Parasitic Copepods of Mackerel- and Tuna-like Fishes (Scombridae) of the World

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ABSTRACT

Cressey, Roger, and Hillary Boyle Cressey. Parasitic Copepods of Mackerel- and Tuna-like Fishes (Scombridae] of the World. *Smithsonian Contributions to Zoology,* number 311, 186 pages, 139 figures, 1980.—Forty-six species of parasitic copepods (one new genus, 8 new species) are reported from all known 46 species of Scombridae subfamily Scombrinae from the world. Literature records are included only where host and/or copepod identifications could be verified. Copepod families include: Bomolochidae; Shiinoidae; Caligidae; Euryphoridae; Tuxophoridae; Pseudocycnidae; Lernanthropidae; Lerneopodidae. The new bomolochid genus is *Unicolax*. The new species are *U. collateralis, U. ciliatus, U. reductus, Holobomolochus divaricatus, H. nudiusculus,* and *H. asperatus* (Bomolochidae); *Caligus omissus* (Caligidae); and *Tuxophorus collettei* (Tuxophoridae). The genus *Pseudocynopsis* Yamaguti has been placed in synonymy with *Pseudocycnoides* Yamaguti. Lists are included of all species of the Scombrinae and their geographic distribution, copepods parasitic on each scombrid species with the relative abundance of each copepod species on each host species, and the scombrid hosts for each copepod species indicating host preferences.

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Contents

Parasitic Copepods of Mackerel- and Tuna-like Fishes (Scombridae) of the World

Roger Cressey
and Hillary Boyle Cressey

Introduction

There are 47 currently recognized species of the family Scombridae; plus an additional new species of *Scomberomorus* being described by Collette and Russo. One species, *Gasterochisma melampus* Richardson, is placed in a separate subfamily and has not been considered in this study. For approximately the last 20 years the first author has been collecting and receiving collections of the copepods parasitic on these fishes. Of the 46 species of parasitic copepods reported here, 40 species are represented in our collections. These 40 species have been collected from 2422 individual fish from all 46 species of Scombrinae. As a result of this exhaustive collection we have presented a comprehensive account of the copepods parasitic on tunas and tuna-related fishes.

Our primary objective has been to produce a baseline study of the copepods parasitic on scombrid fishes. Because of the unreliability of most past literature it has been impossible to assess the host-parasite relationship, especially the degree of host specificity. By compiling a comprehensive collection such as we report here, resolving problems of synonymy with several copepod species, and working closely with scombrid taxonomists (R. H. Gibbs and B. B. Collette) to assure proper host identifications, we feel we have reached that objective. We do not feel that we have produced a definitive work, but hopefully, a solid foundation to which information in future collections can be added. Previous works by Lewis, Kabata, Shiino, and Pillai concerned with scombrid copepods are excellent and we have included some of their information where it fills gaps in our own collection data. For reasons stated above, however, we have not considered most of the earlier works in our host-parasite data.

Because most species of scombrid fishes are commercially important, various aspects of their biology have been investigated for several years. One result of this interest has been the many reports of copepods parasitic on them since the last century. The major failing in this, however, has been the general lack of cooperative effort between parasitologists and ichthyologists. Too often, the copepod worker has been content to repeat unverified host identifications or unreliable common names. This casual approach to that aspect of the record has resulted in an account too confusing to be of much value in determining true relationships between the copepod species and their hosts. Except for a literature compilation by Silas and Ummerkutty

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in 1967, no attempt has been made to critically examine the scombrid parasites in a comprehensive way to determine the taxonomic status of most of the described species. For example, Silas and Ummerkutty list 29 species of *Caligus* as reported parasites of the Scombrinae. As a result of our examinations of type-specimens of a number of these *Caligus* species, and the data based on our own collections, we have been able to place almost half of these in synonymy and reduce the number of *Caligus* species from these hosts to 15.

We have included literature records in our data only in those cases where we could verify the host and/or the copepod identification. To include unverified collections would serve no useful purpose and only cloud the host-parasite relationship. It was with this in mind that we waited until our collections were as complete as reasonably possible to publish our results. We have, with each species, given a skeleton synonymy to provide a brief historical account of each. A complete synopsis of the species of *Caligus* was recently published by Margolis, Kabata, and Parker (1975) but a complete revision of the genus is badly needed. There are slightly over 200 currently recognized species of *Caligus*. Reducing the 29 species cited by Silas and Ummerkutty to 15 illustrates the extent of the problem. Extrapolating from that reduction of 29 species to 15, it would not be unreasonable to expect that a generic revision might result in only 100 or so *Caligus* species as valid.

The first author and B. B. Collette are planning a joint paper summarizing the host-parasite relationship from both ecological and evolutionary standpoints. We feel that this aspect can best be done separately and in conjunction with a scombrid specialist (Collette). In addition to collections made by us, most of the other collections (about one-third of the total) were made by Collette in the course of his studies on scombrids.

KNOWN HOST SPECIES WITH DISTRIBUTION.—Below is a list of the known species of the scombrid subfamily Scombrinae with their general geographic distributions. Although there are 2 recognized species of *Auxis*, we were advised (B. B. Collette, pers. com.) that, for purposes of this study, we should refer to them as "*Auxis* species" until the genus has undergone revision. References to "*Scomberomorus* species" pertain to a new species from Northern Australia to New Guinea being described by Collette and Russo. The following list is adapted from information in Collette and Chao (1975) and Klawe (1977).

Tribe SCOMBRINI Bonaparte (Mackerels)

Rastrelliger brachysoma (Bleeker): South China Sea east to Fiji

Rastrelliger faughni Matsui: South China Sea to Indonesia

Rastrelliger kanagurta (Cuvier): Indian and South Central Pacific oceans

Scomber australasicus (Cuvier): Western & Central Pacific and Socorro Island (off Mexico)

Scomber japonicus Houttuyn: circumglobal antitropical

Scomber scombrus Linnaeus: North Atlantic Ocean and Mediterranean

Tribe SCOMBEROMORINI Starks (Seerfishes)

Acanthocybium solandri (Cuvier): circumtropical and subtropical

Grammatorcynus bicarinatus (Quoy and Gaimard): Red Sea and Western Pacific Ocean

Scomberomorus brasiliensis Collette, Russo, and Zavala-Camin: Western Atlantic (Yucatan to south Brazil)

Scomberomorus cavalla (Cuvier): Tropical western Atlantic Ocean

Scomberomorus commerson (Lacépède): Indian and Western Pacific oceans

Scomberomorus concolor (Lockington): Gulf of California and Monterey Bay

Scomberomorus guttatus (Bloch and Schneider): Indian and western Pacific oceans

Scomberomorus koreanus (Kishinouye): Indian and western Pacific oceans

Scomberomorus lineolatus (Cuvier): India to Indonesia

Scomberomorus maculatus (Mitchill): Western Atlantic (Yucatan to Massachusetts)

Scomberomorus multiradiatus Munro: Gulf of Papua

Scomberomorus niphonius (Cuvier): Northwestern Pacific Ocean (China to Japan)

Scomberomorus plurilineatus Fourmanoir: Mozambique Channel (coastal) and South Africa

Scomberomorus queenslandicus Munro: Northern Australia

Scomberomorus regalis (Bloch): Western Atlantic (especially West Indies)

Scomberomorus semifasciatus (Macleay): Northern Australia to New Guinea

Scomberomorus sierra Jordan and Starks: Eastern Pacific Ocean

Scomberomorus sinensis (Lacépède): Northwestern Pacific Ocean

Scomberomorus tritor (Cuvier): Gulf of Guinea to Mediterranean

Scomberomorus species: Northern Australia to New Guinea

Tribe SARDINI Jordan and Evermann (Bonitos)

Allothunnus fallai Serventy: circumglobal in southern hemisphere
Cybiosarda elegans (Whitley): Northern Australia to New Guinea
Gymnosarda unicolor (Rüppell): Indian to central Pacific oceans
Orcynopsis unicolor (Geoffroy St. Hilaire): Gulf of Guinea to Mediterraean
Sarda australis (Macleay): southeast coast of Australia
Sarda chiliensis (Cuvier), 2 subspecies: Northeastern (*S. c. lineolata*) and southeastern Pacific Ocean (*S. c. chiliensis*)
Sarda orientalis (Temminck and Schlegel): Indian and Pacific oceans (coastal)
Sarda sarda (Bloch): Atlantic Ocean and Mediterranean

Tribe THUNNINI Starks (Tunas)

Auxis rochei (Risso): circumtropical
Auxis thazard Lacépède: circumtropical
Euthynnus affinis (Cantor): Indian and Pacific oceans
Euthynnus alletteratus (Rafinesque): Atlantic Ocean
Euthynnus lineatus Kishinouye: Eastern Pacific Ocean
Katsuwonus pelamis (Linnaeus): circumtropical
Thunnus alalunga (Bonnaterre): circumtemperate and tropical
Thunnus albacares (Bonnaterre): circumsubtropical and tropical
Thunnus atlanticus (Lesson): Western Atlantic Ocean
Thunnus maccoyii (Castelnau): circumglobal in southern hemisphere
Thunnus obesus (Lowe): circumsubtropical and tropical
Thunnus thynnus (Linnaeus): North Pacific, North and South Atlantic (non-tropical)
Thunnus tonggol (Bleeker): Indian and Western Pacific oceans

SPECIMENS EXAMINED.—Scombrids housed in or borrowed from the following places were examined for copepods by us or Collette.

Australian Museum, Sydney (AMS)
Academy of Natural Sciences, Philadelphia, Pa.
British Museum (Natural History), London
Bernice P. Bishop Museum, Honolulu, Hawaii
California Academy of Sciences, San Francisco
Chesapeake Biological Laboratory, Solomons, Md.
CSIRO Marine Biological Laboratory, Cronulla, N.S.W., Australia
Dominion Museum, Wellington, New Zealand
Field Museum of Natural History, Chicago, Ill.
Hebrew University, Jerusalem
Los Angeles County Museum of Natural History, Los Angeles, Calif.
Museo Argentina de Ciencias Naturales, Buenos Aires
Museum of Comparative Zoology, Harvard (MCZ)
Muséum National d'Histoire Naturelle, Paris
Museo di Storia Naturale, Genoa
Museo de La Specola, Universita di Firenze, Florence
Naturhistorisches Museum, Vienna
National Museum of Natural Sciences, Ottawa
Northwest Fisheries Center Auke Bay Laboratory, National Marine Fisheries Service, NOAA, Auke Bay, Alaska
Queensland Museum, Brisbane
Rijksmuseum van Naturlijke Histoire, Leiden
J.L.B. Smith Institute of Ichthyology, Rhodes University, Grahamstown
South African Museum, Cape Town
Sea Fisheries Research Station, Haifa, Israel
Scripps Institution of Oceanography, La Jolla, Calif.
Senckenberg Museum, Frankfurt-am-Main
Southeast Fisheries Center, National Marine Fisheries Service, NOAA (formerly Tropical Atlantic Biological Laboratory), Miami, Fla.
Institute of Fisheries, University of British Columbia, Vancouver
University of California, Los Angeles
Rosenstiel School of Marine and Atmospheric Science, Miami, Fla.
University of Michigan Museum of Zoology, Ann Arbor
Smithsonian Institution, Washington, D.C. (USNM, former United States National Museum, collections in the National Museum of Natural History, Smithsonian Institution)
Western Australia Museum, Perth
Woods Hole Oceanographic Institution, Woods Hole, Mass.
Zoological Museum, Copenhagen
Zoological Museum, Oslo

Representative collections of the following species will be deposited in the British Museum (Natural History, London), Museum National d'Histoire Naturelle (Paris), Australian Museum (Sydney), and California Academy of Sciences (San Francisco): *Holobomolochus divaricatus, H. nudiusculus, Unicolax collateralis, U. reductus, U. ciliatus, Ceratacolax euthynni, Shiinoa inauris, S. occlusa, Caligus coryphaenae, C. omissus, C. bonito, C. productus, C. cybii, Elytrophora brachyptera, E. indica, Pseudocycnus appendiculatus, Pseudocycnoides armata,* and *P. buccata.* All type material and remaining collections are deposited in the Smithsonian Institution.

ACKNOWLEDGMENTS.—This work began with a small collection of copepods parasitic on western Atlantic pelagic fishes given to one of us (R. Cressey) by Arthur Humes as a basis for a graduate research project in 1960. The initial collection was made by Robert Gibbs and Bruce Collette during various cruises of the R. V. *Delaware,* consisting primarily of copepods from sharks and scombrids. The shark parasites formed the basis for R. Cressey's doctoral dissertation revising the family Pandaridae (under the

direction of A. Humes). The remaining collection stimulated a continuing interest in scombrid copepods by the first author and later by the second.

We thank the scientists and staffs of the many institutions cited above for making fish specimens available for examination for parasitic copepods. Through the years many people have sent us material, for which we are grateful. Outstanding among these are: Bruce B. Collette (National Marine Fisheries Service, Washington), Robert H. Gibbs (Smithsonian Institution, Washington), Arthur G. Humes (Boston University), Richard Shomora (National Marine Fisheries Service, Honolulu), and Vladimir Walters (National Marine Fisheries Service, Miami).

Robert Gibbs was our principle consultant concerning problems in scombrid taxonomy during the early years of the work. Later, Bruce Collette began an intensive study of scombrid taxonomy and during the course of his work spent many hours gathering copepods for us. We extend a special thanks to him for his enthusiastic and continued support

We were assisted in the illustrations by Nancy Zacks who rendered Figures 75–79 and 95 and by Michelle Wilcox who did the illustrations for Figures 82–84. Cynthia Hemmings assisted in the final preparation of the manuscript. The staff of the SEM laboratory all participated at various times in the preparation of the SEM photographs (Walter Brown, Mary Jacque Mann, and Susann Braden). We thank all of them for their assistance.

The manuscript was reviewed by Bruce Collette and Brian Kensley and we are grateful for their many helpful suggestions.

Holobomolochus Vervoort, 1969

Holobomolochus divaricatus, new species

FIGURES 1–4, 5*a–c*, 96, 109–113

MATERIAL EXAMINED. — Holotype ♀ (USNM 172244), allotype ♂ (USNM 172245) paratypes 11 ♀ (USNM 172246) from the nasal sinuses of *Scomberomorus brasiliensis* (USNM 188424) from Brazil. In addition, there are 13 collections containing 61 ♀ 2 ♂ from *S. brasiliensis* from Panama (Atlantic), Colombia (Atlantic), Brazil and Argentina; 25 collections containing 70 ♀ 40 ♂ from *S. maculatus* from Cape Cod, New Jersey, Maryland, South Carolina, Georgia, Florida, Mississippi, Alabama, Louisiana, Texas, Panama (Atlantic), Surinam; 11 collections containing 28 ♀ 20 ♂ and 3 immatures from *S. regalis* from Florida, Cuba, Haiti, Puerto Rico, Colombia (Atlantic), Venezuela and Surinam. All copepods were collected from the nasal sinuses of the host fish.

FEMALE.—Body form as in Figure 1*a*. Total length 2.62 mm, greatest width (widest part of cephalon) 1.20 mm. Genital segment (Figure 1*b*) wider than long (348 × 483 μm) with 3 dorsal setae at area of egg sac attachment. Abdomen 3-segmented, segments measuring (l × w) 224 × 318 μm, 153 × 265 μm, 147 × 230 μm respectively; ventral surface of last segment with 2 patches of prominent spinules (see figure 1*c*). Caudal rami (Figure 1*c*) longer than wide (129 × 94 μm) with six setae; longest seta 590 μm.

First antenna (Figure 1*d*) 5-segmented, second segment incompletely divided; first two segments with 15 prominent plumose setae; segments 4 and 5 with one aesthete each. Second antenna (Figure 2*a*) of usual bomolochid type; terminal segment with numerous rows of spinules, 2 processes with spinules, 3 terminal setae and 4 elongate spines. Mandible, paragnath, first maxilla and second maxilla as in Figure 2*b*. Maxilliped (Figure 2*c*) terminal segment with prominent curved claw with slight projection on outer curve, and 3 plumose setae; basal segment with 1 plumose seta.

Leg 1 (Figure 2*d*) exopod with stout, heavily plumose seta on outer corner; basipod with 2 patches of hairs; exopod 2-segmented, first segment with prominent rugose spine on outer distal corner, second segment with small spine at outer proximal corner, minute spine at outer distal corner and 2 stout flagellated spines best viewed dorsally, terminal to inner edge of segment with 6 plumose setae; endopod 3-segmented, first segment with large patch of hairs and inner seta, second segment with smaller patch of hairs and inner seta, third segment with 5 terminal setae, all setae heavily plumose, outer edge of endopod segments haired. Legs 2–4 biramous, rami 3-segmented. Leg 2 (Figure 2*e*) coxopod with short row of spinules at outer distal corner; basipod with dorsal seta; exopod first segment with hairs on outer edge and spine on outer distal corner, second segment with inner seta and outer spine, slender spinules at base of spine, third segment with 6 inner to terminal setae and 3 outer spines; exopod spines broad at base, tapering distally with small terminal flagellum, fine hairs on both

edges of spines; endopod first segment with inner seta and row of fine hairs along outer half of distal border, second segment similar except with 2 inner setae, third segment with 3 inner to terminal seta and 2 outer spines similar to, but smaller than, exopod spines, outer edges of endopod segments haired; interpodal plate with long slender spinules. Leg 3 (Figure 3*a*) coxopod with row of small spinules at outer distal corner; basipod with dorsal seta; exopod segments heavily sclerotized; first segment with outer spine, second segment with outer spine and inner seta, third segment with 2 outer spines and 6 terminal to inner setae, exopod spines heavily sclerotized, spines on second and third segments of about equal length, spine on first segment slightly shorter than others; endopod similar to leg 2 except third segment with only 2 setae; interpodal plate with short, stout spinules. Leg 4 (Figure 3*b*) coxopod and basipod similar to leg 3; exopod first segment with spinules along ventrolateral edge, hairs on inner edge and spine on outer distal corner, second segment with inner seta and outer spine, slender spinules at base of seta, shorter, stouter spinules at base of spine, third segment with 6 inner to terminal setae, 2 outer spines, slender spinules at bases of 2 innermost setae, stouter spinules at bases of spines, spines slender, elongate with fine hair on edges and fine terminal flagellum; endopod first segment with patch of slender spinules near outer distal corner and inner seta spinulose along distal two-thirds, second segment similar to first, third segment elongate, broadened distally with 2 terminal patches of stout spinules and 2 spines flanking terminal seta, spines elongate, of about equal length and finely haired on edges, seta spinulose along distal half; interpodal plate with short, stout spinules. Leg 5 (Figure 3*c*) basal segment with dorsal seta and small patch of slender spinules; free segment with 3 patches of slender spinules, one spine at about mid-point of outer margin and 2 spines flanking terminal, naked seta, spines elongate, simple with finely haired edges. Leg 6 (see Figure 1*b*) represented by 3 naked setae at area of egg sac attachment.

MALE.—Body form as in Figure 3*d*. Total length 1.18mm, greatest width 0.50mm (measured at widest part of cephalon). Genital segment (Figure 4*a*) longer than wide (236 × 182 μm). Abdomen (Figure 4*a*) 2-segmented, segments measure (length × width) 88 × 118 μm, 82 × 106 μm, respectively; ventral surface of second segment with 2–3 rows of prominent spinules forming a proximal transverse band and 2 distal patches of spinules. Caudal rami (Figure 4*b*) slightly longer than wide (41 × 35 μm) with 6 setae; longest seta 572 μm.

First antenna (Figure 4*c*) 5-segmented, second segment incompletely divided, antenna similar to female, but segments not as elongate. Second antenna, mandible, paragnath, first maxilla, second maxilla similar to, but proportionately smaller than, female. Maxilliped (Figure 4*d*) second segment with 2 short setae near inner mid-margin, inner surface of segment with patch of elongate, blunt-tipped spinules and patch of smaller, rounder spinules; terminal claw with 2 setae and numerous closely spaced "teeth" along entire inner edge. Legs 1–4 biramous, rami 3-segmented except leg 4 endopod.

Leg 1 (Figure 4*e*) coxopod heavily haired along outer distal edge; basipod with dorsal seta and ventral ornamentation as indicated in figure; exopod first segment with row of elongate spinules near base of spine on outer distal corner, second segment similar to first with the addition of an inner seta, third segment with 4 inner to terminal setae and 3 outer spines, proximal 2 spines similar to those of first and second segments, finely haired on edges, and with terminal flagellum and with row of spinules near base, distal spine elongate with row of very fine hairs along outer edge; endopod first segment enlarged, covering inner portion of exopod, stout hairs along distal edge and an inner seta, second segment only about half as wide as first segment with inner seta, small spinule on outer distal corner and row of fine hairs along outer half of distal edge, third segment with 4 terminal setae and small outer spinule, outer half of segment with 2 converging rows of small, rectangular, platelike spinules, outer edges of endopod segments heavily haired. Leg 2 coxopod with short row of small spinules on outer distal corner; basipod with dorsal seta; exopod first segment with irregular rows of small bumplike spinules along outer edge, short row of slender spinules at base of spine on outer distal corner, second segment with inner seta and row of spinules at base of outer spine, third segment with 5 inner to terminal setae and 3 outer to terminal spines, proximal 2 spines similar to spines of first and second segments, finely haired on edges with terminal flagellum and short row of spinules near base, terminal spine elongate with row of very fine hairs along outer two-thirds; endopod first segment with outer seta and row of hairs along outer

distal edge, second segment similar to first but with two inner setae, third segment with 3 inner to terminal setae, short row of spinules at base of 2 outer spines, inner spine about twice as long as outer, outer edges of endopod spines heavily haired. Leg 3 (Figure 5*a*) similar to leg 2 except endopod third segment with 2 rather than 3 setae. Leg 4 (Figure 5*b*) coxopod and basipod similar to leg 3; exopod similar to leg 3 with the following exceptions: spines more slender; second segment with no spinules at base of outer spine; third segment with 4 rather than 5 setae; endopod 2-segmented, first segment similar to leg 3, second segment elongate with stout spinules distally and near outer distal edge, 2 spines flanking naked, terminal seta, spines spinulose along edges, lacking terminal flagella, inner spine slightly longer than outer. Leg 5 (Figure 5*c*) basal segment with dorsal seta and small patch of spinules at outer distal corner; free segment with patch of elongate spinules covering inner half of lower two-thirds of segment, terminally with inner spinulose spine and outer seta.

ETYMOLOGY.—The Latin *divaricatus* ("spreading asunder at wide angle") refers to the characteristic appearance of the caudal rami of the female.

REMARKS.—Females of this species can be distinguished from all previously described members of the genus by the nature of the exopod spines of leg 3 (see Discussion); they can be separated from the females of the two following species by the ornamentation of the ventral surface of the caudal rami and last abdominal segment. *Holobomolochus divaricatus* females have two large patches of stout spinules on the last abdominal segment, their caudal rami have no surface ornamentation; H. *nudiusculus* females have relatively small patches of minute hairs on the last abdominal segment; *H. asperatus* females have 2 large patches of hairs on the last abdominal segment and a patch of hairs on the ventral surface of each caudal ramus. In addition the distal spine of the third exopod segment of leg 3 is only as long as, or shorter than, the adjacent spine; in *H. nudiusculus* and *H. asperatus* this spine is longer than the adjacent spine and more outwardly curved than other spines of the ramus (see Figures 3*a*, 6*c*, 8*c*).

This copepod is a common parasite on *Scomberomorus brasiliensis, S. maculatus,* and *S. regalis* in the Western Atlantic from Cape Cod to southern Brazil.

Holobomolochus nudiusculus, new species

FIGURES 5*d–e*, 6, 7*a–b*, 96

MATERIAL EXAMINED. — Holotype ♀ (USNM 172247), allotype ♂ (USNM 172248), paratypes 33 ♀ 1 ♂ (USNM 172249) from the nasal sinuses of *Scomberomorus sierra* from Buenaventura, Colombia (USNM 218565). In addition 13 collections containing 30 ♀ 1 ♂ from the nasal sinuses of *S. concolor* from Baja California and Sonora, Mexico; 26 collections containing 105 ♀ 7 ♂ from the nasal sinuses of *S. sierra* from Baja California, Sonora, Panama (Pacific), Colombia (Pacific), Peru.

FEMALE.—Body form as in Figure 5*d*. Total length 1.76 mm, greatest width 0.72 mm, Genital segment (see Figure 5*e*) wider than long (230 × 271 μm) with 3 naked setae at area of egg sac attachment. Abdomen (Figure 5*e*) 3-segmented segments measuring 171 × 206 μm, 118 × 177 μm, and 112 × 147 μm respectively, ventral surface of last segment with 2 patches of minute spinules (see Figure 6*a*). Caudal rami (Figure 6*a*) slightly longer than wide (59 × 53 μm) with 6 setae (longest 652 μm).

First antenna, second antenna, mandible, paragnath, first maxilla, second maxilla, and maxilliped similar to those of *Holobomolochus divaricatus.*

First leg similar to that of *H. divaricatus.* Legs 2–4 biramous, rami 3-segmented. Leg 2 (Figure 6*b*) similar to that of *H. divaricatus* except endopod third segment with row of blunt spinules at base, 2 outer spinulose spines, gradually tapering, with no terminal flagellum. Leg 3 (Figure 6*c*) coxopod, basipod, exopod similar to those of *H. divaricatus* except exopod spines relatively longer with distal spine longest; endopod similar to leg 2 except third segment with 2 rather than 3 setae and inner spine slightly longer than outer. Leg 4 similar to that of *H. divaricatus.* Leg 5 (Figure 6*d*) generally similar to that of *H. divaricatus* except free segment not as elongate, lateral and terminal spines relatively longer. Leg 6 represented by 3 setae at area of egg sac attachment.

MALE.—Body form as in Figure 6*e*. Total length 0.98 mm, greatest width 0.38 mm. Genital segment (Figure 7*a*) longer than wide (194 × 159 μm). Abdomen (see Figure 7*a*) 2-segmented, segments measuring 53 × 94 μm and 64 × 88 μm respectively, ventral surface of last segment with 2–3 irregular transverse rows of spinules near anterior edge and a small patch of spinules near insertion of each caudal

ramus (see Figure 7*b*). Caudal rami (Figure 7*b*) longer than wide (47 × 29 μm), each with small ventral patch of slender spinules and 6 setae (longest 531 μm).

Cephalic appendages and legs 1–5 as in *H. divaricatus* male.

ETYMOLOGY.—The Latin *nudiusculus* ("somewhat naked") refers to the small patches of minute hairs on the ventral surface of the last abdominal segment and the naked surface of the female caudal rami.

REMARKS.—Females of this species can be distinguished from *H. divaricatus* and *H. asperatus* by the ornamentation of the ventral surface of the last abdominal segment. *Holobomolochus nudiusculus* has 2 small patches of minute hairs on the last abdominal segment; *H. divaricatus* has 2 large patches of stout spinules; *H. asperatus* has 2 large patches of hairs on the last abdominal segment as well as a patch of hairs on each caudal ramus, unlike the caudal rami of *H. nudiusculus*. In addition the third segment endopods of legs 2 and 3 have small spinules near the bases of the outer spines; this ornamentation is lacking in *H. asperatus* and *H. divaricatus*. Females of this species can be distinguished from all other species of *Holobomolochus* by the nature of the exopod spines of leg 3 (see "Discussion").

Holobomolochus nudiusculus seems to be restricted to the eastern Pacific but common on its 2 hosts *Scomberomorus concolor* and *S. sierra* from California to Peru.

Holobomolochus asperatus, new species

FIGURES 7*c–g*, 8, 96

MATERIAL EXAMINED. — Holotype ♀ (USNM 172242) and paratypes 2 ♀ (USNM 172243) from the nasal sinus of *Scomberomorus cavalla* (MCZ 17182) from Cuba. In addition, 9 collections containing 10 ♀ are from the nasal sinus of *S. cavalla* from Georgia, Florida, Texas, Cuba, Trinidad, and Brazil.

FEMALE.—Body form as in Figure 7*c*. Total length 1.79 mm, greatest width 0.75 mm; length of cephalon 0.57 mm. Genital segment (Figure 7*d*) wider than long (212 × 265 μm). Abdomen 3-segmented, segments measure (l × w) 177 × 206 μm, 129 × 177 μm, and 112 × 159 μm respectively; ventral surface of last abdominal segment (see Figure 7*e*) with 2 prominent patches of hairlike spinules. Caudal rami (Figure 7*e*) longer than wide (82 × 53 μm), each ramus with six setae and a patch of hairlike spinules on its ventral surface; longest seta 768 μm.

First antenna (Figure 7*f*) 7-segmented with an aesthete on segments 6 and 7. Second antenna, mandible, paragnath, first maxilla, second maxilla, and maxilliped similar to corresponding appendages in *H. divaricatus*.

Leg 1 similar to that of *H. divaricatus* except endopod and basipod lack hairs found in *H. divaricatus*. Leg 2 (Figure 8*b*) similar to that of *H. divaricatus* except exopod second segment lacks spinules at base of outer spine; endopod first and second segments each have a minute patch of small hairs on outer distal corner, outer spines on third segment are small. Leg 3 (Figure 8*c*) similar to that of *H. divaricatus* except exopod spines comparatively longer and more slender; endopod third segment outer spines slender and without lateral spinules. Leg 4 (Figure 8*d*) coxopod with row of stout spinules on outer distal corner; basipod with dorsal seta; exopod 3-segmented, first segment with slender outer spine with small terminal flagellum, row of small spinules at base of spine, second segment with inner seta and outer spine similar to that of first segment, row of small spinules at base of spine, third segment with 6 inner to terminal plumose setae and 2 outer spines similar to but slightly longer than those of first and second segments, a few minute spinules at base of proximal spines; endopod 3-segmented, first segment with inner seta, spinulose along distal half, second segment with inner seta similar to that of first segment, outer distal border with short row of hairs, outer edges of first and second segments haired, third segment slender, elongate with 2 spinulose spines flanking terminal seta, spines of about equal length, seta spinulose along distal half, short row of elongate spinules near base of each spine. Leg 5 (Figure 8*e*) similar to that of *H. divaricatus* except free segment not as elongate, spinules shorter. Leg 6 (see Figure 7*d*) represented by row of 3 setae on genital segment, inner 2 setae short, outer seta about 3 times longer.

MALE.—Unknown.

ETYMOLOGY.—The Latin *asperatus* ("rough with points or short, stiff hairs") refers to the patches of hairs on the abdomen and caudal rami.

REMARKS.—Females of this species can be separated from *H. divaricatus* and *H. nudiusculus* by the presence of a patch of hairs on the ventral surface of each caudal ramus of *H. asperatus* (no ornamentation

on the rami of *H. divaricatus* or *H. nudiusculus*) and the lack of prominent patches of spinules on leg 4 (present in *H. divaricatus* and *H. nudiusculus*). *Holobomolochus asperatus* can be distinguished from all other members of the genus by the nature of the leg 3 exopod spines (see Discussion).

This species has been collected only from *Scomberomorus cavalla* from Georgia to northern Brazil. Although its range overlaps that of *H. divaricatus*, the 2 parasites have never been collected from a common host species.

Discussion

The 3 species of *Holobomolochus* described here all have highly developed spines on the exopod of leg 3 and the exopod segments themselves are heavily sclerotized. This character separates these 3 species from all previously described *Holobomolochus*. Although we do not feel that this difference alone warrants assigning these new species to a new genus, we feel that an improved understanding of the genus might result in a better basis for doing so. No other species of *Holobomolochus* has been collected from the nasal sinuses of the hosts. This unusual habitat may account for the unique nature of these 3 species.

Unicolax, new genus

DIAGNOSIS.—Bomolochidae. Body form typical of family. Thoracic segments bearing legs 3–5 free in female, thoracic segments bearing legs 2–5 free in male. Abdomen 3-segmented in female, 2-segmented in male. Caudal rami in both sexes with 6 setae, 2 much longer than other 4. First antenna 6- or 7-segmented in female, fourth seta on basal segment modified to form heavily sclerotized straight or nearly straight spine; first antenna in male 6-segmented with no modified setae. Second antenna and oral appendages typical of family. Maxilliped hook in female without accessory process; maxilliped basal segment in male with numerous small spinules. Legs 1–4 biramous in both sexes; rami of legs 1–3 and leg 4 exopod 3-segmented, leg 4 endopod 2- or 3-segmented. Female leg 2 endopod second segment with 2 inner setae, leg 3 endopod second segment with 1 inner seta. Rami of leg 1 in both sexes broad and flattened.

TYPE SPECIES.—*Unicolax collateralis* new genus, new species.

ETYMOLOGY.—The Latin, *uni-colax* (with "colax"), the suffix "colax" is common in other genera of the family and the name alludes to the new genus "with" others of the family.

DISCUSSION.—*Unicolax* can be separated from all the other bomolochid genera except *Bomolochus* by the modified fourth seta on the basal segment of the first antenna. *Holobomolochus, Acanthocolax, Pseudoeucanthus, Orbitacolax, Pseudorbitacolax, Pumiliopes,* and *Pumiliopsis* have no modified setae or cuticular process on the first antenna; *Boylea* has the fifth seta modified; in *Nothobomolochus* the third, fourth, and fifth setae are modified; in *Dicrobomolochus* the second and third setae are modified; *Ceratacolax* and *Tegobomolochus* have a cuticular process in addition to the usual 15 plumose setae on the first antenna. *Bomolochus* is characterized by having the fourth seta of the first antenna modified, but in *Bomolochus* this seta is sharply curved and lightly sclerotized, whereas in *Unicolax* it is straight or nearly so, and heavily sclerotized. *Unicolax* can further be separated from *Bomolochus* as the rami of the first leg of *Unicolax* males are flattened and broad as in the females; the first leg of *Bomolochus* males does not resemble that of *Bomolochus* females.

Unicolax has, so far, only been collected from the nasal sinuses of its hosts.

Unicolax collateralis, new species

FIGURES 9–13, 97, 114–116*a*

MATERIAL EXAMINED. — Holotype ♀ (USNM 172256), allotype ♂ (USNM 172257) paratypes 12 ♀ 23 ♂ (USNM 172258) from the nasal sinus of *Euthynnus alletteratus* (USNM 203838) from St. George Bay, Lebanon. The following collections from *Auxis* species: 2 ♀ from Woods Hole, Mass.; 2 ♂ from St. George Bay, Lebanon; 2 ♀ 3 ♂ from Ghardaqa, Egypt; 2 collections containing 7 ♀ 3 ♂ from Hong Kong; 2 collections containing 2 ♀ 1 ♂ from Japan; 7 collections containing 12 ♀ 4 ♂ from the Philippines; 2 ♀ from Chusan, China; 1 ♀ from Hawaii. One collection containing 5 ♀ from *Cybiosarda elegans* from Brisbane, Australia. The following collections from *Euthynnus affinis:* 2 ♀ 2 ♂ from Elat, Israel; 2 ♀ from Mozambique; 2 ♀ from Madagascar; 1 ♂ from the Seychelles; 4 ♀ from the Arabian Sea 24°N, 67°E; 2 ♀ from Java; 16 collections containing

29 ♀ 9 ♂ from the Gulf of Thailand; 2 ♀ from Formosa; 2 ♀ from Hong Kong; 4 collections containing 8 ♀ 1 ♂ from the Philippines; 1 ♀ from Palau; 1 ♀ from Okinawa; 1 ♂ from Tokyo; 4 ♀ 7 ♂ from Brisbane, Australia. The following collections from *Euthynnus alletteratus:* 1 ♀ from the Caribbean (9°11′N, 77°50′W); 2 ♀ from Brazil; 4 collections containing 29 ♀ 16 ♂ from St. George Bay, Lebanon. The following collections from *Euthynnus lineatus*: 1 ♀ from Galapagos; 1 ♀ from Lower California; 1 ♀ from Mexico (Pacific); 2 ♀ from Costa Rica (Pacific). One collection containing 1 ♀ from *Orcynopsis unicolor* from St. George Bay, Lebanon. Two collections containing 5 ♀ 3 ♂ from *Sarda australis* from New South Wales, Australia. Two collections from *Sarda orientalis* containing 3 ♀ from Pearl Islands, Panama, and Durban, South Africa. All collections from nasal sinuses of hosts.

FEMALE.—Body form as in Figure 9*a*. Total length 1.55 mm, greatest width 0.91 mm; length of cephalon 0.30 mm. Genital segment (Figure 9*b*) wider than long (200 × 312 μm). Abdomen (see Figure 9*b*) 3-segmented, segments measuring (l × w) 153 × 206 μm, 100 × 171 μm, 94 × 141 μm respectively. First 2 segments without ornamentation, last segment with 2 large ventral patches of fine hairs (see Figure 9*c*). Caudal rami (Figure 9*c*) longer than wide (88 × 53 μm), each ramus with ventral patch of fine hairs and 6 setae as indicated in Figure 9*c*; longest seta 413 μm.

First antenna (Figure 9*d*) 7-segmented. Fourth seta on first segment modified to form a heavily sclerotized spine. Ornamentation of segments as follows. Segment 1: 3 plumose setae; 1 spine; 1 plumose seta. Segment 2: 4 antero-dorsal naked setae; 7 antero-ventral plumose setae; 3 ventral plumose setae; 2 ventral naked setae. Segment 3: 1 dorsal naked seta; 3 antero-ventral plumose setae; 1 ventral naked seta. Segment 4: no ornamentation. Segment 5: 1 dorsal naked seta; 1 antero-ventral naked seta; 2 ventral naked setae. Segment 6: 2 terminal ventral naked setae; 1 aesthete. Segment 7: 6 terminal naked setae; 1 subterminal naked seta; 1 aesthete. Second antenna (Figure 9*e*) 3-segmented; second segment with one plumose seta and one short, naked seta; third segment armed with several rows of short spinules, and with 4 hooklike terminal spines and 3 setae. Mouthparts as in Figure 10*a*. Labrum with 2 large patches of hairs, hairs longer along anterior edge. Mandible blade slender, accessory blade smaller. Paragnath with distal and lateral hairs; also distal edge with fine teeth. First maxilla with 3 long, plumose setae and one short, naked seta. Second maxilla with 2 blades, each with uniform spinules along edges. Maxilliped (Figure 10*b*) with 4 plumose setae; hook slightly curved, without accessory process.

Legs 1–4 biramous, each ramus 3-segmented except leg 1 exopod. Leg 1 (Figure 10*c*) coxopod with patch of stout hairs on outer corner and broad inner seta; basipod with outer seta, row of hairs above insertion of endopod, and inner blunt process, exopod first segment with stout outer spine terminating in short flagellum and second segment incompletely divided, with 2 short, outer flagellate spines, and 6 terminal to inner setae, endopod first segment with inner seta and short row of spinules (hairs?) along outer, lower edge, second segment similar to first, third segment with 5 terminal setae, outer edges of endopod segments heavily haired, all setae heavily plumose. Leg 2 (Figure 10*d*) coxopod with patch of slender spinules on outer corner, row of short hairs along mid lower edge, basipod with outer dorsal seta and triangular patch of minute spinules on midventral surface; exopod first segment with long, slender spinules on outer edge, serrate spine with terminal flagellum on outer distal corner, inner edge with small patch of hairs, second segment with inner seta and outer spine similar to that on first segment, third segment with 5 inner to terminal setae and 4 terminal to outer spines, proximal spine with short hairs on both edges and terminal flagellum, next 2 spines similar to those on first and second segments, distal spine elongate with broad outer serrations and short inner hairs; all exopod setae long, slender and plumose; endopod first segment with inner seta and row of fine hairs along distal edge, second segment enlarged with 2 inner setae and row of fine hairs on outer half of distal edge, third segment narrower than second with 3 inner to terminal setae and 2 short terminal spines with short lateral hairs and terminal flagella; endopod setae stout basally and heavily plumose; outer edges of endopod segments haired. Leg 3 (Figure 11*a*) coxopod with row of short spinules on outer distal corner, small central patch of blunt spinules and row of short hairs on mid-lower edge; basipod with outer dorsal seta; exopod first segment with outer distal spine, dorsolateral surface of segment with several rows of short spinules giving bumpy appearance, second segment

with inner seta and outer spine, third segment with 5 inner to terminal setae and 3 terminal to outer spines, exopod spines similar to corresponding spines of leg 2, except leg 3 lacks haired spine present on third segment of leg 2, all setae plumose; endopod first segment with inner seta and row of short hairs along distal edge, second segment similar to first, third segment with 2 inner to terminal setae and 2 terminal to outer spines, each with serrate edges and terminal flagellum, all setae plumose, outer edges of endopod segments haired. Leg 4 (Figure 11*b*) coxopod with central patch of small spinules and row of short hairs along mid-lower edge; basipod lacking ornamentation; exopod similar to leg 3 except first segment lacks dorso-lateral spinules; endopod first segment with inner seta and row of fine hairs along distal edge, seta shorter than corresponding seta of leg 2, constricted slightly at midpoint, plumose distally finely serrate proximally, hairs on distal edge of segment slightly longer than corresponding hairs of leg 2, second segment similar to first, third segment with row of fine hairs distally and 2 spines flanking terminal seta, spines broadly serrate and with terminal flagellum, seta finely serrate on distal half, outer edges of endopod segments haired. Leg 5 (Figure 11*c*) basal segment with outer dorsal seta and dense patch of short spinules on outer distal corner; free segment with 3 dense patches of short spinules, one spine on mid-outer margin and 2 spines flanking one terminal naked seta, spines with serrate edges and terminal flagellum. Leg 6 (see Figure 9*b*) represented by 2 long and one shorter seta on genital segment.

MALE.—Body form as in Figure 11*d*. Total length 1.09 mm, greatest width 0.44 mm; length of cephalon 0.20 mm. Genital segment (Figure 11*e*) longer than wide (236 × 218 μm). Abdomen (see Figure 11*e*) 2-segmented, segments measuring 94 × 112 μm and 70 × 88 μm respectively. Last abdominal segment ornamented ventrally with anterior row of fine spinules and 2 large patches of fine hairs (see Figure 12*a*). Caudal rami (Figure 12*a*) longer than wide (53 × 35 μm); each ramus with ventral patch of fine hairs and 6 setae; longest seta 295 μm.

First antenna (Figure 12*b*) 6-segmented. First segment with 5 plumose setae and no indication of modified spine present on female; fifth and sixth segments each with one aesthete. Second antenna, mandible, paragnath, first and second maxillae similar to female. Maxilliped (Figure 12*c*) with one seta and large patch of small, rounded spinules on second segment; last segment with 2 setae near base and row of teeth along inner edge.

Legs 1–4 biramous. Leg 1 (Figure 12*d*) coxopod with inner seta and spinules as indicated in Figure 12*d;* basipod with outer seta, blunt process between insertion of rami, and inner process sclerotized at base with terminal, fringed membrane, spinules near base of this process; exopod 3-segmented, first segment with outer spine, second segment with outer spine and inner seta, third segment with 2 outer spines and 5 setae; endopod first segment with inner seta, distal outer edge of segment with row of hairs, second segment similar to first, third segment with 5 setae terminally and one outer spine, minute spinules near bases of setae; all setae heavily plumose. Leg 2 (Figure 12*e*) coxopod with short row of spinules on outer distal corner and row of hairs on mid-distal edge; basipod with naked seta dorsally near outer edge; exopod first segment with outer distal serrate spine with terminal flagellum, row of fine spinules near base of spine, dorso-lateral surface of segment with several rows of short, rounded spinules, second segment with inner seta and outer spine similar to that on first segment, third segment with 5 inner to terminal setae and 3 terminal to outer spines, proximal 2 spines similar to those on first and second segments, distal spine elongate with broad outer serrations and short inner hairs; endopod first segment with inner seta and short row of hairs along distal edge, second segment similar, third segment with 3 inner to terminal setae and 2 outer spines, each finely haired on edges and with terminal flagellum; outer edge of endopod segments heavily haired. Leg 3 (Figure 13*a*) similar to leg 2, with following exceptions; exopod second segment lacks outer spine and fine spinules; endopod third segment with only 2 setae, inner spine about twice as long as outer, ornamentation on edges of each spine serrate rather than haired as in leg 2. Leg 4 (Figure 13*b*) coxopod, basipod, and exopod similar to leg 3 except exopod third segment with only 4 setae; endopod 2-segmented, first segment with inner seta, second segment elongate with row of fine hairs distally and 2 spines flanking terminal seta, spines finely serrate with terminal flagella, inner spine about one-third longer than outer, seta finely serrate along distal half. Leg 5 (Figure 13*c*) basal segment with outer dorsal seta and dense patch of spinules on outer distal corner; free segment with terminal outer

seta extending almost to end of genital segment, and inner spine broadly serrate on edges and with terminal flagellum; segment with dense patch of spinules on distal half.

ETYMOLOGY.—The Latin *collateralis* ("standing side by side") alludes to its occurrence in collections with *U. mycterobius.*

REMARKS.—Females of this species can be distinguished from *U. mycterobius, U. ciliatus,* and *U. reductus* principally by the nature of the spines on the exopod third segment of leg 2 as the proximal spine of *U. collateralis* is finely haired on both edges and the next two spines have broad serrations on both side. This is unlike the ornamentation of corresponding spines on any of the other above species. *Unicolax collateralis* can be distinguished from *U. anonymous,* which it most closely resembles, by having 3 spines, 5 setae on the exopod third segment of leg 4; *U. anonymous* has 3 spines, 4 setae on the corresponding segment. The ventral surface of the endopod segments of legs 2–4 are densely haired in *U. anonymous,* whereas *U. collateralis* has only a single row of hairs along the distal edge of some of its endopod segments.

Males of this species can be distinguished from those of *U. anonymous* by the ornamentation of leg 5. *Unicolax collateralis* has a patch of stout spinules that extends from about the middle of the free segment distally and around the entire distal edge; in *U. anonymous* the spinules are distinctly elongate and the patch extends distally from above the middle of the segment and does not continue around to the outer distal edge. Males can be distinguished from *U. mycterobius, U. ciliatus,* and *U. reductus* by the ornamentation of the ventral surface of the last abdominal segment. In *U. collateralis* this segment has a single, even row of spinules near the anterior border, and 2 large patches of hairs. *Unicolax mycterobius* has similar ornamentation, but the anterior row of spinules is irregular and the spinules are minute.

This copepod is circumglobal and occurs in the nasal sinuses of a variety of scombrid hosts (species of *Auxis, Cybiosarda, Euthynnus, Orcynopsis,* and *Sarda*). It is often collected with *U. mycterobius,* which parasitizes some of the same hosts (species of *Auxis* and *Euthynnus*).

Unicolax anonymous (Vervoort, 1965), new combination

FIGURES 14–16, 98, 116*b–f,* 117

Parabomolochus anonymous Vervoort, 1965:3.

MATERIAL EXAMINED.—Two collections containing 31 ♀ 2 ♂ from the nasal rosettes of *Euthynnus alletteratus* from Ghana and the Gulf of Mexico.

FEMALE.—Body form as in Figure 14*a.* Total length of cephalon 0.37 mm. Genital segment wider than long (177 × 247 μm). Abdomen 3-segmented, segments measure 82 × 153 μm, 53 × 141 μm, 70 × 123 μm length × width respectively. First 2 segments without ornamentation, last segment with 2 patches of fine hairs ventrally. Caudal rami each with patch of fine hairs and 6 setae; longest 171 μm.

First antenna (Figure 14*b*) 7-segmented. Fourth seta on first segment modified to form heavily sclerotized spine; one aesthete on each of last 2 segments. Second antenna (Figure 14*c*) 3-segmented, last segment with several rows of hooklike spinules, 4 setae, and 4 hooklike terminal spines. Mandible, paragnath, first maxilla, second maxilla as in Figure 14*d.* Paragnath with outer row of teethlike spinules and long hairs; first maxilla with 3 long plumose setae and one short, naked seta. Maxilliped (Figure 14*e*) with one plumose seta on basal segment, 3 plumose setae on last segment; hook slightly curved, without accessory process.

Legs 1–4 biramous, each ramus 3-segmented except leg 1 exopod. Leg 1 (Figure 15*a*) coxopod with broad inner seta; basipod with outer seta, one small blunt spinule near lower inner edge and two large patches of hairs; exopod first segment with outer spine, second segment with 2 short outer spines and 6 terminal to inner setae; endopod first and second segments each with inner seta and patch of hairs on lower to outer edge, third segment with 5 setae, outer edges of endopod segments heavily haired. Leg 2 (Figure 15*b*) coxopod with inner seta, outer distal corner with short curved spinules; basipod with outer seta and patch of small spinules between insertion of rami; exopod first segment with long, slender spinules on outer edge and stout broadly serrate spine with terminal flagellum on outer distal corner, second segment with inner seta and outer spine similar to that of first segment, third segment with 5 inner to terminal setae and 4 terminal to outer spines, proximal spine with short hairs along both sides and terminal

flagellum, next 2 spines similar to those of first and second segments, distal spine elongate with broad outer serrations and short inner hairs; endopod first segment with inner seta and large patch of short hairs distally, second segment enlarged, with 2 inner setae and patch of short hairs on outer distal corner, third segment narrower than second with 3 inner to terminal setae and 2 short terminal spines each with hairs on edges and terminal flagellum, outer edges of endopod segments haired. Leg 3 (Figure 16*a*) coxopod and basipod similar to leg 2; exopod first segment with outer distal spine, dorso-lateral surface of segment with several uneven rows of short spinules giving bumpy appearance, second segment with inner seta and outer spine, third segment with 5 inner to terminal setae and 3 terminal to outer spines, exopod spines similar to corresponding spines of leg 2, except leg 3 lacks haired spine present on third segment of leg 2; endopod first segment with inner seta and patch of hairs covering distal half of segment, second segment with inner seta and patch of hairs on outer distal corner, third segment with 2 inner to terminal setae and 2 terminal to outer spines, inner spine longer, each with serrate edges and terminal flagellum, outer edges of endopod segments haired. Leg 4 (Figure 16*b*) coxopod with row of short hairs on mid-distal edge; basipod with outer seta; exopod first segment with spine on outer distal corner, second segment with inner seta and outer spine, third segment with 4 inner to terminal setae and 3 terminal to outer spines, exopod spines similar to corresponding spines of leg 3; endopod first segment with inner seta, proximal half plumose, distal portion edged with short bristles, segment with large patch of short hairs distally, second segment with inner seta similar to that of first segment, and patch of short hairs on outer distal corner, third segment with 2 spines flanking terminal seta, spines broadly serrate distally, seta with short bristles on lower half, distal edge of segment with short spinules, outer edges of endopod segments haired. Leg 5 (Figure 16*c*) basal segment with outer seta and dense patch of short spinules on outer distal corner; free segment with 3 dense patches of short spinules, one spine on mid-outer margin, and 2 spines flanking one naked seta distally, spines each with fine serrations along distal half and terminal flagellum. Leg 6 (see Figure 14*a*) represented by 3 setae on genital segment.

MALE.—Body form as in Figure 16*d*. Total length 0.81 mm, greatest width 0.36 mm; length of cephalon 0.20 mm. Genital segment as long as wide (177 × 177 μm). Abdomen 2-segmented, segments measuring (length × width) 35 × 94 μm and 59 × 70 μm. Caudal rami slightly longer than wide (35 × 29 μm); longest seta 177 μm.

All appendages and ornamentation similar to (although proportionately smaller than) *U. collateralis* except leg 5.

Leg 5 (Figure 16*e*) similar to *U. collateralis* except patch of spinules on free segment covers lower two-thirds of inner half of segment and does not extend around the entire distal edge; also, spinules on both basal and free segments are longer and more slender than those of *U. collateralis*.

REMARKS.—*Unicolax anonymous* was described by Vervoort (1965) as *Parabomolochus anonymous* from the nasal sinus of *Euthynnus alletteratus* from the Gulf of Guinea.

We believe the copepods above to be the same species as Vervoort's even though our descriptions differ on some points. Vervoort (1965:6) reported "no spinules on the abdominal somites" of the female. We, however, found 2 patches of hairs on the ventral surface of the last abdominal segment as well as a ventral patch of hairs on each caudal ramus. Vervoort (1965:11) further reported that "the external margin of the first exopod segment [of legs 2–4] is strongly haired." We found this true only of leg 2; on legs 3 and 4 the first exopod segment was ornamented by several irregular rows of bumplike spinules.

In spite of these differences we feel we are dealing with the same species for the following reasons: the copepods reported here are from the same host species and the same locality (and the Gulf of Mexico as well) as those described by Vervoort; Vervoort reported collecting *Ceratocolax euthynni* from the same individual hosts as *U. anonymous,* we also found *C. euthynni* in both our collections with *U. anonymous;* apart from the differences mentioned above, our descriptions are in agreement.

Females of *U. anonymous* can be distinguished from *U. mycterobius, U. ciliatus,* and *U. reductus* by the nature of the spines on the exopod third segment of leg 2. The proximal spine in *U. anonymous* is finely haired on both sides while the remaining spines are broadly serrate; this ornamentation is unlike that of the corresponding spines of any other of the above species. *Unicolax anonymous* can be dis-

tinguished from *U. collateralis,* which it most closely resembles, by the ornamentation of the exopod third segment of leg 4; *U. anonymous* has 3 spines, 4 setae; *U. collateralis* has 3 spines, 5 setae. Further, the endopod segments of legs 2–4 in *U. anonymous* each have a dense patch of hairs; *U. collateralis* has only a single row of hairs near the distal border of some of its endopod segments.

Unicolax anonymous males have, on the free segment of leg 5, a patch of elongate spinules that extends from above the middle of the segment to the inner distal border; the spinules do not continue around the entire distal border of the segment. This ornamentation is unlike that of other species of *Unicolax* males.

This copepod has, so far, only been reported from the nasal sinuses of *Euthynnus alletteratus* from the Gulf of Guinea and the Gulf of Mexico. It is a relatively small copepod and may, as Vervoort noted, frequently be overlooked.

Unicolax mycterobius (Vervoort, 1965), new combination

FIGURES 17–19, 99, 118, 119*a–c*

Parabomolochus mycterobius Vervoort, 1965:11.

MATERIAL EXAMINED.—The following collections from *Auxis* species: 1 ♀ 2 ♂ from Massachusetts; 1 ♀ from Ghardaqa, Egypt; 2 ♀ from Formosa; 3 collections containing 4 ♀ 1 ♂ from Tokyo; 5 ♀ from Luzon, Phillipines; 1 ♀ 3 ♂ from New South Wales; 1 ♀ from Hawaii. The following collections from *Euthynnus alletteratus:* 1 ♀ from Pensacola, Florida; 4 collections containing 5 ♀ 5 ♂ from St. George Bay, Lebanon. The following collections from *E. affinis:* 2 collections containing 2 ♀ 2 ♂ from Tokyo, Japan; 1 ♀ from Kagoshima, Japan. All copepods collected from the nasal sinus of host.

Female.—Body form as in Figure 17*a*. Total length 2.55 mm greatest width 1.45 mm; length of cephalon 0.90 mm. Genital segment wider than long 241 × 454 μm. Abdomen 3-segmented, segments measuring 177 × 318 μm, 135 × 265 μm, 171 × 212 μm respectively. Caudal rami longer than wide 147 × 64 μm, longest seta 501 μm. Last abdominal segment and caudal rami with ornamentation similar to *Unicolax collateralis*.

Cephalic appendages and leg 1 similar to *Unicolax collateralis*.

