

A new occurrence and a new species of *Carcinocaris* Cottarelli *et al.* (Laophontidae, Copepoda), commensal on panopeid crabs

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Abstract

Carcinocaris minipedia n. sp. of Laophontidae (Harpacticoida, Copepoda) found on the carapace setae and eggs of Panopeidae crabs is described. The main characteristics are the absence of endopods on pereopods 2 to 4 and a very robust maxilliped. The nauplius and copepodid stages of the species are also mentioned. The hosts live in the mangrove region of Araçá bay, São Sebastião, Brazil, and in Florida, U.S.A. This is the second species described for the genus and the first record for the Atlantic Ocean.

Key words: mangrove crabs, commensal copepod, Brasil and USA.

Introduction

Boxshall and Halsey (2004) summarized the taxonomical status of the studies about the “large and heterogeneous” family Laophontidae T. Scott, 1905 and listed the 55 genera which belong to the subfamily Laophontinae instituted by Huys and Lee (2000). Among these genera some are found inhabiting the carapace and/or the eggs of several decapod crustaceans such as *Xanthilaophonte* Fiers 1991, *Robustunguis* Fiers 1992, *Myctiricola* Nicholls 1957, *Carcinocaris* Cottarelli, Bruno and Berera 2006. The species here described belongs to this last genus of which the only species known until now is *C. serrichelata* associated with panopeid crabs in the intertidal zone along the coast of some Philippine islands (Cottarelli *et al.*, 2006).

It is numerous and common on the crabs *Panopeus americanus* Saussure, 1857 and *Panopeus herbsti* H. Milne Edwards, 1834 which occur in a mangrove region in Araçá bay (São Sebastião, SP, Brazil) and on *Eurypanopeus depressus* Smith, 1869 near to Fort Pierce, Florida, USA. They are found among the setae of the carapace of the crabs and on their eggs. Adults also occur in rock pools. Nauplii and copepodites were collected among the eggs of the crabs.

There is quite a gap in the knowledge of copepod parasites of marine invertebrates from Brazilian waters. Besides the few papers mentioned in

Young (1998), other contributions were those of Johnsson (1997, 1998a, 1998b, 1998c), Santos and Bjornberg (2004), Kihara, Rocha and Santos (2005), Kihara, Bjornberg and Kawachi (2007). This paper is a small contribution towards the filling of the gap.

Material and Methods

Panopeid crabs were collected in a mangrove region with an outcrop of rocks called Araçá bay in São Sebastião, SP, Brazil. The copepods were separated from the carapace and eggs of the crabs and were fixed in a 10% formalin solution. Material brought by one of us from the USA was also examined. All specimens were cleared in lactic acid and studied in a mixture of glycerine and 10% formalin, and studied with the aid of a Nikon Labophot microscope equipped with a *camera lucida*. Some details were observed in a Leitz photomicroscope.

Details were observed after dissection.

Abbreviations used: A₁ = antennule; A₂ = antenna; CI-CV = copepodite 1 to copepodite V; Md = mandible; P₁-P₆ = limbs 1 to 6.

The holotype and paratypes were deposited in the Museu de Zoologia da Universidade de São Paulo, Brazil (MZUSP n° 16321). Male and

female specimens from Florida coast (USA) are deposited in the CEBIMar collection.

Diagnosis: *Carcinocaris minipedia* n. sp.

Laophontinae with reduced pereopods, without apophysis or hook-like processes on the 6-segmented antennule, extremely strong maxilliped and P2 to P4 without endopods and increasing length and complexity. P3 and P4, similar in male and female. Male with subchirocer antennules. P5: leaf-like in female with 4 bipinnate setae on baseoendopod and outer seta on setophore, exopod with 4 bipinnate setae; in male, P5 forming a bulge bearing one to four pinnate setae and seta on a pedestal representing the coxobasis. Associated with Panopeidae crabs.

Description: *Carcinocaris minipedia* n. sp.

Female (Fig. 1): Color pink, but usually covered with black pigment from the eggs of the host. Body cylindrical, slightly depressed laterally. Length from rostrum to end of caudal rami 0.571-0.685 mm. Body in lateral view robust (Fig. 2) with cephalon highly vaulted. Margins of prolonged lateral scutum with a fringe of long thin setules between insertion of antennules and antennae. Somites tapering slightly posteriorly. In lateral view cephalon in its widest part is 1.3 wider than the first pedigerous somite. Several sensilla scattered over whole surface of cephalon. Body and appendages densely covered with minute thin setules. Rostrum small, fused to cephalon with 2 sensilla. Labrum diamond-shaped with 2 rows of setules posteriorly (Fig. 3). Only one egg-sac present, containing up to 12 eggs. First pedigerous somite partly fused to cephalon. Posterior margins of somites smooth, without teeth-like or other protuberances. Somites with sensilla near the insertion of P2 to P5. Abdominal segments with row of spinules laterally (Fig. 4) and sensilla dorsally (Fig. 5). Caudal rami cylindrical, short, longer than wide. Each ramus with 6 setae: 3 short proximal, 2 shorter, thin terminal and a very long bipinnate seta V, 110 times longer than ramus (Fig. 5). Rows of spinules on parts of the rami. Anal operculum triangular-rounded, without lateral or terminal processes.

Antennule 1 (A_1) (Figs. 6-8) 6-segmented covered with minute thin spinules amongst which very thin and long sparse spinules. Segment 1 with lateral proximal process and rows of spinules.

