts as a powerful organ of attachment. The sternal fork in Caligus is believed to have a function in lifting the carapace to increase the concavity to create a vacuum suction. In order to fill the gap on the posterior side of the carapace, the basipod of the third leg in Caligus is highly flattened and covered with marginal membranes. Identical broadening is observed in the first leg of Taeniacanthids and Bomolochids. Pandarids parasitizing the body surface of the elasmobranchs have well developed adhesion pads on cephalic and thoracic appendages in addition to the sucker shaped carapace.

Development of these adhesion pads may be due to the rough nature of the body surface of the host.

Gill parasites usually have well developed second antenna and maxilliped for firm attachment. In Chondracanthids the second antenna is modified in the form of a clasper and hence lack the sucker shaped modification of the carapace. A few caligoids species inhabiting the gill cavity lack lunules, but have highly modified second antenna and maxilliped. This is observed in the case of Lepeophtheirus and Hermilius. Hermilius hold on to the gill filament by the laterally folded bivalve shaped carapace. This kind of modification is observed in some members of the genus Lernanthropus Blainville. Gill parasites of the elasmobranchs posses special structural modifications. Chelate nature of the second antenna or maxilliped are observed in the members of the genus Kroyeria Van Beneden. The second leg of Nemesis robusta (Van Beneden) is highly modified to perform the function of the chela. The dorsal stylet in Kroyeria may help the parasite to cling to the gill filaments.

Most of the Lernaeopodids are sedentary forms having extreme modification and reduction of appendages.

Lernaeenicus ramosus Kirtisinghe deeply penetrates into the body of the host and remains anchored with the help of profusely branched ramose processes arising from the cephalic area. Members of the genus Thysanote Kroyer and Clavella Oken remain attached by the bulla which may either penetrate into the host body or remain modified as a holdfast.

It is difficult to make direct observation on the feeding mechanism of parasitic copepods. Most of the inference regarding the feeding activity is based on the interpretation of the functional role of the mouth parts. One can assume that the mode of feeding mainly depends on the site of attachment. A copepod located on surface of the host may feed on superficial tissues or mucus and the penetrating forms may depend on host tissued or body fluid. Structure of the mouth parts indicate that Cyclopoids probably depend on the mucus secreted by the host.

During the present study some interesting observations regarding the influence of the host on the convergence of characters of the parasites were noticed The host fish Pseudarius jatius (Hamilton & Buchanan) is invariably parasitized by Caligus arii Bassett-Smith,

Hermilius helleri Pillai and Lepeophtheirus longipalpus Bassett-Smith on their gill filaments. The second maxilliped is modified to cling on the gill filaments. In addition to this in the above three species, the endopod of the first leg is comparatively large and completely covered with fine spinules, whereas in other related species in Caligidae it is vestigial. The dorsal distal seta of the basipod of the first leg is elongated and hirsute. The distal claws on the second exopod segment of the first leg have a broad membrane and the tip of the claws extend beyond the frill as a curved spine. Another prominent feature observed is the elaborate covering of spinules on all appendages. One can assume that these specialization are due to the peculiar character of the host.

Comparative study of Caligus confuses Pillai, Caligus seriolae Yamaguti, Caligus cordyla Pillai and Caligus parapetalopsis Hameed and Pillai collected from the Carangid fishes also exhibit certain structural similarities. In the above species the distal segment of the first antenna is long and slender and the third segment of the second antenna is elongate with a strongly curved falcate claw. The first segment of the endopod of second

leg is with a semicircular row of closely packed teeth. The third leg has a strongly curved claw at the base of the exopod and the apron of the third leg has rows of denticles in line with the endopod. In all these species the fourth leg is four segmented and the basal segment is comparatively large and stout. They all posses nearly squarish anal lamina rather fused with the abdomen. One can only speculate that this may be induced by the characteristics of the host fish. It is also interesting to note that members of the genus Parapetalus Stp. and Lutk collected during the present study have character combination of a similar nature. The members of this genus collected from the fishes of the family Carangidae and Rachycentridae are nearly identical in body characters except in P. hirsutus.

Evaluation of the collection of the present study shows that certain groups of parasites are strict in their host preference. Among the Cyclopoids, Taeniacanthids are found to be parasitizing the body surface of elasmobranchs and teleosts, whereas Bomolochids are exclusively parasitic on teleost fishes. The members of the genus Caligus Muller prefer teleost fishes than elasmobranchs. Members of the genus Pseudocaligus Scott and Parapetalus Stp. & Lutk. were collected mainly

from teleosts. The genus Hermilius Heller is restricted to catfishes only. Alebion Kroyer, Trebius Kroyer, Pandarus Leach and Pseudopandarus Kirtisinghe are found to be exclusively parasitic on the body surface of elasmobranchs, whereas Kroyeria Van Beneden, Eudactylina Van Beneden and Nemesis Risso are confined to the gills of elasmobranchs. Members of the genus Lernanthropus Blainville prefer bony fishes and Hatschekia are confined to teleosts.

The distribution of the parasitic copepods always follow the distribution of their specific host. Bomolochus decapteri Yamaguti, Caligus annularis Yamaguti are collected from the Japanese and Indian waters. Caligus confuses Pillai, Pseudocaligus fistulariae Pillai, Gloiopotes watsoni Kirtisinghe, Alebion carchariae Kroyer and Lernaeenicus ramosus Kirtisinghe are distributed in Indian and Japanese waters. It is observed that Caligus infestans Heller, Caligus epinepheli Yamaguti are common to Australian and Indian regions. This has been confirmed by the collections of these species during the present study.

It is interesting to note that a few species collected from the Indian waters are also reported from

the American waters. Caligus robustus Bassett-Smith is collected from West coast of India and from North America. Caligus confuses Pillai is confined to West coast of India and Panama coast. Parapetalus occidentalis Wilson is reported from North American and Indian waters. A few species collected during the present study show they are widely separated in their distribution, eg. Parapetalus hirsutus Bassett-Smith from Chinese waters, Tuxophorus caligoides Wilson from North American and East African waters and Kroyeria longicauda Cressey from the coast of Florida. Report of the Lernaeenicus hemirhamphi Kirtisinghe was made only from Indian and Hawaiin waters. Hermilius pyriventris is limited to South African and Indian waters. It is evident from the early reports that many of the species of parasitic copepods are common to Indian, Japanese Australian and American waters. Most of them are widely distributed especially in the Indo- Pacific regions. One cannot make out a perfect chart of the distribution of parasitic copepods, since several regions remain uninvestigated.

An appraisal of the earlier works on parasitic copepods shows that so far major emphasis is given only on the taxonomic studies. A number of interesting aspects

such as biology, ecology, functional morphology etc. are still underinvestigated. Sufficient information regarding the effect of the parasite on the host and the extend of damage to the host are lacking.

Based on the information gathered from the present investigation, it can be concluded that the profound structural modifications and host preference make the parasitic copepods a successful group of parasites.

SUMMARY

The present study of the parasitic copepods gives an account of the taxonomic description of seventy seven species of parasites collected from the food fishes of the Kerala coast. Out of the seventy seven species described, fourteen are new to science, two new records for the Indian waters and ten new host records. The males of Parapetalus longipinnatus Rangnekar and Lernanthropus indicus Pillai were collected and described for the first time.

The parasites described belong to the suborders Cyclopoida, Caligoida and Lernaeopodoida. The available description of many species of this locality is reviewed and supplemented with the help of the present detailed study.

The general observations made during this study revealed certain interesting aspects of the host-parasite relationship, host specificity, adaptive modification and geographical distribution. A brief discussion of these observations made is also presented.