Leg 2 (Figure 17*b*) coxopod with inner seta and row of fine spinules on outer distal corner; basipod with outer seta and 2 small patches of fine hairs; exopod first segment with large outer patch of fine hairs and spine on outer distal corner, second segment with inner seta and outer spine, third segment with 5 inner to terminal setae and 4 terminal to outer spines, exopod spines squat with short hairs along margins and terminal flagellum except distal spine on third segment elongate and tapered with fine hairs on outer edge, widely spaced hairs on inner edge; endopod first segment with stout inner seta, outer distal portion of segment with patch of short hairs, second segment enlarged with 2 stout inner setae and patch of short hairs on outer distal edge, third segment narrower than second, with 3 stout inner to terminal setae and 2 terminal spines similar to those on exopod, outer edges of endopod segments heavily haired. Leg 3 (Figure 17*c*) coxopod and basipod similar to leg 2; exopod first segment with patch of short hairs on mid-outer margin and spine on outer distal corner, second segment with inner seta and outer spine, third segment with 5 inner to terminal setae and 3 terminal to outer spines, distal exopod spine elongate and tapered, similar to corresponding spine of leg 2, other exopod spines slightly more elongate than corresponding spines of leg 2; endopod first segment with inner seta and patch of short hairs on outer distal corner, second segment similar to first, third segment with 2 inner to terminal setae, (inner seta plumose, terminal seta with short hairs of uniform length along outer margin) and 2 outer spines, outer edges of endopod segments heavily haired. Leg 4 (Figure 18*a*) coxopod with minute spinules along mid-distal margin; basipod with outer seta; exopod first segment with minute spinules covering most of dorsal surface, extending to small mid-ventral patch, spine on outer distal corner, second segment with inner seta and outer spine, third segment with 5 inner to terminal setae and 3 terminal to outer spines, exopod spines similar to corresponding exopod spines of leg 3; endopod first segment with outer distal patch of short hairs and inner seta with short bristles along distal two-thirds, second segment with distal patch of short hairs and inner seta similar to that of first segment, third segment with distal patch of short hairs, and terminal seta flanked by 2 spines, seta with bristles

along distal half, spines with bristled margins and terminal flagellum, outer edges of endopod segments haired. Leg 5 (Figure 18*b*) basal segment with small outer patch of short hairs and dorsal seta; free segment with dense patches of hairs, one naked spine with terminal flagellum on mid-outer margin, one naked terminal seta flanked by 2 spines, outer spine naked with terminal flagellum, inner spine with short bristles along margins and terminal flagellum. Leg 6 (see Figure 17*a*) represented by 3 setae on genital segment.

MALE.—Body form as in Figure 18*c*. Total length 1.36 mm, greatest width 0.52 mm; length of cephalon 0.35 mm. Genital segment longer than wide (336 × 289 μm). Abdomen 2-segmented, segments measuring (length × width) 100 × 129 μm and 70 × 106 μm respectively; second segment (see Figure 18*d*) ornamented ventrally with anterior, irregular row of minute hairs and distally with 2 patches of minute hairs. Caudal rami (Figure 18*d*) longer than wide (70 × 41 μm); each ramus with ventral patch of hairs and 6 setae; longest seta 383 μm.

Cephalic appendages similar to those of *U. collateralis* male.

Legs 1–4 biramous. Leg 1 (Figure 18*e*) coxopod with broad inner seta and 2 short rows of fine spinules, one on outer distal corner, one on mid-distal edge; basipod with outer seta, blunt process near insertion of rami, and inner spine sclerotized at base and with fringed membrane distally, a large, prominent patch of rounded spinules surrounding base of spine and extending to mid portion of segment (see Figure 18*f*); exopod first segment with stout spine on outer distal corner, row of fine spinules surrounding base of spine, second segment incompletely divided with 6 inner to terminal setae, one outer setiform spine and 2 stout outer spines (one dorsal) as indicated in Figure 18*f*; endopod 3-segmented, similar to *U. collateralis* except first 2 segments each with large patch of hairs on distal half, and third segment with spinules more prominent than those of *U. collateralis* near bases of setae. Leg 2 (Figure 19*a*) coxopod with inner plumose seta and row of hairs on mid-distal margin; basipod with naked seta on outer dorsal corner; exopod similar to that of *U. collateralis* except first segment with large patch of fine hairs around outer ventro-lateral portion of segment, also, spinules at base of proximal 4 spines of ramus stout, some almost half as long as accompanying spines; endopod similar to that of *U. collateralis* except first and second segments each with large patch of fine hairs along outer and distal borders, third segment with comparatively small patch of fine hairs along outer edge, and several short, irregular rows of minute spinules as well as 2 or 3 small patches of bumps along distal margin at bases of terminal 2 spines and 3 setae. Leg 3 (Figure 19*b*) similar to leg 2 with following exceptions: exopod first segment with 2 patches of ventro-lateral spinules, proximal patch hairlike, distal patch small, fine spinules; second segment lacks outer spine and accompanying basal spinules; endopod third segment with only 2 inner to terminal setae, outer spines slightly larger than those of leg 2, with inner spine about one-third longer than outer. Leg 4 (Figure 19*c*) coxopod, basipod, exopod similar to leg 3 except ventro-lateral spinules of first segment all very fine and third segment with only 4 inner to terminal setae; endopod completely or incompletely divided into 3 segments (see "Remarks"), first and second segments similar to those of legs 2 and 3 except second segment lacks inner seta, third segment with 2 or 3 short, irregular rows of fine spinules distally and 2 spines flanking terminal seta, spines of about equal length, each finely serrate and with terminal flagellum, seta finely spinulose along distal two-thirds. Leg 5 similar to that of *U. collateralis,* outer seta extending to about half the length of genital segment.

REMARKS.—Vervoort (1965) first described this species as *Parabomolochus mycterobius.* His description was based on a single collection of 6 females and 2 males from the nasal sinus of *Auxis thazard* from the Gulf of Guinea. Our collections have enabled us to add details to Vervoort's original description.

Unicolax mycterobius females are the only known members of the genus in which all the exopod spines of legs 2–4 are edged with fine hairs; the distalmost spine has fine hairs on the outer edge only, all other exopod spines have hairs on both edges. Females of other species of the genus have stout serrations on some or all of the exopod spines of legs 2–4. The free segment of leg 5 of *U. mycterobius* females has 3 patches of fine hairs; other species have patches of distinctly stout spinules on the corresponding segment.

Males of the species can be separated principally by the nature of legs 1 and 4. Leg 1 basipod has a very large, prominent patch of rounded spinules near the inner distal corner. Although males of other species have ornamentation at the corresponding site, in

no other species is the patch as large or the spinules as prominent as in *U. mycterobius.*

Leg 4 endopod is 2 or 3 segmented, the variation seems to be geographical. In the 7 collections containing *U. mycterobius* males, 3 (containing 6 males) were from the Pacific (Tokyo and New South Wales), 4 (containing 8 males) were from Massachusetts and Lebanon. Males from the Pacific have 3-segmented leg 4 endopods with clear articulation between the second and third segments. Males from Massachusetts and Lebanon have 2-segmented endopods, yet retain evidence of the third segment in that they have a patch of fine hairs mid-way along the outer edge of the last segment where the articulation would be. No other differences were found between males of the 2 populations. Copepods from both populations were found on species of *Auxis* and *Euthynnus;* females collected with males from both populations did not appear to be different from each other.

Males of this species also have more prominent spinules at the base of exopod spines of legs 2–4 and denser patches of hairs on endopod segments of legs 2–4 than males of other species.

Unicolax mycterobius occurs from the northwestern Atlantic to the Western Pacific and is found in the nasal sinuses of species of *Auxis* and *Euthynnus.*

Unicolax ciliatus, new species

FIGURES 20–22, 98

MATERIAL EXAMINED. — Holotype ♀ (USNM 172253) allotype ♂ (USNM 172254) and 1 ♀ paratype (USNM 172255) from the nasal sinus of *Scomberomorus plurilineatus* (USNM 273221) E. African Marine Fisheries, Zanzibar Channel, 6 October 1965. The following collections from *S. commerson:* 2 ♀ from N.W. Coast of Madagascar; 2 ♀, 1 ♂ from Travancore, India; 6 ♀ from Cochin, India; 4 ♀ from Batavia, Java; 2 ♀ 1 ♂ from Phuket, Thailand; 1 ♀ from Hong Kong; 5 collections containing 23 ♀ 1 ♂ from the Philippines. The following collections from *S. guttatus:* 1 ♀ from Calicut, India; 1 ♀ from Padang, Sumatra; 2 ♀ from Batavia, Java; 1 ♀ from Singapore; 1 ♀ from Phuket, Thailand; 2 collections containing 7 ♀ from Hong Kong; 3 collections containing 13 ♀ from China. The following collections from *S. niphonius:* 1 ♀ from Korea; 1 ♀ from China. The following collection from *S. semifasciatus:* 5 ♀ 1 ♂ from New Guinea. The following collections from *S. tritor:* 2 collections containing 4 ♀ from Liberia; 8 ♀ from Ghana; 2 ♀ from Lagos, Nigeria.

FEMALE.—Body form as in Figure 20*a*. Total length 2.30 mm, greatest width 1.01 mm, length of cephalon 0.60 mm. Genital segment wider than long (265 × 330 μm). Abdomen 3-segmented, segments measuring 165 × 212 μm, 118 × 171 μm, 147 × 159 μm respectively. Caudal rami longer than wide (141 × 59 μm), longest seta 590 μm. Ventral side of last abdominal segment and caudal rami with patches of hairs similar to *Unicolax collateralis.*

First antenna (Figure 20*b*) 7-segmented; segments armed similarly to *U. collateralis;* spine on first segment about twice as long as adjacent plumose setae. Second antenna, mouthparts, and maxilliped similar to *U. collateralis.*

Legs 1–4 biramous, each ramus 3-segmented. Leg 1 coxopod and endopod similar to *U. collateralis;* basipod similar to *U. collateralis* except outer plumose seta more robust (see Figure 20*c*); exopod (Figure 20*c*) distinctly 3-segmented, first segment with outer crenulated spine with terminal flagellum, second segment with short outer spine with terminal flagellum about twice as long as spine and 3 terminal to inner plumose setae, third segment with outer spine similar to that on second segment and 3 terminal plumose setae. Leg 2 endopod similar to *U. collateralis,* coxopod with patch of long slender spinules near outer distal corner and short row of minute hairs along mid-lower edge; basipod with outer dorsal seta and row of short spinules along outer distal edges; exopod (Figure 20*d*) first segment with large patch of long, slender spinules on outer edge, patch of hairs on inner edge and outer distal spine with short hairs on edges and short, terminal flagellum, second segment with long inner plumose seta and outer spine similar to that on first segment, third segment with 5 inner to terminal plumose setae and 4 outer to terminal spines, proximal 3 spines similar to spines of first and second segments, terminal spine elongate with outer serrations and short, inner hairs. Leg 3 (Figure 21*a*) coxopod with row of short spinules on outer distal corner; basipod with outer dorsal seta and short row of short spinules on outer distal corner; exopod first segment with outer distal spine with serrate rather than haired edges as in leg 2, and terminal flagellum, inner edge of segment haired, dorsolateral surface of segment with several rows of short spinules giving bumpy appearance,

second segment with inner plumose seta and outer spine similar to that on first segment, third segment with 5 inner to terminal plumose setae and 3 outer to terminal spines, proximal 2 spines similar to those of first and second segments, distal spine elongate, similar to corresponding spine of leg 2; endopod first segment with inner plumose seta and short row of fine hairs near outer distal corner, second segment armed similarly to first but segment slightly more elongate, third segment with 2 inner to terminal plumose setae and 2 outer to terminal spines, each with serrate edges and terminal flagellae, inner spine about twice as long as outer spine, outer edges of endopod segments haired. Leg 4 (Figure 21*b*) coxopod with short row of small spinules on outer distal corner; basipod with outer dorsal seta; exopod first segment with spine on outer distal corner and hairs on inner edge, second segment with inner plumose seta and outer spine, third segment with 5 inner to terminal plumose setae and 3 outer to terminal spines, exopod spines slightly more elongate than corresponding spines of leg 3, but similarly armed; endopod first segment with short row of short hairs on outer half of distal edge and inner seta constricted near mid-point, plumose above constriction, finely serrate below it, second segment similar to first, third segment with fine hairs along outer half of distal edge and 2 spines with serrate edges and terminal flagella flanking a terminal seta finely serrate on lower half, outer edges of endopod segments haired. Leg 5 (Figure 21*c*) basal segment with dorsal seta and row of minute spinules on outer half of distal edge; free segment with 2 outer patches of spinules, one near mid-segment, one distal, both patches with small, widely-spaced spinules, large dense patch of more elongate spinules from mid-inner edge to distal edge of segment, one spine on mid-outer margin and 2 spines flanking terminal, naked seta, spines with finely serrate edges and terminal flagellum. Leg 6 represented by 2 long and one shorter seta on genital segment.

MALE.—Body form as in Figure 21*d*. Total length 1.23 mm, greatest width 0.46 mm; length of cephalon 0.29 mm. Genital segment longer than wide (265 × 177 μm). Abdomen 2-segmented, segments measuring (length × width) 88 × 88 μm, and 88 × 70 μm, ventral surface of second segment (see Figure 21*e*) ornamented with 4 rows of slender, elongate spinules, 2 proximal rows that meet at mid-point of segment and 2 separate distal rows. Caudal rami (Figure 21*e*) longer than wide (59 × 29 μm) each ramus with 6 setae and ventral patch of hairs; longest seta 413 μm.

First antenna similar to that of *U. collateralis* male except distal seta on third segment heavily plumose and extends beyond aesthete of terminal segment. Remaining cephalic appendages similar to those of *U. collateralis* male.

Legs 1–4 biramous. Leg 1 similar to that of *U. collateralis* male except endopod third segment with outer spine haired on outer edge and with terminal flagellum (see Figure 21*f*). Legs 2–5 (Figures 22*a–d* respectively) similar to those of *U. collateralis* male with following exceptions: leg 3 endopod third segment outer 2 spines each with lateral serrations as broad as those of exopod spines; leg 4 endopod first segment inner seta extends beyond spines of second segment almost as far as terminal seta, spines of second segment of about equal length, serrations of outer spine broader than those of inner spine; leg 5 basal segment with single row of small spinules on outer distal edge, free segment with single row of distal spinules near bases of terminal spine and seta, spinules on inner lateral margin of segment limited to a few irregular rows.

ETYMOLOGY.—The Latin *ciliatus* ("hairy") alludes to the hairs rather than serrations on the spines of the exopod of leg 2.

REMARKS.—Females of this species can be distinguished from all others of the genus by the nature of the spines on the exopod third segment of leg 2. The first 3 spines are finely haired on both sides, the distal, elongate spine has conspicuous, broad serrations on the outer edge. *Unicolax anonymous, U. collateralis,* and *U. reductus* have broad, lateral serrations on the last 3 spines of the corresponding segment. *Unicolax mycterobius* has fine hairs rather than serrations on the distal elongate spine.

Unicolax ciliatus is the only species in which the ornamentation of the exopod spines of leg 2 differs from that of legs 3 and 4. The modified spine of the first antenna is comparatively longer and more slender in *U. ciliatus* than in other species.

Males of this species are characterized by having, on the ventral surface of the last abdominal segment, a row of spinules near the insertion of each caudal ramus and a proximal row of spinules in each right and left half; the 2 proximal rows meet along the mid line of the segment, the 2 distal rows are interrupted medially (see Figure 21*e*).

This species is found from the western Pacific to the Gulf of Guinea and is, so far, the only species of *Unicolax* found on species of *Scomberomorus*.

Unicolax reductus, new species

FIGURES 23–26, 99, 119*d–f*, 120–122*a,b*

MATERIAL EXAMINED. — Holotype ♀ (USNM 172259), allotype ♂ (USNM 172260), paratypes 15 ♀ (USNM 172261) from *Katsuwonus pelamis* (USNM 176974) nasal sinus from New South Wales. Additional material from the same host: 24 ♀ 2 ♂ from Tahiti and 25 ♀ 1 ♂ from Japan. All copepods collected from the nasal sinuses of the hosts.

FEMALE.—Body form as in Figure 23*a*. Total length 2.94 mm, greatest width 1.50 mm; length of cephalon 0.94 mm. Genital segment (Figure 23*b*) wider than long (289 × 501 μm). Abdomen (see Figure 23*b*) 3-segmented, segments measuring 206 × 247 μm, 188 × 230 μm, 230 × 200 μm respectively; segments without ornamentation. Caudal rami (Figure 23*c*) longer than wide (206 × 88 μm) each ramus bearing 6 setae and no other ornamentation, longest seta 401 μm.

First antenna (Figure 23*d*) 6-segmented. Ornamentation of segments as follows. Segment 1: 3 plumose setae; 1 seta modified to form a sclerotized spine; 1 plumose seta. Segment 2: 5 antero-dorsal naked setae; 10 long plumose setae in a diagonal line across ventral surface of segment; 4 short, ventral plumose setae; 1 ventral naked seta. Segment 3: one antero-ventral naked seta; one postero-ventral sparcely plumose seta. Segment 4: one ventral naked seta; one dorsal naked seta. Segment 5: 2 terminal ventral naked setae; one ventral aesthete. Segment 6: 6 terminal naked setae; one subterminal naked seta; one terminal aesthete. Second antenna (Figure 23*e*) similar to *U. collateralis* and *ciliatus*. Labrum similar to *U. collateralis*. Remaining mouthparts as in Figure 23*f*. Maxilliped (Figure 24*a*) basal segment with one plumose seta; second segment with 3 plumose setae; hook bent, with elbowlike shape, and without accessory process.

Legs 1–4 biramous, each ramus 3-segmented except leg 1 exopod and leg 4 endopod. Leg 1 (Figure 24*b*) coxopod with broad inner seta, patch of small hairs and a blunt process near inner distal edge; basipod with outer patch of small hairs; exopod first segment with outer spine with fine serrations and terminal flagellum, second segment incompletely divided, with one outer flagellated spine and 6 terminal to inner plumose setae; endopod first segment with inner plumose seta and small hairs on distal and outer portion of segment, second segment with inner plumose seta, third segment with 5 terminal plumose setae. Leg 2 (Figure 24*c*) coxopod with few, widely spaced hairs along distal edge; basipod with outer dorsal seta and patch of fine spinules on distal edge near insertion of endopod; exopod first segment with patch of fine spinules on lower, outer portion of segment, row of several, stout spinules near base of spine on outer distal corner, spine with few, broad serrations and fine terminal flagellum, second segment with short, inner, naked seta, row of stout spinules near base of outer spine similar to that on first segment, third segment with 4 inner to terminal, sparcely plumose setae, and 3 outer to terminal spines, proximal 2 spines each with row of stout spinules near base and similar to those of first and second segments, terminal spine elongate with few, broad outer serrations; endopod first segment with stout, inner, plumose seta and patch of fine hairs on lower, outer edge of segment, second segment enlarged, with 2 inner, plumose setae and patch of fine hairs on outer, distal corner, third segment with 3 inner to terminal plumose setae and 2 small, outer to terminal spines, each with finely serrate edges, outer edges of endopod segments haired. Leg 3 (Figure 24*d*) coxopod without ornamentation; basipod with outer, dorsal seta and small patch of fine spinules near insertion of endopod; exopod similar to leg 2 except spinules on lower, outer portion of first segment slightly larger and more sparcely placed than corresponding spinules of leg 2; endopod first segment with inner, sparcely plumose seta and patch of fine spinules on outer half of distal edge, second segment similar to first, third segment with 2 inner to terminal sparcely plumose setae, 2 outer to terminal spines each with broadly serrate edges and terminal flagellum (terminal spine longer than outer spine) and small patch of spinules near base of spines, outer edges of endopod segments with short hairs. Leg 4 (Figure 25*a*) coxopod and basipod similar to leg 3; exopod similar to leg 3 with following exceptions: first segment with very few spinules on outer portion of segment; third segment with only 3 rather than 4 sparcely plumose setae; also spines slightly longer than corresponding spines of leg 3; endopod first segment

with inner seta finely serrate distally and patch of spinules along outer distal edge, few spinules on outer edge, second segment incompletely divided with triangular patch of spinules proximal to division indicating probable fusion of second and third segments, uneven row of stout spinules distally near bases of terminal seta flanked by 2 spines, seta finely serrate distally, outer spine similar to those on exopod, inner spine with fine serrations, outer edge of segment with two patches of short hairs. Leg 5 (Figure 25*b*) basal segment with naked, dorsal seta, patch of spinules on outer, distal corner; free segment with patch of spinules on inner edge and a row of stout spinules near base of each of the following: one, terminal, naked seta; 3 spines, one on mid-outer edge, one on each side of terminal seta, all spines stout with broad serrations distally and fine, terminal flagellum. Leg 6 (see Figure 23*b*) represented by 3 short setae, of about equal length, on genital segment.

MALE.—Body form as in Figure 25*c*. Total length 1.78 mm, greatest width 0.78 mm; length of cephalon 0.39 mm. Genital segment (Figure 25*d*) slightly wider than long (277 × 300 μm), abdomen 2-segmented, segments measuring (length × width) 159 × 177 μm, and 194 × 147 μm; second segment with two ventral rows of minute spinules (see Figure 25*e*). Caudal rami (Figure 25*e*) longer than wide (141 × 73 μm) with no ornamentation other than 6 setae (longest 371 μm).

First antenna similar to that of *U. collateralis* male. Remaining cephalic appendages (except maxilliped) similar to those of female. Maxilliped (Figure 26*a*) second segment inflated with 2 naked setae and numerous irregular rows of low, rounded spinules; terminal segment claw-like with 2 naked setae and row of teethlike spinules along inner edge to apex.

Legs 1–4 biramous. Leg 1 (Figure 26*b*) basipod with stout outer seta, patch of hairs near insertion of rami, inner spine sclerotized at base with terminal fringed membrane, patch of spinules near base of spine extending midway up segment; exopod 3-segmented, first segment with outer spine with stout terminal flagellum, second segment with inner seta and outer spine similar to that on first segment, third segment with 5 setae and 2 outer spines, proximal spine similar to previous 2, distal spine simple, not heavily sclerotized; endopod 3-segmented, similar to *U. mycterobius* male except patches of hairs on first and second segments smaller. Leg 2 (Figure 26*c*) similar to female except exopod setae comparatively longer; endopod setae longer than and not as robust as in female and second segment not as inflated. Legs 3 and 4 similar to female. Leg 5 (Figure 26*d*) basal segment with dorsal naked seta; free segment ornamented similarly to female, but segment itself not as robust.

ETYMOLOGY.—The Latin *reductus* ("reduced") alludes to the reduced number of setae on exopods of legs 2–4 and the reduced number of segments of the endopod of leg 4.

REMARKS.—Females of *U. reductus* can be distinguished from other *Unicolax* by the following characters: the ventral surface of the last abdominal segment has no ornamentation; the caudal rami have only six setae each, with no ventral hairs or spinules (other species have a ventral patch of hairs on each ramus); leg 2 exopod third segment has 3 spines, 4 setae (other species have 4 spines, 5 setae); leg 3 exopod third segment has 4 setae (other species have 5); leg 4 exopod third segment has 3 setae (*U. collateralis, U. mycterobius,* and *U. ciliatus* have 5, *U. anonymous* has 4); leg 4 endopod is 2-segmented (in all other species it is 3-segmented).

Males of *U. reductus* differ from others of the genus by the following characters: the ventral surface of the last abdominal segment is ornamented by only 2 distal rows of minute spinules; the caudal rami have no ornamentation on the ventral surface (other males have a patch of hairs on the ventral surface of each ramus). Legs 3, 4, and 5 are strikingly similar to those of the female, while the legs of males of others in the genus differ in several ways from their female conspecifics.

Unicolax reductus is the only member of the genus found on *Katsuwonus pelamis* and is probably restricted to that host species.

Because of the number and nature of its unique characteristics, it is the most easily identified member of the genus.

Ceratacolax Vervoort, 1965

Ceratacolax euthynni Vervoort, 1965

FIGURES 27–31, 100, 122*c–f*, 123–125

Ceratacolax euthynni Vervoort, 1965:26.

MATERIAL EXAMINED.—34 collections containing 94 ♀ and 63 ♂ from the following hosts and localities:

Euthynnus alletteratus from Massachusetts, New Jersey, Florida (west coast), and Ghana; *Sarda sarda* from Massachusetts, Rhode Island, Chesapeake Bay, Florida (east and west coasts), Mississippi, Texas, Venezuela, Brazil, Spain (Cadiz), Gulf of Guinea, and South Africa (Port Elizabeth). All collections from the nasal sinuses of the hosts.

Vervoort provided a good discription of both the male and female of this species. We have figured both sexes completely and will comment only on those characteristics not included in, or which differ from, Vervoort's description.

FEMALE.—Ventral surface of last abdominal segment and caudal rami (Figure 27*d*) with patches of prominent spinules (omitted by Vervoort). Leg 1 (Figure 28*b*) exopod 2-segmented (Vervoort indicated 1), second segment incompletely divided; first segment with one crenate spine on outer distal corner, second segment with 3 outer spines (omitted by Vervoort) and 6 inner to terminal setae.

MALE.—Ventral surface of last abdominal segment and caudal rami with patches of spinules as indicated in Figures 27*c* and *d* (Vervoort omitted spinules on caudal rami). Legs 1–3 (Figures 30*c*, 30*d*, 31*a*) endopod third segment, second from innermost seta with row of 4–5 long, slender spinules along proximal outer edge (spinules omitted by Vervoort).

REMARKS.—This bomolochid can be easily separated from other known members of the family on the basis of the following characteristics. The structure of the first antenna is unique by the presence of a long, curved, heavily sclerotized dorsal hook situated at the junction of the first and second segments; this hook is in addition to the usual row of 15 plumose setae on the basal segments and apparently does not represent a modified seta or setae as in some other bomolochid genera. The genital segment includes 3 flaplike structures at the area of egg sac attachment; within these structures are 3 spinulose setae (not easily visible without dissection) representing leg 6. Leg 2 exopod and both rami of legs 3 and 4 are characterized by patches of stout spinules along outer edges, and by setae that are spinulose rather than plumose. Leg 4 endopod is conspicuously elongate, especially the terminal segment.

Males are characterized by a first leg that is neither flattened nor modified as in the female. Legs 2 and 3 endopod second segment both have 2 inner setae. The setae of the male legs are all plumose in contrast to the spinulose setae of the female. Perhaps the most unique feature of the male is the presence of long slender spinules on the base of one seta on each endopod last segment of legs 1–3.

In both sexes there is some individual variation in the pattern of spinules of patches on the last abdominal segment and caudal rami. In the female, particularly, spinules on the caudal rami may appear as a single longitudinal row or as a patch of 2–3 rows. We could not correlate this variation to host or geographic distribution. The variation seems to occur randomly with occasional variation on the same individual from right to left ramus.

Nothobomolochus Vervoort, 1962

Nothobomolochus kanagurta (Pillai, 1965), new combination

FIGURES 32, 33, 100

Bomolochus kanagurta Pillai, 1965:51.

MATERIAL EXAMINED.—5 collections containing 9 ♀ from the gills of *Rastrelliger kanagurta* from China, India (Madras), Red Sea; *R. faughni* from the Philippines.

FEMALE.—Body form as in Figure 32*a*. Total length 1.50 mm. Abdomen 3-segmented, segments measure 118 × 206 μm, 95 × 195 μm, 95 × 177 μm, length by width respectively. Last abdominal segment (Figure 32*b*) with 2 oblique patches of spinules. Caudal rami (see Figure 32*b*) about twice as long as wide (94 × 55 μm); each ramus with a lateral seta, 2 subterminal and 2 terminal setae, one of which is much larger, its base nearly as wide as distal end of ramus. First antenna (Figure 32*c*) with 3 modified setae on basal segment, outer 2 longer than more heavily sclerotized middle seta; remaining setae of usual bomolochid type; an aesthete on each of last 2 segments. Second antenna with rows of hooklets on second segment and armed with terminal setae typical of the genus. Oral appendages typical bomolochid. Maxilliped (Figure 32*d*) with recurved hook bearing a short, blunt-tipped accessory process, base armed with 3 prominent plumose setae.

Legs 1–4 biramous, each ramus 3-segmented. Leg 1 endopod with broad segments as in other bomolochids. Leg 2 (Figure 33*a*) coxopod with a group of long spinules on outer distal corner and a row of short

spinules at articulation with basipod; basipod with a cluster of long spinules arranged in a circle near inner margin and a long, stout seta at outer distal corner; exopod first segment with a patch of long spinules along outer margin and a heavy serrated spine at outer distal corner, second segment with serrated spine at outer distal corner and an inner seta, third segment with 3 serrated spines, a fringed terminal spine, and 5 terminal to inner setae (last 5 spines armed on 1 margin only); endopod first 2 segments each with a row of spinules on distal margin in addition to usual inner setae, last segment with 2 short, outer, lightly fringed spines and 3 terminal setae. Leg 3 (Figure 33*b*) coxopod with a row of stout spinules at outer distal corner; basipod with 3 patches of spinules (outer 2 fine, inner patch heavier) and a seta on outer distal corner; exopod similar to leg 2 except no spinules on first segment and 1 less spine on last segment; endopod as in leg 2 except 1 less seta on last segment. Leg 4 (Figure 33*c*) as in leg 3 except 1 less patch of fine spinules on basipod; 1 less spine and seta on exopod last segment; endopod patches of spinules larger, setae with short spinules rather than usual plumosities, last segment with only 1 long seta. Leg 5 (Figure 33*d*) with 2 prominent patches of spinules in distal third, innermost with longer spinules; 1 lateral, naked seta and 3 terminal setae, outer 2 finely spinulose (all setae of about equal length).

MALE.—We did not collect males of this species but Pillai noted (1965:53) that the second segment of the maxilliped bears 2 rows of "tubercles" on inner margin.

REMARKS.—This species has been collected only from species of *Rastrelliger* from the Indo-West Pacific.

Orbitacolax Shen, 1957

Orbitacolax aculeatus (Pillai, 1962), new combination

FIGURES 34, 35*a–b*, 100

Bomolochus aculeatus Pillai, 1962a:610.

MATERIAL EXAMINED.—2 collections containing 15 ♀ from the nasal sinuses of 2 *Rastrelliger faughni* from Manila and Lingayan Gulf, Philippines.

FEMALE.—Body form as in Figure 34*a*. Total length 1.71 mm. Greatest width 0.73 mm. Rostrum protruding from between bases of first antennae and bearing a pair of ventral hooks (see Figure 34*b*).

Abdomen 3-segmented, ventral surface covered with spinules. Caudal rami about twice as long as wide, each with one lateral, 2 subterminal, and 3 terminal setae (innermost much stouter and longer than others). First antenna (Figure 34*b*) bearing 15 plumose and 6 naked setae along outer edge and 1 plumose and 3 naked setae directed posteriorly on first 3 segments, fourth and fifth segments with 3 setae each, last segment with 7 short and 1 long terminal setae. Second antenna (Figure 34*c*) with 6 rows of small hooks along outer edge of second segment and 6 setae at tip (Pillai indicates 5). Labrum with 2 dense patches of spatulate spinules, posterior corners produced as spinulose knobs. Other oral appendages as in Figure 34*d*. Maxilliped (Figure 34*e*) hook with accessory process, posterior edge of basal segment with spinules (not indicated by Pillai).

We will not repeat a full description of legs 1–5 but rather restrict our discussion to those points where our material differs with the description of Pillai's. Pillai illustrated the basipod of leg 1 with 1 large patch of spinules; in our specimens there are 2 (see Figure 34*f*). Leg 2 as described by Pillai except endopod second segment with 2 setae rather than one. Leg 3 exopod similar to that of leg 2; endopod first and second segments each with one inner seta, third segment with 2 naked subequal outer spines and 2 inner setae. Pillai shows no setae on first and second segments and only one outer spine on third segment. Legs 4 and 5 (Figure 35*a,b*) as described by Pillai.

REMARKS.—In spite of the differences between our material and the description given by Pillai we feel certain that we are dealing with the same species as the same genus of host is involved in both cases. So far this copepod has been collected only from *Rastrelliger* from India and the Philippines.

Pumiliopes Shen, 1957

Pumiliopes capitulatus Cressey and Boyle, 1973

FIGURES 35*c–e*, 36, 37, 100, 126*a–c*

Pumiliopes capitulatus Cressey and Boyle, 1973:1.

MATERIAL EXAMINED.—23 collections containing 35 ♀ from the orbits of the following hosts and localities: *Rastrelliger kanagurta* the Red Sea, Sri Lanka,

India (Madras), western Indian Ocean, Philippines, Java; *R. faughni* from Philippines; *Scomber japonicus* from Gulf of Guinea, Mauritania, Zanzibar; *S. australasicus* from Philippines.

FEMALE.—Body form as in Figure 35*c*. Total length of holotype 1.53 mm, greatest width 0.75 mm. Cephalon about as long as wide. Genital segment (Figure 35*d*) wider than long. Abdomen (see Figure 35*d*) 3-segmented; segments measure 71, 38, and 65 μm long respectively; each of last 2 segments narrower than preceeding one; first 2 segments each with transverse posteroventral band of fine spinules, last segment with 2 ventral patches of scales and row of fine spinules on each outer posterior corner. Caudal rami (Figure 35*e*) nearly 3 times as long as wide. Each ramus with patch of 25–30 scales on ventral surface and 6 setae, longest with stout base.

First antenna (Figure 36*a*) 5-segmented; basal part (first 2 segments) 289 μm long, remaining segments 35, 18, and 24 μm long respectively, no aesthetes on either of last 2 segments. Rostrum without hooks. Second antenna (Figure 36*b*) 3-segmented; basal segment with seta on outer distal corner; second segment with short, blunt medial seta; last segment subdivided, outer part with row of 14–16 prominent recurved hooklets and short terminal seta, inner part armed with stout claw arising near midlength, 3 stout setae constricted in their posterior third, and 2 additional setae (one very short). Labrum without ornamentation. Mouthparts as in Figure 36*c*. Labium represented by row of spinules posterior to mouth. Maxilliped (Figure 36*d*) with short, heavily sclerotized, nearly straight hook, without accessory process.

Legs 1–4 biramous, rami 2-segmented except for leg 4 endopod (3-segmented). We will omit a detailed description of legs 1–4 except to provide illustrations of each and to note that in the present material the exopods bear only 1 setule on outer edge rather than 2 or 3 as reported in the original description. Leg 5 (Figure 37*d*) with patches of scales, a short seta near midlength of outer edge and 3 terminal setae (outermost shortest and middle longest). Leg 6 represented by 3 prominent setae on midlateral border of genital segment.

Egg sacs flattened (probably due to their position on the host between the orbit and adipose eyelid).

MALE.—Unknown.

REMARKS.—We originally described this species based on 2 specimens collected from the orbit of *Clupanodon punctatus* from Hong Kong. The specimens reported here vary somewhat from the original description. The most obvious difference is the greater number of scalelike spinules in the patches on the caudal rami and abdomen of the scombrid parasites. Also, the scombrid copepods have only 1 setule (inappropriately referred to as setae in our original description) on the last exopod segments of legs 2 and 3.

Considering the relative numbers of clupeid and scombrid hosts examined during the 2 studies, we found this species to be more common on the scombrid hosts; for that reason we consider them to be the preferred hosts. Since clupeids are a primary food of these scombrids, it is understandable that they would occassionally be found on clupeids because of the ecological relationship.

Shiinoa Kabata, 1968

Shiinoa inauris Cressey, 1975

FIGURES 38, 39*a–d*, 101

Shiinoa inauris Cressey, 1975:211.

MATERIAL EXAMINED.—14 collections containing 22 ♀ 15 ♂ from the nasal lamellae of *Scomberomorus regalis* from Cuba, Puerto Rico, Surinam, and Venezuela; *Scomberomorus maculatus* from Massachusetts, Florida, Texas; *Scomberomorus brasiliensis* from Surinam, Brazil.

FEMALE.—Body form cylindrical (Figure 38*a*). Total length 3.56 mm (3.45–3.67 mm) based on an average of 3 specimens. Greatest width 0.71 mm. Rostrum produced anteriorly, curved ventrally with distal half covering terminal portion of second antennae (Figure 38*b*). These 2 elements form a loop by which the female attaches to the nasal lamella through a hole in the lamella. Body segmentation indistinct. Posterior outer corners of genital segment produced to form short, dorsally directed processes; tips of processes covered with knobs or bumps. Abdomen 4-segmented. Caudal rami about 3 times longer than wide, bearing 6 short setae.

First and second antennae separated from mouth area. First antenna (Figure 38*b*) with 5–6 segments, each bearing short naked setae. Second antenna well-developed. Each antenna forming a ring and parallel to each other; distal third within the curvature of the rostrum. Mandible, first maxilla, and second maxilla

as in Figure 38*c*. Maxilliped absent.

Leg 1 (Figure 38*d*) biramose; exopod 2-segmented, first segment with a short toothed spine on outer distal corner, second segment with 4 toothed spines and 3 weak setae along inner margin; endopod 3-segmented, first segment unarmed, a non-articulated spine on outer distal corner of second segment, last segment with 2 non-articulated terminal spines and a small seta on inner margin. Leg 2 (Figure 39*a*) as in leg 1 except one less spine and seta on exopod last segment and an additional seta on endopod last segment. Leg 3 (Figure 39*b*) 1-segmented, bearing a spine on inner distal corner and 2 short terminal setae. Legs 4, 5, and 6 absent.

Egg sacs typically cyclopoid.

MALE.—Body form as in Figure 38*a*. All males collected were attached to females. Body segmentation well defined. Abdomen 4-segmented. Caudal rami as in female.

First antenna 8-segmented each with short setae. Second antenna (Figure 39*c*) 3-segmented; first segment with 2 short setae on inner margin, second segment with a seta on outer distal corner and 3 setae on a sclerotized ridge at inner distal corner, third segment in form of a bifurcate claw with an accessory spine near base. Legs 1–3 similar to female except last exopod segment of leg 2 with a long, heavily sclerotized spine (Figure 39*d*).

REMARKS.—This species so far has been collected only from species of *Scomberomorus* from the western Atlantic. For a more complete description the reader should consult the original description (Cressey, 1975).

Shiinoa occlusa Kabata, 1968

FIGURES 39*e–h*, 101, 126*d–f*, 127–128*a,b*

Shiinoa occlusa Kabata, 1968a:497.

MATERIAL EXAMINED.—21 collections containing 41 ♀ 11 ♂ from the nasal lamellae of the following hosts and localities: *Grammatorcynus bicarinatus* from North Celebes, Solomon Islands, Palau, Caroline Islands; *Gymnosarda unicolor* from Solomon Islands; *Scomberomorus commerson* from Mozambique, Pakistan, Gulf of Thailand, Solomon Islands, Philippines, Palau; *S. guttatus* from China; *S. niphonius* from Japan; *S. queenslandicus* from Papua; *S. tritor* from Canary Islands; *Acanthocybium solandri* from Kapingarmarangi Atoll.

When Kabata described this species he stated that his description was based on an immature female. The first author examined that specimen during the course of another study and compared some of the present material with it. It was concluded that Kabata's specimen was a nonovigerous female adult. We have found no differences between the specimens reported here and Kabata's description except for the presence of egg sacs on some of our specimens. We will point out the differences between this species and *S. inauris* rather than repeat a full description here. We have, however, provided several SEM photographs of a female *S. occlusa* (from *Gymnosarda unicolor*). Females of *S. occlusa* can be distinguished from *S. inauris* by the following: the abdomen of *S. occlusa* is about one-sixth of the total body length (one-third in *S. inauris*); the exopods of legs 1 and 2 of *S. occlusa* are 3-segmented (2-segmented in *S. inauris*). Males of the 2 species can be separated by the following characters: distal segment of the second antenna of *S. occlusa* with 3 clawlike terminal spines (a bifid claw in *S. inauris*); 3-segmented exopods of legs 1 and 2 of *S. occlusa* (2-segmented in *S. inauris*); 2 stout, but unequal, spines at tip of leg 2 exopod of *S. occlusa* (1 stout spine in *S. inauris*).

REMARKS.—This species is very similar to *S. inauris* but easily separated by the characters cited above. The species so far has been collected from the Western Pacific, Indian Ocean, and Eastern Atlantic. It should be pointed out that a third species (*S. elagata* Cressey, 1976) has been described from the carangid *Elagatus bipinnulata* (Quoy and Gaimard) from the Western Pacific.

Caligus Müller, 1785

Caligus coryphaenae Steenstrup and Lütken, 1861

FIGURES 40, 41*a–b*, 102; 128*c–f*, 129, 130

Caligus coryphaenae Steenstrup and Lütken, 1861:352.
Caligus scutatus Milne-Edwards, 1840:453.
Caligus thymni Dana 1852:56.
Caligus bengoensis Scott, 1894:130.
Caligus aliuncus Wilson, 1905:576.
Caligus elongatus Heegaard, 1943:11.
Caligus tesserifer Shiino, 1952:89.

MATERIAL EXAMINED.—138 collections containing 316 ♀ and 281 ♂ from the body surface and gills of the following hosts and localities: *Acanthocybium*

solandri from northeast coast of Malagasy Republic, *Auxis* species from Gulf of Guinea; *Euthynnus alletteratus* from Puerto Rico (Atlantic); *Katsuwonus pelamis* from northwest Malagasy Republic, Christmas Island (Pacific), Peru, Ecuador, east coast of United States (several localities), Puerto Rico (Atlantic), Venezuela, Brazil (north coast), Cape Verde Islands, Gulf of Guinea; *Thunnus alalunga* from New Jersey; *Thunnus albacares* from Christmas Island (Pacific), east coast of United States (several localities), Brazil, Gulf of Guinea; *Thunnus atlanticus* from Puerto Rico (Atlantic); *Thunnus obesus* from Christmas Island (Pacific), east coast of United States (several localities), Surinam, Brazil (north coast), Cape Verde Islands; *Thunnus thynnus* from east coast of United States (several localities).

Shiino (1959a), Pillai (1962b), and Lewis (1967) have provided good descriptions and figures for this well known species. We will restrict our consideration of this species to those characters that serve to distinguish it from the other *Caligus* species found on scombrid hosts.

FEMALE.—Body form as in Figure 40*a*. Lewis, et al. (1969:423) provided morphometric data for 36 specimens from 4 host species from the Indian Ocean. The average total length for his material was 5.57 mm. Our material from the Indian Ocean and Pacific areas did not differ significantly from this mean. The Atlantic specimens, however, tended to be larger (5.8–6.5 mm based on 10 specimens from various localities). The cephalon comprises about one-half of the total length with the genital segment and abdomen each comprising about one-fourth.

Frontal lunules widely spaced; space between lunules (1.31 mm) more than twice greatest diameter of either lunule (0.58 mm).

Genital segment slightly longer than wide (1.5 × 1.4 mm) with posterior outer corners produced somewhat beyond origin of abdomen. Abdomen 3-segmented; 1st segment constricted in posterior two-thirds giving the appearance of 2 segments, second segment shortest, third segment with 2 distal lobes separating caudal rami; segments measure 0.9, 0.3, and 0.37 mm respectively. Caudal ramus as in Figure 40*b*.

Postantennal spine lacking. Postoral spine wide at base, triangular. Sternal furca (Figure 40*c*) with short, widely divergent tines; furca with an accessory sclerotized cuticular process on each side.

Leg 1 (Figure 40*d*) basipod with a patch of short spinules, patches of longer hairs, a short plumose seta on inner margin, a long, very plumose, seta at outer distal corner; exopod 3 distal spines each with prominent fringes, inner 2 with accessory process; endopod reduced to a short, sclerotized process. Leg 2 endopod (Figure 40*e*) with patches of long spinules on outer margin of each segment. Leg 3 exopod (Figure 40*f*) with prominent thumblike spine on outer distal corner of first segment, each of last 2 segments with long setules on outer margin in addition to usual spines and setae. Leg 4 exopod (Figure 41*a*) 3-segmented, first and second segment each with a prominent fringed spine on outer distal corner; last segment with 3 fringed spines, distalmost longest, all spines with a fringe at base; spines measure 366, 236, 153, 206, and 247 μm distalmost to proximalmost respectively.

MALE.—Body form as in Figure 41*b*. Total length 5.3 mm. Cephalon comprises more than half total length. Appendages as in female except second antenna with accessory process on claw. Maxilliped with small sclerotized area opposite tip of claw. Sternal furca similar to female except tines not quite as divergent. Thoracic appendages as in female. Legs 5 and 6 represented by setae at the posterior corners of the genital segment.

REMARKS.—This species has been reported many times since its original description in 1861. It is common on the body surface of scombrids of the tribe Thunnini. The single collection from *Acanthocybium solandri* (Scomberomorini) is the only exception reported here of all scombrids examined. It is also common on species of *Coryphaena* and is found in all except polar oceans (see Figure 102). Margolis, Kabata, and Parker, 1975:25 provide a complete synonymy to this species.

Further discussion of this species follows the description of *C. regalis*.

Caligus regalis Leigh-Sharpe, 1930

FIGURES 41*c–g*, 102

Caligus regalis Leigh-Sharpe, 1930:5.
Caligus euthynus Kurian, 1961:63.
Caligus alveolaris Heegaard, 1962:156.

MATERIAL EXAMINED.—5 collections containing 149 ♀, 113 ♂ from the body surface of *Euthynnus affinis* collected off Nosy Bé, Malagasy Republic. Types of *C. alveolaris* (AMS P. 16408) from the

same host species, reported as *E. allitteratus* [sic] from north Queensland, Australia.

FEMALE.—Body form as in Figure 41*c*. Total length 4.62 mm (4.27–4.73 mm) based on an average of 5 specimens. Greatest width 2.1 mm (measured at widest part of cephalon). Cephalon comprises about one-half total body length. Genital segment somewhat longer than wide (1.77 × 1.55 mm), posterior corners produced to form rounded lobes. Abdomen 2-segmented, segments measure 1.02 and 0.43 mm long respectively, comprising about one-third total body length. Caudal rami as in *Caligus coryphaenae* except outer terminal seta much stouter in *C. regalis*.

Frontal lunules widely spaced, each about 400 μm wide, rostral space between each lunule about 950 μm. Cephalic appendages as in *C. coryphaenae* except sternal furca not as divergent in *C. regalis* (Figure 41*d*).

Legs 1–4 as in *C. coryphaenae;* the stout spine on the first exopod segment of leg 3 (Figure 41*e*) is curved inwards rather than straight as in *C. coryphaenae*. The apical seta on the exopod of leg 4 (Figure 41*f*) is only slightly longer than the adjacent seta, setae measure 189, 177, 177, 177, and 183 μm distal to proximal respectively.

MALE.—Body form as *C. coryphaenae*. Total length 3.51 mm (3.37–3.53 mm) based on an average of 5 specimens. Greatest width 1.73 mm (measured at widest part of cephalon). Genital segment (Figure 41*g*) wider than long (914 × 711 μm). Caudal rami with outermost terminal seta stout and about as wide at base as other 3 (much smaller in *C. coryphaenae*). Legs 5 and 6 at posterior outer corners. Abdomen 2-segmented, segments measure 247 and 479 μm respectively.

REMARKS.—Pillai, 1962b, discussed the relationship between this species and *C. coryphaenae* and provided a comprehensive description of *C. regalis* (as *C. euthynus*). All collection records to date indicate that *C. regalis* is specific to *Euthynnus affinis* and *C. coryphaenae* is primarily found on other species of scombrids of the tribe Thunnini.

These 2 species of *Caligus* differ from other members of the genus in lacking a postantennal process (Lewis 1967:105, considered the group of sensillae at the usual site of the postantennal process as representing the process). When the genus *Caligus* has undergone a much needed revision it may be that these 2 species should be removed from the genus.

We have placed Heegaard's *C. alveolaris* and Kurian's *C. euthynus* in synonymy with *C. regalis* of Leigh-Sharpe. Although Leigh-Sharpe's figures are poor there is little doubt that they illustrate the copepods discussed here, especially considering that he collected his material from the same host-species (as *E. yaito*).

Caligus productus Dana, 1852

FIGURES 42–44, 103

Caligus productus Dana, 1852:56.
Caligus alalongae Kroyer, 1863:129.
Caligus monacanthi Kroyer, 1863:133.
Caligus lobatus Wilson, 1935:1.
Caligus katuwo Yamaguti, 1936:6.
Caligus dentatus Heegaard, 1962:160.
Caligus microdontus Heegaard, 1964:139.

This species has been recorded many times from scombrids and occasionally non-scombrid hosts (see Lewis, 1967:116). Shiino, 1959b and Lewis, 1967 have provided good descriptions and we do not feel a need to repeat another here. We have, however, provided pertinent illustrations and a consideration of certain characters to enable the reader to identify this species without resorting to other literature. A complete synopsis of the literature has been provided by Margolis, Kabata, and Parker (1975:64).

MATERIAL EXAMINED.—207 collections containing 2286 ♀, 657 ♂ from the mouth, gills, and body surface of the following hosts and localities: *Acanthyocybium solandri* from the northeast Malagasy Republic, Seychelles, Line Islands, Campeche Bay; *Scomberomorus cavalla* from east coast United States (several localities); *Scomberomorus regalis* from Dominican Republic, Puerto Rico, Virgin Islands; *Scomberomorus* species from Australia (east coast); *Scomberomorus tritor* from Nigeria; *Sarda sarda* from Massachusetts; *Sarda orientalis* from Panama (Pacific); *Sarda chiliensis lineolatus* from Baja California; *Auxis* species from Panama (Pacific), Mexico (Pacific); *Euthynnus affinis* from Hawaii; *Euthynnus alletteratus* from Bermuda, Anagada Passage (W. Indies); *Katsuwonus pelamis* from northwest Malagasy Republic, Tahiti, Line Islands, Suitcases Bank (E. Pacific), Peru, Ecuador, Gulf of Mexico (Alabama), New Jersey, Dominican Republic, Venezuela, Brazil, Gulf of Guinea; *Thunnus alalunga* from North Carolina; *Thunnus albacares* from northwest Malagasy

Republic, Mozambique Channel, Chagos Islands, Somalia, Palau, Line Islands, Brazil (north coast), Dominican Republic (Atlantic), Bermuda, east coast United States (several localities); *Thunnus atlanticus* from West Indies (several localities), Nicaragua; *Thunnus thynnus* from east coast United States (several localities), Gulf of Mexico, Japan.

FEMALE.—Body form as in Figure 42*a*. Range of total length (including data of Lewis 1967, 1968) 3.85–5.45 mm. We did not find any significant differences in total length between our measurements of Atlantic specimens and those of ours and Lewis' from the Indian and Pacific oceans. Examination of specimens from several different hosts from widely separated geographic areas revealed no significant variations in form. It appears that this is a very stable species, well established as a parasite of scombrids except members of the tribe Scombrini (*Scomber* and *Rastrelliger*).

Caligus productus females can be easily separated from other species of the genus by a combination of the following characters: the outer distal corners of the genital segment are rounded and extend well beyond the insertion of the abdomen; the ventral surface of the abdomen bears a medial subterminal patch of minute spinules and a terminal transverse patch of fine hairs (see Figure 42*b*); the last exopod segment of leg 1 lacks the usual 3 lateral setae; the outer distal corner of the first endopod segment of leg 2 bears a row of long spinules, the second segment bears a double row of stout spines (7–9 per row) along its outer edge; leg 4 exopod is 2-segmented, the last segment bearing one lateral and 3 terminal setae (outermost seta slightly longer than others).

MALE.—Cephalothoracic appendages as in female except second antenna (Figure 44*e*) with short claw and 2 prominent bossed areas on basal segment. Genital segment and abdomen as in Figure 44*d*.

REMARKS.—This species is common on scombrid fishes throughout the circumtropical and subtropical area. We have recorded it here from 15 species of hosts, infesting the buccal area, gills and body surface. Data presented by Lewis, et al, 1969, and our own collection data indicate the parasite is most commonly found in the buccal area, next in the gill area, and occasionally on the body surface. The fewer records from the body surface could result from the more exposed site and consequently the copepods more easily drop off prior to examination of the host. Certainly our own records, based in large part on the examination of preserved hosts, would be biased in that regard.

Although we collected *Caligus productus* from 14 species of scombrid fishes it is common (found on more than 25% of the specimens examined) on only 4 species; *Katsuwonus pelamis* 52%, *Thunnus albacares* 45%, *T. atlanticus* 92%, and *T. thynnus* 28%. It is curious that, although this parasite was found on 8 of the 13 species of Thunnini, we did not collect it from any of the 40 specimens of *T. obesus* examined.

This species was not found on any species of the tribe Scombrini (*Rastrelliger* and *Scomber*). Leigh-Sharpe (1926:384) reported this species from *Scomber scombrus* and placed the previously described *Caligus scomberi* Bassett-Smith in synonymy with it. Later writers (see Margolis, Kabata, and Parker 1975:74) and our examination of the type of *Caligus scomberi* agree that it is a synonym of *Caligus pelamydis* Kroyer, 1863 and the records of *C. productus* from *Scomber scombrus* discounted.

Caligus asymmetricus Kabata, 1965

FIGURES 45–47, 104

Caligus asymmetricus Kabata, 1965:109.
Caligus thynni Pillai, 1963:89.

In addition to Pillai's original description, Lewis (1967:131) redescribed this species and presented an account of its rather confusing history. In view of these recent works we will not present another full description of *C. asymmetricus*, but, as with some other *Caligus* species from scombrids, discuss only the salient features and provide full illustrations to enable the reader to identify this species without consulting the earlier works.

MATERIALS EXAMINED.—22 collections containing 71 ♀ and 25 ♂ from the gills, gill arches, and roof of the mouth (1 collection) of the following hosts and localities: *Grammatorcynus bicarinatus* from Palau, Marshall Islands, Kapingamarangi Atoll; *Scomberomorus commerson* from New South Wales, East Indies; *Sarda australis* from New South Wales; *Sarda orientalis* from Seychelles, Hawaii; *Cybiosarda elegans* from western Australia; *Auxis* sp. from New South Wales; *Euthynnus affinis* from New South Wales, northwest Malagasy Republic; *Katsuwonus pelamis*

from northwest Malagasy Republic; *Thunnus albacares* from Queensland.

FEMALE.—Body form as in Figure 45*a*. Range of total length 3.00–4.20 mm (3.49 mm average of 22 specimens). Those from *Cybiosarda elegans* (western Australia) averaged somewhat longer (3.78 mm of 9 specimens) than those from other hosts from other areas of the Pacific and Indian oceans. Those measured from other areas and other hosts did not vary significantly.

Caligus asymmetricus can be separated from other *Caligus* species found on scombrids by the combination of the following characters: abdomen short (about 10 percent of total length); sternal furca narrow, tines often asymmetrical or otherwise distorted; leg 2 endopod first segment with long spinules at outer distal corner, second segment with a row of 6–8 stout spines; leg 4 exopod 2-segmented, outermost seta longest, other 4 exopod setae all about equal in length to each other.

MALE.—Characters described above apply to males except abdomen comprises about 15 percent of total body length.

REMARKS.—*Caligus asymmetricus* was reported by Pillai (1963:89) from *Euthynnus affinis* from India, by Kabata (1965:110) from the same host (reported as *E. alletteratus*) from Queensland, Australia, and by Lewis (1967:131) from the same host (reported as *E. yaito*) from Hawaii. We record this species from 9 scombrid species within the Indo-West Pacific. Although the records are scattered throughout 3 of the 4 tribes of Scombrinae, our collections indicate that Indo-West Pacific species of the tribe Sardini may be preferred hosts (17 percent infestation rate on 3 host species as opposed to 4 percent infestation rate on 2 species of Scomberomorini, 2 percent infestation rate on 4 species of Thunnini and no records from the 5 Indo-West Pacific species of Scombrini).

Kabata (1965:110) notes that both his and Pillai's specimens were collected with specimens of *Caligus bonito* (reported as *C. kuroshio*). Of the 22 collections reported here only 2 were accompanied by *C. bonito*, nor did we find any other species common in collections of *C. asymmetricus*.

We found that the peculiar asymmetry or distortion of the tines of the sternal furca reported previously in the collections from India, Australia, and Hawaii did not occur in all collections but rather seems to occur randomly within populations. The sternal furcae of our specimens from *Sarda orientalis* from Hawaii are usually distorted, including one specimen with 1 central tine rather than the usual 2. In certain other collections the furcae were normally developed.

Caligus bonito Wilson, 1905

FIGURES 48–50, 105

Caligus bonito Wilson, 1905:589.
Caligus sarda Pearse, 1952:17.
Caligus kuroshio Shiino, 1959b:51.

This species has been reported many times (see Margolis, Kabata, and Parker, 1975:18 for complete literature history) and has been recently redescribed by Pillai, 1971:161 and Lewis, 1967:124. Because of these recent good descriptions it is unnecessary to completely redescribe this species again. We discuss only certain taxonomic features that we consider important in distinguishing this species from other *Caligus* found on scombrid fishes. We have, however, provided illustrations so the reader can identify specimens without consulting other work.

