Parasitic Copepods from the Gulf of Mexico and Caribbean Sea, III: *Caligus*

ROGER CRESSEY

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ABSTRACT

Cressey, Roger. Parasitic Copepods from the Gulf of Mexico and Caribbean Sea, III: *Caligus*. *Smithsonian Contributions to Zoology*, number 497, 53 pages, 220 figures, 1991.—Twenty-six species of *Caligus* are described from the Gulf of Mexico and Caribbean Sea. Most of the collections were made off the west coast of Florida (Placida) and off Belize (Carrie Bow Cay). Four species *(kabatae, ocyurus, pomacentrus,* and *xystercus)* are described as new and the following 13 species are placed in synonymy: *alatus, canthidermis, germoi, kuroshio, microdontis, mirabilis, polycanthi, rectus, sarda, sciaenops, sensilis setosus,* and *tenax*. *Caligus biaculeatus* Brian is reported for the first time since its original description and is redescribed.

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Contents

Parasitic Copepods from the Gulf of Mexico and Caribbean Sea, III: *Caligus*

Roger Cressey

Introduction

This is the first of 2 papers to result in a much needed revision of the circumglobal genus *Caligus*. This effort has been facilitated by the *Catalogue and Synopsis of Caligus* by Margolis et al. (1975). Their work brought the literature up to date and will facilitate a much needed generic revision.

Most of the collections reported herein were made from the west coast of Florida and Carrie Bow Cay, Belize. Carrie Bow Cay, located 15 miles southeast of Dangriga, Belize, is a small island on the barrier reef leased to the Smithsonian Institution as a research station. During my participation, seven 2-week trips were taken from 1980 to 1989. Fish were collected by poison stations, trawl, spearfishing, rod and reel, trapping, and donations of "trash" fish from the local fishermen. Although Carrie Bow Cay is on the barrier reef, several mangrove islands lie between the reef crest and the Belize shore. The fish examined during the study were from both of these habitats.

The Florida collections were made from a substation of the Mote Marine Laboratory located in Placida, Florida, on the estuary of Charlotte Harbor. Fish were collected mostly by trawl, poison, and rod and reel.

During the study 192 species of marine fishes and over 4400 individuals were examined for parasitic copepods from both collection areas. The parasites are the basis for the present paper.

The genus can be divided into subgroups based on the character of the fourth leg. A discussion of that and other taxonomic characters follows the descriptions.

Cressey and Cressey (1980) redescribed the known species and described new species of copepods parasitic on scombrid fishes. That paper contained descriptions of 5 species of *Caligus* known from the Gulf of Mexico and Caribbean Sea. In the present paper I have included only synoptic descriptions and selected illustrations of those five species. The reader is referred to the earlier work for more complete descriptions.

I have included in the synonymies only citations of those species that have been cited in the literature since Margolis et al. (1975).

The abbreviation USNM refers to the former United States National Museum, collections now in the National Museum of Natural History, Smithsonian Institution, Washington, D.C.

ACKNOWLEDGMENTS.—I thank the staff of the Mote Marine Laboratory and in particular, 2 former directors, Eugenie Clark and Perry Gilbert, for their support during the study. The Carrie Bow Cay studies were supported in part by the Exxon Corporation, and the program is administered by Klaus Ruetzler, whose support is gratefully acknowledged. This paper is contribution number 254 of the Reef and Mangrove Study—Belize, Smithsonian Institution.

The following people contributed considerably to this effort in various ways: Marjorie Stodgell, Tony Rath, Mike Carpenter, Brian Kensley, Paula L. Rothman, and special thanks goes to Hillary Boyle Cressey, who illustrated most of the species. Thomas Byrnes donated a small collection of *Caligus* species from Jamaica that included specimens of *C. epinephali* Yamaguti, previously known only from the Indo-Pacific.

Caligus afurcatus Wilson, 1913

FIGURES 1–8

Caligus afurcatus Wilson, 1913:215.

MATERIAL EXAMINED.—Wilson (1913) described this species from the typehost *Sparisoma viride* (Bonnaterre) from Montego Bay, Jamaica. The description below is based on the type material (USNM 43518).

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FEMALE.—Total length 2.77 mm, greatest width 1.44 mm (Figure 1). Cephalothorax widest posteriorly and comprising more than half total length. Genital complex longer than wide and comprising about one-third of total length. Abdomen very small, indistinctly articulated with genital complex (length of genital complex about 5 times longer than abdomen). Caudal rami (Figure 2) small, about as long as wide and placed at outer lateral corners of abdomen and somewhat divergent, terminal setae broken on specimen.

Lunules widely spaced. Second antenna (Figure 3*a*) claw curved but not at right angle, posterior spine pointed. Postantennal process (Figure 3*b*) reduced to a sclerotized knob. Spiniform process of first maxilla (Figure 3*c*) pointed. Sternal furca (Figure 4) very small, tines somewhat divergent and longer than box.

Leg 1 (Figure 5) exopod with 4 terminal setae, medial 2 with accessory process; medial lateral setae relatively short, each bearing pinnules, endopod reduced. Leg 2 (Figure 6) first segment of exopod with prominent, inwardly directed spine at outer distal corner, extending well beyond second segment; second segment short, bearing much smaller spine at outer distal corner (spine less than half length of first segment spine); last segment bearing 2 small outer spines, outer terminal spine bearing terminal flagellum and medial pinnae; all remaining medial exopod setae pinnate; endopod outer margins of all 3 segments with short setules as indicated in figure, all terminal to medial setae pinnate. Leg 3 exopod (Figure 7) spine on outer corner of first segment extending to base of last segment, remaining segments armed as in figure; endopod 2-segmented, first segment with 1 medial seta, second segment with 2 medial setae, last segment with 6 setae. Leg 4 (Figure 8) exopod 2-segmented, first segment with terminal spine extending to about mid-margin of second segment, second segment with spine on outer margin and 3 terminal spines; terminalmost spine about twice as long as other 4 lateral spines; fringed processes at bases of 2 terminal spines.

MALE.—Unknown.

REMARKS.—This species has not been reported since Wilson's original collection. The author has examined several specimens of *S. viride* from Carrie Bow Cay, Belize, and, so far, has been unsuccessful in collecting additional material. Wilson based the species name on the observation that the sternal furca was missing. Examination of the type specimens reveals the presence of a small sternal furca. Ho and Bashirullah (1977) examined the holotype and also noted that, contrary to Wilson's description, a small sternal furca is present. Their observation is reconfirmed in this paper.

Caligus asperimanus Pearse, 1951

FIGURES 9–19

Caligus asperimanus Pearse, 1951:344.

MATERIAL EXAMINED.—Pearse described this species from the typehost *Lutjanus analis* (Cuvier) collected off Bimini (Bahamas). The description below is based on Pearse's material and subsequent collections by the author from *L. apodus* (Walbaum), *L. analis*, *L. jocu* (Bloch and Schneider), and *L. synagris* (Linnaeus) from Carrie Bow Cay, Belize.

FEMALE.—Body form as in Figure 9. Total length 4.42 mm. Cephalothorax comprising less than half total body length (1.6 mm). Genital complex widest posteriorly and about as long as wide. Abdomen about 3 times as long as wide (700 × 233 μm) (genital complex about 1.4 times longer than abdomen). Caudal rami (Figure 10) somewhat longer than wide (116 × 70 μm) and armed with setae as in figure.

Lunules about as wide as space between lunules. Second antenna (Figure 11*a*) with prominently recurved distal hook, posterior spine spatulate. Postantennal spine (Figure 11*b*) recurved at or nearly at right angle. Spiniform process of first maxilla (Figure 11*c*) with pointed tip. Sternal furca (Figure 12) tines widely divergent and about same length as box.

Leg 1 (Figure 13) basipod with a patch of spinules as in the figure; last segment of exopod with 3 terminal spines (medialmost 2 with accessory spine on medial margin), terminal seta at medial corner pinnate on outer margin, 3 setae on medial margin, each bearing row of setules at base of outer margin, followed by pinnules and sparsely pinnate on medial margin, as in figure. Leg 2 (Figure 14) exopod first segment with stout spine at outer distal corner, outer margin with narrow hyaline, fringed membrane; second segment with stout spine at outer distal corner, about three-fourths as long as spine on first segment, both margins fringed; last segment with small outer spine on outer margin followed by longer stout spine with membrane on inner margin and terminal semipinnate seta with membrane on outer margin; all other medial setae on exopod segments pinnate. Endopod first segment with sparse patch of setules at outer distal corner; second segment with 2–3 rows of blunt-tipped spines on outer margin; last segment with small patch of setules at outer proximal corner. Leg 3 basipod with scattered spinules on outer surface; exopod (Figure 15) first segment with spine across second segment not reaching last segment, spine with fine membrane along outer margin and slightly recurved; second segment with weak outer spine and medial pinnate seta; last segment with 3 weak outer spines and 4 pinnate setae; exopod setal formula 0,1,4. Endopod setal formula 1,6. Leg 4 (Figure 16) exopod 2-segmented; first segment with outer spine reaching beyond base of first spine of last segment, last segment with spine at outer mid-margin and 3 terminal spines, medialmost spine about one-third longer than other 4 (it should be noted that spine on first segment is somewhat longer than following 3 spines of last segment); all spines with pecten.

MALE.—Body form as in Figure 17. Total length 2.33 mm, greatest width 1.16 mm. Genital complex somewhat longer than wide (0.35 × 0.30 mm). First abdominal segment shorter than second segment (0.19 × 0.16 mm and 0.21 × 0.16 mm, respectively). Caudal rami somewhat longer than wide (0.10

× 0.08 mm). Second antenna (Figure 18) claw bifid. Other appendages as in female except middle segment of endopod of leg 2 with thick setules (Figure 19) rather than stout recurved spines present in corresponding segment of female.

REMARKS.—This species appears to be host-specific to species of *Lutjanus* and is so far known only from the western Atlantic.

Caligus atromaculatus Wilson, 1913

FIGURES 20–29

Caligus atromaculatus Wilson, 1913:214.—Cressey and Nutter, 1987:600.

MATERIAL EXAMINED.—Wilson (1913) described this species from *Teuthis (Acanthurus) hepatus* (Bloch and Schneider) from Montego Bay, Jamaica (holotype USNM 42348). Additional material was collected by the author from the following hosts at Carrie Bow Cay, Belize: *Acanthurus bahianus* Castelnau (4 collections), *A. chirurgus* (Bloch) (2 collections), *A. coeruleus* Schneider (9 collections), *Anisotremus virginicus* (Linnaeus) (1 collection), *Aulostromus maculatus* Valenciennes, *Bodianus rufus* (Linnaeus) (2 collections), *Calamus pennatula* Geuchenot (1 collection), *Chaetodon striatus* Linnaeus (2 collections), *C. capistratus* Linnaeus, *Haemulon sciurus* (Shaw) (1 collection), *Halichoeres radiatus* (Linnaeus) (6 collections), *Holacanthus ciliaris* (1 collection), *Lachnolaimus maximus* (3 collections), *Malacanthus plumieri* (Bloch) (1 collection), *Odontoscion dentex* (Cuvier), *Pomacanthus arcuatus* (Linnaeus), *Sparisoma chrysopterum* (Bloch and Schneider) (1 collection). Additional material is present in the Smithsonian collections from the following hosts and localities: Haiti: *Chaetodon capistratus;* North Carolina: *Chaetodon ocellatus* Bloch; Barbados and St. Thomas: *Chaetodon striatus;* Jamaica: *Sparisoma viride.*

FEMALE.—Body form as in Figure 20. Total length of type specimen 1.98 mm. Cephalothorax somewhat triangular, widest posteriorly and comprising about half total body length. Lunules not as wide as space between. Genital complex also widest posteriorly and about as wide as long. Abdomen (Figure 21) very small, about as wide as long (length of genital complex approximately 5.5 times longer than abdomen). Caudal rami small, about as wide as long and usually somewhat divergent at outer corners of abdomen; each ramus bearing 3 terminal setae of about equal length, 2 shorter outer setae and 1 short medial seta (see Figure 21). Second antenna (Figure 22*a*) claw bent nearly at right angle at outer third, posterior process pointed. Postantennal spine (Figure 22*b*) digitiform and somewhat recurved. Spiniform process of first maxilla (Figure 22*c*) long, digitiform. Sternal furca (Figure 23) tines somewhat divergent and spatulate, tines somewhat longer than box.

Leg 1 (Figure 24) basipod with a patch of spinules; exopod last segment with 4 terminal naked setae, medial 2 each with an accessory spine extending to tip of seta; 3 medial pinnate setae; outermost pinnate seta only about two-thirds length of other 2; proximal outer edge pinnules thicker at base; outer distal edge of all 3 setae with much shorter pinnules than others on setae. Leg 2 (Figure 25) exopod first segment with prominent, inwardly directed spine on outer corner, outer edge of spine with fine fringe; second segment with inwardly directed spine on outer distal corner but spine only about one-half length of spine on first segment, spine fringed as in figure; last segment with 3 outer spines and 5 pinnate setae as in figure; endopod first segment without ornamentation on outer distal corner, second segment with setules along outer edge; last segment with patch of setules at base of outermost seta; pinnate setae on all segments as in figure. Leg 3 exopod (Figure 26) with spine on first segment, outer edge of spine with hyaline fringed membrane; other spines and setae as in figure. Leg 4 (Figure 27) exopod 2-segmented; first segment with terminal seta extending beyond base of spine at mid-margin; last segment with seta near mid-margin of outer edge and 3 terminal setae (outermost very short and difficult to see behind pecten).

MALE.—Body form as in Figure 28. Total length 1.30 mm, greatest width 0.80 mm. Genital complex somewhat longer than wide (0.21 × 0.19 mm). Abdominal segments measure 0.04 × 0.21 and 0.08 × 0.21 mm respectively. Caudal rami somewhat longer than wide (0.07 × 0.05 mm). Second antenna terminal claw not bifurcate. Other appendages as in female.

REMARKS.—Wilson (1913) described this species from the "doctorfish," *Teuthis hepatus,* from Jamaica. This paper records this species from 16 different host fish from Belize. Although it appears that there is little host specificity for the parasite, 15 records were from 3 species of acanthurid fishes (like Wilson's record). The remaining records were scattered among 13 diverse species of hosts. From most hosts there are only 1 or 2 records with the interesting exception of 6 records from *Halichoeres.* It would be premature in this paper to speculate on the host-parasite relationships but an analysis of *Caligus* host specificity is anticipated when more collections are completed.

Caligus balistae Steenstrup and Lütken, 1861

FIGURES 30–37

Caligus balistae Steenstrup and Lütken, 1861:354s.—Cressey and Nutter, 1987:600.
Caligus alatus Heegaard, 1943:14 [new synonymy].
Caligus polycanthi Gnanamuthu, 1950:159 [new synonymy].
Caligus canthidermis Yamaguti and Yamasu, 1959:112 [new synonymy].
Caligus sensilis Kabata amd Guzev, 1966:156 [new synonymy].

MATERIAL EXAMINED.—This species was originally described from specimens collected from *Balistes* in the West Indies. Two additional specimens were found by the author in a collection in the Smithsonian (USNM 69885) identified by Wilson as *C. atromaculatus* from *Monacanthus hispidus* (Linnaeus) from the Sargasso Sea. Additional material included

herein was collected by the author from hosts housed in the fish collections of the Smithsonian Institution as follows: 7 females, 4 immature females from *Aluterus scriptus* (Osbeck); 1 female from *Canthidermis sobaco* Poey; 2 females from *C. maculatus* (Bloch), and 1 female from *Coryphaena hippurus* Linnaeus. All collections were from the northeast coast of South America and southern United States. These new collections are incorporated into the collections of the Smithsonian Institution.

FEMALE.—Body form as in Figure 30. Cephalothorax comprising about half of total body length. Lunules widely spaced; distance between lunules about three times lunule diameter. Genital complex about as wide as long, posterolateral corners somewhat produced posteriorly. Abdomen small, pedunculate, 1-segmented, about as wide as long (genital complex about 3.2 times longer than abdomen). Caudal rami (Figure 31) truncate, greatest width about equal to total length. Second antenna (Figure 32*a*) robust; terminal claw acutely recurved at distal third; posterior process pointed. Postantennal spine (Figure 32*b*) stout; sickle-shaped; spiniform process of first maxilla (Figure 32*c*) pointed, heavily sclerotized, and broad. Sternal furca (Figure 33) tines divergent; tips somewhat rounded, tines shorter than box.

Leg 1 (Figure 34) exopod last segment with 1 short spine on outer corner, 3 terminal spines, medialmost longest and each without accessory processes, and 3 pinnate medial setae; very fine pinnules along outer edge, and medial edge with stouter and more widely spaced pinnules. Endopod small, membranous. Leg 2 (Figure 35) exopod first segment spine toothed along medial margin; second segment spine with 1 medial tooth and about half as long as first spine; last segment with 2 outer spines, terminal semipinnate seta, and 5 pinnate setae; endopod segments each with setules on outer margin as indicated in figure; all setae on both rami pinnate. Leg 3 exopod (Figure 36) first segment with stout recurved spine on outer corner; second segment with medial seta and weak spine at outer distal corner, last segment with 4 medial setae and 3 weak outer spines. Leg 4 (Figure 37) with 2-segmented exopod; first segment with terminal spine nearly reaching to end of second segment; second segment without spine on outer mid-margin and bearing 3 terminal spines, outer 2 about equal in length, and medialmost longest, pecten at bases of spines.

MALE.—No males found in collections reported herein. Heegaard (1943) reported immature male and figured second antenna. Based on known differences between second antennae of *Caligus* females and males, his illustration appears more like typical female than usually modified male second antenna.

REMARKS.—So far, this species has been collected only from monocanthid fishes and it seems to be circumglobal in distribution. In 1950 Gnanamuthu described this species as *polycanthi*, which Ho (1966) placed in synonymy with *C. canthidermis* described by Yamaguti and Yamasu (1959). I consider both of these species and Heegaard's (1943) *C. alatus* to be synonymous with *C. balistae*.

Caligus berychis Wilson, 1936

FIGURES 46–55

Caligus berychis Wilson, 1936:107.

MATERIAL EXAMINED.—Wilson (1936) described this species from a single collection containing both females and males. The females and holotype male were deposited at Harvard University (MCZ) and paratypes at the Smithsonian Institution (USNM 69836). The description of the female herein is based on the USNM material. The host (*Beryx decadactylus* Cuvier and Valenciennes) is a relatively deep-water form and, as such, is unusual as a host for *Caligus* species, more commonly found on inshore, shallow-water fishes. An additional collection made by the author consists of 4 females (USNM 180660) collected from *Strongylura notata* (Poey) off Sarasota, Florida.

FEMALE.—Body form as in Figure 46. Total length 6.6 mm, greatest width 2.6 mm, measured at widest part of cephalothorax. Genital complex about twice as long as wide (2.4 × 1.4 mm), produced at posterior corners. Abdomen somewhat longer than wide (1.0 × 0.8 mm). Caudal rami (Figure 47) short, about as long as wide, armed as in figure (length of genital complex approximately 2.6 times longer than abdomen).

Lunules widely spaced, interspace more than twice lunule diameter. Second antenna (Figure 48*a*) claw bent at nearly right angle at tip and bearing a short, somewhat pointed process at inner posterior corner. Postantennal process (Figure 48*b*) digitiform, slightly recurved; spiniform processs of first maxilla (Figure 48*c*) also long-digitiform. Sternal furca (Figure 49) box longer than tines, latter divergent with rounded tips.

Leg 1 (Figure 50) exopod last segment bearing 3 terminal claw-like spines, each with an accessory process, a seta, pinnate on outer edge at medial corner, and 3 medial pinnate setae, all about equal in length. Leg 2 (Figure 51) exopod first 2 segments each bearing an inwardly directed spine on outer distal corner; second segment spine nearly as long as first, each spine with fringed membrane along outer edge; last segment with 2 outer spines and terminal semi-innate seta; pinnate setae on medial exopod margin as in figure. Endopod first segment bearing patches of setules along outer margin and row of longer spines at outer corner; second segment with fine setules along outer margin; last segment bearing U-shaped row of spines on outer margin and pinnate setae as in figure. Leg 3 exopod (Figure 52) with stout distal spine on first segment reaching to third segment; second segment with weak spine at outer distal corner; last segment with 3 weak spines along distal outer margin and 4 pinnate setae. Leg 4 (Figure 53) exopod 2-segmented; first segment bearing a spine at distal corner; second segment with spine at mid-margin and 3 terminal spines (medialmost somewhat longer than others), all spines fringed along outer margin and those on last segment with prominent pecten at base of each.

MALE.—Body form as in Figure 54 and as in female except genital complex not produced at posterior corners. Second antenna as in Figure 55; terminal hook recurved about 180°. Other appendages as in female.

Caligus biaculeatus Brian, 1914

FIGURES 56-64

Caligus biaculeatus Brian, 1914:2.

MATERIAL EXAMINED.—This species has not been reported since Brian's original description. The specimens on which Brian based his description (holotype from the Musée Océanographique in Monaco) were recovered from a trawl sample that contained specimens of *Macrurus* and *Bathygadus*. The collections were apparently made near the Madeira Islands. The recent collections4 6from Caribbean shallow-water fishes suggests that the deep-water fishes present in the trawl from which the original collection was made are probably not the true hosts and it is more likely that fishes of the shallow water around the Madeira Islands were. The collections reported herein were recovered from off Belize from the following: *Aulostomus maculatus* (6 collections), *Sparisoma viride* (4 collections), *Halichoeres bivittatus* (Bloch) (2 collections), *Acanthurus bahianus* (3 collections), *Acanthurus coeruleus, Acanthurus chirugus, Haemulon sciurus* (Shaw), *Malacanthus plumieri* (1 collection each). The holotype was borrowed from the Musée Océanographique, Monaco, and compared with the material cited above.

FEMALE.—Body form as in Figure 56. Total length 3.5 mm, greatest width 1.4 mm. Cephalothorax widest posteriorly and comprising less than half of total length (~40%). Genital complex about twice as long as wide (1.8 × 0.8 mm) and comprising about half total length. Abdomen very small, somewhat longer than wide (0.37 × 0.28 mm), articulation with genital complex not well defined (genital complex about 8 times longer than abdomen). Caudal rami (Figure 57) very small (0.9 × 0.7 mm), somewhat longer than wide and with usual 6 setae as in figure. Holotype smaller (2.3 mm long) and genital complex proportionaly shorter than new material described above.

Lunules not widely spaced. Second antenna (Figure 58*a*) terminal claw at right angle; small accessory process near base of claw; posterior process pointed. Postantennal spine (Figure 58*b*) digitiform, not sharply curved. Spiniform process of first maxilla (Figure 58*c*) with rounded tip. Sternal furca (Figure 59) tines somewhat longer than box, widest near tip, recurved distally.

Leg 1 (Figure 60) last segment with 4 terminal spines, middle 2 each with accessory process, medial setae each with an outer row of thickened setules on outer third followed by short, fine setules on remaining outer edge; medial margin with more sparsely spaced setules as indicated in the figure. Leg 2 (Figure 61) exopod first segment with spine bearing membrane along outer margin on outer corner extending across second segment and second segment with spine at outer distal corner about half length of first segment spine and with fringe along outer margin; last segment with small spine on outer margin followed by a longer digitiform spine; tip of segment with longer semipinnate seta with outer membrane and medial pinnae; all segments with usual medial pinnate setae; all 3 endopod segments with setules on outer margin as in figure and usual terminal to medial setae. Leg 3 (Figure 62) exopod first segment with recurved terminal spine not reaching second segment; second segment with naked seta on outer distal corner; last segment with 3 outer naked setae and inner pinnate setae. Leg 4 (Figure 63) exopod 2-segmented, first segment with terminal seta reaching base of next seta; last segment with 1 lateral and 3 terminal setae (outermost terminal seta very small, covered by pecten; see arrow Figure 64), terminal seta about twice length of subterminal seta.

MALE.—Unknown.

REMARKS.—Although this species was collected from 8 different hosts it was most common on the trumpetfish *(Aulostomus maculatus)*, wrasse *(Halichoeres bivittatus)*, and parrotfish *(Sparisoma viride)*. Its presence on 7 different hosts, however, indicates that it is not very host specific. This evidence may support my previous comments about Brian's (1914) original collection. If this species is not very host-specific, it may spend a good part of its life in the plankton, moving from host to host and thus might be captured in a trawl tow.

Caligus bonito Wilson, 1905

FIGURES 65-68

Caligus bonito Wilson, 1905:479.—Cressey and Cressey, 1980:26.—Pillai, 1985:252.—Cressey and Nutter, 1987:600.

Caligus sarda Pearse, 1952:45 [new synonymy].

Caligus productus.—Causey, 1953:6 [ex. *C. hippurus*]; 1955:5 [ex. *C. hippurus*].

Caligus kuroshio Shiino, 1959:51 [new synonymy].

MATERIAL EXAMINED.—This species has been reported many times from a variety of hosts (see Margolis et al., 1975 for a comprehensive account). It was more recently redescribed by Cressey and Cressey (1980). A few additional details are added here.

FEMALE.—The total length varies from 5 to 8 mm depending on geographic area (larger in colder water). The lunules are prominent but the diameter is not quite as great as distance between them. Diagnostic characters are as follows. Second antenna bears a strongly recurved claw and posterior spatulate process. Three main body divisions are of about equal length (Figure 65). Furca tines (Figure 66) nearly parallel and blunt tipped and box slightly longer or equal to length of tines. Each medial lateral seta of first leg (Figure 67) bears row of stout spines on basal outer margin of first 2 setae; outermost seta

with fewest. Mid-endopod segment of second leg bears double row of stout, bent spines. Ventral surface of abdomen bears small patch of spinules on each posterior corner and patch between (sometimes divided as 2) more anterior to corner patches. Leg 4 as in Figure 68. See Cressey and Cressey, 1980, for a more complete description.

MALE.—See Cressey and Cressey, 1980.

Caligus chelifer Wilson, 1905

FIGURES 69–76

Caligus chelifer Wilson, 1905:479.—Cressey and Nutter, 1987:601.

MATERIAL EXAMINED.—Wilson (1905) described this species from menhaden, swordfish, and *Trichiurus lepturus* from off the coast of Massachusetts. Kabata (1972) provided a good redescription of the species based on specimens from Miami, Florida. The present author reported its occurrence off the coast of Texas in a paper re-identifying copepods collected and reported by David Causey. Causey's material was from *Brevoortia tyrannus* (Latrobe) at Port Aransas, Texas. The present author has not collected this species from the west coast of Florida or from off Belize. The illustrations are from Wilson's type material.

FEMALE.—Body form as in Figure 69. Total length of holotype 4.93 mm, greatest width 2.0 mm (measured at widest part of cephalothorax). Cephalothorax widest posteriorly with its length nearly half entire length of specimen. Genital complex longer than wide, and widest posteriorly. Abdomen (Figure 70) appears 2-segmented from dorsal aspect but segmentation less apparent from ventral aspect (length of genital complex approximately same as abdomen). Caudal rami (Figure 70) about 2.5 times longer than wide.

Diameter of lunules slightly less than distance between them. Second antenna (Figure 71*a*) terminal claw bent nearly at right angle in distal third; posterior process as in figure. Postantennal spine (Figure 71*b*) digitiform with rounded tip. Spiniform process of first maxilla (Figure 71*c*) with rounded tip. Sternal furca (Figure 72) box longer than tines, latter only slightly divergent.