Segment 2 with marginal spinules and 6 setae. Segment 3, the longest, with 5 setae. Segment 4, short with a pedestal bearing a very long bithek (an aesthetasc fused at the base to a seta), laterally a long seta. Segment 5, the shortest, with one seta, and, segment 6 with terminal bithek, composed of aesthetasc plus longer seta, and 7 smaller lateral setae. Variations may occur: antennules left and right of the same specimen with different number of segments (Figs. 7 and 8). The bithek may be very hairy proximally.

Antenna (A_2) (Fig. 9): 3-segmented with coxa, allobasis and 2 one-segmented rami; endopod as long as basis and 4.6 times longer than wide, bearing 4 well developed pinnate setae (2 geniculate) and 2 smaller lateral setae; exopod shorter than basis with 4 pinnate apical setae. Whole appendage covered with minute setules.

Mandible (Fig. 10): gnathobasis composed of 3 strong finger-like processes and 3 bifid cuspidate teeth plus plumose seta. Subcylindrical palp bearing 3 terminal and 2 lateral setae, and long thin setules proximally, providing a plumose aspect.

Maxillule (Fig. 11) Praecoxa showing row of spinules and 6 finger-like spines on distal margin of arthrite. Coxal endite represented by long thick spine or claw. Basal endite with 3 distal setae. Endopod fused with basis represented by 2 setae. Exopod bearing 2 setae.

Maxilla (Fig. 12) Syncoxa very wide bearing seta and pre-coxal endite with seta and several thin distal spinules, middle endite with lateral and 2 terminal setae, distal endite with 2 setae. Claw-like allobasis, with lateral seta, and endopod represented by 2 setae.

Maxilliped (Fig. 13) with row of spinules and 2 pinnate setae on syncoxa; basis considerably dilated, robust with row of strong spines along inner margin; endopod also strongly dilated with 4 teeth-like bulges along inner margin and forming clasper with the basis.

P1 (Fig. 14) with bare coxa; basis 1.5 times longer than coxa with patch of spinules on posterior margin and 1 spine. Exopod very small about half the width of basis, with 3 terminal and 2 lateral setae. Endopod 1.5 times longer than basis; endopod-1 finely setose; endopod-2 short, 1/3 the length of endopod-1, setose; endopod-3 about as long as endopod-1, claw-like, also finely setose and with 2 rows of spinules on anterior margin.

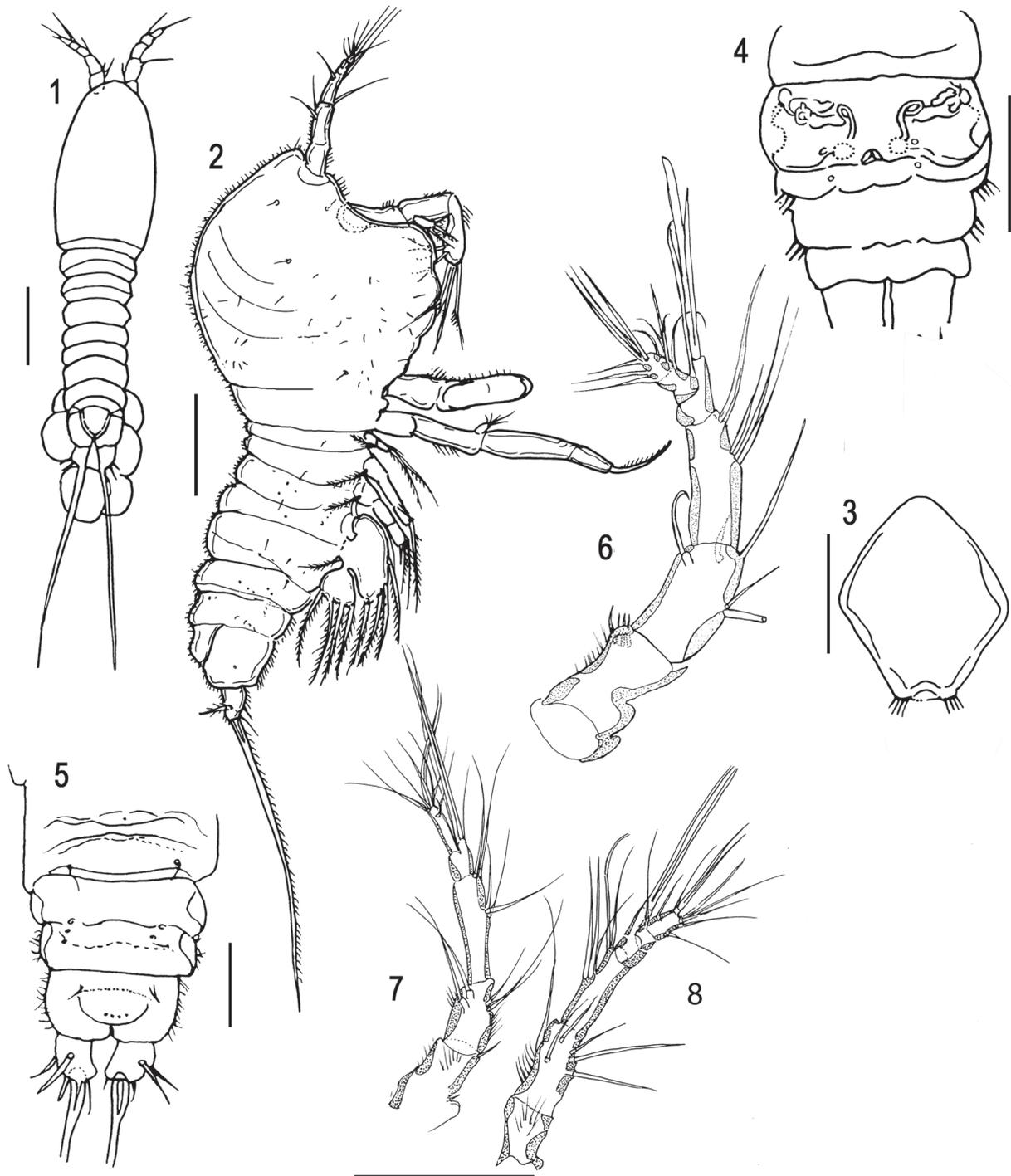
P2 to 4 (Figs. 15-17) without endopods, coxobasis bearing a long outer seta. All setae bipinnate.