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EXPLANATION OF FIGURES

Taeniacanthus lagocephali Pearse

Figs. 1-7

1. Female, dorsal view
2. First antenna
3. Second antenna
4. Maxillary hook
5. Maxilliped
6. Second leg
7. Fourth leg

Bomolochus decapteri Yamaguti

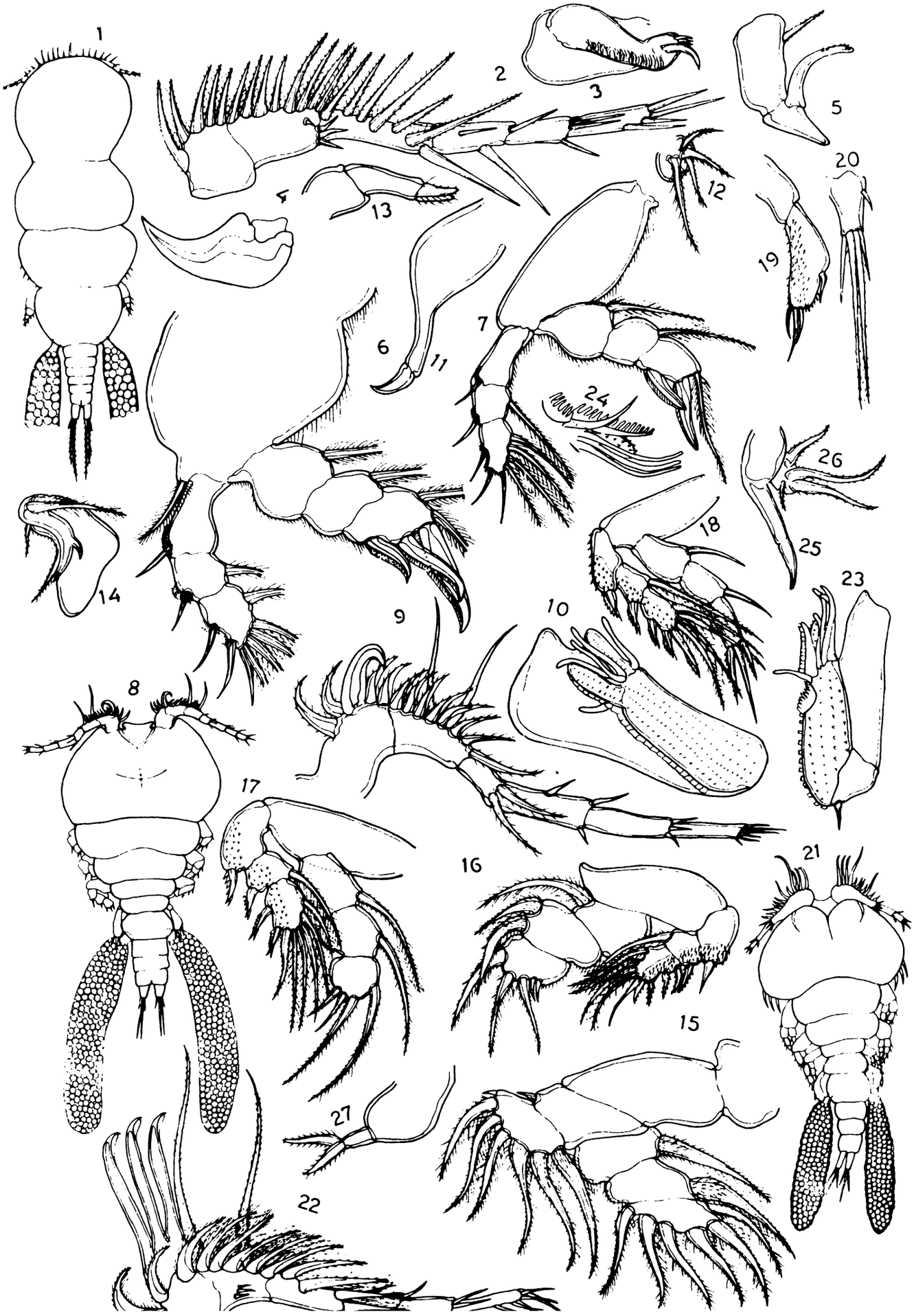
Figs. 8-20

8. Female, dorsal view
9. First antenna
10. Second antenna
11. Mandible
12. First maxilla
13. Second maxilla
14. Maxilliped
15. First leg
16. Second leg
17. Third leg
18. Fourth leg
19. Fifth leg
20. Anal lamina

Nothobomolochus multispinosus (Gna

Figs. 21-35

21. Female, dorsal view
22. First antenna
23. Second antenna
24. Same, tip enlarged
25. Mandible
26. First maxilla
27. Second maxilla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EXPLANATION OF FIGURES

Nothobomolochus multispinosus (Gnanamuthu)

28. Maxilliped
29. First leg
30. Second leg
31. Third leg
32. Fourth leg
33. Same, outer spine enlarged
34. Fifth leg
35. Anal lamina

Caligus quadratus Shiino

Figs. 36-43

36. Female, dorsal view
37. First antenna
38. Second antenna
39. Postantennal process
40. Postoral process
41. Maxilla
42. Maxilliped
43. Sternal fork

Caligus hamruri Pillai

Figs. 44-47

44. Female, dorsal view
45. Maxilla
46. Same, tip enlarged
47. Second leg, exopod

Caligus priacanthi Pillai

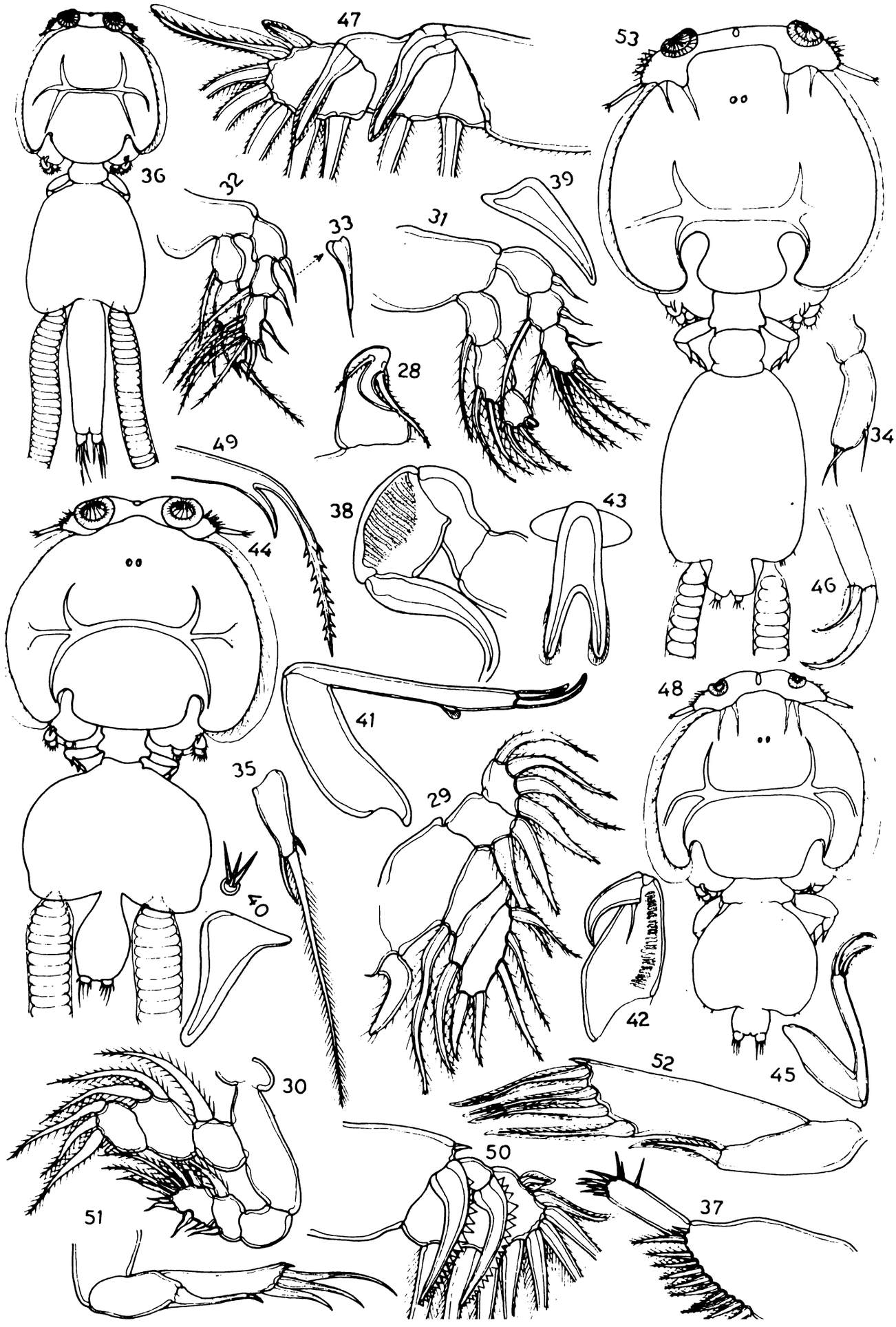
Figs. 48-52

48. Female, dorsal view
49. Maxilla, tip enlarg
50. Second leg, exopod enlarged
51. Fourth leg
52. Same, tip enlarged

Caligus confusus Pillai

Figs. 53-64

53. Female, dorsal view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EXPLANATION OF FIGURES

Caligus confusus Pillai

54. First antenna
55. Second antenna
56. Postantennal process
57. Postoral process
58. Sternal fork
59. Maxilliped
60. First leg, tip enlarged
61. Male, dorsal view
62. Second antenna
63. Postantennal process
64. Postoral process

