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ADDITIONS TO THE COPEPODS PARASITIC ON THE MARINE FISHES OF INDIA

3. THREE SPECIES OF *SHIINOA* (CYCLOPOIDA)

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(With 63 Text-figures)

INTRODUCTION

Kabata (1968) created the genus *Shiinoa* to describe a copepod collected from the gill filaments of *Scomberomorus commersoni* (Lacépède) in the Queensland waters. Subsequently Cressey (1975) described *S. inauris* from the nasal lamellae of *Scomberomorus regalis* (Bloch) and *S. maculatus* (Mitchill) in the Atlantic. Cressey also collected both sexes of the type species, *S. oeclusa*, from the nasal lamellae of *Grammatorcycnus bicarinatus* (Quoy and Gaimard) in the Arabian sea. The third species, *S. elagata* Cressey (1976) was collected from the nasal lamellae of *Elagatus bipinnulatus* (Quoy and Gaimard) from the Indo-Pacific.

During a survey of the copepods parasitic on the fishes of the coastal waters of Kerala the second author collected *S. occlusa* Kabata, *S. elagata* Cressey and a new species to which we give the name *S. rostrata*. Our collection includes both sexes of all the three species. We give below detailed descriptions of all the species, a revised definition of the genus and an artificial key for the identification of the four known pecies.

TAXONOMIC ACCOUNT

Genus **Shiinoa** Kabata

1968. *Shiinoa* Kabata, *J. Nat. Hist.*, **2** : 497.

1975. *Shiinoa* : Cressey, *Crustaceana*, **28** : 211.

Diagnosis : Body narrow and subcylindrical or broad and dorso-ventrally flattened, with indistinct segmentation. A cephalothoracic, three thoracic and three abdominal segments indicated by constrictions or septa. Cephalothorax drawn out into a rostrum carrying the antennules and antennae and a posterior enlarged portion carrying

the oral appendages and the first one or two pairs of legs, the two portions connected by a narrow neck. First thoracic segment carrying the third pair of legs, second without appendages but often produced into a pair of postero-lateral lobes. Genital segment small. Abdomen long or short, three-jointed. Caudal rami well developed, often with spine-like setae. Egg tubes cylindrical, eggs multiseriate.

Antennules and antennae far removed from the oral appendages. Antennules fully segmented and setose. Antennae parallel to each other, curved beneath the rostrum providing an attachment organ, two- to three-jointed. Labrum prominent and projecting. Mandible with long bilaterally dentate blade and accessory blade. Maxillule with three spines. Maxilla with bilaterally dentate distal segment carrying two spine-like setae. Legs three pairs, placed just behind the oral appendages or the third pair shifted backwards. First and second pairs biramous, rami two- or three-segmented. Third leg uniramous, with two-jointed protopod and one-jointed ramus.

Male much smaller than female, free or attached to female. Body varying in shape, clearly segmented. Cephalothoracic segment with indistinct partition, thoracic segments, excluding the genital segment five, genital segment not enlarged, abdomen two- to five-jointed.

Antennae modified into strong prehensile organs, third segment with two to four strong claws. Legs generally as in female but exopod of second usually large, terminating in long stout claws.

Type species : *S. occlusa* Kabata.

Parasitic on the nasal lamellae of teleosts.

Discussion : *Shiinoa* now contains four species falling into two distinct groups. The first group which includes *S. occlusa* and *S. inauris* has long slender body with a pair of conical postero-lateral trunk processes. In the second group which includes *S. elagata* and *S. rostrata* the body is broad and dorso-ventrally flattened and the trunk has only rounded posterolateral lobes. Judging from the available information species belonging to the first group are parasites of scomberid fishes and those of the second of other teleosts. All except the type specimen of *S. occlusa* have been collected from the nasal fossae to teleosts. As observed by Cressey (1975) the occurrence of Kabata's specimen on the gill filaments is accidental.

There have been some comments on the affinity of the family Shiinoidae. Kabata observed that *Shiinoa* should be placed in the family Chondracanthidae. This suggestion was prompted by the close similarity of the oral appendages. The mode of attachment of the

male, at least in *S. rostrata*, reminds one of the chondracanthids. Ho (1971) suggested that *Shiinoa* should be placed in a new family. Acting on this suggestion Cressey (1975) created the family Shiinoidae and observed that shiinoids are closely related to ergasilids. Cressey also suggested a possible affinity between Shiinoidae and Philichthyidae. Copepods inhabiting unusual locations like the eye ball or nasal fossae generally show such peculiar morphology that their true affinity is often difficult to detect. We are describing elsewhere a caligid copepod collected from the nasal fossae of *Pomadasys maculatus* (Bloch). This copepod though a true caligid is totally different from all the other caligids in external morphology illustrating how the site and mode of attachment can bring about profound adaptive modifications.

Key to Species of **Shiinoa**

FEMALE

1.	Body narrow and cylindrical. ...	...	2
	Body broad and dorso-ventrally flattened. ...	...	3
2.	Abdomen longer than pregenital segment, exopod of legs one and two two-jointed. ...		*inauris* Cressey
	Abdomen shorter than pregenital segment, exopod of legs one and two three-jointed. ...		*occlusa* Kabata
3.	Rostral process narrowing forwards, rami of legs one and two three-jointed. ...		*elagata* Cressey
	Rostral process broadening forwards, rami of legs one and two two-jointed. ...		*rostrata* sp. nov.