P2 reduced to 1/5 of length of P3 or P4; exopod 1-segmented with 3 bipinnate setae.

P3 with row of spines (on inner margin of coxobasis, exopod-1 with modified finger-like strong and finely setuled seta, plus pinnate seta on outer margin; exopod-2 with 4 distal, pinnate setae.

P4 with 2 bipinnate outer marginal setae on exopod-1 and exopod-2 with 4 distal bipinnate setae, with rows of setules.

P5 (Fig. 18) leaf-like baseoendopod with 4 bipinnate setae on endopodal lobe and outer seta on setophore; exopod roundish, and, about half the size of baseoendopod, with 4 bipinnate setae,



Figures 1-8. 1. Female, dorsal view (schematic); 2. Female, lateral view; 3. Labrum; 4. Genital and following somites of the abdomen, ventral view; 5. Genital somites to furcal rami (female), dorsal view; 6. Antennule (female); 7. Antennule, right (female); 8. Antennule left of same specimen (all scales = 0.10 mm excepting when written differently).

row of setules, and minute spinules covering the whole leg.

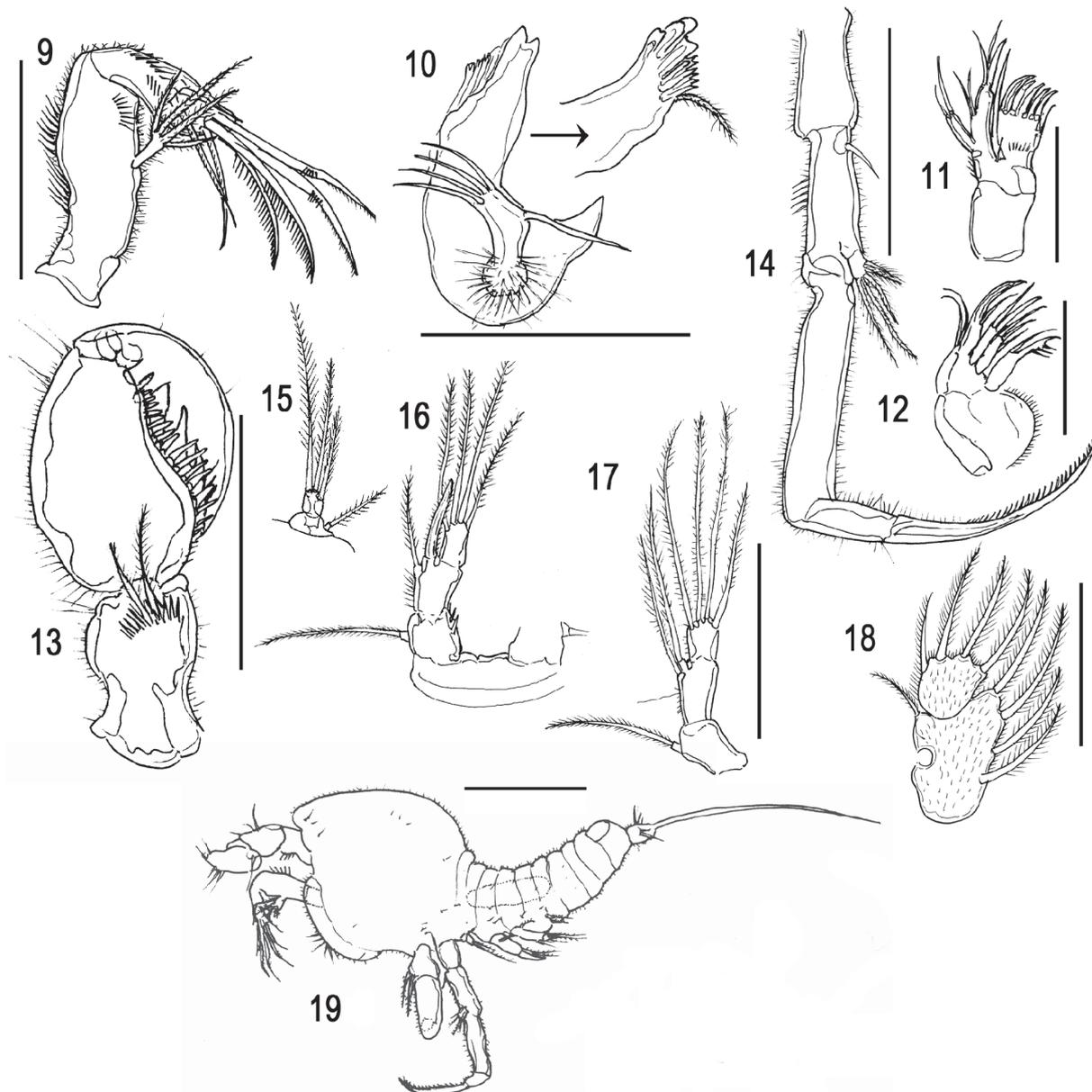
Male (Figs. 19) Length 0.380-0.410 mm. Body similar in form to female body, but shorter. Cephalon less vaulted. Rostrum short with lateral spinules and median pore. Abdominal somites with rows of setules along ventral margins (Fig. 21). Caudal rami and setae as in female (Fig. 22). Mandibles, maxillules and maxillae similar to corresponding appendages of female.