Caligus arii Basset-Smith

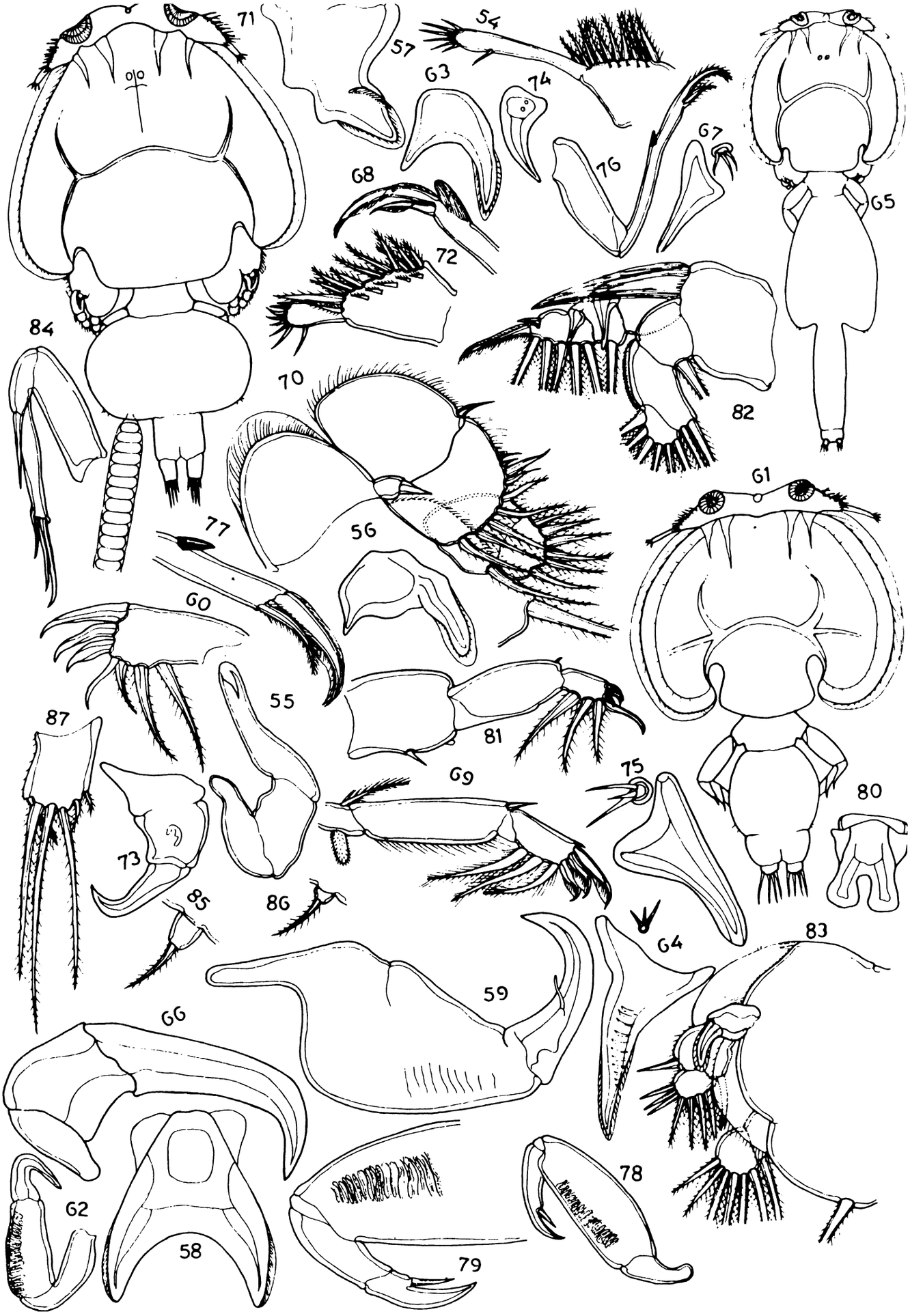
Figs. 65-70

65. Female, dorsal view
66. Second antenna
67. Postoral process
68. Maxilla, tip enlarged
69. First leg
70. Third leg

Caligus pelagicus Kurian

Figs. 71-94

71. Female, dorsal v
72. First antenna
73. Second antenna
74. Postantennal pro
75. Postoral process
76. Maxilla
77. Same, tip enlarg
78. Maxilliped
79. Same, distal seg enlarge
80. Sternal fork
81. First leg
82. Second leg
83. Third leg
84. Fourth leg
85. Fifth leg
86. Sixth leg
87. Anal lamina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EXPLANATION OF FIGURES

Caligus pelagicus Kurian

88. Male, dorsal view
89. Second antenna
90. Postoral process
91. Maxilliped
92. Sternal fork
93. Third leg
94. Fifth and sixth legs

Caligus nautili sp. nov.

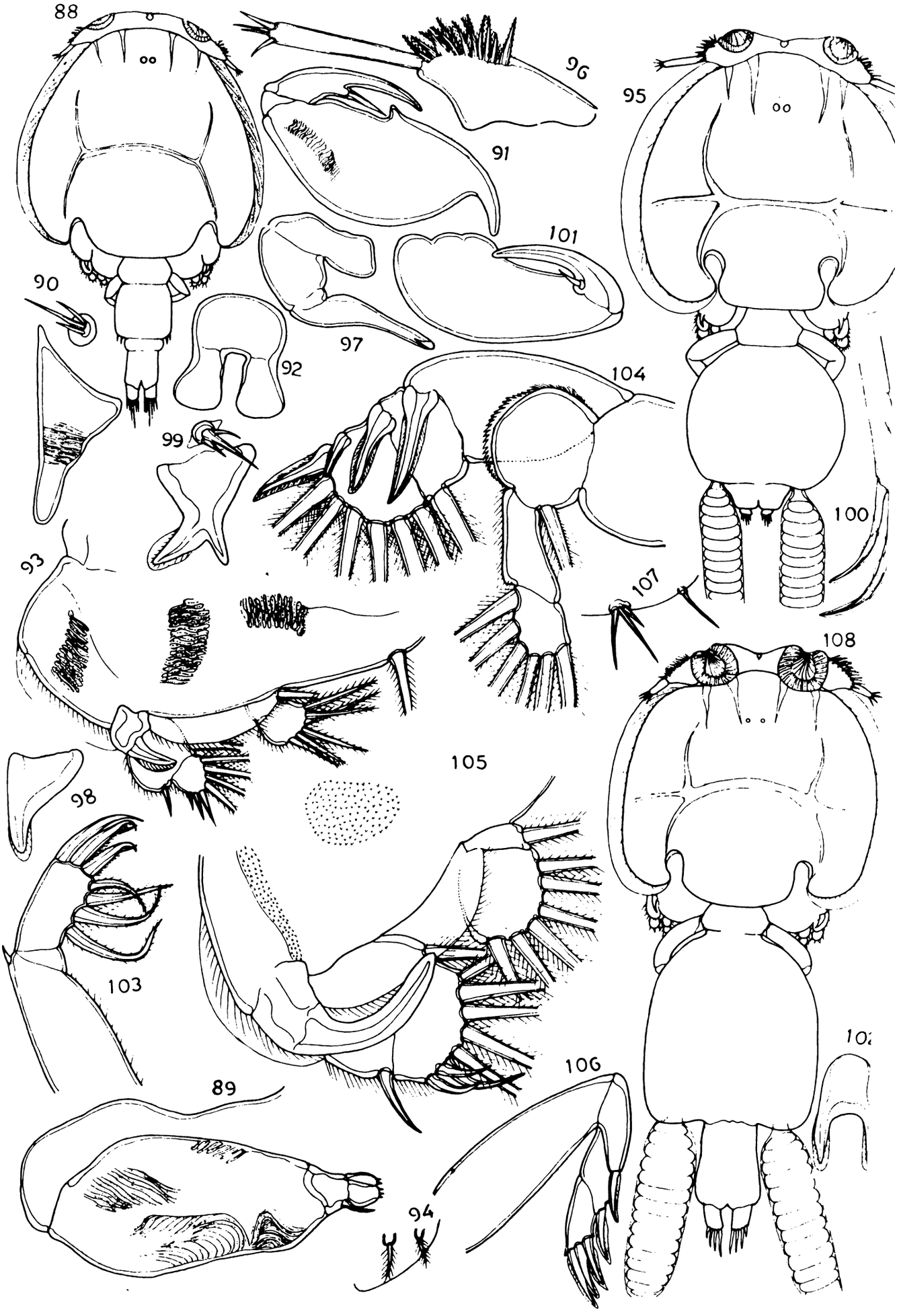
Figs. 95-107

95. Female, dorsal view
96. First antenna
97. Second antenna
98. Postantennal process
99. Postoral process
100. Maxilla, tip enlarged
101. Maxilliped
102. Sternal fork
103. First leg, distal segment enlarged
104. Second leg
105. Third leg
106. Fourth leg
107. Fifth and sixth legs

Caligus industri sp. nov.