MALE

1.	Post-cephalothoracic part of body regularly narrowing backwards, antennule with first two segments produced into stout processes, antenna with four apical claws. ...		*elagata* Cressey
	Post-cephalothoracic part of body not regularly narrowing backwards, first two segments of antennule not produced into processes, antenna with less than four apical claws. ...	...	2
2.	Basal segment of antenna with blunt processes, distal with two claws, legs with two-jointed rami. ...		*rostrata* sp. nov.
	Basal segment of antenna without blunt processes, distal with three claws, legs with three-jointed rami. ...	...	3
3.	Antenna with a bifid apical claw, legs with two-jointed rami. ...		*inauris* Cressey
	Antenna with three apical claws, legs with three-jointed rami. ...		*occlusa* Kabata

Shiinoa occlusa Kabata

(Text-figs. 1-21)

1968. *Shiinoa occlusa* Kabata, *J. Nat. Hist.*, **2** : 497, Figs. 1-2.

1975. *Shiinoa occlusa* : Cressey, *Crustaceana*, **28** : 216. Figs. 16-20.

Material : One female and one male from the nasal fossa of *Acanthocybium solandri* (Cuvier) examined at Trivandrum.

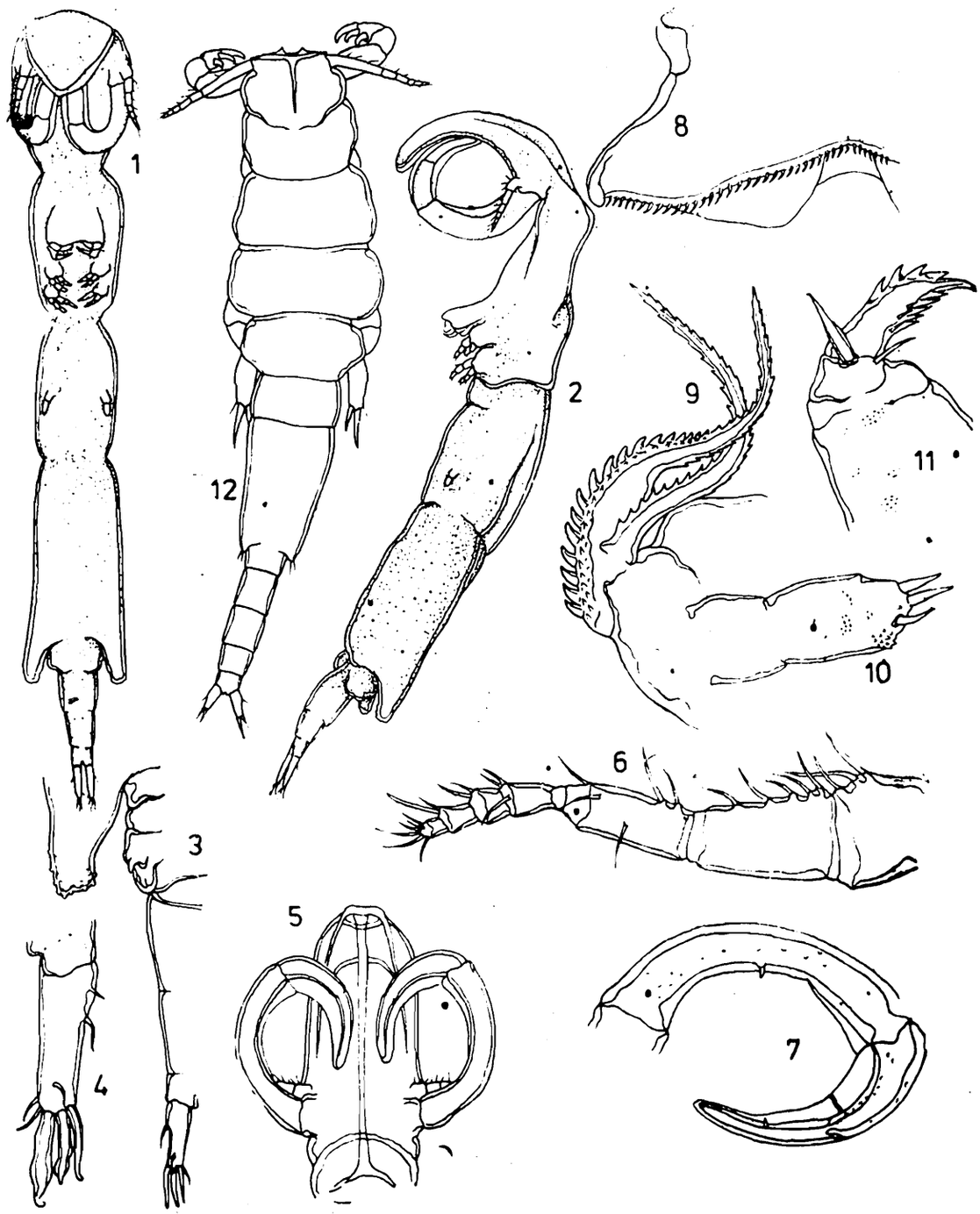
Female : Body long and slender, with indistinct segmentation ; segments indicated by lateral constrictions. Cephalothoracic segment demarcated by a deep constriction into an anterior broad and posterior narrow part, former produced forwards into a rostrum carrying the antennules and antennae on its base and the latter carrying the oral appendages and the first two pairs of legs. Rostrum antero-medially slightly produced and strengthened by chitinous ridges as shown in the figure. First thoracic segment shorter and narrower than the adjacent segments, carrying the third pair of legs. Second segment long and gradually widening backwards and postero-laterally produced into conical lobes, their tips roughened by small pustules. Third or genital segment rounded and immersed in the previous segment. Abdomen comparatively short and three-segmented, narrowing backwards. Caudal rami as long as the first abdominal segment, with two outer, two inner and one ventral setae and three stout distal processes.