Antennules (Fig. 20) subchirocer. Segment 1 with row of minute spines. Segment 2 with 8 setae

and segment 3 with 5 setae. Segment 4 dilated, strongly developed with pedestal bearing long bithek composed of strong aesthetask and thin seta. The following segments fused, bearing 10 or 11 setae and forming a claw-like clasper. Maxilliped (Fig. 23) with bulges and spines blunter than in female.

P1, 2 and 4 as in female (Figs. 24; 25). P3 also similar (Fig. 26), however finger-like seta slightly stronger than in female.

P5 with 1 to 4 longer pinnate setae on a bulge and strong lateral pinnate seta on pedestal representing coxobasis (Figs. 21, 27, 28).

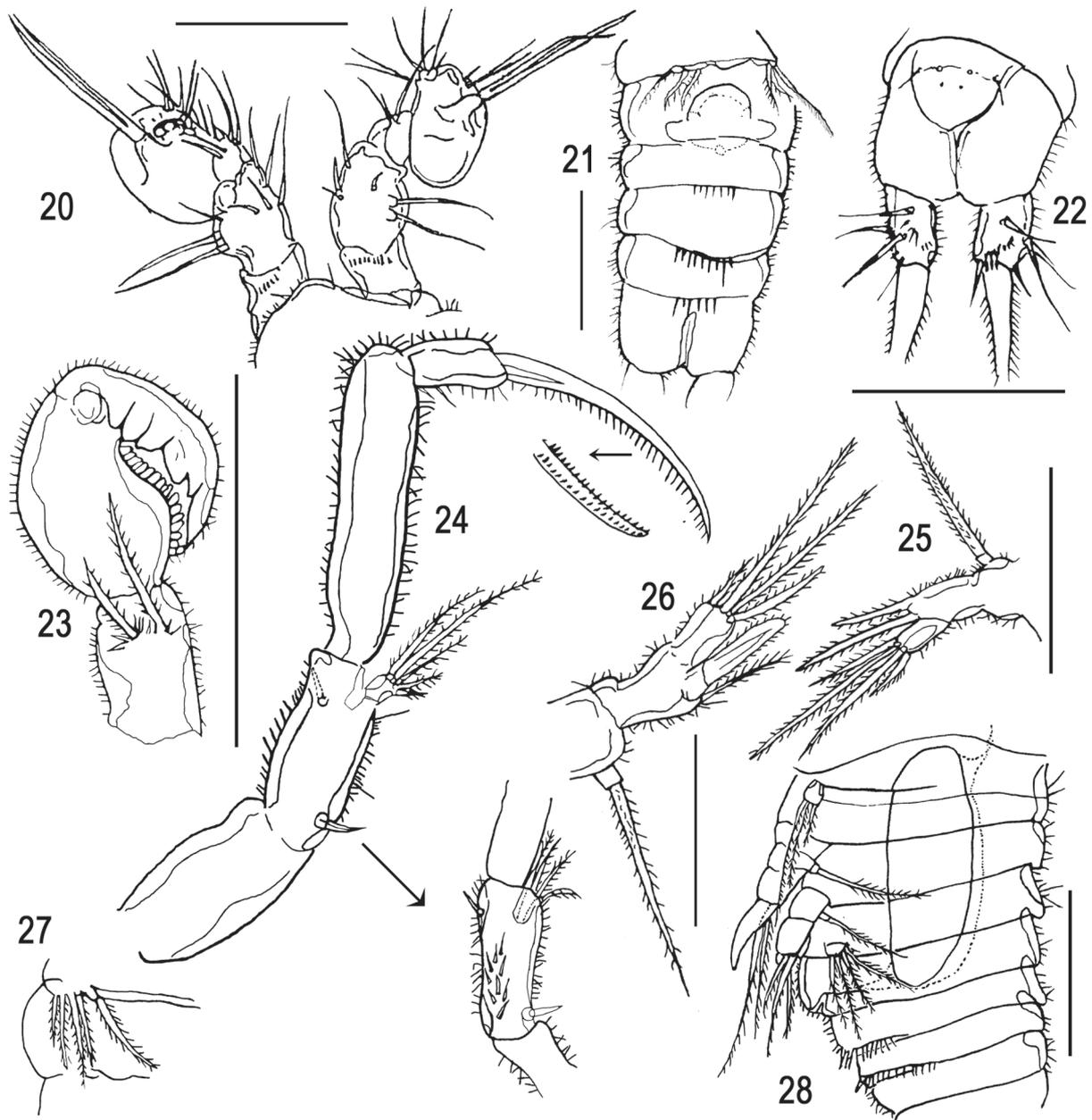


Figures 9-19. 9. Antenna (female); 10. Mandible and detail of gnathobase (arrowed) (scale = 0.05 mm); 11. Maxillule (scale = 0.05 mm); 12. Maxilla (scale = 0.05 mm); 13. Maxilliped; 14. P1; 15. P2; 16. P3 (female); 17. P4 (female); 18. P5 (female); 19. Male, lateral view (all scales = 0.10 mm excepting when written differently).

The spermatophore is long and cylindrical (Fig. 28).

The Nauplius: Stage five. Length 0.175 mm. Body pinkish, pear-shaped (Fig. 29). Setae thick in first two thirds of the length and very thin distally. Antennules (Fig. 30) with rows of setules, pinnate seta, very thin setules and long distal seta on second segment. Third segment with many setules 4 long setae and spinose seta. Labrum: wide frontally

and straightening posteriorly. A2 as in many benthonic harpacticoids (Fig. 31), but claw finely setuled on anterior margin and first segmental seta as long or longer than claw. Mandible also follows general description of benthonic nauplii (Fig. 32) but exopodal setae are the peculiar shape mentioned above. Maxillules: two very long setae. Two small preterminal plus two long strong setae on the caudal region.