Figs. 108-132

108. Female, dorsal view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EXPLANATION OF FIGURES

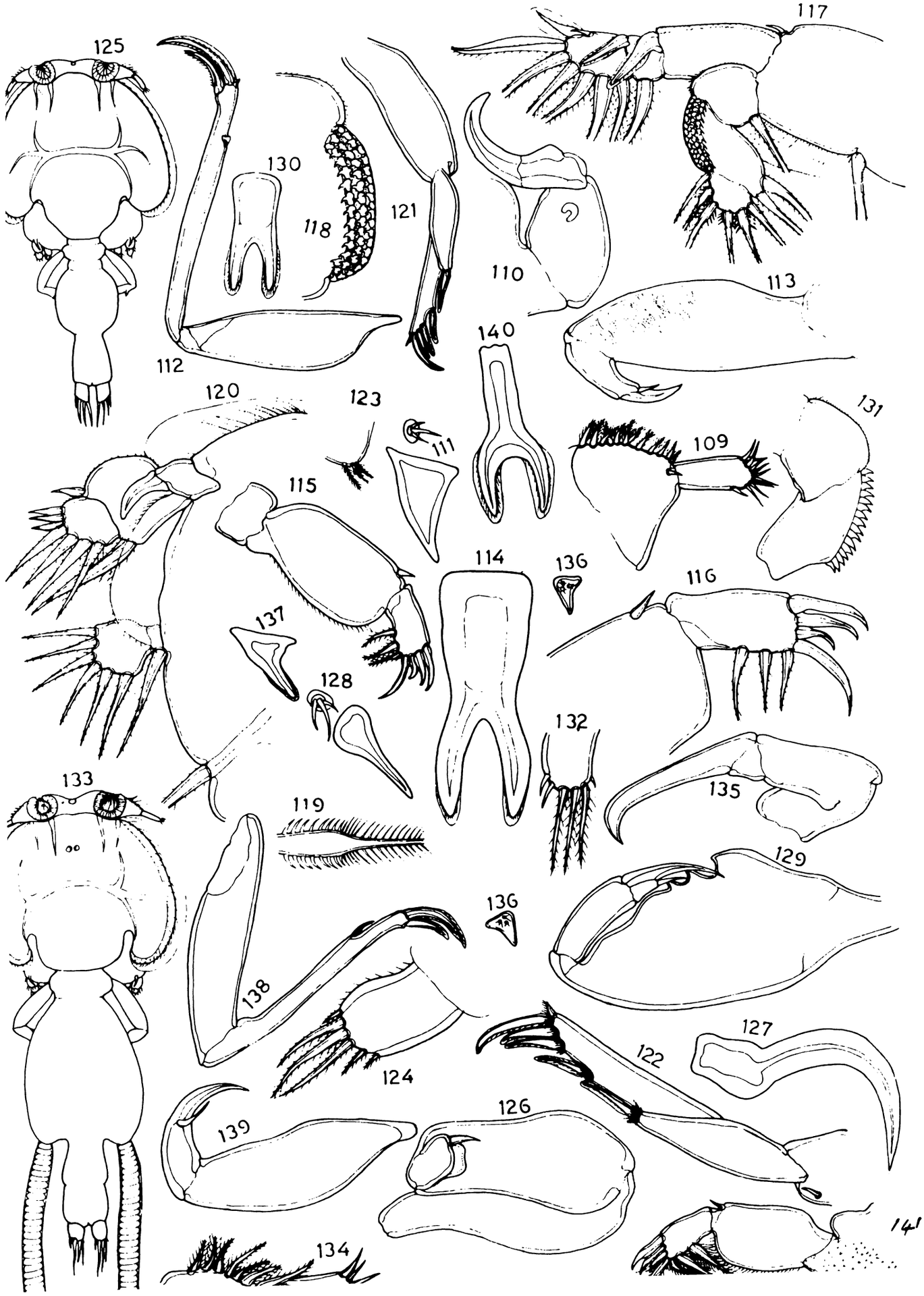
Caligus industri sp. nov.

109. First antenna
110. Second antenna
111. Postoral process
112. Maxilla
113. Maxilliped
114. Sternal fork
115. First leg
116. Same, distal segment enlarged
117. Second leg
118. Same, endopod enlarged
119. Same, modified seta enlarged
120. Third leg
121. Fourth leg
122. Same, tip enlarged
123. Fifth and sixth legs
124. Anal lamina
125. Male, dorsal view
126. Second antenna
127. Postantennal proces
128. Postoral process
129. Maxilliped
130. Sternal fork
131. Second leg, endopod enlarged
132. Anal lamina

Caligus kaloori sp. nov.

Figs. 133-154

133. Female, dorsal view
134. First antenna
135. Second antenna
136. Postantennal proces
137. Postoral process
138. Maxilla
139. Maxilliped
140. Sternal fork
141. First leg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EXPLANATION OF FIGURES

Caligus kaloori sp. nov.

142. Second leg
143. Same, exopod enlarged
144. Same, endopod enlarged
145. Third leg
146. Same, exopod spine enlarged
147. Fourth leg
148. Same, distal segment enlarged
149. Anal lamina
150. Male, dorsal view
151. Second antenna
152. Postantennal process
153. Maxilliped
154. Anal lamina

Pseudocaligus lunari sp. nov.

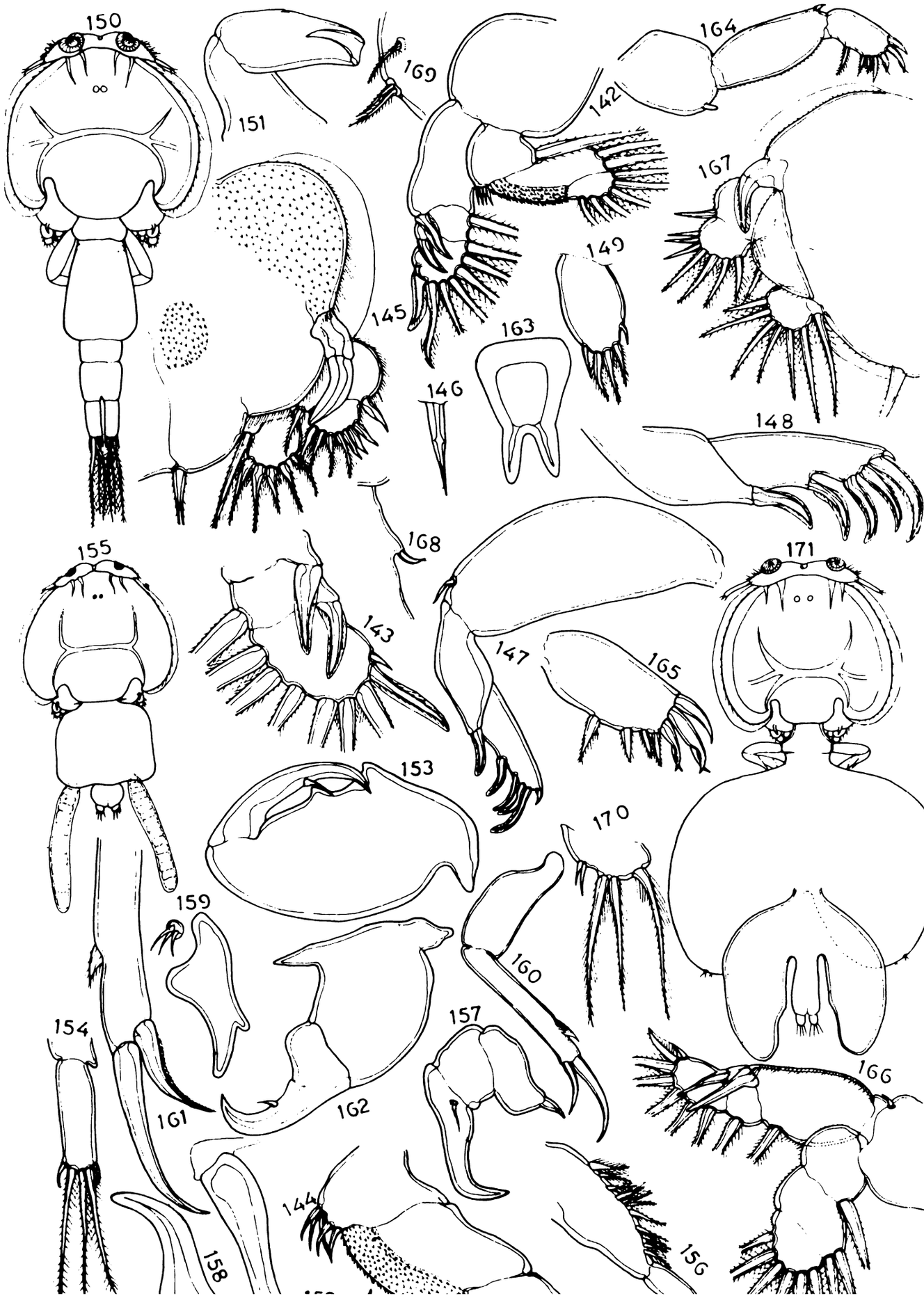
Figs. 155-170

155. Female, dorsal view
156. First antenna
157. Second antenna
158. Postantennal process
159. Postoral process
160. Maxilla
161. Same, tip enlarged
162. Maxilliped
163. Sternal fork
164. First leg
165. Same, distal segment enlarged
166. Second leg
167. Third leg
168. Fourth leg
169. Fifth and sixth legs
170. Anal lamina

Parapetalus orientalis Stp. & I

Figs. 171-175

171. Female, dorsal view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EXPLANATION OF FIGURES

Parapetalus orientalis Stp. & Lutk.