Antennule seven-jointed and fairly well setose, first three segments stout, sixth segment with an aesthete. Antenna apparently two-jointed but the distal segment with indication of a division, basal segment with median inner process, distal segment with broad hyaline covering. Labrum as described by Kabata but the hyaline lobes larger. Mandible, maxillule and maxilla as described by Kabata but the maxillule with a prominent constriction.

First two segments of endopod of first leg externally expanded, second segment with one outer distal spine and third with three inner setae and two distal spines. Exopod narrower than endopod, first two segments with one spine each, third with three inner setae and three distal spines. Second leg slightly larger than first, third segment of endopod comparatively broader and with four distal spines. Basal segment of exopod with three inner spinules and outer distal spine, third segment with two inner spinules and three distal spine. Basipod of third leg indistinctly two-jointed and with a long seta, ramus with two pectinate spines and a long seta.

Length : 4.6 mm

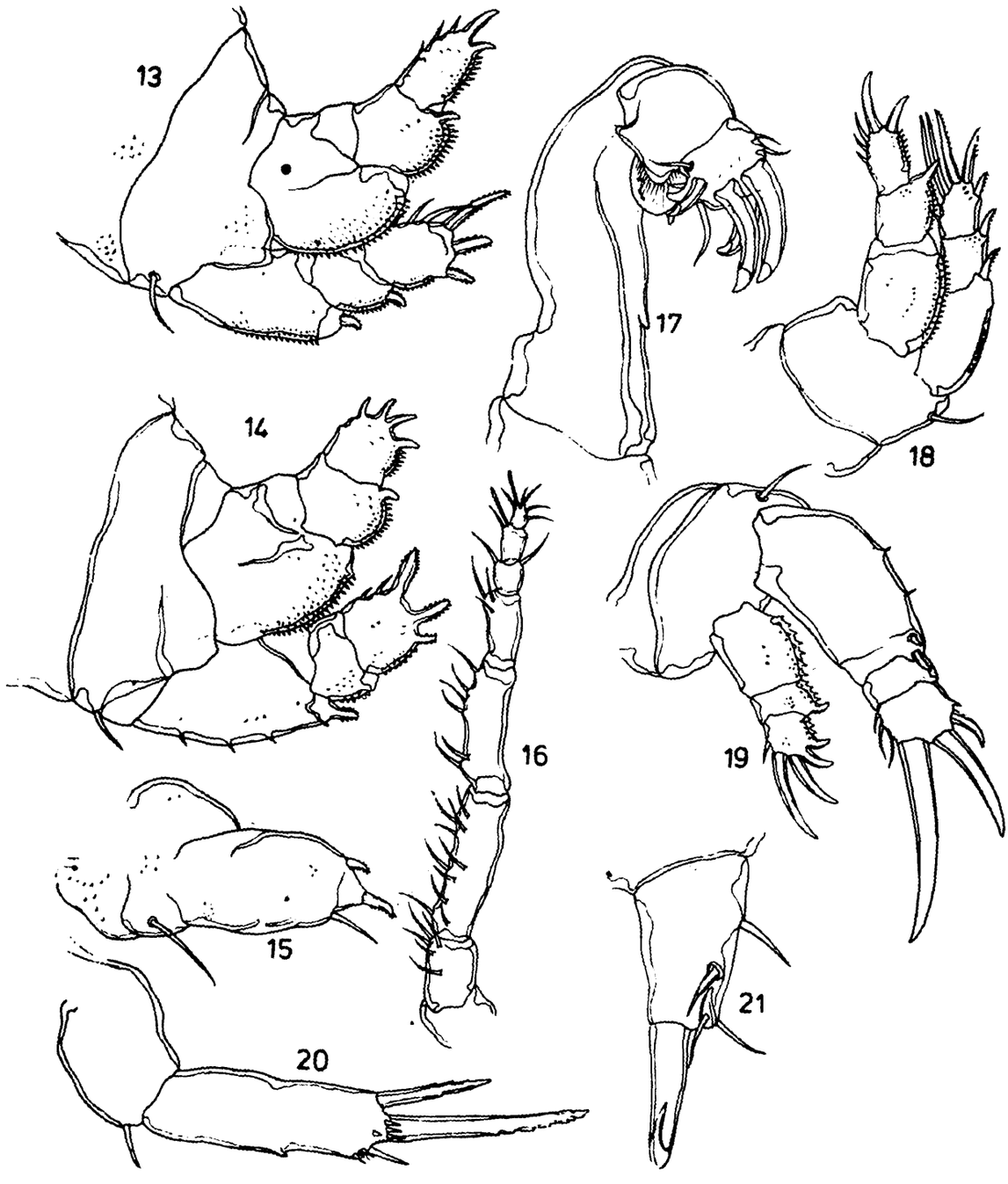
Male : The pregenital part of the body clearly broader than the post-genital, subequal in length. Cephalic segment longer than broad, its anterior border subtruncate, with a pair of conical processes, lateral borders with a constriction and transverse grooves dividing the segment into two parts. Trunk segments one and two subequal in size, third segment smaller. Fourth segment as broad as genital segment and demarcated from the latter by a partition. Genital segment one and a half



Text-figs. 1-12. *Shiinoa occlusa* Kabata.