MATERIAL EXAMINED.—76 collections containing 155 ♀ and 58 ♂ from the mouth and gills of the following hosts and localities: *Euthynnus affinis* from New South Wales; *E. alletteratus* from Florida (Gulf coast), Dominican Republic (Atlantic); *E. lineatus* from Galapagos Islands, Panama (Pacific), Baja California (Pacific); *Thunnus thynnus* from Florida (Atlantic); *Scomberomorus regalis* from Antigua; *Sarda sarda* from western North Atlantic (several localities Massachusetts to Brazil); Florida (north Gulf coast), Rio de Janeiro, Norway, Tunisia, Gulf of Guinea, Angola, South Africa (Port Elizabeth); *Sarda australis* from New South Wales; *Sarda chiliensis chiliensis* from Peru; *Sarda chiliensis lineolatus* from Cedros Islands, California; *Sarda orientalis* from Red Sea (Elat), South Africa (Port Elizabeth), India (Cochin), China, Galapagos; *Gymnosarda unicolor* from Bikini.

FEMALE.—Body form as in Figure 48*a*. Total length 6.45 mm. (average of 37 specimens 5.10–8.10 mm range). Measurements taken from collections from *Sarda sarda, S. australis,* and *S. chiliensis*. No significant differences could be seen between *C. bonito* from different host species or geographic areas, except that specimens from warmer water tend to be smaller than those from colder.

Caligus bonito females can be easily separated from other species of the genus except *Caligus omissus* new species by a combination of the following characters: cephalon, genital segment, and abdomen each comprising about one-third of the body length (abdomen widest anteriorly), endopod first and second segments of leg 2 with a group of prominent spinules at outer distal corner and a double row of stouter spinules along outer edge respectively (see Figures 49*e,f*), tines of sternal furca (Figure 49*c*) nearly parallel and blunt tipped, lateral setae of leg 1 exopod last segment with stout spinules on basal fourth (see Figure 49*d*), leg 4 exopod 2-segmented with terminalmost seta about twice as long as others. See discussion of characters separating *C. bonito* from *C. omissus* new species in the description of the new species.

MALE.—Body form as in Figure 50*c*. Total lengths of males are approximately 80 percent that of the females in any collection. The ranges would be proportionately the same as given for the females. Male as in female except in the following characters: abdomen 2-segmented; second antenna (Figure 50*d*) second segment with 2 rugose areas, claw with 2 short processes at tip and a seta on inner margin; maxilliped (Figure 50*e*) basal segment with sclerotized bifid knob on margin opposite tip of claw.

DISCUSSION.—We have recorded this species here from 11 scombrid species. From our data *Caligus bonito* seems to be primarily a parasite of scombrids of the tribe Sardini (collected from 7 species); to a lesser extent a parasite of species of Thunnini (from 4 species); rarely found on members of the Scomboromorini (1 species); not found on the tribe Scombrini (*Rastrelliger* and *Scomber*). It is recorded from all except polar oceans and previous records are cited by Lewis (1967:125) (including nonscombrid hosts).

Lewis (1967:131) discussed the difficulties distinguishing this species from *Caligus productus* and *C. quadratus* Shiino. Although these 3 species superficially resemble each other, the nature of the armature on the first, second, and fourth legs should easily separate them. *Caligus quadratus* is easily separated from *C. productus* by the normally developed setae on the leg 1 exopod of *C. quadratus* (absent in *C. productus*) and from *C. bonito* by the stout spinules present on these same setae of *C. bonito* (normal plumosities on *C. quadratus*).

After examining the type-specimens of *Caligus sarda* Pearse (USNM 92667) we have placed it in synonymy with *Caligus bonito* Wilson.

Caligus mutabilis Wilson, 1905

FIGURES 51, 52, 53*a–b*, 105

Caligus mutabilis Wilson, 1905:573.

MATERIAL EXAMINED.—8 collections containing 8 ♀ from the gills or gill chambers of *Scomberomorus brasiliensis* from Brazil and Costa Rica; *S. cavalla* from Surinam; *S. maculatus* from west coast of Florida; *Scomber japonicus* from Campeche.

FEMALE.—Body form as in Figure 51*a*. Total length 2.78 mm. Greatest width 1.12 mm. Frontal lunules large, greatest width of lunule more than least distance between each lunule (307 vs 254 μm). Genital segment (Figure 51*b*) longer than wide (986 × 725 μm), widest posteriorly, posterior corners rounded and only slightly produced. Abdomen (see Figure 51*b*) incompletely divided into 2 segments, about twice as long as wide (681 × 362 μm), posterior ventral surface with patches of spinules as in Figure 51*c*. Caudal rami (Figure 51*c*) longer than wide (159 × 106 μm) bearing 6 plumose setae as indicated in figure.

Oral area as in Figure 52*c*. First antenna (Figure 51*d*) first segment with 27 setae (all but 2 are plumose), last segment with 13 naked setae. Second antenna (Figure 51*f*) with spatulate posterior process, otherwise of usual form of genus. Maxillae and maxilliped as in *Caligus bonito*. Sternal furca (Figure 52*b*) tines slightly divergent, blunt tipped.

Leg 1 (Figure 52*d*) basipod with large patch of fine spinules and 2 plumose setae; exopod first segment with row of spinules on inner edge and short spine at outer distal corner, second segment with 3 terminal spines (2 with accessory processes), a terminal seta plumose on outer edge and 3 lateral setae, each with outer edge armed with stout spinules at base becoming finer toward tip and short plumosities along inner edge. Leg 2 (Figure 52*e*) exopod similar to other species of genus, endopod first segment with a patch of long spinules at outer distal corner, second segment with a dense patch of long spinules along outer edge, last segment with 3–4 shorter spinules at proximal outer edge, all segments with plumose setae as in figure. Leg 3 (Figure 53*a*) similar to other species of genus, thumblike spine at outer distal corner of exopod first segment only slightly recurved. Leg 4

(Figure 53*b*) exopod 2-segmented, first segment with prominent spine at outer distal corner, second segment with 3 terminal and 1 lateral spine, distalmost longest (setae measure 177, 112, 83, 83, 124 μm distal to proximal respectively). Leg 5 represented by 3 short setae near posterior corner of genital segment.

MALE.—None collected.

REMARKS.—This species is apparently common on a number of host species in the western Atlantic and Gulf of Mexico (scombrid and non-scombrid). It has also been reported from the Gulf of California and Pacific coast of Mexico from a number of host species by Causey (1960:329) and Wilson (1937:27). We describe here a new, closely related, species of *Caligus* from eastern Pacific *Scomberomorus* and it seems likely that at least some of the specimens reported by these 2 authors may have been the new species. None of that material has been deposited in the Smithsonian collections so we have not been able to verify the identifications.

Examination of the type-specimens (USNM 6155) from Woods Hole, Mass. indicate variation from our specimens on at least 2 points. The outermost of the 4 terminal setae on the caudal rami of the type specimens is less than half the length of the outer edge of the ramus, whereas in our specimens that seta is almost as long as the outer edge of the ramus. The longest seta on the exopod of leg 4 of the type specimens is only slightly longer than the adjacent seta (218 and 177 μm) whereas in our material this seta is much longer than the adjacent seta (177 in 112 μm). We do not consider these differences important enough to warrant describing a new species but rather may reflect ecological differences between the 2 groups of material.

Caligus omissus, new species

FIGURES 53*c–e*, 54–56, 105

MATERIAL EXAMINED.—58 collections containing 147 ♀ 41 ♂ from the gills, gill arches, gill rakers, inner operculum, and roof of the mouth from 41 specimens (114 examined) of *Scomberomorus sierra* from Peru, Colombia, Panama, Costa Rica, Pacific coast of Mexico, and Baja California; from 7 specimens (47 examined) of *Scomberomorus concolor* from off Sonora, Mexico and Gulf of California. Holotype (USNM 172239), allotype (USNM 172240) and 40 ♀ 3 ♂ paratypes (USNM 172241) from the gills of *S. sierra* from San Juan Lagoon, Mexico (USNM 219623).

FEMALE.—Body form as in Figure 53*c*. Total length 2.96 mm (2.78–308 mm) based on an average of 6 specimens from the type series. Greatest width 1.15 mm (1.12–1.19). Cephalon comprises about 40 percent of total length. Frontal lunules prominent, diameter of lunule (266 μm) slightly more than least distance (218 μm) between lunules (interlunular space). Genital segment (Figure 53*d*) slightly longer than wide (1.16 × 1.09 mm), posterior corners rounded, only slightly produced, comprising about 30 percent of total length. Abdomen (see Figure 53*d*) 1-segmented, nearly 3 times as long as wide (0.96 × 0.36 mm), usually slightly wider in posterior third but never noticeably wider in anterior half; distal ventral surface with patches of spinules as in Figure 53*e*. Caudal rami (see Figure 53*e*) longer than wide (142 × 94 μm) armed with 6 plumose setae as indicated in figure, longest seta 307 μm.

Oral area as in Figure 54*a*. First antenna (Figure 54*b*) first segment with 27 setae, all plumose except 2 in middle anterior group; last segment with 13 naked setae. Second antenna (Figure 54*d*) with prominent hook, basal segment with conspicuous pointed posterior process. Post antennal process (Figure 54*c*) a prominent recurved hook. Postoral process (Figure 54*e*) with slight outward curve, extending well beyond tip of mouth tube. Maxilliped (Figure 54*f*) with a strongly sclerotized, recurved claw. Sternal furca (Figure 54*g*) with widely divergent tines, each with a blunt tip.

Leg 1 (Figure 55*a*) basipod with a patch of prominent spinules covering two-thirds of ventral surface; exopod first segment with row of spinules along inner edge and short, naked spine on outer distal corner; exopod with 3 terminal spines (2 with accessory spines), 1 terminal seta (plumose on outer edge), and 3 lateral setae with stout spinules on base of outer edge of each followed by short plumosities; endopod reduced to a short process with 2 small distal spines. Leg 2 (Figure 55*b*) as in other species of the genus except exopod spine on outer distal corner of last segment very small; endopod first segment with 3–4 stout spinules on outer distal corner, second segment with a double row of stout spinules along outer edge, a patch of 4–5 short spinules on proximal outer edge of last segment, all segments with plumose setae as in figure. Leg 3 (Figure 55*c*) basipod with con-

spicuous spinules on outer quarter and a patch of finer spinules at inner, proximal corner; endopod first segment with stout, recurved claw on outer distal corner, a short spine on outer distal corner of second segment, 3 short spines on outer edge of last segment and each segment with plumose setae as in figure; endopod with plumose setae as indicated in figure. Leg 4 (Figure 55*d*) exopod 2-segmented, first segment with a prominent spine on outer distal corner, second segment with one lateral spine and 3 terminal spines, distalmost spine longest, spines measure 201, 124, 106, 100, and 130 μm distal to proximal spine respectively. Leg 5 represented by 3 short plumose setae near distal corner of genital segment.

MALE.—Body form as in Figure 56*a*. Total length 3.15 mm (3.08–3.23 mm), based on an average of 2 specimens. Greatest width 1.27 mm. Cephalon comprising about one-half total length. Genital segment (Figure 56*b*) longer than wide (884 × 580 μm). Abdomen (Figure 56*b*) 2-segmented, first segment nearly square (348 × 348 μm), second segment longer than wide (449 × 334 μm) with ventral patches of spinules as in female. Caudal ramus as in female. Appendages as in female except as follows. Postantennal process (Figure 56*d*) a prominent, sharply recurved, hook. Second antenna (Figure 56*c*) with 2 rugose areas on basal segment and a short bifid claw. Maxilliped (Figure 56*f*) basal segment with a pair of sclerotized processes on inner margin opposite tip of claw. Sternal furca (Figure 56*g*) with tines less divergent than female.

Legs 1–4 as in female. Legs 5 and 6 each represented by 2 short plumose setae on the genital segment as in Figure 56*b*.

ETYMOLOGY.—The Latin *omissus* ("neglected") alludes to its common association with eastern Pacific *Scomberomorus* species but not collected or, if so, not recognized as new.

REMARKS.—This new species seems to be closely related to *Caligus mutabilis* and *C. bonito* to a lesser extent. These 3 *Caligus* share a number of characters: the similar pattern of fine spinule patches on the distal-ventral surface of the abdomen, a prominent posterior process arising from the base of the second antennae, inner lateral setae of leg 1 with spinules along the basal part of the outer edge, prominent, stout spinules along the outer edges of the leg 2 endopod segments, and a 2-segmented exopod of leg 4. The new species can be separated from the other 2 species as well as all other species of *Caligus* found on scombrids by a combination of the following characters: abdomen narrowest anteriorly, widely divergent tines on the sternal furca, distal process on the base of the second antenna pointed, basipod of leg 1 with a large patch of prominent spinules (fine spinules in *C. mutabilis* and *C. bonito*), the spinules on the outer basal margin of the lateral setae of leg 1 are fingerlike (short and stout in *C. mutabilis* and *C. bonito*).

Wilson (1937:27) reported *C. mutabilis* from *Scomberomorus maculatus* (= *S. sierra*) from Mexico (Pacific). We suspect that this material was actually the new species reported here. Causey (1960:329) reported *C. mutabilis* from the Gulf of California and Pacific coast of Mexico from several species of fishes including *Scomberomorus sierra*. It seems likely to us that at least the specimens from *S. sierra* were actually *C. omissus* and some or all of those from the non-scombrid hosts may have been as well.

Caligus omissus was collected from 36 percent (41 of 114) of the specimens of *S. sierra* and 15 percent (7 of 47) of the *S. concolor* examined. This would indicate that these species may well be the preferred hosts for this species. Examination of collections from non-scombrid hosts from the Eastern Pacific may well turn up additional material of this new species.

Caligus biseriodentatus Shen, 1957

FIGURES 57–59, 105

Caligus biseriodentatus Shen, 1957:352.
Caligus proboscidatus Heegaard, 1962:161.
Caligus obovatus Heegaard, 1962:166.
Caligus auxisi Pillai, 1963:85.

MATERIAL EXAMINED.—1 ♀ from the inner surface of the operculum of *Auxis thazard* from Trivandrum, India (a specimen of *Caligus auxisi* donated to the Smithsonian by Dr. Pillai); holotype (AMS P16418) of *C. obovatus* Heegaard from *Scomberomorus queenslandicus* from Queensland. Holotype (AMS P16420) of *C. proboscidatus* Heegaard from *Scomberomorus queenslandicus;* from Queensland; 237 immature ♀ and ♂ from mouth, gill arches, and inner operculum of the following hosts and localities: *Scomberomorous commerson* from northwest Malagasy Republic, Somalia, Ceylon, East Indies, Philippines, China; *Scomberomorus guttatus* from Arabian Sea, Ceylon, Thailand, East Indies (various locali-

ties), Hong Kong; *Scomberomorus queenslandicus* from Onslow (W. Australia), Ambon (Moluccas); *Scomberomorus plurilineatus* from Zanzibar.

FEMALE.—Body form as in Figure 57*a*. Total length 3.15 mm. Greatest width 1.50 mm (measured at widest part of cephalon); cephalon comprising about 40 percent of total length. Genital segment somewhat longer than wide (0.90 × 0.75 mm). Abdomen about twice as long as wide (0.68 × 0.30 mm), 1-segmented; dorsal surface distal half with a large patch of spinules, ventral surface distal half with groups of spinules as in Figure 57*b*. Caudal rami slightly longer than wide, each with a seta on middorsal surface and 6 subterminal to terminal setae.

Space between frontal lunules (254 μm) greater than diameter of lunule (207 μm). First antenna of usual type of genus except last segment about 4 times longer than wide (177 × 44 μm). Postantennal process fingerlike. Second antenna with usual claw, base with posterior spatulate process. Postoral process slender. First maxilla represented by 2 short and 1 long setae (nearly as long as postoral process). Second maxilla typical of the genus. Maxilliped with stout recurved claw at tip. Sternal furca (see Figure 57*c*) tines nearly parallel and, together, wider than base.

Leg 1 (Figure 57*d*) basipod covered with conspicuous spinules, a short plumose seta on distal margin and a longer plumose seta at outer corner; exopod first segment with row of toothlike spinules on inner edge, second segment with usual 3 distal spines, each with inconspicuous fringe and no accessory process, one terminal plumose seta and 3 short lateral setae, each with 2–3 stout spinules on outer basal border; endopod reduced. Leg 2 of usual form of the genus except setae of both rami with a row of 15–20 conspicuous spinules on proximal outer edge (Figure 57*e*) followed by usual plumosites; endopod first segment with group of 3–4 stout spinules on outer distal corner, second segment with a double row of stout spinules (7–8 spinules in each) along outer edge (Figure 57*e*). Leg 3 similar to other species of genus, heavily sclerotized spine on exopod first segment (Figure 58*a*) recurved inwardly. Leg 4 (Figure 58*b*) basipod with scattered stout spinules on dorsal surface; exopod first segment with a row of spinules on outer edge and outer distal spine, second segment with 4 spines, distalmost longest and each with a fringe at base, spines measure 159, 118, 106, 94, and 106 μm distal to proximal respectively.

MALE.—According to Pillai (1963:87) the second antenna basal segment with a bossed pad opposite tip of claw. The postantennal process (first maxilla of Pillai) a long "sickle-shaped" claw. Maxilliped base with 4 low projections on inner border. Total length 2.70 mm.

IMMATURE FEMALE.—Body form as in Figure 58*d*. Total length 2.90 mm (3.00–2.70 mm) based on an average of 5 specimens. Frontal lunules greatest width (236 μm) less than least space (interlunular space) between them (265 μm). First antenna typical of the genus. Second antenna with strong claw and pointed posterior process on base. Postantennal process a short recurved hook. Postoral process a sharply pointed process, tip not extending beyond tip of mouth tube. Second maxilla typical of the genus. Maxilliped (Figure 58*e*) base with 2 sclerotized processes on inner margin (not shown on Shen's figure), claw with a short sclerotized process near base of seta near inner midmargin.

Leg 1 basipod covered with conspicuous spinules; coxopod with row of spinules on posterior margin; exopod (Figure 58*g*) with 3 fringed spines and a short plumose seta at tip, inner lateral margin with 3 short setae; endopod lacking. Leg 2 (Figure 59*a*) endopod first segment with a group 4–5 spinules on outer distal corner, second segment with a double row of 8–9 stout spinules on outer edge, last segment without spinules on proximal outer corner. Leg 3 exopod first segment spine only slightly recurved inwards. Leg 4 (Figure 59*b*) exopod 2-segmented, distalmost spine slightly longer than adjacent spine, all spines relatively short.

IMMATURE MALE.—Body form as in Figure 59*c*. Total length 3.60 mm (3.50–3.80 mm) based on an average of 5 specimens. As in female except as follows. Second antenna with short claw, basal segment with 2 rugose areas, no posterior process. Postantennal process prominent, recurved with inner angle less than 45°. Maxilliped (Figure 59*f*) very large, basal segment with heavily trilobed process on inner margin opposite tip of claw. Legs 1–4 as in female. Caudal ramus with ventral patch of spinules; spinules also present on abdomen at outer distal corner (see Figure 59*d*).

REMARKS.—The description of this species was based on immature specimens. When we examined the adult ♀ specimen of *Caligus auxisi* sent to us by Dr. Pillai we were struck by a number of similarities

between it and *C. biseriodentatus*. They are as follows: space between lunules slightly greater than diameter of either lunule; second antenna with a posterior process; one of the setae of the first maxilla is exceptionally long; base of furca is narrower than spread of tines; basipod of leg 1 covered with stout spinules; lateral setae on leg 1 exopod very short; armature of leg 2 endopod the same; leg 4 exopod 2-segmented and terminal spines relatively short and distalmost spine only slightly longer than adjacent spine; armature of caudal rami simliar. Based on these common characters we concluded that *Caligus auxisi* represents the adult form of *Caligus biseriodentatus*.

We feel that the adult form of this species probably prefers a non-scombrid host—possibly a prey species. The first author has experienced a similar circumstance in a species of *Caligus* from the Gulf of Mexico with the immature stages common on one species of fish and the adults found only on others.

Discussion

The preceding 4 species (*C. bonito, C. mutabilis, C. omissus,* and *C. biseriodentatus*) are morphologically closely related as pointed out below. They show an interesting distribution and host selection. *Caligus bonito,* possibly the ancestral form, is circumglobal in distribution and seems to prefer hosts of the tribes Thunnini and Sardini, with an infestation rate of 17 percent in the 11 species infested. A single collection was made from *Scomberomorus regalis* (1 ♀ 1 ♂), which was probably an adventitious association. *Caligus mutabilis* apparently infests several species of hosts in the Western Atlantic but, of the scombrids of that area, it is found on species of *Scomberomorus* with a 3 percent infestation rate on the 3 species infested. A single collection (1 ♀) was made from *Scomber japonicus. Caligus omissus* apparently is restricted to the eastern Pacific and is a common parasite on the 2 species of *Scomberomorus* endemic to that area with a 29 percent infestation rate. We have not examined non-scombrid hosts of that area but we suspect that, as in *C. mutabilis* in the western Atlantic, it occurs on non-scombrid hosts as well. The scombrid hosts of *Caligus biseriodentatus* are *Auxis* species and *Scomberomorus*. The parasite occurs on *Scomberomorus* only in its immature stages. The adults have been collected from *Auxis*. We believe that some other host species is preferred for the adult as the only collection of this species in the adult form was a single collection from *Auxis*.

These 4 species have the following characters in common: an elongate, 1-segmented abdomen; second antenna with a posterior process on the basal segment; caudal ramus longer than wide; leg 1 basipod with a prominent patch of spinules; leg 1 lateral setae with stout spinules on the outer basal part; leg 2 endopod second segment with conspicuous stout spinules on the outer edge; leg 4 exopod 2-segmented. Other *Caligus* species possess some of these characters but none of those found on scombrids share as many.

It is interesting to note that 2 of these species (*C. mutabilis* and *C. biseriodentatus*) apparently utilize one host species for the immature forms and another for the adult. The relationship between *Caligus mutabilis* and its various hosts is being studied by the first author as part of a study of the parasitic copepods of the teleost fishes of Charlotte Harbor, Florida.

No counterpart *Caligus* has been collected from the 21 specimens of the eastern Atlantic endemic, *Scomberomorus tritor* (the record of *Caligus diaphanus* probably represents an accidental infestation because species of *Trigla* are its usual hosts).

Caligus cybii Bassett-Smith, 1898

FIGURES 60–63, 104

Caligus cybii Bassett-Smith, 1898a:6.
Caligus brevisoris Shen, 1957:357.
Caligus quinqueabdominalis Heegaard 1962:162.

MATERIAL EXAMINED.—19 collections containing 158 ♀ and 59 ♂ from the gills and gill area of the following hosts and localities: *Scomberomorus commerson* from Red Sea (Suez), northwest Malagasy Republic, Andaman Sea, Gulf of Thailand, Philippines, Hong Kong: *Scomberomorus koreanus* from Bombay, Sumatra, Japan; *Scomberomorus* species from New Guinea; *Scomberomorus semifasciatus* from the Gulf of Carpenteria; *Scomberomorus sinensis* from Hong Kong.

FEMALE.—Body form as in Figure 60*a*. Total length 4.84 mm (4.65–5.25 mm), based on an average of 7 specimens. Greatest width 1.65 mm. Cephalon comprises about 40 percent of total length. Genital segment (Figure 60*b*) trapizoidal (widest posteriorly), somewhat wider than long (1.6 × 1.8 mm), compris-

ing about 20 percent total length, posterior corners not produced. Abdomen (see Figure 60*b*) incompletely divided into 2 segments, widest anteriorly and tapering to caudal rami, about 2½ times longer than wide (2.03 × 0.79 mm) comprising about 25 percent of total length. Caudal rami (Figure 60*c*) small, somewhat longer than wide (236 × 200 μm) armed with plumose setae as in the figure.

Oral area as in Figure 60*d*. First antenna (Figure 60*e*) with 27 setae (most plumose) on first segment and 13 naked setae on last segment. Postantennal spine (Figure 61*a*) very small. Postoral spine as in Figure 61*c*. Second maxilla (Figure 61*d*) of usual caligoid type with 2 terminal, fringed, flagella. Maxilliped (Figure 61*e*) a stout claw. Sternal furca (Figure 61*f*) with divergent tines, not sharply pointed.

Leg 1 (Figure 61*g*) basipod with a patch of fine spinules, a short plumose seta on posterior border, and a long plumose seta on outer distal corner; exopod first segment with a row of long spinules along most of inner edge and a short, finely serrate spine on outer distal corner, last segment with 4, finely serrate, spines without accessory spines and 3 setae on inner margin (plumosities of setae thickened); endopod reduced to a short process with 2 small spines at tip. Leg 2 (Figure 62*a*) coxopod with a patch of fine spinules on outer surface; basipod with very short spine at outer distal corner; exopod first 2 segments with heavily sclerotized, finely serrate, inwardly directed spines on outer distal corner, last segment with 2 short spines and a longer terminal spine with prominent plumosities along inner margin, all segments with plumose setae in the figure; endopod second segment with a prominent patch of long spinules on outer edge, last segment with a small patch of similar spinules at outer proximal half, all segments with plumose setae as in the figure. Leg 3 (Figure 62*b*) typical of the genus, outer margin of basipod with heavy spinules; exopod first segment with stout, inwardly directed spine on outer distal corner, other 2 segments with plumose setae as in figure; endopod reduced with 3 incompletely separated segments bearing plumose setae as in figure. Leg 4 (Figure 62*c*) exopod 3-segmented; the first 2 each bearing a prominent spine on outer distal corner, last segment with 3 terminal spines, terminalmost longest, the 5 spines of the exopod measure 171, 124, 142, 142, and 200 μm proximal to distal respectively, each with a conspicuous fringe at base and on edges as figured. Leg 5 represented by a pair of small plumose setae at outer posterior corners of genital segment.

MALE.—Body form as in Figure 62*d*. Total length 3.24 mm (3.00–3.45 mm) based on an average of 5 specimens. Genital segment (Figure 63*a*) somewhat longer than wide (841 × 739 μm). Abdomen 2-segmented, somewhat longer than wide (580 × 450 μm), second segment about 2½ times length of first. Caudal rami as in female.

Cephalic appendages as in female except second antenna (Figure 63*b*) with rugose areas on basal segment and a bifid claw; postoral process (Figure 63*c*) with an accessory process and spine near distal two-thirds; maxilliped (Figure 63*d*) basal segment with sclerotized processes opposite tip of claw, claw more robust than in female.

Legs as in female except leg 5 represented by 3 short, plumose, setae at each lateral mid-margin and leg 6 represented by 3 similar setae at posterior distal corners of genital segment (see Figure 63*a*).

REMARKS.—So far this species is reported only from Indo-West Pacific species of *Scomberomorus*. Collection data indicates this parasite is usually found on the gills, gill arches, operculum, and pseudobranch of the host.

Caligus pelamydis Kroyer, 1863

FIGURES 64–66, 104

Caligus pelamydis Kroyer, 1863:124.
Caligus scomberi Bassett-Smith, 1896:11.
Caligus scombri Scott, T., 1901:148.
Parapetalus sp. Silas and Ummerkutty, 1967:908.

This species has been recorded many times from scombrid and non-scombrid hosts (see Lewis, 1967: 139). Shiino, 1965 and Lewis, 1967 have provided good descriptions of this species. We will discuss only those features of special taxonomic importance in addition to including figures. A complete synopsis of the literature has been provided by Margolis, Kabata, and Parker, 1975:59.

MATERIAL EXAMINED.—30 collections containing 97 ♀ and 4 ♂ from the gill arches, gills, and inner wall of the operculum of the following hosts and localities: *Scomber scombrus* from France; *Scomber japonicus* from Gulf of Mexico, Florida (Atlantic), Gulf of Guinea; *Scomberomorus niphonius* from Japan; *Auxis* species from New South Wales; *Euthynnus affinis* from New South Wales; *Euthynnus allet-*

teratus (locality unknown); *Sarda sarda* from Argentina, Gulf of Guinea, Tunis, South Africa (Port Elizabeth); *Sarda australis* from New South Wales; *Sarda chiliensis lineolatus* from California.

FEMALE.—Body form as in Figure 64*a*. Range of total length 3.00–4.65 mm. As in other species of *Caligus* with widespread distribution, the size differences seem to be correlated with water temperature rather than host species.

Caligus pelamydis females can be separated from other species of *Caligus* found on scombrids by the following combination of characters: cephalon 40–45 percent of total length; abdomen 23–25 percent of total length; second and third segments of leg 2 endopod (see Figure 65*e*) each with a large patch of fine spinules along outer edge; leg 4, 3-segmented with last segment produced distally to give segment a triangular shape (see Figure 66*b*) and prominent fringes at bases of all setae, tines of sternal furca spatulate and as wide or wide than base (Figure 65*c*).

MALE.—Body form as in Figure 66*c*. Range of total length 2.48–2.55 mm (based on 3 specimens from *Sarda sarda,* Gulf of Guinea). Males are generally rare in collections (comprising only about 4 percent of the total sample studied). Shiino (1965:411), described the male of this species comparing it to an immature female in the same collection. Certain appendages differ between the sexes but some of those noted by Shiino were probably due to the immaturity of the female. In our sample we found the following differences based on adults of both sexes: second antenna of male with rugose patch along posterior edge of basal segment; postoral process of male (Figure 66*e*) with rugose patch on basal half; maxilliped of male (Figure 66*f*) with sclerotized process on basal segment opposing tip of claw; fifth and sixth legs represented by 3 setae at mid-margin and 2 setae at posterior corner of genital segment respectively; abdomen 2-segmented with first segment about half as long as second (Figure 66*d*).

REMARKS.—We have recorded this species here from 9 species of scombrids from all 4 tribes. Although it is found on several species of hosts it seems to prefer species of *Sarda* (approximately 13 percent infestation of specimens examined). Although this species has wide distribution it has not been recorded from the Indian Ocean. We consider *Parapetalus* species of Silas and Ummerkutty to be *C. pelamydis* based on their illustrations.

Caligus infestans Heller, 1868

FIGURES 67–69, 104

Caligus infestans Heller, 1868:167.
Caligus sphyraenae Nunes-Ruivo and Fourmanoir, 1956:71.
Caligus maculatus Heegaard, 1962:157.

MATERIAL EXAMINED.—5 collections containing 7 ♀ and 1 ♂ from the gills and body surface of 5 *Scomberomorus commerson* from Indonesia, Thailand, and Mozambique.

FEMALE.—Body form as in Figure 67*a*. Total length 5.14 mm (based on an average of 4 specimens ranging 4.80–5.55 mm). Greatest width 2.18 mm (1.95–2.40 mm). Cephalon comprises nearly half total length. Genital segment somewhat longer than wide (1.8 × 1.4 mm) with posterior distal corners lobed and extending to about middle of abdomen. Abdomen 2-segmented, longer than wide (0.77 × 0.48 mm). Caudal rami (Figure 67*c*) about as long as wide (271 × 248 μm) with outer edge about twice length of inner edge, one small, subterminal seta at inner distal corner and 4 terminal plumose setae (outermost much shorter than others). Pillai (1971:160) states that there is a ventral patch of fine denticles on the caudal ramus (anal laminae). These are actually on the dorsal surface rather than ventral and appear as sclerotized bumps in the outer proximal quarter.

Oral area as in Figure 67*d*. First antenna (Figure 67*e*) typically caligoid but posterior 6 setae of last segment with tips feathered giving them a frayed appearance. Second antenna (Figure 68*a*) with usual hookshaped last segment, basal segment with posterior, pointed, sclerotized process. Tip of second maxilla (Figure 68*b*) with usual 2 fringed processes but tips of processes somewhat expanded. Maxilliped (Figure 68*c*) with stout terminal hook and sclerotized process on basal segment opposite tip of hook. Sternal furca (Figure 68*d*) with widely divergent tines, tips of tines pointed and somewhat recurved inwards.

Leg 1 (Figure 68*e*) basipod with large patch of spinules; exopod first segment with short spine on outer distal corner and row of long spinules along inner edge, last segment armed as in other species of the genus but 3 inner setae with plumosities stouter than usual from bases to tips; endopod weakly developed. Leg 2 (Figure 68*f*) exopod, first segment

with long inwardly directed spine, on outer distal corner, second segment with somewhat shorter similar spine, last segment with similar spine about half length of that of the first segment, exopod segments otherwise armed with plumose setae as in the figure; endopod first segment with a row of short spinules along outer edge and a patch of longer spinules at outer distal corner, second segment with a dense patch of long spinules along outer edge, third segment with a few long spinules at outer proximal edge, endopod with plumose setae as in the figure. Leg 3 (Figure 69*a*) exopod first segment with stout, slightly recurved spine, on outer distal corner, second segment with short, weak, spine on outer distal corner, last segment with 3 weak spines and 4 plumose setae; endopod with 2 segments bearing plumose setae as in the figure. Leg 4 (Figure 69*b*) exopod first segment outer edge produced as approximate right angle at distal two-thirds; last segment with distalmost spine 2½ times length of others (442 × 177 μm). Leg 5 represented by 3 short plumose setae near edge of genital segment at distal three-fourths.

MALE.—Body form as in Figure 69*c*. Total length 4.95 mm. Greatest width 2.10 mm. Genital segment about as long as wide. Abdomen (Figure 69*d*) 2-segmented, first segment shorter than second (second about 3 times length of first). Appendages as in female except second antenna (Figure 69*e*) with 2 rugose areas on basal segment, a short, recurved, terminal claw, a seta near base of terminal claw.

REMARKS.—This species is easily separated from the other species of *Caligus* reported from scombrids by the peculiar shape of the first segment of the exopod of leg 4.

Heller described this species from *Scomber* species from Java. According to B. Collette (pers. comm.) the specimens reported by Heller as *Scomber* species from Java must have been *Rastrelliger* species since no true *Scomber* were taken from Java during the *Novara* cruise that was the basis of his report. Since then it has been reported by Bassett-Smith 1898b: 360; Nunes-Ruivo and Fourmanoir 1956:69; Heegaard 1962:157; Kirtisinghe 1964:52; Kabata 1965:119; and herein from *Scomberomorus commerson* and *S. queenslandicus* from the Indo-West Pacific. Kabata 1965:119 also reported a single male from *Euthynnus affinis* (as *E. alletteratus*). It seems apparent that this species is primarily a parasite on the body surface of *Scomberomorus commerson*. It is probably more common than our records indicate as most of our collections from this host were from preserved specimens and body surface parasites were no longer present.

Caligus diaphanus Nordmann, 1832

FIGURES 70–72

Caligus diaphanus Nordmann, 1832:26.
Caligus caudatus Kroyer, 1838:16.
Caligus isonyx Steenstrup and Lütken, 1861:354.

MATERIAL EXAMINED.—4 ♀ 1 ♂ from the gills of a specimen of *Scomberomorus tritor* collected from the mouth of the Belas River, Ghana.

FEMALE.—Body form as in Figure 70*a*. Total length 3.48 mm, greatest width (measured at widest part of cephalon) 1.59 mm. Genital segment (Figure 70*b*) somewhat wider than long (1.09 × 1.31 mm), globose, comprising about one-third of the total body length. Abdomen (see Figure 70*b*) 2-segmented, segments measure 0.55 × 0.48 mm and 0.29 × 0.35 mm (length × width) respectively. A patch of fine spinules at the outer distal corners of the last abdominal segment. Caudal rami (Figure 70*c*) longer than wide (153 × 106 μm) with 6 plumose setae, terminal 3 nearly equal in length (longest 224 μm).

First antenna (Figure 70*d*) first segment with 27 setae, most with fine plumosities, last segment with 14 naked setae, segments measure 118 μm and 100 μm respectively along posterior margins. Second antenna (Figure 70*f*) and stout recurved claw. Mandible within mouth tube, tip with 12 teeth. First maxilla (Figure 70*g*) reduced to 3 setae near base of postoral process. Second maxilla (Figure 71*a*) with 2 fringed subequal processes at tip, a hyaline process near tip of last segment. Maxilliped (Figure 71*b*) in form of a stout uncinate claw. Sternal furca (Figure 71*c*) with nearly parallel tines, tines rounded at tip and somewhat recurved. Ventral cephalic area as in Figure 71*d*.

First leg (Figure 71*e*) basipod with plumose seta at outer distal corner and a shorter plumose seta near inner mid-margin; exopod first segment with a short spine on outer distal corner and a row of spinules along inner margin, second segment with 4 outer to terminal spines and 3 inner plumose setae. Second leg (Figure 71*f*) basipod with a short plumose seta on outer distal corner; exopod first and second segments each with a stout fringed spine on outer distal

corner and an inner seta, last segment with 3 outer spines and 5 terminal to inner setae; endopod first segment with an inner seta, second segment with a patch of long spinules along outer edge and 2 inner setae, last segment with a patch of long spinules on outer edge and 6 setae. Third leg (Figure 72*a*) basipod with scattered short spinules near outer margin; exopod first segment with a prominent spine on outer distal corner, second segment with a short spine on outer distal corner and inner seta, last segment with 3 short outer spines and 4 terminal to inner setae; endopod first segment with an inner seta, last segment with 6 terminal setae. Fourth leg (Figure 72*b*) basipod with a small seta on outer distal corner; exopod first segment with a fringed seta (112 μm) on outer distal corner, second segment with fringed seta (136 μm) on outer distal corner, last segment with 3 fringed setae (153, 165, and 206 μm long respectively), a fringe at base of each seta. Fifth leg represented by 4 setae near the posterior distal corner of the genital segment.

MALE.—Body form as in Figure 72*c*. Total length 2.39 mm, greatest width 1.30 mm. Genital segment about as long as wide (0.43 × 0.45 mm). Abdomen 2-segmented segments measure 88 × 250 μm and 292 × 280 μm (length × width) respectively. Caudal rami as in female. Appendages as in female except as follows. Second antenna (Figure 72*d*) with accessory process on claw and bossed areas on segments as illustrated. Postoral process (Figure 72*e*) with accessory process at distal two-thirds. Maxilliped (Figure 72*f*) base with 2 well-developed processes opposing tip of claw, portion of claw distal to seta proportionately shorter than in female. Fifth leg represented by 4 setae at mid-lateral margin of genital segment. Sixth leg represented by 3 setae at posterior distal corners of genital segment.

REMARKS.—This species has been reported by numerous authors from the west coasts of Europe and Africa (see Margolis, et al, 1975). It is apparently commonly found on species of *Trigla* but has been reported from several other hosts as well. Our report here is the first from a scombrid host and in light of the many previous literature citations it should not be considered a primary parasite of scombrids. We have included its description here as no complete description exists in modern literature. The specimens studied in this description were compared with material collected by us from *Trigla lineata* from off Naples, Italy.

Caligus savala Gnanamuthu, 1948

FIGURE 73*a–f*

Caligus savala Gnanamuthu, 1948:591.
Caligus affinis Kurian, 1961:71.
Caligus acutus Kirtisinghe, 1964:66.

Gnanamuthu described this species from specimens collected from the plankton and a single male from the body surface of *Trichiurus savala* Cuvier. Kurian collected 2 ♀ from the body surface of *Euthynnus affinis* (described as *C. affinis*). Kirtisinghe, 1964, noted that *Caligus affinis* was preoccupied and renamed the species *Caligus acutus* Kirtisinghe. Pillai, 1971:164 redescribed the species from type material of *C. savala* deposited in the British Museum and placed *C. affinis* and *C. acutus* in synonymy with *C. savala.*

The single record of this species from a scombrid indicates that its occurrence on such a host was probably accidental.

The female may be characterized as follows. Body form as in Figure 73*a*. Second antenna (Figure 73*b*) with pointed posterior process on base. Postantennal process (Figure 73*c*) not strongly curved. Sternal furca (Figure 73*d*) with tines only slightly divergent and spreading only slightly wider than base. Leg 2 endopod with patches of slender spinules along outer margin of each (entire margin of segment 1 with spinules—usually only at outer corner of other species). Stout spine at the outer distal corner of leg 3 exopod first segment not curved inwardly. Leg 4 exopod (Figure 73*f*) 2-segmented, distalmost spine about one-third longer than adjacent spine.

We did not collect this species and have based the brief description and figures on Pillai's redescription in 1971.

Caligus macarovi Gussev, 1951

FIGURES 73*g–i*, 74*a–b*

Caligus macarovi Gussev, 1951:408.
Caligus fulvipurpureus Shiino, 1954:150.

Gussev described this species from specimens collected from 4 species of fish including *Auxis* and *Cololabis saira* (Brevoort) from the Sea of Japan.

Shiino later (1954:150) reported it (as *C. fulvipurpureus*) from the body surface of several *Cololabis saira* from Japan and again (Shiino, 1959b:277) from off Mexico (Pacific) as *C. macarovi*. This parasite apparently is common on Pacific *Cololabis* (also reported from this host by Kazachenko, et al, 1972: 224). It is not surprising that a copepod common on a prey species of fish (*Cololabis*) would occasionally be found on its predator species. The female of this species is characterized by the following. Cephalon comprises about 40 percent of total length (see Figure 73*g*). Genital segment about as wide as cephalon, sides nearly parallel. Abdomen one-segmented, about twice as long as wide. Second antenna with usual claw, posterior process on basal segment. Postantennal spine short, angle of inner curve greater than 90° (see Figure 73*h*). Maxilliped with 2-segmented claw. Sternal furca (Figure 73*i*) tines not widely divergent, not sharply pointed. Leg 1 basipod with patch of spinules, 3 inner lateral setae of last segment with spinules on outer basal part followed by fringe. Leg 2 endopod segments (Figure 74*a*) each with a dense patch of spinules on outer edge. Leg 4 (Figure 74*b*) exopod 2-segmented, last segment without midlateral spine, distalmost spine longer than adjacent spine. Male as in female except in body form. Second antenna with short claw and rugose areas on basal segment. Maxilliped with rugose area on basal segment opposite tip of claw.

We did not collect this parasite during the course of this study. This is undoubtedly due to its rarity on scombrids and its occurrence on the body surface of the host (not usually found on preserved hosts).

Caligus amblygenitalis Pillai, 1961

FIGURE 74*c–g*

Caligus amblygenitalis Pillai, 1961:98.

Pillai describted this species from a single female collected from the body surface of *Euthynnus affinis* from Vizhingom, India. It has not been recorded since.

The female is distinguished by the following characters. Frontal lunules widely separated, interlunular space about 3 times diameter of lunule (according to Pillai's figure). Genital segment about as long as cephalon and with lobed posterior corners. Abdomen 1-segmented, about twice as long as wide. Second antenna with posterior process on basal segment. Postantennal process (first maxilla of Pillai) long and blunt. Sternal furca with widely divergent tines, spread of tines wider than base. Leg 1 lateral setae with spinules on basal part of outer edge. Leg 2 endopod segments with a patch of narrow spinules on the outer edge of each, second spine on exopod with strong teeth on outer edge. Leg 4 exopod 2-segmented, bearing 4 spines (no lateral spine on last segment which is usually present in other species when exopod is 2-segmented), distalmost spine about one-third longer than adjacent spine.

Caligus pseudokalumai Lewis, 1968

Caligus pseudokalumai Lewis, 1968:59.

This species was described from a single female collected from the body surface of a *Gymnosarda unicolor* from Eniwetok Atoll. Lewis compared this species with a previously described species, *Caligus kalumai* Lewis, 1964, collected from *Acanthurus guttatus* from Hawaii. The differences between the 2 species are slight and Lewis suggested that their close relationship should be more closely examined when additional material is available. We feel that this species represents an accidental infestation and *Gymnosarda unicolor* is not its usual host. Lewis has provided a good description with illustrations and since this is undoubtedly not a scombrid parasite we will not repeat a description here.

Elytrophora Gerstaecker, 1853

Elytrophora brachyptera Gerstaecker, 1853

FIGURES 75–77, 106

Elytrophora brachyptera Gerstaecker, 1853:58.
Elytrophora hemiptera Wilson, 1921:4.

MATERIAL EXAMINED.—78 collections containing 771 ♀ 269 ♂ from the gill area of the following hosts and localities: *Thunnus alalunga* from Ile Amsterdam, Chile, New Jersey, Brazil (north coast), North Atlantic (25°N, 35°W), Azores Islands; *T. albacares* from Chagos, Australia (NSW), Christmas Island (Pacific), Hawaii, New Jersey, Brazil (north coast); *T. atlanticus* from St. Thomas Island; *T. maccoyii* from Western Australia (Albany); *T. obesus* from Ile Amsterdam, Seychelles, Christmas Island (Pacific),

Hawaii, Juan Fernandez Islands, New Jersey, Brazil (north coast), Cape Verde Islands, Canary Islands, Azores Islands; *T. thynnus* from South Africa (west coast), Eastern Pacific, Western North Atlantic, New Jersey, Portugal (Lisbon); *Allothunnus fallai* from New Zealand, California.

FEMALE.—Body form as in Figure 75*a*. Total length 8.26 mm, greatest width 4.71 mm (measured at widest part of cephalon). Genital segment longer than wide (2.61 × 1.89 mm). Abdomen 2-segmented, segments measure (l × w) 0.72 × 0.87 mm, 0.68 × 0.85 mm respectively; first segment partially hidden in dorsal view by flaps of genital segment. Caudal rami (Figure 75*b*) longer than wide (680 × 400 μm), each with 6 setae (2 very small). First antenna (Figure 75*c*) 2-segmented. Second antenna (Figure 75*d*) basal segment with prominent triangular process, terminal segment clawlike with 1 short spine and 1 seta. Mouthtube, mandible, post oral process and first maxilla as in Figure 75*e*; mandible with 12 teeth; post oral process about as long as mouthtube; first maxilla with 3 small setae. Second maxilla (Figure 75*f*) terminal segment with 2 prominent pectinated membranes at about mid-point, terminally with 2 long curved, subequal fringed processes. Maxilliped (Figure 75*g*) claw distal half finely grooved. Sternal furca (Figure 76*a*) with stout, widely divergent tines.

Leg 1 (Figure 76*b*) biramous, endopod first segment without ornamentation, second segment spinulose along outer edge, 3 inner setae; exopod one-segmented with 3 stout, fringed outer spines, 1 terminal plumose seta, 3 inner plumose setae. Leg 2 (Figure 76*c*) biramous, rami 3-segmented, endopod first and second segments each with spinulose outer edges, third segment small, with 6 setae; exopod with 4 outer spinulose spines, last segment with 6 setae. Leg 3 (Figure 76*d*) endopod first segment with inner seta, second segment with 2 inner setae, third segment small, with 4 setae; exopod as in Figure 77*a*. Leg 4 (Figure 77*b*) endopod 2-segmented, first segment with inner seta, second segment incompletely divided with one short inner seta and 3 short terminal setae; exopod first segment with outer spinulose spine, second segment similar, with inner seta, third segment with 3 outer to terminal spines and 4 short inner setae. Legs 5 and 6 represented by 1 and 3 setae respectively on lateral genital segment.

MALE.—Body form as in Figure 77*d*. Total length 6.67 mm, greatest width 3.62 mm (measured at widest part of cephalon). Genital segment (Figure 77*e*) longer than wide (1.74 × 1.53 mm). Abdomen 2-segmented, segments measure (l × w) 0.56 × 0.72 mm, 0.52 × 0.69 mm respectively. Caudal rami similar to female. First antenna 2-segmented, similar to female. Second antenna (Figure 77*f*) terminal segment long, recurved claw with stout spine on inner margin; triangular process on basal segment not as prominent as in female. Remaining cephalic appendages except maxilliped similar to female. Maxilliped modified as in Figure 77*g*. Sternal furca slender, tines less divergent than in female. Legs 1–6 similar to female, except leg 4 endopod setae longer.

REMARKS.—Examination of Wilson's types of *E. hemiptera* indicate that they are actually *E. brachyptera* and we have placed his species in synonomy. Hewitt (1968) made a tentative revision of the genus *Elytrophora* in which he considered *E. brachyptera* to be the only species with 2 additional subspecies (*atlantica* and *indica*). We feel that *E. indica* is a valid species and have indicated it as such below. *Elytrophora brachyptera* is a circumglobal species found on several species of Thunnini.

We noticed that material collected from colder waters (New Zealand and Ile Amsterdam) show a variation in the armature of leg 4. One of the 4 inner setae is strongly developed whereas in specimens from more temperate waters all of these setae are reduced (compare Figures 77*b* and *c*). We did not feel this variation warranted designating the colder water material as a new species. These variant specimens were collected from the Ile Amsterdam specimen of *Thunnus obesus* and the southernmost specimens of *Allothunnus*.

Elytrophora indica Shiino, 1958

FIGURES 78, 79*a,b*, 106

Elytrophora indica Shiino, 1958:107.
Elytrophora brachyptera indica Shiino.—Hewitt, 1968:124.

MATERIAL EXAMINED.—9 collections containing 128 ♀ 27 ♂ from the gill area of *Thunnus obesus* from Ile Amsterdam, Seychelles, Christmas Island (Pacific), Juan Fernandez Islands.

FEMALE.—Body form as in Figure 78*a*. Total length 10.15 mm, greatest width 5.80 mm (measured at widest part of cephalon). Genital segment (Figure 78*b*) longer than wide (2.97 × 2.20 mm). Abdomen

(see Figure 78*b*) first segment crescent-shaped, produced at posterior corners to envelope anterior half of second segment; segments measure (l × w) 1.01 × 1.50 mm, 1.02 × 1.10 mm respectively. Caudal rami longer than wide (0.65 × 0.43 mm) similar to *E. brachyptera*. First antenna (Figure 78*c*) 2-segmented, first segment with 25 setae, one modified into sclerotized spine; second segment with one subterminal seta, 13 terminal setae. Second antenna as in Figure 78*d*. Mouth tube, mandible, post oral process, and first maxilla as in Figure 78*e*; post oral process longer than mouthtube. Second maxilla, maxilliped, sternal furca, and legs 1–3 similar to *E. brachyptera*. Leg 4 (Figure 78*f*) similar to *E. brachyptera* except exopod spines relatively longer in *E. indica*. Legs 5 and 6 (Figure 78*g*) represented by 1 and 3 setae respectively on lateral genital segment.

MALE.—Body form as in Figure 79*a*. Total length 8.33 mm, greatest width 4.16 mm (measured at widest part of cephalon). Genital segment longer than wide (1.97 × 1.68 mm). Abdomen 2-segmented, segments measure 0.65 × 0.94 mm, 0.87 × 0.85 mm respectively. Caudal rami longer than wide (0.71 × 0.40), similar to female. First antenna similar to female. Second antenna (Figure 79*b*) similar to *E. brachyptera* male except basal segment with only small process. Mouth tube, mandible, post oral process, first maxilla, second maxilla similar to female. Maxilliped and sternal furca similar to *E. brachyptera* male. Legs 1–6 similar to female.

REMARKS.—So far this species has been collected only from *Thunnus obesus* and may well be restricted to that host. It occurs in collections with *E. brachyptera* but we have no data to indicate if these 2 species occupy the same microhabitat. We have included Shiino's records of this copepod on the map (Figure 105).

Gloiopotes Steenstrup and Lütken, 1861

Gloiopotes hygomianus Steenstrup and Lütken, 1861

FIGURE 79*c–i*

Gloiopotes hygomianus Steenstrup and Lütken, 1861:363.

MATERIAL EXAMINED.—27 collections containing 77 ♀ 56 ♂ from the body surface of *Acanthocybium solandri* from the following localities: Seychelles Islands, Malagasy Republic, Ile Amsterdam, Christmas Island (Pacific), Washington Island, Hawaii, Socorro Island, Revillagigedo, Puerto Rico, Nicaragua, North Atlantic (39°N, 41°W), North Carolina, Brazil, Canary Islands, Cape Verde Islands, Azores Islands.

Shiino (1960:533) provided a good description of this species and we will provide description and illustrations to enable the reader to recognize this species without resorting to earlier works. For a comprehensive account consult the work of Shiino (1960) and Cressey (1967).

FEMALE.—Body form as in Figure 79*c*. Total length 16.7 mm (15.0–17.7 mm.) greatest width 6.2 mm (6.0–6.5 mm). Measurements based on an average of 8 specimens. Caudal rami much longer than wide. Frontal lunules absent. First antenna 2-segmented (distal half of last segment sclerotized giving the impression of 2 segments). Second antenna clawlike, heavily sclerotized at tip. Sternal furca (Figure 79*d*) with accessory process lateral to the base of each tine. Leg 1 exopod last segment (Figure 79*f*) with 2 bifid spines plus an accessory spine giving trifid appearance; and unmodified spine on outer distal corner and 3 lateral setae. Leg 4 (Figure 79*h*) exopod 3-segmented, last segment with 3 short terminal spines.

MALE.—Body form as in Figure 79*i*. Total length 12.1 mm (11.7–12.5 mm). Greatest width 4.8 mm (4.2–5.7 mm). Measurements based on 6 specimens. Appendages similar to female except second antenna with an accessory process on claw.

REMARKS.—This species is restricted to *Acanthocybium solandri* and probably found throughout the range of the host. The 4 other species of the genus are parasites of billfishes (Istiophoridae). The genus *Gloiopotes* was revised by the first author (Cressey, 1967).

Caligulus Heegaard, 1962

Caligulus longispinosus Heegaard, 1962

FIGURE 80

Caligulus longispinosus Heegaard, 1962:171.

We did not collect this species but we have examined the type male deposited in the Australian Museum (AMS P. 16429). Heegaard stated that a female holotype and male allotype were deposited but only

a partially dissected male was in the vial when we received it from the Australian Museum. Examination of this specimen and Heegaard's figures of the female lead us to believe that this species was erroneously placed in the Euryphoridae by the author. His basis for doing so was the presence of dorsal plates covering the fourth thoracic segment. His figures do not indicate these and the male specimen does not have them. Unfortunately, lacking the female, we could not resolve the problem of its true taxonomic position. We hope that additional material of this interesting species will be collected eventually and its taxonomic position made clear.

We have refigured the male maxilliped (Figure 80*c*), sternal furca (Figure 80*d*), leg 1 (Figure 80*e*), and leg 2 (Figure 80*f*).

The original collection was made from the body surface of *Euthynnus affinis* (reported as *E. alletteratus*) from Howick Island, north Queensland, Australia.

The total length of the male is 3.35 mm.

Tuxophorus Wilson, 1908

Tuxophorus cybii Nunes-Ruivo and Fourmanoir, 1956

FIGURE 81*a*

Tuxophorus cybii Nunes-Ruivo and Fourmanoir, 1956:76.
Tuxophorus solandri Kurian, 1961:72.

We did not collect this species but we have reproduced the figure of the female based on the illustration of Nunes-Ruivo and Fourmanoir. In 1961 Kurian described a new species, *T. solandri*, based on a single specimen from the body surface of *Acanthocybium solandri* from India. Kurian was apparently unaware of the description of *T. cybii* earlier as he made no mention of it. Comparisons of the 2 descriptions leave no doubt that they represent the same species and, consequently, we have placed Kurian's *T. solandri* in synonymy with *T. cybii*.

Furthermore, we suspect that *T. cervicornis* of Heegaard (described below) may also be a synonym of *T. cybii*. The only difference we find between Heegaard's species and *T. cybii* and *T. solandri* is the highly developed processes on the outer distal corners of *T. cervicornis* (absent in the other 2). This could be accounted for if the descriptions of *T. cybii* and *T. solandri* are based on immature specimens. Each description is based on a single specimen and neither Nunes-Ruivo and Fourmanior or Kurian show egg strings in the illustrations (Heegaard does).

One of our collections of *T. cervicornis* is from Pakistan, extending the range of that species to within the known range of *T. cybii*.

Since we did not collect specimens of *T. cybii* or immature *T. cervicornis* we feel it would be premature to place *T. cybii* in synonymy. We trust that future collection will bear out our suspicions regarding the synonymy of these 2 species.

Tuxophorus cervicornis Heegaard, 1962

FIGURE 81*b–g*

Tuxophorus cervicornis Heegaard, 1962:172.

MATERIAL EXAMINED.—2 collections containing 2 ♀ from the body surface of *Scomberomorus commerson* from Coffs Harbor, New South Wales, Australia, and Karachi, Pakistan.