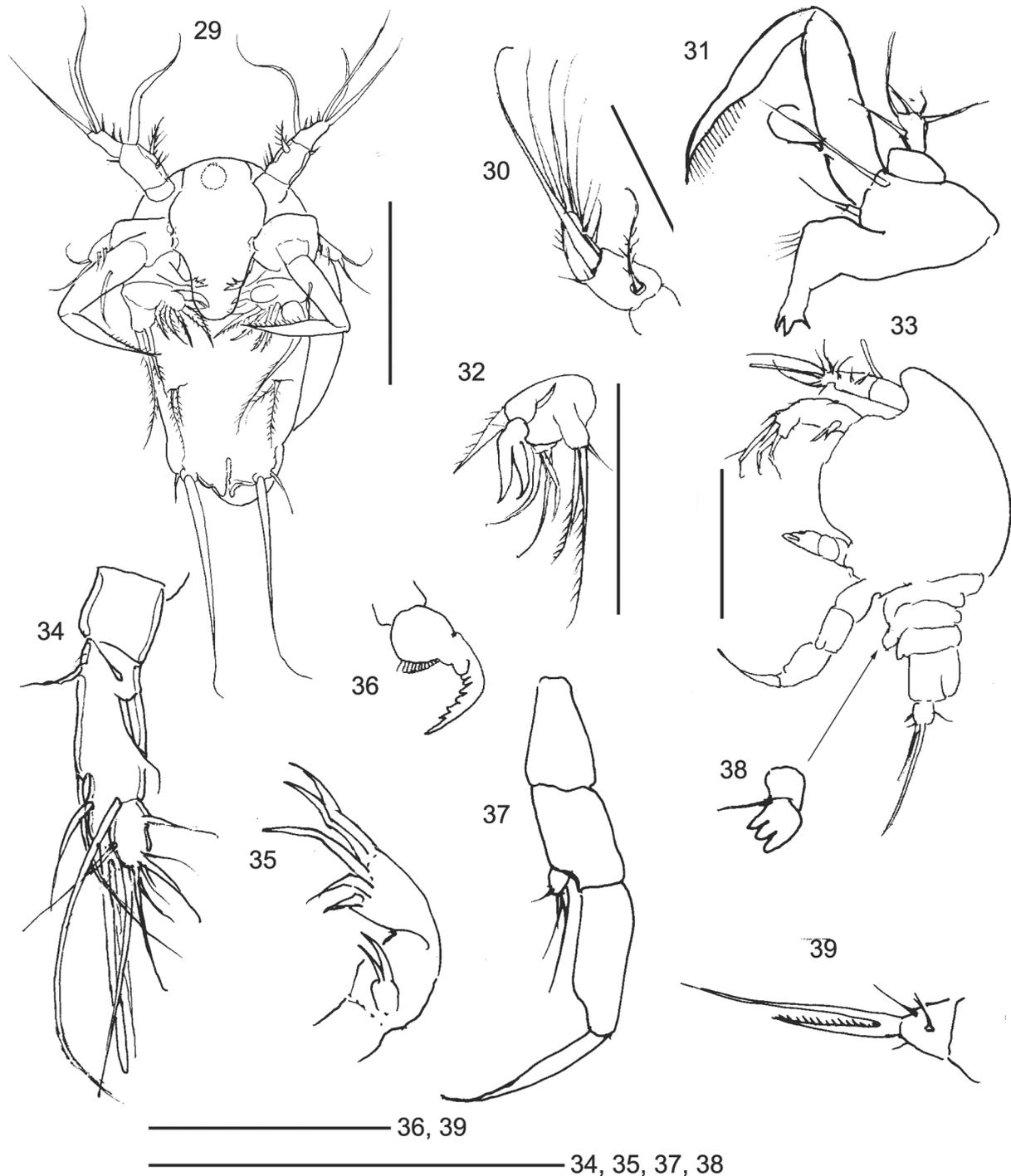


Figures 20-28. 20. Rostrum and antennule of male; 21. Abdomen (ventral), showing P5 and genital structures (caudal rami not represented), male; 22. Anal segment, anal operculum and caudal rami (longer seta cut short), male; 23. Male maxilliped; 24. P1; lateral view and detail of terminal claw and basis of P1 seen from opposite side (arrowed); 25. P4 (male) (scale=0.05 mm); 26. P3 (male) (same scale as in figure 25); 27. P5 (male); 28. Lateral view of pedigerous somite 2 to 5 and 3 following somites of male. Spermatophore visible (all scales = 0.10 mm excepting when written differently).

Copepodites

CI: 0.200-0.211 mm long. (Fig. 33-40)
5-segmented. Cephalon almost twice as long and
as wide as rest of the body. A1 3-segmented. A2
indistinctly divided into 2 segments, with exopod
bearing 3 setae, endopod with 4 long setae and

a spine. Maxilliped 2-segmented, with marginal
ridge, later divided vertically into setules, and claw
with inner margin crenate. P1 exopod bearing
2-3 setules. P2 represented by a little bulge with 3
finger-like protuberances and lateral seta. Ventral
bulges on following 2 somites indicate sites of P3
and P4. Two longest caudal setae coalesced at basis.



Figures 29-39. 29. Nauplius V (ventral view); 30. Antennule; 31. Antenna; 32. Mandible; 33. Copepodite I (lateral view); 34. Antennule; 35. Antenna; 36. Maxilliped; 37. P1; 38. P2; 39. Caudal ramus with coalesced setae (all scales = 0.10 mm excepting when written differently).