1. Female, ventral view ; 2. same, lateral view ; 3. hind end of body, dorsal view ; 4. caudal ramus ; 5. rostral prolongation, ventral view ; 6. antennule ; 7. antenna ; 8. labrum ; 9. mandible ; 10. maxillule ; 11. maxilla ; 12. male, dorsal view.

times as long as broad, narrowing backwards. Abdomen five-jointed, first segment telescoped into the genital segment, fifth small. Caudal rami stout, with four elements, two setiform, one spine-like and the fourth a claw carrying a seta.



Text-figs. 13-21. *Shiinoa occlusa* Kabata.

13-15. female ; 16-21. male ; 13. leg 1 ; 14. leg 2 ; 15. leg 3 ; 16. antennule ; 17. antenna ; 18. leg 1 ; 19. leg 2 ; 20. leg 3 ; 21. caudal ramus.

Antennule seven-jointed and fairly well setose, segments two and three long, last two segments with aesthetes. Antenna stout and prehensile, basal segment with median inner projection, second segment

internally produced into a large semicircular lobe and a short blunt claw, third segment with two inner claws and two setae, its outer border with two setae and the distal with three stout claws. Oral appendages generally as in the female.

First leg with three-jointed subsimilar rami, much different from the corresponding leg of the female. Second leg with dissimilar rami, very much different from that of female, exopod much longer than endopod and the inner and middle claws on the third segment very stout. Third leg with long parallel sided ramus carrying on its distal border a short spine and two long sparsely dentate processes very much different from that of the female.

Length : 3.0 mm.

Remarks : The original description of this species by Kabata was based on a single female. Cressey who collected both sexes described the male but not the female observing that the female has been well described by Kabata. Kabata had to study the appendages *in situ* and hence his description differs from ours in some details. The antennule is seven and not six-jointed. The antenna is three and not two-jointed. The postero-lateral processes on the last thoracic segment are tubercular and the abdomen shows segmentation though indistinctly.

The male described here shows difference from those of Cressey. On the basal segment of the antenna Cressey has illustrated a small spine and a moderately large lobe carrying a spine. Instead of the median spine our specimen has a low lobe and the distal lobe is a large semicircular flattened expansion originating on the second segment and not the first.

Shiinoa elagata Cressey

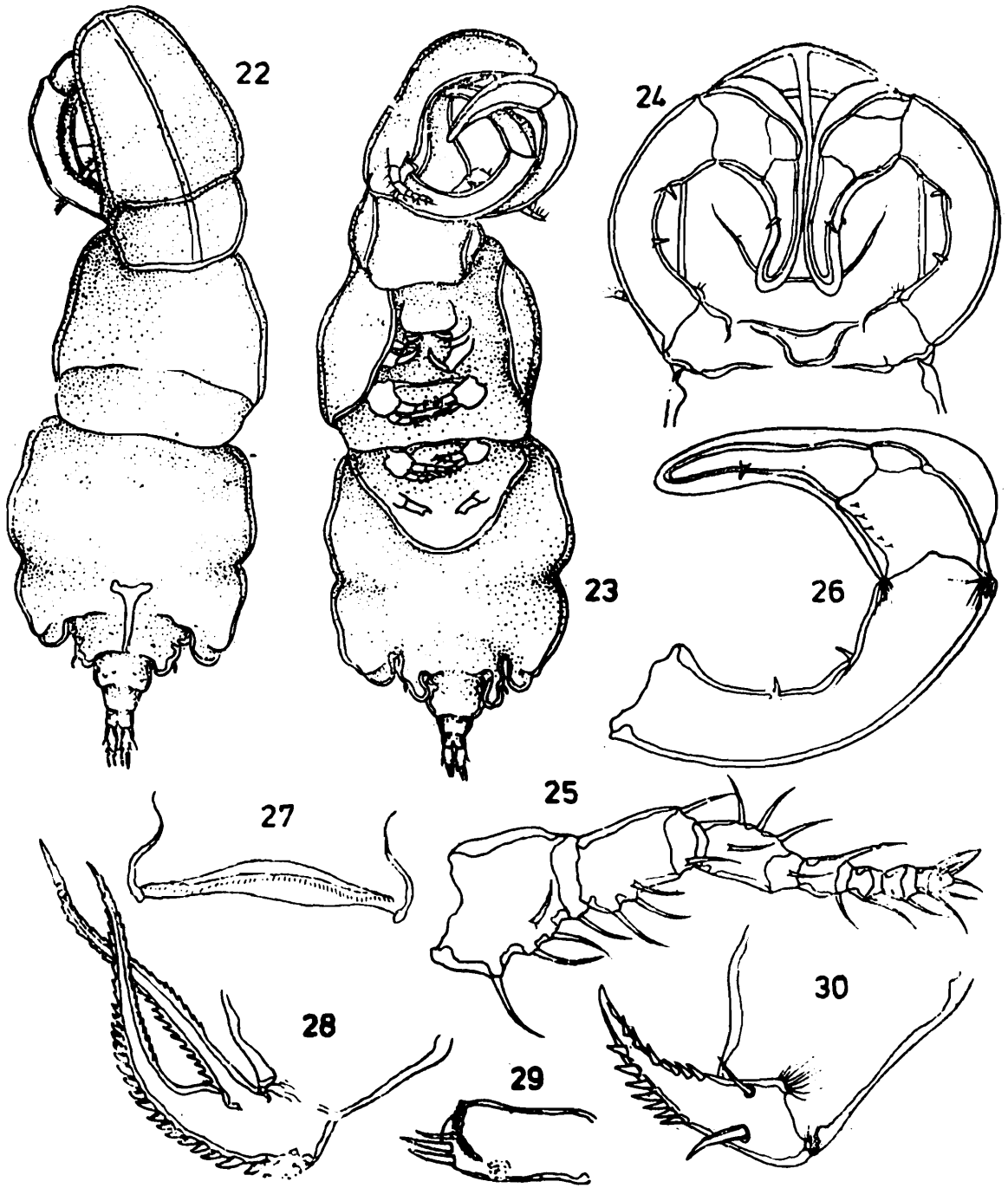
(Text-figs. 22-43)

1976. *Shiinoa elagata* Cressey, *Proc. biol. Soc. Wash.*, 88 : 433, Figs. 1-12.