172. Second antenna
173. Postoral process
174. Sternal fork
175. First leg, distal segment enlarged

Parapetalus longipinnatus Rangnekar

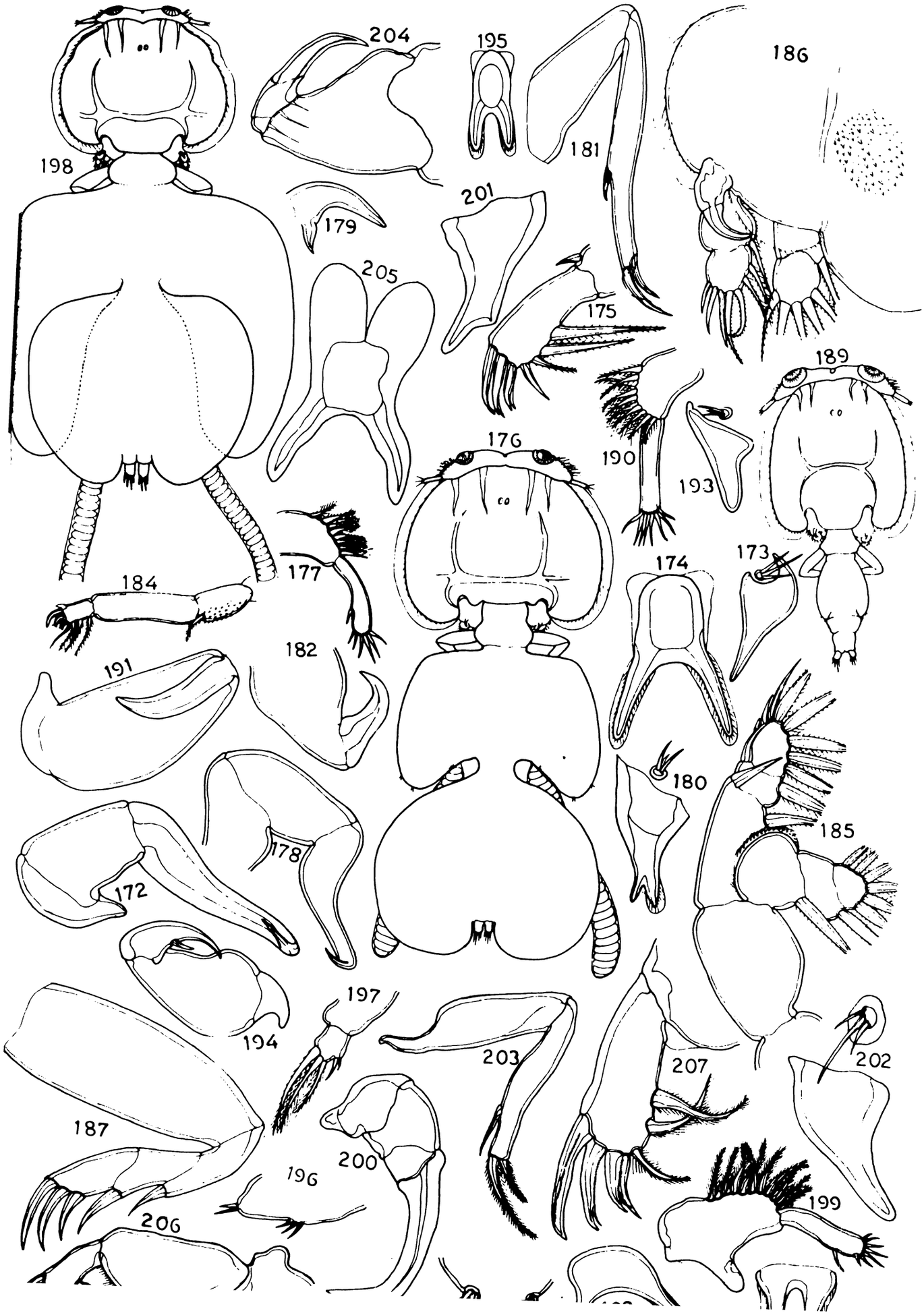
Figs. 176-197

176. Female, dorsal view
177. First antenna
178. Second antenna
179. Postantennal process
180. Postoral process
181. Maxilla
182. Maxilliped
183. Sternal fork
184. First leg
185. Second leg
186. Third leg
187. Fourth leg
188. Fifth and sixth legs
189. Male, dorsal view
190. First antenna
191. Second antenna
192. Postantennal proc
193. Postoral process
194. Maxilliped
195. Sternal fork
196. Fifth and sixth l
197. Anal lamina

Parapetalus dewani sp. nov.

Figs. 198-216

198. Female, dorsal vi
199. First antenna
200. Second antenna
201. Postantennal proc
202. Postoral process
203. Maxilla
204. Maxilliped
205. Sternal fork
206. First leg
207. Same, distal segm enlarged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EXPLANATION OF FIGURES

Parapetalus dewani sp. nov.

208. Second leg
209. Same, exopod enlarged
210. Same, endopod basal segment enlarged
211. Third leg
212. Same, exopod spines enlarged
213. Fourth leg
214. Same, distal segment enlarged
215. Fifth and sixth legs
216. Anal lamina