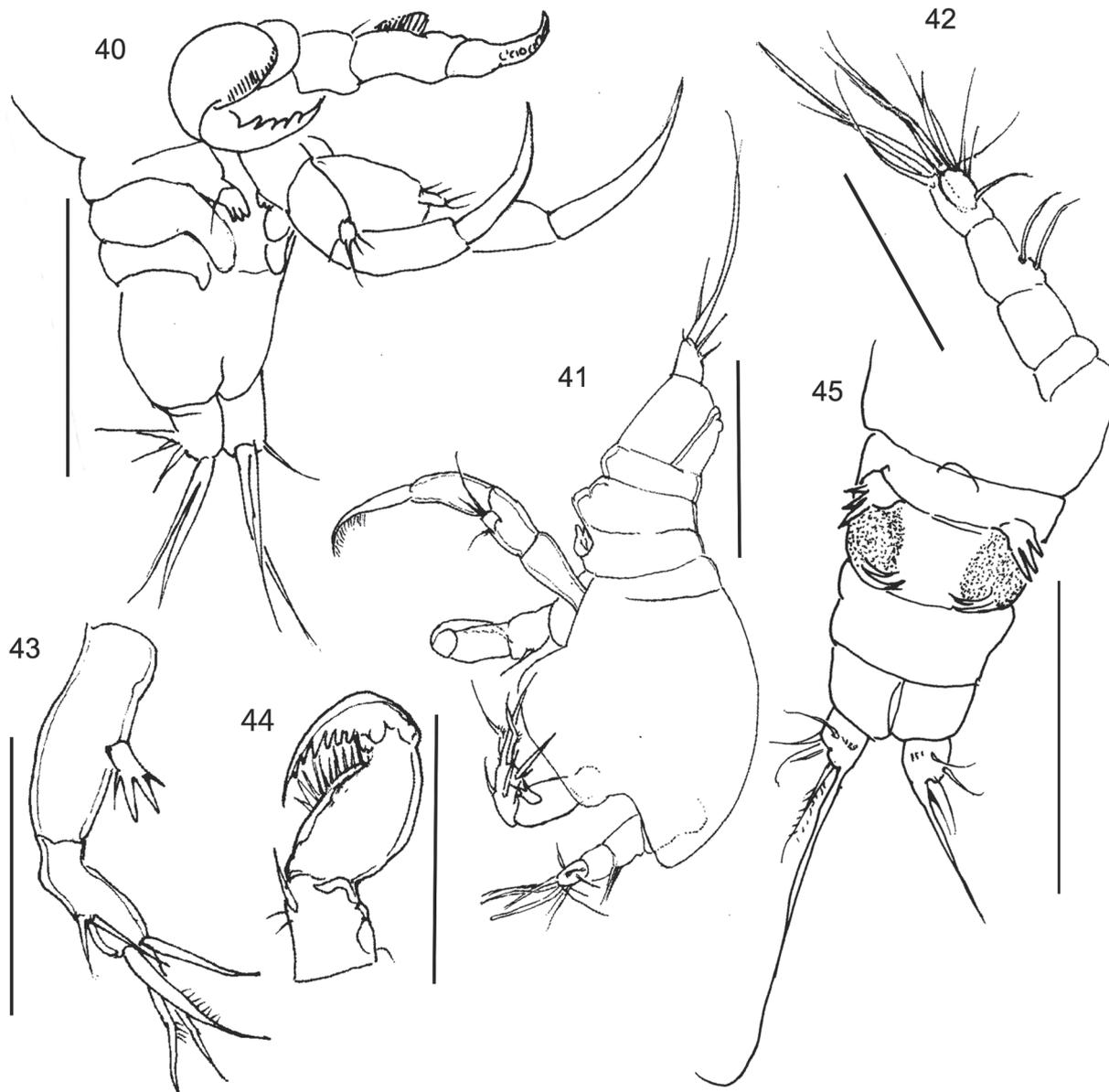
CII: 0.245 mm long (Fig. 41-45) 6-segmented. Cephalon about as long as rest of body. A1 4-segmented, aesthetask on third segment. A2 endopod setae geniculate. Mxp 3-segmented. P1 with three setae on exopod. P3 represented by 2 horizontally marginal setae on a ventral bulge. Two terminal longest caudal setae separate at the basis.

CIII: 0.260-0.270 mm long (Fig. 46-47) 7-segmented. Cephalon slightly shorter than rest of the body. A1 5 or 4-segmented, aesthetask on fourth segment. A2 with rows of spinules on coxa and basis, exopod with 3 spines. P1 4-segmented. P2 2-segmented. P3 indistinctly 2-segmented. P4

represented by strong bulge. Other structures as in CII..

CIV: 0.301-0.360 mm (Figs. 48-51) 8 or 9-segmented. A1 male with 4 large, short segments; A1 female more slender, 5-segmented. P3 3-segmented, P4 2-segmented, P5 armed with 3 small marginal setae on male. P5 female: bulge divided into wider portion with 4 finger-like protuberances plus setule, the exopod, and a smaller protuberance, the endopod, with two finger-like protuberances.