Material : Seven females from the nasal fossae of *Parastromateus niger* (Bloch), four females and one male from the nasal fossae of *Seriolichthys bipinnulatus* Bleeker and one female and two males from the nasal fossae of *Platax orbicularis* (Forskal), all collected at Trivandrum.

Female : Body comparatively broad and dorso-ventrally flattened, distinctly segmented. Lateral parts of thoracic segments folded downwards. Cephalothorax composed of three distinct parts, rostral prolongation, segment proper and a short neck segment connecting these two. Rostrum nearly parallel sided or slightly narrowing forwards,

its anterior border evenly rounded ; dorso-median part with a strong chitinised rib. First thoracic segment interpolated between the cephalothorax and the second trunk segment, dorsally visible as a small constriction and an incomplete groove and ventrally as an arcuate groove.



Text-figs. 22-30. *Shiinoa elagata* Cressey.

22. female. dorsal view ; 23. same, ventral view ; 24. rostral process, ventral view ; 25. antennule ; 26. antenna ; 27. labrum ; 28. mandible ; 29. maxillule ; 30. maxilla.

Second thoracic segment large, nearly equal in length and width, postero-laterally expanded into rounded lobes. Genital segment immersed in the previous segment, twice as broad as long, with a pair of chitinised processes carrying a small seta ; dorsal side with a median rib. Abdomen three-jointed and short, first segment comparatively

large, with two pairs of dorsal tubercles, second and third segments small. Caudal rami large, each with three slender and two stout setae.

Antennule seven-segmented, segmentation somewhat obscured, first three segments comparatively long, others short. Antenna clearly three-segmented, first segment with two sharp inner processes, second short, with a row of tubercles carrying a spinule, third segment with an inner process, second and third segments with hyaline covering. Lateral parts of the free border of labrum produced, distal border concave and fringed with a row of spinules, with hyaline flap projecting beyond the border. Mandible very much like that of *S. occlusa* but the submarginal row of teeth very few, both blades comparatively stouter and shorter. Maxillule with a seta and two spines and a transverse arc of small teeth ending in a patch of spinules. Maxilla with the two customary spines, ventral border of the claw with seven and dorsal with six sharp teeth.

First and second legs with three-jointed rami. Basal segment of endopod with inner distal seta, second segment, with a strong outer distal claw, third segment with three inner setae and two distal claws. Basal segment of exopod with outer claw, second segment with an outer claw (that of second leg with an inner seta), third segment with three inner setae and three distal claws. Rami of both legs sparsely tuberculated. Third leg with clearly two-jointed protopod, the ramus carries two inner claws and a spine fringed outer distal hemispherical bulge.

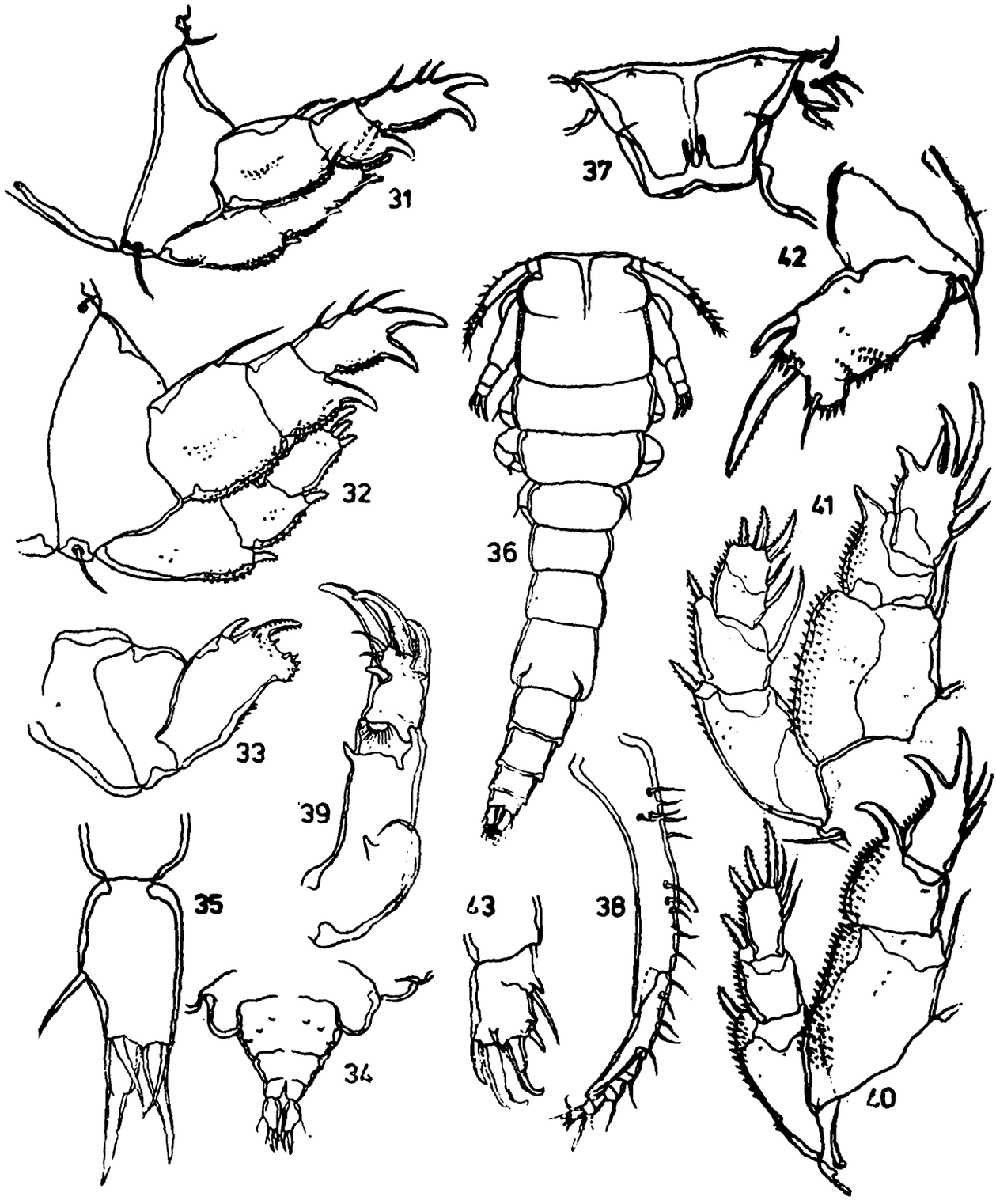
Length : 2.7 mm.