Lepeophtheirus longipalpus Bassett-Smith

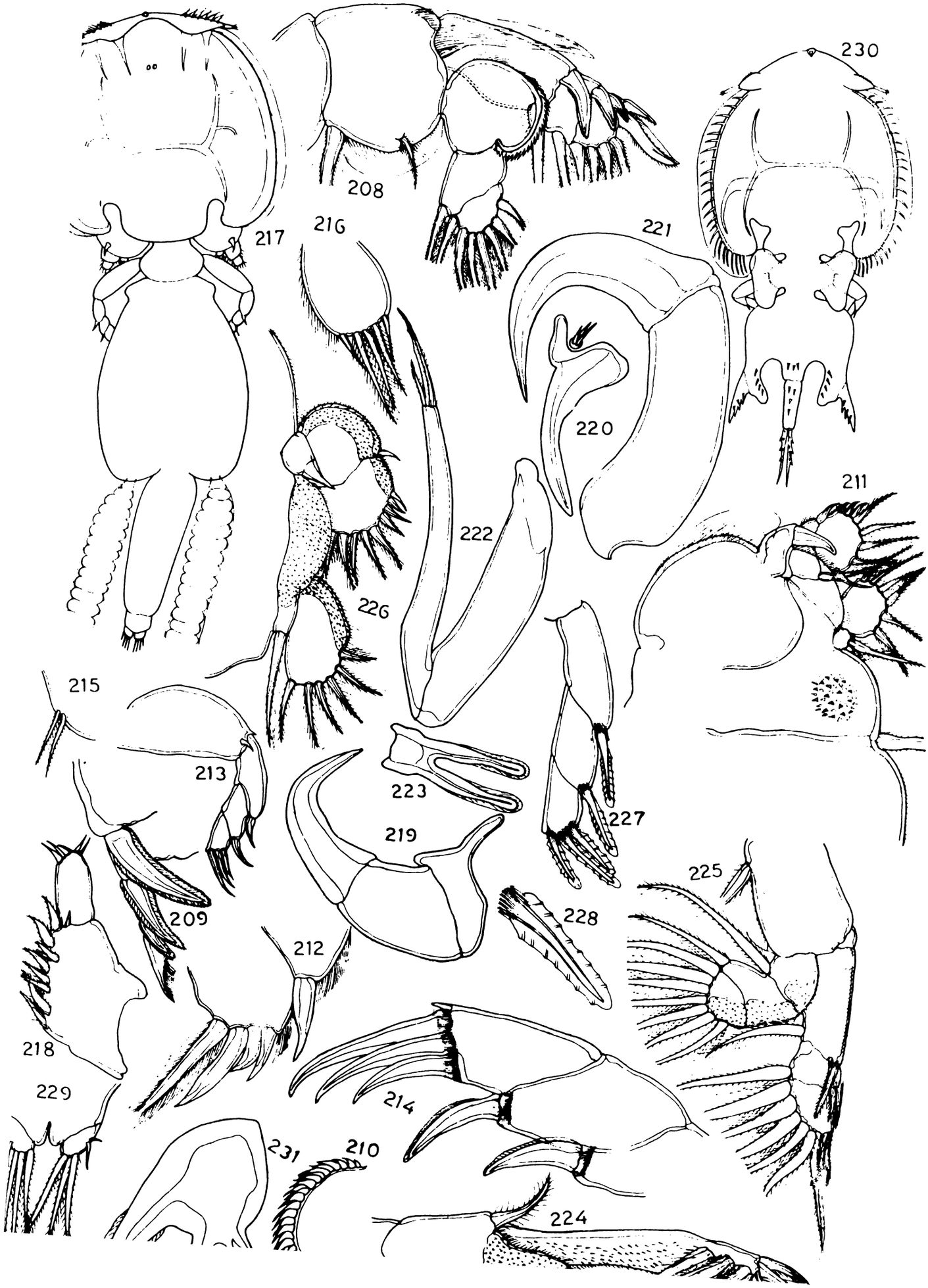
Figs. 217-229

217. Female, dorsal view
218. First antenna
219. Second antenna
220. Postoral process
221. Maxilliped
222. Maxilla
223. Sternal fork
224. First leg
225. Second leg
226. Third leg
227. Fourth leg
228. Same, distal claw enlarged
229. Anal lamina

Gloiopotes watsoni Kirtising

Figs. 230-234

230. Female, dorsal vi
231. Postantennal proc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EXPLANATION OF FIGURES

Gloiopotes watsoni Kirtisinghe

232. Postoral process
233. First leg, distal segment enlarged
234. Third leg, exopod basal claw

Pandarus cranchii Leach

Figs. 235-259

235. Female, dorsal view
236. First antenna
237. Second antenna
238. First maxilliped
239. Second maxilliped
240. First leg
241. Second leg
242. Same, exopod enlarged
243. Same, endopod enlarged
244. Third leg
245. Same, exopod tip enlarged
246. Fourth leg
247. Same, exopod tip enlarged
248. Male, dorsal view
249. First antenna
250. Second antenna
251. First maxilliped
252. Second maxilliped
253. First leg
254. Second leg
255. Third leg
256. Same, exopod spine enlarged


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EXPLANATION OF FIGURES

Pandarus cranchii Leach

257. Fourth leg
258. Same, exopod outer spines enlarged
259. Fifth leg

Pandarus niger Kirtisinghe

Figs. 260-268

260. Female, dorsal view
261. First antenna
262. Second antenna
263. First maxilliped
264. Second maxilliped
265. First leg
266. Second leg
267. Third leg
268. Fourth leg

Lernanthropus indicus (Pillai)

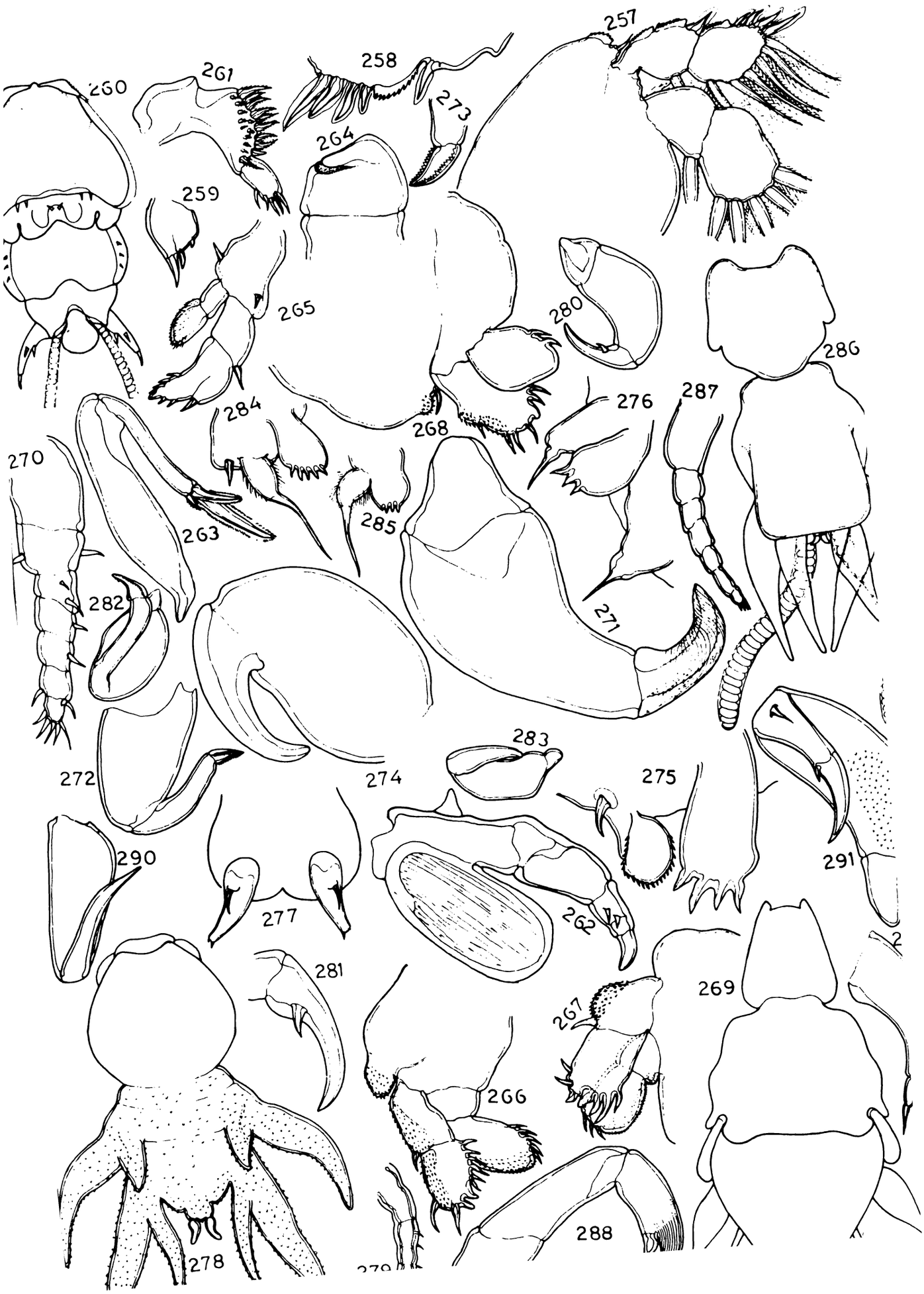
Figs. 269-285

269. Female, dorsal view
270. First antenna
271. Second antenna
272. First maxilliped
273. Same, tip enlarged
274. Second maxilliped
275. First leg
276. Second leg
277. Abdomen with anal lamina
278. Male, dorsal view
279. First antenna
280. Second antenna
281. Same, tip enlarged
282. First maxilliped
283. Second maxilliped
284. First leg
285. Second leg

Lernanthropus aneezi sp. nov.

Figs. 286-294

286. Female, dorsal vie
287. First antenna
288. Second antenna
289. Maxilla
290. First maxilliped
291. Second maxilliped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EXPLANATION OF FIGURES

Lernanthropus aneezi sp. nov.

292. First leg
293. Second leg
294. Abdomen with anal lamina

Lernanthropus carangoidi sp. nov.