CV: male 0.300-0.330; female 0.458 mm (Fig. 52-56) 9 or 10-segmented. Dorsal region

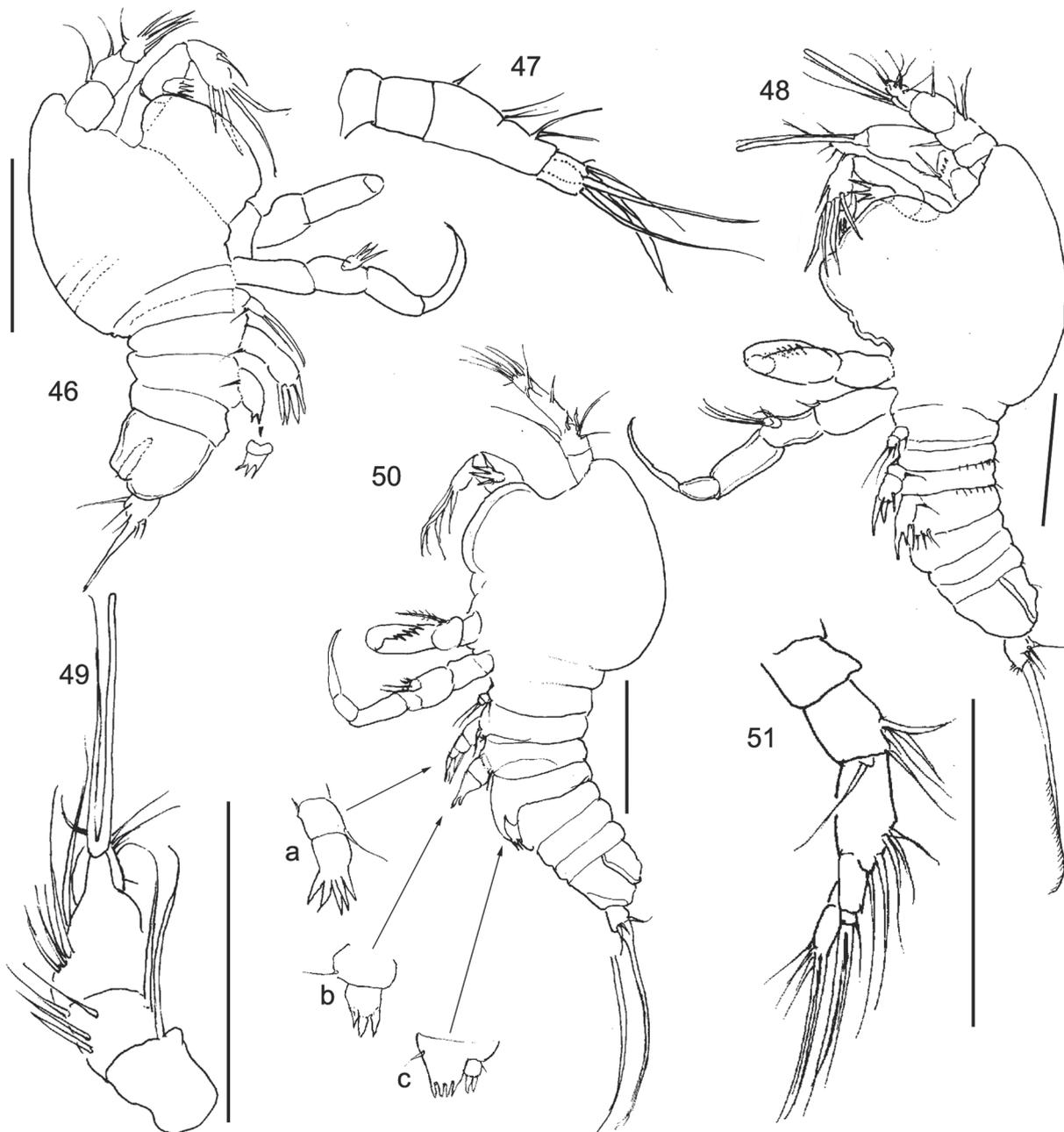


Figures 40-45. 40. Latero-ventral view of posterior copepodite I body; 41. Copepodite II (lateral view); 42. Antennule; 43. P1; 44. Maxilliped; 45. Ventral view of last four somites of copepodite II, P2 and primordium of P3, with furcal rami (all scales = 0.10 mm excepting when written differently).