Leg 1 (Figure 73) first segment with small, finely serrate spine at outer distal corner and row of short setules on distal half of medial margin; last segment with 4 terminal spines, medial 2 each with accessory process; medial lateral setae short and finely pinnate. Leg 2 (Figure 74) exopod first segment with large spine with serrated margins extending across segment; second segment with similiar, but somewhat shorter spine extending across segment; last segment with outer curved spine, serrate along outer edge, a broad, short, distal spine with long spinules on medial margin, and a long terminal spine serrate along outer margin as in figure; medial setae on all segments typical of genus; all 3 segments of endopod with patches of setules along outer margin; medial setae as in genus. Leg 3 exopod (Figure 75) first segment with nearly straight, posteriorly directed sclerotized spine not extending to last segment; second segment with naked, weak seta at outer distal corner, last segment with 3 weak outer naked setae and 4 terminal pinnate setae. Leg 4 (Figure 76) exopod 2-segmented; first segment with an outer spine extending well beyond base of next spine; second segment with medial spine extending beyond tip of segment; last segment with 3 spines, outer 2 nearly equal in length and medial spine about one-third longer than other 2; all spines with fine spinules along outer margin.

MALE.—See Kabata (1972).

REMARKS.—This species has been reported from a variety of hosts. It seems to be most common on clupeids. Except for a doubtful record by Brian (1924) from Mauritania, this species is known only from a few collections from the western Atlantic, in spite of the ubiquitous nature of clupeid fishes.

Caligus chorinemi Krøyer, 1863

FIGURES 198–205

Caligus chorinemi Krøyer, 1863:141.
Caligus tenax Heller, 1865:172.—Pillai, 1985:356 [new synonymy].
Caligus germoi Pearse, 1951:347 [new synonymy].
Caligus rectus Pearse, 1952:15 [new synonymy].

MATERIAL EXAMINED.—Holotype, female, borrowed from the Zoological Museum, University of Copenhagen. Heller (1865) described *Caligus tenax* from *Caranx carangus?* (= *Caranx hippos* (Linnaeus)) from Brazil. Pearse (1952) described *Caligus rectus*, holotype, from the gills of *Caranx hippos* from Port Aransas, Texas (USNM 92665). Additional collections made by the author from *Caranx hippos* from the west coast of Florida (Sarasota and Placida), and from *Carangoides crysos* and *Carangoides bartholomaei* (Cuvier) from Belize.

FEMALE.—Body form as in Figure 198. Total length 5.1 mm; greatest width 2.3 mm. Cephalothorax somewhat wider than long (2.3 × 2.2 mm). Lunules widely spaced. Genital complex longer than wide (1.6 × 1.2 mm). Abdomen nearly 3 times longer than wide (1.1 × 0.4 mm) (genital complex about 1.2 times longer than abdomen). Caudal rami (Figure 199) very small and slightly longer than wide (0.7 × 0.9 mm).

First antenna typical of genus except that last segment is noticeably longer (367 μm) than first segment (posterior margin 188 μm). This seems to be characteristic of other species of *Caligus* found on carangid and related hosts (i.e., *C. isonyx*). Second antenna (Figure 200*a*) last segment (claw) much longer than base and recurved sharply at tip; posterior process reduced to a rounded projection. Post antennal process (Figure 200*b*) recurved slightly at tip and somewhat blunt tipped. Spiniform process of first maxilla (Figure 200*c*) bifid. Sternal furca (Figure 201) with broad base and widely divergent tines; slightly recurved and round tipped.

Leg 1 (Figure 202) coxopod with patch of spinules in addition to usual setae; endopod more prominent than usual

in genus, about 4 times longer than wide; exopod first segment long and bearing row of stout spinules on medial margin; last segment with very small spine-like process on outer distal corner, well-developed sclerotized spine at outer corner, 2 sclerotized terminal spines each bearing accessory process and short spinules on inner margin, naked seta at medial distal corner; medial margin bearing 3 short, sparsely pinnate setae on medial margin. Leg 2 as in *C. isonyx*. Leg 3 (Figure 203) basipod bearing row of sclerotized spines near outer border, a patch of 12 to 15 more heavily sclerotized spines (the numbers of spines in this patch varies from specimen to specimen), and conspicuous internal sclerotized rod, terminating in bifid tip; exopod first segment with heavily sclerotized, recurved spine extending over second segment and reaching third segment; setae on rami as in figure and typical for genus. Leg 4 as in *C. isonyx*.

MALE.—As in Figure 204. Total length 2.9 mm. Cephalothorax about as wide as long (1.7 mm). Genital complex somewhat longer than wide (0.7 × 0.6 mm). Abdomen not as long as wide (0.3 × 0.4 mm). Caudal rami very small and slightly wider than long (0.09 × 0.1 mm). Second antenna (Figure 205) terminal claw short and sharply recurved and bearing 2 naked setae, adhesion pads as indicated in figure.

REMARKS.—So far, the author has found this species only on carangid fishes from the western Atlantic. Based on my examinations of collections of *Caligus* from the Indian and Pacific Ocean carangids, records of *C. tenax* from those areas are actually of a different, but closely related, species of *Caligus*. These collections will be treated in a later work. *Caligus chorinemi* is very closely related to *C. isonyx* and other *Caligus* species from Indo-Pacific carangids. It differs from *C. isonyx* in the nature of the female fourth leg. In *C. chorinemi* the terminalmost seta of the fourth leg is more than twice as long as the 2 other terminal setae (outermost very short). In *C. isonyx* the 3 terminal setae are nearly equal in length (the terminalmost somewhat longer). Also, the spiniform process of the first maxilla of *C. chorinemi* bears an accessory process whereas that of *C. isonyx* does not.

Caligus coryphaenae Steenstrup and Lütken, 1861

FIGURES 77–81

Caligus coryphaenae Steenstrup and Lütken, 1861.—Cressey and Cressey, 1980:22.—Pillai, 1985:274.

This species was recently redescribed by Cressey and Cressey (1980) and the reader is referred to that paper for a more complete description. I have included a few illustrations to facilitate identification of specimens. The species is apparently circumtropical in distribution and occurs primarily on species of *Thunnus, Euthynnus, Auxis,* and *Katsuwonus*.

This species differs from most species of *Caligus* by lacking a postantennal spine and by the presence of accessory sclerotized processes near the base of the sternal furca. We suggested in the earlier account that this species and *C. regalis* may not belong in the genus *Caligus*, but a decision as to the proper assignment for these species will be deferred until an overall reevaluation of the genus *Caligus* is completed.

Caligus epinephali Yamaguti, 1936

FIGURES 214–220

Caligus epinephali Yamaguti, 1936:18.

MATERIAL EXAMINED.—Five females from the "queenfish," collected from Jamaica by Dr. Thomas Byrnes.

FEMALE.—Body form as in Figure 214. Total length 4.2 mm; greatest width 1.7 mm (measured at widest part of cephalothorax). Genital complex longer than wide (1.25 × 1.16 mm). Abdomen 2-segmented; 0.8 mm long and 0.4 mm wide, last segment somewhat shorter than first segment (length of genital complex about the same as abdomen). Caudal rami longer than wide (0.14 × 0.09 mm).

Lunules not widely spaced, distance between lunules about equal to diameter of lunule. Second antenna (Figure 215*a*) claw recurved slightly at tip; posterior process long, about 3 times as long as width at base, tip not sharply pointed. Postantennal spine recurved, sickle-shaped (Figure 215*b*); first maxilla bearing 3 setae, outermost stout and very prominent, spiniform process of first maxilla digitiform (Figure 215*c*). Sternal furca (Figure 216) tines divergent with rounded tips and longer than box.

Leg 1 (Figure 217) coxopod with patch of spinules as in figure; endopod more prominent than in most other species of genus; first exopod segment with prominent row of spinules on posterior edge; last segment with 4 terminal setae, outermost 3 (usually 2) each with accessory process, medialmost pinnate on outer margin; medial margin without usual 3 setae. Leg 2 (Figure 218) exopod first 2 segments each with fringed spine at outer distal corner; spine on first segment somewhat longer than spine on second segment; last segment with small, naked seta near outer distal corner, blunt-tipped spine bearing membrane on inner and outer margins, longer terminal semipinnate seta with hyaline membrane on outer margin and usual 5 pinnate setae on inner margin; endopod first segment with row of setules at outer distal corner, second segment with patch of setules on outer margin, last segment without setules. Leg 3 (Figure 219) basipod (apron) with outer and medial patch of spinules as in figure; exopod first segment with recurved spine reaching to last segment, other spines and setae as in figure. Leg 4 (Figure 220) exopod 2-segmented; spine on first segment reaching beyond base of spine at mid-margin of last segment; last segment with 4 spines, each with pecten at base (none on first segment spine); outer medial spine on last segment shorter than other spines, which are about equal in length.

MALE.—Shiino (1952) described the male from *Sparus macrocephalus* from Japan. No males were present in the Gulf and Caribbean collections.

REMARKS.—This species was originally described from *Epinephalus septemfasciatus* (Thunberg) and *E. akaara* (Temminck and Schlegel). Since then, it has been reported from non-serranid hosts (*Sparus, Chorinemus, Drepane,* and "queenfish"). The material reported herein extends the known range from the Indo-Pacific to the western Atlantic.

Caligus haemulonis Krøyer, 1863

FIGURES 82–91

Caligus haemulonis Krøyer, 1863:122.—Cressey and Nutter, 1987:600.
Caligus sciaenops Pearse, 1952:18 [new synonymy].
Caligus setosus Pearse, 1953:201 [new synonymy].

MATERIAL EXAMINED.—Krøyer (1863) described this species from *Haemulon elegans* (= *H. sciurus)* from the Danish West Indies. Additional material has been collected by the author from various hosts from off the west coast of Florida (Charlotte Harbor) and from Carrie Bow Cay, Belize, as follows: Florida: *Chaetodipterus faber* (Broussonet) (11 collections), *Arius felis* (Linnaeus) (6 collections), *Archosargus probatocephalus* (Walbaum), *Bairdiella chrysura* (Lacépède) (2 collections each), *Menticirrus americanus* (Linnaeus), and *Aleuterus schoepfi* (Walbaum) (1 collection each). Belize: *Haemulon sciurus* (7 collections), *H. carbonarium* Poey (2 collections), *H. plumieri, H. macrostomum* Günther (1 collection each), and *Anisotremus virginicus* (3 collections).

FEMALE.—Body form as in Figure 82. Total length 3.56 mm (average of 3 specimens from the west coast of Florida). Cephalothorax widest near mid-region and about as wide as long. Cephalothorax and thoracic somites comprise about one-half of total length. Genital complex widest posteriorly. Abdomen (Figure 82) about 2.5 times longer than wide and comprising about one-fifth of total body length (length of genital complex about 1.5 times longer than abdomen). Caudal rami (Figure 83) small, somewhat longer than wide; terminal setae nearly equal in length (medialmost slightly longer).

Lunules not widely spaced; distance between lunules about equal to diameter of lunule. Frontal margin between lunules usually indented. Second antenna (Figure 84*a*) claw curved at right angle at mid-length; posterior process spatulate; posterior portion only lightly sclerotized. Postantennal process (Figure 84*b*) prominent and bent at right angle near mid-margin. Spiniform process of first maxilla (Figure 84*c*) tip not pointed. Sternal furca (Figure 85) tines pointed, somewhat divergent, and about as long as box.

Leg 1 (Figure 86) coxopod with patch of spinules; exopod last segment with 4 weakly sclerotized terminal spines, middle 2 each with accessory process; medial margin without usual 3 setae. Leg 2 (Figure 87) exopod first 2 segments each with a heavily sclerotized spine at outer distal corner; each spine with fringe along outer border (first spine slightly longer than second); last segment with 3 terminal spines, 1 small naked spine, 1 with outer membrane and 1 semipinnate seta, exopod bearing 5 setae along medial margin; endopod first segment with a small patch of spinules at outer distal corner and an medial seta; second segment bearing patch of heavy spinules on outer margin and 2 medial setae, last segment with 6 setae. Leg 3 exopod (Figure 88) spine on first segment extending across second segment to base of third; second segment with outer weak spine and medial pinnate seta; last segment with 3 weak outer spines and 4 medial, short pinnate setae. Leg 4 exopod (Figure 89) 2-segmented; spine at outer corner of first segment fringed, extending beyond base of mid-seta of last segment; mid-seta on last segment fringed; 3 terminal spines not fringed, terminalmost somewhat longer than others; all spines with pecten at base.

MALE.—Body form as in Figure 90, total length 1.86 mm, greatest width 1.0 mm (at widest part of cephalothorax) cephalothorax about half body length. Second antenna (Figure 91) with short, bifid claw and adhesion pads. Maxilliped with pointed process on corpus in opposition to tip of claw. Other appendages as in female.

REMARKS.—This species is easily separated from all other *Caligus* from the western Atlantic except *C. productus* by the absence of the usual 3 lateral medial setae on the last exopod segment of the first leg. It can be easily separated from *C. productus* by the prominent sickle-shaped postantennal process and second antennal claw of *C. haemulonis.* Both of these are only slightly bent at their tips in *C. productus.* Also, in *C. productus* the tines of the sternal furca are much longer than the box whereas those of *C. haemulonis* are about equal.

This species has so far been reported from only the western Atlantic. Wilson, 1905; Bere, 1936; Causey, 1953a, b, 1955, 1960; and I, herein, have reported this species from the several different, non-haemulonid hosts from the Gulf of Mexico. It is curious, however, that although I have examined fishes of many different families from off Belize, much further south in the Caribbean, I have collected this species from only 6 species of haemulonids. This suggests that haemulonids are preferred hosts when present, but a variety of non-haemulonids can be utilized in the absence of the preferred species.

Caligus isonyx Steenstrup and Lütken, 1861

FIGURES 92–101

Caligus isonyx Steenstrup and Lütken, 1861:354. [Not sensu T. Scott, 1891.]

MATERIAL EXAMINED.—This species was described by Steenstrup and Lütken (1861) from specimens collected from *Sphyraena barracuda* (Walbaum) from the "West Indies." The following redescription is based on specimens recently collected from the same host from Carrie Bow Cay, Belize.

FEMALE.—Body form as in Figure 92. Total length 5.4 mm, greatest width 2.3 mm. Cephalothorax comprising about

one-third total body length. Free fourth pedigerous somite and genital complex about as long as cephalothorax (1.6 mm long × 1.5 mm wide). Abdomen (Figure 92) constricted in posterior third (genital complex about 1.7 times longer than abdomen). Caudal rami (Figure 93) small, somewhat longer than wide (0.13 × 0.10 mm).

Lunules widely spaced. Second antenna claw bent at right angle forming smooth arc (Figure 94); posterior process spatulate, short. Postantennal process somewhat recurved (Figure 94). Spiniform process of first maxilla bifid, medial process at posterior two thirds margin; tip of terminal process rounded (Figure 94). Sternal furca (Figures 95, 96) box longer than tines, latter only slightly divergent and not much wider than box (Figure 95 of usual form and Figure 96 represents a variant).

Leg 1 (Figure 97) exopod last segment bearing very small spine or pecten at outer distal corner and 3 terminal spines, medial margin of each spine armed with a row of spinules and medial 2 spines each with accessory process near tip as in figure, a subterminal medial, naked seta, and 3 short pinnate setae on inner medial margin. Leg 2 (Figures 98, 99) exopod first segment with prominent, serrated spine at outer distal corner; second segment with similiar but smaller outer spine; last segment with smaller serrated spine on outer margin, fringed spine at outer distal corner, terminal semipinnate seta, and usual 5 pinnate setae; endopod first segment outer margin with proximal row of short setules and distal row of spines; second segment with row of setules on outer margin, last segment with small patch of setules on proximal corner. Leg 3 (Figure 100) basipod with row of short sclerotized spines along outer edge, short row of spinules near base of exopod, and patch of 20–25 sclerotized spines lateral to sclerotized blunt-tipped process on basipod; exopod first segment with prominent sclerotized recurved spine at outer corner, extending beyond second segment; second segment with weak spine on outer distal corner; third segment with 3 weakly sclerotized, outer spines and usual 4 terminal to medial setae. Leg 4 (Figure 101) 3-segmented; first segment with stout spine at outer distal corner; second segment with similiar spine at outer distal corner; third segment with 3 terminal spines, outermost shortest and other 2 each somewhat longer that preceeding spine; all spines with pecten at base.

MALE.—Unknown.

REMARKS.—*Caligus isonyx* appears to be closely related to *C. chorinemi* by the nature of the ornamentation on the first segment of the endopod of leg 2 and the sclerotized rod-like structure and patch of heavily sclerotized short spines on the apron of leg 3. These 2 characteristics are found in some other species of *Caligus* parasitic on carangids and sphyraenids in other oceans.

In Cressey and Cressey, 1980, we included *C. isonyx* as a synonym of *C. diaphanus*. This was based on comparisons between the specimens of *C. diaphanus* and illustrations of *C. isonyx* in Steenstrup and Lütken, 1861. The specimens of *C. isonyx* recently collected from the type host near the type locality indicate that these 2 species are not synonymous and can be separated by the nature of the sternal furca, the armature of the second segment of leg 2 (spines in *isonyx*, setules in *diaphanus*), and other characters as well.

Caligus kabatae, new species

FIGURES 102–111

MATERIAL EXAMINED.—Holotype (USNM 240147), allotype (USNM 240148), paratypes (USNM 240149) collected at Carrie Bow Cay, Belize, from *Acanthurus coeruleus*. Other material was collected from the following hosts from Belize: *Acanthurus bahianus*, *A. chirurgus*, and *Cantherhines pullus* (Ranzani).

FEMALE.—Body form as in Figure 102. Total length 1.44 mm, greatest width (measured at widest part of cephalothorax) 0.62 mm. Length of cephalothorax 0.70 mm. Genital complex slightly longer than wide (0.56 × 0.53 mm). Abdomen and caudal rami (Figure 103) very small, each about as long as wide (genital complex about 7.5 times longer than abdomen).

Space between lunules somewhat wider than diameter of lunule. Second antenna with pointed posterior process; tip of claw bent at right angle at terminal two-thirds (Figure 104*a*). Postantennal process somewhat recurved and with spatulate tip (Figure 104*b*). Spiniform process of first maxilla with spatulate tip (Figure 104*c*). Sternal furca box only slightly longer than tines; latter slightly divergent and spatulate at tips (Figure 105).

Leg 1 (Figure 106) coxopod with patch of short spinules; last exopod segment with 4 terminal spines, inner 2 each with accessory process, outermost element serrate, and 3 medial, pinnate setae; distal pinnules on outer edges of setae finer than pinnules on proximal and medial edges (see figure). Leg 2 (Figure 107) exopod first segment with prominent toothed spine (usually 5 teeth) at outer corner extending inwards across second segment; second segment with smaller, less sclerotized spine bearing 2–3 weaker teeth; last segment with an outer, very small spine, round-tipped spine, terminal semipinnate seta, and 5 terminal to medial pinnate setae: endopod 3-segmented; first segment with 1 medial pinnate seta, second segment with 2 medial pinnate setae, and last segment with 6 pinnate setae, outer borders of all 3 segments with patches of setules as in fi gure.

Leg 3 (Figure 108) exopod 3-segmented; first segment with terminal spine extending about two-thirds across second segment; second segment with outer naked spine and medial pinnate seta; last segment with 3 outer naked spines and 4 terminal to medial pinnate setae; endopod free segment with 6 pinnate setae. Leg 4 (Figure 109) exopod 2-segmented; first segment with terminal fringed seta reaching beyond base of second seta, second segment with similiar fringed seta near middle of outer margin, 2 prominent terminal fringed setae, and very short third seta at outer corner (seta obscured by

pecten). Pecten near bases of the 2 longer setae.

MALE.—Body form as in Figure 110. Total length 103 mm, greatest width 0.56 mm. Second antenna (Figure 111) claw not bifurcate, bearing single seta and adhesion pads as in figure. The single specimen is damaged and details of most oral and thoracic appendages cannot be determined.

ETYMOLOGY.—This species is named for Dr. Zbigniew Kabata to honor his many important contributions to the study of parasitic copepods (according to the International Code for Zoological Nomenclature, Article 31(a)(i), the name kabata, if accepted as Latin, is spelled *kabatae* in the genitive case; it is so accepted here).

REMARKS.—This species can be separated from most *Caligus* by the prominent serrations on the spines of the first and second segments of the exopod of leg 2. It can be separated from those few species *(amblygenitalis, clavatus, planktonis,* and *priacanthi)* with prominent serrations on the same exopod spines by the nature of the fourth leg. In *C. kabatae* the last segment of the fourth leg bears only 2 prominent terminal setae (outermost seta obscured by pecten). In the other species with serrate spines on the exopod of leg 2 there are 3 prominent terminal setae on the fourth leg. Of the 12 collections of this species, 9 were from *A. coeruleus,* which seems to be its preferred host and secondarily found on other acanthurids or monocanthids.

Caligus longipedis Bassett-Smith, 1898

FIGURES 112–122

Caligus longipedis Bassett-Smith, 1898:358.—Lewis, 1967:144.—Pillai, 1985:314.

Caligus amplifurcus Pearse, 1953:199.—Lewis, 1967:144 [= *Caligus longipedis*].

MATERIAL EXAMINED.—Although this species has previously only been reported from *Caranx melampygus* by Bassett-Smith (Aden), Lewis (1967, Hawaii), and Pearse (1953), the author has collected this species from a number of hosts from off the west coast of Florida and Belize as follows. Belize: *Acanthurus bahianus, A. coeruleus, Carangoides chrysos, Haemulon sciurus, Lactophrys bicaudalis* (Linnaeus), *Pomacanthus arcuatus,* and *Sparisoma viride.* Florida (west coast): *Caranx hippos* (3 collections), *Centropristis melana* Ginsburg, *Paralichthys lethostigma* Jordan and Gilbert, and *Selene vomer.*

FEMALE.—Body form as in Figure 112. Total length 3.8 mm, greatest width 1.9 mm. Cephalothorax about as wide as long. Genital complex about as long as wide (1 mm). Abdomen (Figure 113) about as long as wide (0.35 mm) (genital complex approximately 4.2 times longer than abdomen). Caudal ramus (Figure 113) nearly twice as long as wide (0.20 × 0.11 mm). Lunules widely spaced; distance between lunules more than twice diameter of lunule. Second antenna (Figure 114*a*) with relatively short, robust claw, recurved at distal third and bearing fusiform posterior process. Postantennal spine (Figure 114*b*) nearly as long as second antennal claw and only slightly bent. Spiniform process of first maxilla digitiform (Figure 114*c*). Sternal furca (Figure 115) tines somewhat expanded laterally (similiar to *C. robustus),* box longer than tines.

Leg 1 (Figure 116) medial 2 terminal spines each with accessory process; each of the 3 medial lateral setae with fine pinnules along distal portion of outer margin and sparsely pinnate on medial margin. Leg 2 (Figure 117) exopod first segment with prominent spine with membranes on both margins at outer distal corner extending across second segment; second segment with much shorter spine extending across base of last segment (membraneous strip on outer margin, medial margin with denticles); last segment with small, outer, lateral spine, longer subterminal spine bearing weak membrane along medial margin, terminal semipinnate seta, membranous along outer margin; medial margins of all segments with pinnate setae as in figure; endopod first 2 segments with setules along outer margin as in figure, last segment with 2 crescent-shaped sclerotized areas, each bearing 2 rows of striations (Figures 117, 118); endopod bearing pinnate setae typical of genus. Leg 3 (Figure 119) exopod first segment with heavily sclerotized terminal spine not reaching to base of last segment; other armature as in figure. Leg 4 (Figure 120) exopod 2-segmented; first segment with distal seta extending nearly to end of last segment; last segment with 3 terminal setae, medialmost seta about twice length of other setae; all setae with pecten near base.

MALE.—Body form as in Figure 121. Total length 2.35 mm, greatest width 1.44 mm. Genital complex somewhat longer than wide (0.37 × 0.33 mm), abdomen indistinctly divided, somewhat longer than wide (0.24 × 0.19 mm). Caudal rami longer than wide (0.21 × 0.19 mm) and bearing usual terminal setae. Second antenna (Figure 122) with adhesion pads as in figure; terminus of claw nearly bifid. Other appendages as in female.

REMARKS.—Although this species has been reported from a variety of hosts, it seems to be most common on carangids. The crescent-shaped sclerotized areas on the last segment of the endopod of the second leg have, so far, not been reported from any other species of the genus, except *C. robustus* redescribed herein.

Caligus mutabilis Wilson, 1905

FIGURES 123–126

Caligus mutabilis Wilson, 1905:573.—Cressey and Cressey, 1980:27.—Cressey and Nutter, 1987:600.

REMARKS.—This species was recently redescribed by Cressey and Cressey (1980) and the reader is referred to that work for a more complete description. This species has been reported from several species of inshore fishes from the western Atlantic and eastern Pacific. The record by Causey (1955) from

Trachinotus carolinensis from the Gulf of Mexico was recently verified by the author (Cressey and Nutter, 1987).

Figures of the female habitus (Figure 123), sternal furca (Figure 125), leg 1 (Figure 124), and leg 4 (Figure 126) are included but Cressey and Cressey (1980) should be used for additional description. This parasite seems to be most common on inshore scombrids, carangids, and related fast-swimming inshore fishes. Causey's Pacific coast records have yet to be verified.

Caligus ocyurus, new species

FIGURES 127–136

MATERIAL EXAMINED.—Five females and 1 male were collected from 3 specimens of the yellowtail snapper (*Ocyurus chrysurus* Bloch) from Carrie Bow Cay, Belize (holotype female, USNM 24014; allotype male, USNM 240145; paratypes, USNM 240146).

FEMALE.—Body form as in Figure 127. Total length 2.70 mm, greatest width 0.95 mm. Lateral margins of cephalothorax nearly parallel and cephalothorax somewhat longer than wide (1.39 × 0.95 mm). Genital complex longer than wide (1.09 × 0.77 mm). Abdomen (Figure 128) longer than wide (0.21 × 0.16 mm) (length of genital complex about 1.3 times longer than abdomen). Caudal ramus (Figure 128) longer than wide (0.12 × 0.07 mm).

Lunules widely separated. Second antenna (Figure 129*a* claw bent nearly at right angle in distal third with prominent sclerotized spine near base of claw; basal segment bearing prominent pointed spiniform posterior process. Postantennal process (Figure 129*b*) somewhat recurved, tip not sharply pointed, and outer margin membranous. Process of first maxilla (Figure 129*c*) distal third margins membranous and tip not sharply pointed. Sternal furca (Figure 130) tines about as long as box, somewhat divergent and pointed.

Leg 1 (Figure 131) coxopod with a patch of fine spinules, a digitiform process (?), and medial, outer pinnate seta, as in figure; last exopod segment with 4 short, terminal setae, medial 2 with pinnules on outer margin and accessory process, 3 pinnate setae on medial margin; outer distal margins of setae more finely pinnate than basal and outer margins. Leg 2 (Figure 132) exopod first segment with sclerotized spine at outer distal corner bearing fringed membrane along outer edge; second segment with naked outer spine, about one-half length of spine on first segment; last segment with short, naked outer spine, and outer terminal fringed spine, terminal semipinnate seta, and 5 medial pinnate setae; all three segments of endopod with patches of setules as in figure, last segment with usual 6 pinnate setae. Leg 3 (Figure 133) exopod first segment with heavily sclerotized spine extending across three-fourths of second segment; last segment with 3 weak outer spines and 4 pinnate setae. Leg 4 (Figure 134) exopod 2-segmented; first segment with outer distal seta extending to base of seta at mid-margin of last segment; last segment with outer seta and three terminal setae, outermost about one-third length of terminalmost seta, mid-seta about two-thirds length of last seta; all three terminal setae with prominent pecten at bases.

MALE.—Body form as in Figure 135. Total length 3.50 mm, greatest width 2.14 mm. Genital complex longer than wide (63 × 58 mm). First abdominal segment much wider than long (0.11 × 0.28 mm); second segment slightly wider than long (0.26 × 0.28 mm). Caudal rami longer than wide (0.21 × 0.14 mm). Second antenna (Figure 136) claw bifid; corpus with adhesion pads as in figure.

ETYMOLOGY.—The specific epithet refers to the host *Ocyurus chrysurus*.