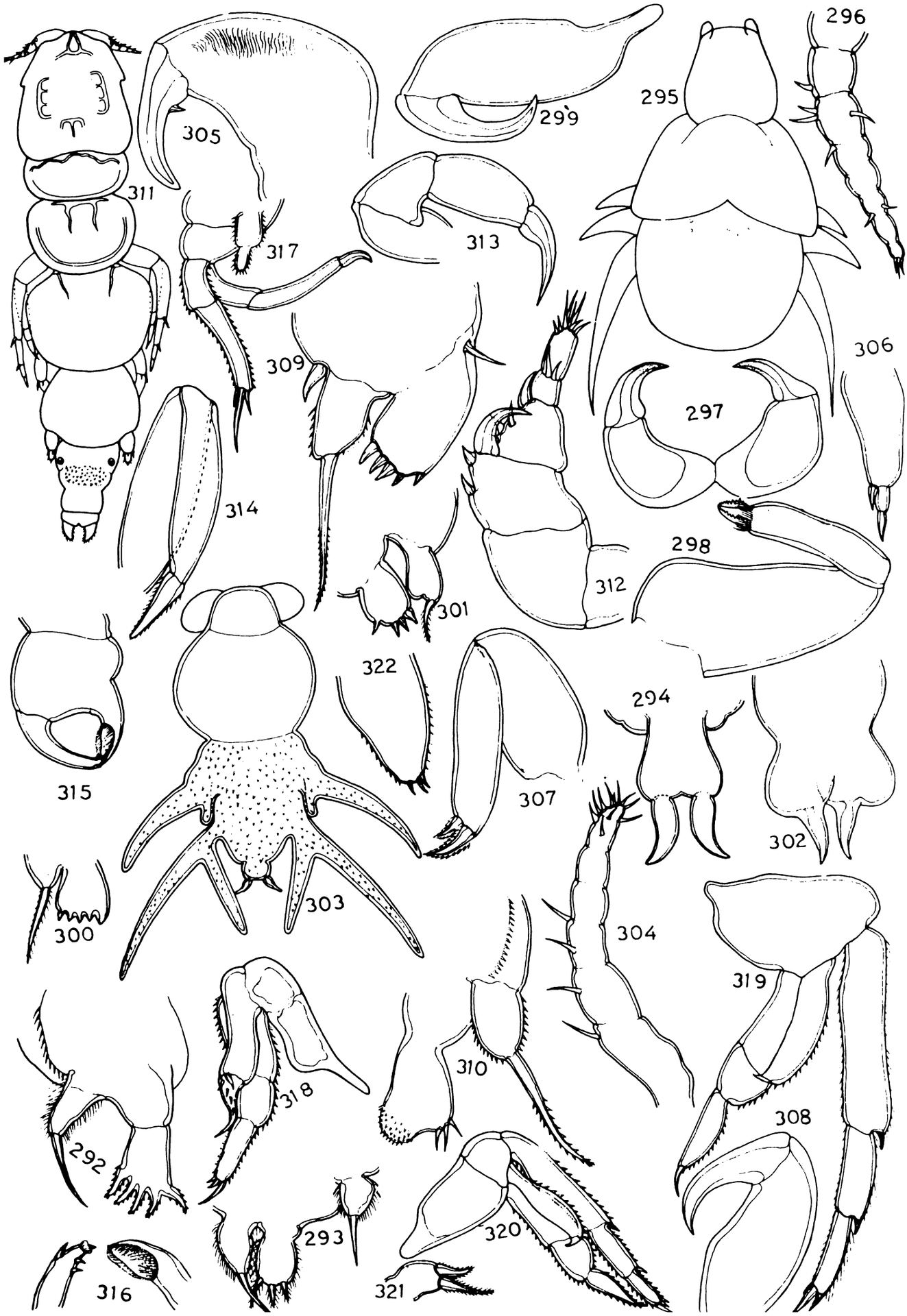
Figs. 295-310

295. Female, dorsal view
296. First antenna
297. Second antenna
298. First maxilliped
299. Second maxilliped
300. First leg
301. Second leg
302. Anal lamina
303. Male, dorsal view
304. First antenna
305. Second antenna
306. Maxilla
307. First maxilliped
308. Second maxilliped
309. First leg
310. Second leg

Eudactylina diaboli sp. nov.

Figs. 311-322

311. Female, dorsal vi
312. First antenna
313. Second antenna
314. First maxilliped
315. Second maxilliped
316. Same, tips enlarg
317. First leg
318. Second leg
319. Third leg
320. Fourth leg
321. Fifth leg
322. Anal lamina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EXPLANATION OF FIGURES

Eudactylina eulamini sp. nov.

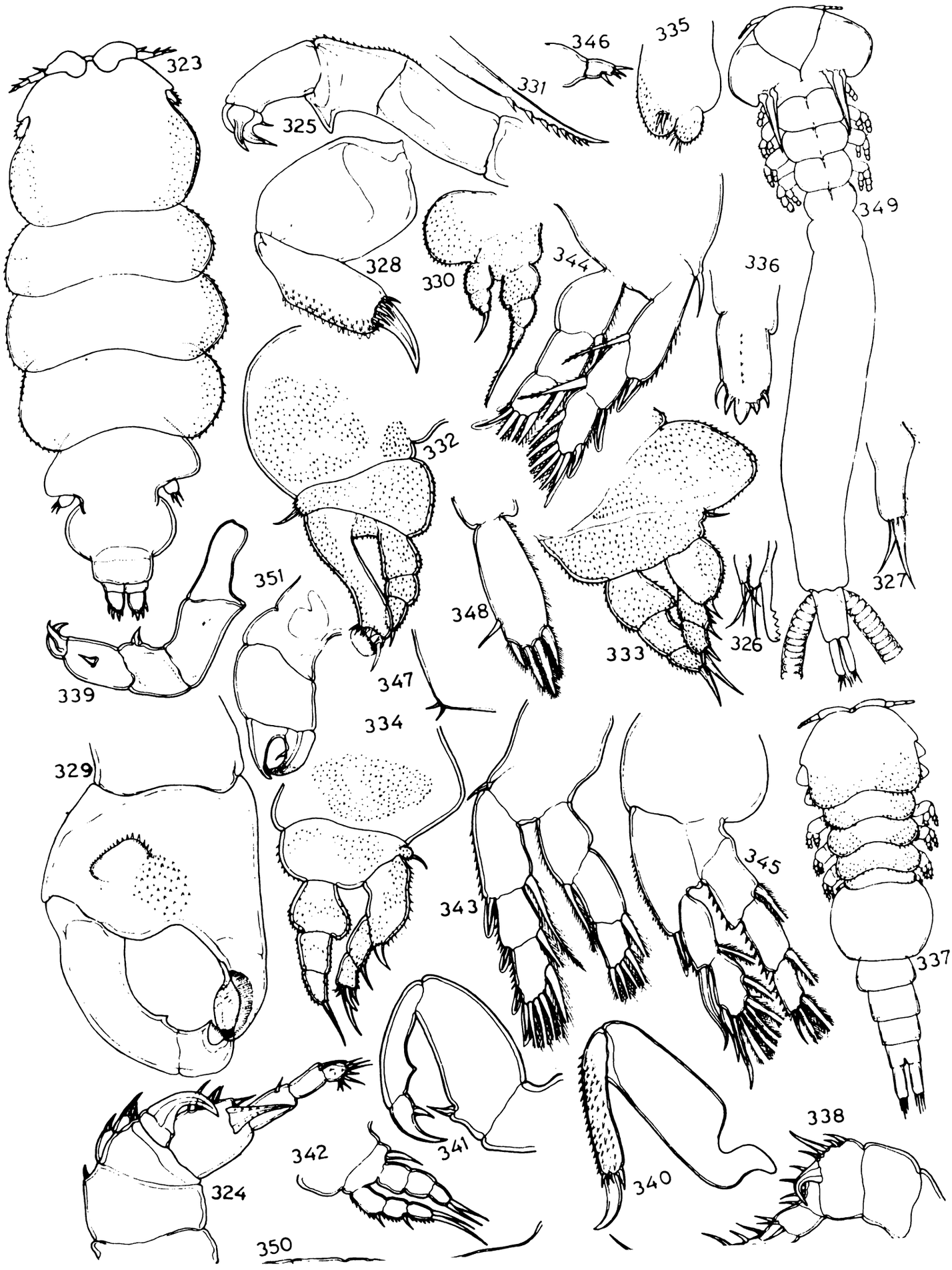
Figs. 323-348

323. Female, dorsal view
324. First antenna
325. Second antenna
326. Mandible
327. Maxilla
328. First maxilliped
329. Second maxilliped
330. First leg
331. Same, distal spine enlarged
332. Second leg
333. Third leg
334. Fourth leg
335. Fifth leg
336. Anal lamina
337. Male, dorsal view
338. First antenna
339. Second antenna
340. First maxilliped
341. Second maxilliped
342. First leg
343. Second leg
344. Third leg
345. Fourth leg
346. Fifth leg
347. Sixth leg
348. Anal lamina

Kroyeria melanopteri sp. nov.