Male : Cephalic segment squarish, with an indistinct partition as in *S. occlusa*, anteriorly produced into a large remotely triangular distally truncate rostrum remaining bent downwards. Trunk segments, in addition to genital segment, five in number, successively decreasing in width. Genital segment longer and broader than the previous segment, broader behind. Abdomen four-jointed, gradually narrowing backwards. Caudal rami slightly longer than last abdominal segment, with outer short spine and long seta, distal border with four strong claw-like processes and a submarginal seta.

Antennule seven-segmented and highly chitinised, first segment forming half of the appendage and distally produced into a conical process, second segment moderately long and produced into a process as long as the segment, succeeding four segments short. Antenna cylindrical and nearly straight, basal segment with proximal outer bulge and inner distal process, second segment produced distally into a lobe carrying three setae below which is a small claw, third segment short,

with four claws successively increasing in length, fourth claw very long. Oral appendages as in female.

Legs one and two subsimilar except that the endopod of the second is stouter. First endopod segment with inner seta, second with outer claw, third segment of the first leg with three setae and two claws, of



Text-figs. 31-43. *Shiinoa elegata* Cressey.

31-35. female ; 36-43. male 31. leg 1 ; 32. leg 2 ; 33. leg 3 ; 34. genital segment and abdomen ; 35. caudal ramus ; 36. male, dorsal view ; 37. rostral lobe, ventral view ; 38. antennule ; 39. antenna ; 40. leg 1 ; 41. leg 2 ; 42. leg 3 ; 43. caudal ramus.

second leg with two setae and four claws. Exopods differing in the presence of a stout seta on the inner border of the second segment of the second leg. Rami of both legs strongly spiny. Basipod of third leg with a long seta, ramus as in female but with longer distal spines and a large ventral patch of denticles.

Length : 2.0 mm.

Remarks : In spite of certain differences there is no doubt that the present specimens belong to *S. elagata*. In the description of the female Cressey observes, "cephalon posterior to second antennae constricted, followed by laterally expanded area bearing mouth parts and first legs." This description is applicable to our specimens but in the dorsal view of the animal the rostral segment, neck segment and the cephalothoracic segment are delimited by septa. Following the cephalothorax (cephalon of Cressey) is a large segment which Cressey describes as the genital segment. This does not appear to be correct, since the genital segment is a small clearly visible segment partially fused with the trunk segment and also immersed in it, more or less as in *S. occlusa*. At the hind end of the cephalothorax is a constriction with two transverse grooves and on the ventral side of the pregenital segment an arcuate ridge just behind the third pair of legs. These structures indicate the presence of a vestigial trunk segment which is well developed in the type species and also in the new species described below.

The male which has not so far been described is remarkable in the shape of the body, nature of the antennule, armature of the antenna, presence of a large downwardly bent rostrum and in the armature of the caudal rami. The similarity of legs one and two is also significant.

Shiinoa rostrata sp. nov.

(Text-figs. 44-63)