REMARKS.—This new species can be separated from the known *Caligus* species of the Gulf of Mexico and Caribbean Sea by the following. Except for *C. xystercus*, cited below, it can be separated from the others by the nature of the exopod of the fourth leg. The following 11 species have a fourth leg with a 2-segmented exopod bearing 5 setae, as in *C. ocyurus*. The new species differs from *asperimanus, berychis, bonito, haemulonis, mutabilis,* and *suffuscus* as all of these species have spines on the outer border of the second leg endopod (the new species has setules). Of the remaining 6 other species with setules on the second leg endopod segments it can be separated as follows: *Caligus chelifer* has a 2-segmented abdomen and very short lateral setae on the exopod of leg 1; *C. praetextus* bears "hooded" spines at the tip of the exopod of leg 1, and the inner terminal seta of leg 4 is twice the length of the other 2 terminal setae, *C. afurcatus* has very small caudal rami and very reduced sternal furca; *C. rufimaculatus* sternal furca tines spatulate and caudal rami only slightly longer than wide, *C. productus* has no medial lateral setae on first leg, and it differs from *C. xystercus*, new species described below, in ways cited in that description.

Caligus pelamydis Krøyer, 1863

FIGURES 137–140

Caligus pelamydis Krøyer, 1863;124.—Cressey and Cressey, 1980:32.

REMARKS.—This species was redescribed by Cressey and Cressey (1980) and the reader is referred to that work for a more complete description. It has been recorded from *Scomber japonicus* from the Gulf of Mexico (Cressey and Cressey, 1980). As noted earlier, this species seems to prefer species of *Sarda* as its host but it has been recorded from all major oceans and from a wide variety of scombrid species. Although Causey (1953a, b, 1960) reported this species from a variety of fishes in the Gulf of Mexico, a reexamination of those collections (Cressey and Nutter, 1987) indicated that all of the material we were able to examine had been misidentified.

Figures of female (Figure 137), second antenna (Figure 138), sternal furca (Figure 139), and leg 4 (Figure 140) included but Cressey and Cressey, 1980, should be consulted for additional descriptions of female and male.

Caligus pomacentrus, new species

FIGURES 141-152

MATERIAL EXAMINED.—Holotype female (USNM 240141), allotype (USNM 240142), and paratypes (USNM 240143) from *Microspathodon chrysurus* (Cuvier and Valenciennes) from Belize. Additional material was obtained from *Pomacentrus fuscus* (2 collections), *Microspathodon chrysurus* (2 collections), *Anisotremus virginicus* (1 collection), *Aulostomus maculatus* (1 collection), *Bothus lunatus* (1 collection), *Holacanthus tricolor* (1 collection), *Malacanthus plumieri* (1 collection), and *Sparisoma viride* (1 collection).

FEMALE.—Body form as in Figure 141. Total length 2.0 mm, greatest width 0.98 mm (measured at widest part of cephalothorax). Cephalothorax widest posteriorly and comprising more than half total length. Genital complex (Figure 142) 0.75 mm wide and 0.61 mm long. Abdomen (Figure 142) wider than long (282 × 188 μm), widest anteriorly (genital complex about 3 times longer than abdomen). Caudal rami about as long as wide (Figure 142) bearing usual 6 setae, terminalmost 3 setae about equal in length.

Lunules widely spaced. Second antenna claw bent at right angle at about mid-length; posterior process (Figure 143) pointed. Postantennal process slightly bent, tip not sharply pointed (Figure 144). Spiniform process of first maxilla with rounded tip (Figure 145). Sternal furca (Figure 146) tines directed inwards at tip and tips rounded; box and tines of about equal length.

Leg 1 (Figure 147) exopod with 4 outer terminal spines (middle 2 each with fine serrations and accessory process) and 3 pinnate inner medial setae, outer margin setules on basal portion of seta longer than those on distal portion. Leg 2 (Figure 148) exopod first segment with sclerotized spine at outer corner bearing fringed membrane along outer edge; second segment spine about half the length of first segment spine and bearing prominent denticles on both medial and outer edges, last segment with 2 short spines on outer corner (longer spine blunt tipped), terminal semipinnate seta with outer membrane and medial pinnae and 5 medial pinnate setae; endopod with patches of fine brush-like setules on all 3 segments as in figure.

Leg 3 exopod first segment (Figure 149) spine reaching nearly to posterior margin of second segment; last exopod segment with 3 naked spines and 4 pinnate setae. Leg 4 (Figure 150) exopod 2-segmented; seta on first segment not reaching to base of seta on mid-margin of last segment; tip of last segment with 2 prominent setae, each with basal pectens (medialmost nearly twice length of medial seta), an inconspicuous semipinnate seta present on outder corne.r hidden by pecten; all setae with membranous element on both margins.

MALE.—Body form as in Figure 151. Total length 1.9 mm, greatest width 1.1 mm. Appendages as in female except for second antenna (Figure 152) with short terminal claw and adhesion pads as in figure.

ETYMOLOGY.—The name of this copepod was taken from the family name (Pomacentridae) of the host fish that harbored the first collection.

REMARKS.—This new species is superficially similiar to *C. atromaculatus* but can be separated from it by its widely separated lunules and the shape of the furca.

Caligus praetextus Bere, 1936

FIGURES 153-163

Caligus praetextus Bere, 1936:583.—Cressey and Nutter, 1987:600.

MATERIAL EXAMINED.—Bere (1936) described this species from several hosts from the west coast of Florida (see Margolis et al., 1975:62). The author has also collected this species from Charlotte Harbor, Florida, from the following hosts: *Bairdiella chrysura, Cynoscion nebulosus* (Cuvier), *Centropomus undecimalis* (Bloch), *Chilomycterus atinga* (Linnaeus), *Diplopodus holbrooki* (Bean), *Diapterus plumieri* (Cuvier), *Echineis naucrates* Linnaeus, *Lutjanus synagris, Lagodon rhomboides* (Linnaeus), *Myctoperca microlepis* (Goode and Bean), *Synodus foetens* (Linnaeus), *Spheroides nephalus* (Goode and Bean), and *Sciaenops ocellatus* (Linnaeus). The infestation rates on the various hosts indicated little host specificity.

FEMALE.—Body form as in Figure 153. Total length 2.16 mm, greatest width 0.86 mm. Cephalothorax widest posteriorly and comprising about one-third of total length. Genital complex about as long as wide (0.56 mm) and widest posteriorly. Abdomen approximately twice as long as wide (0.47 × 0.21 mm) (genital complex about 1.7 times longer than abdomen). Caudal rami (Figure 154) about twice as long as wide (94 × 56 μm), usually convergent posteriorly and bearing 6 setae as in figure.

Lunules widely spaced. Second antenna (Figure 155*a*) claw recurved at tip, posterior spine pointed. Postantennal process (Figure 155*b*) digitiform, tip not sharply pointed. Spiniform process of first maxilla (Figure 155*c*) pointed as in postantennal process. Sternal furca (Figure 156) tines not divergent and about as long as base, giving the furca a "square" look.

Leg 1 (Figure 157) last exopod segment with an outer naked spine, 2 terminal spines, each with spatulate hood-like membrane covering terminal half of spine and each with an accessory process (Figure 158), naked seta at medial terminal corner, and 3 pinnate setae on medial margin. Leg 2 (Figure 159) exopod first segment with a fringed stout spine extending across segment and medial seta; second segment with fringed spine at outer corner (about half the length of first segment spine) and a medial seta; last segment with 2 short fringed spines near outer corner, prominent terminal semipinnate seta with coarsely serrated membrane along outer margin and bearing short pinnules on distal half of medial margin, and 5 pinnate setae on medial margin of last segment; endopod with

setules on outer margins of all three segments. Leg 3 exopod (Figure 160) first segment with heavily sclerotized spine on first segment not reaching last segment; second segment with medial pinnate seta and weak spine on outer distal corner; last segment with 4 pinnate setae and 3 short outer terminal spines. Leg 4 (Figure 161) exopod 2-segmented; first segment with spine at outer corner extending to base of medial spine of last segment, last segment with an outer medial spine and 3 terminal spines, medialmost about twice the length of the 2 outer terminal spines (all spines with a basal pecten).

MALE.—Body form as in Figure 162. Second antenna (Figure 163) with terminal, short bifid claw and rugose adhesion pads as indicated in figure. Other appendages as in female.

REMARKS.—This species is known only from the Gulf of Mexico from a variety of hosts. It is easily recognized by the "square" sternal furca and the inwardly directed caudal rami.

Caligus productus Dana, 1852

FIGURES 164–167

Caligus productus Dana, 1852:56.—Pillai, 1985:340.
Caligus mirabilis Leigh-Sharpe, 1934:22 [new synonymy].
Caligus microdontis Heegaard, 1964:319 [new synonymy].

REMARKS.—This species has been recently redescribed by Cressey and Cressey (1980) and appears to be circumglobal in distribution. Although it is primarily associated with scombrid fish, it has also been recorded several times from non-scombrid fishes. Examination of collections identified by D. Causey as *C. productus*, from non-scombrids in the Gulf of Mexico, proved to be other species (see Cressey and Nutter, 1987).

Caligus productus can be easily separated from all other Gulf/Caribbean species of *Caligus* (except *C. epinephali* and *C. haemulonis*) by the absence of the 3 medial lateral setae of the first leg. There are 13 other *Caligus* species (*alaihi* (1 seta), *annularis, ariicolus, bicycletus, bocki, chiloscilli, fugu, lagocephali, lobates, mauritanicus, minutus, pagrasomi,* and *paxillifer*) that lack the same 3 setae but they have not been reported from the Gulf/Caribbean region.

See Cressey and Cressey, (1980) for a more complete description of this species. The following illustrations are included herein: female (Figure 164), sternal furca (Figure 165), leg 1 (Figure 166), and leg 4 (Figure 167).

Caligus robustus Bassett-Smith, 1898

FIGURES 168–177

Caligus robustus Bassett-Smith, 1898:357.—Pillai, 1985:345.—Cressey and Nutter, 1987:600.

MATERIAL EXAMINED.—Bassett-Smith (1898) described this species from 3 species of carangids and a species of *Thunnus* from Ceylon and Aden. Since then it has been recorded many times from the western Atlantic and Indian Ocean from carangid and scombrid fishes. Additional material has been collected by the author from Belize: *Carangoides bartholomaei, Carangoides chrysos, Caranx hippos, Caranx ruber, Lutjanus apodus* (1 immature male copepod); Florida: *Caranx hippos;* Philippines and Celebes: *Caranx sexfasciatus, Alectis* species; Borneo: *Caranx sexfasciatus* Quoy and Gaimard; Tutuila Island: *Caranx sexfasciatus;* and Revilligidado Island: *Caranx melampygus* Cuvier and Valenciennes.

FEMALE.—Body form as in Figure 168. Total length 4.7 mm, greatest width 1.98 mm. Cephalothorax about as long as wide and comprising about one-third of total body length. Lunules widely separated, space between them about twice lunule diameter. Genital complex widest posteriorly and longer than wide (1.2 × 0.82 mm). Abdomen 1-segmented and nearly 3 times longer than wide (length of genital complex about 1.2 times longer than abdomen). Caudal rami (Figure 169) longer than wide (0.84 × 0.39 mm) with usual 6 setae.

Second antenna (Figure 170*a*) claw recurved near tip; posterior process rounded and directed laterally. Postantennal process (Figure 170*b*) small with small distal process. Spiniform process of first maxilla (Figure 170*c*) with accessory process near tip. Sternal furca (Figure 171) basal portion about as long as tines; latter broad, slightly divergent, narrowing near tips.

Leg 1 (Figure 172) coxopod with patch of fine spinules; exopod first segment with a small spine at outer distal corner; second segment with small, subterminal spine, outer 2 terminal spines with fringe on medial and outer margins, tips naked, medialmost terminal spine naked and 3 well-developed medial setae; basal portion of outer margins of medial setae with stout setules followed by finer and shorter setules; setules on medial margins longer and more widely spaced. Leg 2 (Figure 173) exopod first 2 segments each with prominent, gently curved spine at outer corner (first spine slightly longer than second spine) and medial seta; last segment with 2 small outer spines followed by larger semipinnate seta and 5 terminal to medial pinnate setae. Endopod first segment with irregular row of setules and transverse row of spinules as in figure, medial margin with long seta; second segment with prominent patch of bristles covering most of proximal half and 2 medial setae; last segment with patch of bristles on basal portion, sclerotized, striated cresent-shaped process at outer distal corner, and 6 terminal setae. Leg 3 exopod (Figure 174) first segment with prominent sclerotized spine, fringed along outer margin and not reaching last segment; second segment with weak spine at outer corner and well-developed medial seta; last segment with 3 weak outer spines and 3 terminal setae. Leg 4 (Figure 175) exopod 3-segmented, outer margins of all 3 segments with double row of short setules; all exopod spines with similiar rows of fringe and all of about equal length.

MALE.—Body form as in Figure 176. Total length 2.65 mm, greatest width 1.37 mm. Cephalothorax 1.37 mm in length; genital complex 0.55 mm long and 0.48 mm wide. First

abdominal segment 0.23 mm long and 0.48 mm wide, second segment 0.74 mm long and 0.67 mm wide. Caudal rami longer than wide (0.48 × 0.27 mm). Second antenna (Figure 177) with small adhesion pad at medial distal corner; last segment (claw) with naked seta on medial proximal corner sclerotized process beyond seta, tip of claw heavily sclerotized and bent at right angle.

REMARKS.—This species is apparently circumglobal in distribution and is generally associated with carangids and to a lesser extent scombrid fishes.

Caligus rufimaculatus Wilson, 1905

FIGURES 178–187

Caligus rufimaculatus Wilson, 1905:497.

MATERIAL EXAMINED.—Lectotype and paralectotype designated by R. Parker (USNM 42028). Additional material collected by the author from Florida and the Gulf of Mexico from the following hosts: *Eucinostomas gula* (Quoy and Gaimard), *Centropristis melana* Ginsberg, *Diplopodus holbrooki*, *Haemulon plumieri*, *Lactophrys quadricornis* (Linnaeus), *Lagodon rhomboides* (Linnaeus), *Lutjanus synagris*, *Monacanthus hispidius*, *Nicholsina usta* (Valenciennes), and *Orthopristis chrysoptera* (Linnaeus).

FEMALE.—Body form as in Figure 178. Total length 3.49 mm, greatest width 1.60 mm. Cephalothorax comprising about half of total length. Genital complex 1.7 mm in length and 1.4 mm wide. Abdomen longer than wide (0.51 × 0.35 mm) (genital complex about 1.7 times longer than abdomen). Caudal rami (Figure 179) longer than wide (0.17 × 0.08 mm).

Lunules widely spaced, distance between lunules more than twice width of lunule. Second antenna claw recurved at right angle; posterior process not sharply pointed (Figure 180*a*). Postantennal spine nearly straight (Figure 180*b*), and spiniform process of first maxilla only slightly recurved (Figure 180*c*). Sternal furca (Figure 181) tines widely divergent and somewhat spatulate at tips.

Leg 1 (Figure 182) exopod last segment bearing an outer naked seta, 2 inner setae, each with accessory process and long naked seta on inner corner; 3 medial setae, each with thickened pinnules on outer basal half and thinner pinnules distally. Leg 2 (Figure 183) exopod first 2 segments each with fringed spine at outer distal corner; spine on second segment about half length of first spine; last segment with small outer spine fringed on outer margin, subterminal short spine, longer terminal semipinnate seta with hyaline membrane on outer margin and pinnate on medial margin; pinnate setae on medial margins of exopod as in figure; all 3 segments of endopod with setules along outer margins, setules on last 2 segments shorter than those on first segment; terminal to medial pinnate setae as in figure. Leg 3 exopod (Figure 184) first segment with recurved spine, fringed along outer margin and nearly reaching to third segment; other spines and setae as in figure. Leg 4 (Figure 185) exopod 2-segmented; first segment bearing long, blunt-tipped seta extending beyond base of first seta on last segment; last segment with outer seta at mid-margin and 3 terminal setae, medialmost at least twice length of other setae.

MALE.—Body form as in Figure 186. Total length 3.1 mm, greatest width 1.8 mm, measured at widest part of cephalothorax. Abdomen 2-segmented, first segment wider than long (0.14 × 0.31 mm), second segment longer than wide (0.37 × 0.28 mm). Caudal ramus longer than wide (0.20 × 0.11 mm). Second antenna with short terminal claw (Figure 187) and adhesion pads as in figure. Maxilliped corpus with round-tipped sclerotized process in opposition to terminal claw.

REMARKS.—Wilson (1905) described this species from *Fundulus* and *Mugil* from Woods Hole and North Carolina. Bere (1936) reported it from several species of hosts from the Gulf of Mexico. In view of the variety of hosts from which this species has been recorded, there are, so far, no indications of host specificity. Because I did not collect this species from Belize, and the reexamination of Causey's western and northern Gulf of Mexico collections did not result in any additional records, this species seems to be confined to the Atlantic coast of the United States and the southwest Florida coast.

Caligus suffuscus Wilson, 1913

FIGURES 188–197

Caligus suffuscus Wilson, 1913:219.

MATERIAL EXAMINED.—Wilson (1913) described this species from *Scarus coeruleus* (Bloch) from Jamaica and later from other hosts from the Dry Tortugas (Florida). The author collected this species from the following hosts from Belize: *Acanthurus bahianus*, *Bodiana rufus*, *Lactophrys quadricornis*, *Malacanthus plumieri*, *Sparisoma viride*, and *Balistes vetula* Linnaeus.

FEMALE.—Body form as in Figure 188. Total length 1.8 mm, greatest width 1.0 mm, measured at cephalothorax. Cephalothorax about as long as wide (0.95 mm long × 1.0 mm wide). Genital complex 0.51 mm long × 0.39 mm wide. Abdomen small and about as long as wide (150 μm) (genital complex about 4.7 times longer than abdomen). Caudal rami (Figure 189) somewhat longer than wide (60 × 55 μm) and bearing setae as in figure.

Lunules widely spaced. Second antenna (Figure 190*a*) claw longer than basal segment and recurved at right angle, posterior process pointed. Postantennal process (Figure 190*b*) pointed and recurved slightly. Spiniform process of first maxilla (Figure 190*c*) long, slender, and pointed. Sternal furca (Figure 191) tines divergent, longer than base, with rounded tips.

Leg 1 (Figure 192) coxopod with patch of spinules on posterior margin; endopod last segment with small outer spine, 2 setae with accessory process, each of which bears spinules along outer margin; long, unarmed terminal seta and 3 medial

pinnate setae. Leg 2 (Figure 193) exopod first 2 segments each with sclerotized spine at outer distal corner, extending across following segment and each with membrane along outer margin; spine on second segment about half as long as first spine; last segment with 2 small, weak spines on outer margin, terminal semipinnate seta (fringed on outer margin, and pinnate on medial margin); pinnate setae on medial margins of all segments as in figure; endopod first segment unarmed on outer margin; second segment with row of spinules along outer margin, last segment with patch of spinules near base of first outer seta, outer to medial setae as in figure. Leg 3 (Figure 194) exopod first segment with heavily sclerotized straight terminal spine bearing membrane along lateral margin, spine extending nearly across entire length of second segment; spines and setae as in figure. Leg 4 (Figure 195) exopod 2-segmented; first segment with outer distal spine extending beyond base of next spine; second segment with outer spine near mid-margin and 3 terminal spines, outermost very short and weakly sclerotized, terminalmost spine fringed in distal half and more than twice as long as other spines, three terminal spines each with pecten near base.

MALE.—Body form as in Figure 196. Total length 2.1 mm, greatest width 1.4 mm. Cephalothorax about two-thirds of total length. Genital complex about as long as wide (0.37 × 0.42 mm). Abdomen 2-segmented; first segment much shorter than second. Caudal rami about as long as wide (94 × 94 μm). Second antenna (Figure 197) with short, heavily sclerotized, claw bearing short seta on medial base and adhesion pads as in figure.

REMARKS.—Wilson (1913) collected this species from the blue parrotfish (*Scarus coeruleus?*) from Jamaica, and the author has collected this species from 5 different hosts in Belize. Although it was recovered from 5 relatively unrelated hosts, the collections from 3 specimens of *Sparisoma viride* contained 25 *C. suffuscus*, whereas the other hosts only harbored 1 or 2 specimens. This suggests that the parasite prefers members of the Scaridae.

Caligus wilsoni Delamare Deboutteville and Nunes Ruivo, 1958

FIGURES 38–45

Caligus wilsoni Delamare Deboutteville and Nunes Ruivo, 1958:217.

MATERIAL EXAMINED.—Two females collected from *Lutjanus griseus* (Linnaeus), Charlotte Harbor, Florida.

FEMALE.—Body form as in Figure 38. Total length 5.0 mm, greatest width 2.2 mm. Genital complex somewhat longer than wide (1.4 × 1.2 mm). Abdomen slightly longer that wide (0.7 × 0.6 mm) (genital complex about 1.6 times longer than abdomen). Caudal rami (Figure 39) as long as wide (0.23 × 0.23 mm).

Lunules widely spaced, distance between lunules about twice the diameter of lunule. Second antenna (Figure 40*a*) claw bent nearly at right angle at terminal third and bearing posterior process as in figure. Postantennal process (Figure 40*b*) robust and recurved as in figure. Spiniform process of first maxilla (Figure 40*c*) stout, tip pointed but not sharp. Sternal furca (Figure 41) tines robust, divergent with rounded tips, and shorter than box.

Leg 1 (Figure 42) exopod with 4 terminal setae, medial 2 each with accessory process; terminalmost seta nearly twice as long as other 3; 3 medial setae pinnate; outer basal portion with dense patch of setules, feather-like pinnules along medial border sparce. Leg 2 (Figure 43) exopod first 2 segments with fringed spines on outer distal corner; spine on first segment about twice length of spine on second segment, additional stout spine with broad membrane and longer terminal semipinnate seta on last segment; terminal to medial margin of exopod with 5 pinnate setae; first 2 endopod segments with patch of setules on outer margin; terminal to medial margin with usual setae. Leg 3 exopod (Figure 44) with stout spine on first segment not reaching last segment, outer edge of spine bearing membrane; last 2 segments with spines and setae. Leg 4 (Figure 45) exopod 2-segmented; seta on first segment reaching nearly to tip of exopod; no lateral seta on outer mid-margin of last segment; all setae with pecten at base.

MALE.—None available for study.

REMARKS.—Delamare Deboutteville and Nunes Ruivo based their designation of Wilson's treatment of *C. belones* as a separate species from *C. belones* Krøyer because of the lack of the lateral seta on the last exopod segment of leg 4 in Wilson's material. I have collected *C. wilsoni* from *Belone* species in the north Atlantic as well as the Florida collection reported herein.

Caligus xystercus, new species

FIGURES 206–213

MATERIAL EXAMINED.—Holotype (USNM 240139) and paratypes (USNM 240140) collected at Carrie Bow Cay, Belize from *Anisotremus virginicus*, *Aulostomus maculatus*, *Calamus calamus*, *Calamus pennatula*, *Lutjanus apodus*, *Pomacanthus arcuatus*, and *Priacanthus cruenatus* (Lacépède).

FEMALE.—Body form as in Figure 206. Total length 2.3 mm, greatest width 1.2 mm (measured at widest part of cephalothorax). Cephalothorax comprises more than half total length (1.3 mm). Genital complex slightly longer than wide (0.75 × 0.65 mm). Abdomen about as long as wide (0.15 × 0.15 mm) (genital complex approximately 3.6 times longer than abdomen). Caudal rami (Figure 207) about as long as wide (0.08 × 0.08 mm) and bearing 6 pinnate setae. Lunules widely spaced. Second antenna (Figure 208*a*) claw recurved at right angle near tip with small, proximal accessory process; posterior process heavily sclerotized, pointed, but not sharply so. Postantennal process (Figure 208*b*) digitiform with rounded

tip. Spiniform process of first maxilla (Figure 208*c*) digitiform and bearing weak hyaline membrane on outer margin near tip. Sternal furca (Figure 209) tines somewhat divergent, membranous on outer margin and longer than base.

Leg 1 (Figure 210) with patch of fine spinules on coxopod, last exopod segment bearing 2 spines, each with accessory process, with medial single seta distally and 3 medial pinnate setae, setae more sparsely pinnate on medial margin (usual small seta on outer terminal corner not seen). Leg 2 (Figure 211) exopod first segment bearing spine reaching across second segment to third segment, spine with membrane on outer margin; second segment with much shorter spine recurved with membrane on outer margin and reaching to middle of last segment; last segment with short, naked spine on outer margin, longer sclerotized, blunt-tipped spine at outer distal corner, terminal semipinnate seta, and usual pinnate setae on medial margins of all segments; endopod segments with patches of setules on outer margins as in figure; other pinnate setae as typical for genus. Leg 3 (Figure 212) exopod first segment with stout, slightly recurved, terminal spine with thin flange on outer lateral margin nearly reaching to third segment; setae as in figure and typical of genus; endopod with 6 pinnate setae on last segment. Leg 4 (Figure 213) exopod 2-segmented; first segment with terminal seta reaching to base of lateral seta of last segment; terminus of exopod bearing 3 setae, outermost shortest and medialmost longest; each with pecten at base.

MALE.—Unknown.

REMARKS.—This species is closely related to *Caligus ocyurus* but can be distinguished from it because the abdomen and caudal rami of *C. xystercus* are not longer than wide, as in *C. ocyurus*. Also, the postantennal spine of *C. ocyurus* is much stouter and broader at the tip than in *C. xystercus* (compare Figures 129*b* and 208*b*).

ETYMOLOGY.—The Latin *xyster* (scraper) alludes to the method of feeding in *Caligus* and other caligid copepods.

Discussion

The genus *Caligus* has been reported from every major body of marine water. Earlier descriptions lack much of what we now know to be essential details necessary to recognize the different species, and revisions are hampered by those superficial descriptions. In this and future efforts, thge author is attempting to recollect from the type hosts and, as nearly as possible, the type localities to facilitate the redescriptions. Type material has been used whenever possible to verify the characters.

The genus can be divided into 4 major groups based on the nature of the fourth leg: (a) exopod 3-segmented, first 2 segments bearing a spine at outer distal corner and last segment with 3 terminal spines, medialmost usually longest (see Figures 80, 101, 140, 175); (b) exopod 2-segmented, first segment bearing a spine at outer distal corner and last segment with a spine at outer mid-margin and 3 terminal spines (see Figures 53, 68, 76, 89); (c) exopod 2-segmented, first segment bearing a spine at outer distal corner and last segment with 3 terminal spines (see Figures 37, 45, 120); (d) exopod 2-segmented, first segment bearing a spine at outer distal corner, second segment with a spine at outer mid-margin, 2 prominent terminal spines and an inconspicuous outer spine seta usually hidden by a pecten (see Figures 27, 63, 109, 150). Although a few species have been reported with a different armature on the fourth leg, the majority of the known species bears one of the types described above.

An analysis of the various characters will wait until a more comprehensive work is completed, but a few remarks based on the present work may be in order. The sternal furca is usually a stable character but I have seen some individuals with a variant furca. In some cases I have illustrated those but they are not common and the discovery of such a deviant should not prompt its description as a new species unless there are substantial other differences as well. The shape of the claw of the second antenna of the female is generally reliable but some collections containing several adult females with prominent sickle-shaped hooks on the second antenna (as in *C. haemulonis)* have also contained an occasional specimen (which in all other aspects appears to be *C. haemulonis*) where the claw is bent only near the tip.

The armature on the outer margins of the 3 endopod segments of the second legs (setules, spines, teeth, etc.) is an important character and, also, whether or not all 3 segments bear ornamentation in addition to the setae. The nature of the ornamentation is worth noting.