FEMALE.—Body form as in Figure 81*b*. Total length 6.80 mm. Greatest width 3.15 mm. Cephalon slightly longer than wide (3.10 × 3.15 mm). Thoracic segment bearing leg 4 with dorso-lateral winglike plates. Genital segment slightly wider than long (2.10 × 2.25 mm, including posterior processes); outer posterior corners produced. Abdomen 3-segmented. Caudal ramus about 6.5 times longer than wide (1.95 × 0.30 mm). Oral appendages as in *T. collettei* except sternal furca with pointed tines (Figure 81*e*) rather than spatulate. Leg 1 as in *T. collettei* except spinules on terminal spines thicker in *T. cervicornis*. Legs 2–3 as in *T. collettei*. Leg 4 (Figure 81*g*) exopod 3-segmented, terminalmost spine shorter (relative to adjacent spine) than in *T. collettei*.

MALE.—Unknown.

REMARKS.—This species has been reported from *Scomberomorus commerson* from northern Australia and Pakistan. See the discussion following the description of *T. cybii* for comparisons with that species.

Tuxophorus collettei, new species

FIGURES 82–84

MATERIAL EXAMINED.—Holotype ♀ (USNM 172250), allotype (USNM 172251), and 13 ♀ 1 ♂

paratypes (USNM 172252 collected from the body surface of *Scomberomorus regalis* caught off the Virgin Islands, 8 June 1967 during a cruise of the R.V. *Oregon II*. Collected by C. A. Child.

FEMALE.—Body form as in Figure 82*a*. Total length (including caudal rami) 9.0 mm, greatest width (measured at widest part of cephalon) 2.33 mm. Cephalon somewhat longer than wide (2.55 × 2.33 mm). Thoracic segments bearing legs 1–3 fused, incorporated within posterior lateral lobes of cephalon. Thoracic segment bearing leg 4 with lateral winglike plates, posterior margins of plates reaching to "shoulders" of genital segment. Genital segment longer than wide (1.58 × 1.35 mm) with lateral margins parallel giving segment a boxlike shape; distal corners rounded and slightly produced, ventral surface with 2 lateral patches of stout spinules (Figure 82*b*); a dorsal, heavily sclerotized process near each distal corner (Figure 82*a*). Abdomen about 6 times longer than wide (3.45 × 0.58 mm) narrowing near mid-margin and near distal end. Caudal rami about 3.8 times longer than wide (490 × 129 μm), widest proximally; 2 short setae on each lateral margin at distal two-thirds, 1 subterminal inner seta, 3 short, plumose, terminal setae.

First antenna (Figure 82*d*) 2-segmented; first segment with 13 short, stout, plumose setae, second segment with 11 naked setae. Second antenna (Figure 82*e*) robust with stout recurved claw, claw with short seta near base of longer seta near middle of outer edge. Mandible of usual caligoid type with 12 teeth at tip. First maxilla represented by 3 short setae lateral to mouthtube near base of post-oral process. Second maxilla (Figure 83*a*) long and slender, a patch of long hairs (compound setae?) at junction of first and second segment, a palmate fringe near mid-margin of second segment; 2 terminal fringed flagella, outermost about twice length of inner. Maxilliped (Figure 83*b*) basal segment with a short, stout seta near inner mid-margin; second segment in form of a recurved claw bearing a short seta near middle. Sternal furca (Figure 83*c*) with short, divergent, truncate tines, tines with lateral flanges on basal half; accessory processes lateral to furca.

Legs 1–3 biramose. Leg 1 (Figure 83*d*) basipod with posterior seta and plumose seta on outer distal corner; exopod first segment with row of hairs along posterior border and short spine on outer distal corner; second segment with 3 terminal spines, outermost with inner row of spinules, others bifid and with broad serrations on inner and outer edges, each spine with a fringe near its base, a short terminal seta and 3 lateral plumose setae: endopod a small process near base of exopod bearing a row of hairs near tip. Leg 2 (Figure 83*e*) basipod unarmed except a prominent fringe on both inner and outer margins; exopod 3-segmented, first segment with a stout serrate spine, inwardly directed, on outer distal corner and an inner seta, second segment armed as first except spine smaller and more finely serrate, third segment with 2 outer spines (terminalmost finely fringe) and 6 plumose setae; endopod first segment outer edge with a row of long spinules and an inner seta, second segment with 2 inner setae and spinules on outer margins (smaller than those on first segment), third segment with spinules on outer edge and 6 plumose setae. Third leg (Figure 84*a*) basipod with patch of spinules on outer half and smaller patch of finer spinules near inner margin; exopod first segment with stout spine on outer distal corner and fringe on outer margin, second segment with spine on outer distal corner, inner seta, and patch of long spinules on outer edge, last segment with 3 outer spines, 4 short terminal to inner setae, and long spinules on outer edge; endopod first segment with patch of spinules along outer edge and inner seta, second segment with patch of spinules on outer edge and 6 plumose setae. Leg 4 (Figure 84*b*) basipod unarmed; exopod 3 segmented, first and second segments each with a fringed spine on outer distal corner, last segment with 3 fringed spines measuring 82, 112, and 236 μm respectively, each exopod spine with a fringe near its base. No evidence of legs 5 or 6 could be found.

Egg strings of usual caligoid type, reaching well beyond tip of abdomen.

MALE.—Body form as in Figure 84*c*. Total length (including caudal rami) 6.15 mm, greatest width (measured at widest part of cephalon) 2.68 mm. Cephalon about as wide as long (2.68 × 2.33 mm). General morphology of cephalon as in female. Genital segment (Figure 84*d*) longer than wide (1.3 × 0.9 mm), ventral surface with spinules as indicated in figure. Abdomen similar to that of female except only 3.7 times as long as wide (2.68 × 0.73 mm), small spinules on ventral surface. Caudal rami as in female (590 × 141 μm). Cephalic appendages as in female except second antenna (Figure 84*e*) with large rugose areas on basal segments and maxilliped with

small rugose knob on basal segment opposing tip of claw.

Legs 1–4 as in female. Legs 5 and 6 absent.

REMARKS.—Of the 5 previously described species (not including *T. tylosuri*, which was replaced in the genus *Caligus* by Pillai, 1961) the new species can be separated from *T. wilsoni* Kirtisinghe and *T. caligodes* Wilson by the long, slender caudal ramus of the new species (nearly square in *T. wilsoni* and *T. caligodes*). It can be separated from *T. cybii* Nunes-Ruivo and Fourmanoir, *T. solandri* Kurian (synonymous with *T. cybii*), and *T. cervicornis* Heegaard by the much longer abdomen, the spatulate tines of the sternal furca, and the relatively longer inner seta on the end of leg 4 (twice as long as other leg 4 setae) of *T. collettei*.

ETYMOLOGY.—This species is named for Dr. Bruce Collette whose enthusiastic support and collecting efforts made this paper considerably more comprehensive than it would have been otherwise.

Pseudocycnus Heller, 1868

Pseudocycnus appendiculatus Heller, 1868

FIGURES 85–87, 131–136*a*

Pseudocycnus appendiculatus Heller, 1868:218.
Pseudocycnus spinosus Pearse, 1952:30.
Pseudocycnus thynnus Brandes, 1955:190.

MATERIAL EXAMINED.—43 collections containing 85 ♀ 4 ♂ from the gills of the following hosts and localities: *Thunnus tonggol* from Pakistan, Gulf of Thailand; *T. albacares* from Seychelles Island, Somalia, Australia (Queensland), Philippines, Caroline Islands, Kapingamarangi Atoll, Peru, Costa Rica (Pacific), Juan Fernandez Islands, Gulf of Guinea; *T. obesus* from Juan Fernandez Islands, North Atlantic (40°N, 49°W); *Katsuwonus pelamis* from Malagasy Republic, Surinam, Gulf of Guinea; *Euthynnus alletteratus* from Florida (West Coast), Gulf of Mexico; *E. affinis* from Malagasy Republic, Gulf of Thailand.

FEMALE.—Body form as in Figure 85*a*. Thoracic segments bearing legs 2 and 3 free, without lateral processes. Abdomen short, incompletely separated from genital segment. Caudal rami long, about one-half length of genital segment, fused with abdomen. First antenna (Figure 85*b*) 7-segmented; first segment without setae; second segment with 4 setae, outer distalmost stout (not as prominent as in *Pseudocycnoides*), other segments with setae as in the figure. Second antenna (Figure 85*c*) with heavily sclerotized claw, 2 short, stout setae on inner margin. Mouthtube (Figure 85*d*) without ornamentation on labrum. Mandible (Figure 85*d*) with 7 teeth at tip. First maxilla (Figure 85*e*) with 2 stout and 1 weak setae at tip. Second maxilla (Figure 85*f*) with irregular rows of stout spinules along outer edge of distal 2 segments. Maxilliped (Figure 86*a*) with wide basal articulation, basal segment narrows proximally to articulate with claw; claw with bifid tip and stout accessory process near mid-margin.

Leg 1 (Figure 86*b*) biramous; basipod with 2 patches of long spinules; exopod 1-segmented, bearing 3 short, stout spines at tip; endopod mostly obscured by fleshy tissuelike processes from basipod, bearing 2 spines and 2 setae at tip. Leg 2 (Figure 86*c*) basipod with 3 patches of spinules and well-developed seta at outer distal corner; exopod with 4 stout spines at tip and 3 spinules along outer and distal margins; endopod with 3 stout, terminal spines, 2 groups of spinules as figured; both rami 1-segmented. Leg 3 (Figure 86*d*) basipod with a large patch of spinules; exopod fused with basipod and bearing 3 spines at tip. Leg 4 represented by a single lateral seta at proximal part of genital segment. Egg strings long.

MALE.—Body form as in Figure 87*a*. Total length 2.70 mm. Greatest width 0.75 mm. Genital segment less than half total body length (520 × 370 μm length by width). Abdomen (Figure 87*b*) longer than wide (300 × 220 μm). Caudal rami (see Figure 87*b*) somewhat longer than abdomen and about 4 times as long as wide (450 × 110 μm) ventral surface with 5 patches of sclerotized knobs.

First antenna (Figure 87*c*) 6-segmented (fourth segment of male is fused fourth and fifth segments of female), segment with bulbous spine on outer distal corner, remaining segments with setae as in the figure. Maxilliped (Figure 87*d*) base with patches of short spinules on inner margin and a heavily sclerotized claw, a short seta at outer distal corner of penultimate segment. Other cephalic appendages as in female except first maxilla with 1 less seta and second maxilla with more spinules at tip.

Leg 1 (Figure 87*e*) basipod with 2 patches of stout spinules, a seta at outer distal corner, a prominent, heavily sclerotized process arising from inner mid-

margin, process extends to tip of exopod; exopod with 1 spine at tip and surface ornamentation as in the figure; endopod an elongate process modified at tip giving it a tubelike appearance (see SEM photo). Leg 4 (Figure 87*f*) a prominent lateral process with a single seta at tip. Other legs as in the female.

REMARKS.—This species has been recorded many times from scombrids and is apparently circumglobal in distribution. Kabata (1970:171) summarized the known hosts and distribution to that time.

Our collection indicates that this parasite is most common on scombrids of the tribe Thunnini and to a lesser extent Sardini. The 6 species of Thunnini infested were parasitized at a rate of nearly 10 percent and the single species of Sardini about 2 percent.

Females of this species show considerable variation in total length. Lewis, et al. (1969) have presented data based on hosts and locality. Total lengths range from 11–18 mm with the longer specimens from colder waters.

Pseudocycnoides Yamaguti, 1963

Pseudocycnoides armatus (Bassett-Smith, 1898)

FIGURES 88–91*a–b*, 107, 136*b–f*, 137

Hellaria armata Bassett-Smith, 1898a:10.
Cybicola armata.—Bassett-Smith, 1898b:371
Pseudocycnus armatus.—Kirtisinghe, 1935:339.
Paracycnus lobosus Heegaard, 1962:182.
Pseudocycnoides armatus.—Yamaguti, 1963:172.
Pseudocycnoides rugosa Kensley and Grindley, 1973:104.

MATERIAL EXAMINED.—31 collections containing 149 ♀ 11 ♂ from the following hosts and localities: *Scomberomorus commerson* from Red Sea (Suez), Malagasy Republic, India (Cochin), Pakistan, Sri Lanka, Gulf of Thailand, Australia (NSW and Queensland), Philippines, Hong Kong; *S. guttatus* from Borneo (Padang), Hong Kong; *S. semifasciatus* from New Guinea; *S. lineolatus* from India (Palk Strait); *S. koreanus* from India (Bombay), Sumatra, China; *S. queenslandicus* from Papua New Guinea; *S. plurilineatus* from South Africa (Natal).

FEMALE.—Body form (Figure 88*a*) elongate with winglike process on each side of second free thoracic segment and anteriormost genital segment (fused with third thoracic segment). Total length 8.4 mm (7.8–8.7 mm based on 5 specimens). Greatest width 1.2 mm (1.05–1.35 mm based on 5 specimens). Genital segment comprising well over half total body length. Abdomen and caudal rami fused; each ramus tapering to a point. First antenna (Figure 88*b*) 7-segmented, first segment with no ornamentation, second segment with prominent sclerotized spine at anterodistal corner and other setae as in the figure; all segments with membranelike covering. Second antenna (Figure 88*c*) terminal segment clawlike with prominent medial spine and small proximal seta. Mouthtube (Figure 88*d*) tapering posteriorly; labrum with 4 patches of bumplike spinules; mandible with 7 teeth. First maxilla as in *P. buccata* Wilson. Second maxilla (Figure 88*e*) basal segment with large patch of spinules; second segment elongate, curved distally, together with short third segment forming a claw with rows of numerous stout spines along outer distal edge. Maxilliped (Figure 89*a*) basal segment enlarged, visible from dorsal aspect; terminal segment forming stout, heavily sclerotized claw, darkened and rugose at tip with small accessory spine on inner curve.

Leg 1 (Figure 89*b*) biramous, rami not distinctly separate from basipod; coxopod with small patch of slender spinules and triangular process on outer distal corner; exopod 1-segmented with 2 terminal spines; endopod 1-segmented with medial inner spine and 4 terminal spines, innermost shortest. Leg 2 (Figure 89*c*) basipod with patches of slender spinules and stout outer spine; rami 1-segmented, exopod with 4 terminal spines, outermost stout, toothed along outer edge; endopod with patches of slender spinules and 3 terminal spines. Leg 3 (Figure 89*d*) uniramous, ramus with slender spinules and 3 terminal spines, outermost spine stout, toothed along outer edge. Leg 4 represented by a simple seta on anterolateral genital segment. Egg strings usually as long as body.

MALE.—Body form as in Figure 89*e*. Total length 2.39 mm. Greatest width 0.59 mm. Genital segment more than half total body length. Abdomen (Figure 90*a*) without ornamentation. Caudal rami (see Figure 90*a*) with numerous spinules near tips and 5 setae. First antenna (Figure 90*b*), second antenna, mouthtube, mandible, and first maxilla as in female. Second maxilla (Figure 90*c*) similar to female, but spines on last 2 segments more numerous and more closely spaced. Maxilliped (Figure 90*d*) basal segment with 3 patches of small spinules and process on inner edge; distal 2 segments clawlike, each segment with 1 accessory spine.

Leg 1 (Figure 90*e*) biramous, each ramus 1-segmented and not distinctly separate from basipod; basipod with patch of slender spinules, triangular process, and several lobate processes; exopod with dense outer patch of spinules, smaller spinules in semicircle and 2 medial lobes, 2 spines and 3 lobed processes distally; endopod produced as a slender, elongate, heavily sclerotized spine with several small distal processes, spine with membranelike covering. Leg 2 (Figure 91*a*) biramous, each ramus 1-segmented; basipod with dense inner patch of spinules, 2 lighter patches of spinules and long, slender outer spine; exopod with irregular distal row of short spinules, 4 terminal spines, outermost spine enlarged, toothed along outer edge, row of hairs near bases of 3 smaller, inner spines; endopod with irregular patches of spinules, 1–2 rows of hairs at bases of 3 terminal spines, innermost spine elongate, densely spinulose around entire distal three-fourths, tapering gradually. Leg 3 (Figure 91*b*) similar to female. Legs 4 and 5 represented by simple spines on lateral genital segment.

REMARKS.—This species is common on species of *Scomberomorus* throughout the Indo-West Pacific (except *S. niphonius*). We examined the type material of *P. rugosa* Kensley and Grindley and concluded that their material was actually *P. armatus*. Their conclusion that *P. rugosa* represented a new species was based on comparisons with poor literature descriptions of *P. armatus* (B. Kensley, pers. comm.). We place *P. rugosa* in synonymy with *P. armatus*.

Pseudocycnoides scomberomori (Yamaguti, 1939)

FIGURES 91*c–g*

Pseudocycnus scomberomori Yamaguti, 1939:457.
Pseudocycnoides scomberomori.—Yamaguti, 1963:172.

MATERIAL EXAMINED.—7 collections containing 22 ♀ from the gills of *Scomberomorus niphonius* from Korea, North China, Japan.

FEMALE.—Body form as in Figure 91*c*. Total length 4.8 mm. Greatest width 0.9 mm. Abdomen and caudal rami of about equal length (0.6 mm); abdomen much shorter in *P. armatus*. Appendages as in *P. armatus* except as described below. Maxilliped (Figure 91*d*) claw longer and tip more recurved. Leg 1 (Figure 91*e*) basipod with large patch of spinules (spinules on outer edge only in *P. armatus*). Leg 2 (Figure 91*f*) endopod longest spine extending beyond tip of exopod spines and heavily spinulose (longest spine on endopod of *P. armatus* much shorter and with few spinules). Leg 3 (Figure 91*g*) outer spine not as robust as in *P. armata*.

MALE.—Unknown.

REMARKS.—This species is apparently restricted to *Scomberomorus niphonius*, which is endemic to waters of North China and Japan. Yamaguti described this parasite from *S. chinensis* (probably *S. niphonius*) from the Inland Sea of Japan.

Pseudocycnoides scomberomori is closely related to *P. armatus* but easily separated from it by the characters cited above.

Pseudocycnoides buccata (Wilson, 1922), new combination

FIGURES 92–94*a–c*, 107, 138, 139

Pseudocycnus buccata Wilson, 1922:79.
Cybicola elongata Pearse, 1951:365.
Pseudocycnopsis buccata (Wilson).—Yamaguti, 1963:172.

MATERIAL EXAMINED.—125 collections containing 667 ♀ 10 ♂ from the gill filaments of following hosts and localities: *Scomberomorus sierra* from Peru, Colombia (Pacific), Panama (Pacific), Costa Rica (Pacific), Gulf of California, Baja California; *S. concolor* from Gulf of California, California; *S. regalis* from Brazil (north coast), Surinam, Gulf of Venezuela, Virgin Islands, Haiti, Cuba, Florida (Atlantic); *S. maculatus* from Mexico (Vera Cruz), Florida (west coast), Alabama, United States east coast (several localities from Florida to Cape Cod); *S. brasiliensis* from Brazil (Rio de Janeiro to north coast), Trinidad, Panama (Atlantic), Costa Rica, British Honduras, Mexico (Mazatlán); *S. cavalla* from Brazil, Trinidad, Cuba, Gulf of Mexico, Cape Cod.

FEMALE.—Body from as in Figure 92*a*. Total length 5.14 mm. Greatest width 1.20 mm. Thoracic segments bearing legs 2 and 3 free. Genital segment comprising about 60 percent total body length; ventral surface with a patch of spinules between bases of leg 3, 3 patches of spinules between leg 4 setae, and another patch distal to leg 4 setae. Considerable variation of total length occurs in this species and this will be considered in a separate study by the first author and B. B. Collette. Abdomen (Figure 92*a*) somewhat wider than long (652 × 493 μm). Caudal rami about twice as long as wide (362 × 188 μm),

bearing 2 short terminal setae. Entire body covered with dense, fine hairs. First antenna (Figure 92*c*) 7-segmented, no ornamentation on first segment, remaining segments with short, naked setae as indicated in the figure. Second antenna (Figure 92*d*) a simple claw with 2 short, stout setae on inner edge of claw. Mouth tube (Figure 92*e*) without surface ornamentation. Mandible with 6–7 teeth. First maxilla (Figure 92*f*) bearing 3 setae at tip. Second maxilla (Figure 92*g*) similar to that of *P. armatus* except no patch of spinules on basal segment. Maxilliped (Figure 93*a*) with a short, heavily sclerotized claw (Figure 93*b*), basal segment with a thumblike process at inner proximal corner as in *P. armatus*.

Legs 1–3 rudimentary. Leg 1 (Figure 93*c*) rami 1-segmented; exopod with 5 short terminal spines; endopod bearing a short terminal spine; both rami covered with dense hairs and difficult to study. Leg 2 (Figure 93*c*) rami 1-segmented; basipod with a well-developed seta at outer distal corner; exopod bearing 4 terminal spines; endopod with 1 easily visible spine, 2 very short spines, and spinules as in the figure. Leg 3 (Figure 93*c*) reduced to a short knob bearing a short spine. Leg 4 represented by a lateral seta on anterior genital segment.

Egg string long.

MALE.—Body form as in Figure 93*d*. Total length 1.88 mm. Greatest width 0.55 mm. Thoracic segments bearing legs 2 and 3 incompletely separated. Genital segment about twice as long as wide (1.04 × 0.53 mm); abdomen (Figure 93*e*) nearly twice as wide as long (259 × 147 μm) with a ventral patch of spinules near each outer distal corner. Caudal rami (see Figure 93*e*) about twice as long as wide (123 × 64 μm), bearing 2 prominent lateral setae, 2 small lateral setae and a terminal spine, ventral surface covered with spinules. First antenna as in female. Second antenna (Figure 93*f*) similar to female except claw longer and more pointed. Mouth tube (Figure 94*a*) with 3 patches of spinules on labrum. First maxilla (Figure 94*a*) with 2 stout setae at tip, setae relatively longer than in female. Second maxilla as in *S. armatus* except no spinules on basal segment. Maxilliped (Figure 94*b*) with 2-segmented claw and spinules on proximal inner corner of base.

Leg 1 (Figure 94*c*) biramous, each ramus 1-segmented and not distinctly articulated with basipod; basipod with a patch of spinules and a triangular process and a seta at outer distal corner; exopod with patches of spinules and spinulose lobes in distal third, 2 short spines at tip; endopod modified as a curved, heavily sclerotized process, lobed at tip and most of its length enclosed in a membrane (compare with *P. armatus*). Leg 2 similar to *P. buccata* except exopod inner 3 spines smaller and distal half with widely spaced spinules; endopod with 2 distinct patches of spinules. Leg 3 (Figure 94*d*) reduced to a spinulose process with a short spine at tip.

REMARKS.—Yamaguti (1963:172) removed this species from *Pseudocycnus* in which it had been placed by Wilson. He designated the new genus *Pseudocynopsis* for this species and another new genus *Pseudocycnoides* to include *P. armatus* and also *P. scomberomori* (Yamaguti), both originally described as species of *Pseudocycnus*. We agree with Yamaguti that these 3 species should be removed from *Pseudocycnus* but we do not feel that placing *P. buccata* in a genus separate from *P. armatus* and *P. scomberomori* is justified. Consequently we have placed this species in the genus *Pseudocycnoides*. The original description of *P. buccata* was superficial and inaccurate and was undoubtedly the basis for Yamaguti's conclusions. Our studies of these 3 species indicate them to be much more closely related than previously known. These conclusions are based on the comparative morphology, not only of the female, but first descriptions of males of *P. buccata* and *P. armatus* as well. It should be pointed out that the first pair of legs in all 3 of these species is very small, between the bases of the maxillipeds, and not easily seen.

This species is found on all American species of *Scomberomorus* (western Atlantic and eastern Pacific) and is relatively common on all its hosts.

Examination of the type-specimen of *Cybicola elongata Pearse* (USNM 88538) leaves no doubt that it is the same as Wilson's species. The host for Pearse's material was *Scomberomorus maculatus*.

The genus *Pseudocycnopsis* Yamaguti should be considered a synonym of *Pseudocycnoides* Yamaguti.

Lernanthropus Blainville, 1822

Lernanthropus kanagurta Tripathi, 1962

FIGURE 94*e–g*

Lernanthropus kanagurta Tripathi, 1962:194.

MATERIAL EXAMINED.—1 collection containing 1 ♀ from the gills of *Rastrelliger brachysoma* from Borneo.

FEMALE.—Body form as in Figure 94*e*. Total length 3.23 mm. Greatest width 1.35 mm. Cephalon about one-fourth total body length (not including posterior processes) and only about one-half greatest width. The single specimen was somewhat mutilated so we were not able to examine all of the appendages. The form of the second antenna and leg 1 are as in Figures 94*f* and 94*g*.

REMARKS.—When Tripathi described this copepod he reported it from *Megalaspis cordyla* (Linnaeus) from India. Since it seems to be rare on species of *Rastrelliger* it may be that *Megalaspis* (Carangidae) or some other host is preferred.

Brachiella Cuvier, 1830

Brachiella thynni Cuvier, 1830

FIGURES 95*a*, 108

Brachiella thynni Cuvier, 1830:257.
Thynnicola ziegleri Miculicich, 1904:47.

MATERIAL EXAMINED.—58 collections containing 114 ♀ from the axil of the pectoral fin of the following hosts and localities: *Acanthocybium solandri* from Malagasy Republic, Ile Amsterdam, Seychelles, Palau Island, Yap Island, Kapingamarangi Atoll; Raroia Island, Line Islands, California, Nicaragua (Atlantic), Campeche, Brazil (north coast), Surinam, Azores; *Thunnus albacares* from Christmas Island (Pacific), Juan Fernandez Islands, off New Jersey, Azores; *Thunnus obesus* from Seychelles, Christmas Island (Pacific), Hawaii, mid-North Atlantic (39°N, 44°W), Azores; *Thunnus thynnus* from east coast of United States, Portugal; *Scomberomorus regalis* from Leeward Islands.

This species has been reported many times from scombrids and other hosts. It is usually attached to its host in the axil of the pectoral fin. This copepod is easily recognized and has been well described (both sexes) by Shiino (1956:238) and we will not repeat a description here.

Brachiella magna Kabata, 1968

FIGURES 95*b*, 108

Brachiella magna Kabata, 1968b;508, fig. 2a–j

MATERIAL EXAMINED.—3 collections containing 3 ♀ from the gills and nasal lamellae of *Scomberomorus commerson* from Australia (New South Wales) and *S. sinensis* (gills) from Hong Kong.

The original description was based on a collection from the gills of *S. commerson* from off Queensland, Australia. Considering the number of specimens of the 2 hosts examined (121) it is apparently uncommon on and known only from west Pacific *Scomberomorus*.

Kabata has provided a good description with illustrations.

Clavellisa Wilson, 1915

Clavellisa scombri (Kurz, 1877)

FIGURES 95*c*, 108

Anchorella scombri Kurz, 1877:403.
Clavella scombri.—Brian, 1906:116.
Clavellisa scombri.—Wilson, 1915:694.

MATERIAL EXAMINED.—10 collections containing 17 ♀ from the following hosts and localities: *Scomber japonicus* from Philippines, Peru, Gulf of Mexico (Campeche and Alabama), Sierra Leone, Liberia; *Scomber australasicus* from Taiwan, Australia.

This species was originally described from material collected from the gills of *Scomber scombrus* from Trieste. Our material was collected from the other 2 species of *Scomber*. Since we examined 97 specimens of the type host without recovering this species we wonder if perhaps the earlier hosts were misidentified. Whatever the case, it seems apparent that this species is restricted to species of *Scomber* and is found wherever its hosts are. Later records by Yamaguti (1939) and Shiino (1959c) cite *Scomber japonicus* as the host species. Yamaguti (1939) redescribed this species and provided good illustrations. He inadvertently omitted this species in his 1963 synoptic survey of fish copepods.

Clavellopsis Wilson, 1915

Clavellopsis saba Yamaguti, 1939

FIGURES 95*d*, 108

Clavellopsis saba Yamaguti, 1939:558.

This species was described from Japan from *Scomber japonicus* and reported again by Shiino (1959c:367) from the same host from the Sea of

Japan (Tsunodayama). During our studies we examined 11 specimens of *S. japonicus* from Japan but did not recover this copepod.

Shiino (1959c) has provided a good description with illustrations.

Pennella Oken, 1816

Pennella species

Members of this genus have been reported many times from large marine pelagic animals. It is easily recognized attached to the body of the host; the head buried in the muscle tissue and the long wormlike body trailing free. Specimens have been recorded several inches long.

This genus is in need of revision and species names should be used with caution. At least 6 species have been reported from whales, 7 from flyingfishes, and 4 from swordfish. A revision would undoubtedly reduce these numbers of *Pennella* species.

We have collected *Pennella* from *Acanthocybium solandri* and *Thunnus thynnus*. Because of the confusion surrounding the taxonomy of this genus we have not assigned species names to our specimens.

Summary

Our data, relative to infestation rates, are subject to considerable bias because of variables in collecting methods throughout the course of the study. Much of the material was collecetd from preserved fish in museum collections. In these cases copepods usually found on the body surfaces of the hosts are lost. Consequently, rate of infestation data for each species, based on data from the entire collection, is biased. Nevertheless, we have included infestation rates in spite of this, as we feel that they do reflect, in a general way, host preferences and relative common-to-rare occurrences of the parasite species on their hosts. Selected collections will be considered in more detail in the joint work with Collette.

The following is a list of scombrid fishes with the parasitic copepods collected from them during the course of this study. The number in parentheses after the host name indicates the number of individuals examined. The number in parentheses after the copepod name indicates the number of fish infested. The copepods are listed with each host in descending order of frequency.

SCOMBRINI

Rastrelliger kanagurta (108)
- *Pumiliopes capitulatus* (11)
- *Nothobomolochus kanagurta* (4)

Rastrelliger brachysoma (33)
- *Lernanthropus kanagurta* (1)

Rastrelliger faughni (14)
- *Pumiliopes capitulatus* (2)
- *Nothobomolochus kanagurta* (2)
- *Orbitacolax aculeatus* (2)

Scomber scombrus (97)
- *Caligus pelamydis* (1)

Scomber japonicus (500)
- *Pumiliopes capitulatus* (8)
- *Clavellisa scombri* (9)
- *Caligus pelamydis* (4)
- *Caligus mutabilis* (1)
- *Clavelopsis saba*

Scomber australasicus (17)
- *Clavellisa scombri* (1)
- *Pumiliopes capitulatus* (1)

SCOMBEROMORINI

Acanthocybium solandri (61)
- *Brachiella thynni* (37)
- *Gloiopotes hygomianus* (26)
- *Caligus productus* (9)
- *Caligus coryphaenae* (1)
- *Shiinoa occlusa* (1)
- *Pennella* species (1)

Grammatorcynus bicarinatus (37)
- *Shiinoa occlusa* (5)
- *Caligus asymmetricus* (4)

Scomberomorus brasiliensis (62)
- *Pseudocycnoides buccata* (39)
- *Holobomolochus divaricatus* (14)
- *Caligus mutabilis* (4)
- *Shiinoa inauris* (3)

Scomberomorus cavalla (36)
- *Pseudocycnoides buccata* (18)
- *Holobomolochus asperatus* (10)
- *Caligus mutabilis* (2)
- *Caligus productus* (1)

Scomberomorus commerson (113)
- *Pseudocycnoides armatus* (20)
- *Unicolax ciliatus* (20)
- *Shiinoa occlusa* (11)

Caligus biseriodentatus (11)
Caligus cybii (10)
Caligus infestans (5)
Caligus asymmetricus (2)
Brachiella magna (2)
Tuxophorus cervicornis (2)

Scomberomorus concolor (47)
Pseudocycnoides buccata (14)
Holobomolochus nudiusculus (13)
Caligus omissus (7)

Scomberomorus guttatus (55)
Caligus biseriodentatus (16)
Unicolax ciliatus (13)
Pseudocycnoides armatus (2)
Shiinoa occlusa (1)

Scomberomorus koreanus (17)
Caligus cybii (11)
Pseudocycnoides armatus (3)

Scomberomorus lineolatus (10)
Pseudocycnoides armatus (1)
Unicolax ciliatus (1)
Caligus biseriodentatus (1)

Scomberomorus maculatus (76)
Pseudocycnoides buccata (27)
Holobomolochus divaricatus (24)
Shiinoa inauris (7)
Caligus mutabilis (1)

Scomberomorus multiradiatus (4)
Pseudocycnoides armatus (2)

Scomberomorus niphonius (18)
Pseudocycnoides scomberomori (6)
Unicolax ciliatus (2)
Caligus pelamydis (2)
Shiinoa occlusa (1)

Scomberomorous plurilineatus (3)
Pseudocycnoides armatus (3)

Scomberomorus regalis (38)
Pseudocycnoides buccata (12)
Holobomolochus divaricatus (11)
Shiinoa inauris (5)
Caligus productus (3)
Caligus bonito (1)
Brachiella thynni (1)
Tuxophorus collettei (1)

Scomberomorus semifasciatus (17)
Pseudocycnoides armatus (2)
Unicolax ciliatus (2)
Caligus cybii (1)

Scomberomorus sierra (116)
Pseudocycnoides buccata (48)
Caligus omissus (39)
Holobomolochus nudiusculus (28)

Scomberomorus sinensis (8)
Caligus cybii (2)
Brachiella magna (1)

Scomberomorus tritor (21)
Unicolax ciliatus (4)
Shiinoa occlusa (1)
Caligus productus (1)
Caligus diaphanus (1)

Scomberomorus queenslandicus (19)
Caligus biseriodentatus (11)
Pseudocycnoides armatus (2)
Unicolax ciliatus (1)
Shiinoa occlusa (1)

Scomberomorus species (3)
Unicolax ciliatus (1)
Caligus productus (1)
Caligus cybii (1)

SARDINI

Sarda sarda (104)
Caligus bonito (23)
Ceratacolax euthynni (21)
Caligus pelamydis (7)
Caligus productus (1)

Sarda australis (20)
Caligus bonito (13)
Caligus pelamydis (11)
Caligus asymmetricus (2)
Unicolax collateralis (2)

Sarda chiliensis (44)
Caligus bonito (24)
Caligus pelamydis (2)
Caligus productus (1)

Sarda orientalis (27)
Caligus bonito (6)
Caligus asymmetricus (4)
Unicolax collateralis (4)
Caligus productus (1)

Gymnosarda unicolor (7)
Caligus bonito (1)
Caligus productus (1)
Shiinoa occlusa (1)

Cybiosarda elegans (8)
Caligus asymmetricus (2)
Unicolax collateralis (1)

Orcynopsis unicolor (6)
Unicolax collateralis (1)

Allothunnus fallai (3)
Elytrophora brachyptera (3)

THUNNINI

Auxis species (65)
- *Unicolax collateralis* (19)
- *Unicolax mycterobius* (9)
- *Caligus productus* (2)
- *Caligus asymmetricus* (1)
- *Caligus coryphaenae* (1)
- *Caligus pelamydis* (1)

Euthynnus affinis (71)
- *Unicolax collateralis* (29)
- *Caligus asymmetricus* (5)
- *Caligus regalis* (5)
- *Pseudocycnus appendiculatus* (4)
- *Unicolax mycterobius* (3)
- *Caligus pelamydis* (2)
- *Caligus productus* (1)
- *Caligus bonito* (1)

Euthynnus alletteratus (64)
- *Caligus coryphaenae* (9)
- *Unicolax collateralis* (8)
- *Ceratacolax euthynni* (7)
- *Caligus productus* (5)
- *Caligus bonito* (4)
- *Pseudocycnus appendiculatus* (3)
- *Unicolax mycterobius* (3)
- *Unicolax anonymous* (2)
- *Caligus pelamydis* (1)

Euthynnus lineatus (15)
- *Unicolax collateralis* (4)
- *Caligus bonito* (3)
- *Ceratacolax euthynni* (2)
- *Unicolax mycterobius* (1)

Katsuwonus pelamis (132)
- *Caligus coryphaenae* (51)
- *Caligus productus* (51)
- *Pseudocycnus appendiculatus* (7)
- *Unicolax reductus* (3)
- *Caligus asymmetricus* (1)

Thunnus alalunga (12)
- *Elytrophora brachyptera* (7)
- *Caligus coryphaenae* (1)
- *Caligus productus* (1)
- *Pseudocycnus appendiculatus* (1)

Thunnus albacares (110)
- *Caligus productus* (49)
- *Elytrophora brachyptera* (39)
- *Caligus coryphaenae* (32)
- *Pseudocycnus appendiculatus* (21)
- *Brachiella thynni* (8)
- *Caligus asymmetricus* (1)

Thunnus atlanticus (76)
- *Caligus productus* (70)
- *Caligus coryphaenae* (9)
- *Elytrophora brachyptera* (1)

Thunnus maccoyii (2)
- *Elytrophora brachyptera* (2)

Thunnus obesus (40)
- *Elytrophora brachyptera* (20)
- *Caligus coryphaenae* (18)
- *Brachiella thynni* (10)
- *Elytrophora indica* (9)
- *Pseudocycnus appendiculatus* (3)

Thunnus thynnus (57)
- *Caligus coryphaenae* (16)
- *Caligus productus* (16)
- *Elytrophora brachyptera* (11)
- *Pennella* species (3)
- *Brachiella thynni* (2)
- *Caligus bonito* (1)
- *Pseudocycnus appendiculatus* (1)

Thunnus tonggol (26)
- *Pseudocycnus appendiculatus* (7)

Below is a list of the copepods and the fishes on which they were found. The number in parentheses after the host name indicates the infestation rate (number of infested fish/number of fish examined). We remind the reader of the bias in the infestation rates discussed above. No number after a fish name indicates the record is from the literature.

BOMOLOCHIDAE

Holobomolochus divaricatus
- *Scomberomorus maculatus* (32)
- *Scomberomorus regalis* (29)
- *Scomberomorus brasiliensis* (23)

Holobomolochus nudiusculus
- *Scomberomorus concolor* (28)
- *Scomberomorus sierra* (24)

Holobomolochus asperatus
- *Scomberomorus cavalla* (28)

Unicolax collateralis
- *Euthynnus affinis* (41)
- *Auxis* species (29)
- *Euthynnus lineatus* (27)
- *Sarda orientalis* (21)
- *Orcynopsis unicolor* (17)
- *Cybiosarda elegans* (13)
- *Euthynnus alletteratus* (13)

Unicolax anonymous
- *Euthynnus alletteratus* (3)

Unicolax mycterobius
- *Auxis* species (14)
- *Euthynnus alletteratus* (5)
- *Euthynnus affinis* (4)

Unicolax ciliatus
- *Scomberomorus guttatus* (24)
- *Scomberomorus tritor* (19)
- *Scomberomorus commerson* (18)
- *Scomberomorus semifasciatus* (12)
- *Scomberomorus niphonius* (11)
- *Scomberomorus lineolatus* (10)

Unicolax reductus
- *Katsuwonus pelamis* (2)

Ceratacolax euthynni
- *Sarda sarda* (20)
- *Euthynnus alletteratus* (14)

Nothobomolochus kanagurta
- *Rastrelliger faughni* (14)
- *Rastrelliger kanagurta* (4)
- *Rastrelliger* species

Orbitacolax aculeatus
- *Rastrelliger faughni*

Pumiliopes capitulatus
- *Rastrelliger faughni* (14)
- *Rastrelliger kanagurta* (10)
- *Scomber japonicus* (2)
- *Scomber scombrus* (1)

Shiinoidae

Shiinoa inauris
- *Scomberomorus regalis* (13)
- *Scomberomorus maculatus* (9)
- *Scomberomorus brasiliensis* (5)

Shiinoa occlusa
- *Grammatorcynus bicarinatus* (14)
- *Gymnosarda unicolor* (14)
- *Scomberomorus commerson* (10)
- *Scomberomorus niphonius* (6)
- *Scomberomorus queenslandicus* (5)
- *Scomberomorus guttatus* (1)
- *Scomberomorus tritor* (1)
- *Acanthocybium solandri* (1)

Caligidae

Caligus coryphaenae
- *Thunnus obesus* (45)
- *Katsuwonus pelamis* (38)
- *Thunnus albacares* (29)
- *Thunnus thynnus* (28)
- *Euthynnus alletteratus* (14)
- *Thunnus atlanticus* (12)
- *Thunnus alalunga* (8)
- *Auxis* species (1)

Caligus regalis
- *Euthynnus affinis* (70)

Caligus productus
- *Thunnus atlanticus* (92)
- *Thunnus albacares* (45)
- *Katsuwonus pelamis* (39)
- *Thunnus thynnus* (28)
- *Acanthocybium solandri* (15)
- *Sarda orientalis* (13)
- *Euthynnus alletteratus* (8)
- *Thunnus alalunga* (8)
- *Scomberomorus regalis* (8)
- *Scomberomorus tritor* (5)
- *Scomberomorus cavalla* (3)
- *Auxis* species (3)
- *Sarda chiliensis lineolatus* (2)
- *Euthynnus affinis* (1)
- *Sarda sarda* (1)
- *Scomberomorus* species

Caligus asymmetricus
- *Cybiosarda elegans* (25)
- *Sarda orientalis* (21)
- *Grammatorcynus bicarinatus* (11)
- *Sarda australis* (10)
- *Euthynnus affinis* (7)
- *Auxis* species (2)
- *Scomberomorus commerson* (2)
- *Katsuwonus pelamis* (1)
- *Thunnus albacares* (1)

Caligus bonito
- *Sarda australis* (65)
- *Sarda chiliensis chiliensis* (54)
- *Sarda chiliensis lineolatus* (35)
- *Sarda orientalis* (39)
- *Euthynnus lineatus* (20)
- *Gymnosarda unicolor* (14)
- *Euthynnus alletteratus* (6)
- *Scomberomorus regalis* (3)
- *Thunnus thynnus* (2)
- *Euthynnus affinis* (1)

Caligus mutabilis
- *Scomberomorus brasiliensis* (6)
- *Scomberomorus cavalla* (6)
- *Scomberomorus maculatus* (1)
- *Scomber japonicus* (1)

Caligus omissus
- *Scomberomorus sierra* (34)
- *Scomberomorus concolor* (15)

Caligus biseriodentatus
- *Scomberomorus queenslandicus* (58)
- *Scomberomorus guttatus* (29)
- *Scomberomorus commerson* (10)
- *Scomberomorus lineolatus* (10)
- *Auxis* species

Caligus cybii
- *Scomberomorus koreanus* (65)
- *Scomberomorus sinensis* (25)
- *Scomberomorus* species (20)

Scomberomorus commerson (9)
Scomberomorus semifasciatus (6)

Caligus pelamydis
Sarda australis (55)
Scomberomorus niphonius (11)
Sarda chiliensis lineolatus (10)
Sarda sarda (7)
Euthynnus affinis (3)
Euthynnus alletteratus (2)
Auxis species (2)
Scomber japonicus (1)
Scomber scombrus (1)

Caligus infestans
Scomberomorus commerson (4)

*Caligus diaphanus**
Scomberomorus tritor (5)

*Caligus savala**
Euthynnus affinis

*Caligus macarovi**
Auxis species

*Caligus amblygenitalis**
Euthynnus affinis

Caligus pseudokalumai
Gymnosarda unicolor

Euryphoridae

Elytrophora brachyptera
Allothunnus fallai (100)
Thunnus maccoyii (100)
Thunnus alalunga (58)
Thunnus obesus (50)
Thunnus albacares (35)
Thunnus thynnus (19)
Thunnus atlanticus (1)

Elytrophora indica
Thunnus obesus (23)

Gloiopotes hygomianus
Acanthocybium solandri (43)

Caligulus longispinosus
Euthynnus affinis

Tuxophoridae

Tuxophorus cybii
Scomberomorus commerson
Acanthocybium solandri

Tuxophorus cervicornis
Scomberomorus commerson (2)

Tuxophorus collettei
Scomberomorus regalis (3)

Pseudocycnidae

Pseudocycnus appendiculatus
Thunnus tonggol (27)
Thunnus albacares (19)
Thunnus obesus (8)
Euthynnus affinis (6)
Euthynnus alletteratus (5)
Katsuwonus pelamis (5)

Pseudocycnoides armatus
Scomberomorus plurilineatus (100)
Scomberomorus koreanus (18)
Scomberomorus commerson (18)
Scomberomorus semifasciatus (12)
Scomberomorus queenslandicus (11)
Scomberomorus lineolatus (10)
Scomberomorus guttatus (4)

Pseudocycnoides scomberomori
Scomberomorus niphonius (33)

Pseudocycnoides buccata
Scomberomorus brasiliensis (63)
Scomberomorus cavalla (50)
Scomberomorus sierra (41)
Scomberomorus maculatus (36)
Scomberomorus regalis (32)
Scomberomorus concolor (30)

Lernanthropidae

*Lernanthropus kanagurta**
Rastrelliger brachysoma (3)

Lerneopodidae

Brachiella thynni
Acanthocybium solandri (61)
Thunnus obesus (25)
Thunnus albacares (7)
Thunnus thynnus (4)
Scomberomorus regalis (3)

Brachiella magna
Scomberomorus sinensis (13)
Scomberomorus commerson (2)

Clavellisa scombri
Scomber australasicus (6)
Scomber japonicus (2)

Clavellopsis saba
Scomber japonicus

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* Probably not usually scombrid parasites.

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Figures

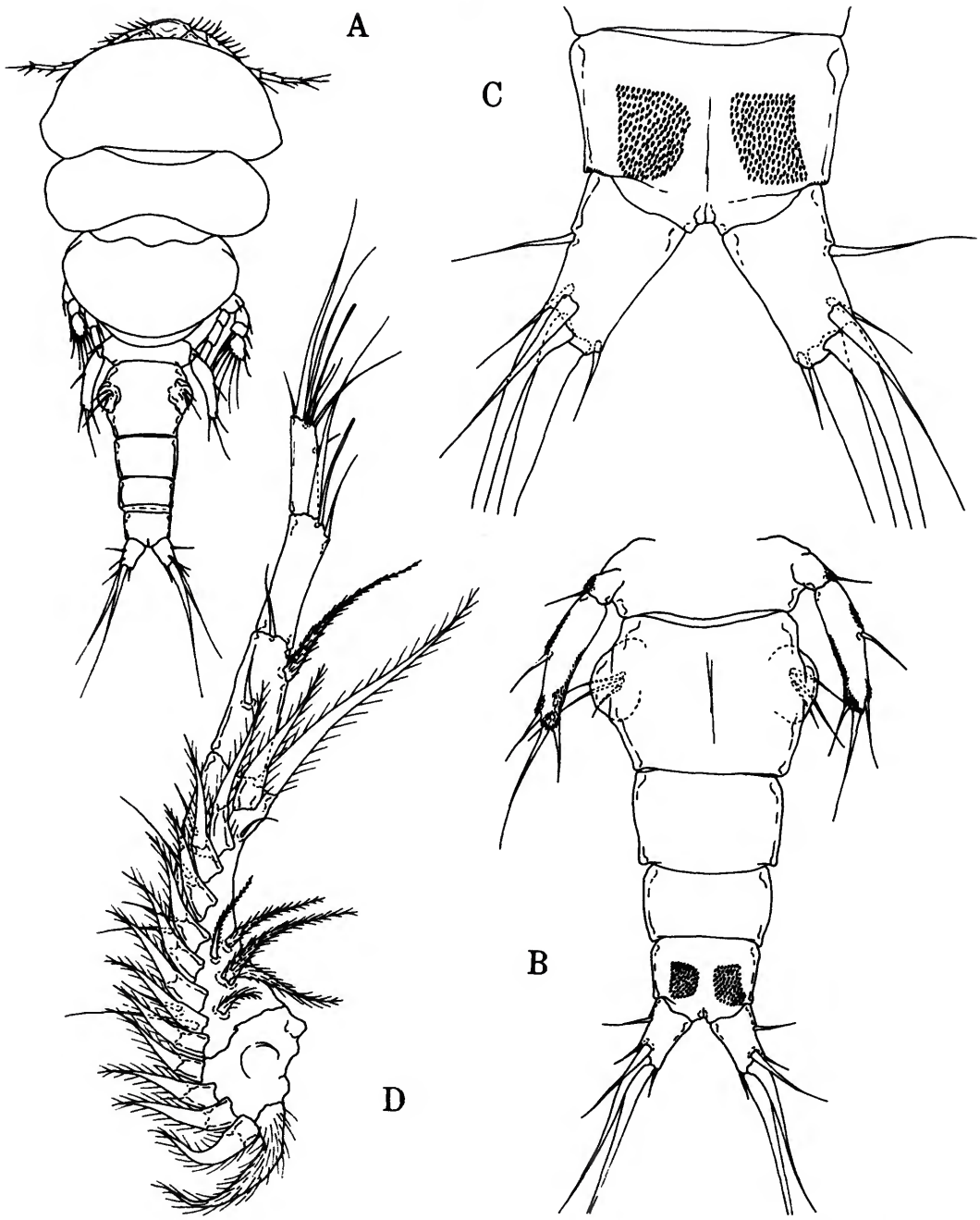

FIGURE 1.—*Holobomolochus divaricatus*, new species, female: *a*, dorsal; *b*, genital segment and abdomen, ventral; *c*, last abdominal segment and caudal rami, ventral; *d*, first antenna.

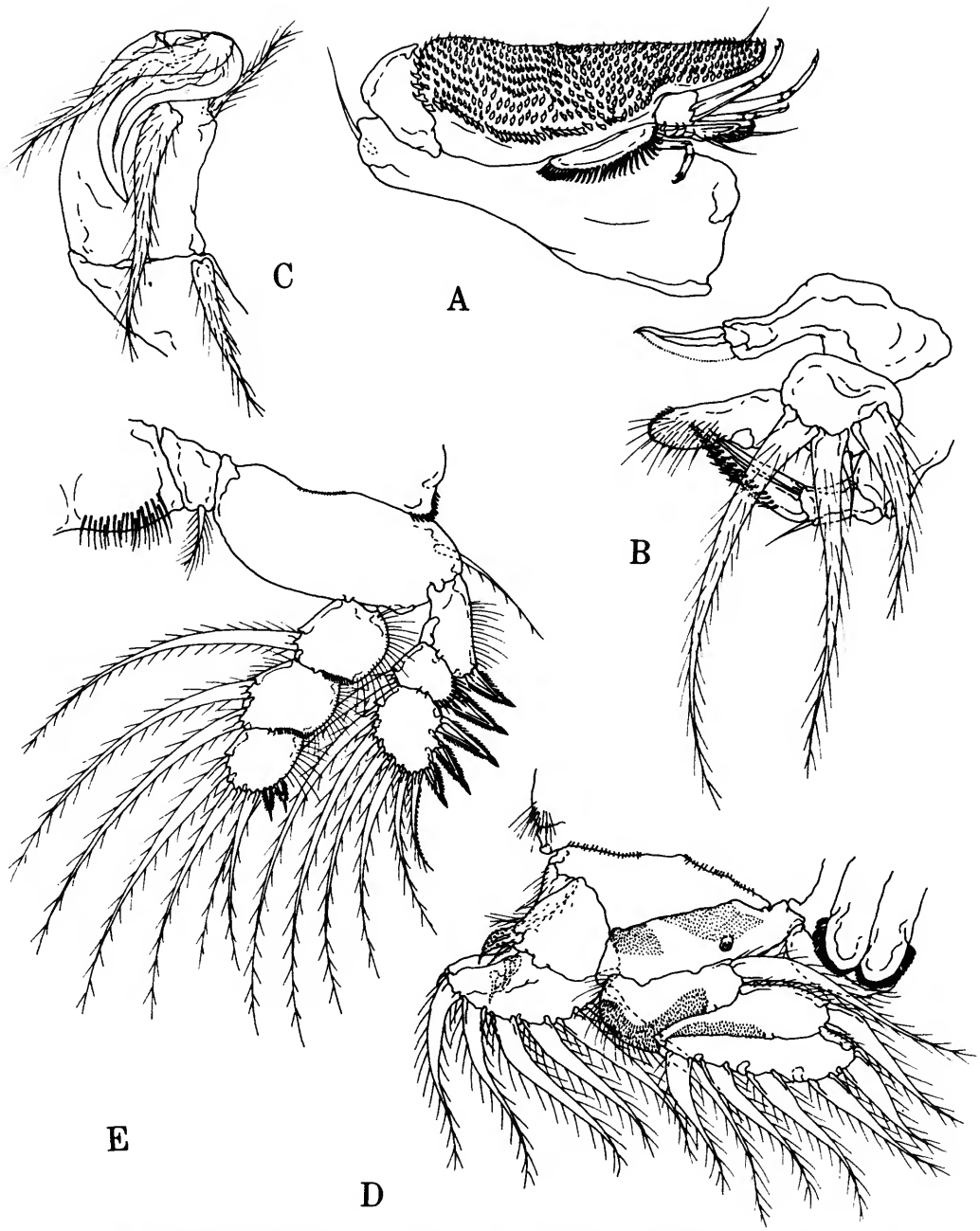

FIGURE 2.—*Holobomolochus divaricatus,* new species, female: *a,* second antenna; *b,* mandible, paragnath, first maxilla, second maxilla; *c,* maxilliped; *d,* leg 1; *e,* leg 2.

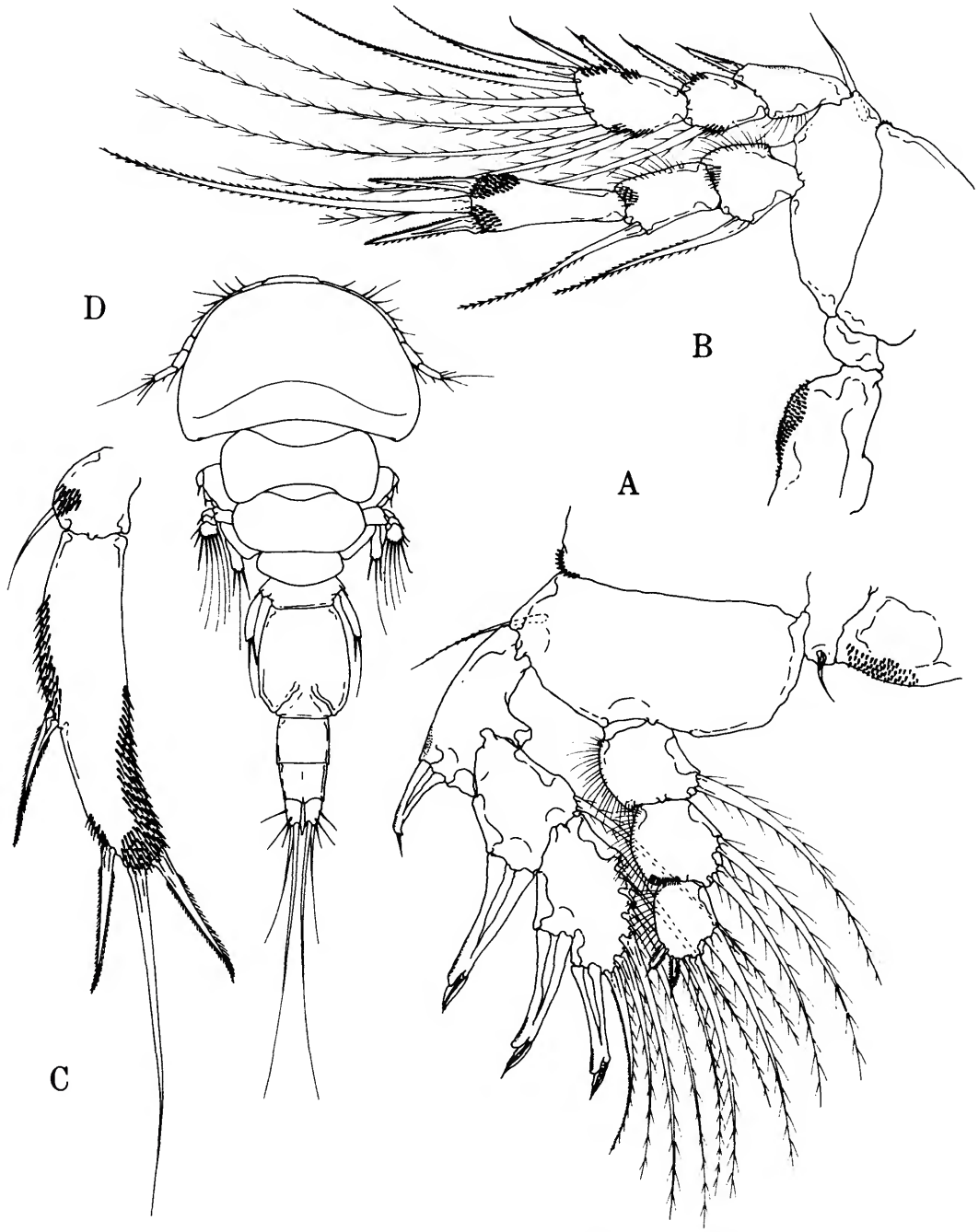

FIGURE 3.—*Holobomolochus divaricatus*, new species, female: *a*, leg 3; *b*, leg 4; *c*, leg 5; male: *d*, dorsal.