Figs. 349-365

349. Female, dorsal view
350. First antenna
351. Second antenna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EXPLANATION OF FIGURES

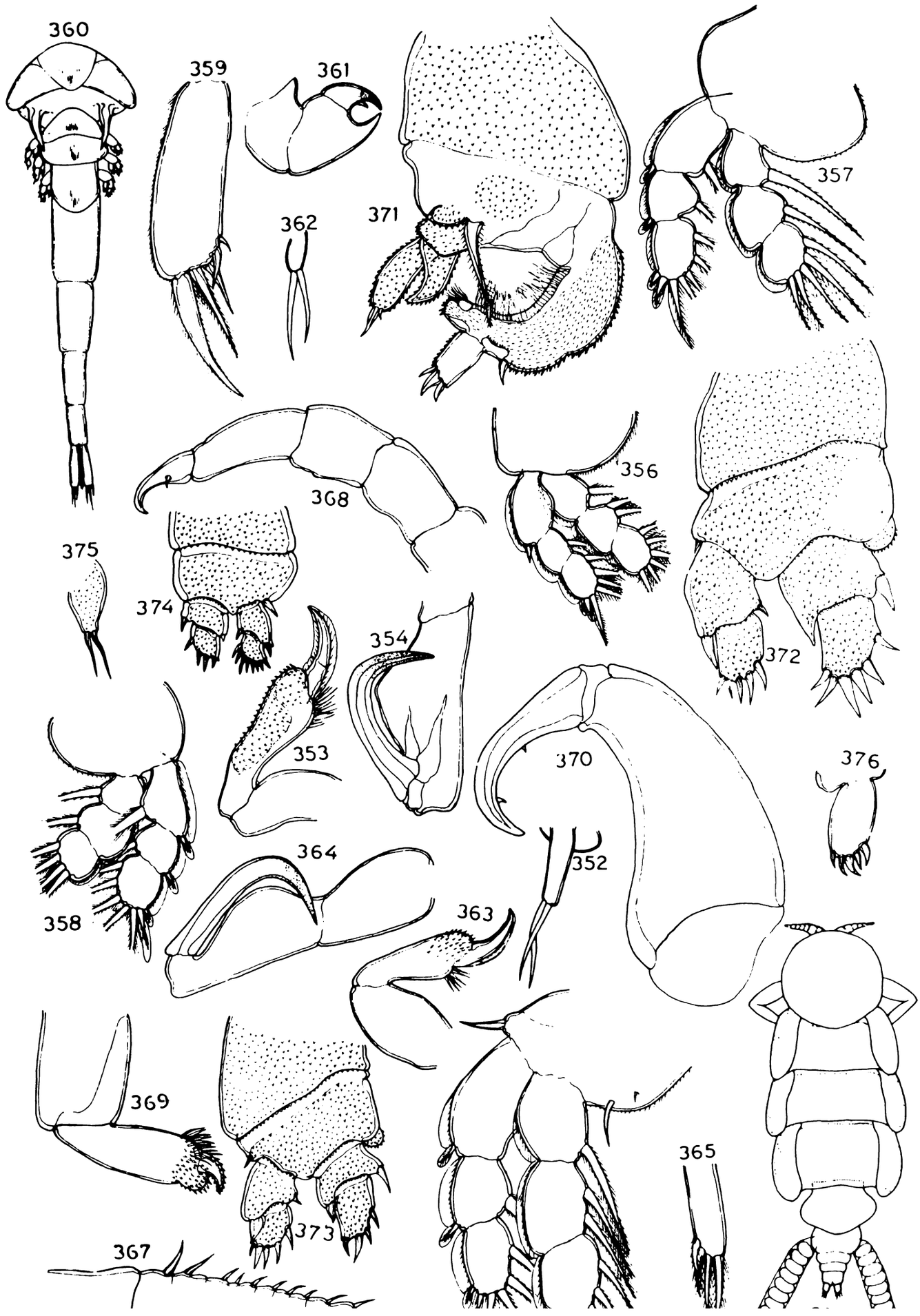
Kroyeria melanopteri sp. nov.

352. Maxilla
353. First maxilliped
354. Second maxilliped
355. First leg
356. Second leg
357. Third leg
358. Fourth leg
359. Anal lamina
360. Male, dorsal view
361. Second antenna
362. Maxilla
363. First maxilliped
364. Second maxilliped
365. Anal lamina

Nemesis robusta (Van Beneden)

Figs. 365-375

366. Female, dorsal view
367. First antenna
368. Second antenna
369. First maxilliped
370. Second maxilliped
371. First leg
372. Second leg
373. Third leg
374. Fourth leg
375. Fifth leg
376. Anal lamina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EXPLANATION OF FIGURES

Hatschekia gastri sp. nov.
Figs. 377-383

377. Female, dorsal view
378. First antenna
379. Second antenna
380. Maxilliped
381. First leg
382. Second leg
383. Anal lamina

Clavella japoni sp. nov.
Figs. 384-390

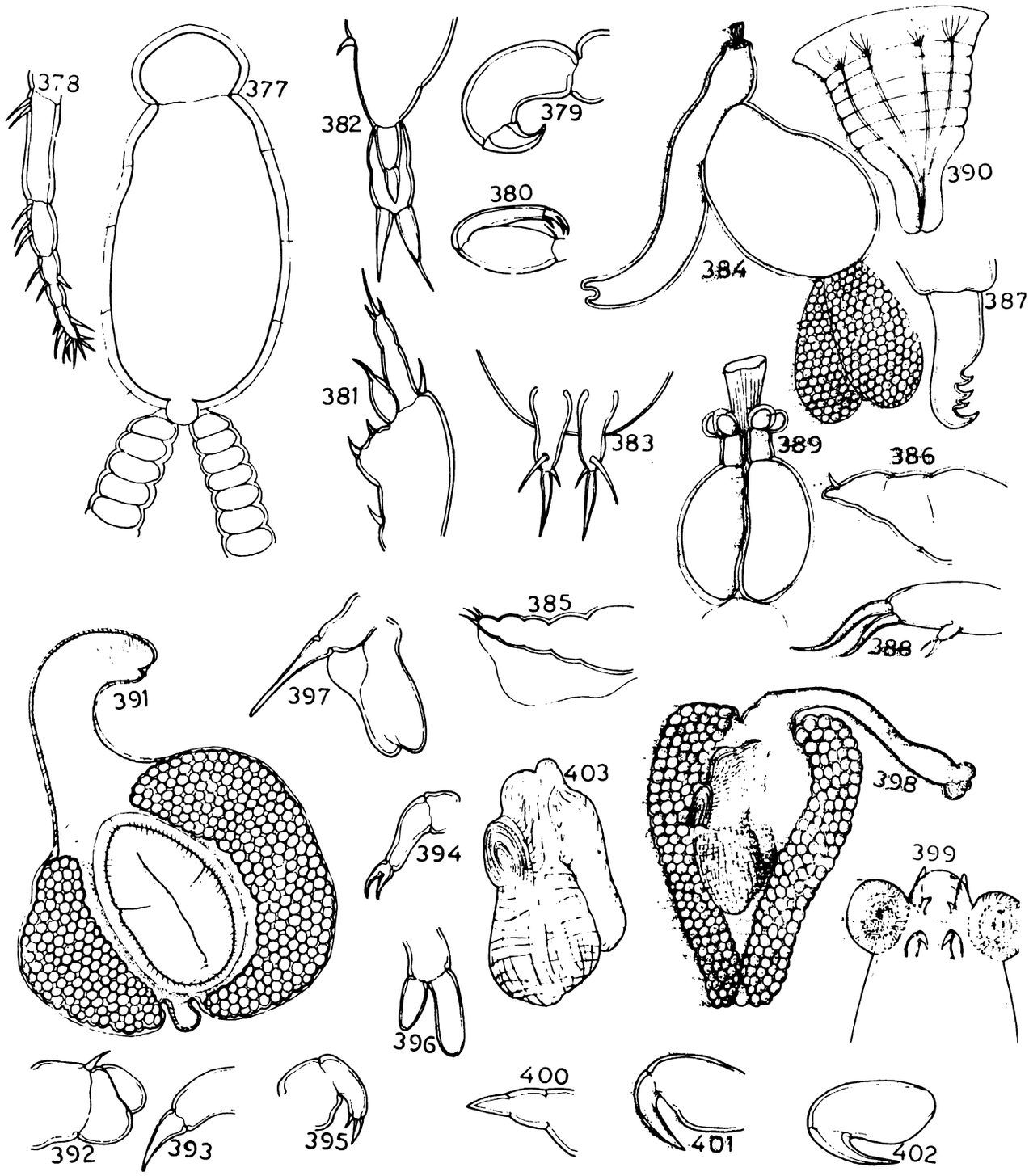
384. Female, dorsal view
385. First antenna
386. Second antenna
387. Mandible
388. Maxilla
389. First maxilliped
390. Bulla

Naobranchia theraponi sp. nov.
Figs. 391-397

391. Female, dorsal view
392. Second antenna
393. Mandible
394. Maxilla
395. Maxilliped
396. First leg
397. Second leg

Naobranchia cochinensis sp. nov.
Figs. 398-403

398. Female
399. Cephalic area enlarged
400. First antenna
401. Second antenna
402. Maxilliped
403. Trunk.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