Appendix

Host-Parasite List

CLUPEIFORMES

CLUPEIDAE
Brevoortia
tyrannus — C. chelifer

MYCTOPHIFORMES

SYNODONTIDAE
Synodus
foetens — C. praetextus

SILURIFORMES

ARIIDAE
Arius
felis — C. haemulonis

ATHERINIFORMES

BELONIDAE
Belone
belone — C. wilsoni
Strongylura
notata — C. berychis

BERYCIFORMES

BERYCIDAE
Beryx
decadactylus — C. berychis

GASTEROSTEIFORMES

AULOSTOMIDAE
Aulostomus
maculatus — C. atromaculatus, C. biaculeatus

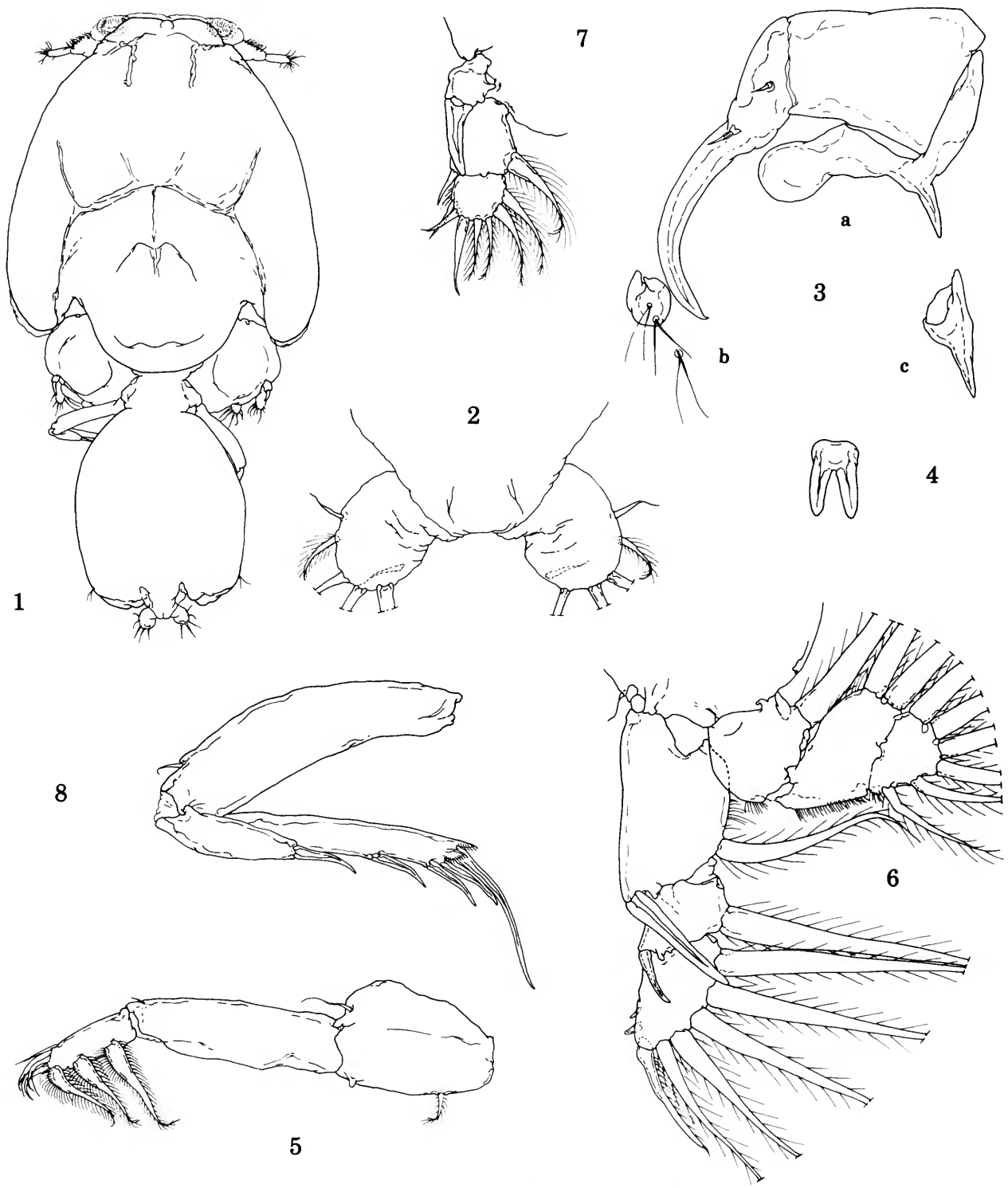
PERCIFORMES

SERRANIDAE
Centropristis
melana — C. longipedis, C. rufimaculatus
Mycteroperca
microlepis — C. praetextus
PRIACANTHIDAE
Priacanthus
cruentatus — C. xystercus
CENTROPOMIDAE
Centropomus
undecimalis — C. praetextus
CARANGIDAE
Carangoides
bartholomaei — C. chorinemi, C. robustus
crysos — C. chorinemi, C. longipedis, C. robustus
ruber — C. robustus
Caranx
hippos — C. chorinemi, C. longipedis, C. robustus
Selene
vomer — C. longipedis
Trachinotus
carolinus — C. mutabilis
CORYPHAENIDAE
Coryphaena
hippurus — C. balistae
ECHENEIDIDAE
Echeneis
naucrates — C. praetextus
MALACANTHIDAE
Malacanthus
plumieri — C. biaculeatus, C. suffuscus
GERRIDAE
Diapterus
plumieri — C. praetextus
Eucinostomus
gula — C. rufimaculatus
HAEMULIDAE
Anisotremus
virginicus — C. atromaculatus, C haemulonis, C. xystercus
Haemulon
carbonarium — C. haemulonis
macrostomum — C. haemulonis
plumieri — C. atromaculatus, C. haemulonis, C. rufimaculatus
sciurus — C. atromaculatus, C. biaculeatus, C. haemulonis, C. longipedis
Orthopristis
chrysoptera — C. rufimaculatus
LUTJANIDAE
Lutjanus
analis — C. asperimanus
apodus — C. asperimanus, C. robustus, C. xystercus
griseus — C. wilsoni
jocu — C. asperimanus
synagris — C. asperimanus, C. praetextus, C. rufimaculatus
Ocyurus
chrysurus — C. ocyurus

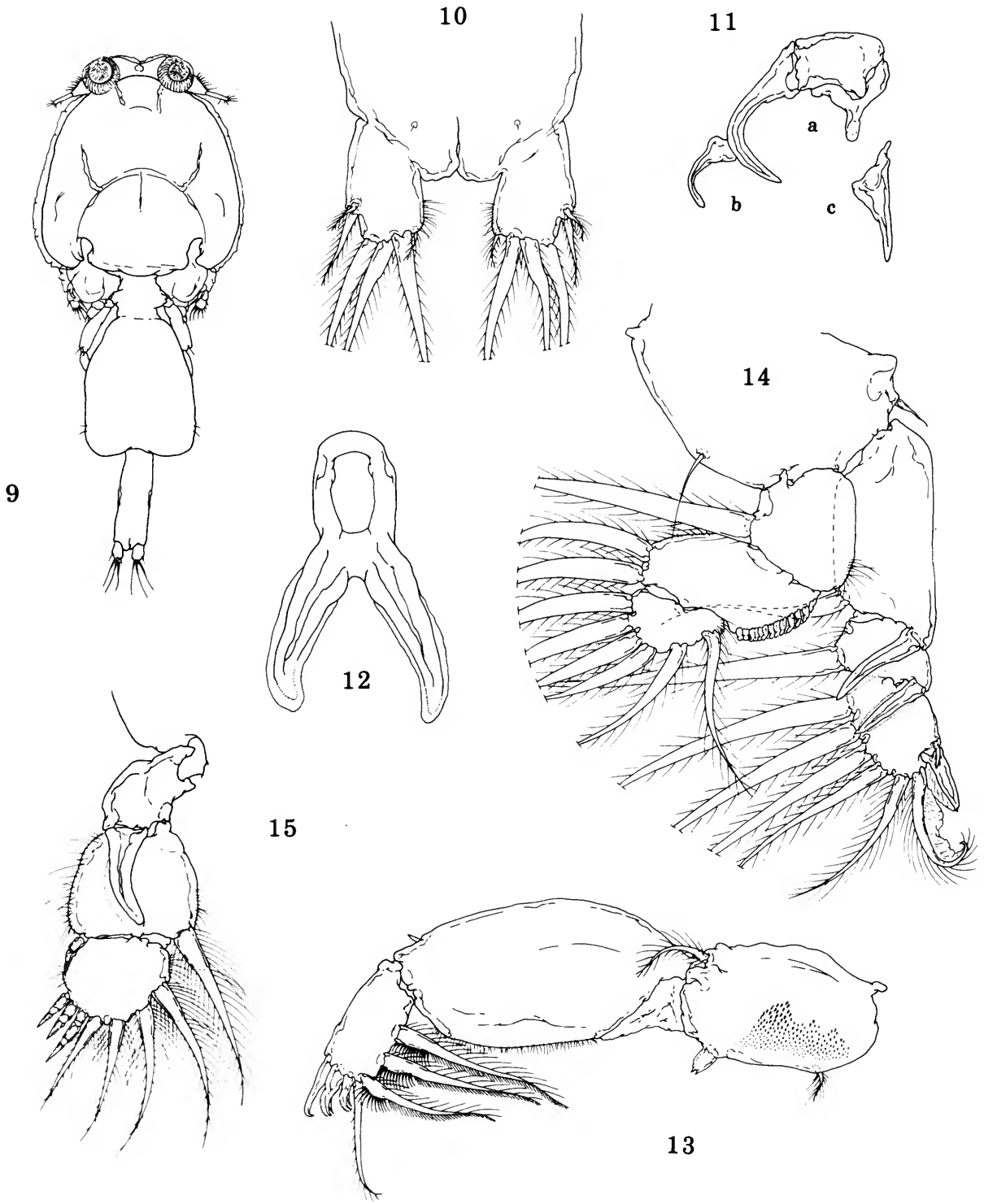
TRICHIURIDAE
Trichiurus
lepturus — *C. chelifer*
SPARIDAE
Archosargus
probatocephalus — *C. haemulonis*
Calamus
calamus — *C. xystercus*
pennatula — *C. atromaculatus, C. xystercus*
Diplodus
holbrooki — *C. praetextus, C. rufimaculatus*
Lagodon
rhomboides — *C. praetextus, C. rufimaculatus*
SCIAENIDAE
Bairdiella
chrysura — *C. haemulonis, C. praetextus*
Cynoscion
nebulosus — *C. praetextus*
Menticirrhus
americanus — *C. haemulonis*
Odontoscion
dentex — *C. atromaculatus*
Sciaenops
ocellatus — *C. praetextus*
SCARIDAE
Nicholsina
usta — *C. rufimaculatus*
Sparisoma
chrysopterum — *C. atromaculatus*
viride — *C. afurcatus, C. atromaculatus, C. longipedis, C. suffuscus, C. biaculeatus*
EPHIPPIDAE
Chaetodipterus
faber — *C. haemulonis*
POMACENTRIDAE
Microspathodon
chrysurus — *C. pomacentrus*
Pomacentrus
fuscus — *C. pomacentrus*
POMACANTHIDAE
Pomacanthus
arcuatus — *C. atromaculatus, C. longipedis, C. xystercus*
ciliaris — *C. atromaculatus*
CHAETODONTIDAE
Chaetodon
capistratus — *C. atromaculatus*
ocellatus — *C. atromaculatus*
striatus — *C. atromaculatus*
Holacanthus
tricolor — *C. pomacentrus*
LABRIDAE
Bodianus
rufus — *C. atromaculatus, C. suffuscus*
Halichoeres
bivittatus — *C. biaculeatus*
radiatus — *C. biaculeatus*
Lachnolaimus
maximus — *C. atromaculatus*
SPHYRAENIDAE
Sphyraena
barracuda — *C. isonyx*
ACANTHURIDAE
Acanthurus
bahianus — *C. atromaculatus, C. biaculeatus, C. kabatae, C. longipedis, C. suffuscus*
chirurgus — *C. atromatulatus, C. biaculeatus, C. kabatae*
coeruleus — *C. atromaculatus, C. biaculeatus, C. kabatae, C. longipedis*
heptatus — *C. atromaculatus*
SCOMBRIDAE
Scomber
japonicus — *C. pelamydis*

PLEURONECTIFORMES

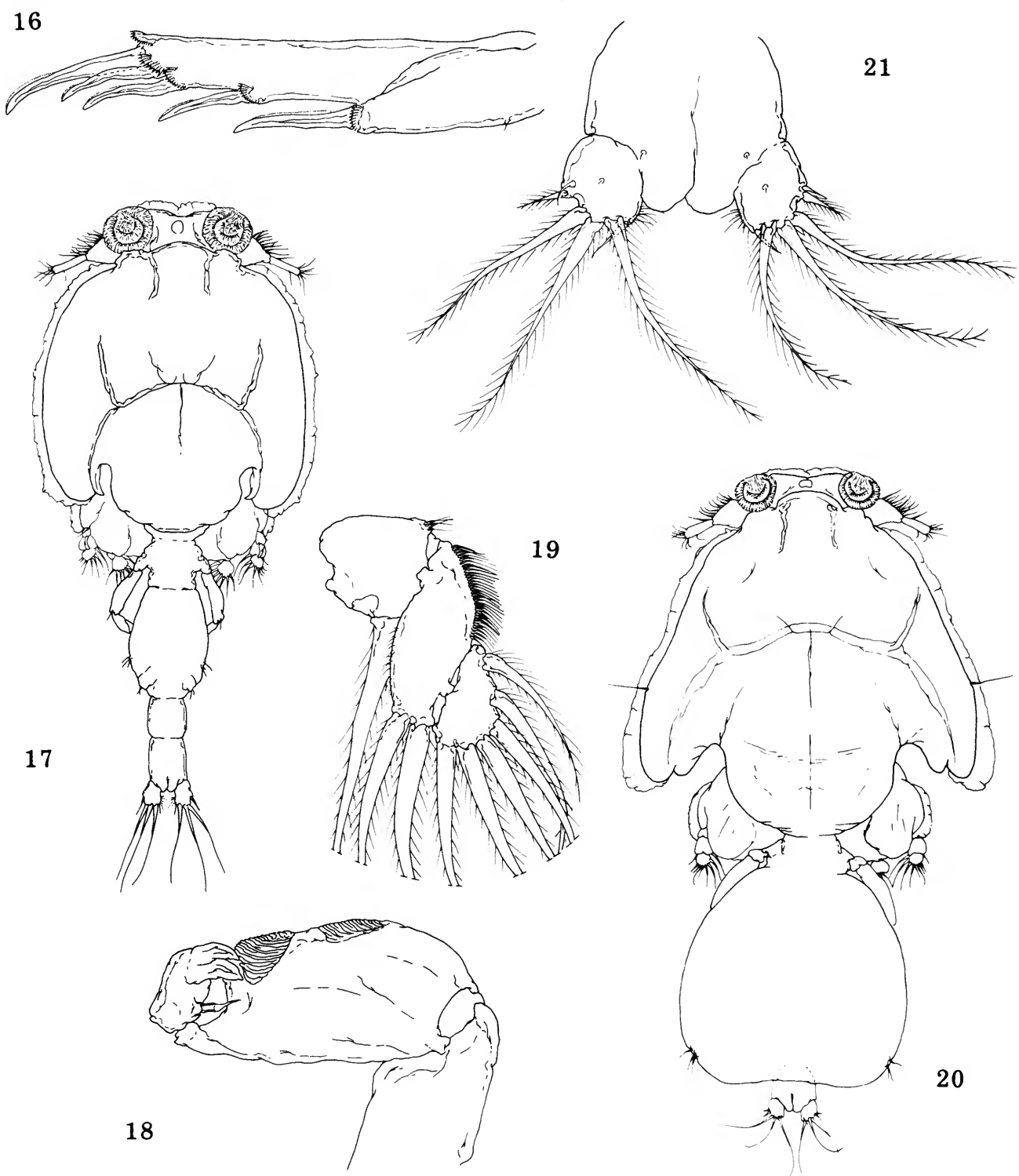
BOTHIDAE
Paralichthys
lethostigma — *C. longipedis*
Bothos
lunatus — *C. pomacentrus*
BALISTIDAE
Balistes
vetula — *C. suffuscus*
Canthidermis
maculatus — *C. balistes*
sobaco — *C. balistes*
MONACANTHIDAE
Aluterus
schoepfii — *C. haemulonis*
scriptus — *C. balistae*
Cantherhines
pullus — *C. kabatae*
Monacanthus
hispidus — *C. balistae, C. rufimaculatus*
OSTRACIIDAE
Lactophrys
bicaudalis — *C. longipedis*
quadricornis — *C. suffuscus, C. rufimaculatus*
DIODONTIDAE
Chilomycterus
atinga — *C. praetextus*



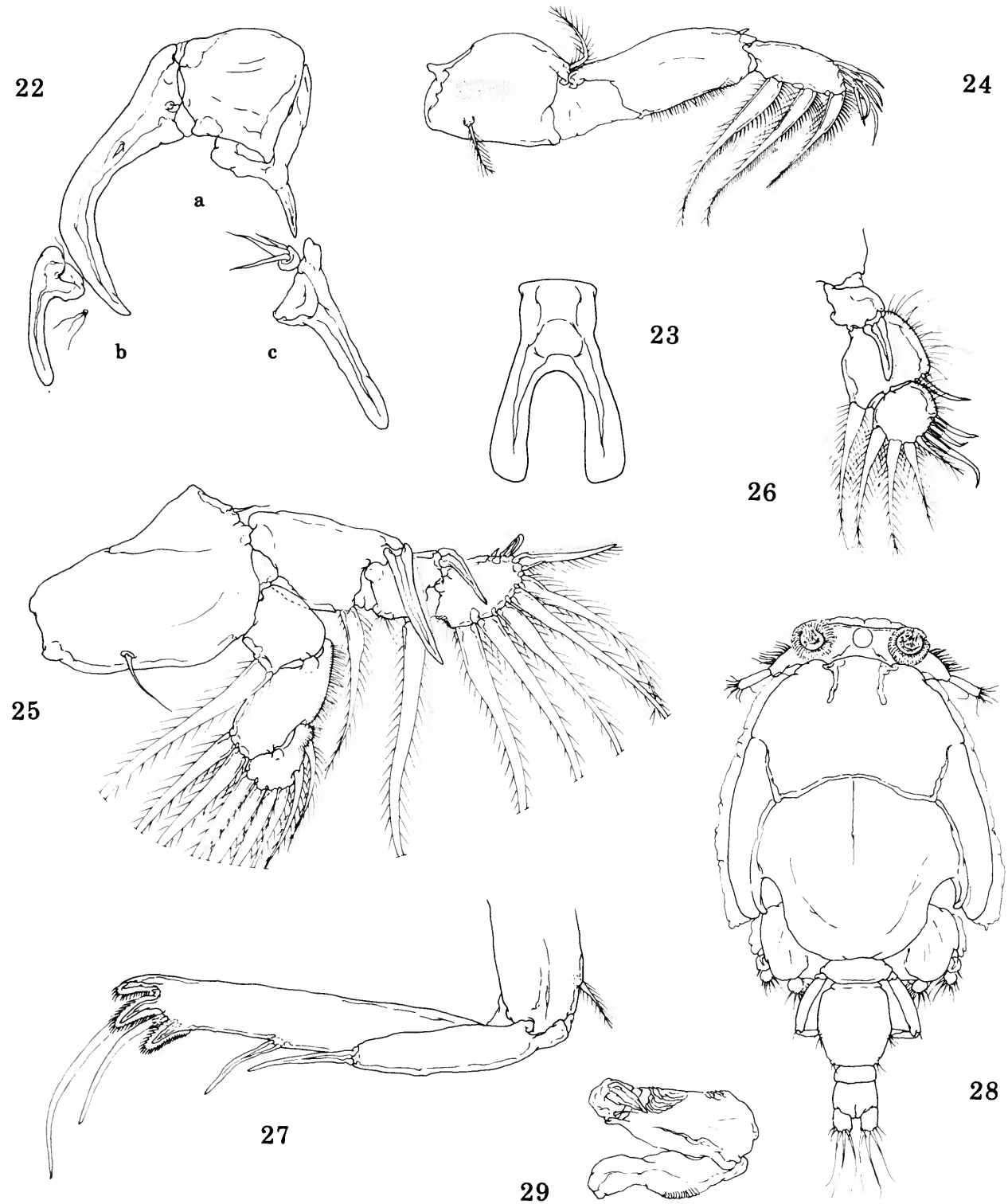
FIGURES 1–8.—*Caligus afurcatus* Wilson, female: 1, dorsal; 2, caudal rami; 3*a*, second antenna; 3*b*, postantennal spine; 3*c*, spiniform process of first maxilla; 4, sternal furca; 5, leg 1; 6, leg 2; 7, exopod of leg 3; 8, leg 4.



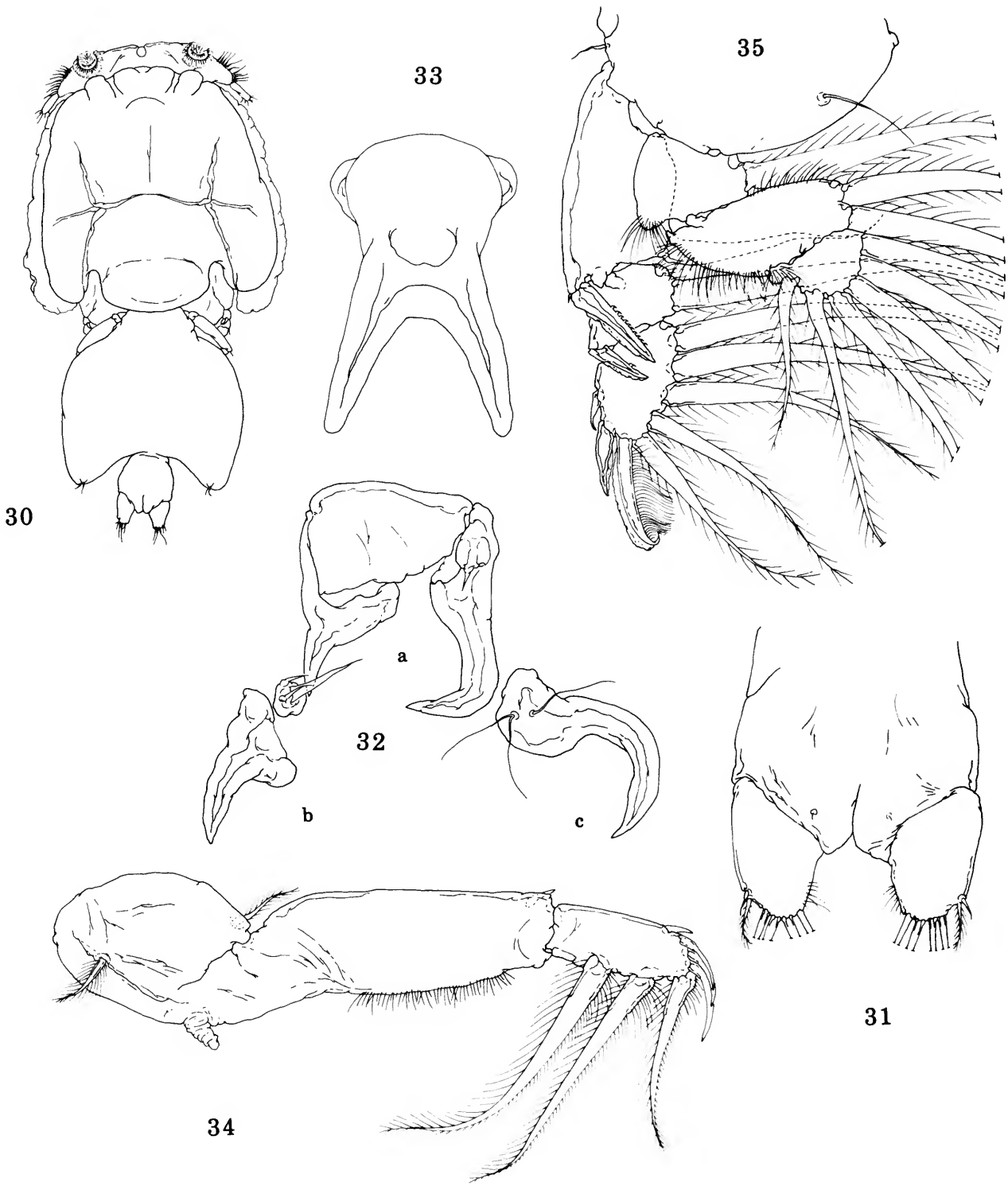
FIGURES 9–15.—*Caligus asperimanus* Pearse, female: 9, dorsal; 10, caudal rami; 11*a*, second antenna; 11*b*, postantennal spine; 11*c*, spiniform process of first maxilla; 12, sternal furca; 13, leg 1; 14, leg 2; 15, exopod of leg 3.



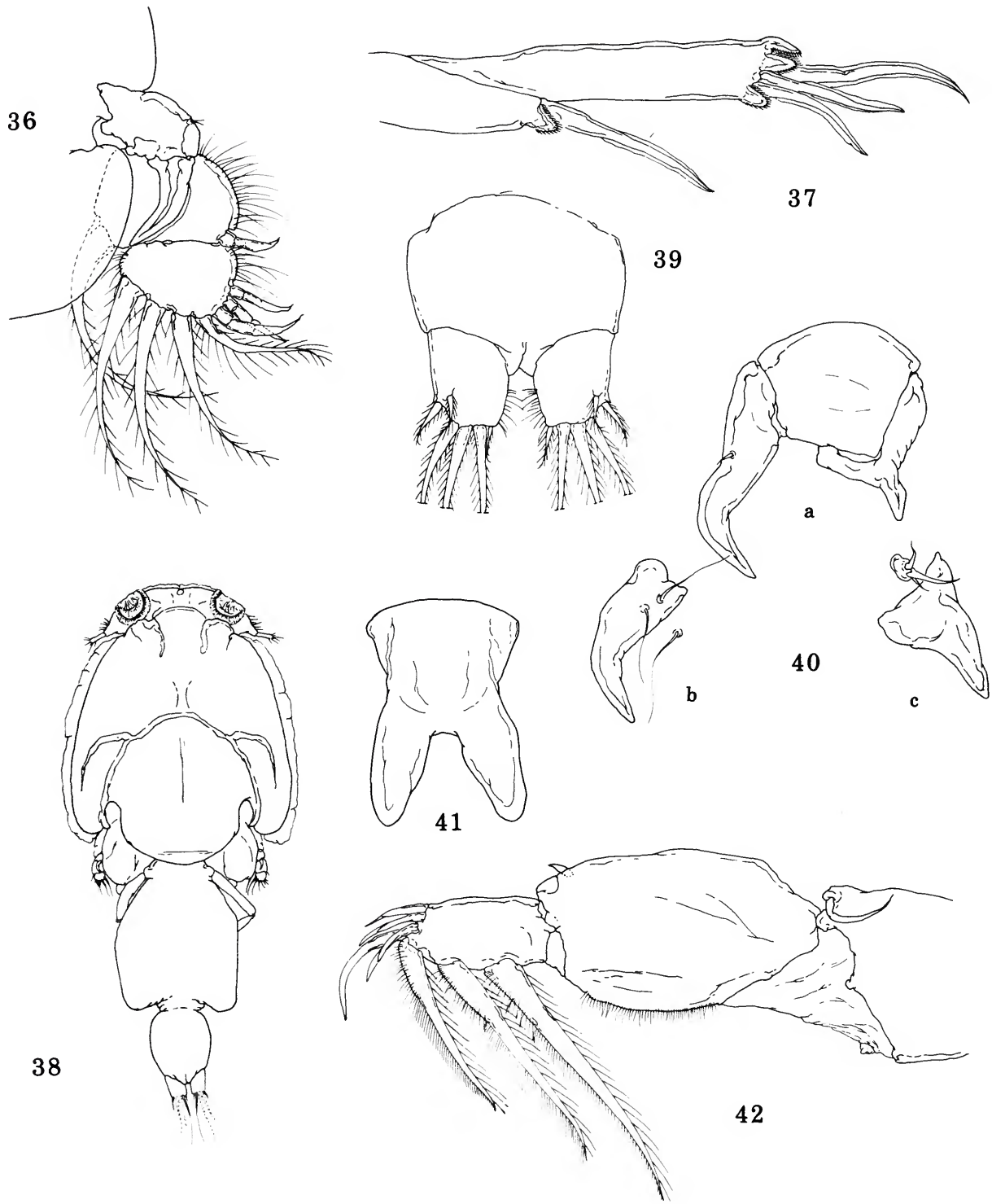
FIGURES 16–21.—*Caligus asperimanus* Pearse: 16, female, leg 4; 17, male, dorsal; 18, male, second antenna; 19, male, endopod of leg 2. *Caligus atromaculatus* Wilson, female: 20, dorsal; 21, abdomen and caudal rami.