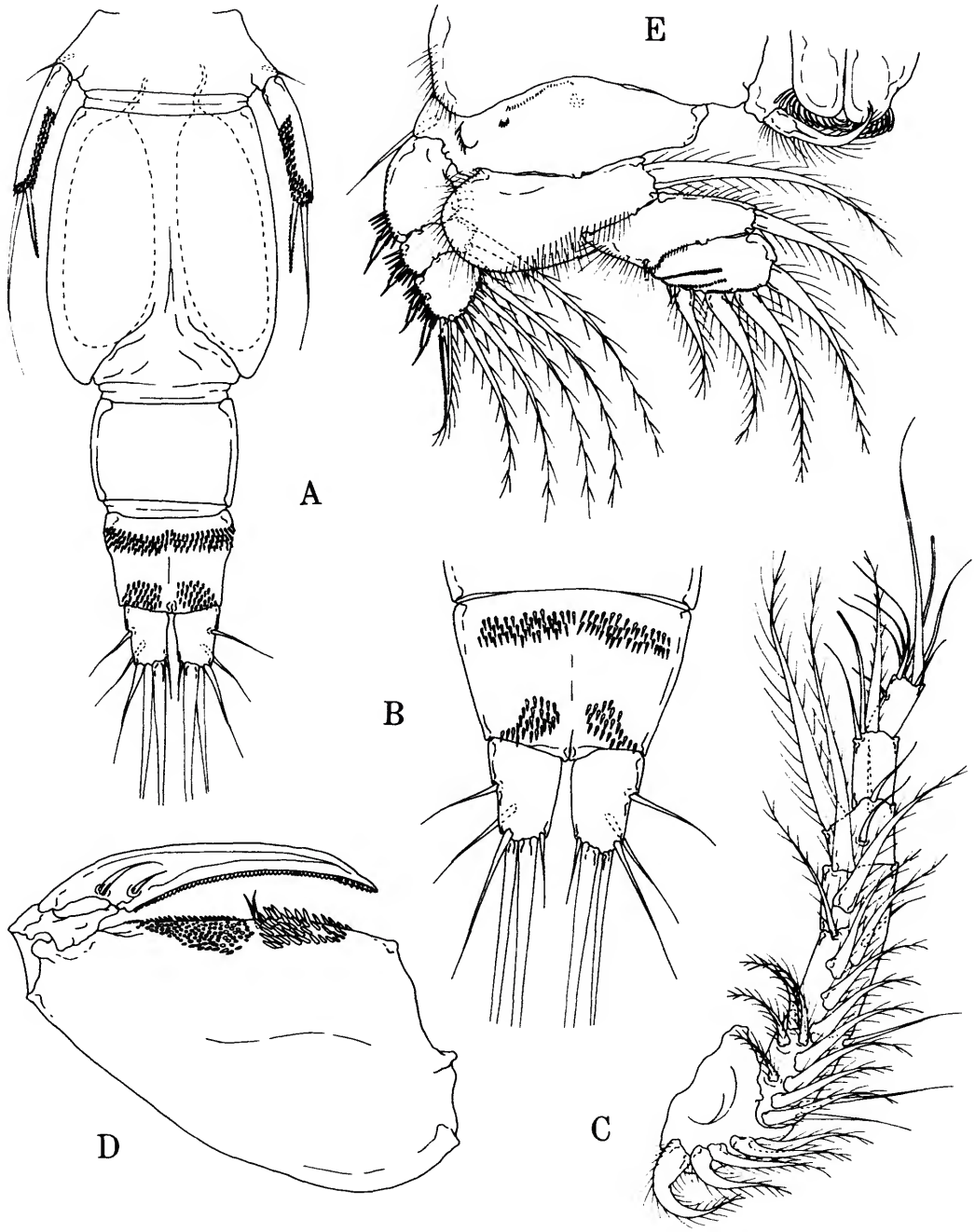

FIGURE 4.—*Holobomolochus divaricatus,* new species, male: *a,* genital segment and abdomen, ventral; *b,* last abdominal segment and caudal rami, ventral; *c,* first antenna; *d,* maxilliped; *e,* leg 1.

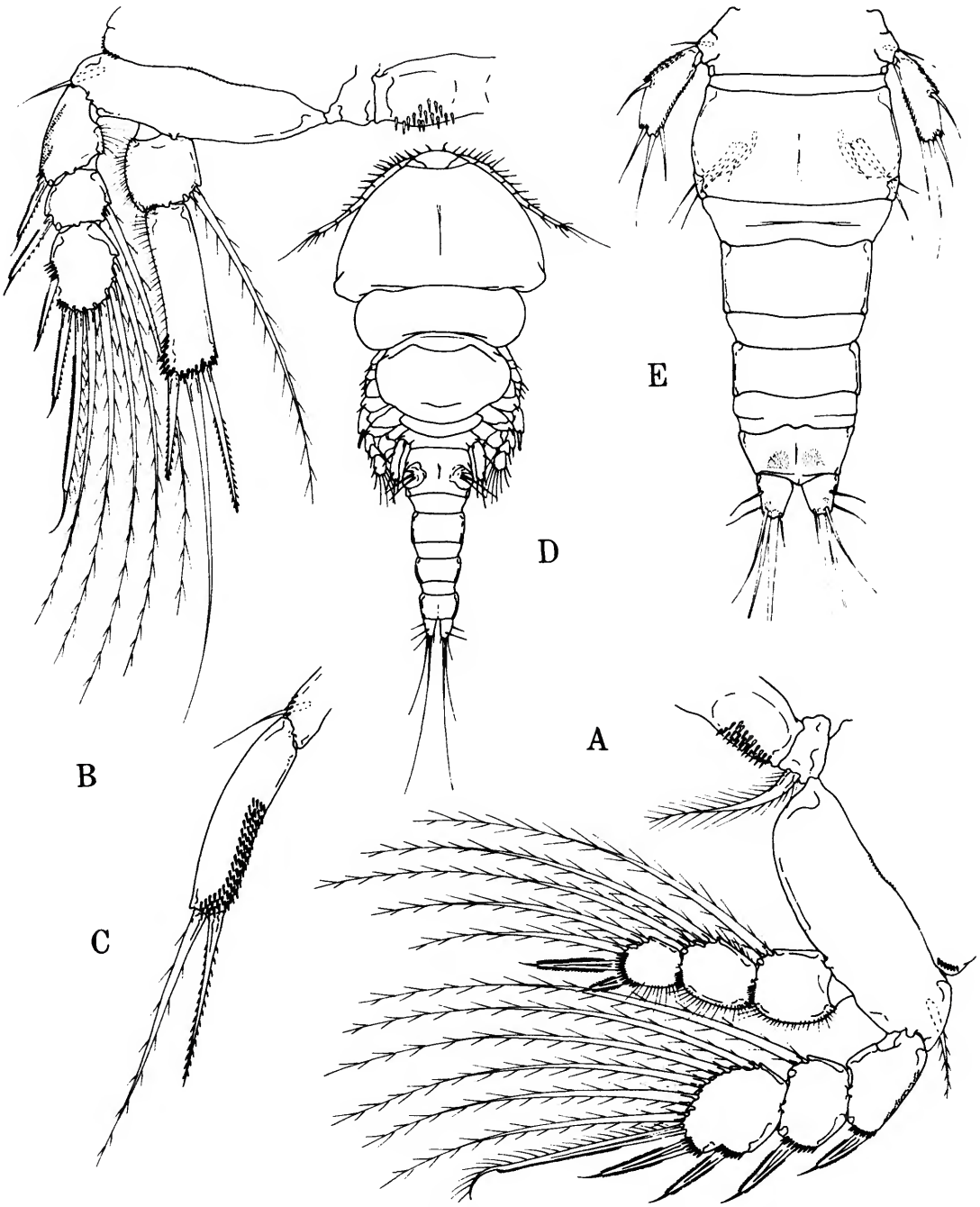

FIGURE 5.—*Holobomolochus divaricatus,* new species, male: *a,* leg 3; *b,* leg 4; *c,* leg 5. *Holobomolochus nudiusculus,* new species, female: *d,* dorsal; *e,* genital segment and abdomen, ventral.

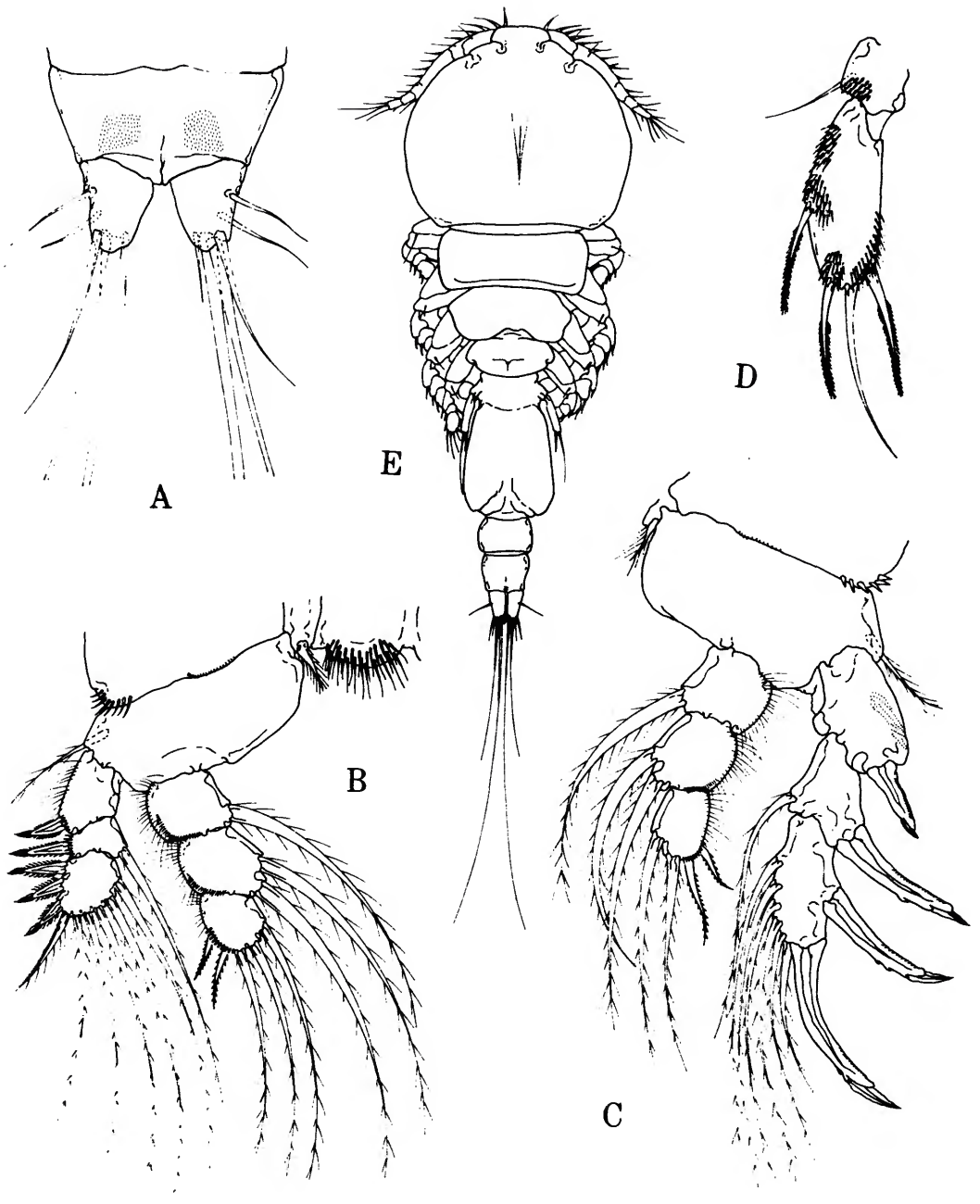

FIGURE 6.—*Holobomolochus nudiusculus,* new species, female: *a,* last abdominal segment and caudal rami, ventral; *b,* leg 2; *c,* leg 3; *d,* leg 5; male: *e,* dorsal.

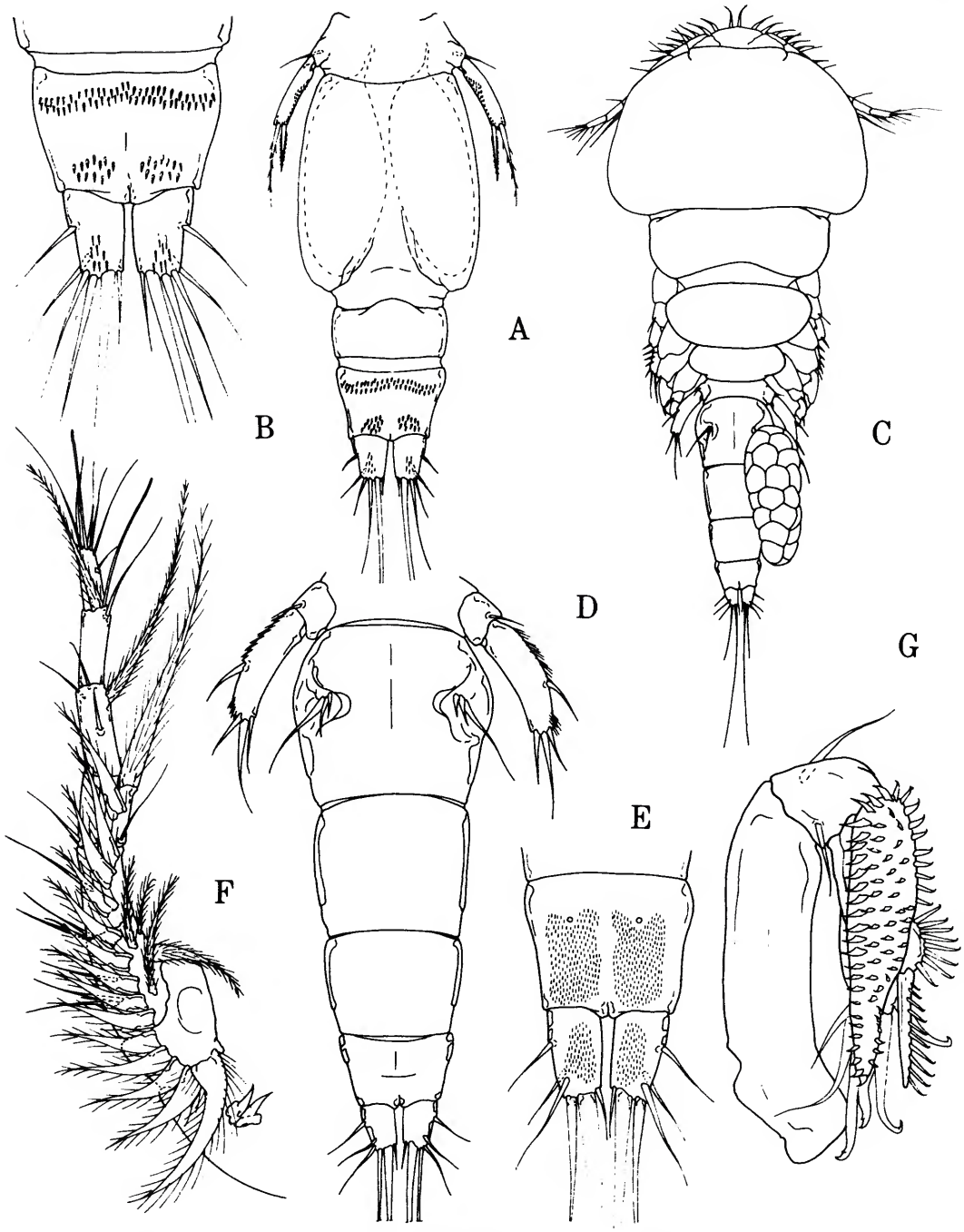

FIGURE 7.—*Holobomolochus nudiusculus,* new species, male: *a,* genital segment and abdomen, ventral; *b,* last abdominal segment and caudal rami, ventral. *Holobomolochus asperatus,* new species, female: *c,* dorsal; *d,* genital segment and abdomen, dorsal; *e,* last abdominal segment and caudal rami, ventral; *f,* first antenna; *g,* second antenna.

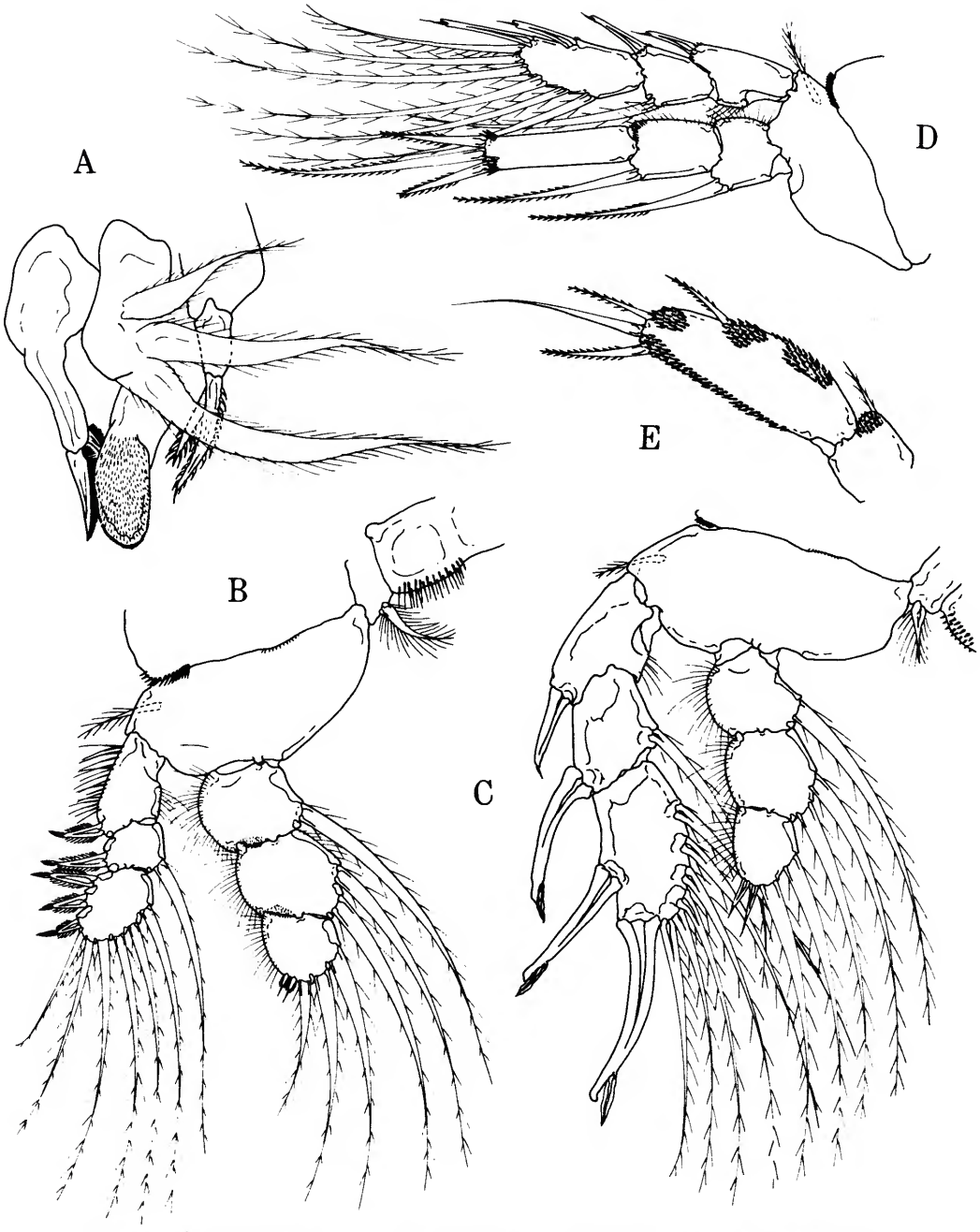

FIGURE 8.—*Holobomolochus asperatus*, new species, female; *a*, mandible, paragnath, first maxilla, second maxilla; *b*, leg 2; *c*, leg 3; *d*, leg 4; *e*, leg 5.

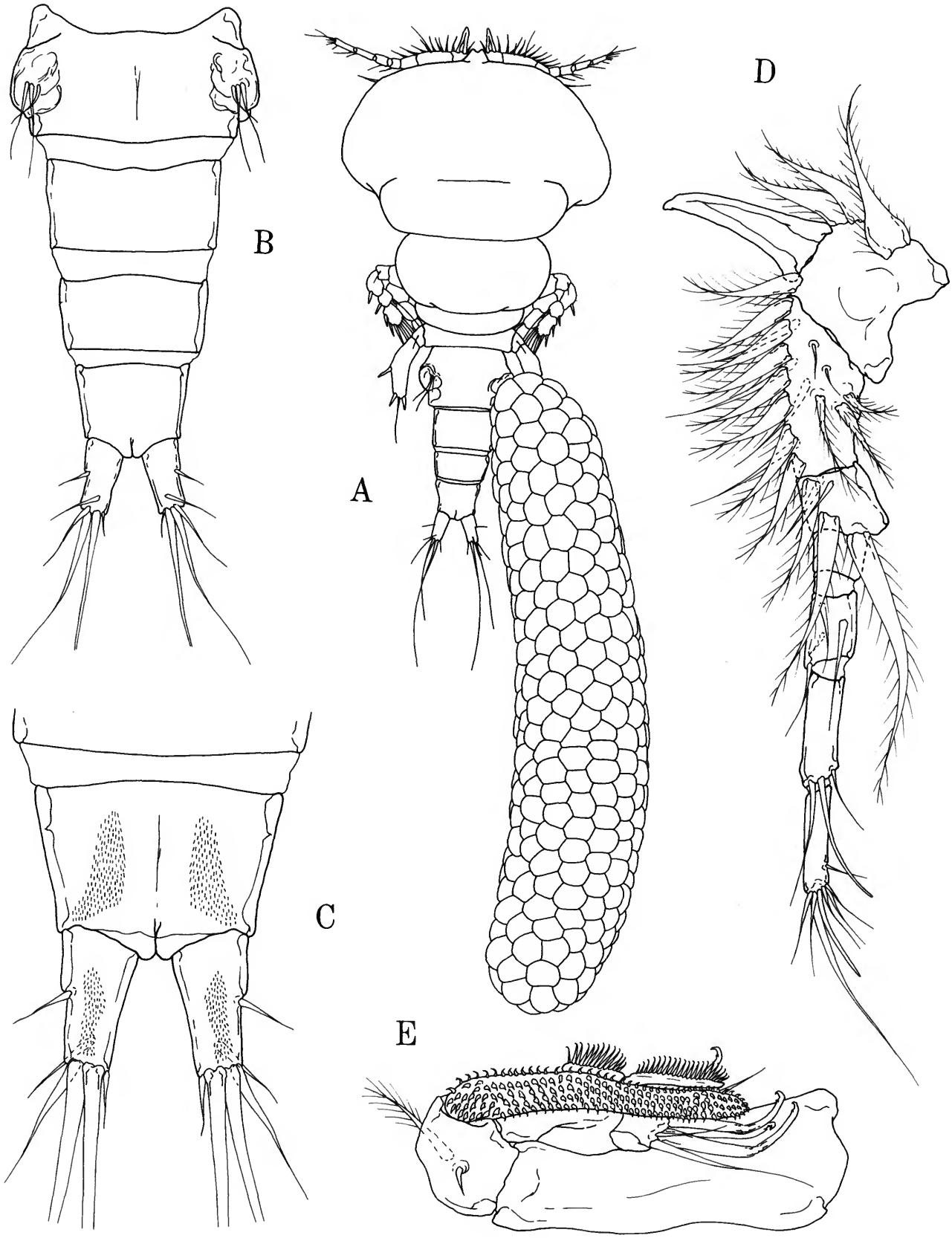

FIGURE 9.—*Unicolax collateralis,* new genus, new species, female: *a,* dorsal; *b,* genital segment and abdomen, dorsal; *c,* last abdominal segment and caudal rami, ventral; *d,* first antenna; *e,* second antenna.

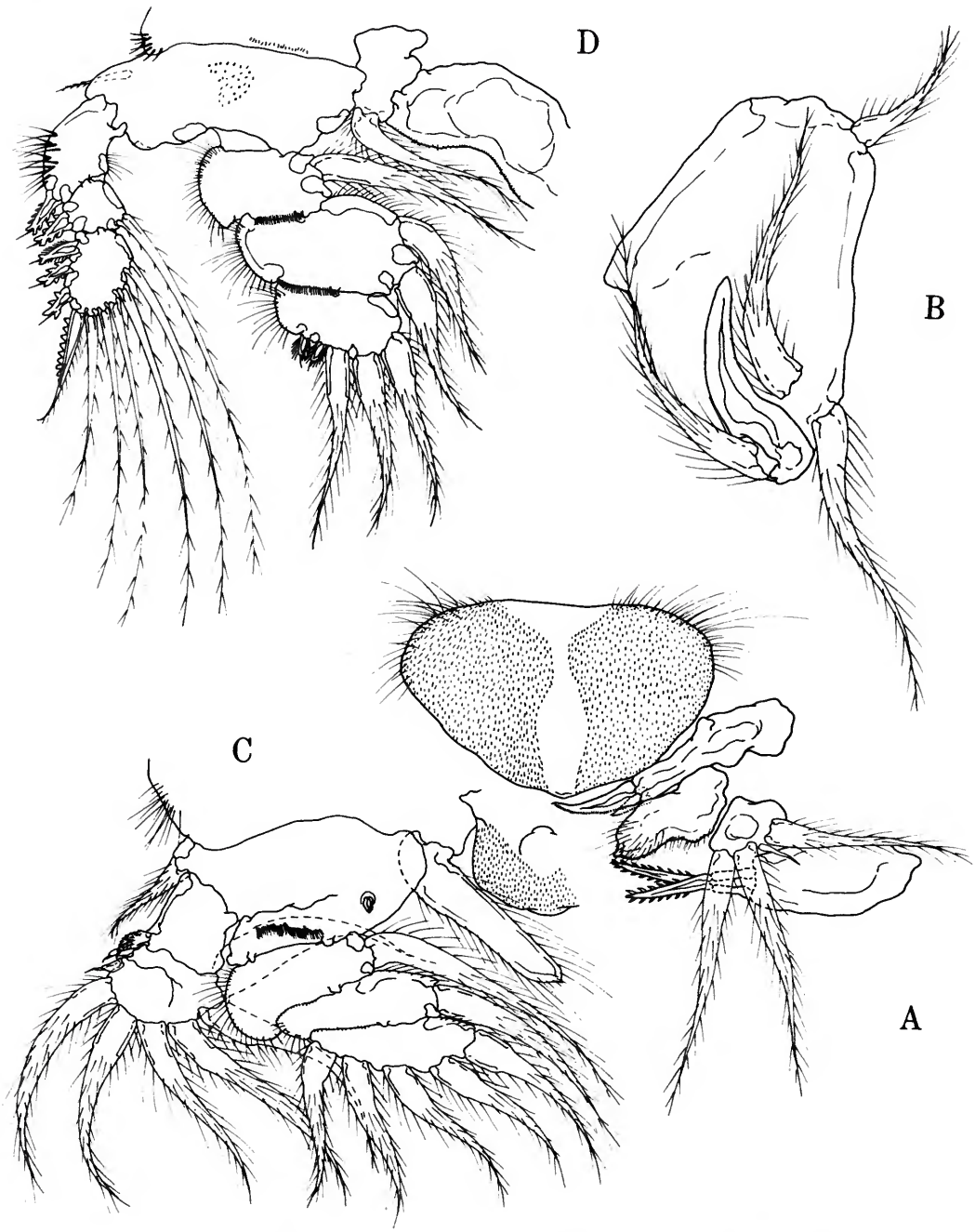

FIGURE 10.—*Unicolax collateralis*, new genus, new species, female: *a*, labrum, mandible, paragnath, first maxilla, second maxilla; *b*, maxilliped; *c*, leg 1; *d*, leg 2.

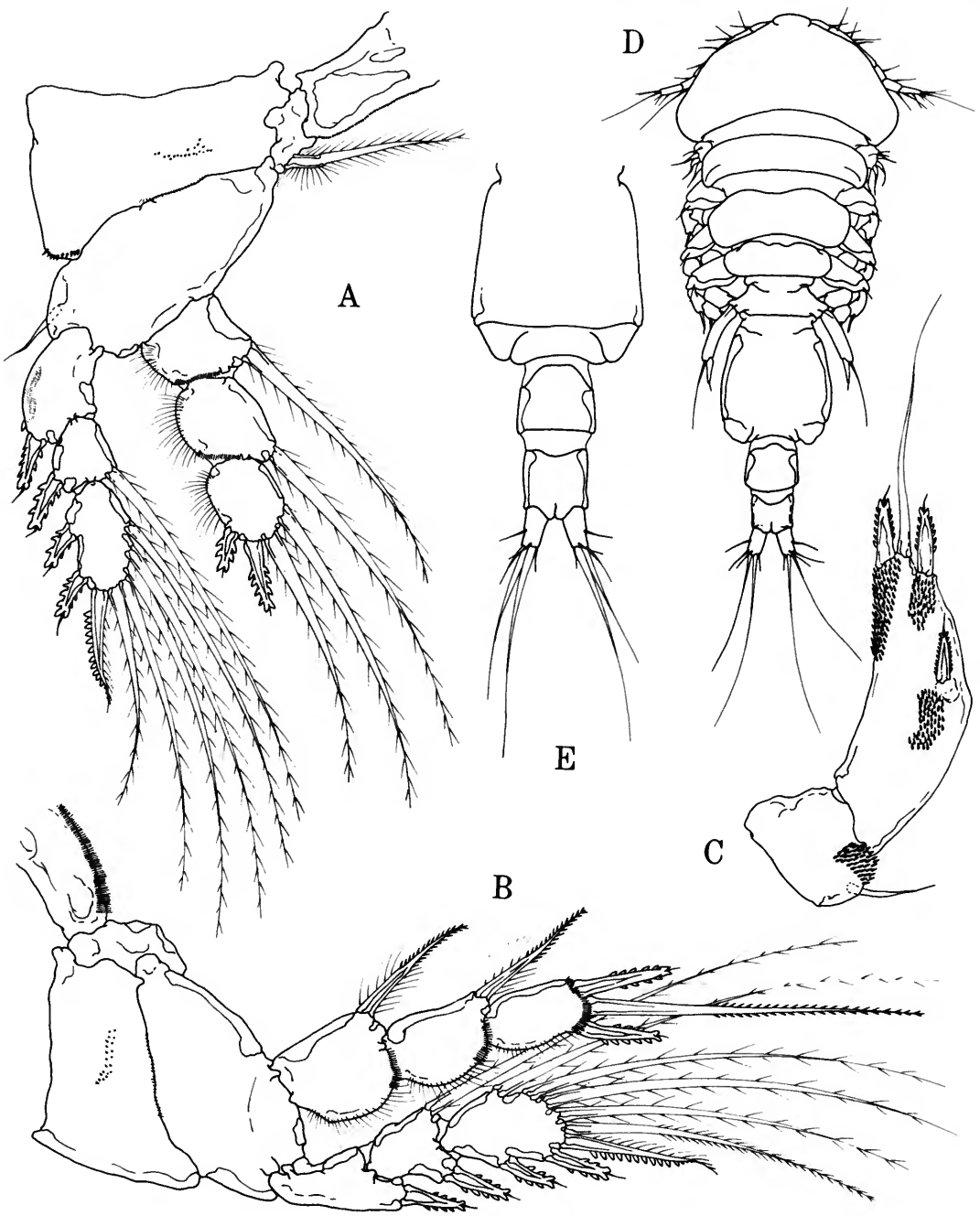

FIGURE 11.—*Unicolax collateralis*, new genus, new species, female: *a*, leg 3; *b*, leg 4; *c*, leg 5; male: *d*, dorsal; *e*, genital segment and abdomen, dorsal.

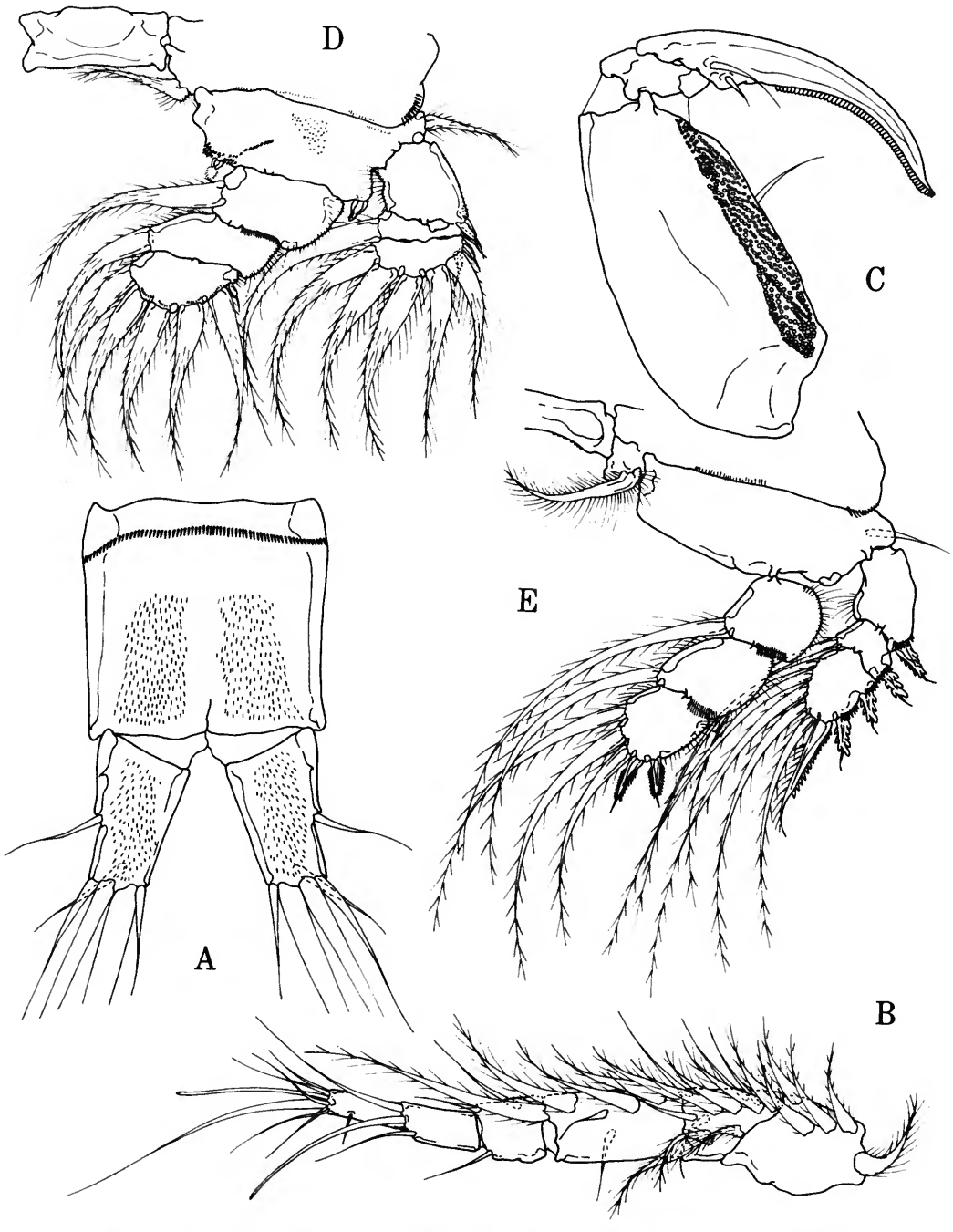

FIGURE 12.—*Unicolax collateralis*, new genus, new species, male: *a*, last abdominal segment and caudal rami, ventral; *b*, first antenna; *c*, maxilliped; *d*, leg 1; *e*, leg 2.

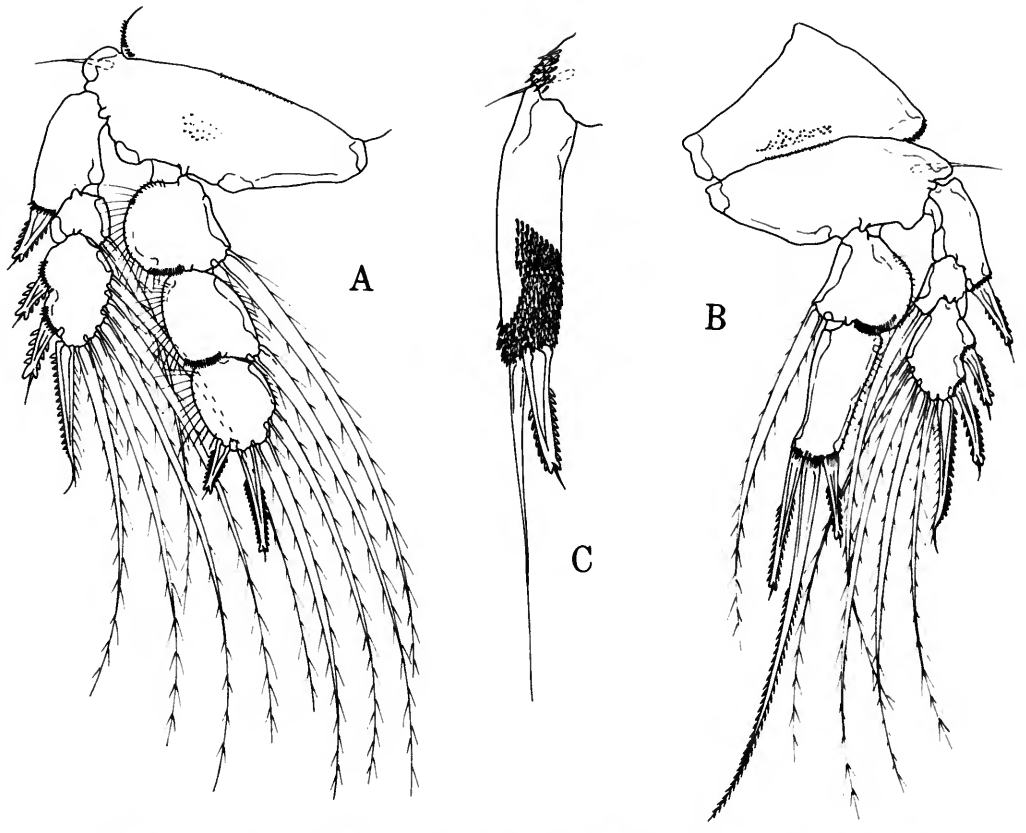

FIGURE 13.—*Unicolax collateralis*, new genus, new species, male: *a*, leg 3; *b*, leg 4; *c*, leg 5.

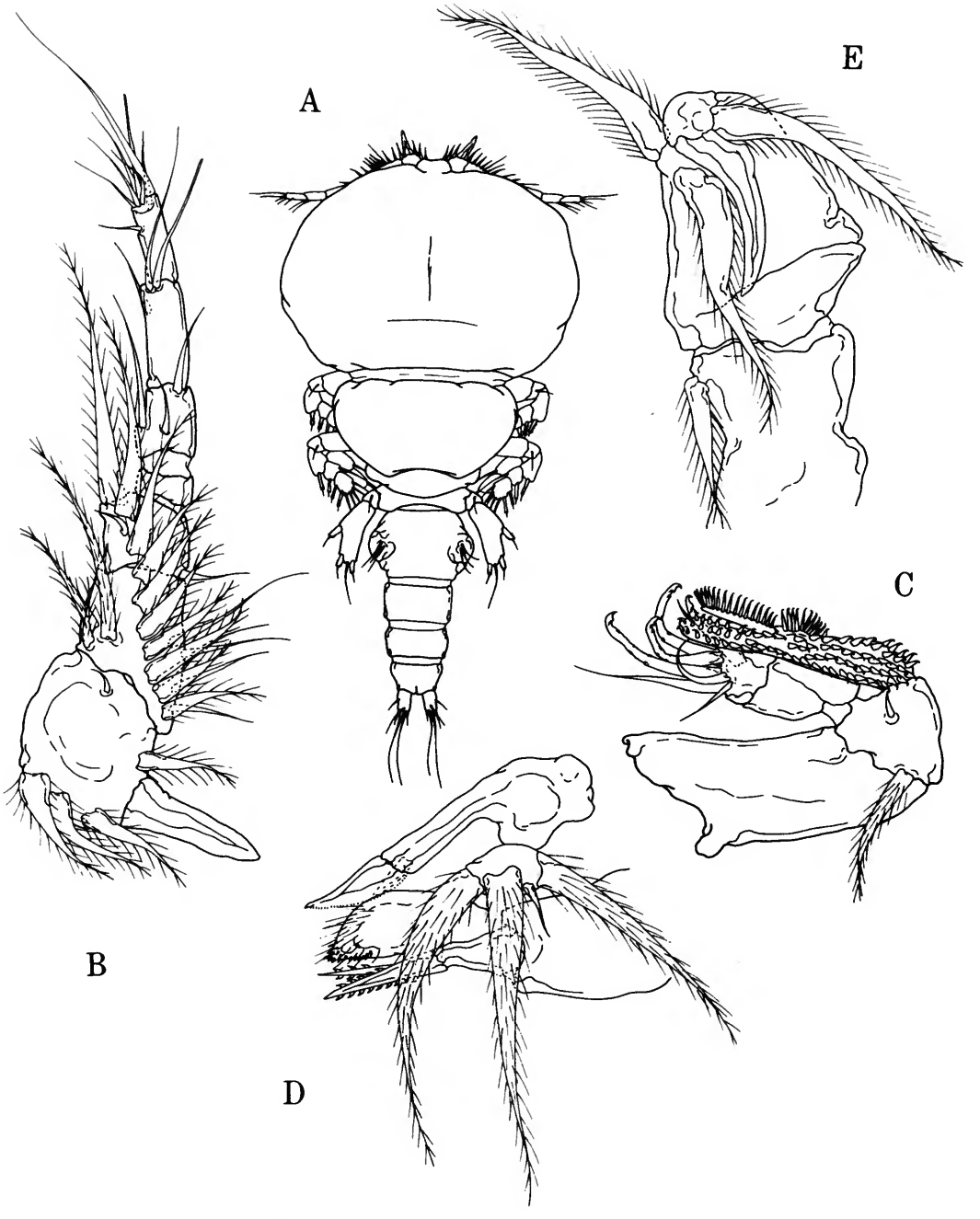

FIGURE 14.—*Unicolax anonymous* (Vervoort), new genus, female: *a*, dorsal; *b*, first antenna; *c*, second antenna; *d*, mandible, paragnath, first maxilla, second maxilla; *e*, maxilliped.

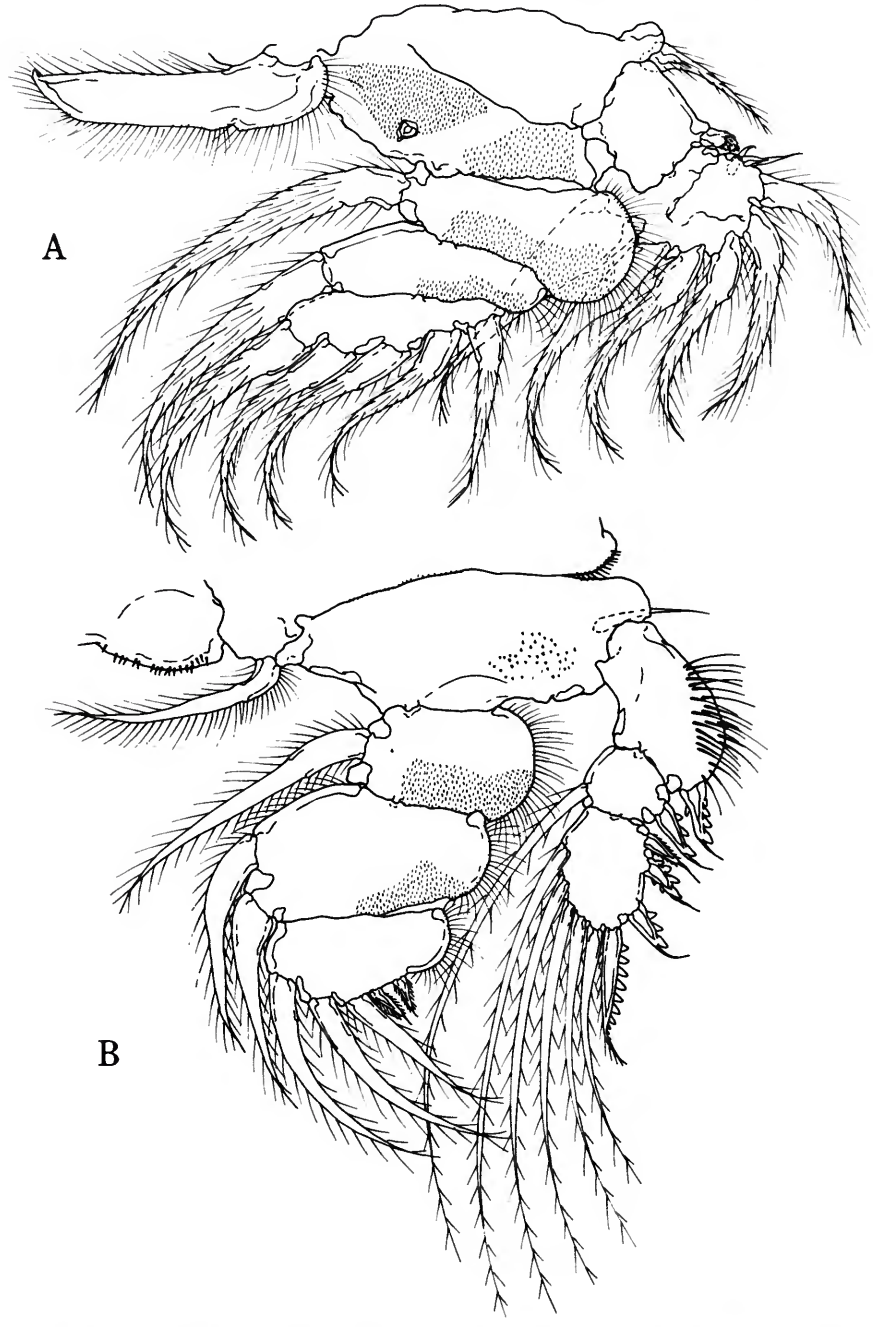

FIGURE 15.—*Unicolax anonymous* (Vervoort), new genus, female: *a*, leg 1; *b*, leg 2.

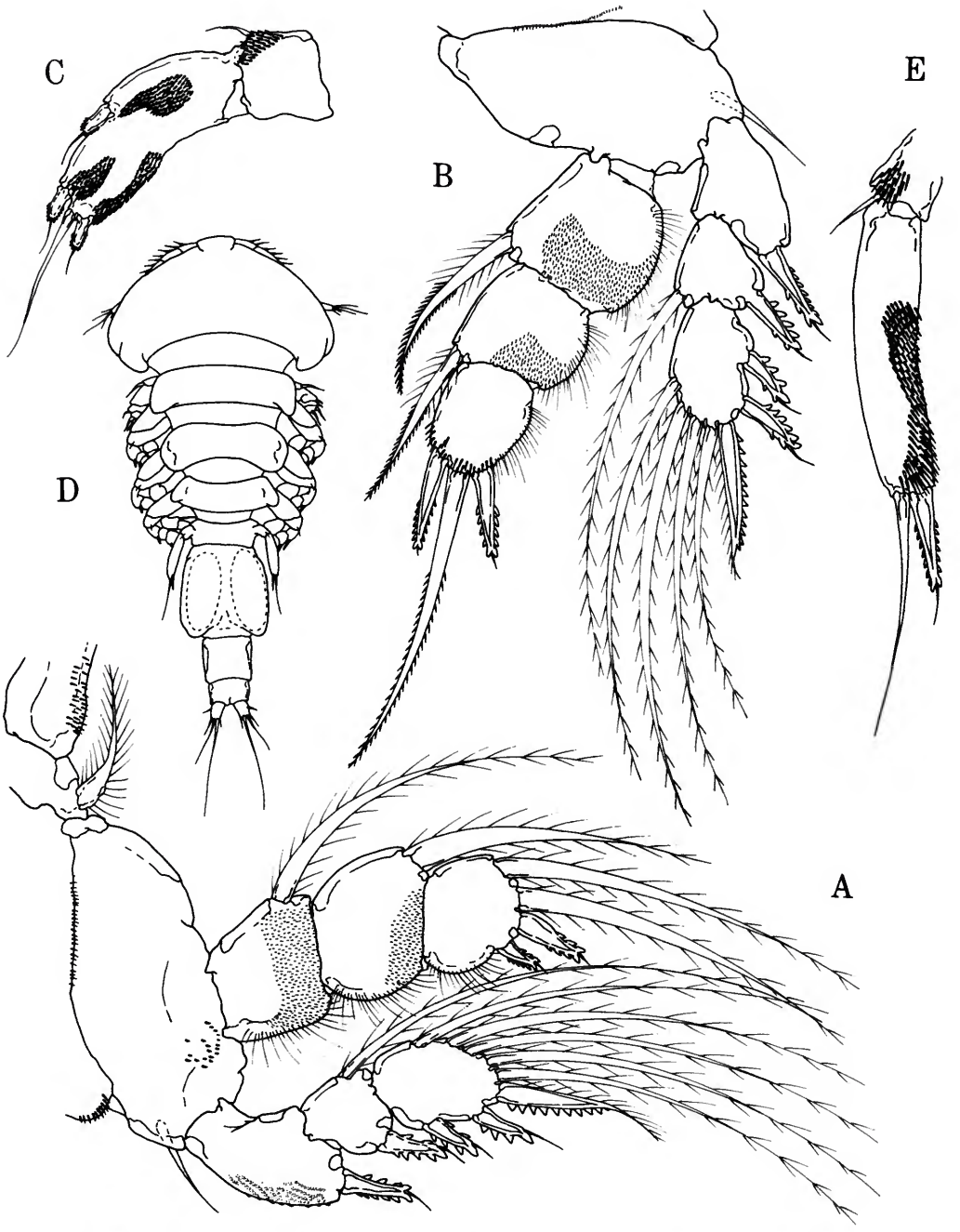

FIGURE 16.—*Unicolax anonymous* (Vervoort), new genus, female: *a*, leg 3; *b*, leg 4; *c*, leg 5; male: *d*, dorsal; *e*, leg 5.

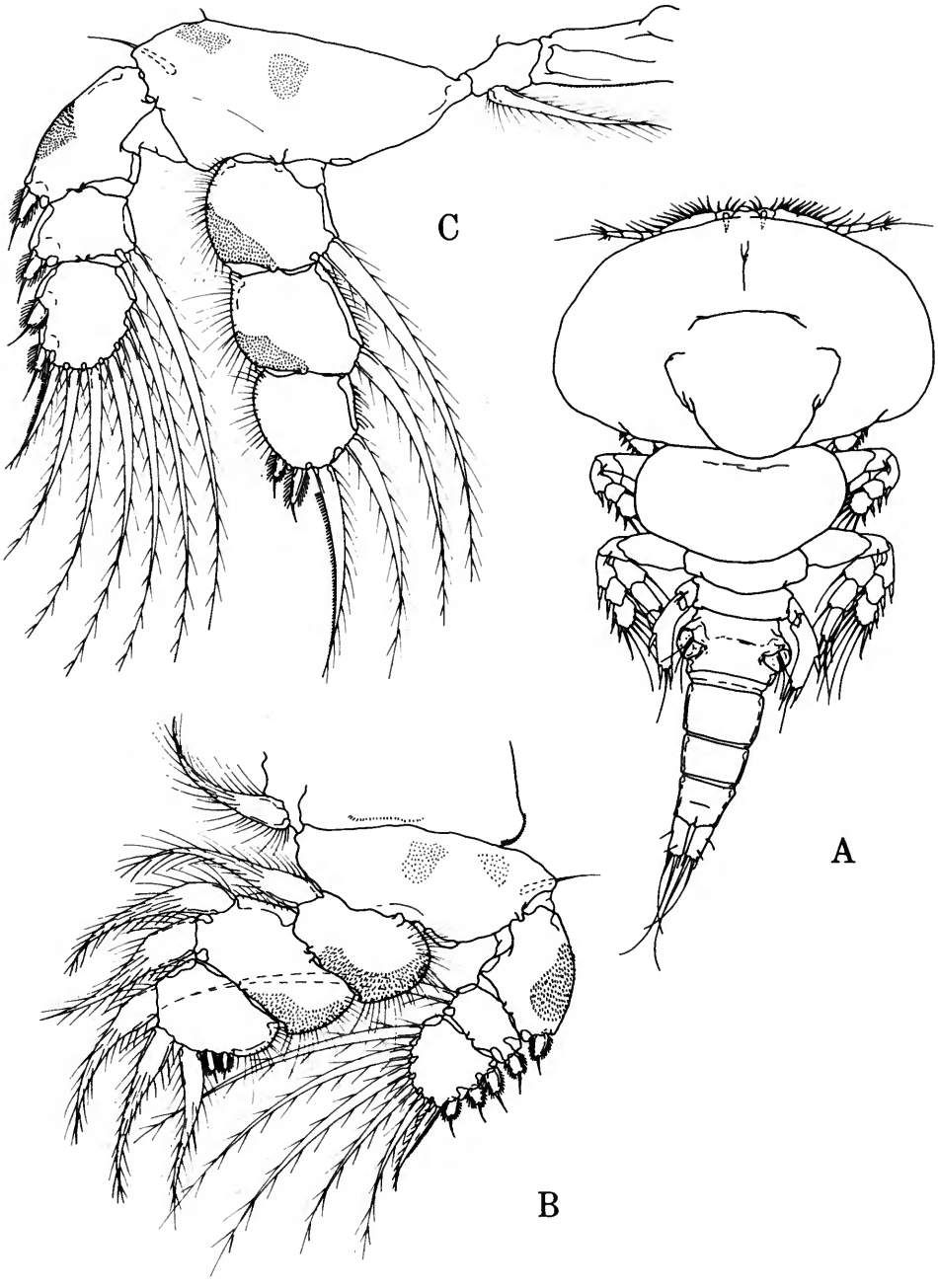

FIGURE 17.—*Unicolax mycterobius* (Vervoort), new genus, female: *a*, dorsal; *b*, leg 2; *c*, leg 3.