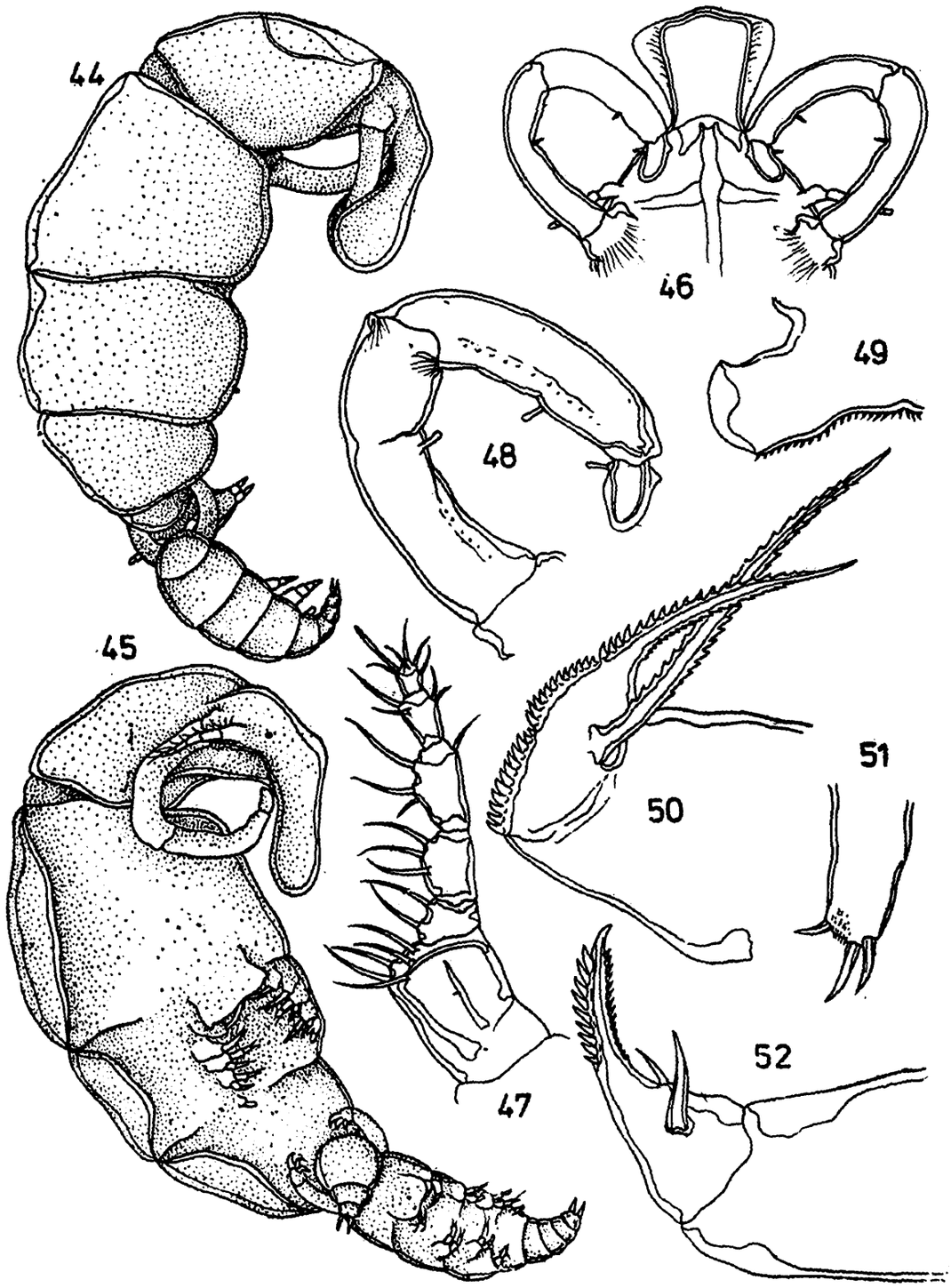
Holotype.—Female, Reg. No. C. 2903/2 Zoological Survey of India, Calcutta ; loc. ; Trivandrum, Kerala ; host : *Priacanthus hamrur* (Forskal), nasal fossae ; Coll. *C. Prabha*.

Paratype.—3 ♀ ♀ and 1 ♂, loc. Trivandrum, Kerala ; host. *Epinepheles* sp. *Lutianus* sp., *Priacanthus hamrur* ; other details same as for holotype.

Female : Body closely resembling that of *S. elagata*. Cephalothorax clearly demarcated into rostral segment, a fairly large neck segment carrying the antennules and antennae and a large dorso-ventrally flattened hind segment carrying the oral appendages. First and second trunk segments distinct, the former, unlike as in other species, carrying the three pairs of legs. Second segment without postero-lateral lobes. Geni-

tal segment and abdomen fused into a swollen part terminating in a pair of rectangular caudal rami, each armed with a lateral and distal small seta and three distal stout spines.