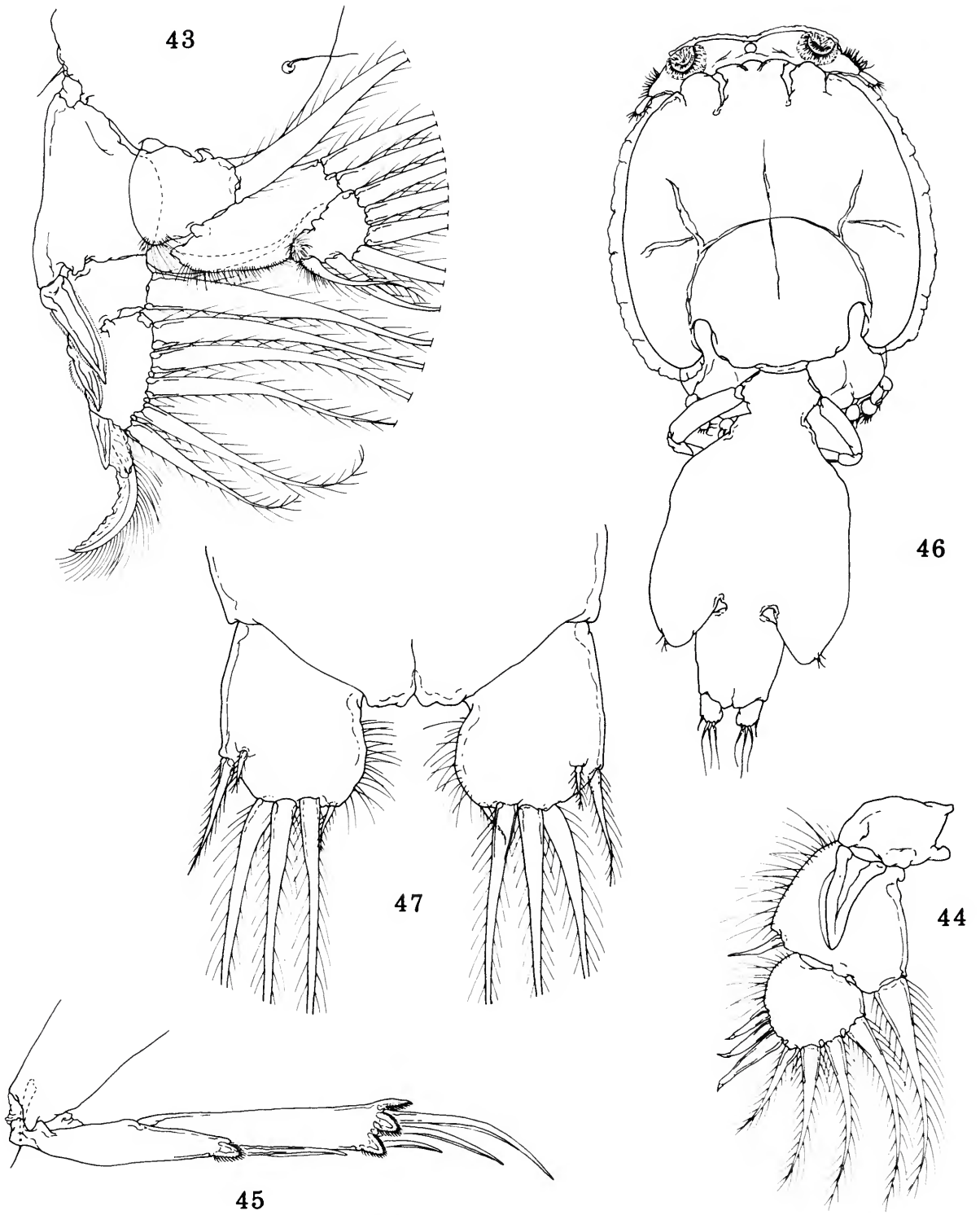
FIGURES 22–29.—*Caligus atromaculatus* Wilson: 22*a*, second antenna; 22*b*, postantennal spine; 22*c*, spiniform process of first maxilla; 23, sternal furca; 24, leg 1; 25, leg 2; 26, exopod of le g 3; 27, leg 4; 28, male, dorsal; 29, male, second antenna.



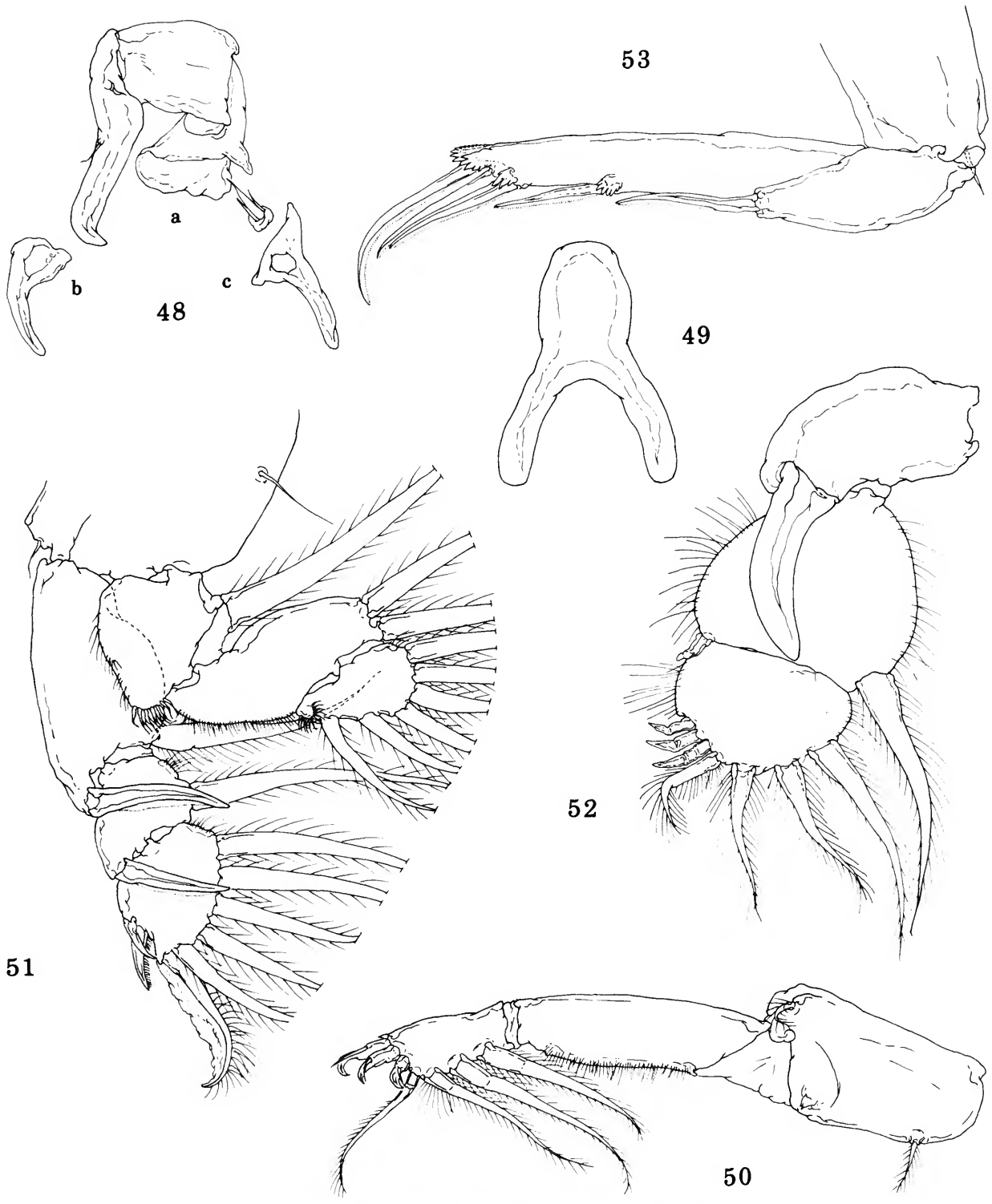
FIGURES 30–35.—*Caligus balistae* Steenstrup and Lütken, female: 30, dorsal; 31, abdomen and caudal rami; 32*a*, second antenna; 32*b*, postantennal spine; 32*c*, spiniform process of first maxilla; 33, sternal furca; 34, leg 1; 35, leg 2.



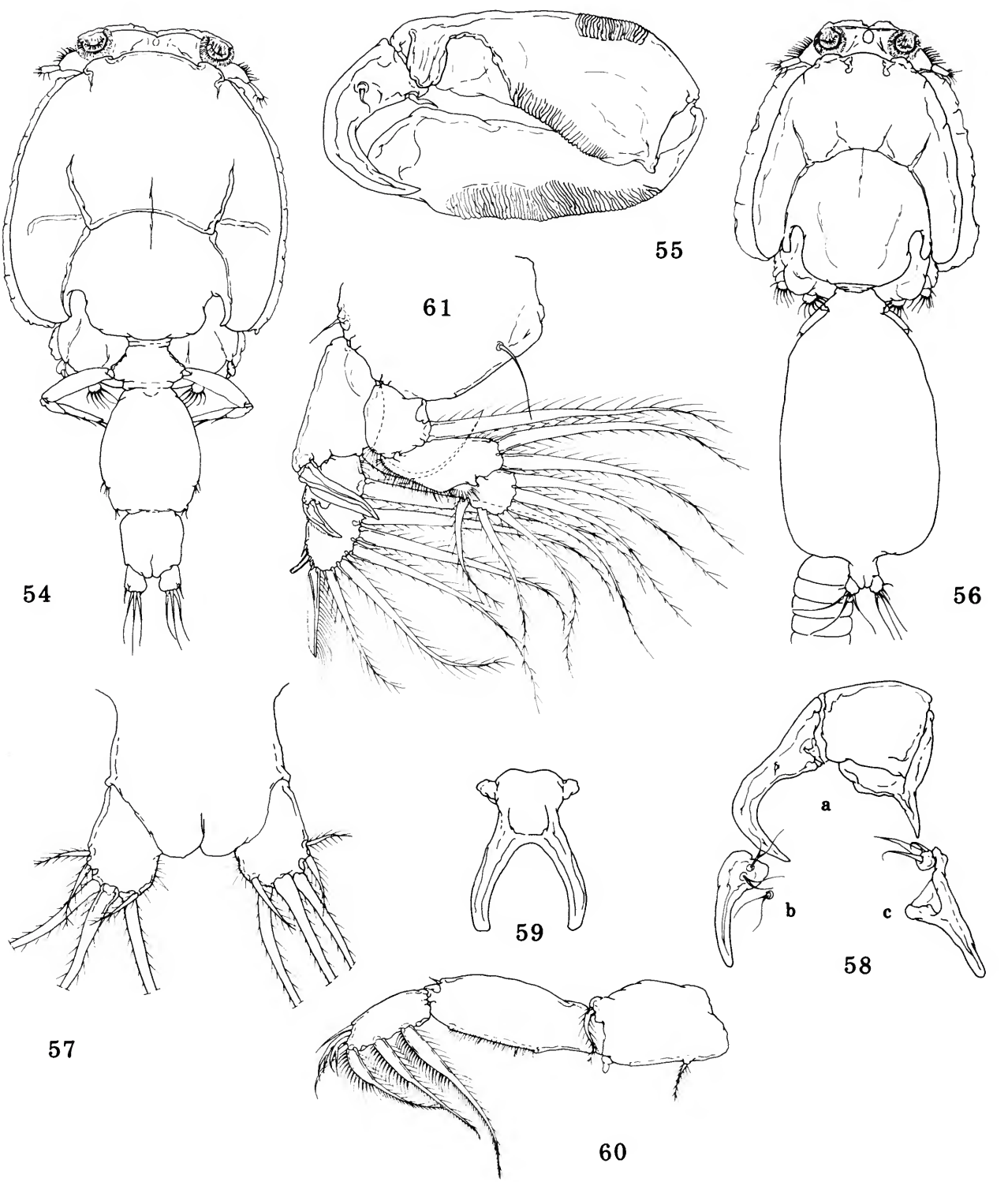
FIGURES 36–42.—*Caligus balistae* Steenstrup and Lütken, female: 36, exopod of leg 3; 37, leg 4. *Caligus wilsoni* Delamare Deboutteville and Nunes Ruivo, female: 38, dorsal; 39, caudal rami; 40*a*, second antenna; 40*b*, postantennal spine; 40*c*, spiniform process of first maxilla; 41, sternal furca; 42, leg 1.



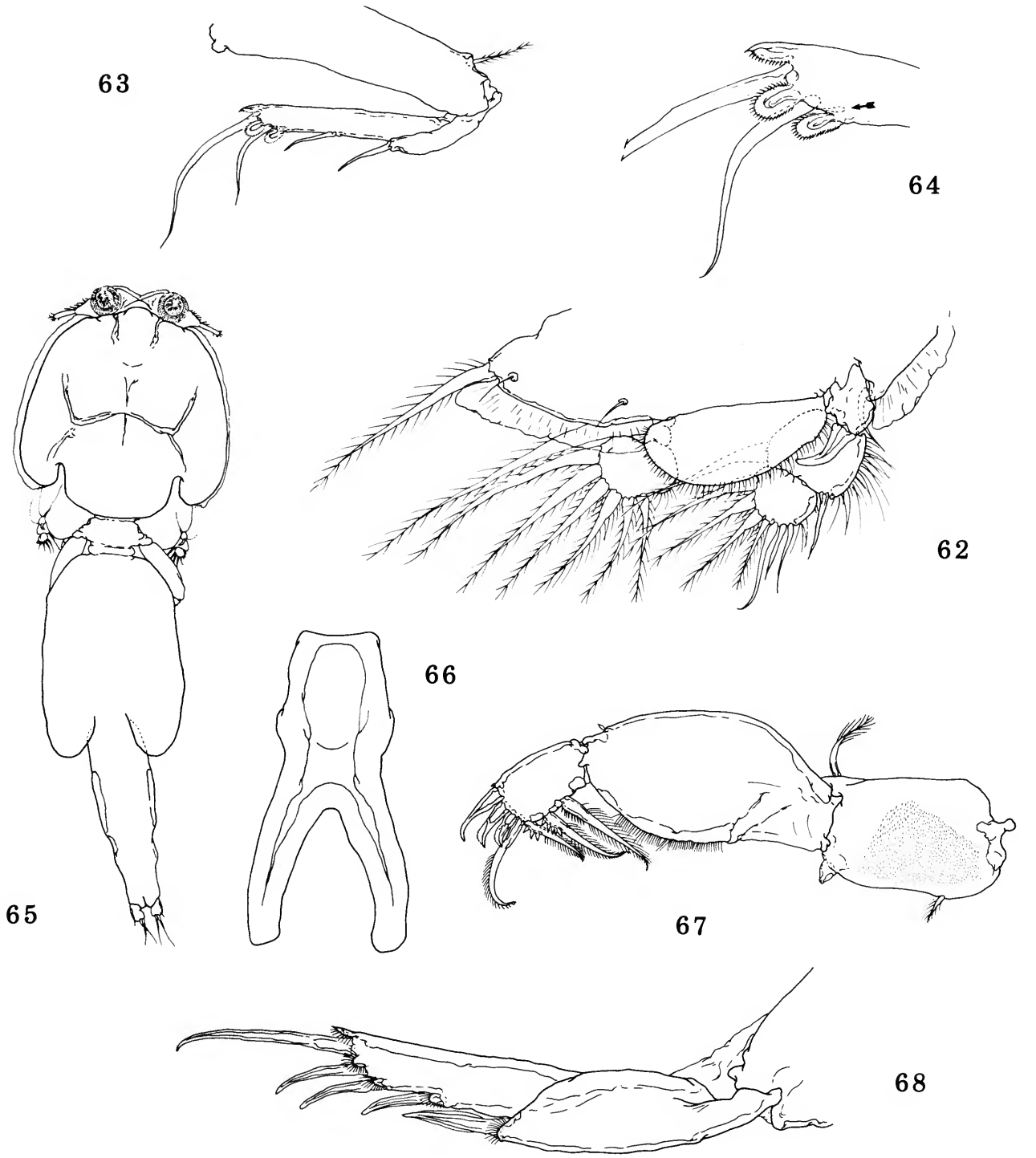
FIGURES 43–47.—*Caligus wilsoni* Delamare Deboutteville and Nunes Ruivo, female: 43, leg 2; 44, exopod of leg 3; 45, leg 4. *Caligus berychis* Wilson, female: 46, dorsal; 47, caudal rami.



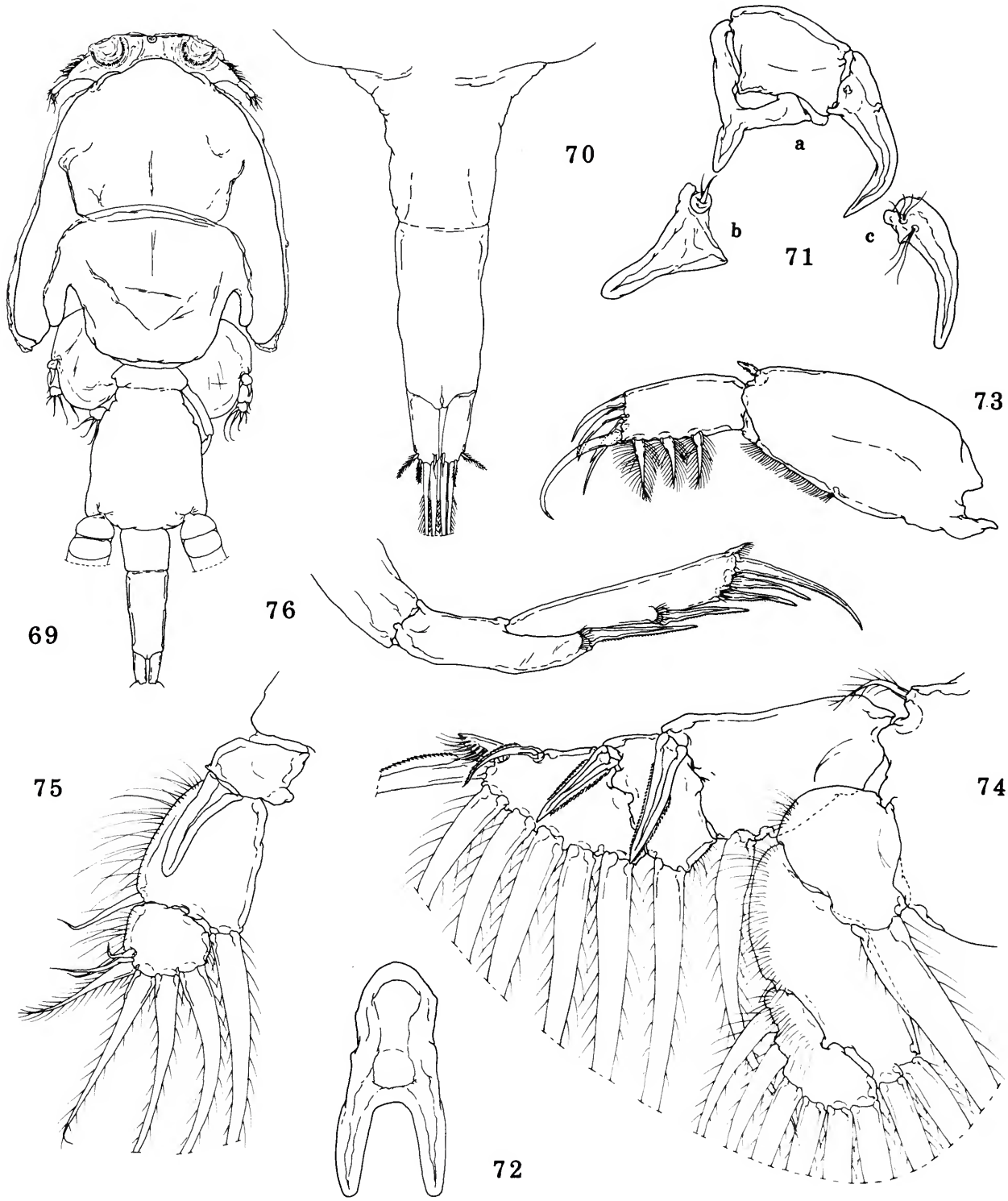
FIGURES 48–53.—*Caligus berychis* Wilson, female: 48*a*, second antenna; 48*b*, postantennal spine; 48*c*, spiniform process of first maxilla; 49, sternal furca; 50, leg 1; 51, leg 2; 52, exopod of leg 3; 53, leg 4.



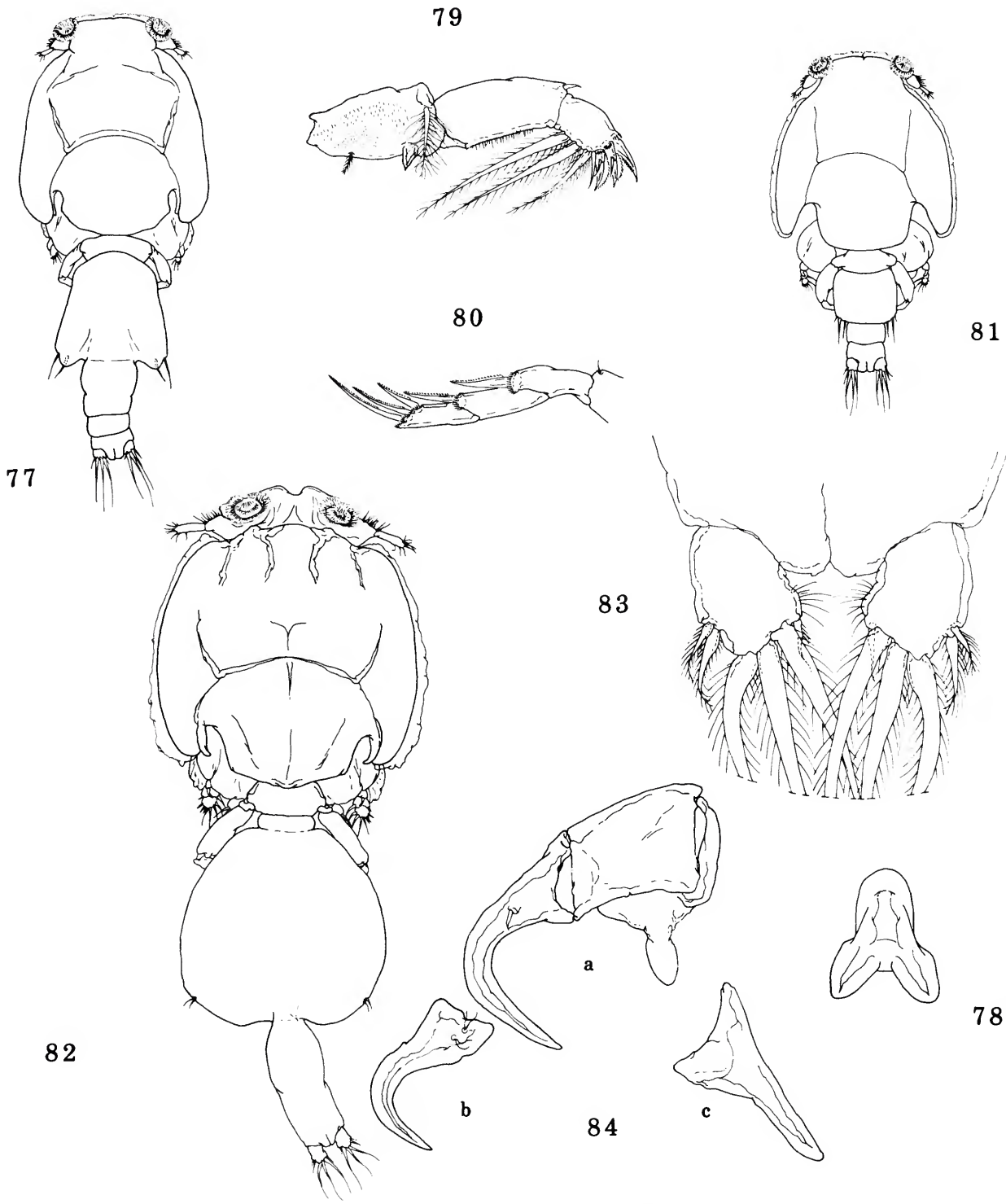
FIGURES 54–61.—*Caligus berychis* Wilson, male: 54, dorsal; 55, second antenna. *Caligus biaculeatus* Brian, female: 56, dorsal; 57, caudal rami; 58*a*, second antenna; 58*b*, postantennal spine; 58*c*, spiniform process of first maxilla; 59, sternal furca; 60, leg 1; 61, leg 2.



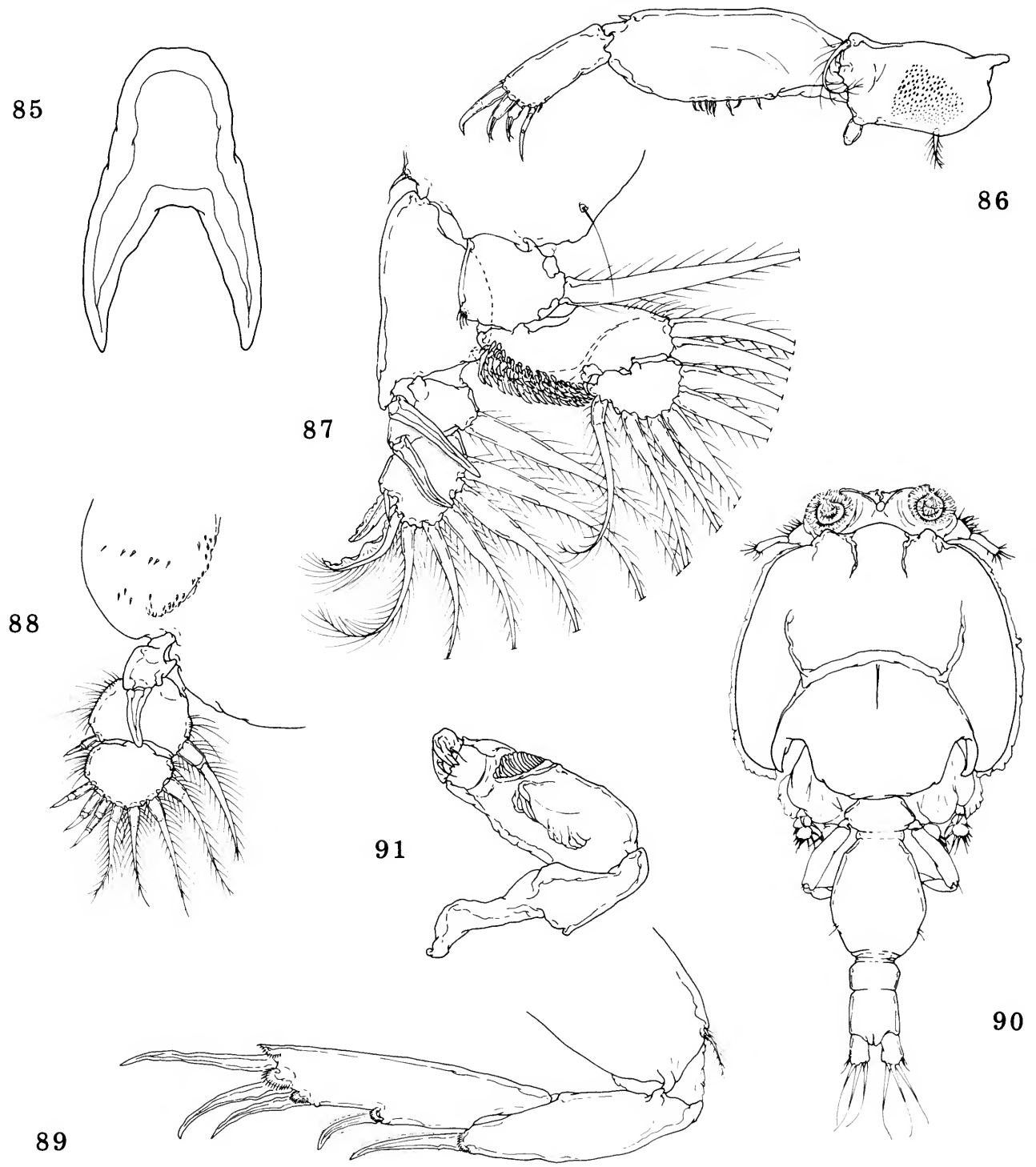
FIGURES 62-68.—*Caligus biaculeatus* Brian, female: 62, leg 3; 63, leg 4; 64, detail of tip of leg 4. *Caligus bonito* Wilson, female: 65, dorsal; 66, sternal furca; 67, leg 1; 68, leg 4.