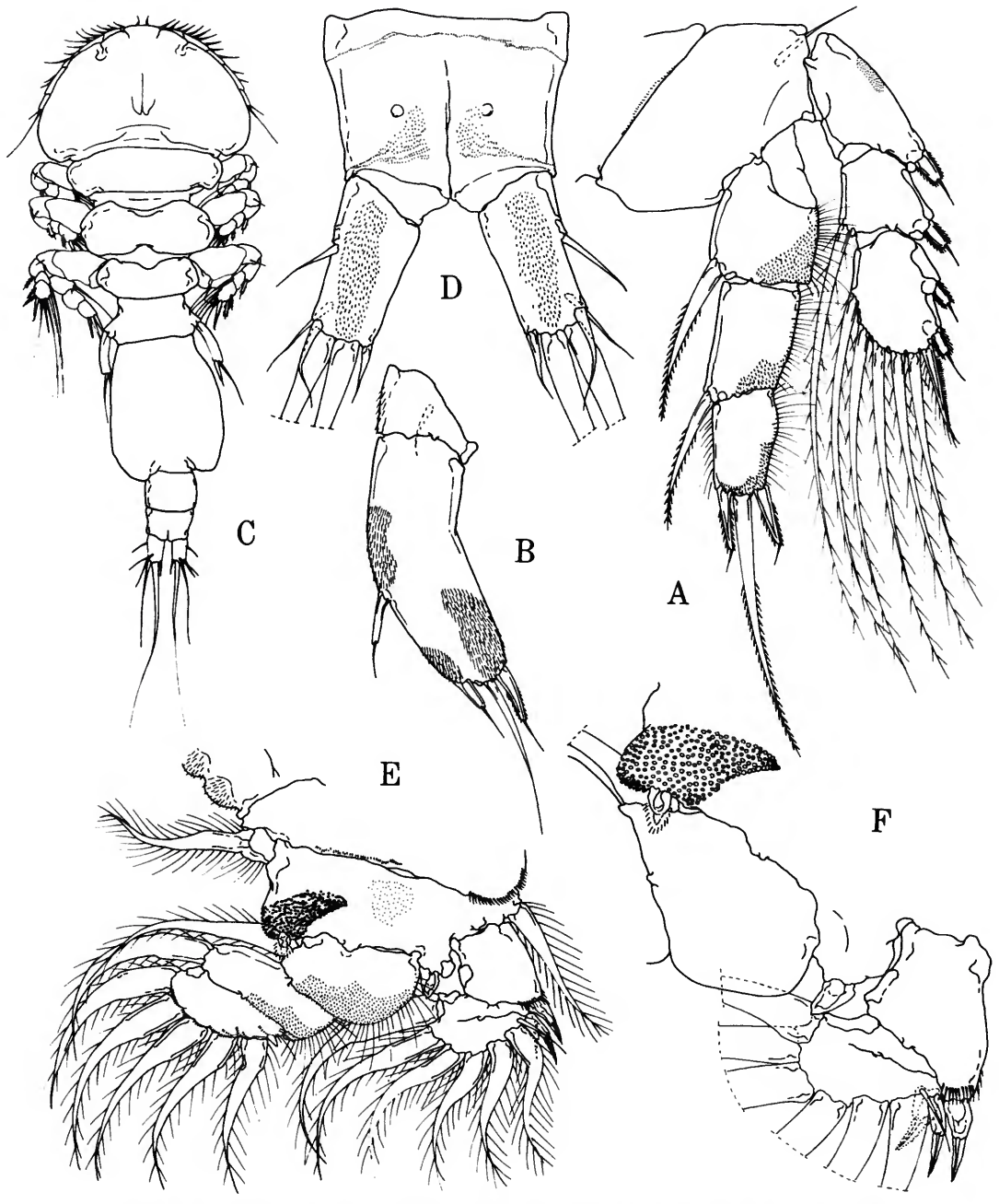

FIGURE 18.—*Unicolax mycterobius* (Vervoort), new genus, female: *a*, leg 4; *b*, leg 5; male: *c*, dorsal; *d*, last abdominal segment and caudal rami, ventral; *e*, leg 1; *f*, leg 1 exopod.

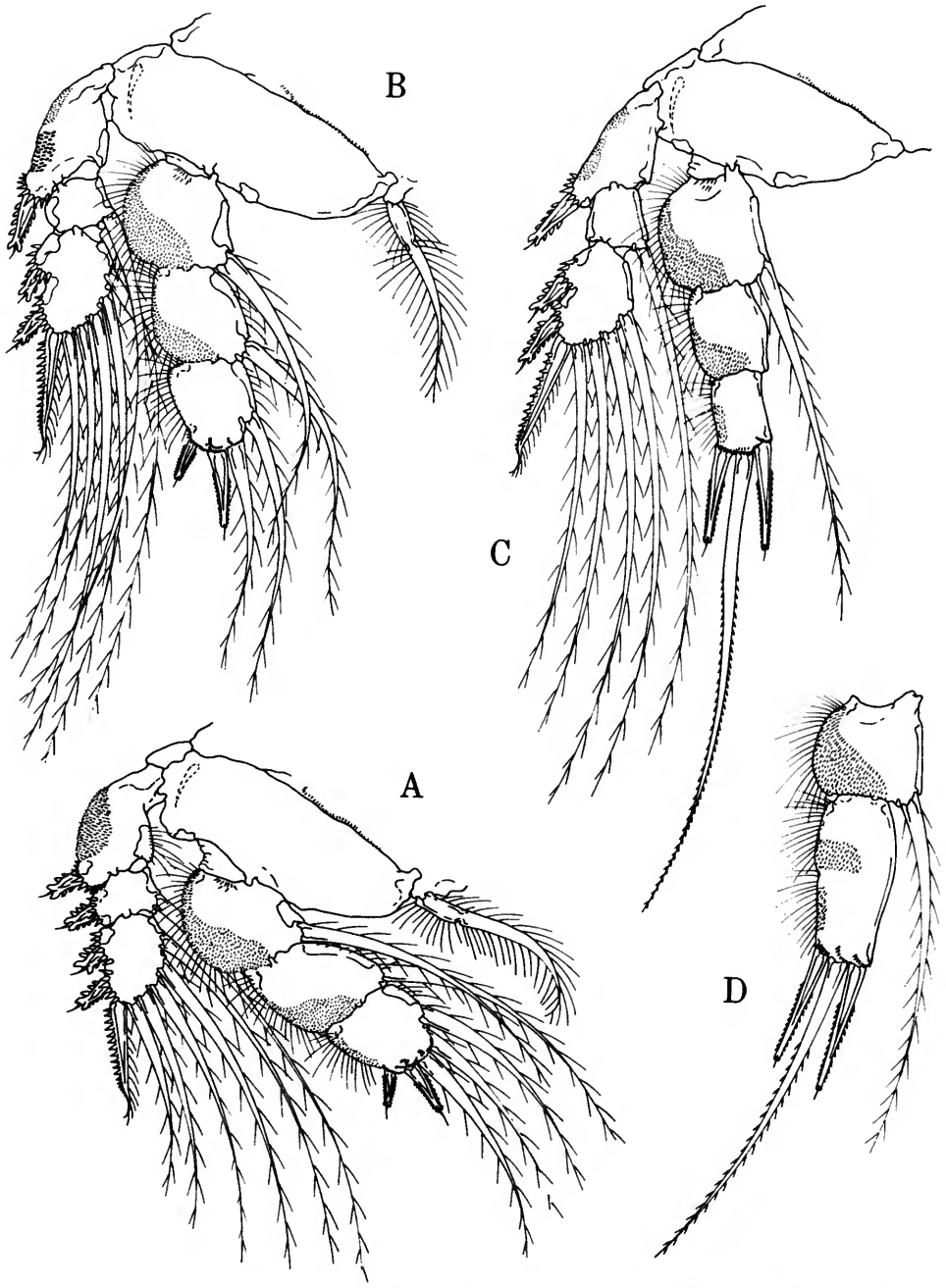

FIGURE 19.—*Unicolax mycterobius* (Vervoort), new genus, male: *a*, leg 2; *b*, leg 3; *c*, leg 4; *d*, leg 4 last 2 endopod segments.

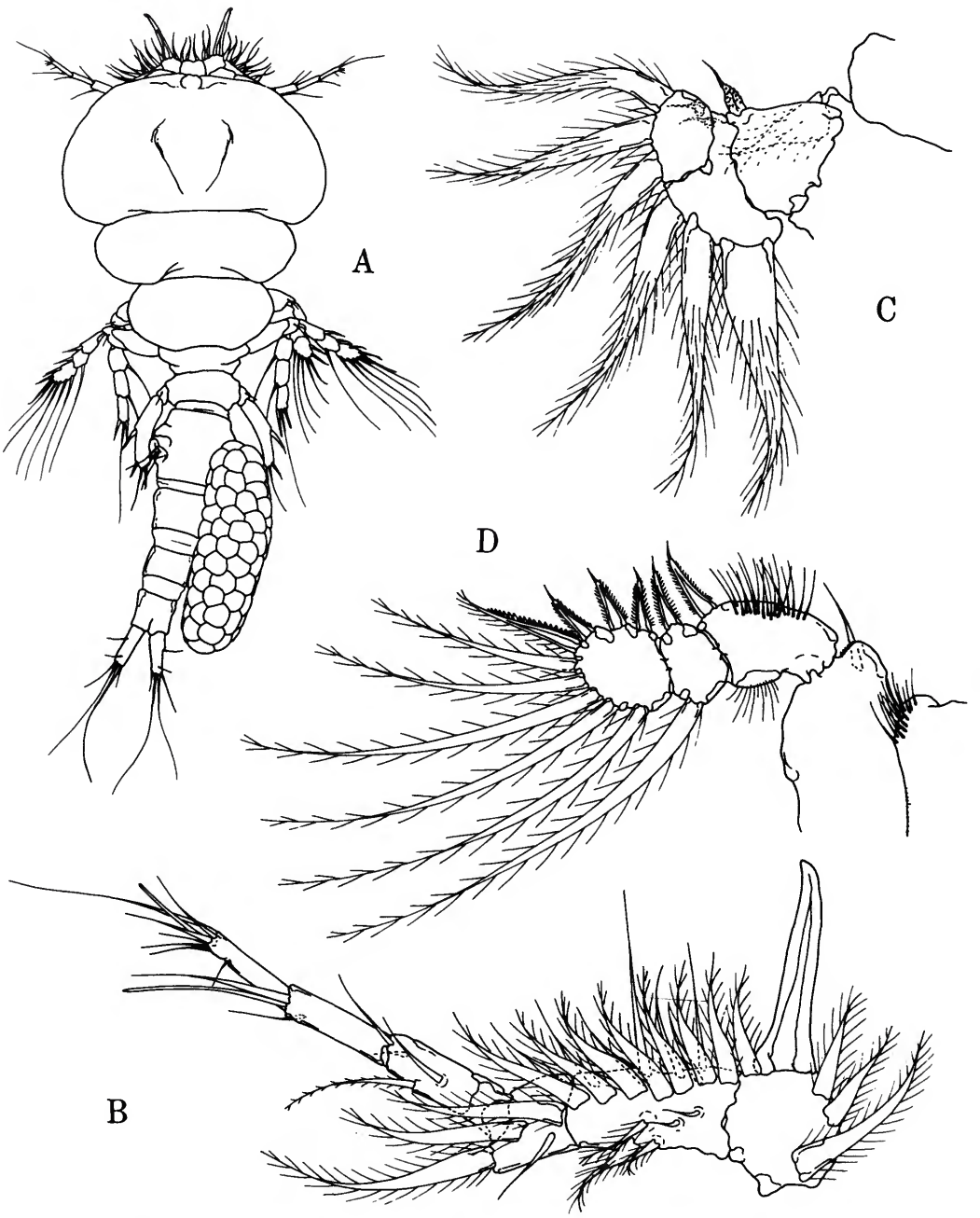

FIGURE 20.—*Unicolax ciliatus*, new genus, new species, female: *a*, dorsal; *b*, first antenna; *c*, leg 1 exopod; *d*, leg 2 exopod.

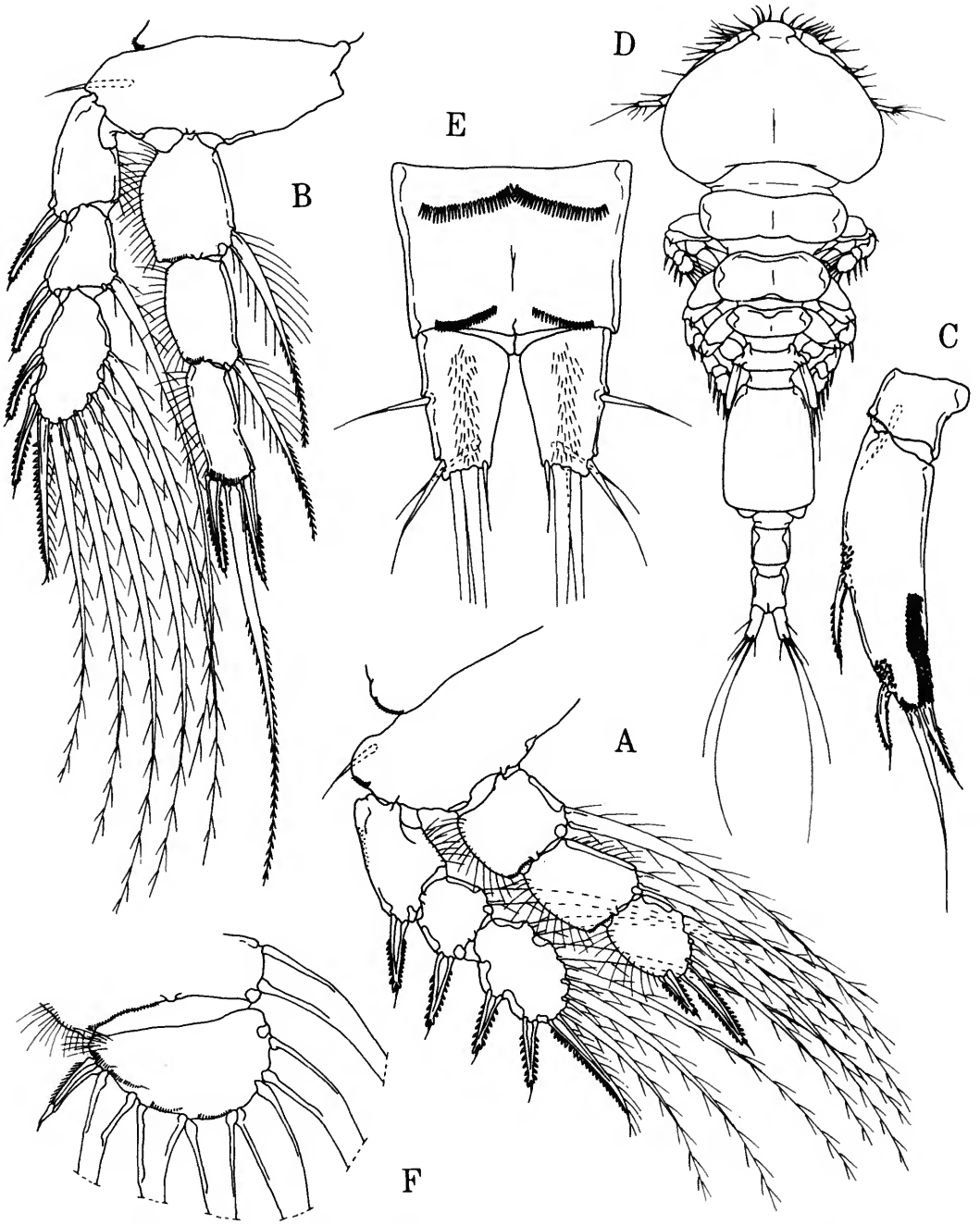

FIGURE 21.—*Unicolax ciliatus*, new genus, new species, female: *a*, leg 3; *b*, leg 4; *c*, leg 5; male: *d*, dorsal; *e*, last abdominal segment and caudal rami, ventral; *f*, leg 1 endopod.

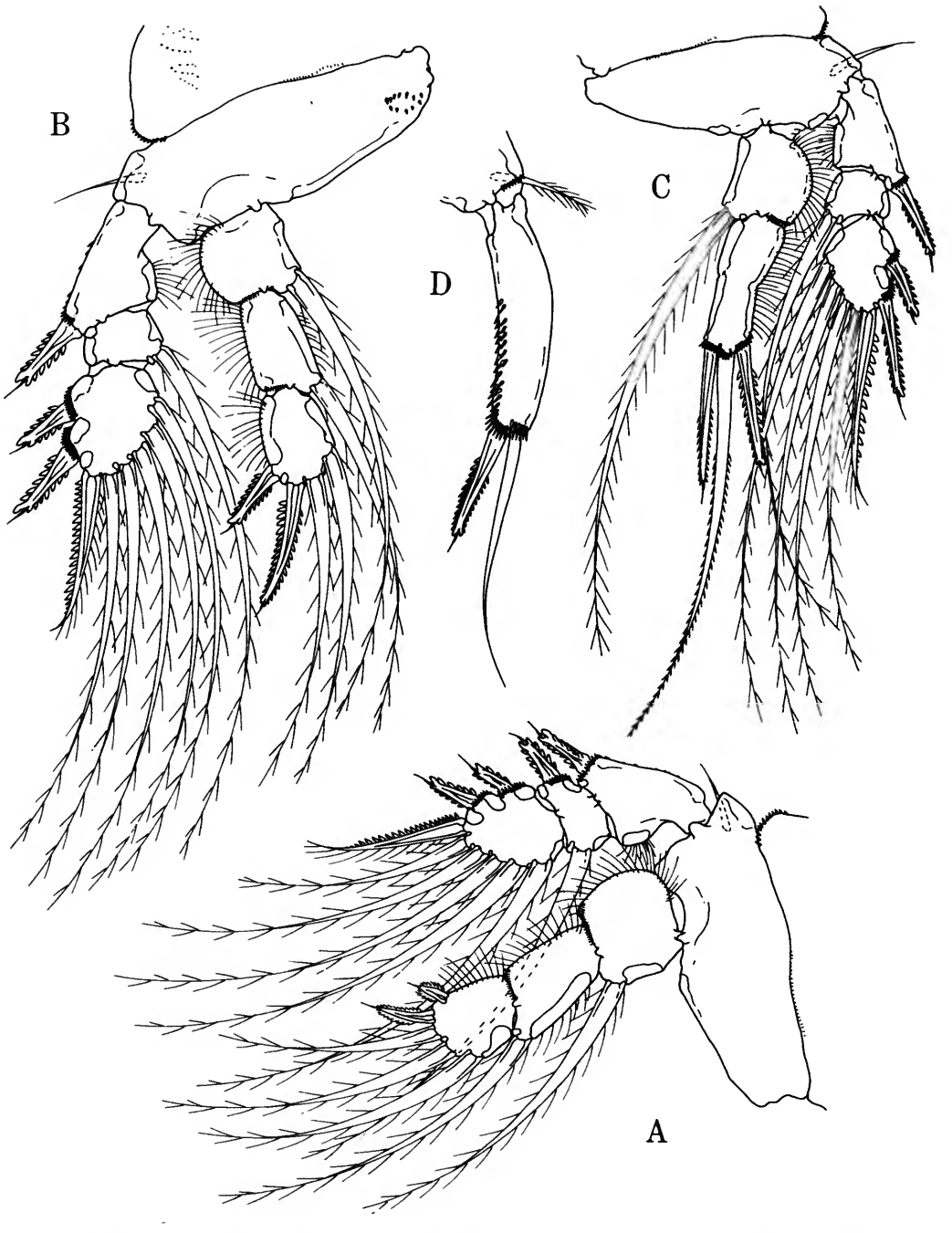

FIGURE 22.—*Unicolax ciliatus*, new genus, new species, male: *a*, leg 2; *b*, leg 3; *c*, leg 4; *d*, leg 5.

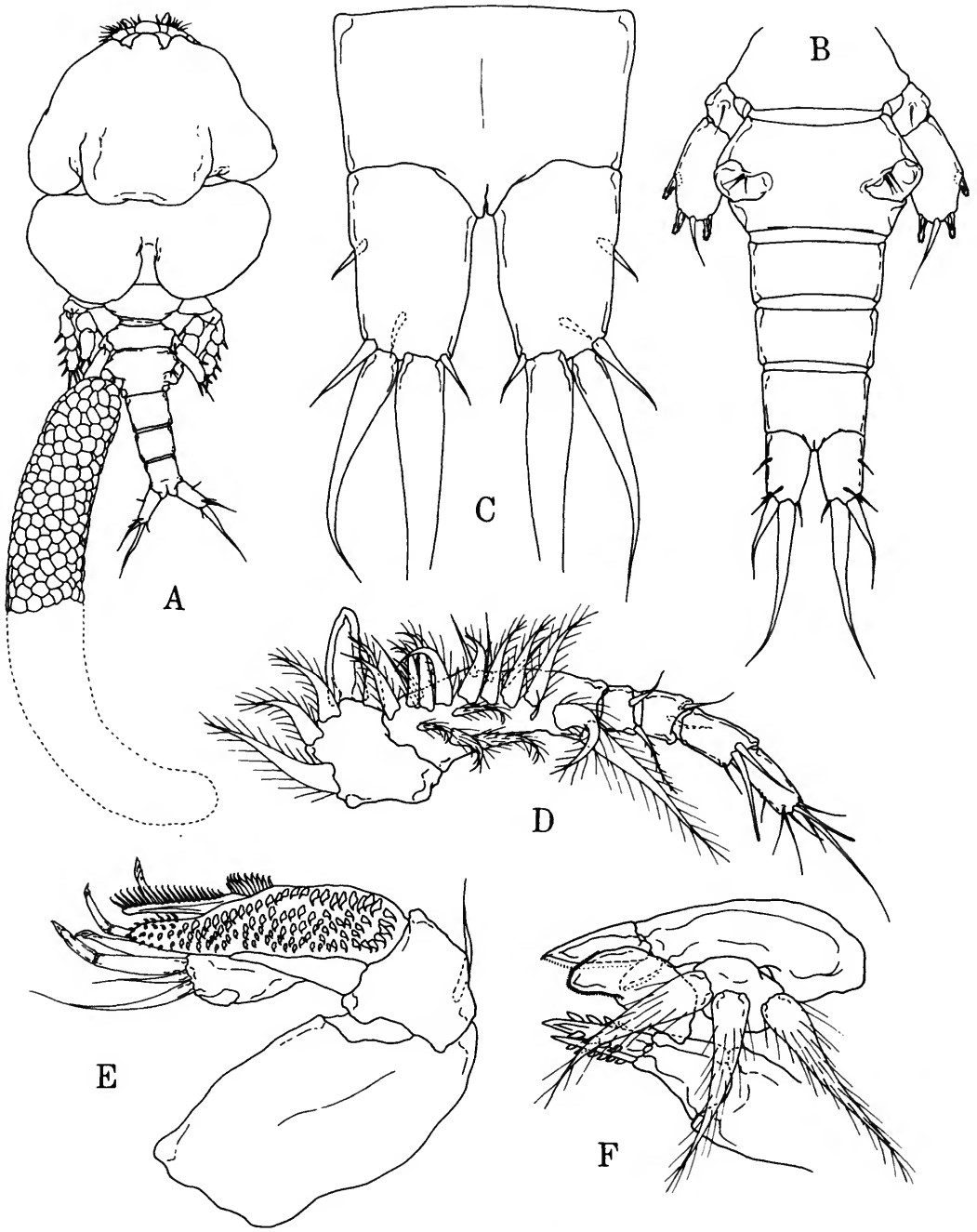

FIGURE 23.—*Unicolax reductus* new genus, new species, female: *a*, dorsal; *b*, genital segment and abdomen, dorsal; *c*, last abdominal segment and caudal rami, ventral; *d*, first antenna; *e*, second antenna; *f*, mandible, paragnath, first maxilla, second maxilla.

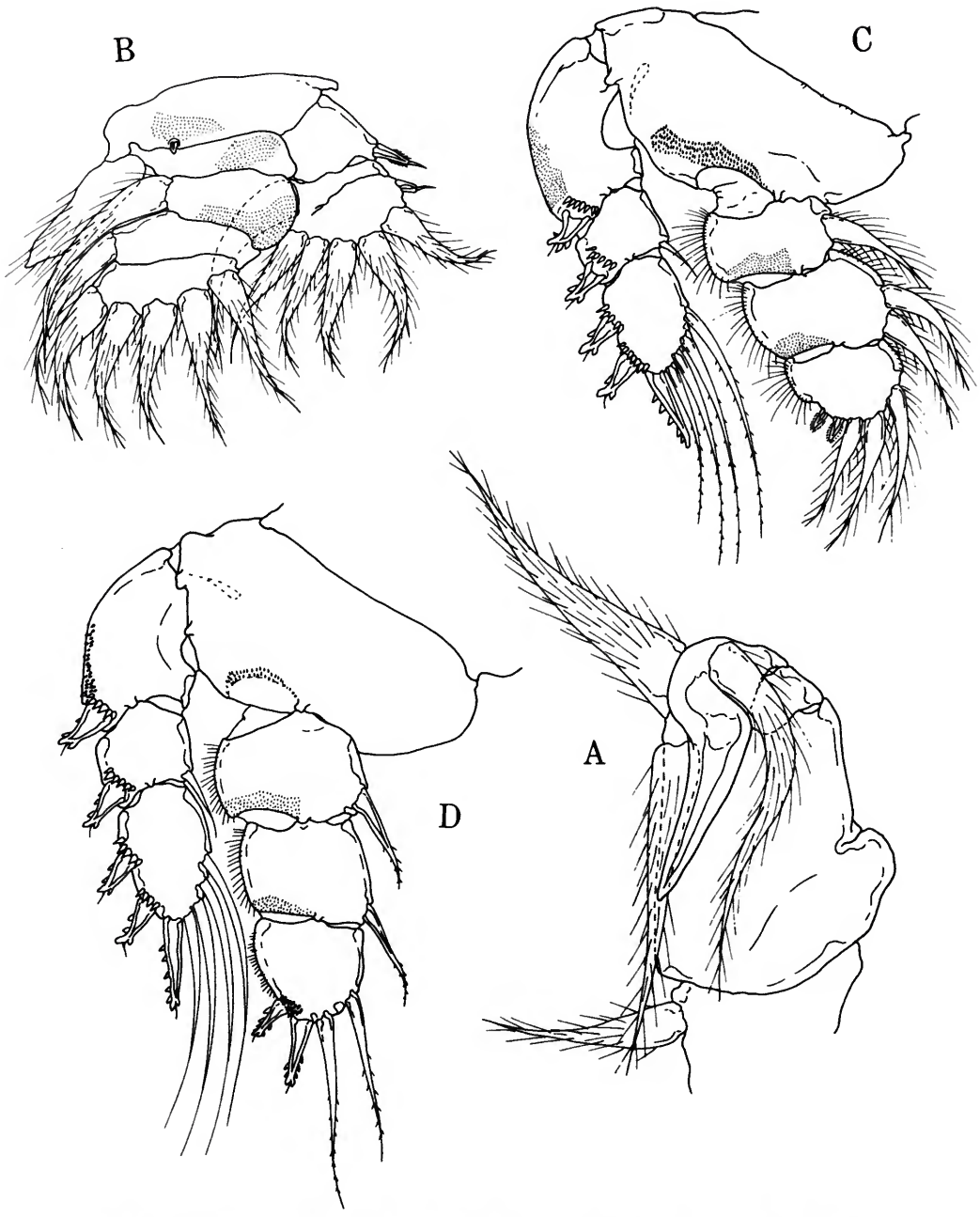

FIGURE 24.—*Unicolax reductus*, new genus, new species, female: *a*, maxilliped; *b*, leg 1; *c*, leg 2; *d*, leg 3.

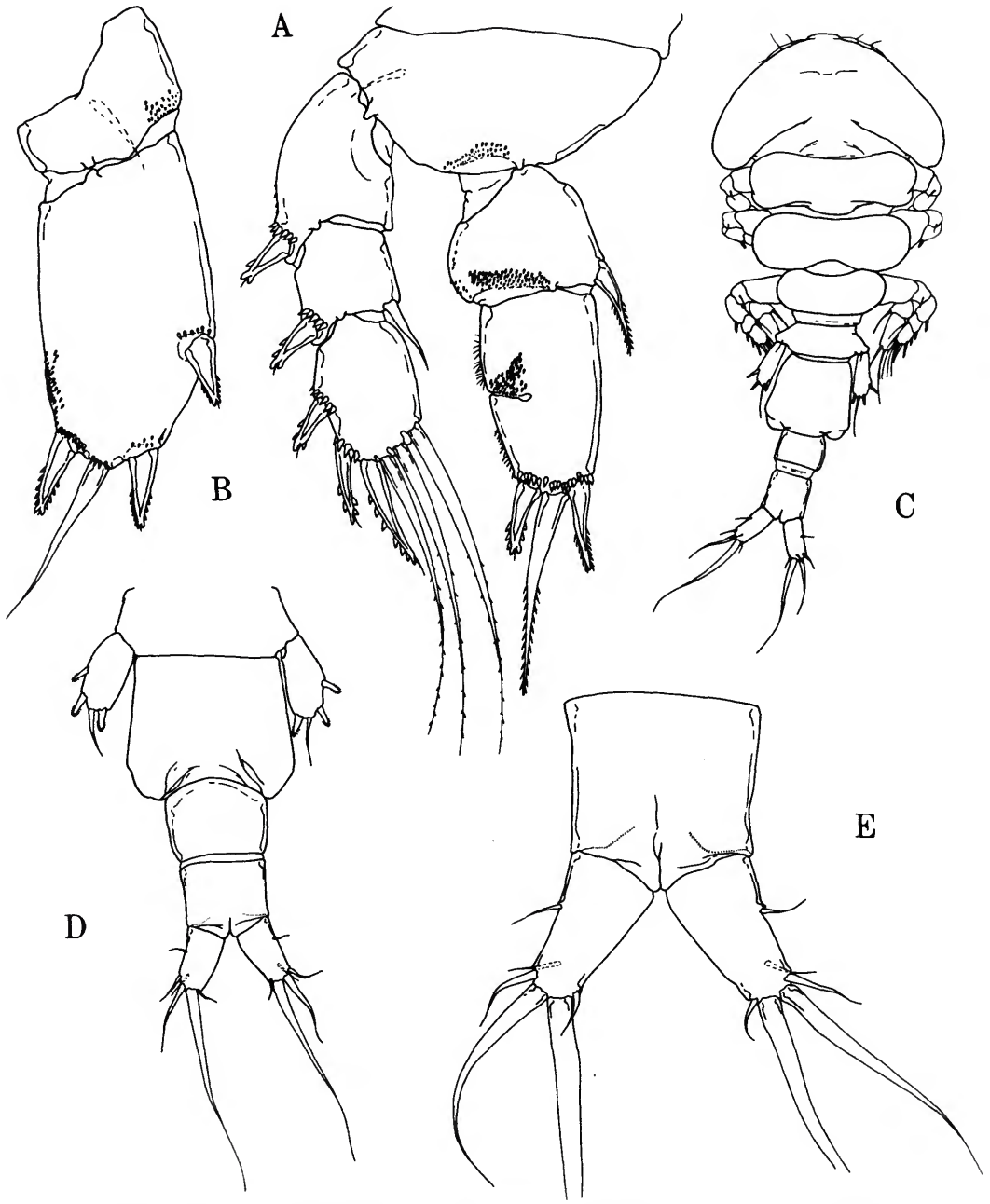

FIGURE 25.—*Unicolax reductus*, new genus, new species, female: *a*, leg 4; *b*, leg 5; male: *c*, dorsal; *d*, genital segment and abdomen, ventral; *e*, last abdominal segment and caudal rami, ventral.

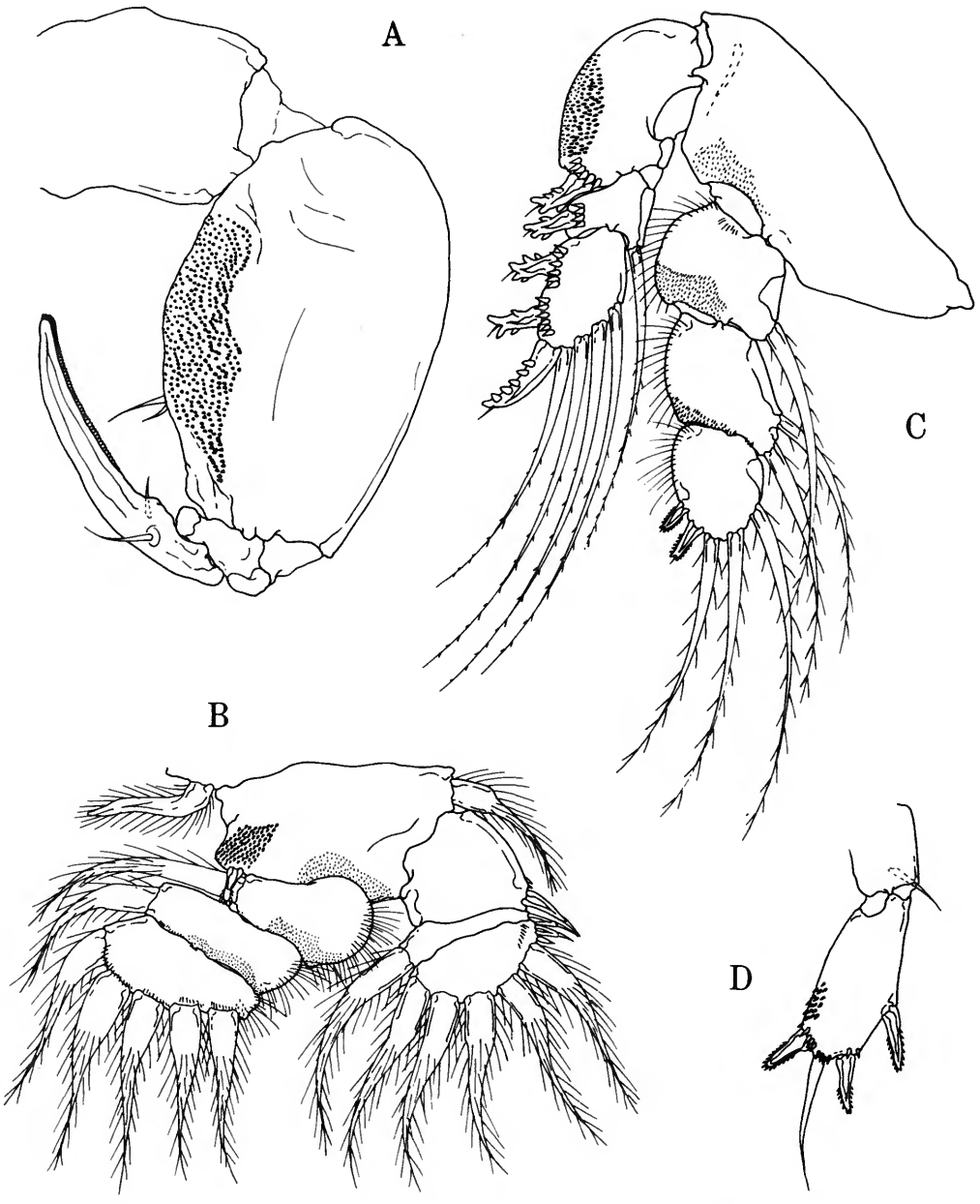

FIGURE 26.—*Unicolax reductus*, new genus, new species, male: *a*, maxilliped; *b*, leg 1; *c*, leg 2; *d*, leg 5.

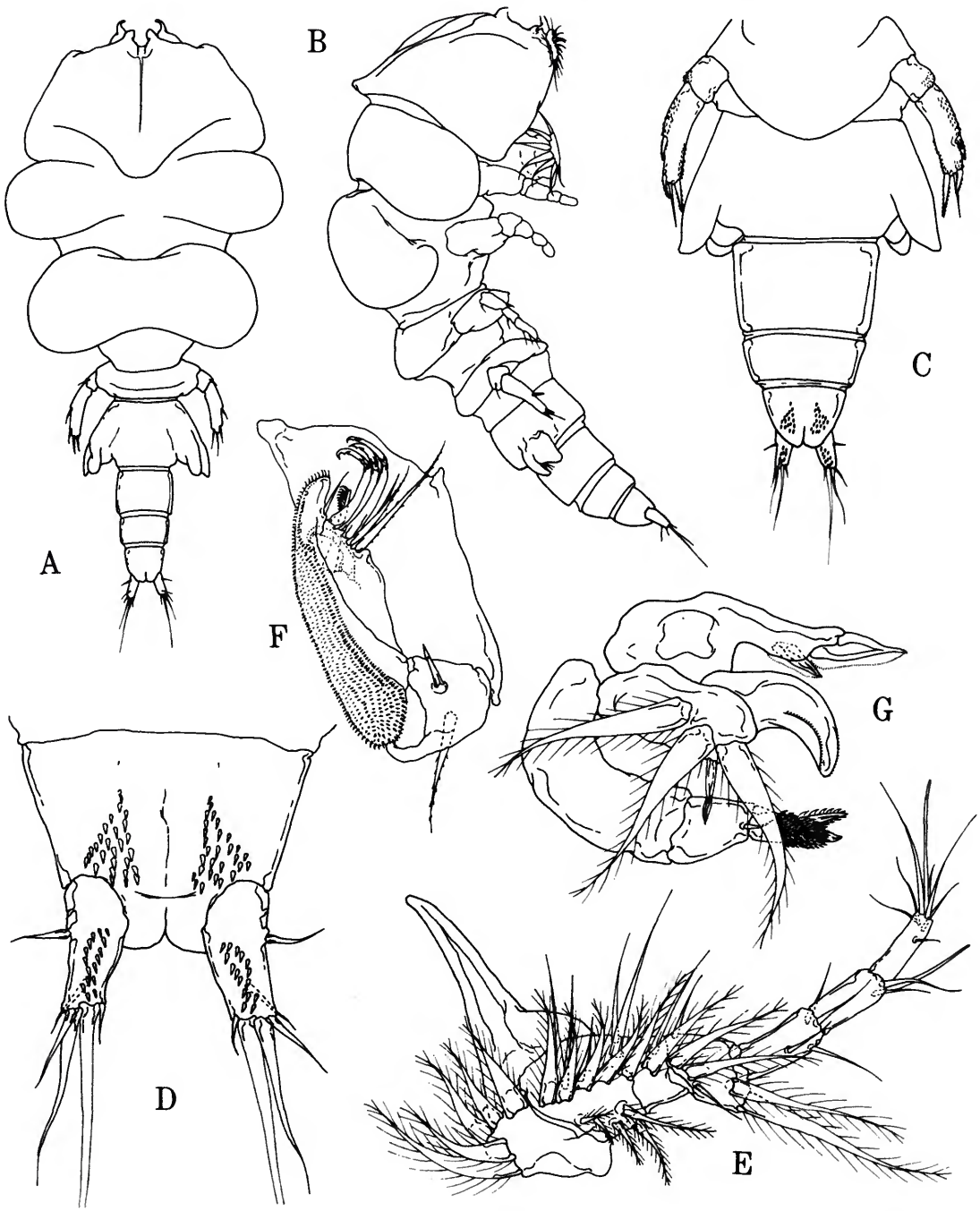

FIGURE 27.—*Ceratacolax euthynni* Vervoort, female: *a*, dorsal; *b*, lateral; *c*, genital segment and abdomen, ventral; *d*, last abdominal segment and caudal rami; *e*, first antenna; *f*, second antenna; *g*, mandible, paragnath, first and second maxilla.

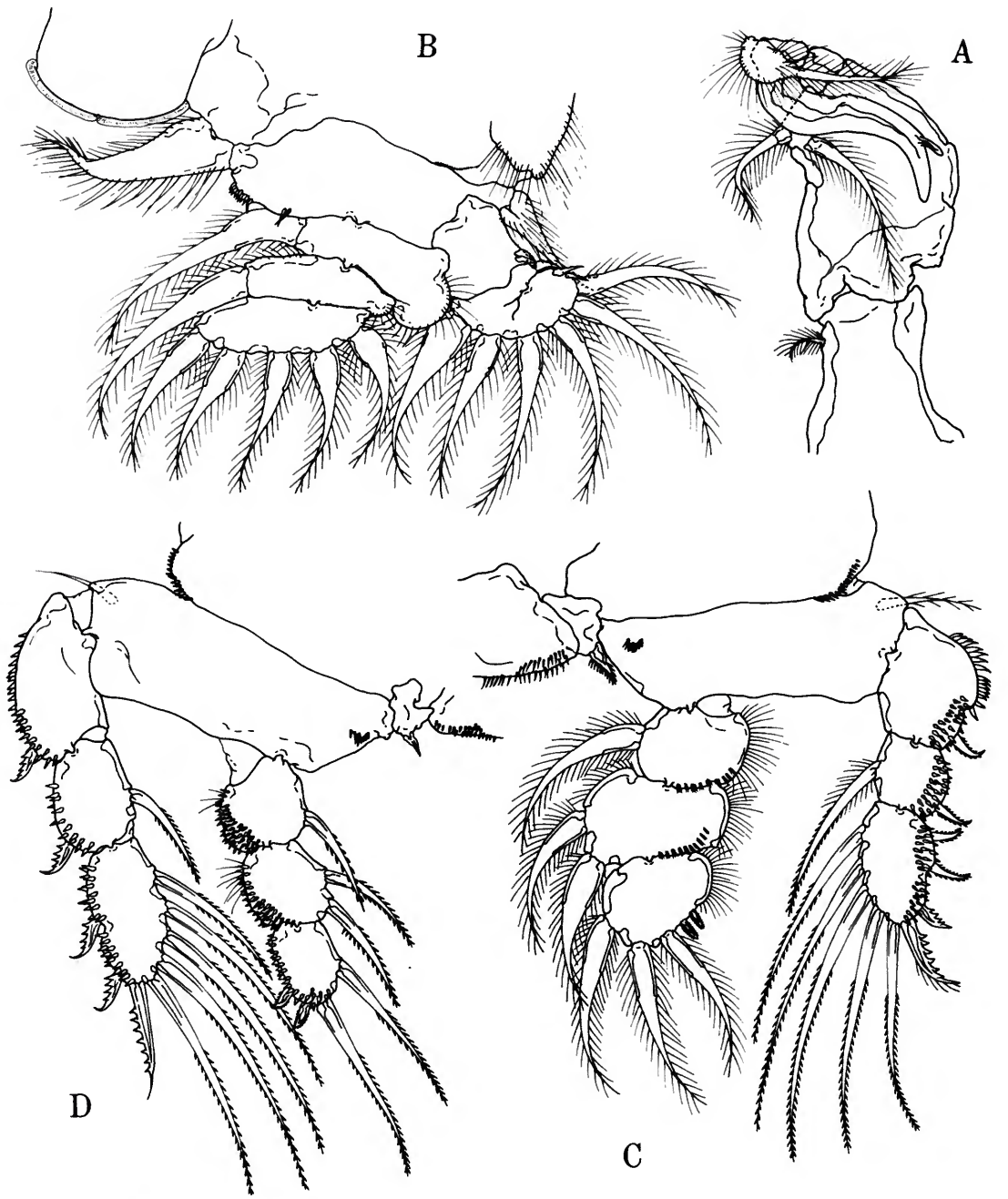

FIGURE 28.—*Ceratacolax euthynni* Vervoort, female: *a*, maxilliped; *b*, leg 1; *c*, leg 2; *d*, leg 3.

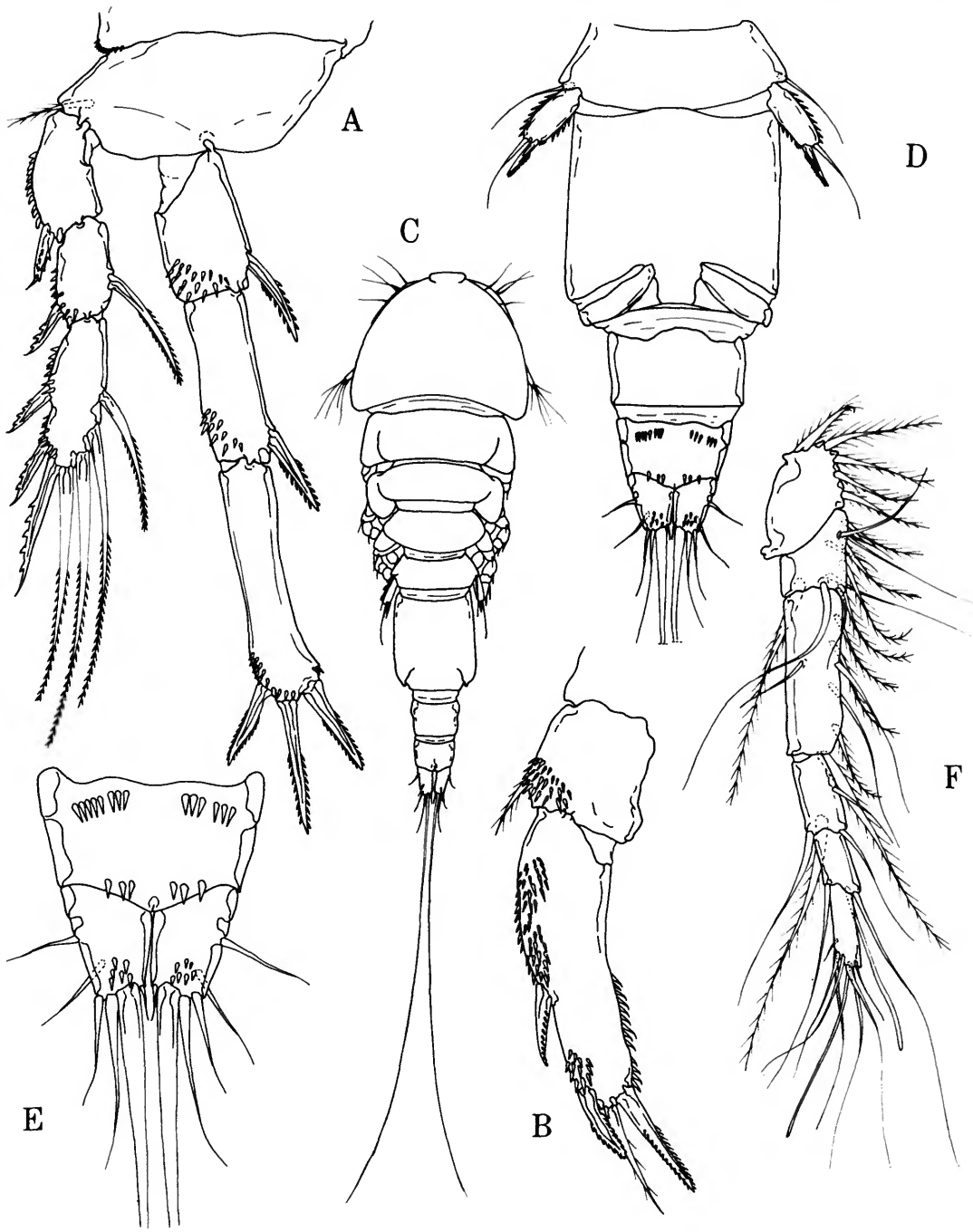

FIGURE 29.—*Ceratacolax euthynni* Vervoort, female: *a*, leg 4; *b*, leg 5; male: *c*, dorsal; *d*, genital segment and abdomen, ventral; *e*, last abdominal segment and caudal rami, ventral; *f*, first antenna.

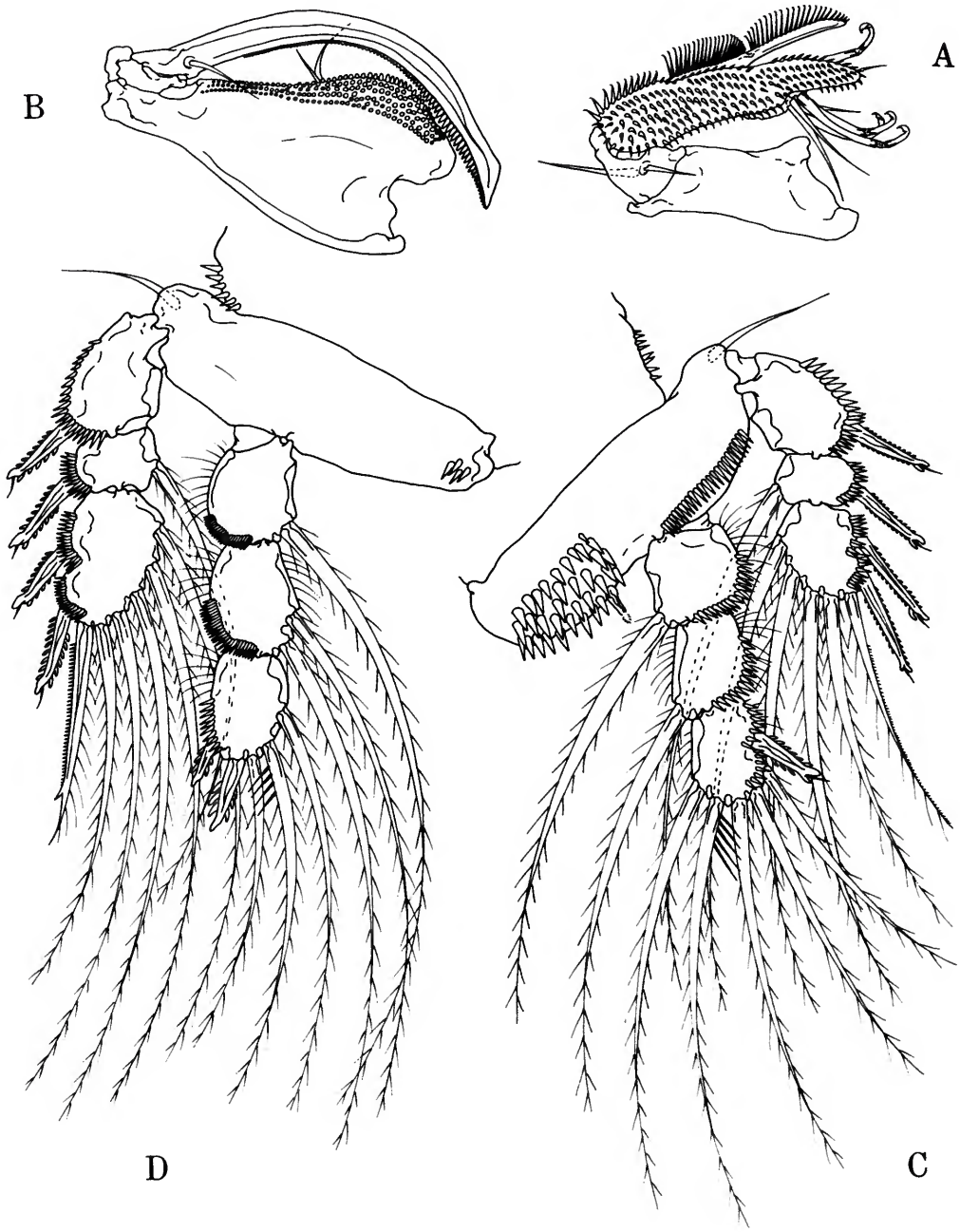

FIGURE 30.—*Ceratacolax euthynni* Vervoort, male: *a*, second antenna; *b*, maxilliped; *c*, leg 1; *d*, leg 2.

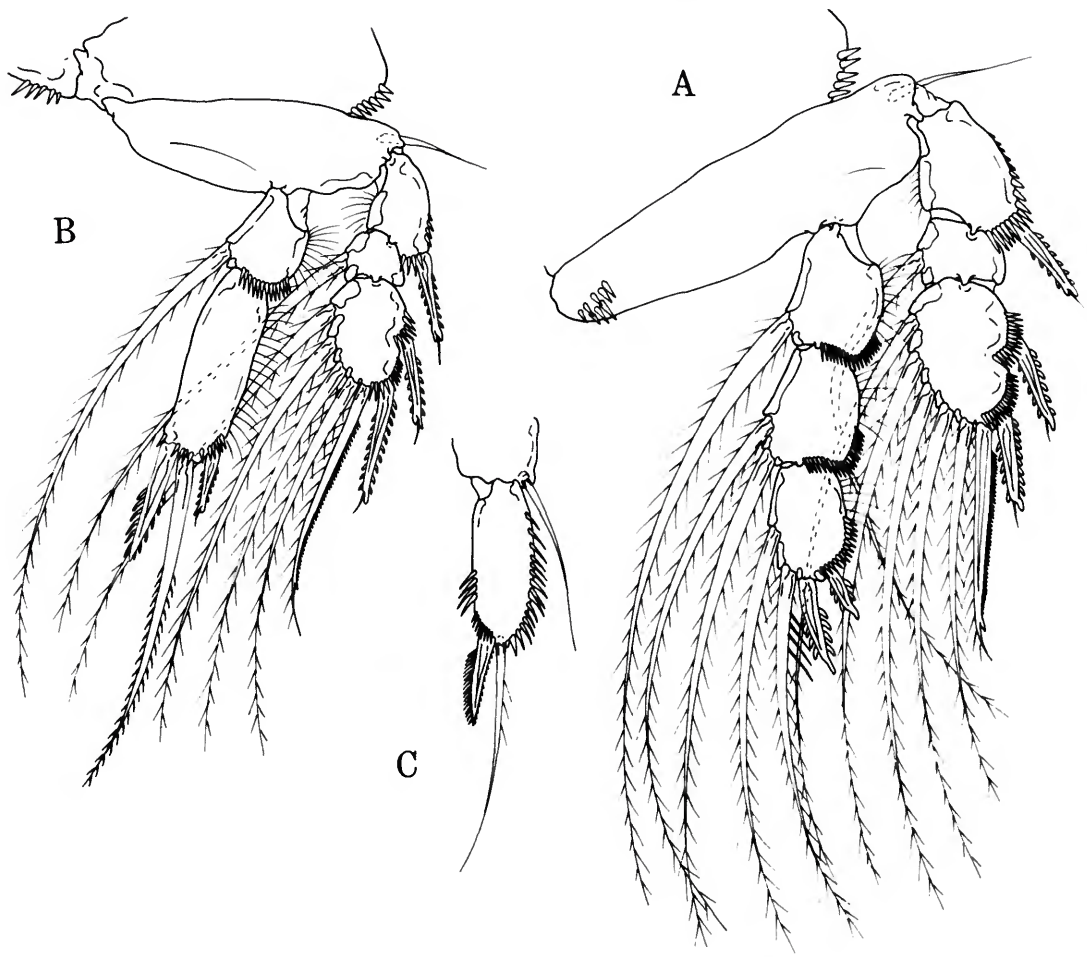

FIGURE 31.—*Ceratacolax euthynni* Vervoort, male: *a*, leg 3; *b*, leg 4; *c*, leg 5.

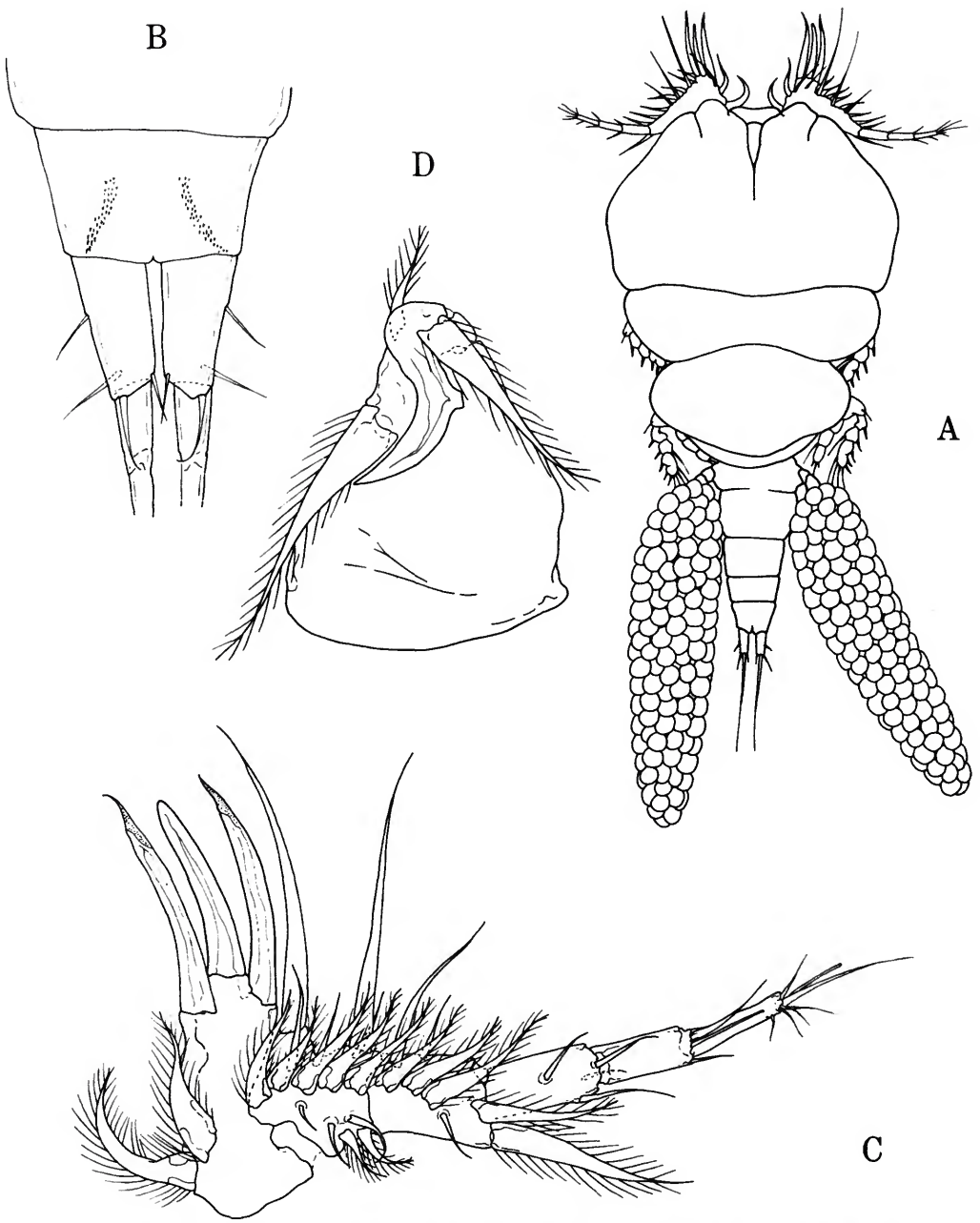

FIGURE 32.—*Nothobomolochus kanagurta* Pillai, female: *a*, dorsal; *b*, last abdominal segment and abdomen, ventral; *c*, first antenna; *d*, maxilliped.