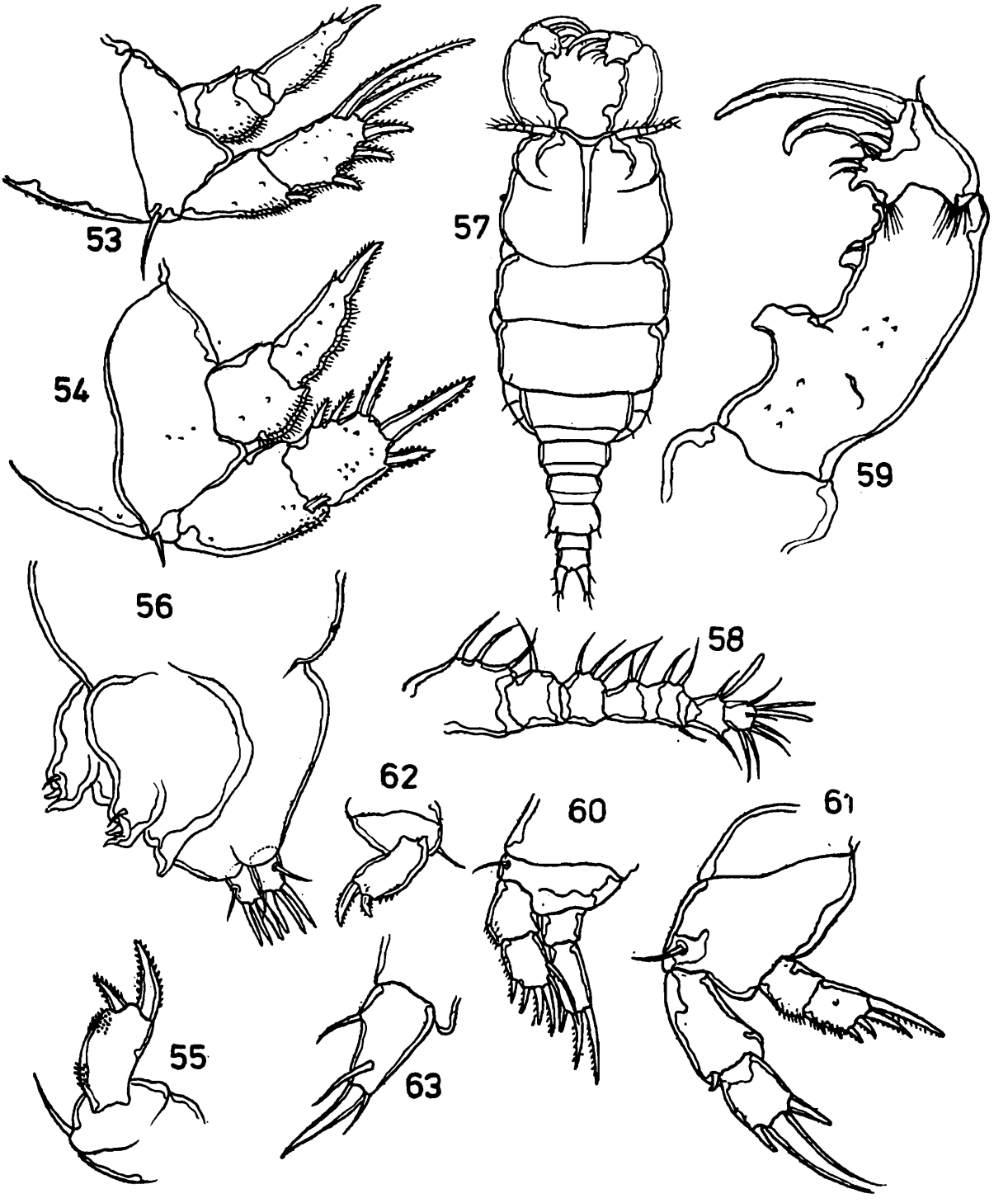
Antennule six-jointed, basal segment stout, each of the last two segments with an aesthetasc. Antenna clearly three-jointed, first seg-



Text-figs. 44-52. *Shiinoa rostrata* sp. nov.

44. female and male, lateral view ; 45. same, ventral view ; 46. rostral prolongation, ventral view ; 47. antennule ; 48. antenna ; 49. labrum ; 50. mandible ; 51. maxillule ; 52. maxilla.

ment with an indistinct partition and an inner process, second segment nearly as long as first, with one inner process, third segment very short, ovate and with a hyaline covering, an inner process and a conical outer



Text-figs. 53-63. *Shiinoa rostrata* sp. nov.

53-56. female. 57-63. male. 53. leg. 1 ; 54. leg 2 ; 55. leg 3 ; 56. genital segment and abdomen ; 57. male, dorsal view ; 58. antennule ; 59. antenna ; 60. leg 1 ; 61. leg 2 ; 62. leg 3 ; 63. caudal ramus.

projection. Labrum with large lateral wing-like expansions, free broder armed with sharp spines. Mandible with large basal segment, main blade basally broad and with bilobed margin, each lobe with a row of

teeth, narrow part slightly longer than the basal and bilaterally dentate, accessory blade bilaterally dentate and reaching far beyond the main blade. Maxillule with three strong processes and a patch of denticles. Basal segment of maxilla stout, distal with two spines, one of them very stout, blade with about ten large ventral and fourteen to fifteen small dorsal teeth.

Legs placed close together behind the oral appendages, first two pairs biramous, with two-jointed rami, third pair uniramous. Endopod of first leg smaller than exopod, its distal segment with three small inner distal spinules and a stout apical process. Basal segment of exopod with an outer process, distal segment with five processes regularly increasing in length so that the last is longer than the segment. Second leg generally like the first, distal endopod segment with one inner spinule and a stout distal process. Exopod compared to that of first leg stout, distal segment with two inner and three distal strong processes. Both legs with poorly spiny rami. Third leg with indistinctly two-jointed basipod with a seta, ramus with two patches of spinules and two processes, one of the processes large.

Length. —3.0 mm.

Male. —Closely attached to the abdomen of female. Body clearly demarcated into a broad anterior division comprising the cephalic and the first two thoracic segments and a comparatively narrow posterior division composed of three thoracic segments, genital segment and the abdomen. Cephalic segment squarish, with an incomplete partition. First two thoracic segments rectangular, as broad as the cephalic segment, third segment abruptly narrowed, narrowing backwards to meet the narrow fourth segment. Genital segment not enlarged, slightly broader than long. Abdomen very short and two-jointed, as long as genital segment. Caudal rami strongly narrowing, with one stout apical process and three slender setae.

Antennule seven-jointed, first segment only moderately stout, penultimate segment with one and ultimate with two aesthetes. Antenna stout, with massive basal segment internally produced into a pair of blunt median processes and three smaller distal processes, second segment internally produced into a lobe carrying one spine and two setae. Third segment almost non-existent, with three setae and two very long curved slender processes. Oral appendages generally as in female.

Legs one and two biramous, with two-jointed rami, endopods normally developed, exopod of second showing the usual dimorphism. Distal segment of endopod of first leg with three apical spines, first very