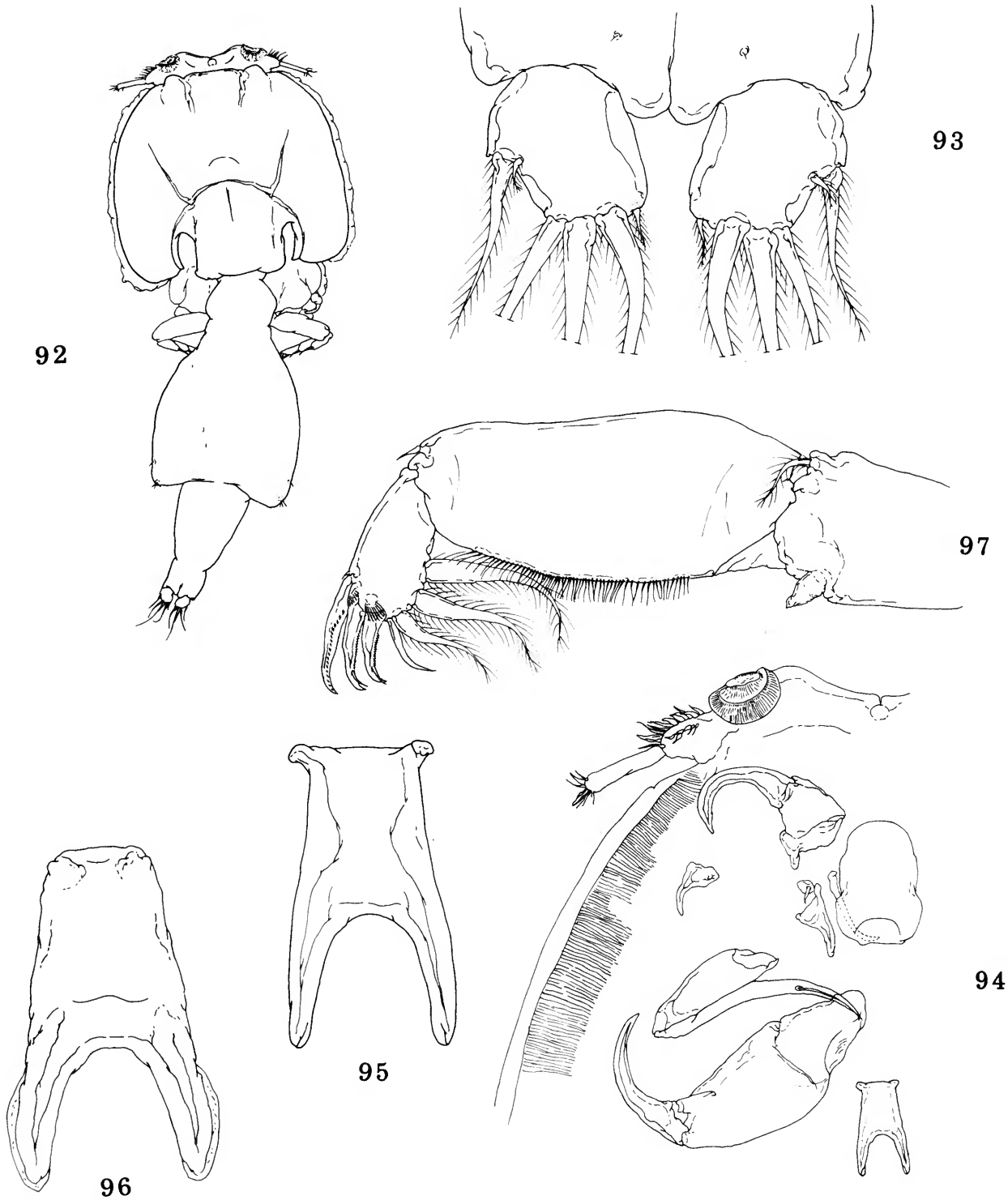
FIGURES 69–76.—*Caligus chelifer* Wilson, female: 69, dorsal; 70, abdomen and caudal rami; 71*a*, second antenna; 71*b*, postantennal spine; 71*c*, spiniform process of first maxilla; 72, sternal furca; 73, leg 1; 74, leg 2; 75, exopod of leg 3; 76, leg 4.



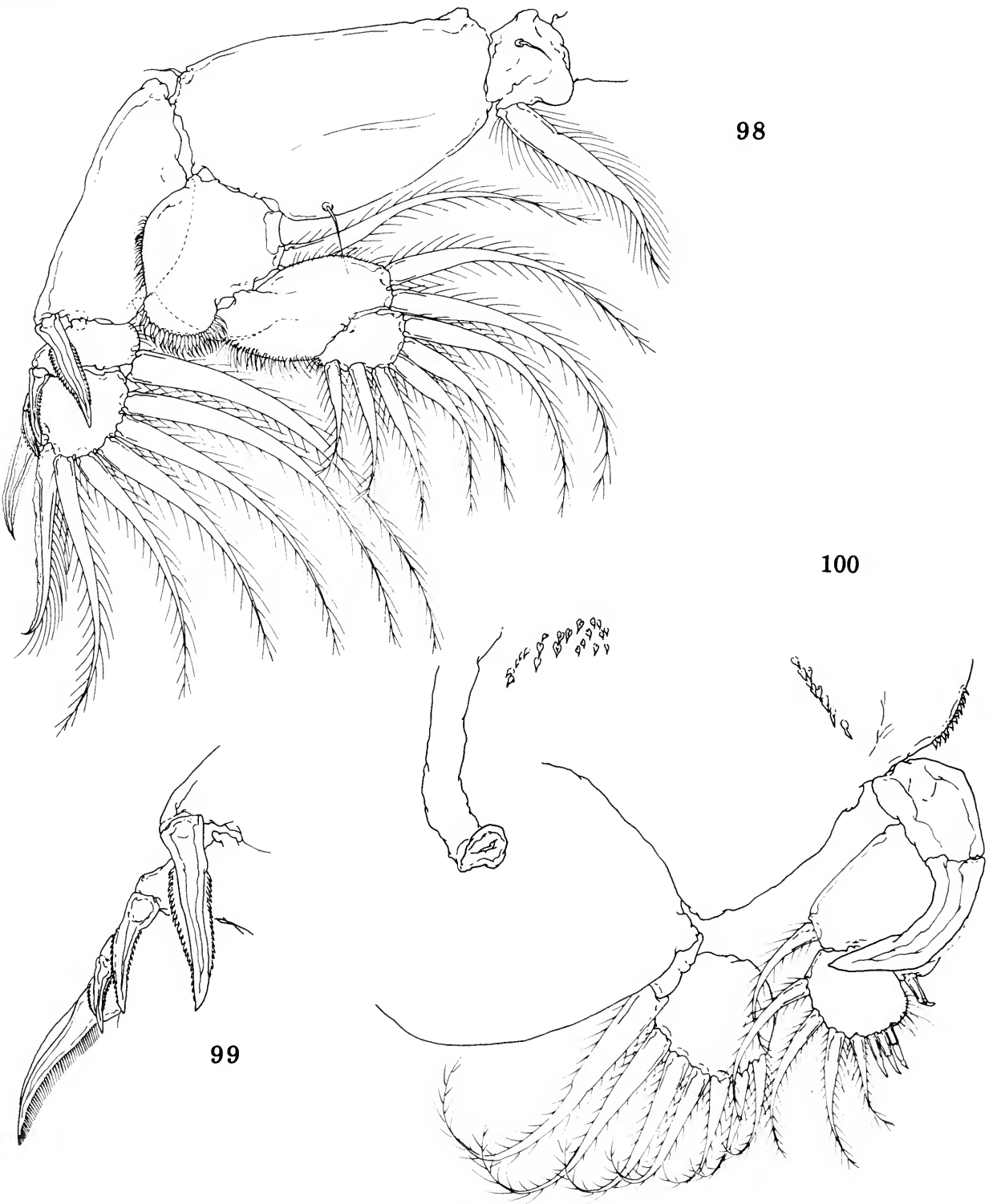
FIGURES 77–84.—*Caligus coryphaenae* Steenstrup and Lütken, female: 77, dorsal; 78, sternal furca; 79, leg 1; 80, leg 4; 81, male, dorsal. *Caligus haemulonis* Krøyer, female: 82, dorsal; 83, caudal rami; 84*a*, second antenna; 84*b*, postantennal spine; 84*c*, spiniform process of first maxilla.



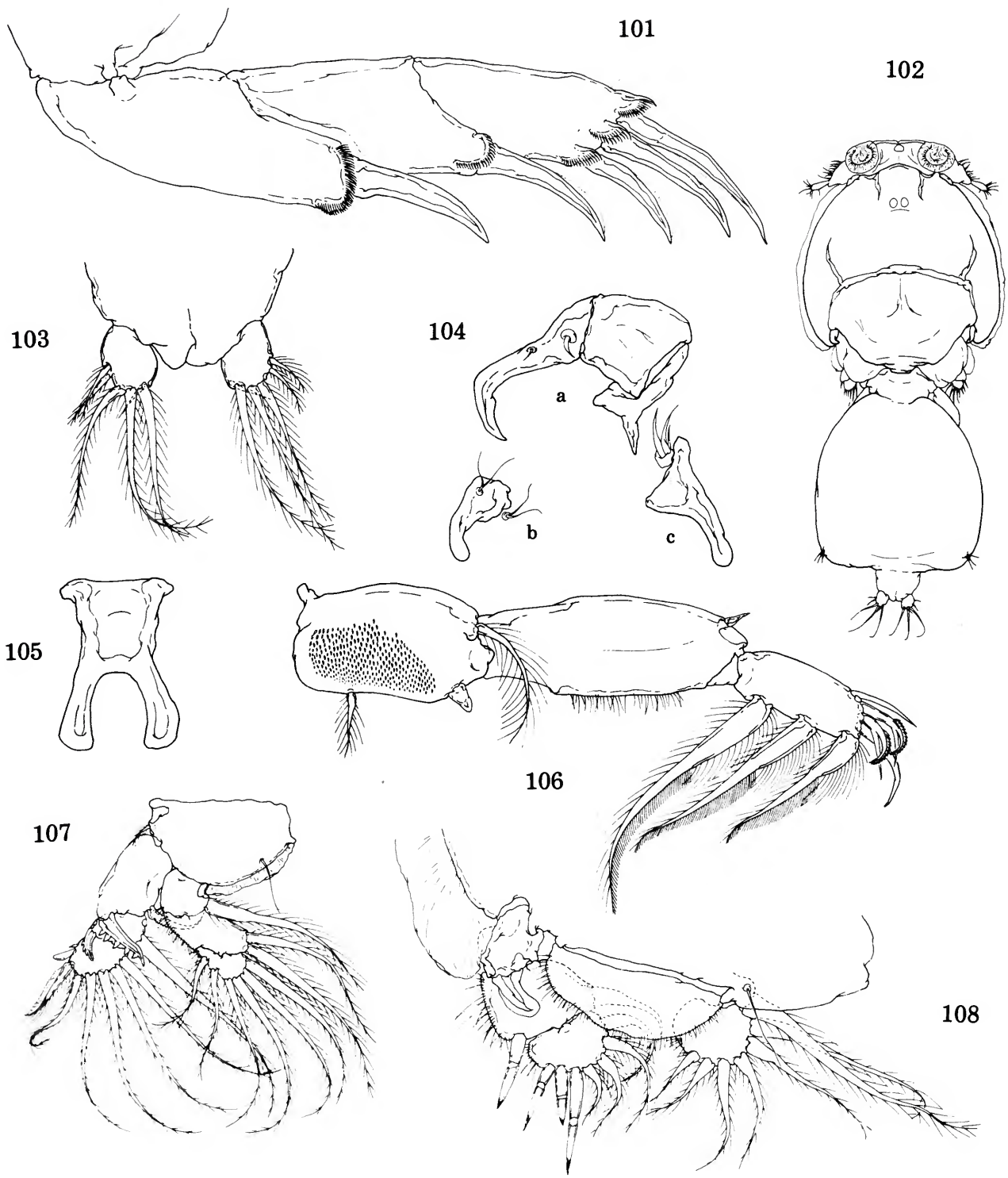
FIGURES 85–91.—*Caligus haemulonis* Krøyer. Female: 85, sternal furca; 86, leg 1; 87, leg 2; 88, exopod of leg 3; 89, leg 4. Male: 90, dorsal; 91, second antenna.



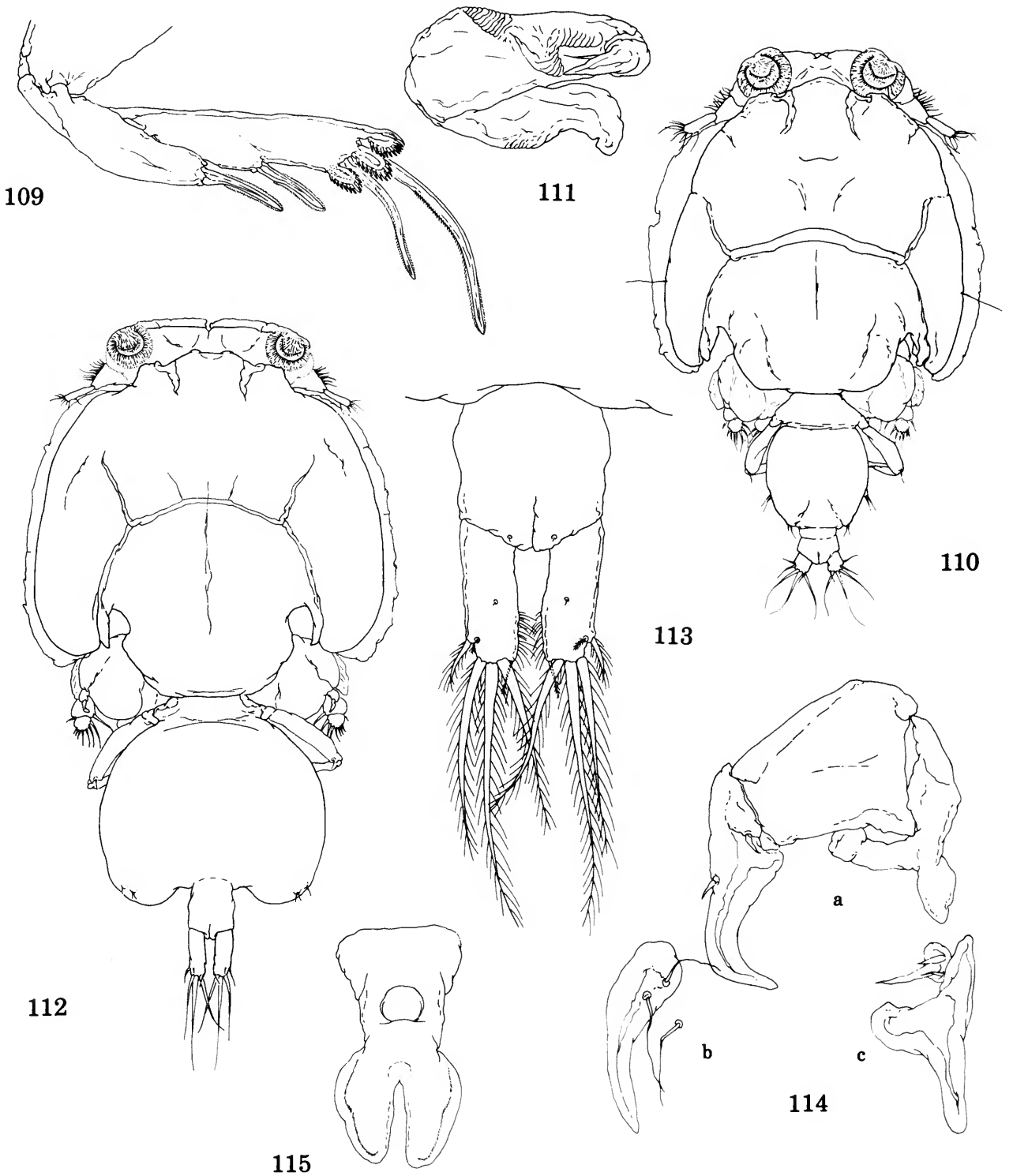
FIGURES 92-97.—*Caligus isonyx* Steenstrup and Lütken, female: 92, dorsal; 93, caudal rami; 94, anterior portion of cephalothorax, ventral; 95, sternal furca; 96, sternal furca (variant); 97, leg 1.



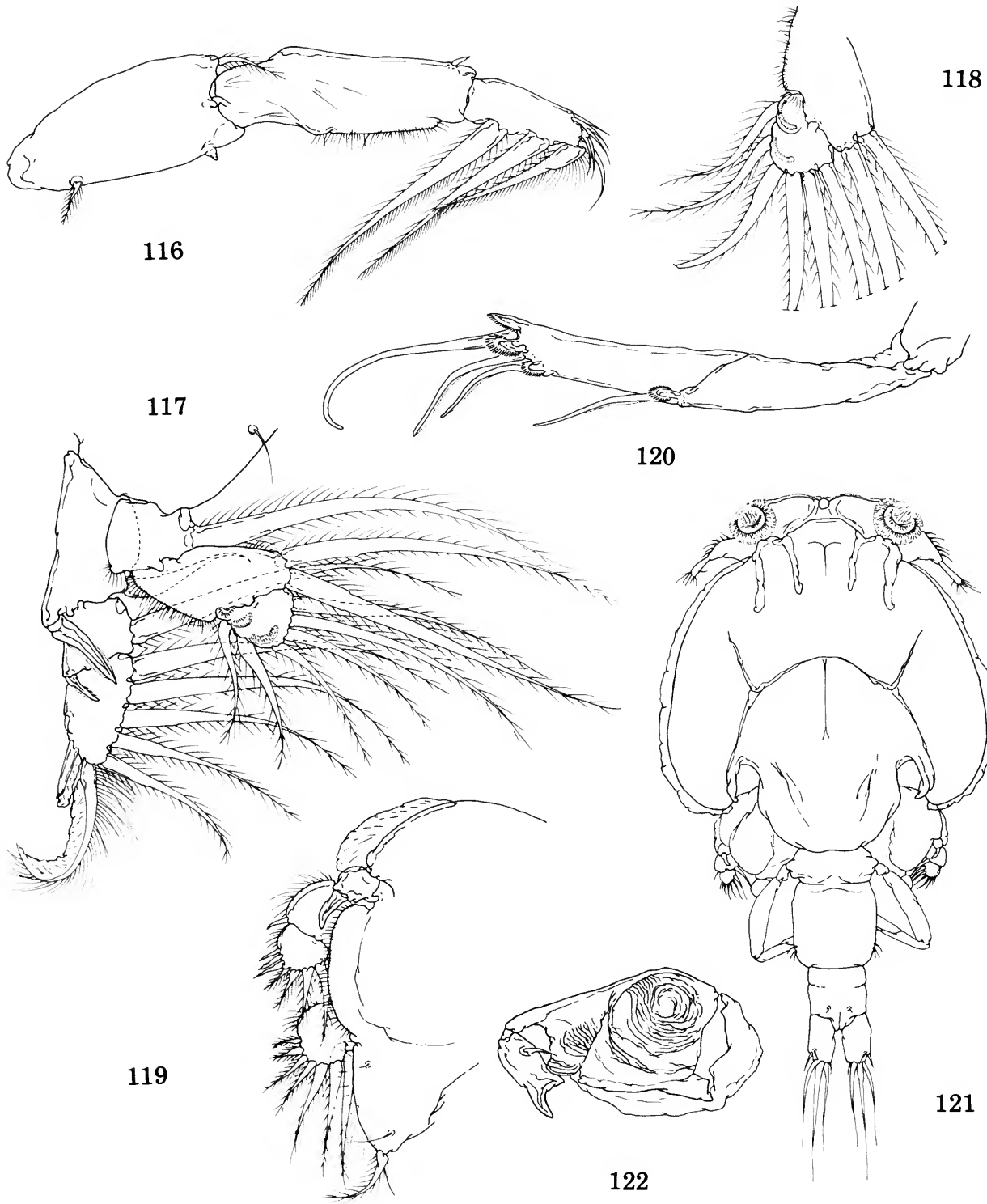
FIGURES 98–100.—*Caligus isonyx* Steenstrup and Lütken, female: 98, leg 2; 99 detail of exopod spines of leg 2; 100, leg 3.



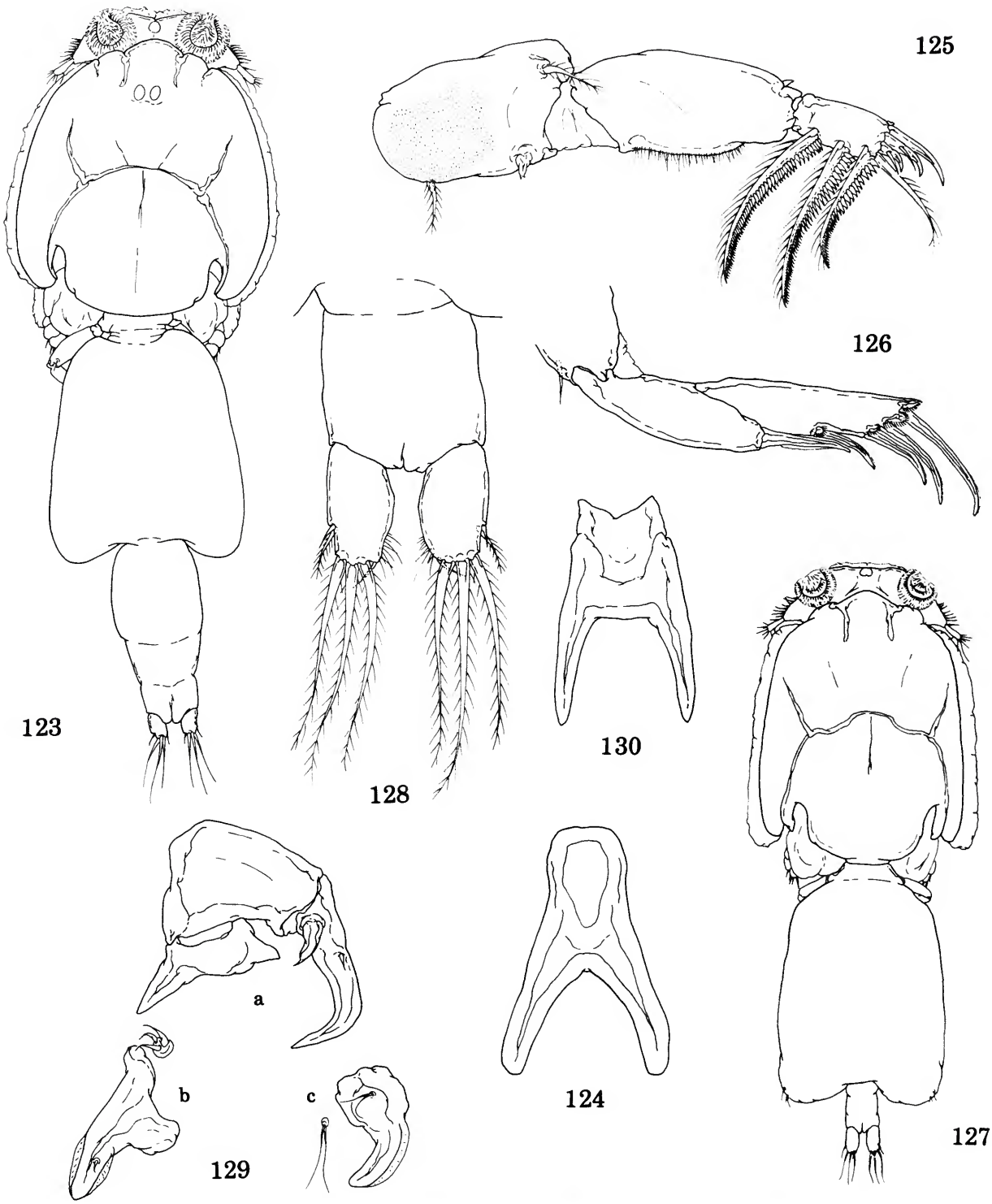
FIGURES 101–108.—*Caligus isonyx* Steenstrup and Lütken, female: 101, leg 4. *Caligus kabatae*, new species, female: 102, dorsal; 103, caudal rami; 104*a*, second antenna; 104*b*, postantennal spine; 104*c*, spiniform process of first maxilla; 105, sternal furca; 106, leg 1; 107, leg 2; 108, leg 3.



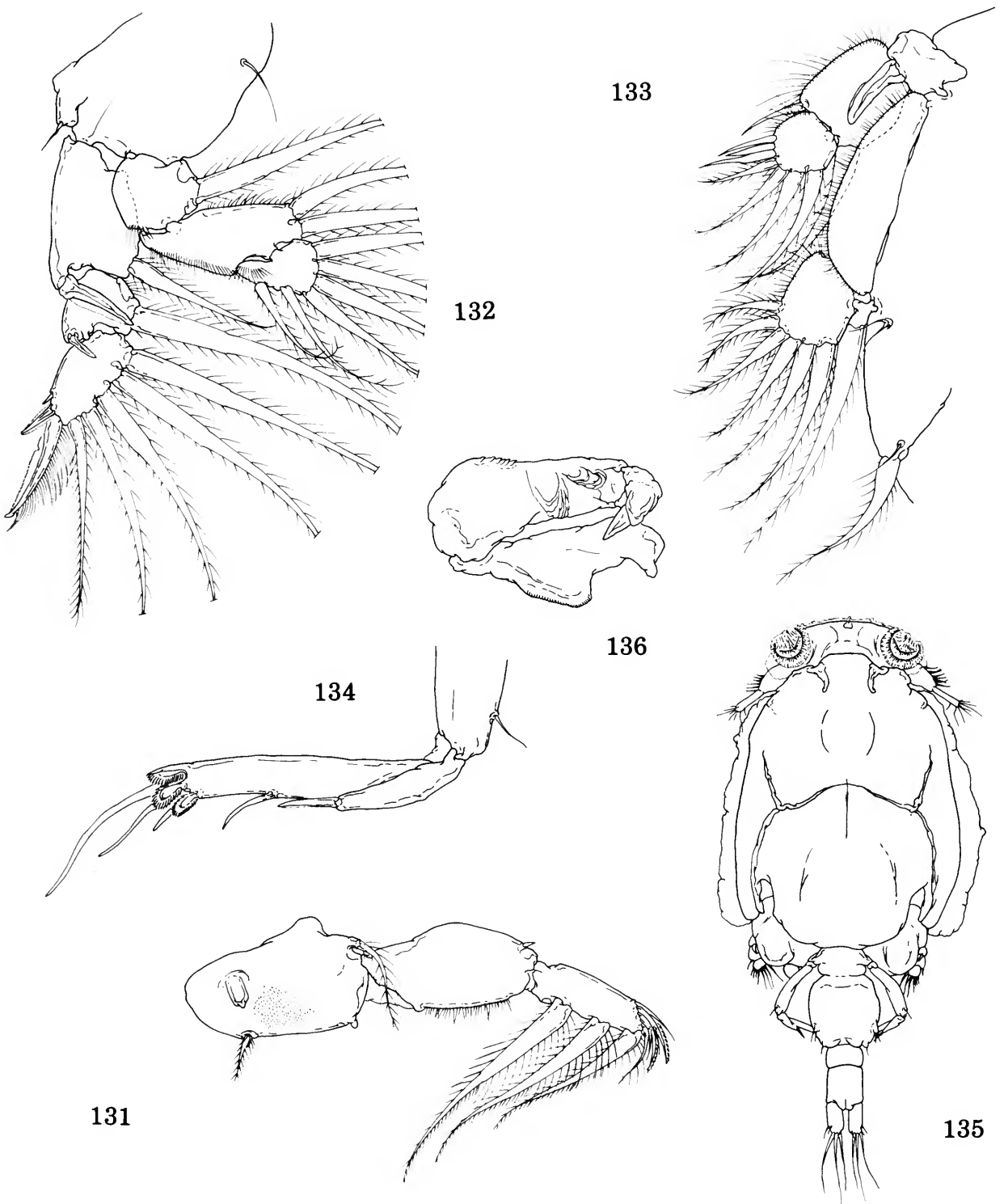
FIGURES 109–115.—*Caligus kabatae*, new species: 109, female, leg 4; 110, male, dorsal; 111, male, second antenna. *Caligus longipedis* Bassett-Smith, female: 112, dorsal; 113, abdomen and caudal rami; 114*a*, second antenna; 114*b*, postantennal spine; 114*c*, spiniform process of first maxilla; 115, sternal furca.