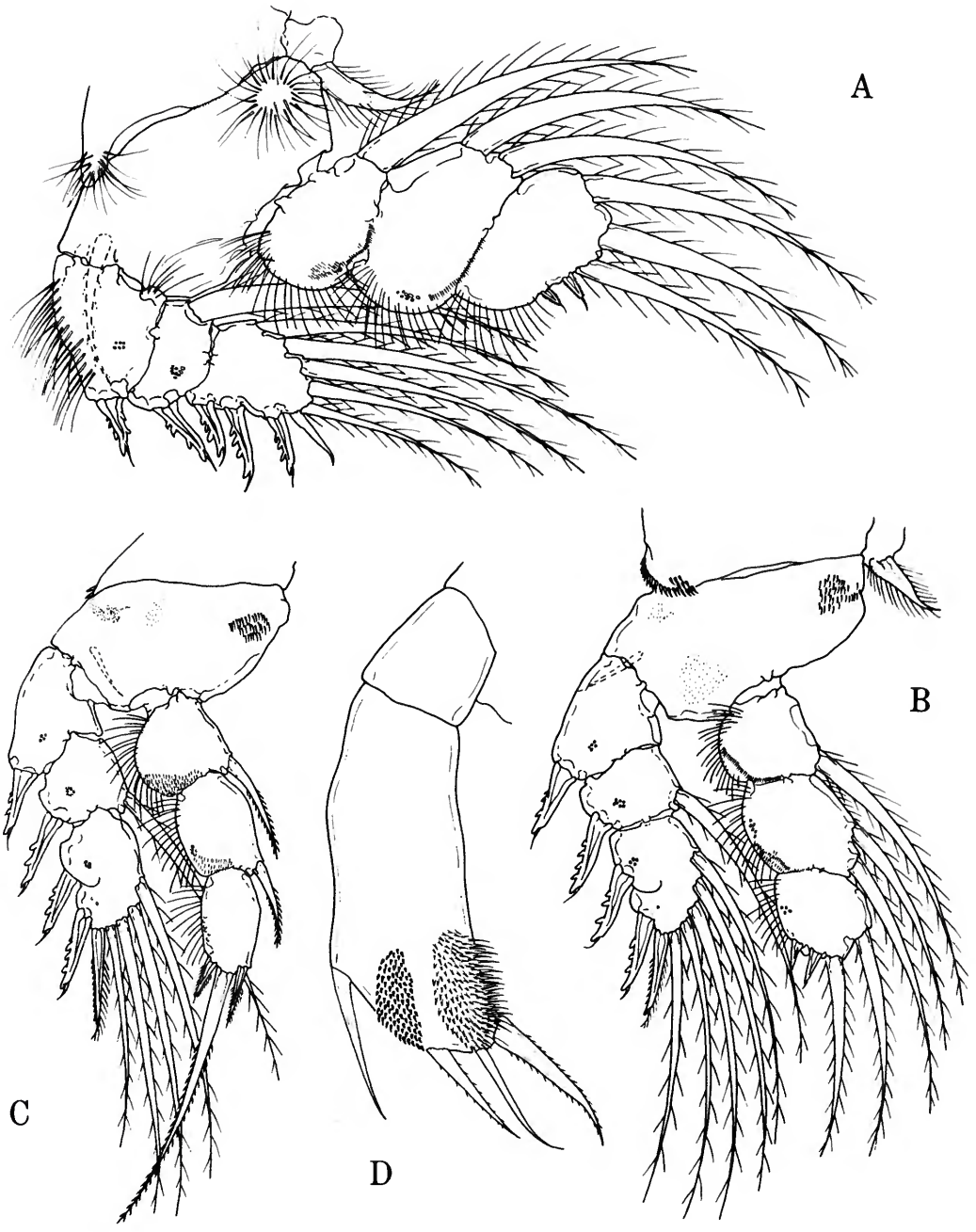

FIGURE 33.—*Nothobomolochus kanagurta* Pillai, female: *a*, leg 2; *b*, leg 3; *c*, leg 4; *d*, leg 5.

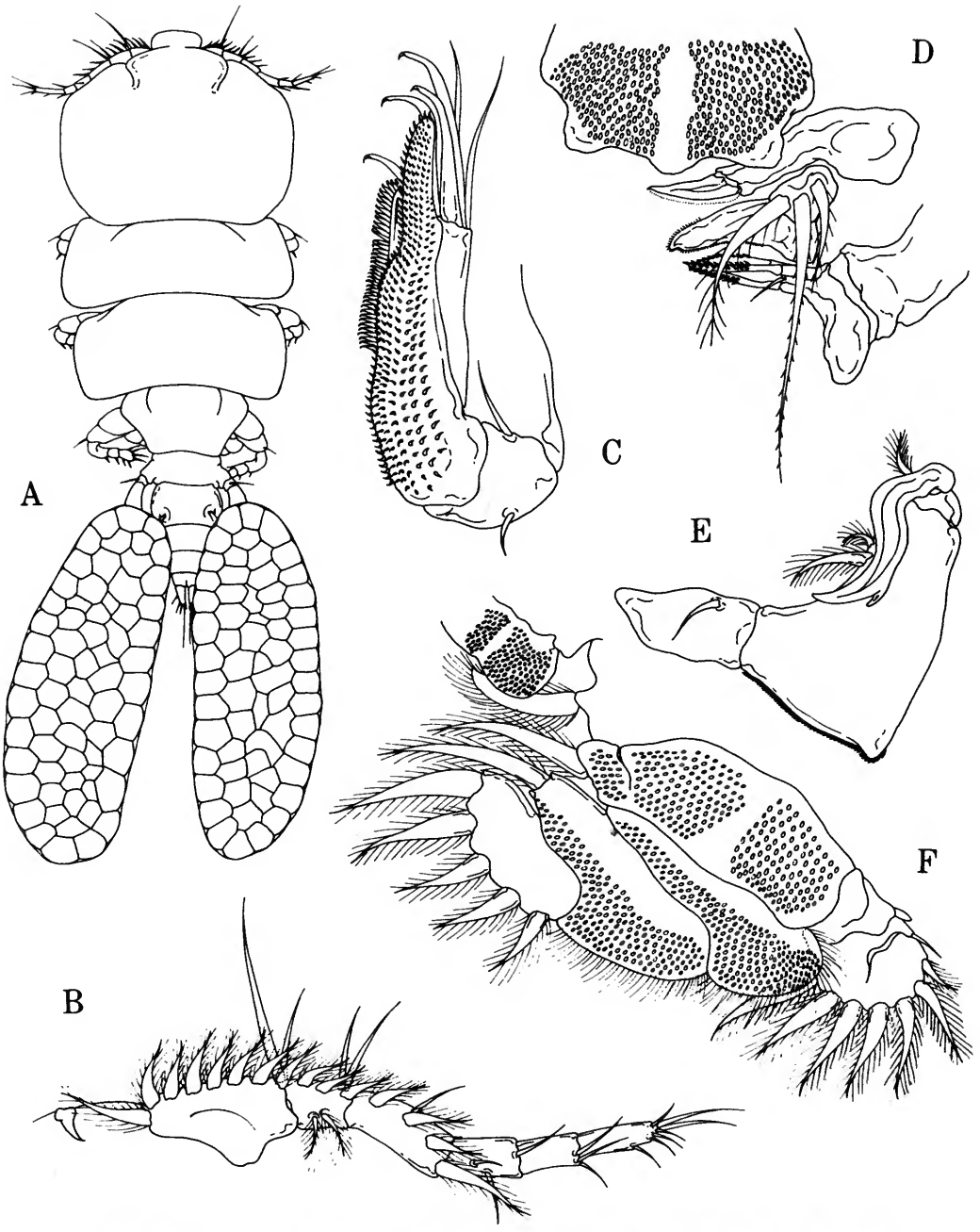

FIGURE 34.—*Orbitacolax aculeatus* (Pillai), female: *a*, dorsal; *b*, first antenna; *c*, second antenna; *d*, oral area; *e*, maxilliped; *f*, leg 1.

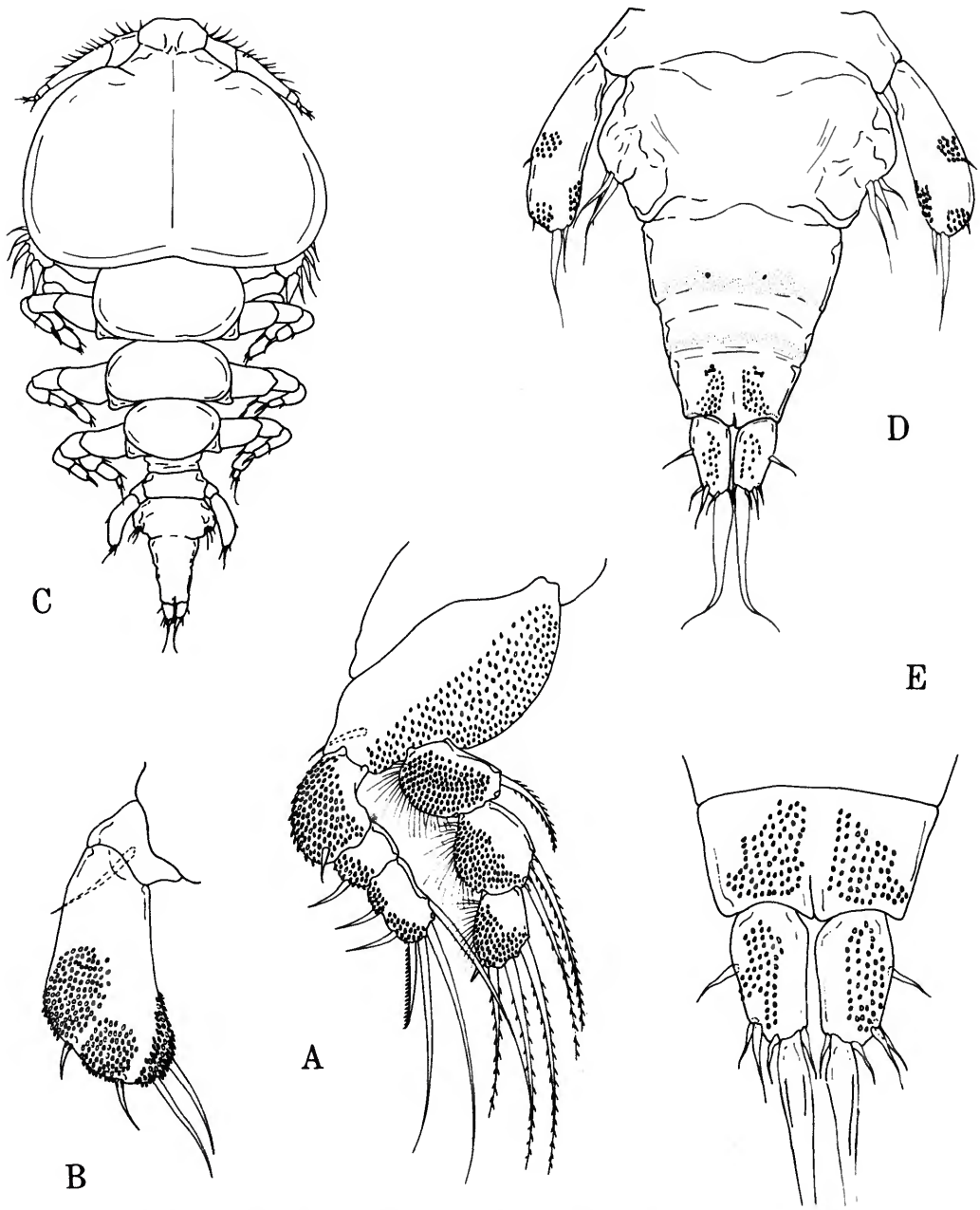

FIGURE 35.—*Orbitacolax aculeatus* (Pillai), female: *a*, leg 2; *b*, leg 5. *Pumiliopes capitulatus* Cressey and Boyle, female: *c*, dorsal; *d*, genital segment, abdomen, caudal rami, ventral; *e*, last abdominal segment and caudal rami, ventral.

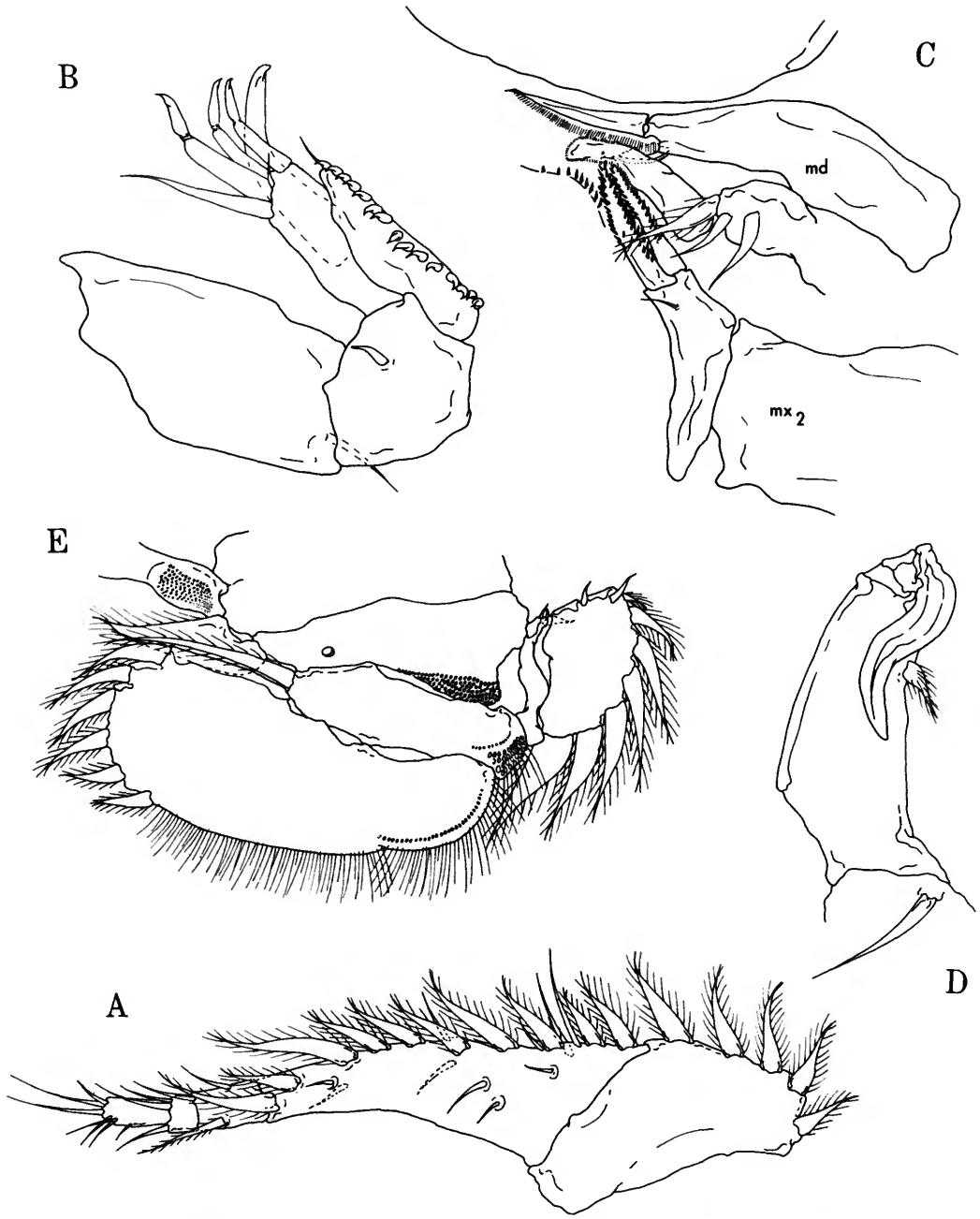

FIGURE 36.—*Pumiliopes capitulatus* Cressey and Boyle, female: *a*, first antenna; *b*, second antenna; *c*, oral area; *d*, maxilliped; *e*, leg 1.

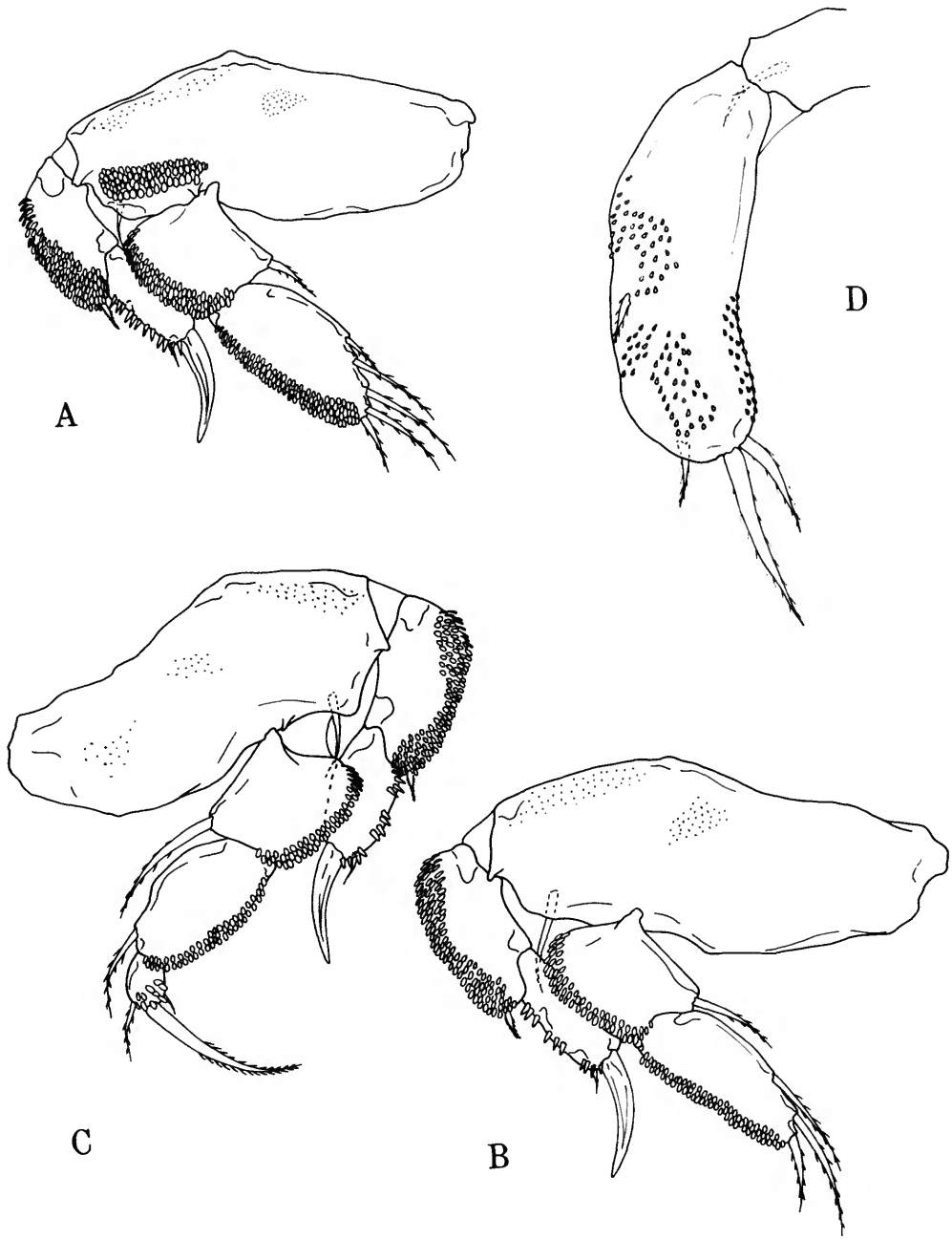

FIGURE 37.—*Pumiliopes capitulatus* Cressey and Boyle, female: *a*, leg 2; *b*, leg 3; *c*, leg 4; *d*, leg 5.

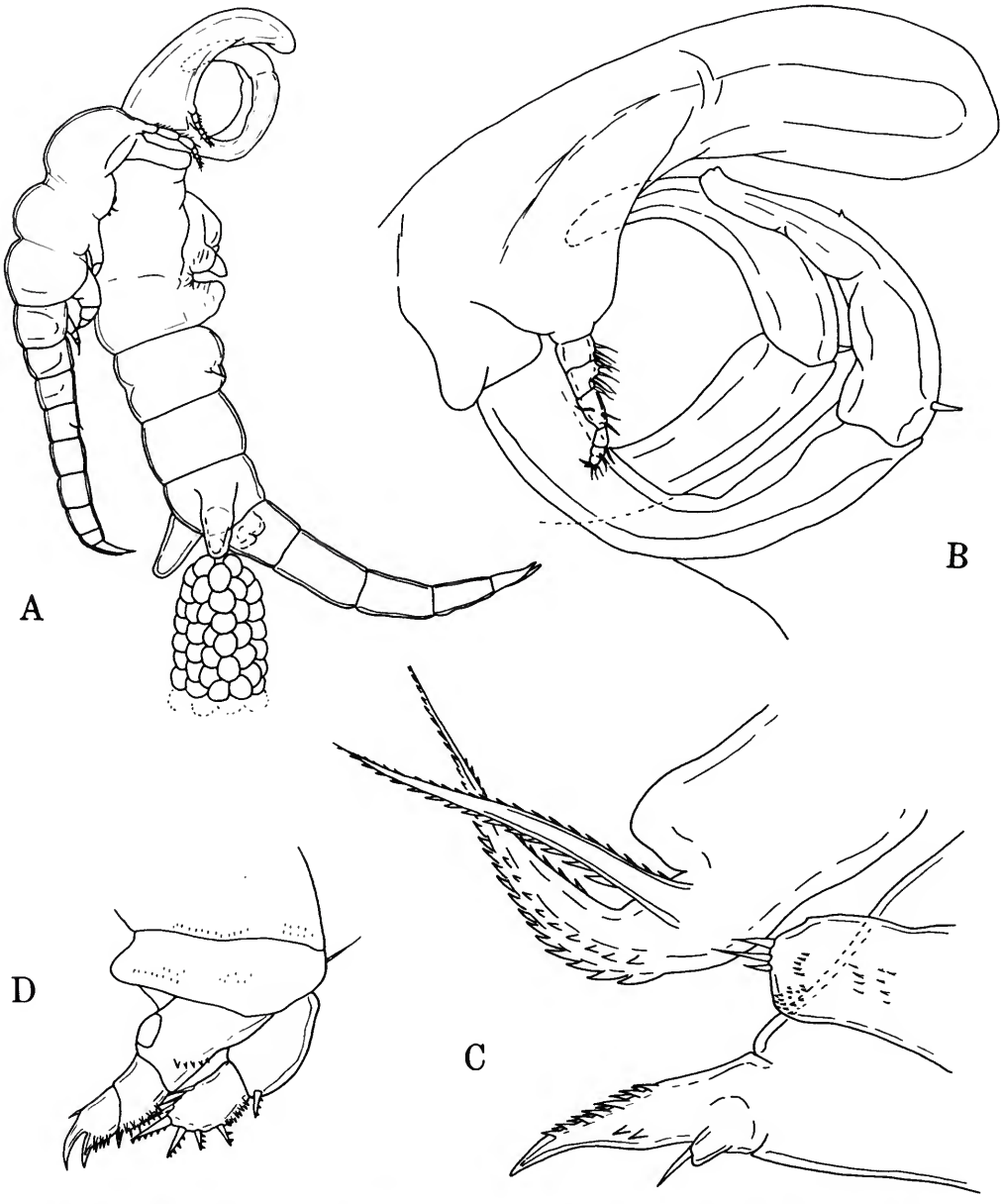

FIGURE 38.—*Shiinoa inauris* Cressey, female: *a*, lateral with attached male; *b*, rostral area, lateral; *c*, oral area; *d*, leg 1.

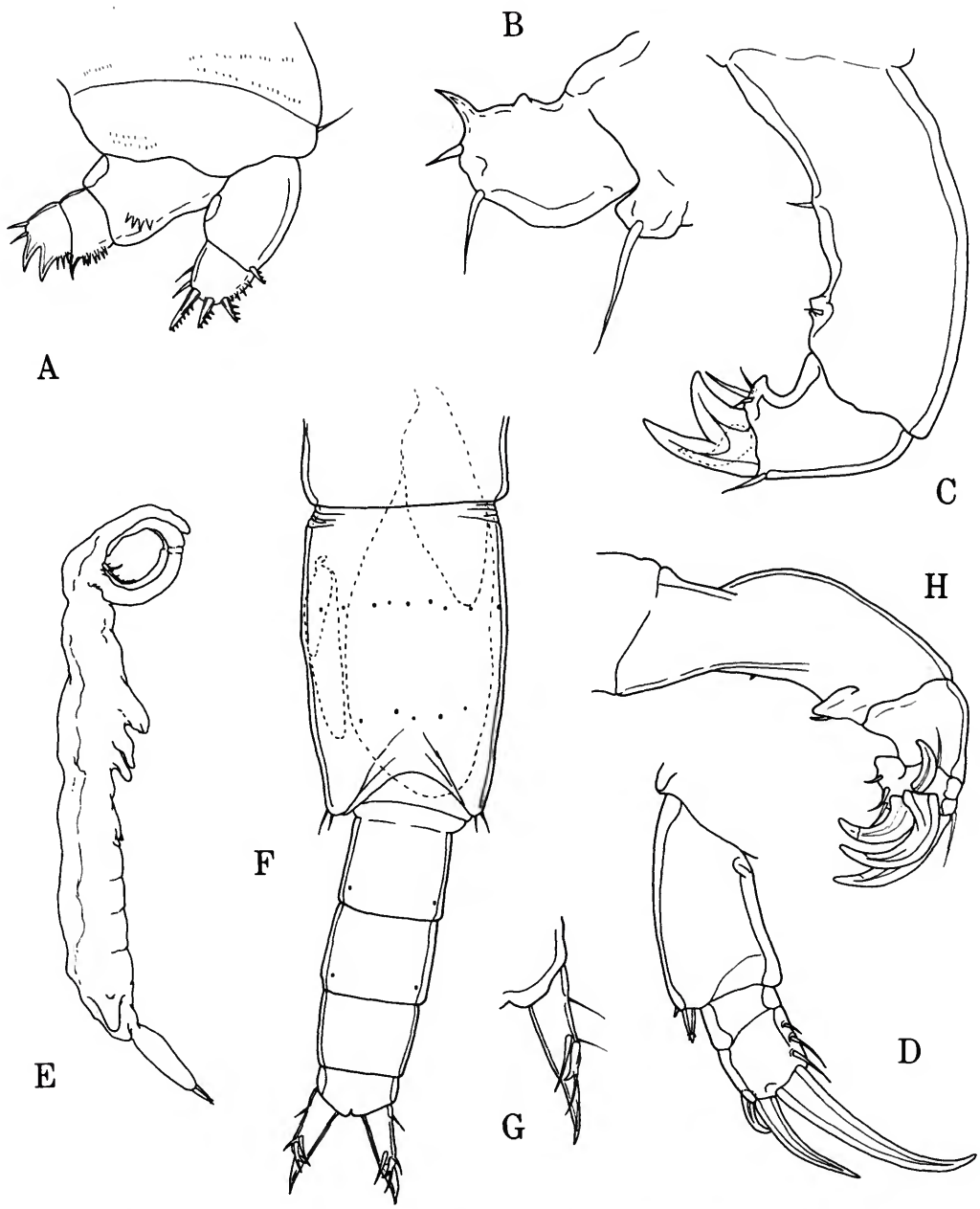

FIGURE 39.—*Shiinoa inauris* Cressey, female: *a*, leg 2; *b*, leg 3; male: *c*, second antenna; *d*, exopod of leg 2. *Shiinoa occlusa* Kabata, female: *e*, lateral; male: *f*, genital segment and abdomen; *g*, caudal ramus; *h*, second antenna.

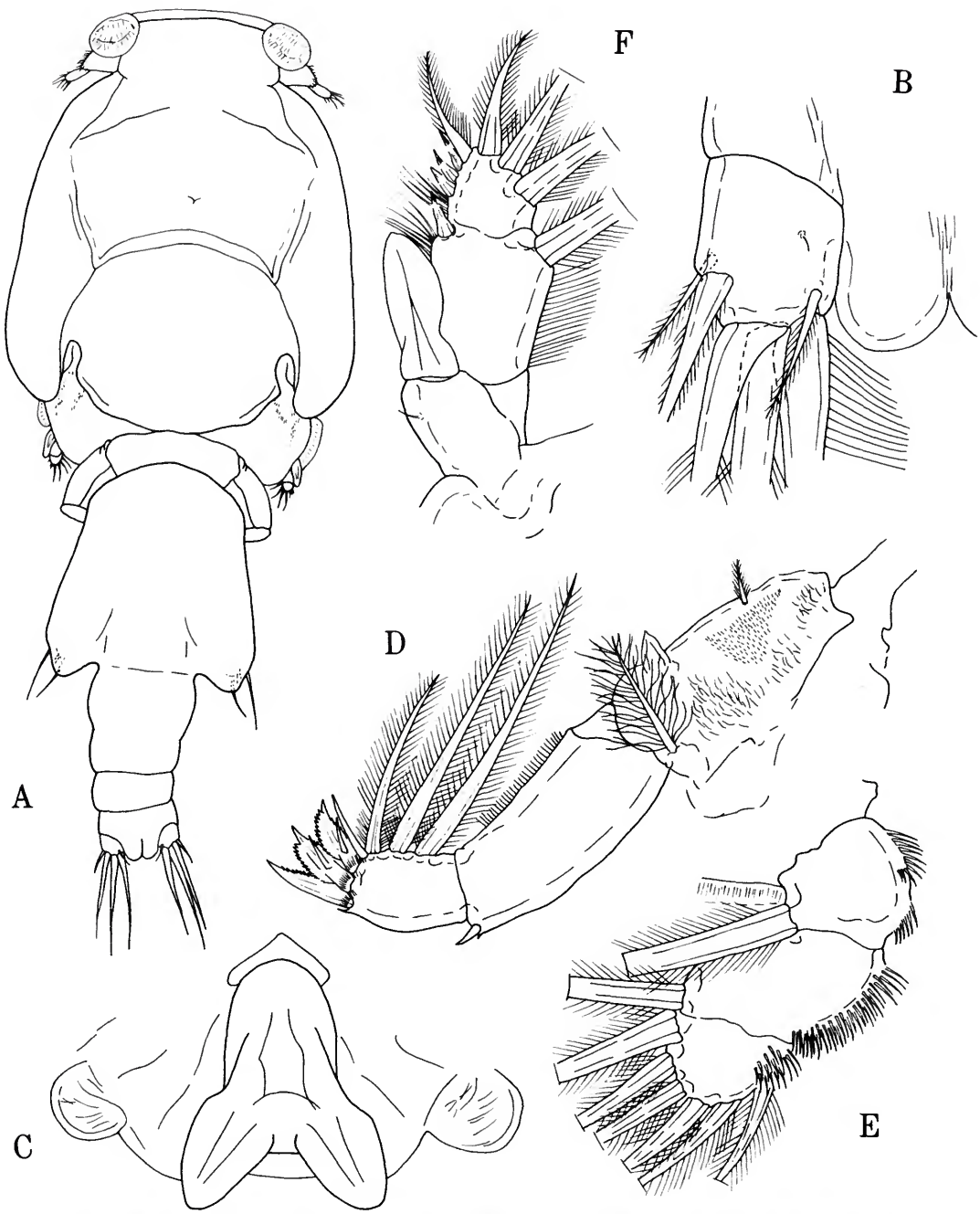

FIGURE 40.—*Caligus coryphaenae* Steenstrup and Lütken, female: *a*, dorsal; *b*, caudal ramus, ventral; *c*, sternal furca; *d*, leg 1; *e*, leg 2 endopod; *f*, leg 3 exopod.

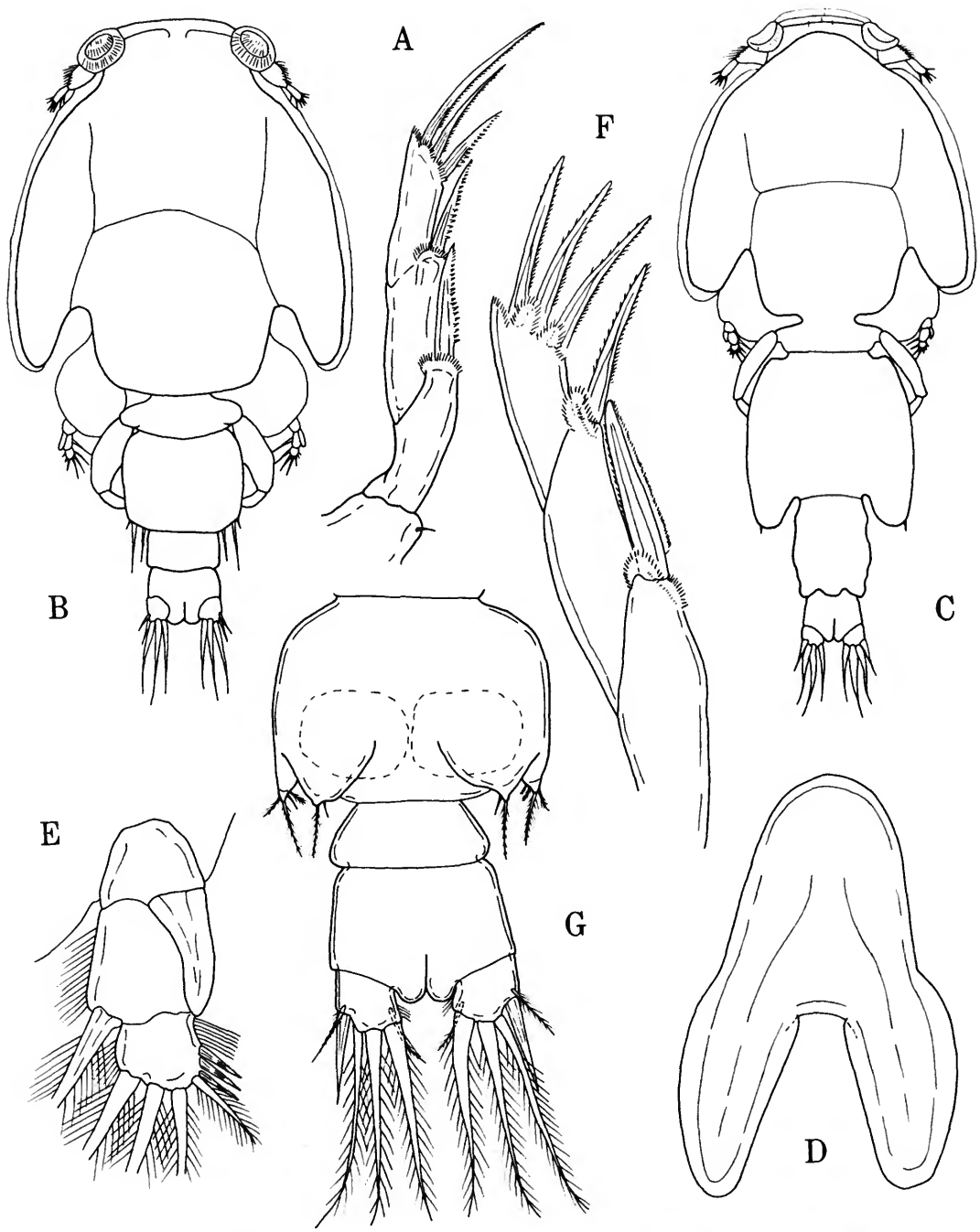

FIGURE 41.—*Caligus coryphaenae* Steenstrup and Lütken, female: *a*, leg 4 exopod; male: *b*, dorsal. *Caligus regalis* Leigh-Sharpe, female: *c*, dorsal; *d*, sternal furca; *e*, leg 3 exopod; *f*, leg 4 exopod; male: *g*, genital segment and abdomen, ventral.

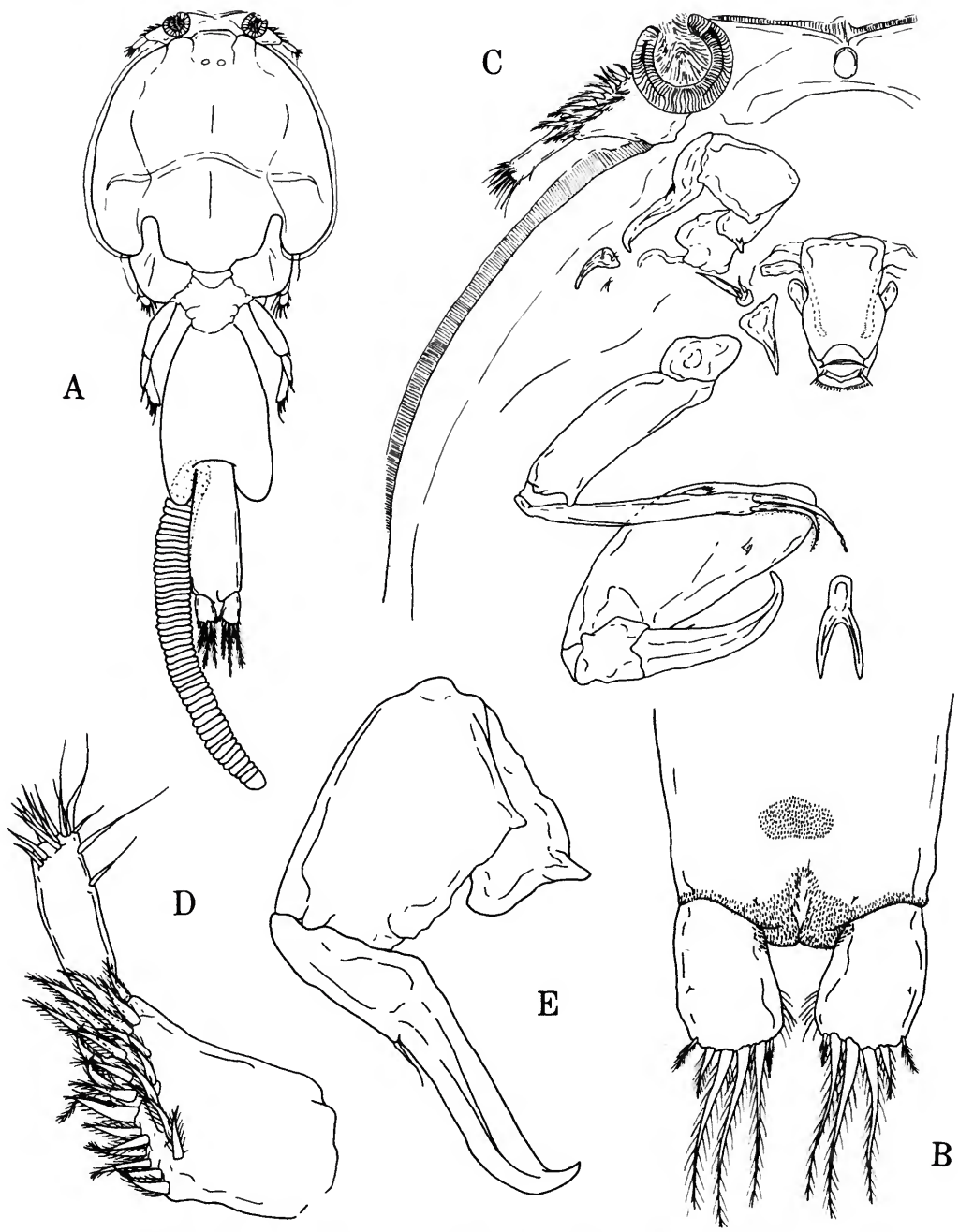

FIGURE 42.—*Caligus productus* Müller, female: *a*, dorsal; *b*, last abdominal segment and caudal rami, ventral; *c*, oral area; *d*, first antenna; *e*, second antenna.

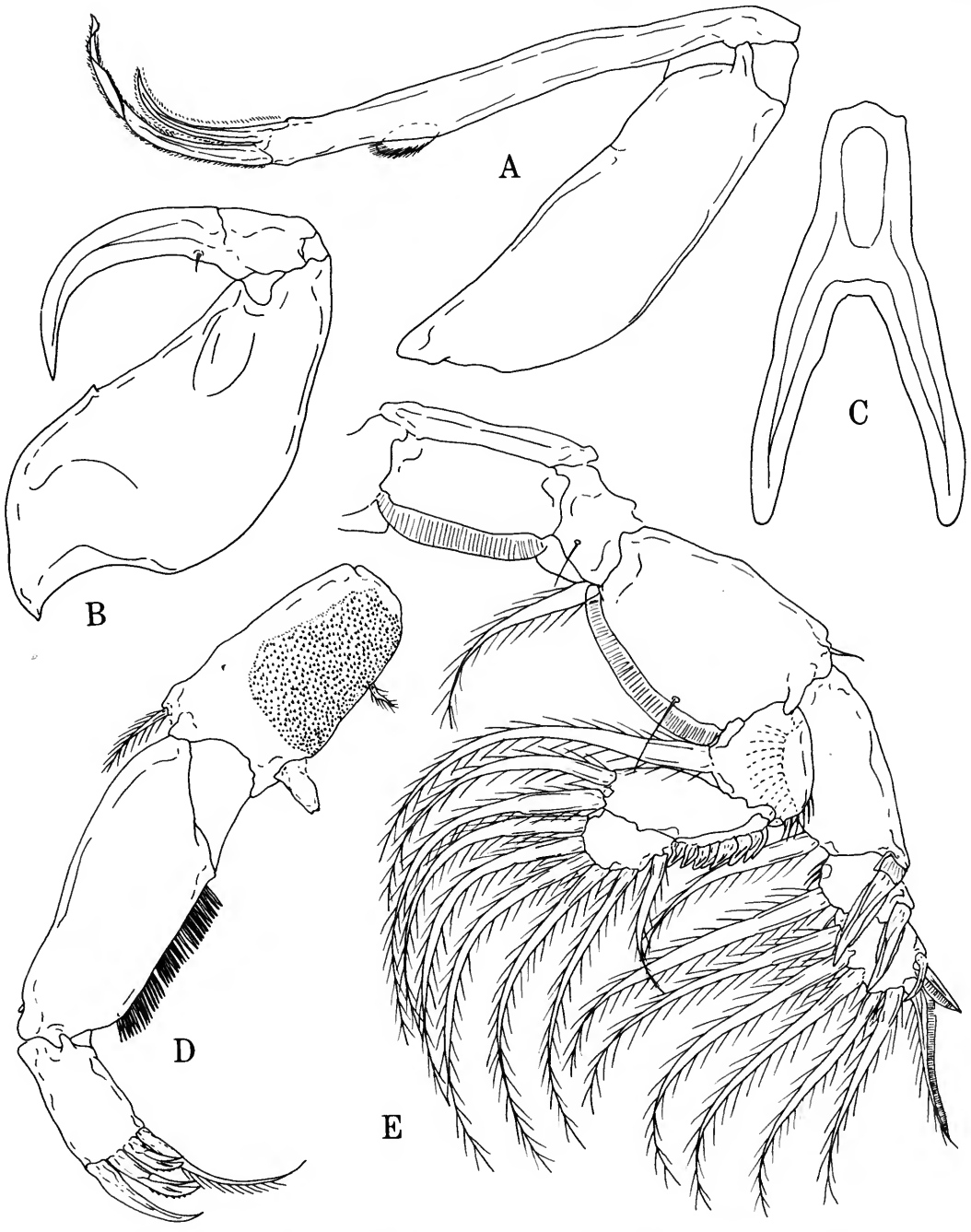

FIGURE 43.—*Caligus productus* Müller, female: *a*, second maxilla; *b*, maxilliped; *c*, sternal furca; *d*, leg 1; *e*, leg 2.

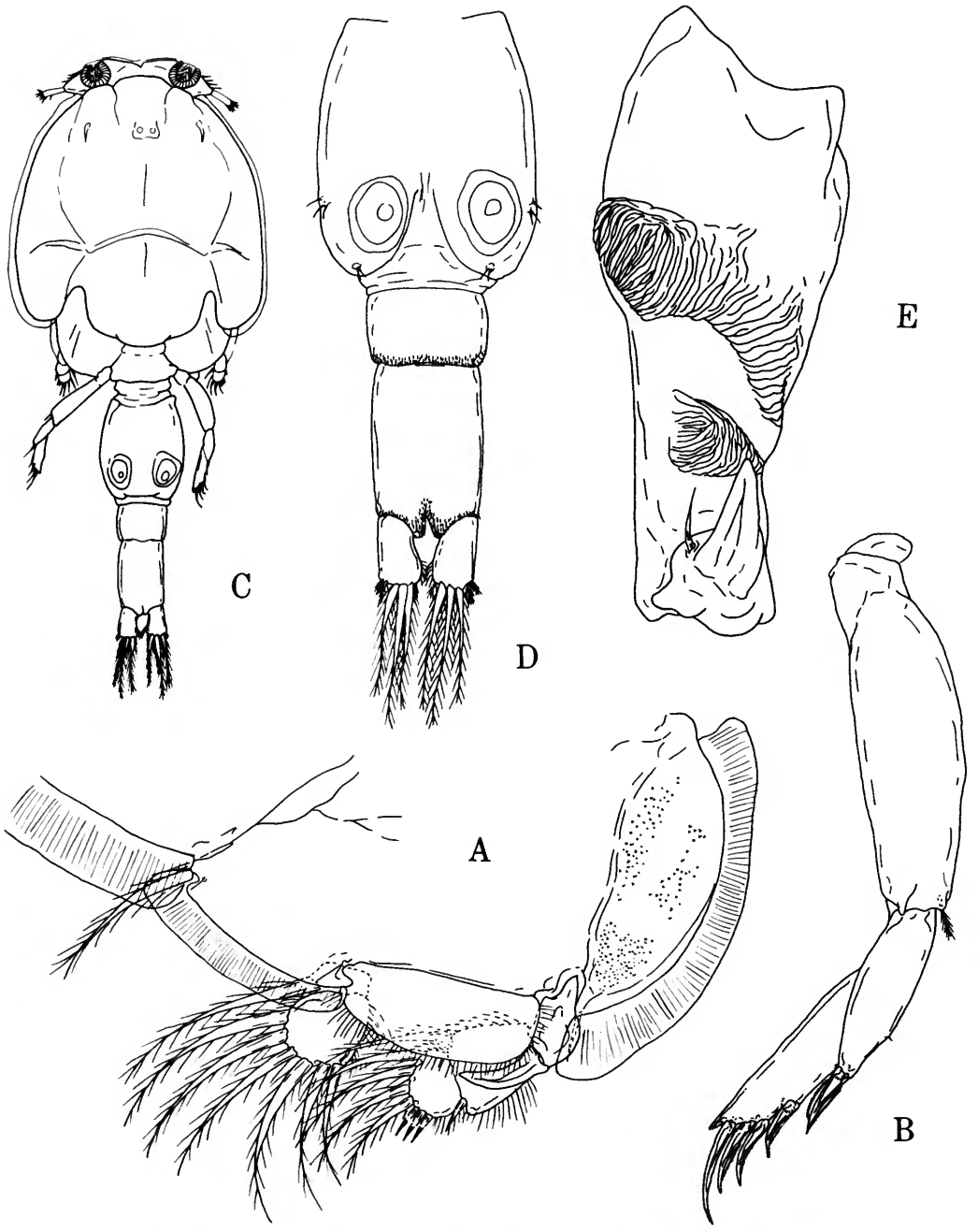

FIGURE 44.—*Caligus productus* Müller, female: *a*, leg 3; *b*, leg 4; male: *c*, dorsal; *d*, genital segment and abdomen; *e*, second antenna.

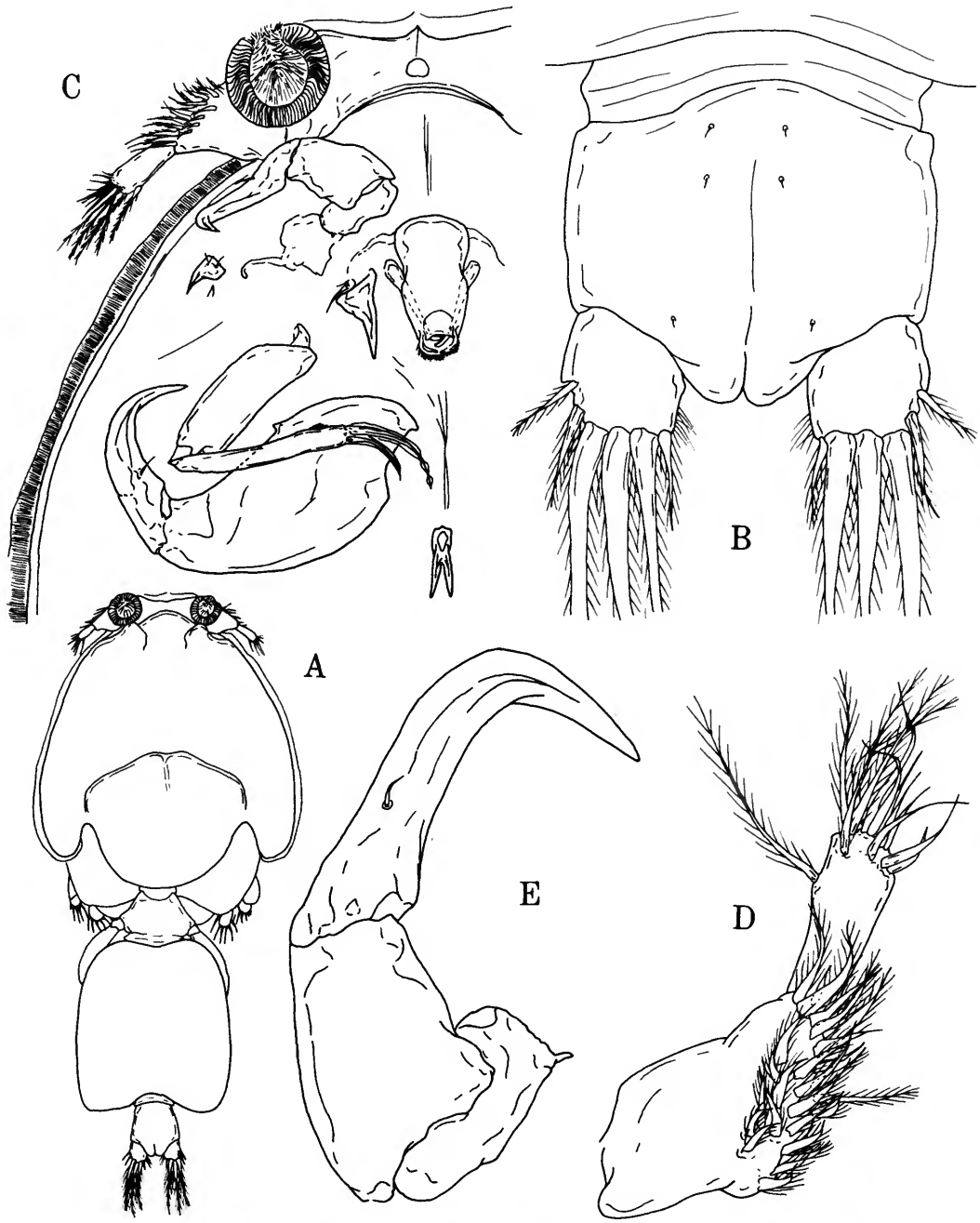

FIGURE 45.—*Caligus asymmetricus* Kabata, female: *a*, dorsal; *b*, abdomen and caudal rami, ventral; *c*, oral area; *d*, first antenna; *e*, second antenna.

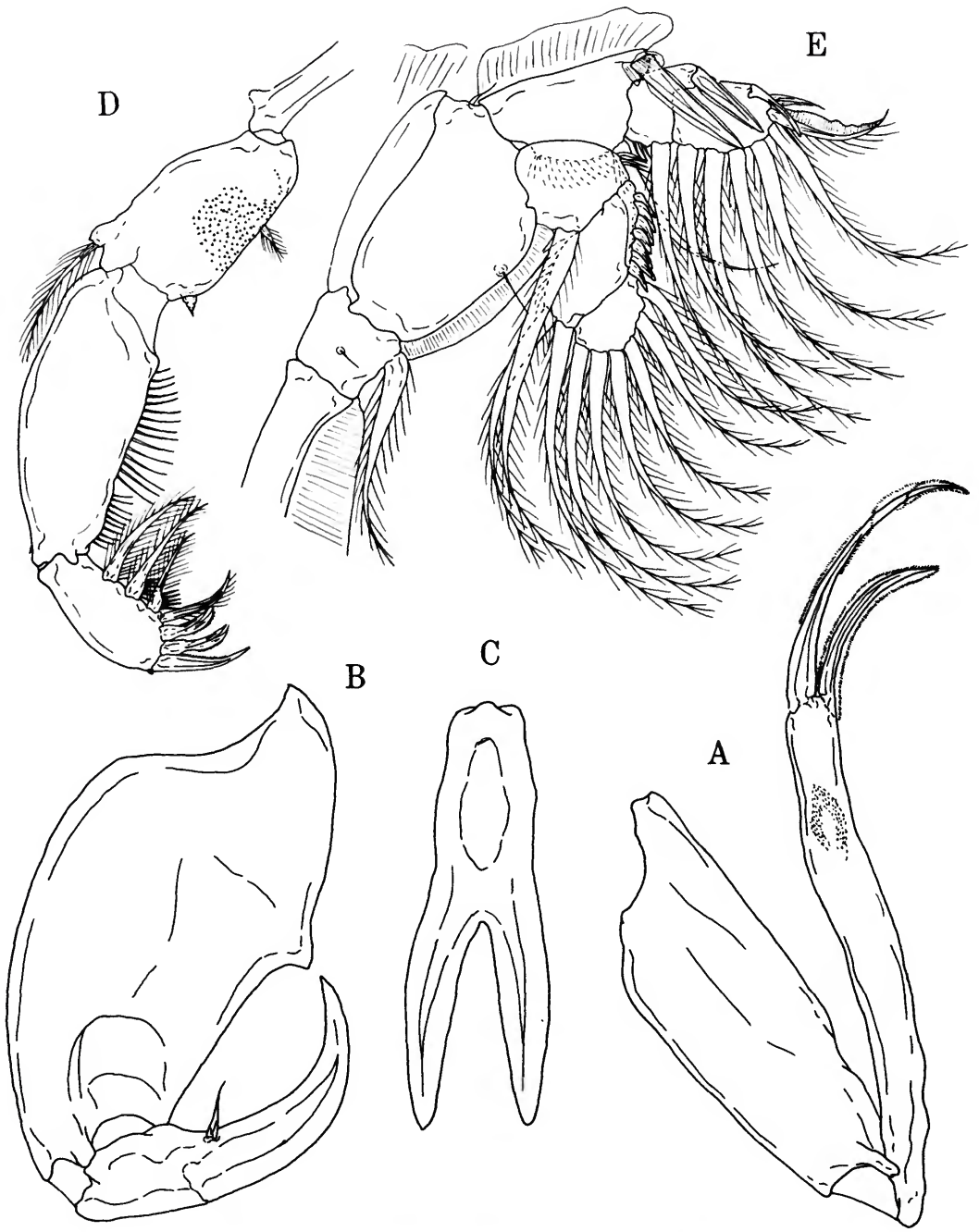

FIGURE 46.—*Caligus asymmetricus* Kabata, female: *a*, second maxilla; *b*, maxilliped; *c*, sternal furca; *d*, leg 1; *e*, leg 2.