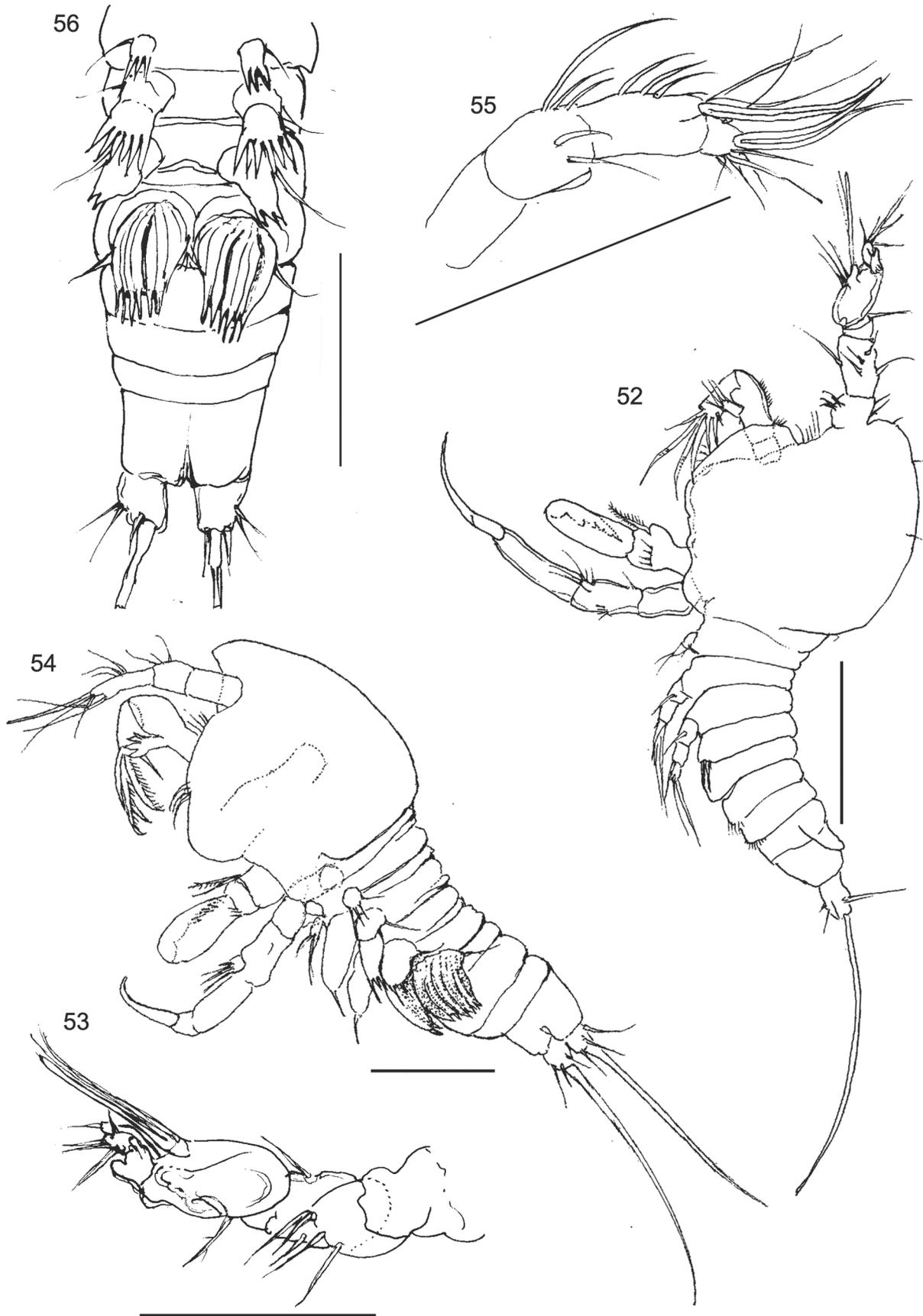
of cephalic scutum bearing some longer setules. A1 male with strong enlargement on penultimate segment and strongly indented in last segment or tapering to thin point. Female A1 similar to observed in the preceding stage. The other appendages do not suffer considerable changes except P5. Male P5 appears as 3 or 4 marginal setae. Female P5 composed by 2 foliaceous structures longitudinally furrowed and bearing finger-like protuberances: 4 on the exopod and 2 on the endopod.

Discussion

Cottarelli *et al.* (2006) described the new genus *Carcinocaris* associated with panopeid (xanthid) crabs and characterized by a maxilliped “very well developed and ornate”, P1 exopodite reduced to a short segment, P2 reduced to a small plate; P3 without endopodite and with 2-segmented exopodite in both sexes; P4 very reduced. These features are also present in the new species and *Carcinocaris* is without doubt the genus to which it belongs, but



Figures 46-51. 46. Copepodite III (lateral view); 47. Antennule; 48. Copepodite IV male, lateral; 49. Antennule; 50. Copepodite IV female, lateral: a. P3, b. P4, c. P5; 51. Female antennules (all scales = 0.10 mm excepting when written differently).



Figures 52-56. 52. Copepodite V male, lateral view; 53. Antennule; 54. Copepodite V female 1 (lateral view); 55. Antennule; 56. Ventral aspect of second pedigerous somite to furcal rami, showing P2 to P5 (all scales = 0.10 mm excepting when written differently).

the West Atlantic differs from the Philippine species. *Carcinocaris minipedia* n. sp. is very hirsute, more than described for *C. serrichelata* Cottarelli *et al.* (2006). The numerous setules guarantee the strong attachment of the parasite to its host. P2 of *C. serrichelata* has 2 setae plus the articulated one, while the new species has 3 plus the articulated one. P3 in the Atlantic species has a modified seta in both sexes, being more slender in the female. In the Philippine species only the male shows the modified seta. The male P5 is composed of a single seta in *C. serrichelata* while the Atlantic species has 2-4 setae plus the articulated one. The Philippine species has one endite less on the maxilla.

During development the copepodites I, II and III are easily recognized. The copepodites IV and V, vary in the aspect of the fifth limbs and the males differ in the aspect of the antennule.

Parasite nauplii are usually not as complex as free-living ones. Laophontidae free-living nauplii (Goswamy, 1977; Gurney, 1932; Raibaut, 1963) are therefore more hirsute and ornate than the nauplii of the new species which lives among the eggs of the host. Other differences are the shape of some setae (swollen proximally and distally thin, which are not so in free-living nauplii), the stronger row of setules on the A2 (with less setules in the free living) and the shape of the labrum (wider in the free-living nauplii).

The copepodites of the new species can be easily recognized by the highly vaulted cephalothorax or cephalosome, the strongly developed maxilliped and the minute P2. The various copepodite stages do not follow very strict rules of development (see Ferrari and Dahms, 2007): but it is easy to distinguish the young stages from the older ones. The first stage bears caudal setae V and IV coalesced at the basis. Copepodite II sometimes shows this same characteristic, but usually these setae are already separated and there are 6 on dorsal view.

A1 during development does not show a clear limit between the segments. CI and CII, both may show A1 with 3 or 4 segments. In CIII A1 shows 4 segments better delimited.

The sizes of the copepodites vary and the limits of the somites are not always easily discernible. Thus, to distinguish the female CIV from CV it is better accomplished observing P5 and A1.

Etymology: The name *minipedia* (*mini* = small; *pedia* = feet), of the new species refers to its reduced P2.

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