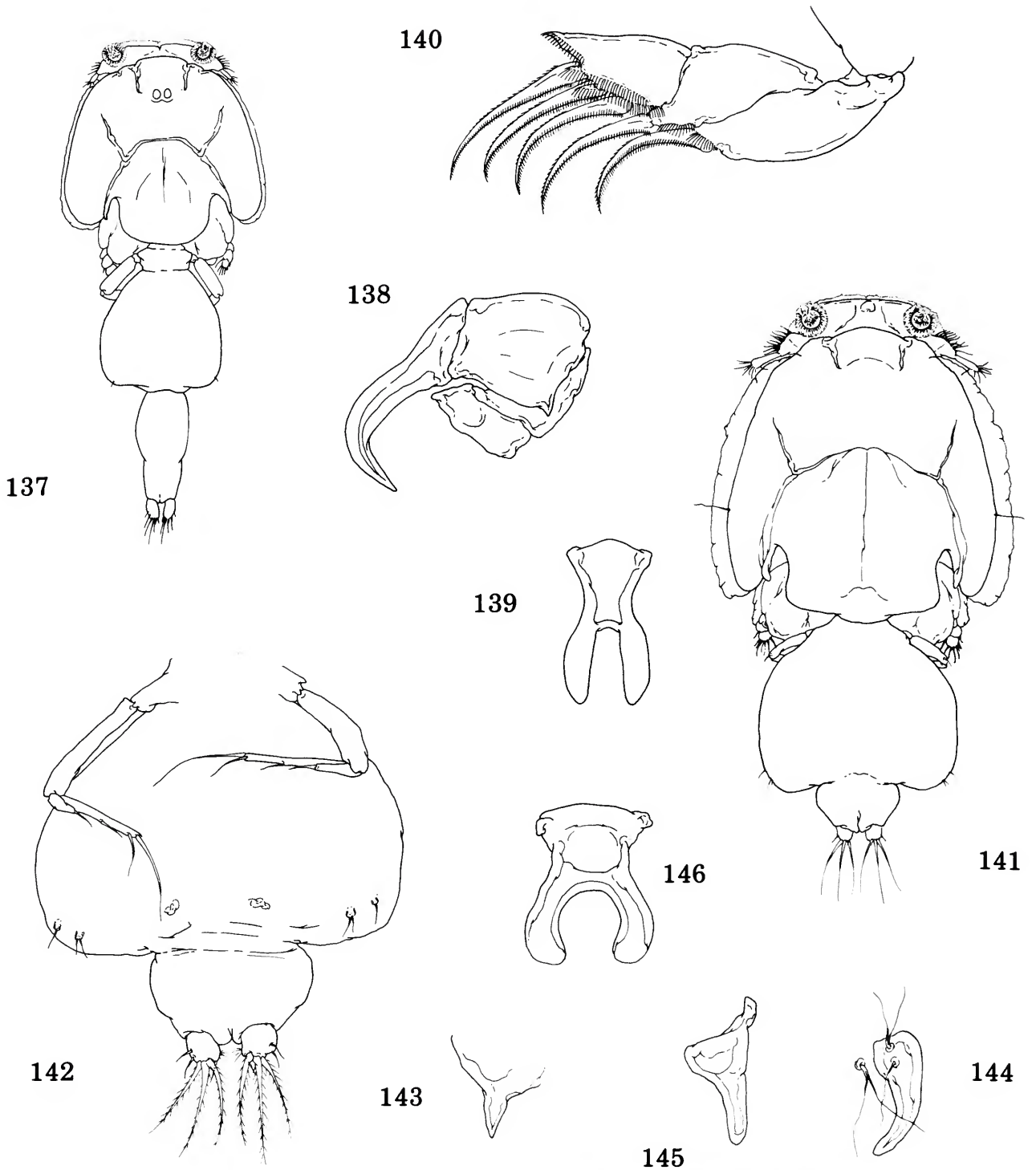
FIGURES 116–122.—*Caligus longipedis* Bassett-Smith. Female: 116, leg 1; 117, leg 2; 118, detail of leg 2 endopod last segments; 119, leg 3; 120, leg 4. Male: 121, dorsal; 122, second antenna.



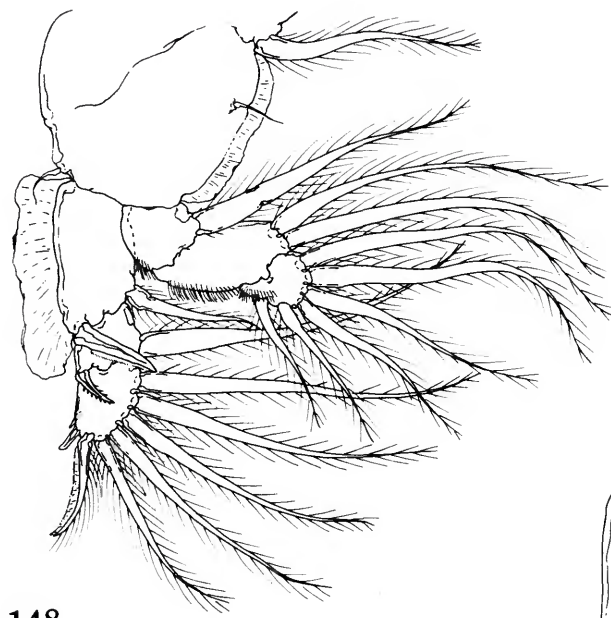
FIGURES 123–130.—*Caligus mutabilis* Wilson, female: 123, dorsal; 124, leg 1; 125, sternal furca; 126, leg 4. *Caligus ocyurus*, new species, female: 127, dorsal; 128, abdomen and caudal rami; 129*a*, second antenna; 129*b*, postantennal spine; 129*c*, spiniform process of first maxilla; 130, sternal furca.



FIGURES 131–136.—*Caligus ocyurus*, new species. Female: 131, leg 1; 132, leg 2; 133, leg 3; 134, leg 4. Male: 135, dorsal; 136, second antenna.



FIGURES 137–146.—*Caligus pelamydis* Krøyer, female: 137, dorsal; 138, second antenna; 139, sternal furca; 140, leg 4. *Caligus pomacentrus*, new species, female: 141, dorsal; 142, genital complex, abdomen, caudal rami; 143, posterior spine of second antenna; 144, postantennal spine; 145, spiniform process of first maxilla; 146, sternal furca.



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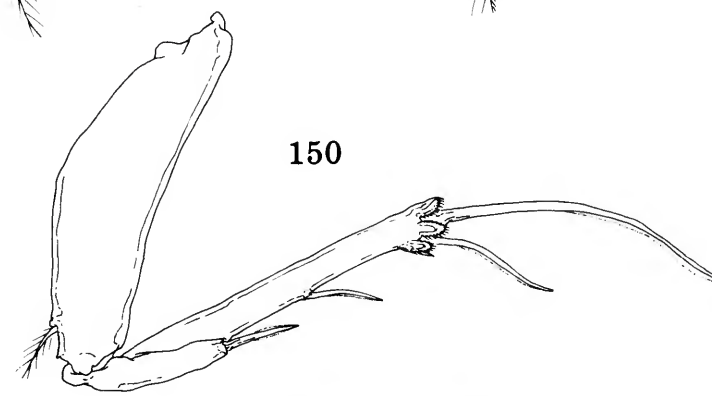
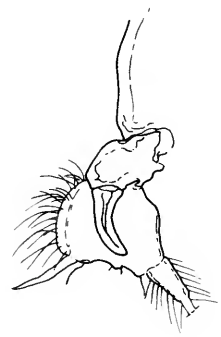
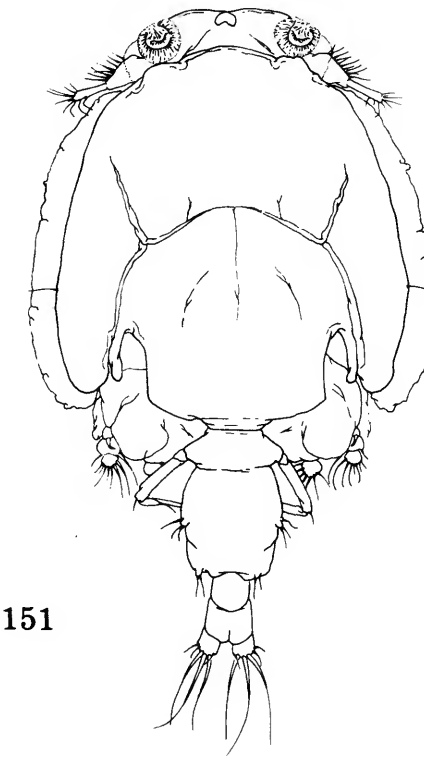
147



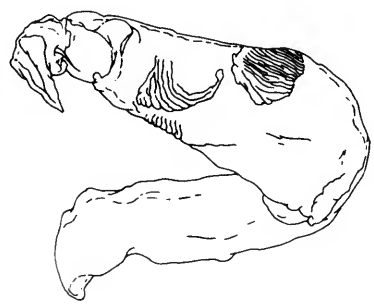
150



149



151



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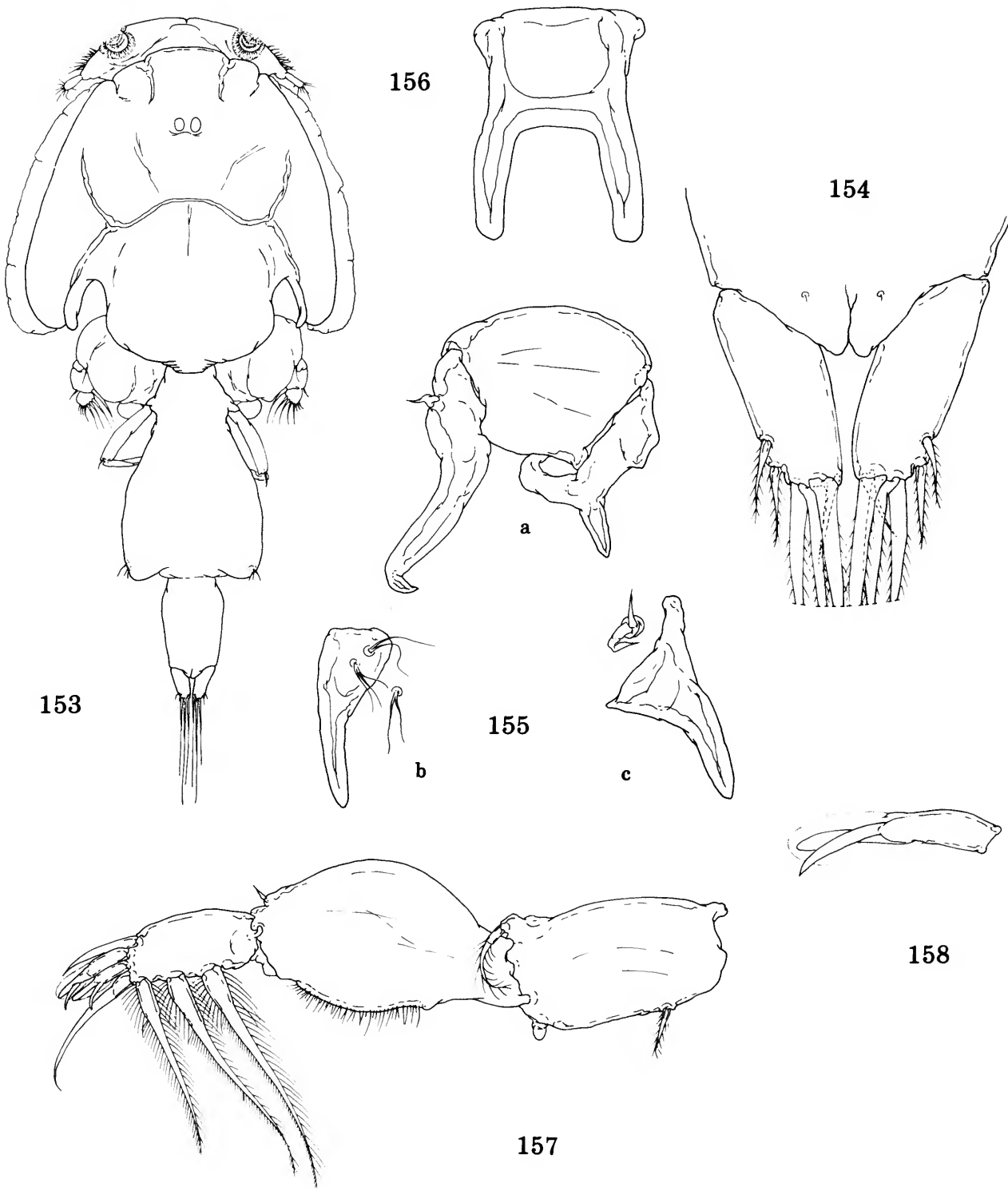
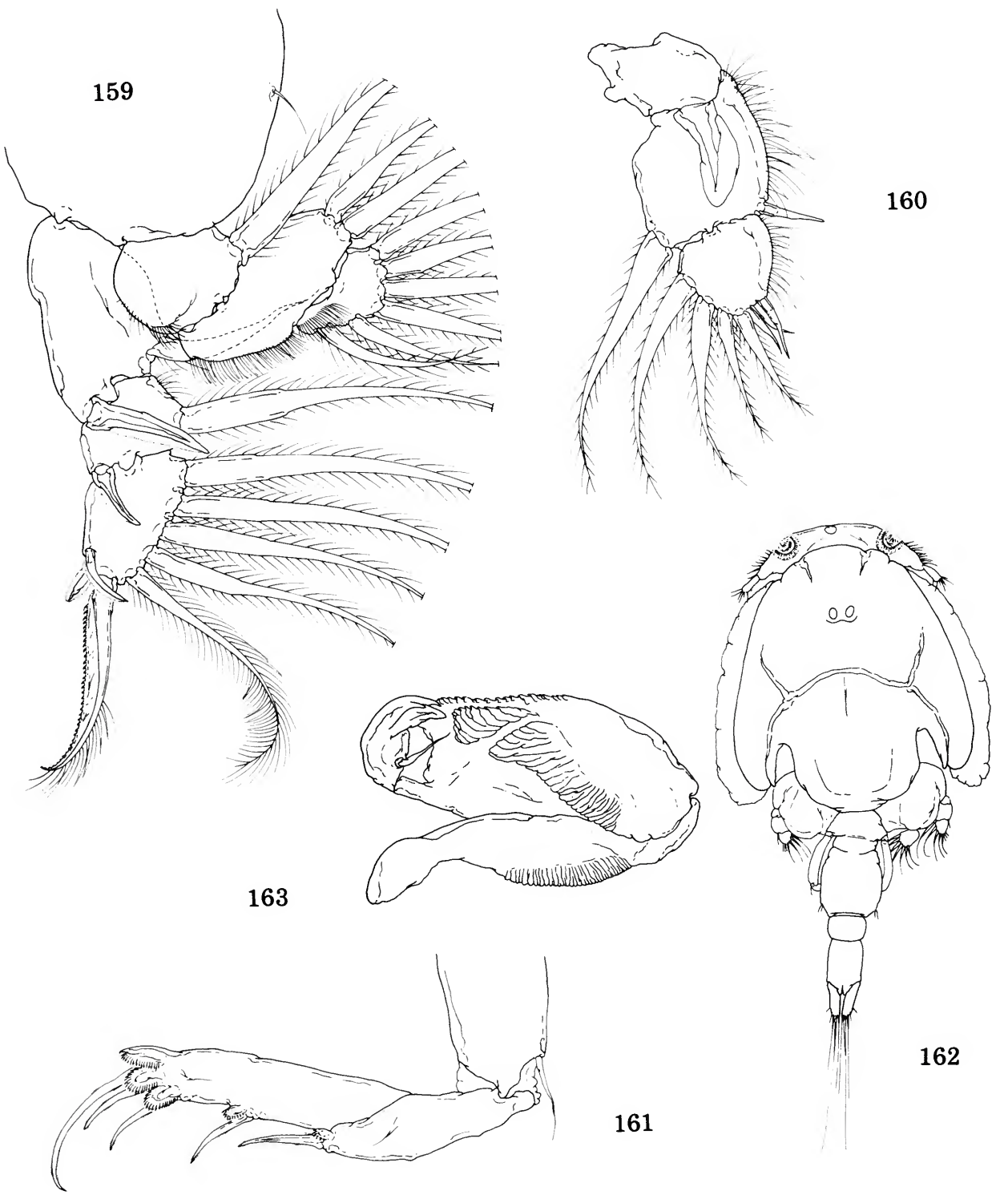
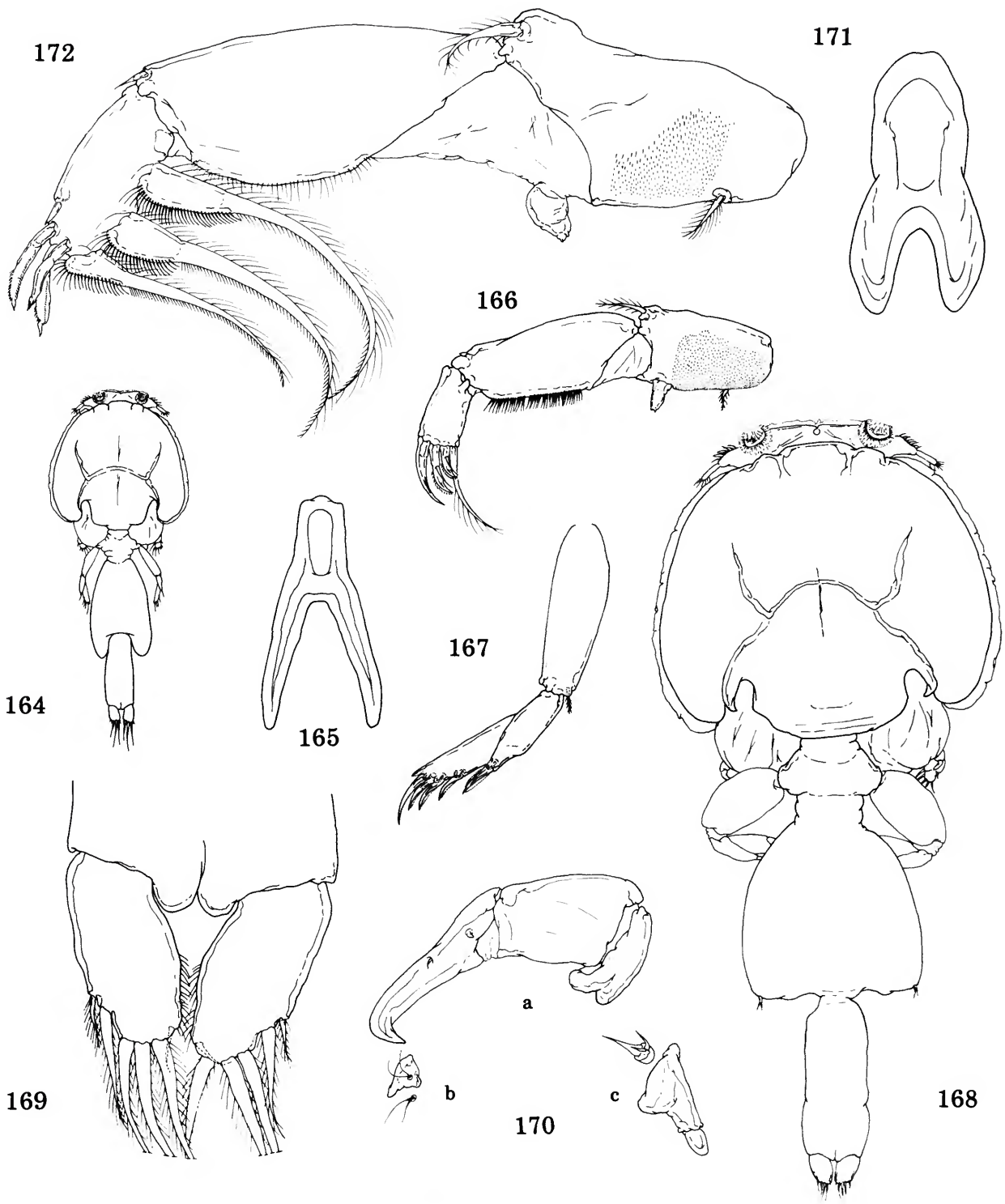
FIGURES 147–152.—*Caligus pomacentrus*, new species. Female: 147, leg 1; 148, leg 2; 149, first 2 exopod segments of leg 3; 150, leg 4. Male: 151, dorsal; 152, second antenna.



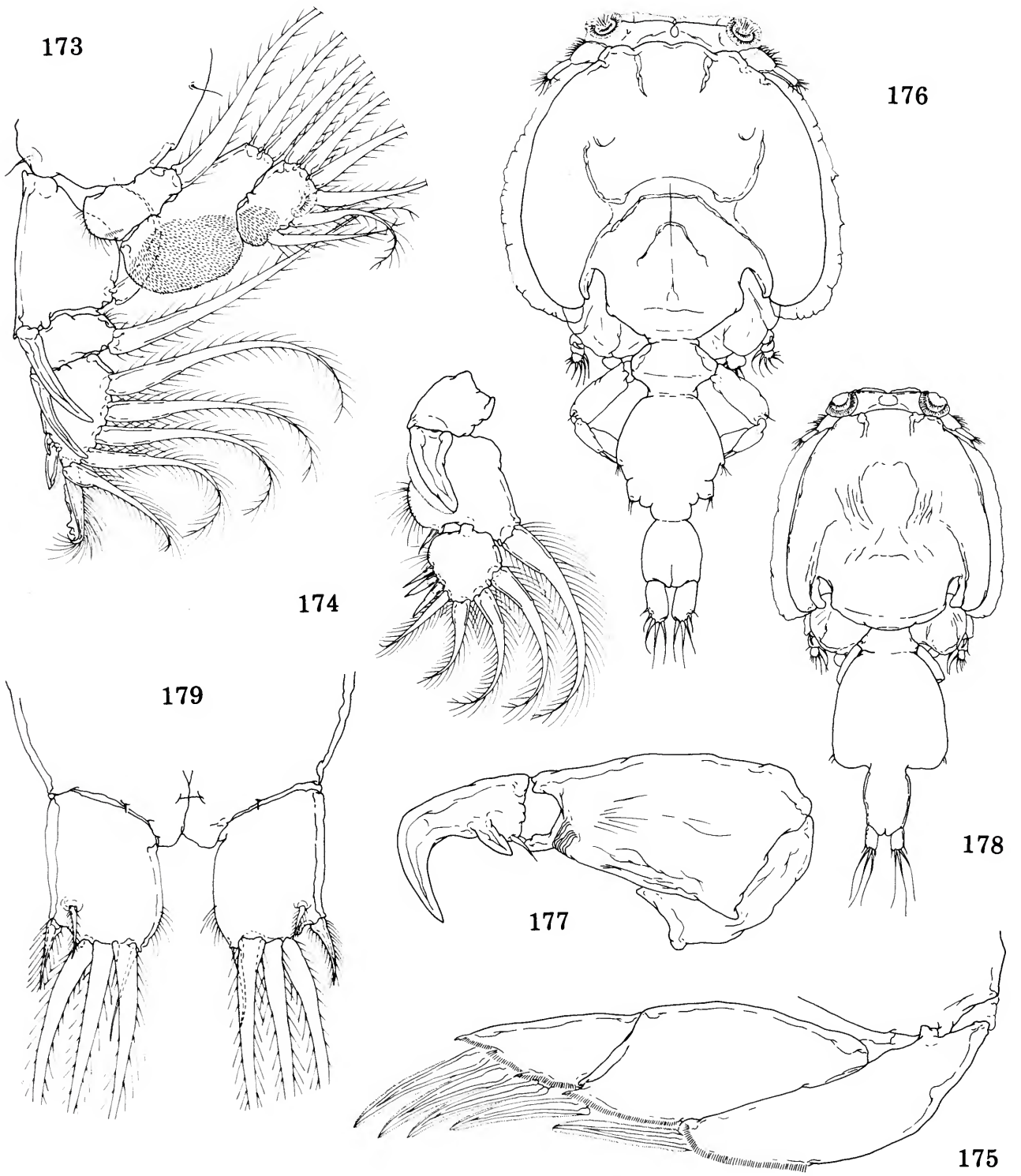
FIGURES 153–158.—*Caligus praetextus* Bere, female: 153, dorsal; 154, caudal rami; 155*a*, second antenna; 155*b*, postantennal spine; 155*c*, spiniform process of first maxilla; 156, sternal furca; 157, leg 1; 158, detail of terminal spine of leg 1 exopod.



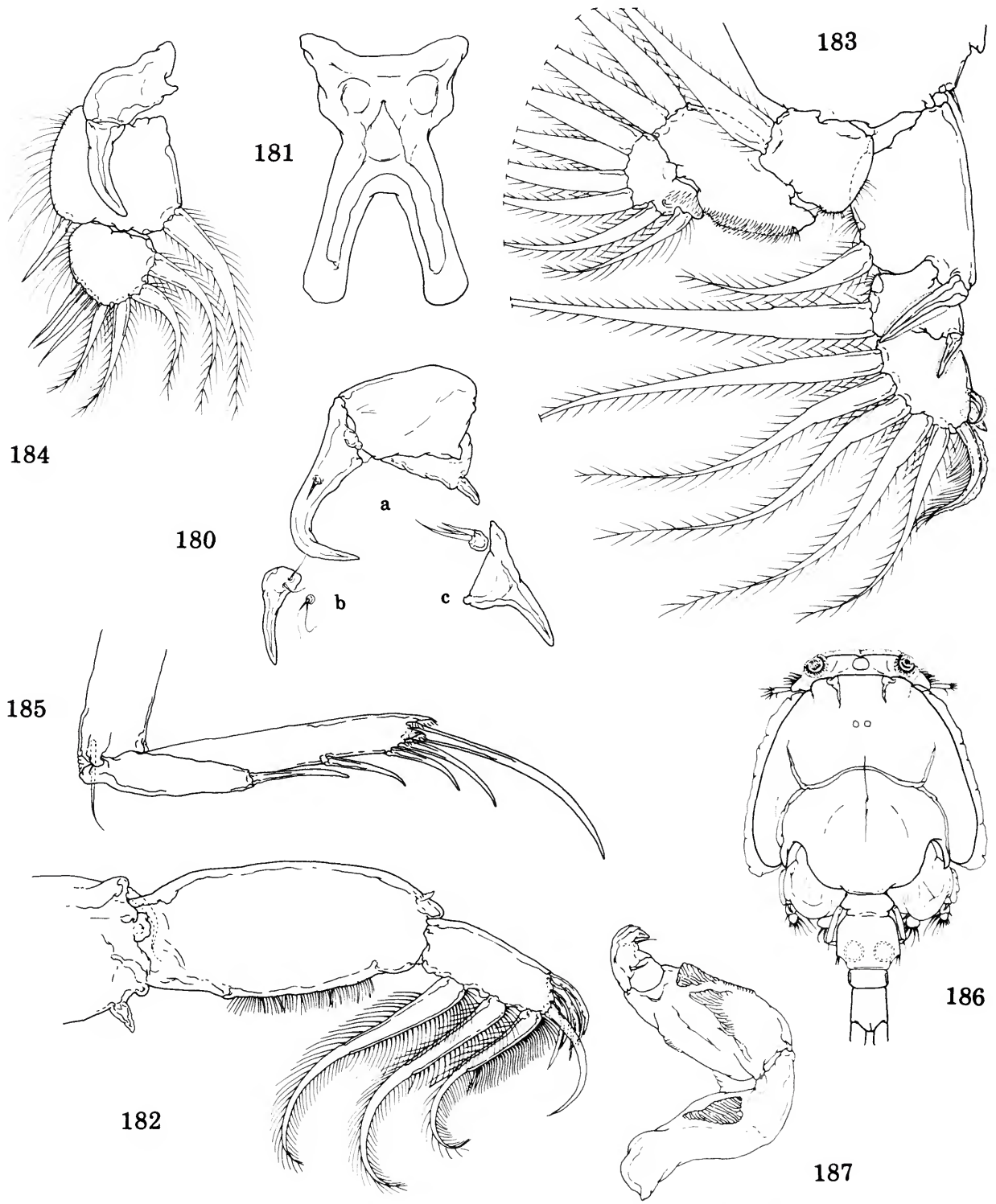
FIGURES 159–163.—*Caligus praetextus* Bere. Female: 159, leg 2; 160, exopod of leg 3; 161, leg 4. Male: 162, dorsal; 163, second antenna.



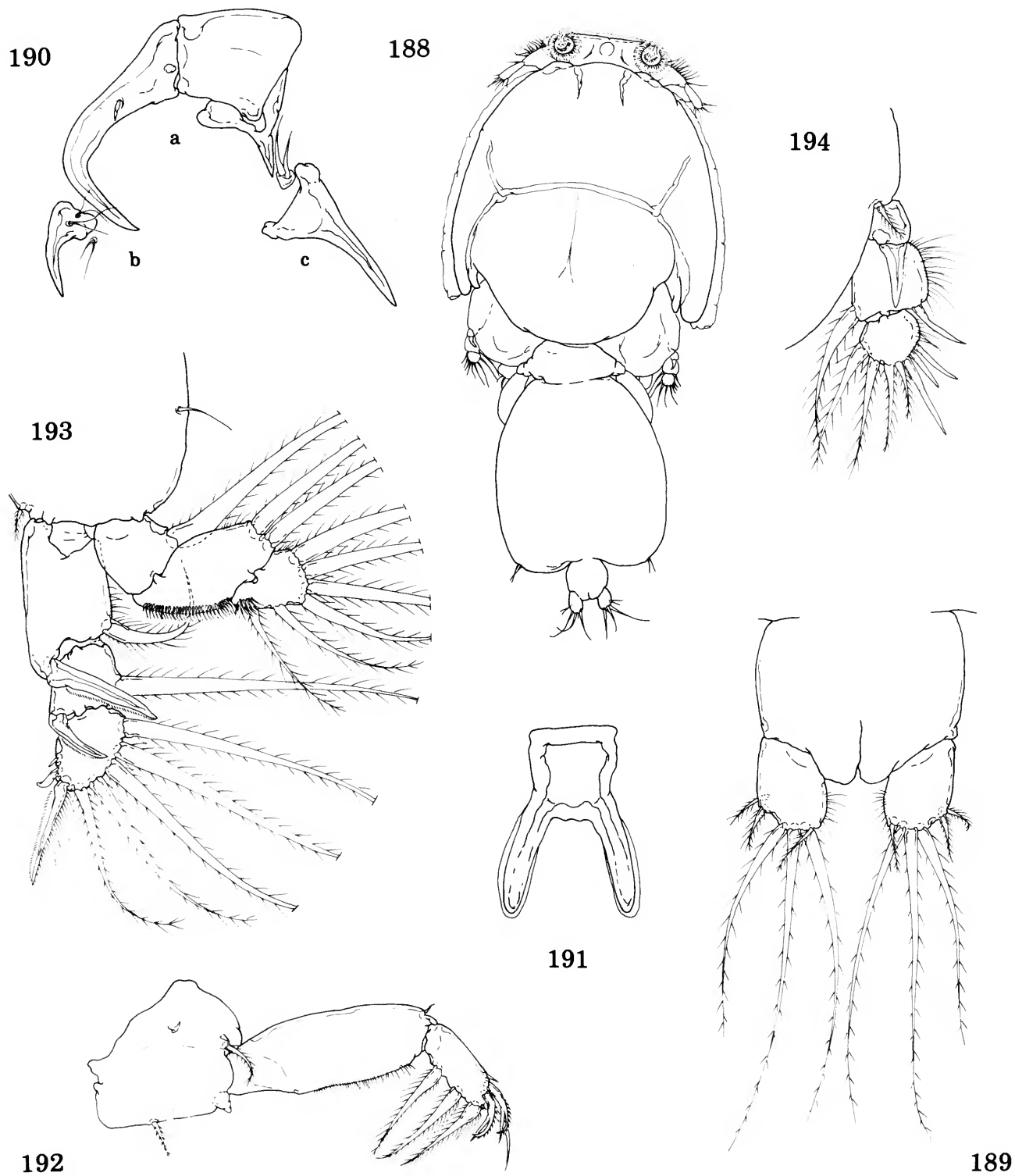
FIGURES 164–172.—*Caligus productus* Dana, female: 164, dorsal; 165, sternal furca; 166, leg 1; 167, leg 4. *Caligus robustus* Bassett-Smith, female: 168, dorsal; 169, caudal rami; 170*a*, second antenna, 170*b*, postantennal spine, 170*c*, spiniform process of first maxilla; 171, sternal furca; 172, leg 1.



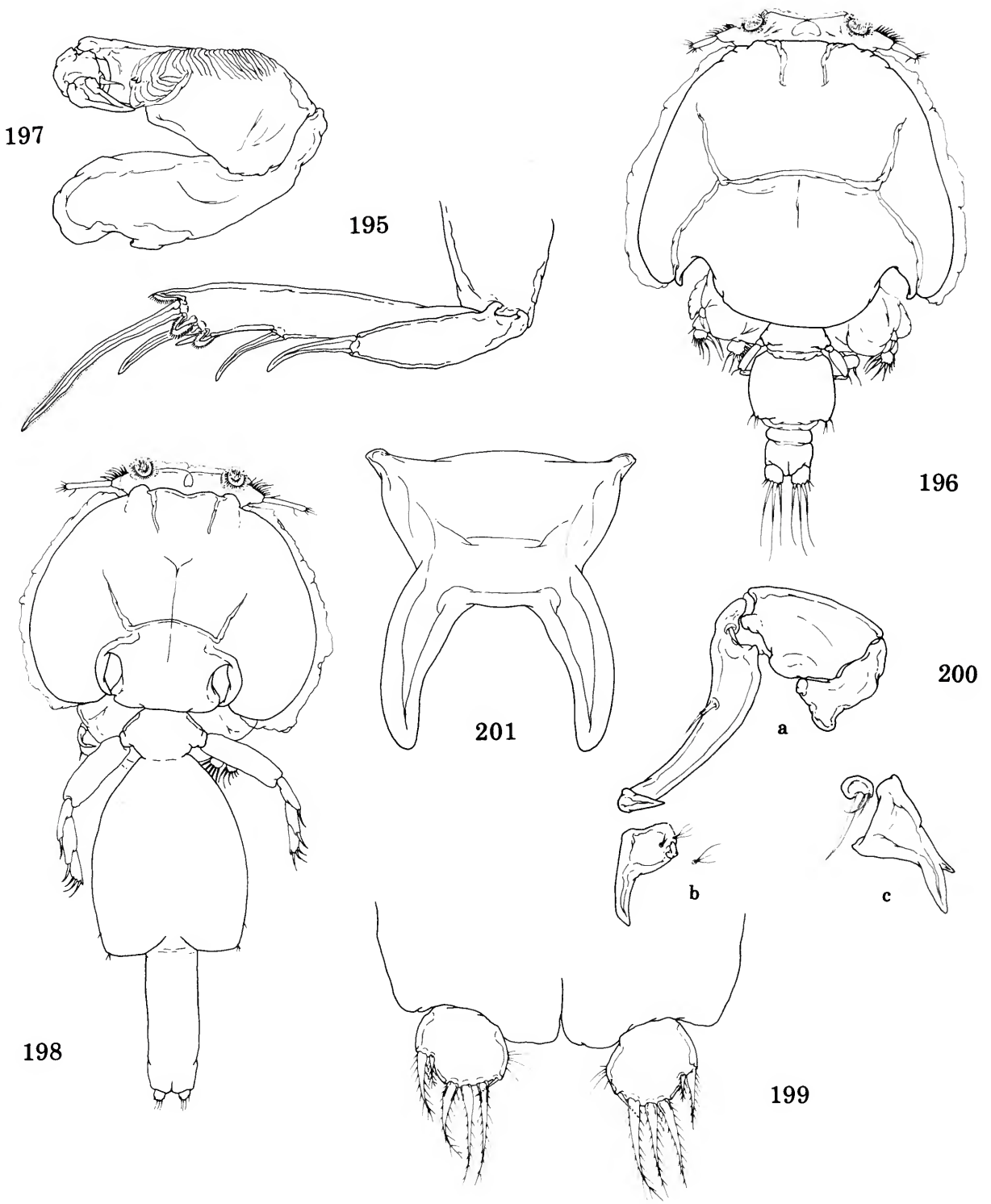
FIGURES 173–179.—*Caligus robustus* Bassett-Smith. Female: 173, leg 2; 174, exopod of leg 3; 175, leg 4. Male: 176, dorsal; 177, second antenna. *Caligus rufimaculatus* Wilson, female: 178, dorsal; 179, caudal rami.



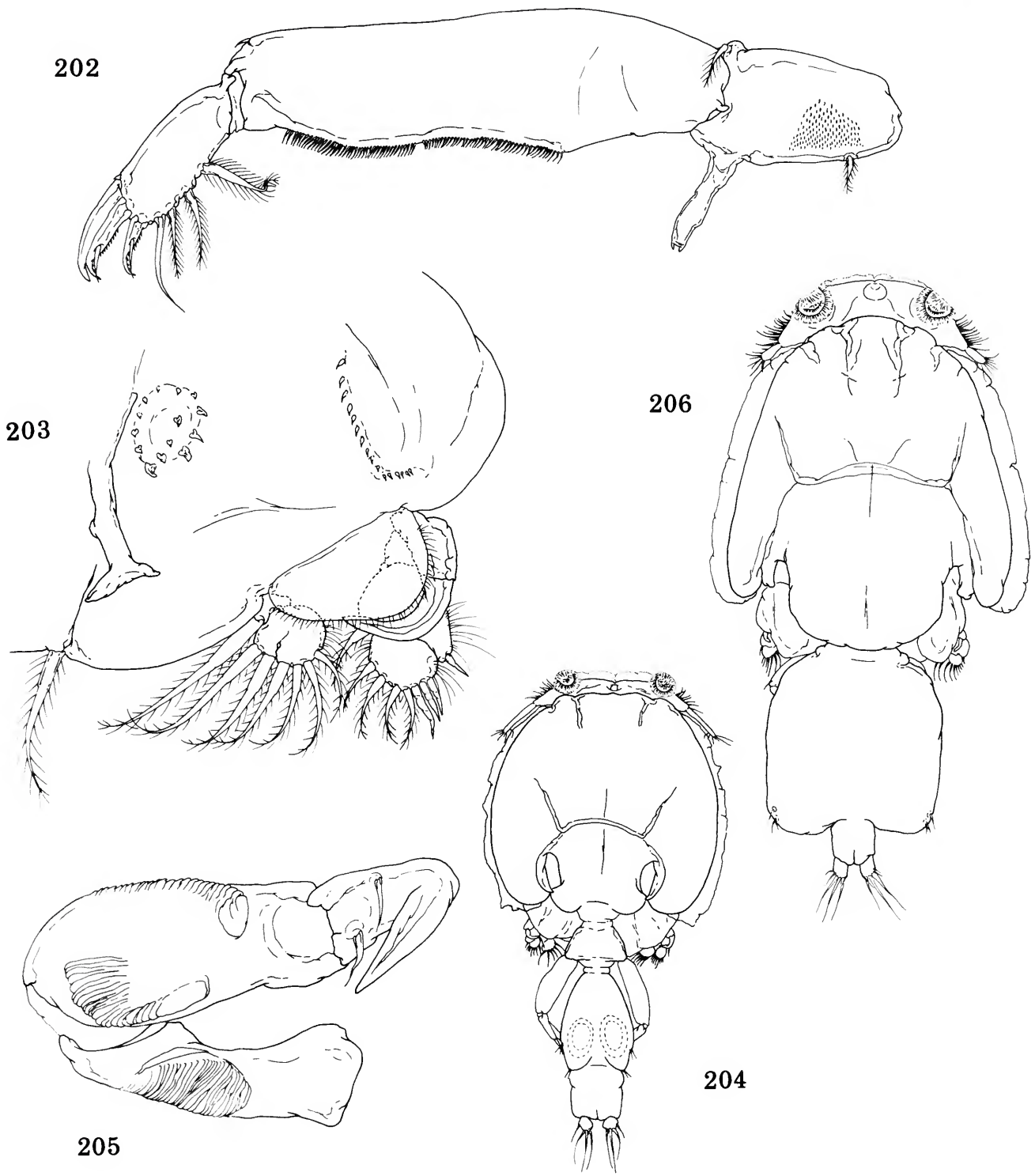
FIGURES 180–187.—*Caligus rufimaculatus* Wilson. Female: 180*a*, second antenna; 180*b*, postantennal spine; 180*c*, spiniform process of first maxilla; 181, sternal furca; 182, leg 1; 183, leg 2; 184, exopod of leg 3; 185, leg 4. Male: 186, dorsal (terminal setae of caudal rami missing on all specimens examined); 187, second antenna.



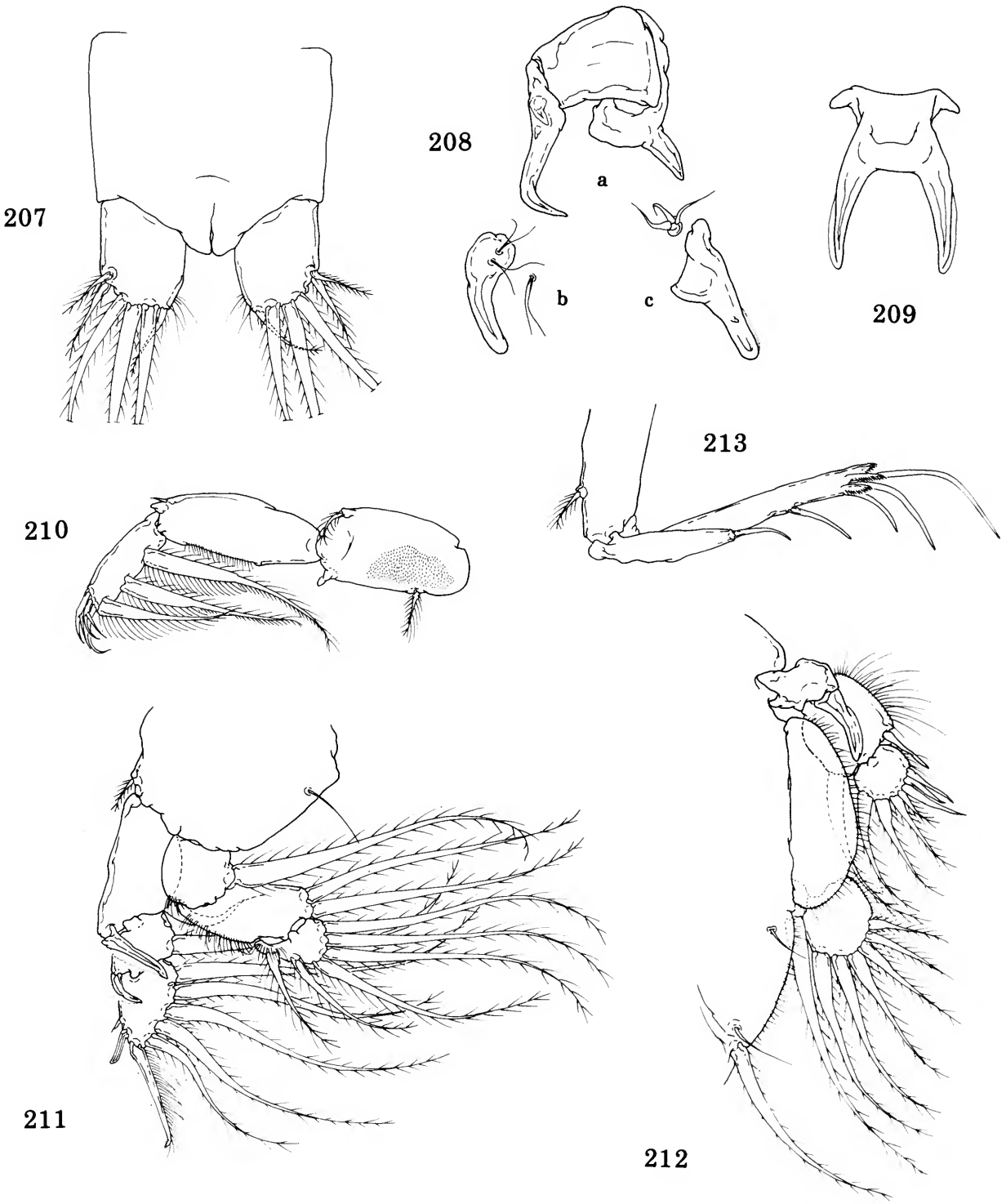
FIGURES 188–194.—*Caligus suffuscus* Wilson, female: 188, dorsal; 189, abdomen and caudal rami; 190*a*, second antenna; 190*b*, postantennal spine; 190*c*, spiniform process of first maxilla; 191, sternal furca; 192, leg 1; 193, leg 2; 194, exopod of leg 3.



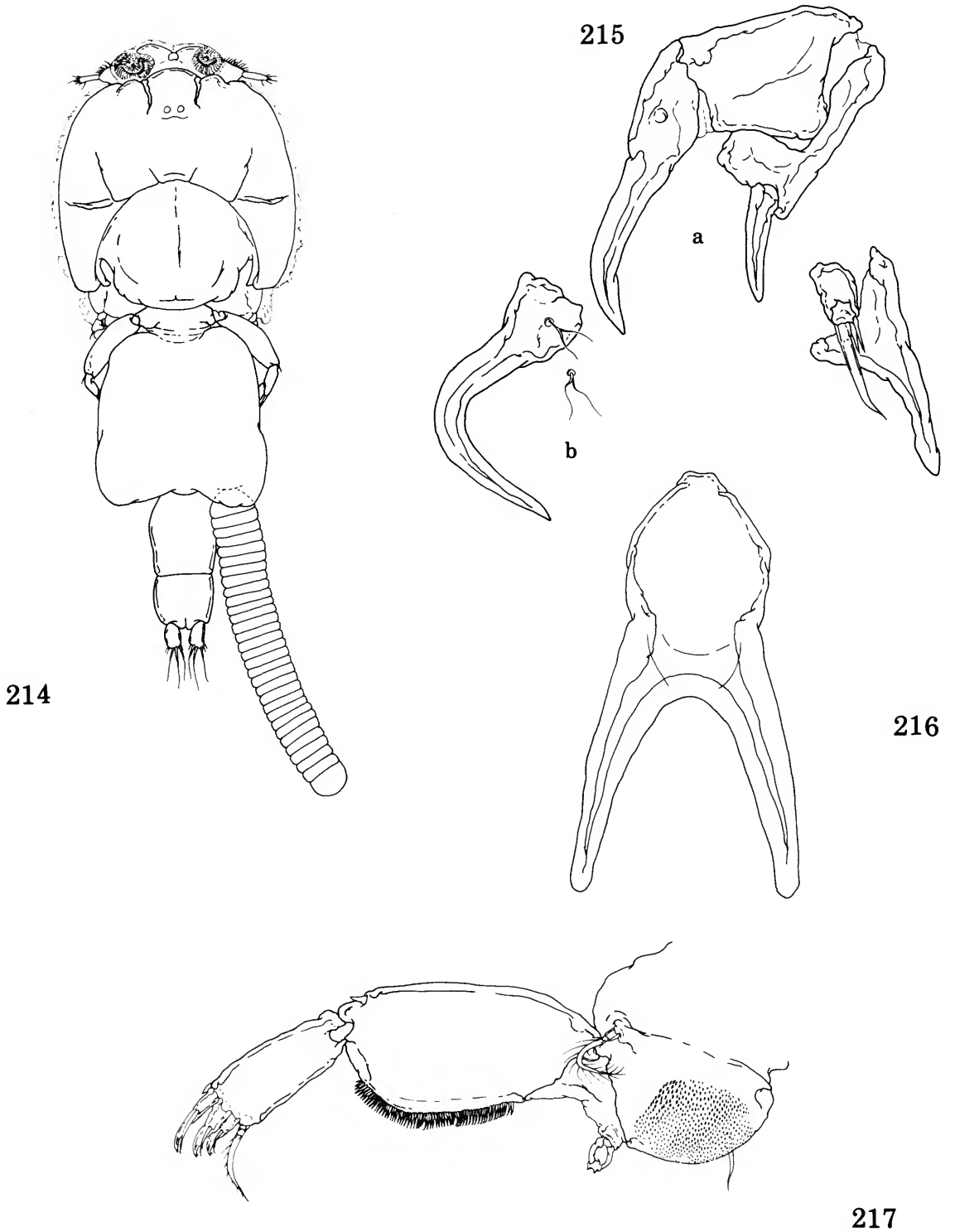
FIGURES 195–201.—*Caligus suffuscus* Wilson: 195, female, leg 4; 196, male, dorsal; 197, male, second antenna. *Caligus chorinemi* Krøyer, female: 198, dorsal; 199, caudal rami; 200*a*, second antenna, 200*b*, postantennal spine, 200*c*, spiniform process of first maxilla; 201, sternal furca.



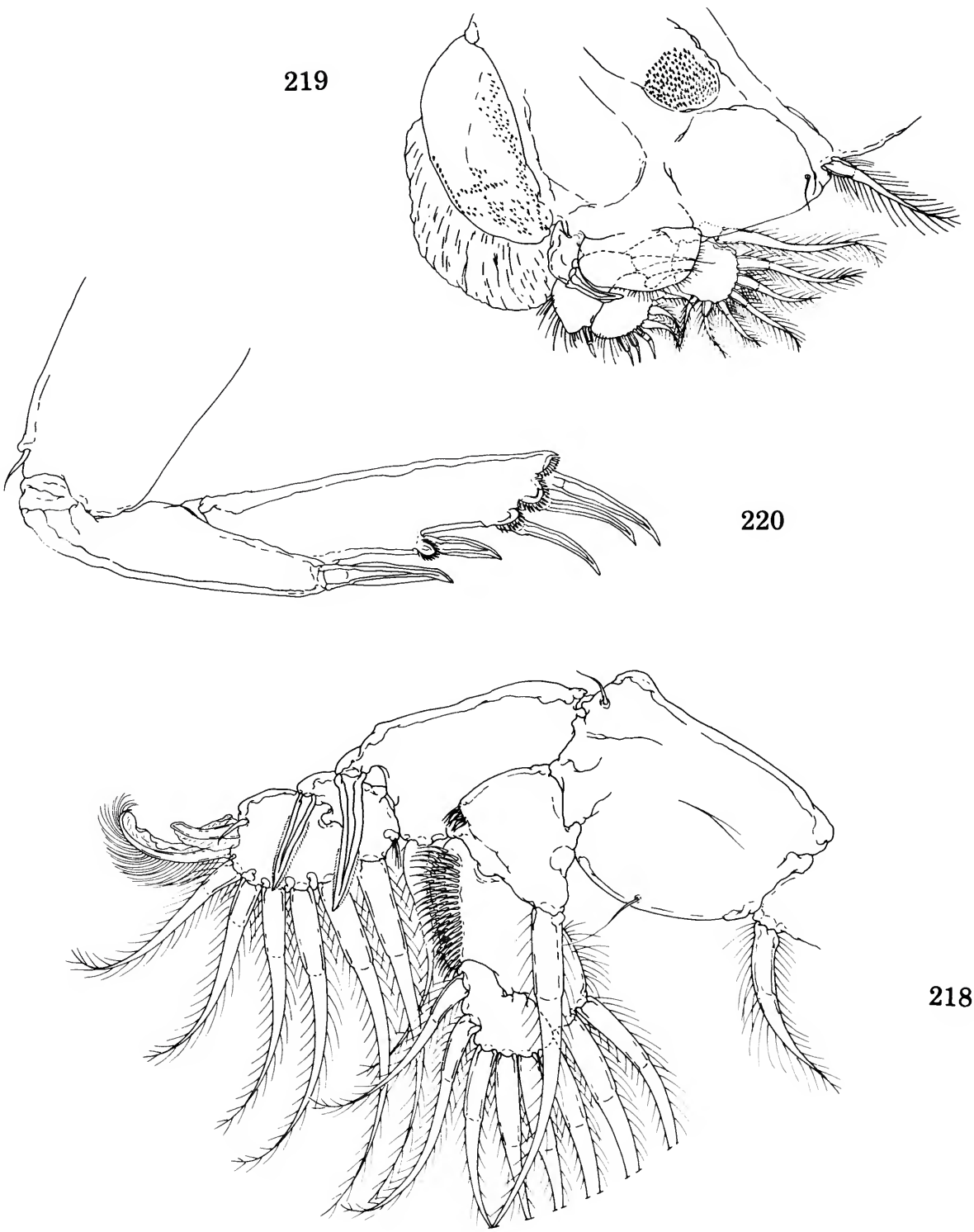
FIGURES 202–206.—*Caligus chorinemi* Krøyer: 202, female, leg 1; 203, female, leg 3; 204, male, dorsal; 205, male, second antenna. *Caligus xystercus*, new species, female: 206, dorsal.



FIGURES 207-213.—*Caligus xystercus*, new species, female: 207, abdomen and caudal rami; 208*a*, second antenna; 208*b*, postantennal spine; 208*c*, spiniform process of first maxilla; 209, sternal furca; 210, leg 1; 211, leg 2; 212, leg 3; 213, leg 4.



FIGURES 214–217.—*Caligus ephinephali* Yamaguti, female: 214, dorsal; 215*a*, second antenna; 215*b*, postantennal spine; 215*c*, spiniform process of first maxilla; 216, sternal furca; 217, leg 1.



FIGURES 218–220.—*Caligus ephinephali* Yamaguti, female: 218, leg 2; 219, leg 3; 220, leg 4.

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