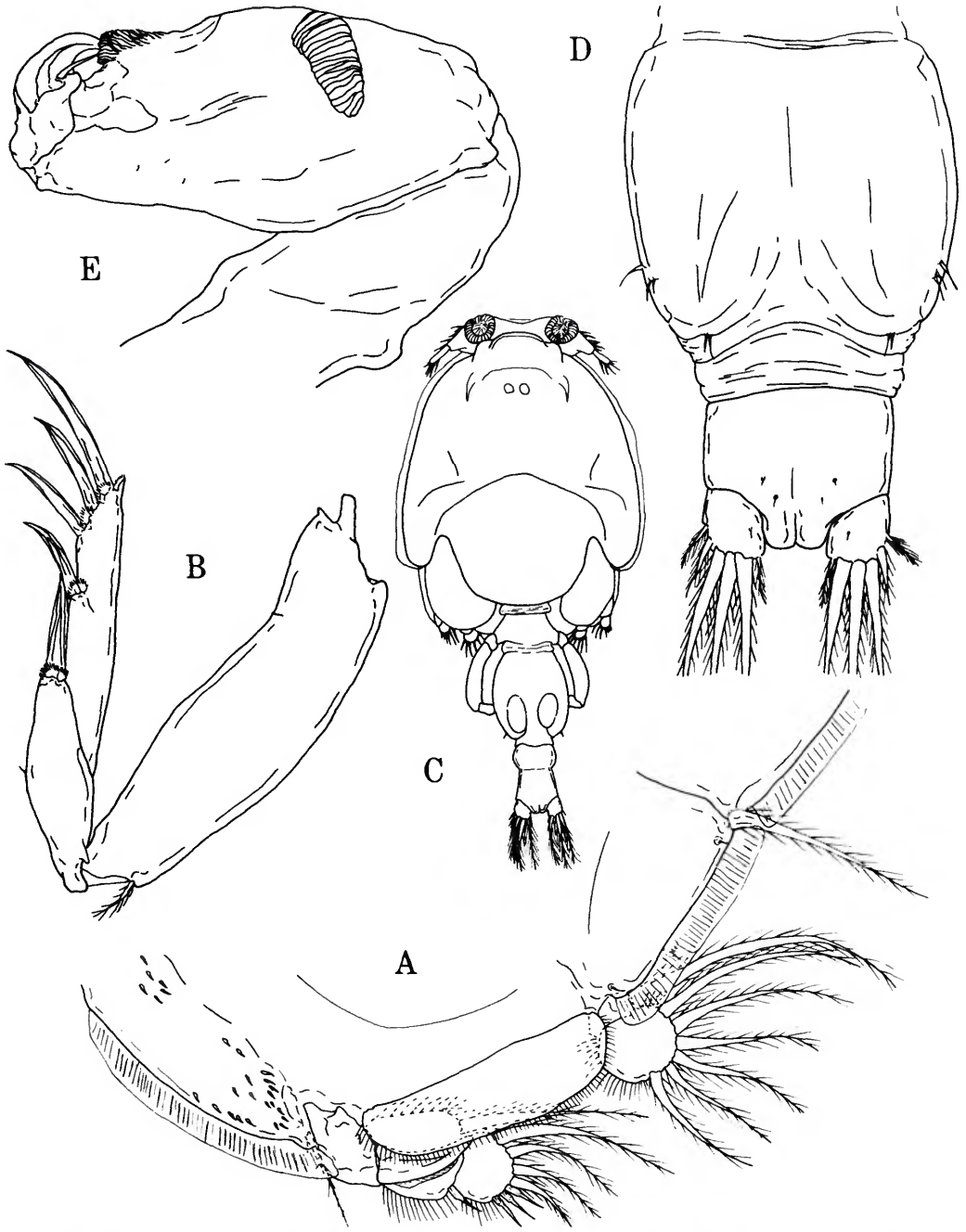

FIGURE 47.—*Caligus asymmetricus* Kabata, female: *a*, leg 3; *b*, leg 4; male: *c*, dorsal; *d*, genital segment and abdomen, ventral; *e*, second antenna.

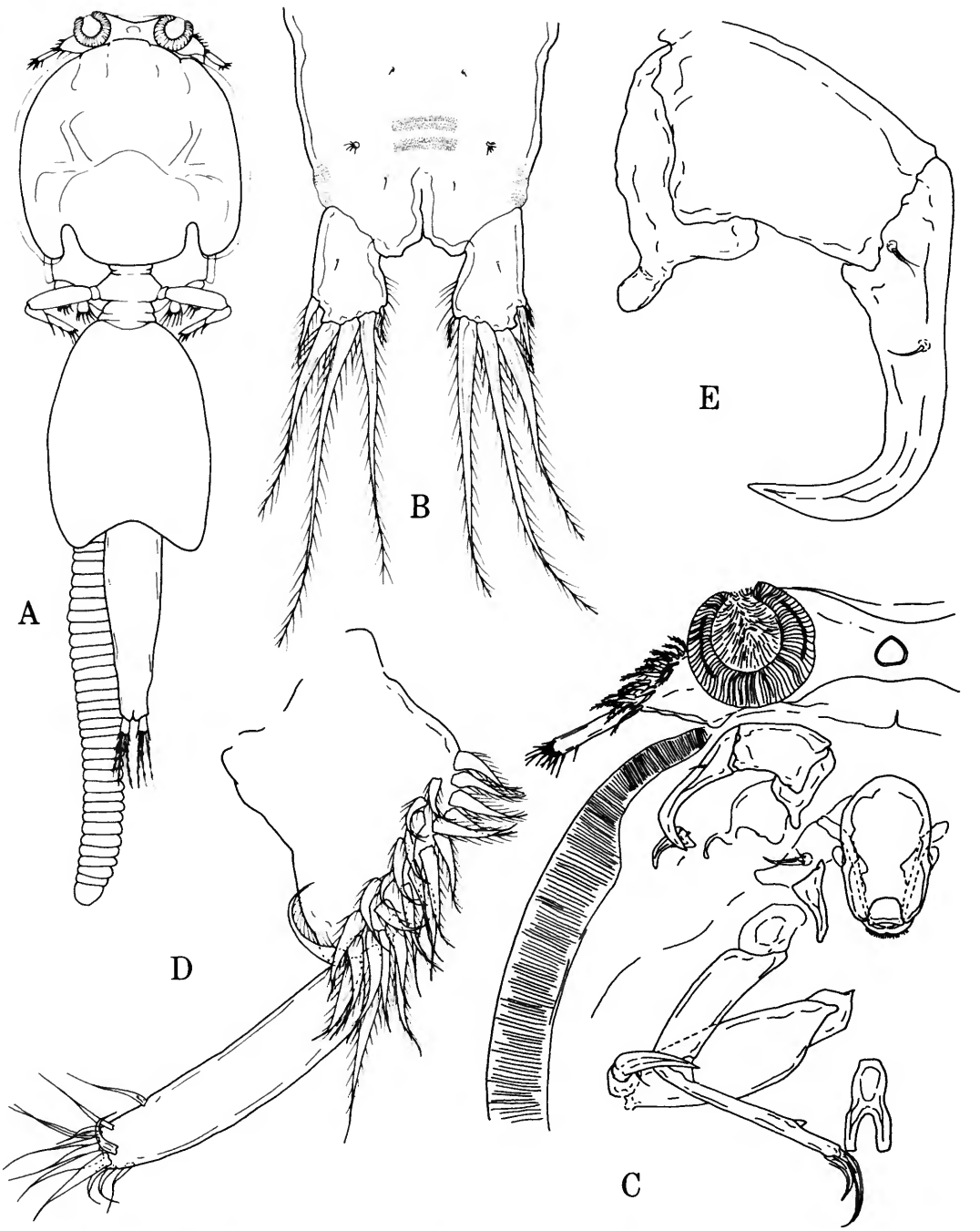

FIGURE 48.—*Caligus bonito* Wilson, female: *a*, dorsal; *b*, posterior portion of abdomen and caudal rami, ventral; *c*, oral area; *d*, first antenna; *e*, second antenna.

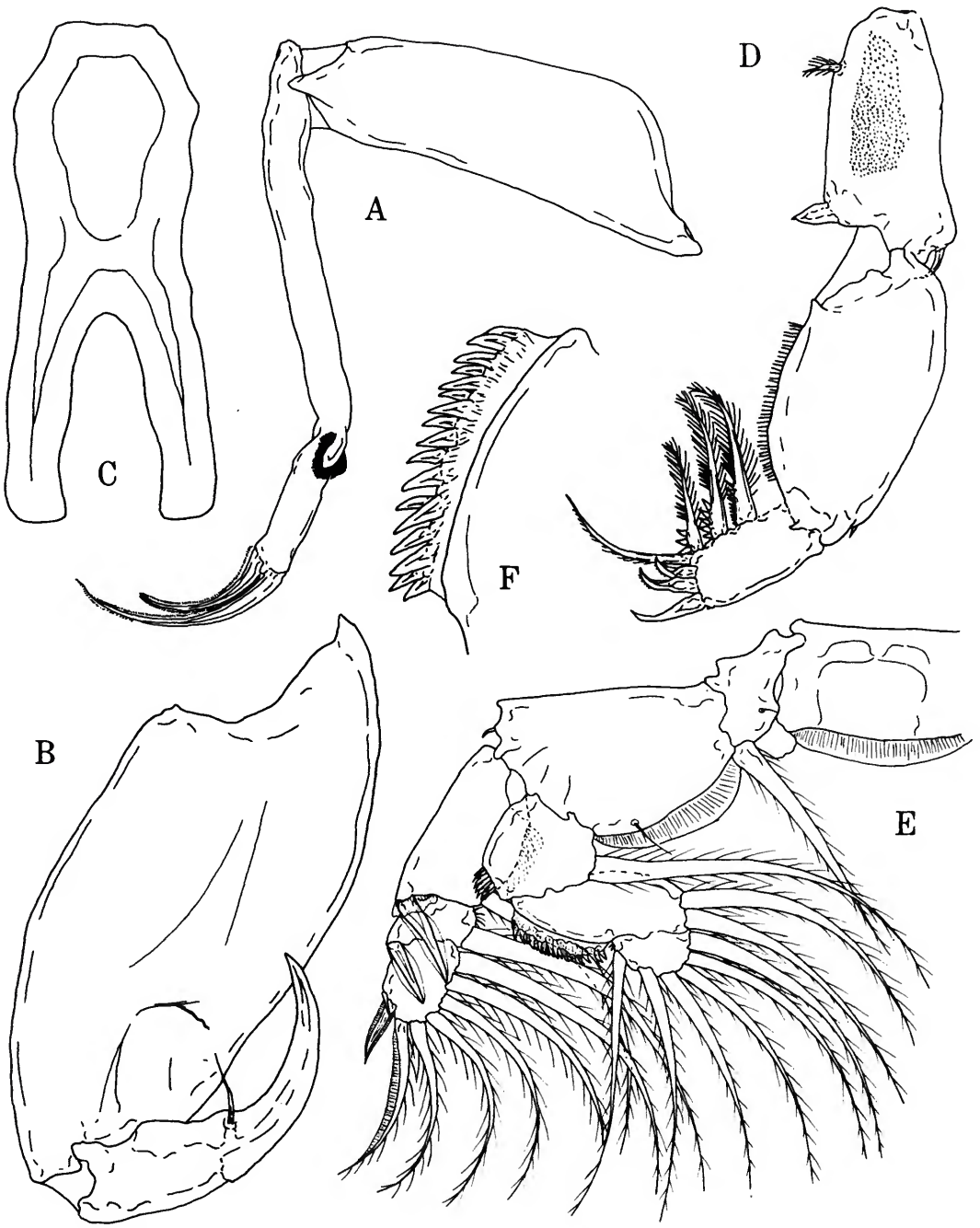

FIGURE 49.—*Caligus bonito* Wilson, female: *a*, second maxilla; *b*, maxilliped; *c*, sternal furca; *d*, leg 1; *e*, leg 2; *f*, detail of outer edge of leg 2 endopod second segment.

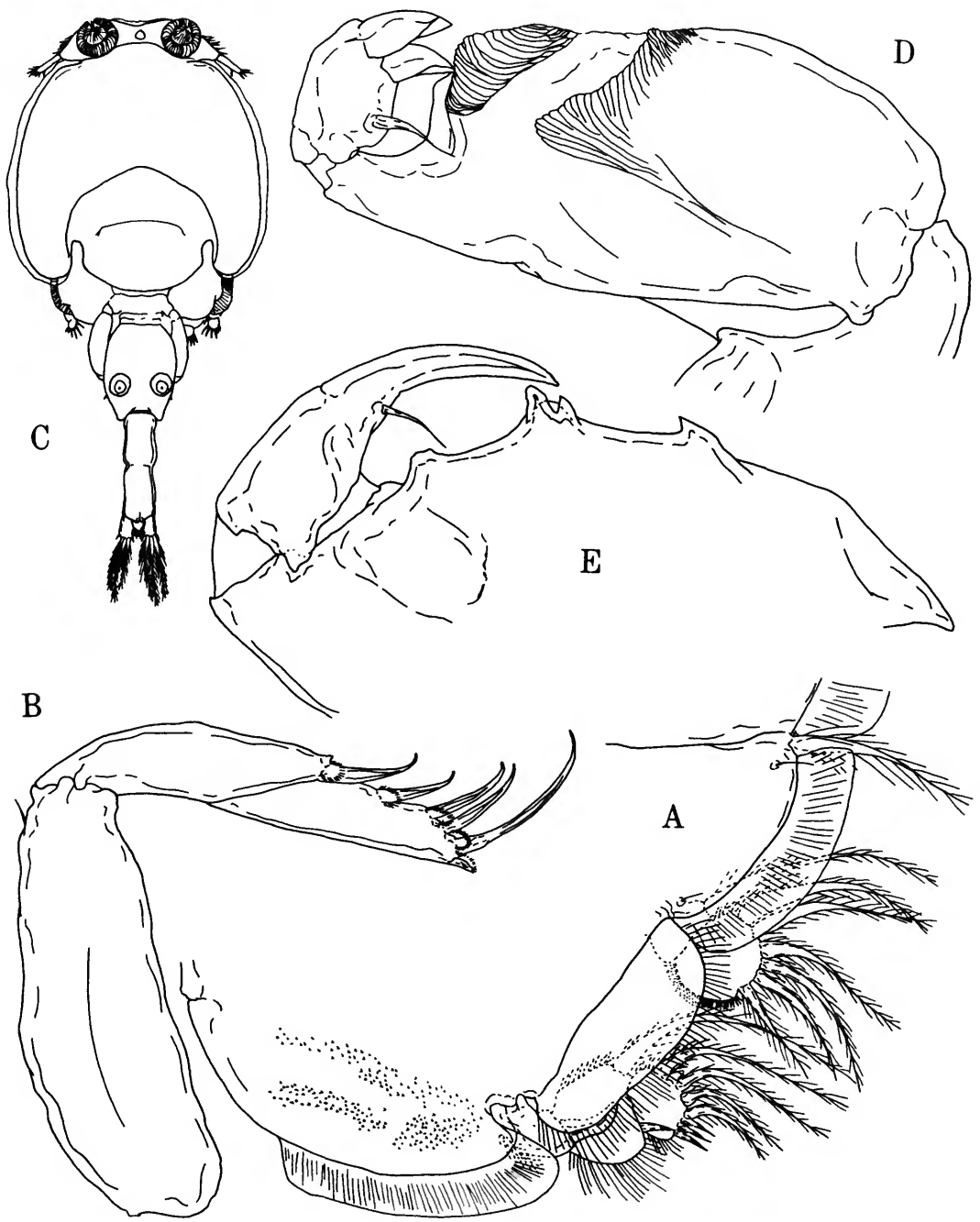

FIGURE 50.—*Caligus bonito* Wilson, female: *a*, leg 3; *b*, leg 4; male: *c*, dorsal; *d*, second antenna; *e*, distal portion of maxilliped.

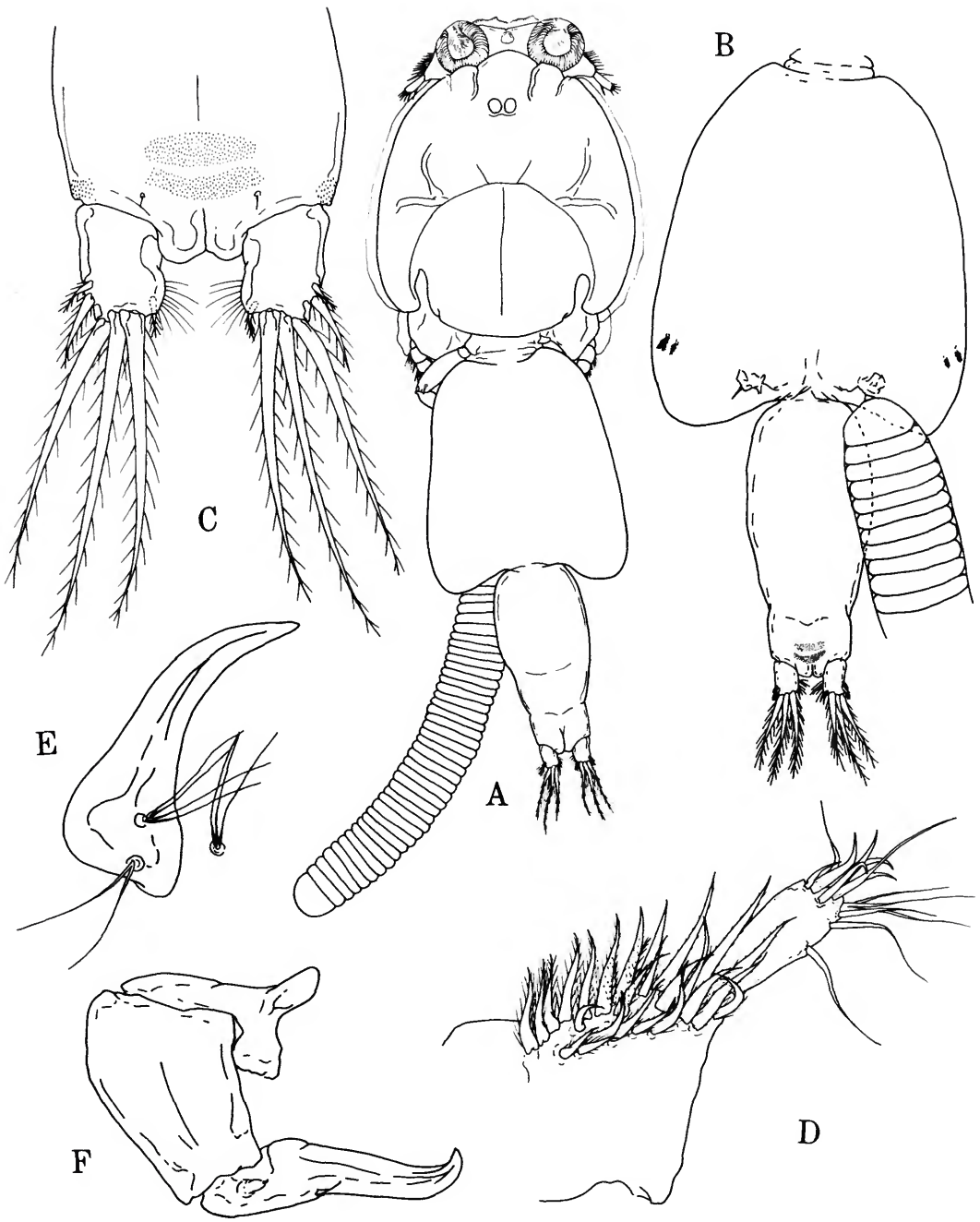

FIGURE 51.—*Caligus mutabilis* Wilson, female: *a*, dorsal; *b*, genital segment and abdomen, ventral; *c*, last abdominal segment and caudal rami, ventral; *d*, first antenna; *e*, postantennal process; *f*, second antenna.

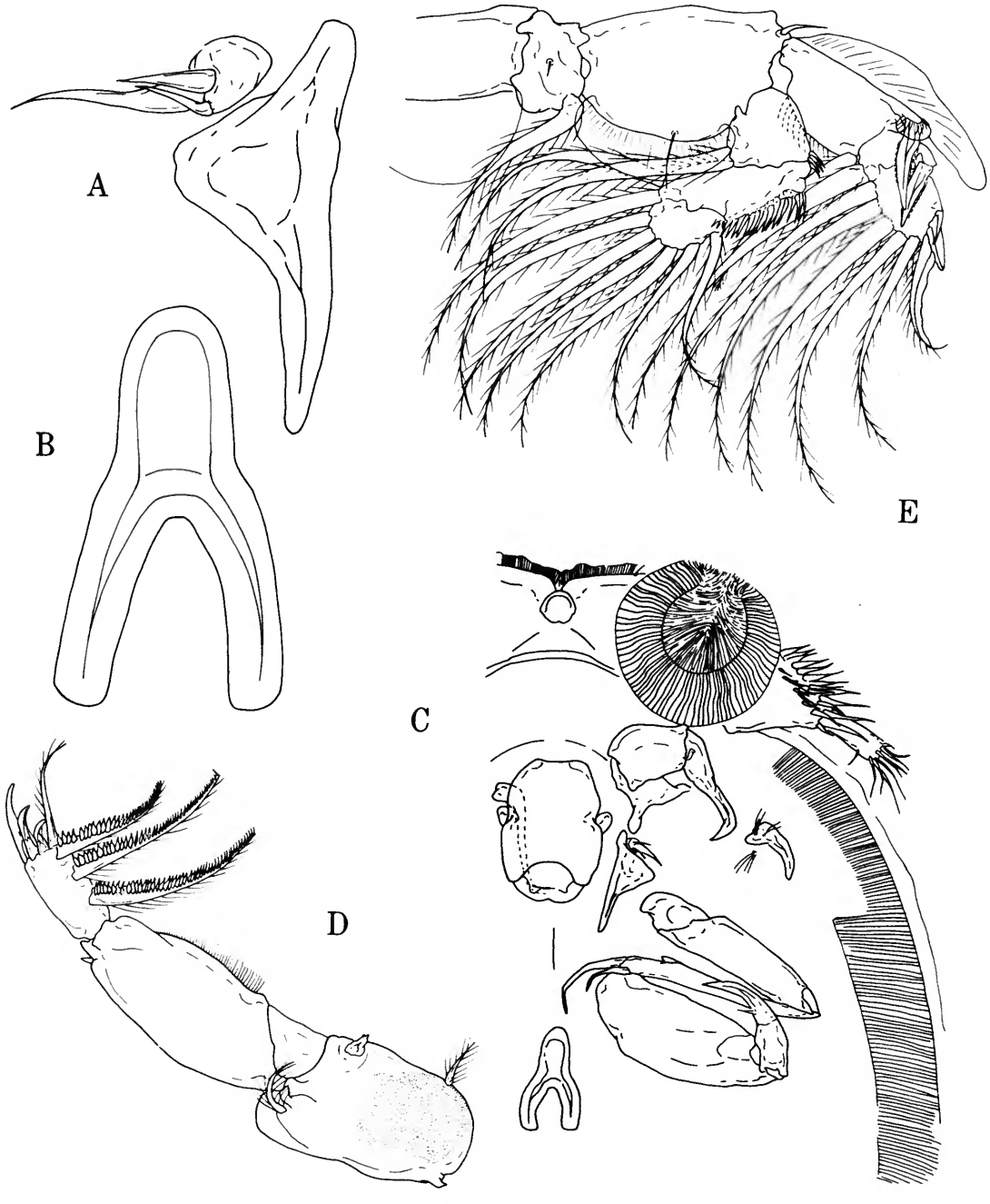

FIGURE 52.—*Caligus mutabilis* Wilson, female: *a*, postoral process; *b*, sternal furca; *c*, oral area; *d*, leg 1; *e*, leg 2.

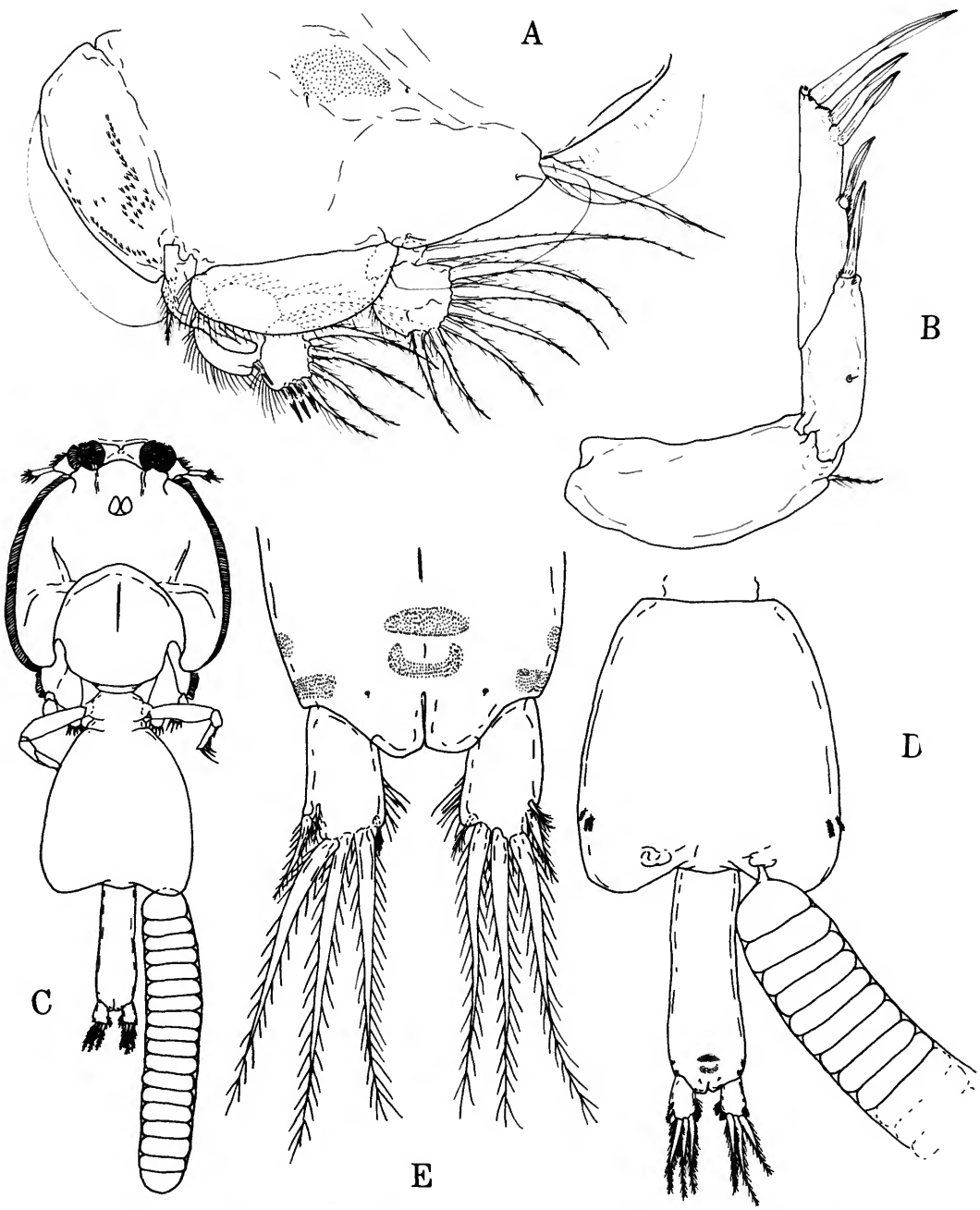

FIGURE 53.—*Caligus mutabilis* Wilson, female: *a*, leg 3; *b*, leg 4. *Caligus omissus*, new species; female: *c*, dorsal; *d*, genital segment and abdomen, ventral; *e*, last abdominal segment and caudal rami, ventral.

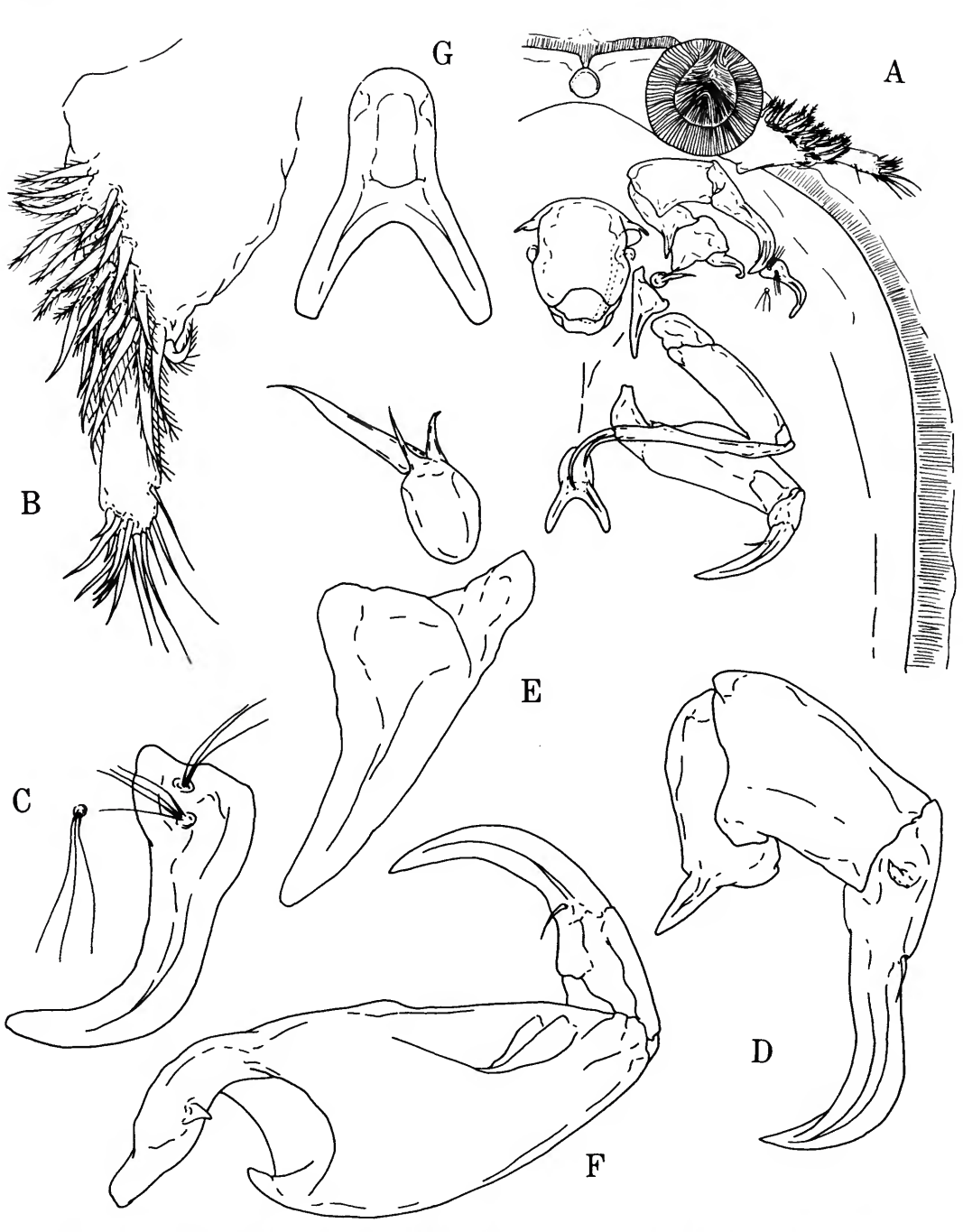

FIGURE 54.—*Caligus omissus*, new species, female: *a*, oral area; *b*, first antenna; *c*, postantennal process; *d*, second antenna; *e*, postoral process; *f*, maxilliped; *g*, sternal furca.

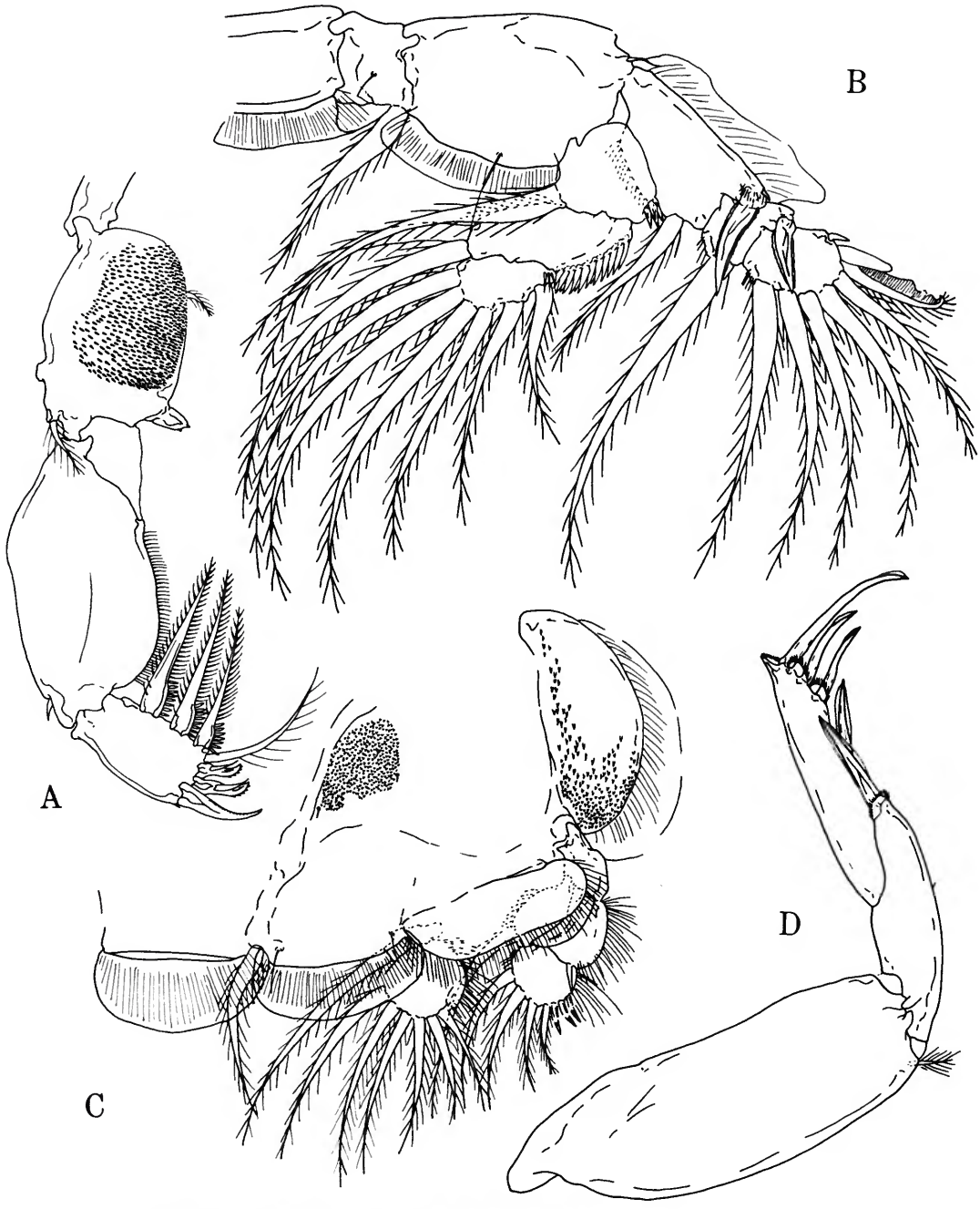

FIGURE 55.—*Caligus omissus*, new species, female: *a*, leg 1; *b*, leg 2; *c*, leg 3; *d*, leg 4.

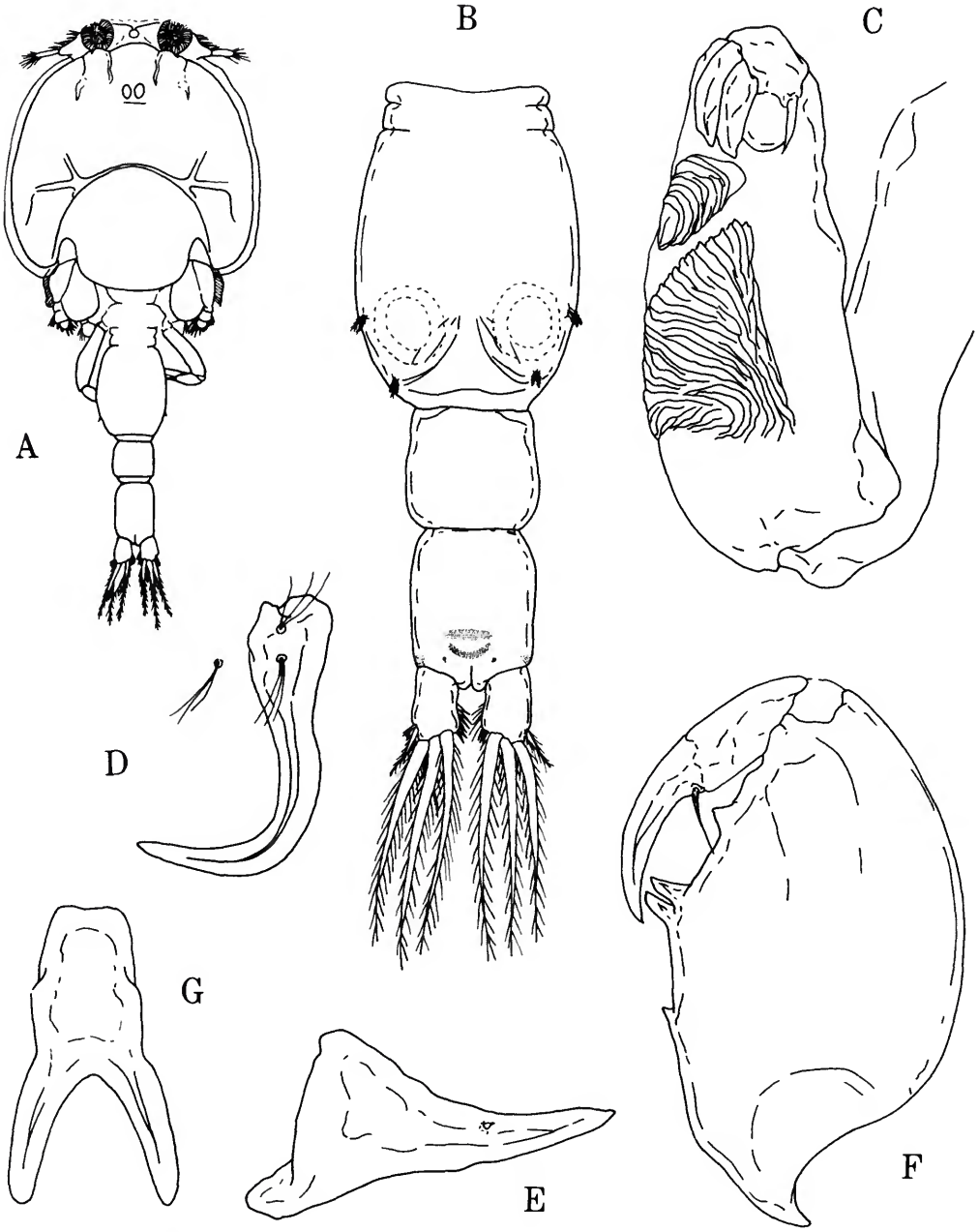

FIGURE 56.—*Caligus omissus*, new species, male: *a*, dorsal; *b*, genital segment and abdomen, ventral; *c*, second antenna; *d*, postantennal process; *e*, postoral process; *f*, maxilliped; *g*, sternal furca.

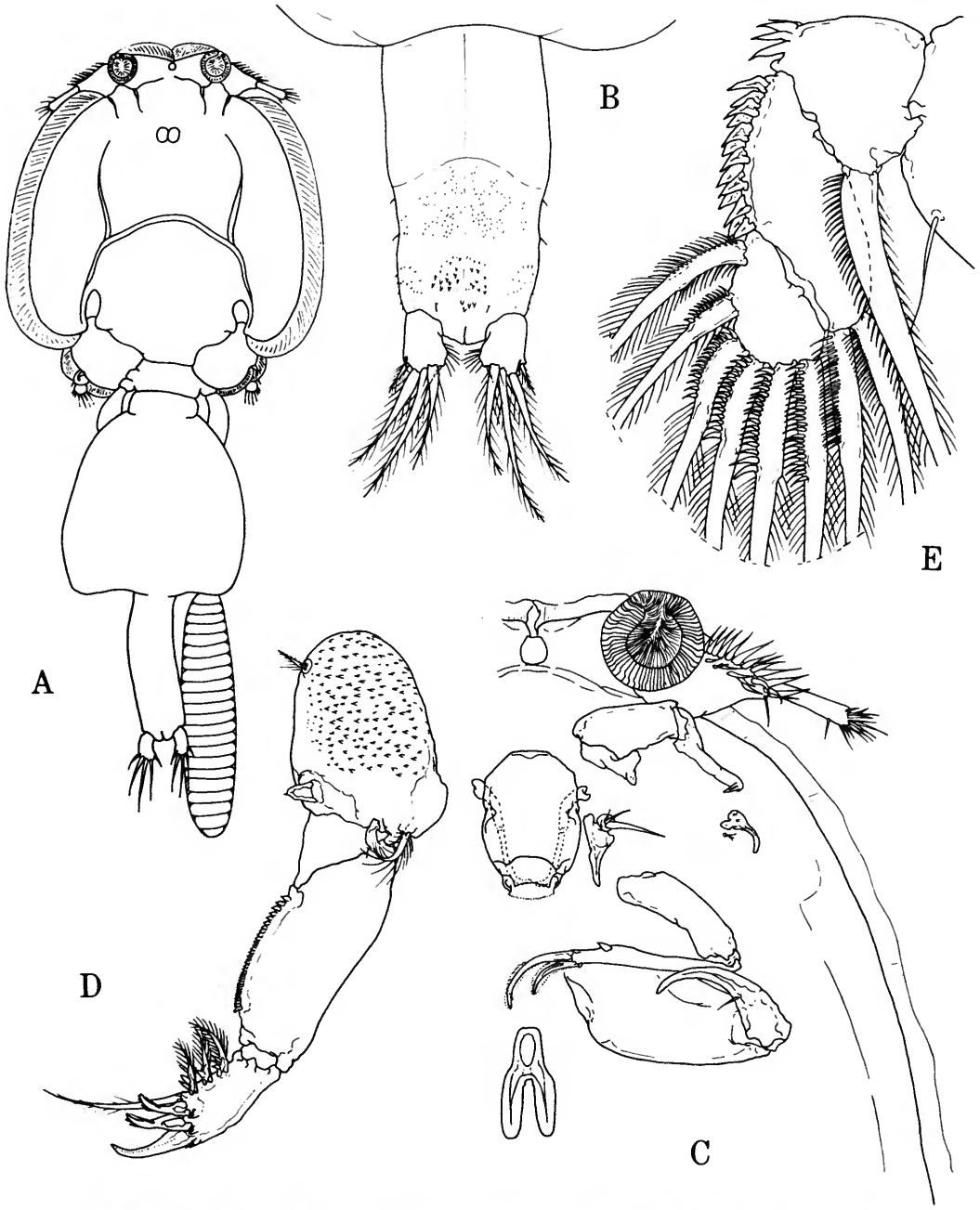

FIGURE 57.—*Caligus biseriodentatus* Shen, female: *a*, dorsal; *b*, abdomen and caudal rami, ventral; *c*, cephalon, ventral; *d*, leg 1; *e*, leg 2 endopod.

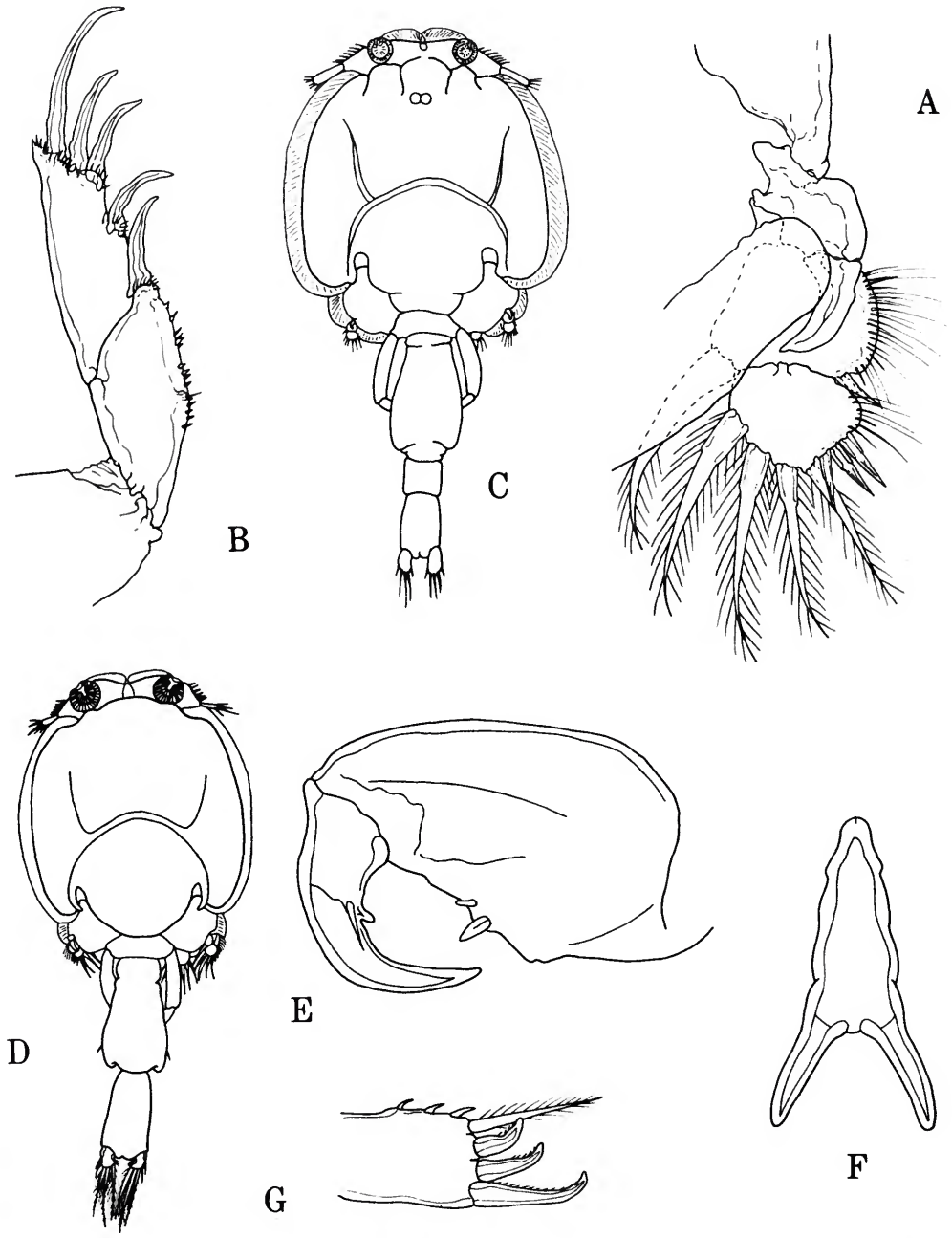

FIGURE 58.—*Caligus biseriodentatus* Shen, female: *a*, leg 3 exopod; *b*, leg 4; male: *c*, dorsal; immature female: *d*, dorsal; *e*, maxilliped; *f*, sternal furca; *g*, leg 1 last segment.

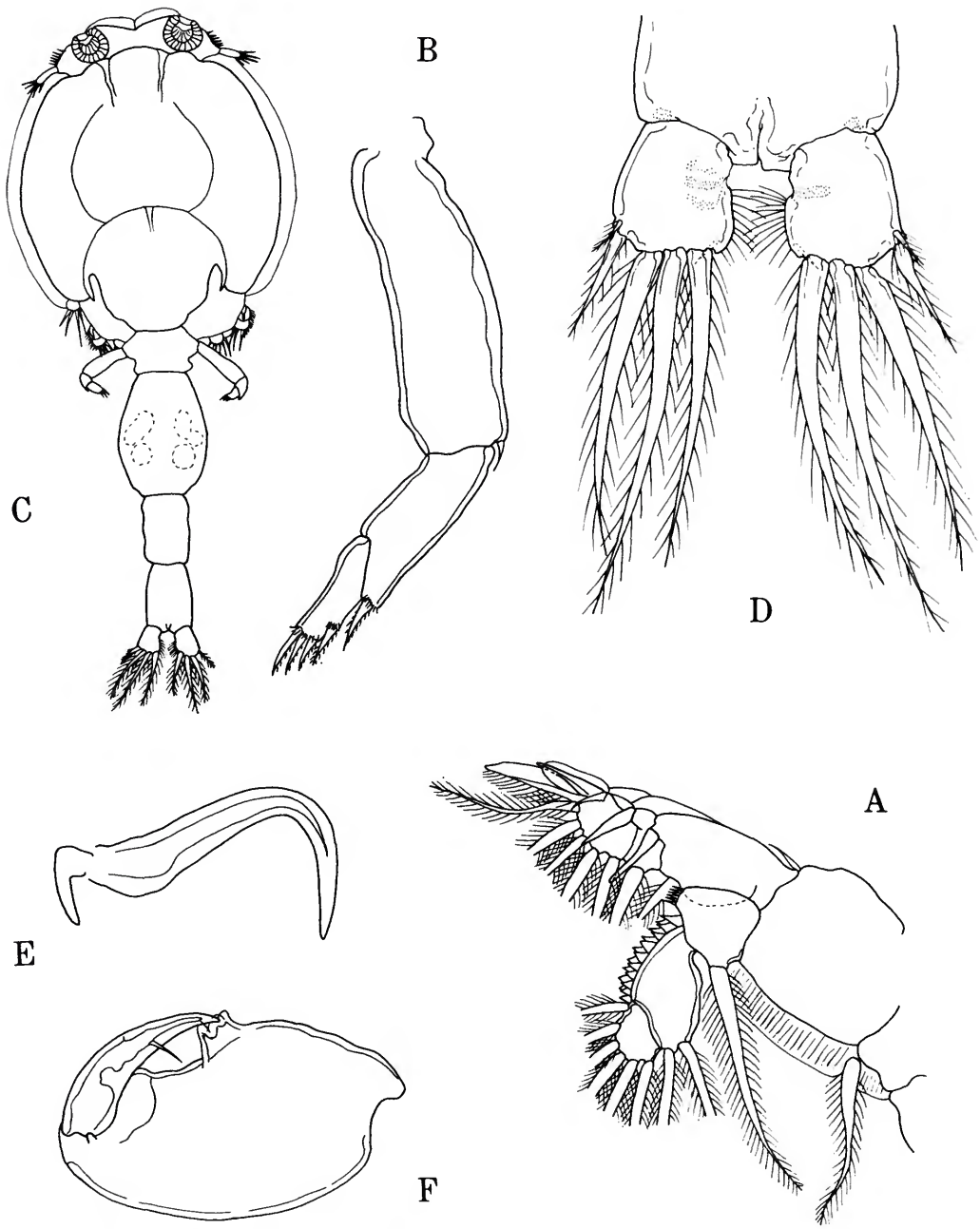

FIGURE 59.—*Caligus biseriodentatus* Shen, immature female: *a*, leg 2; *b*, leg 4; immature male: *c*, dorsal; *d*, tip of abdomen and caudal ramus, ventral; *e*, postantennal process; *f*, maxilliped.

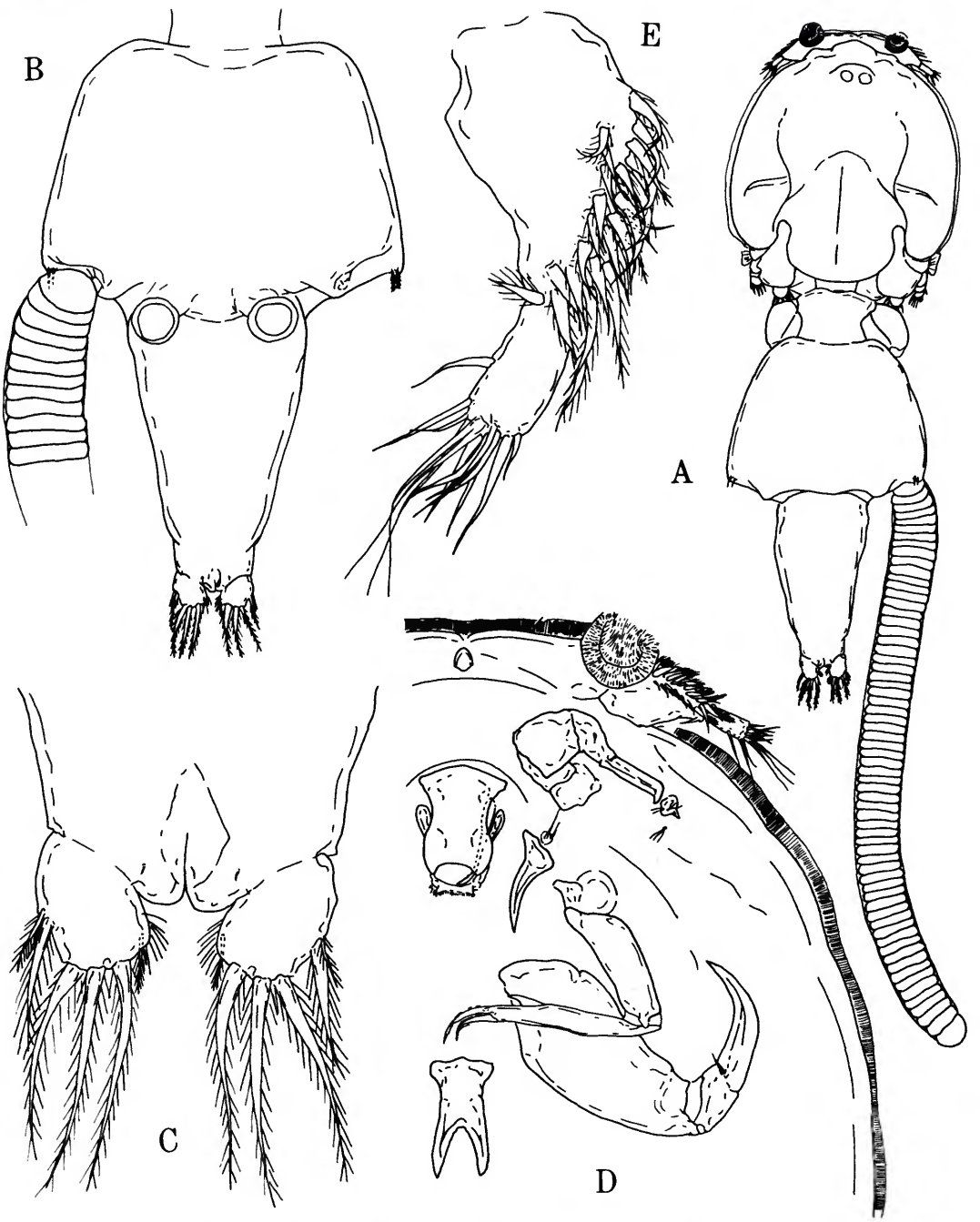

FIGURE 60.—*Caligus cybii* Bassett-Smith, female: *a*, dorsal; *b*, genital segment and abdomen, ventral; *c*, last abdominal segment and caudal rami, ventral; *d*, oral area; *e*, first antenna.

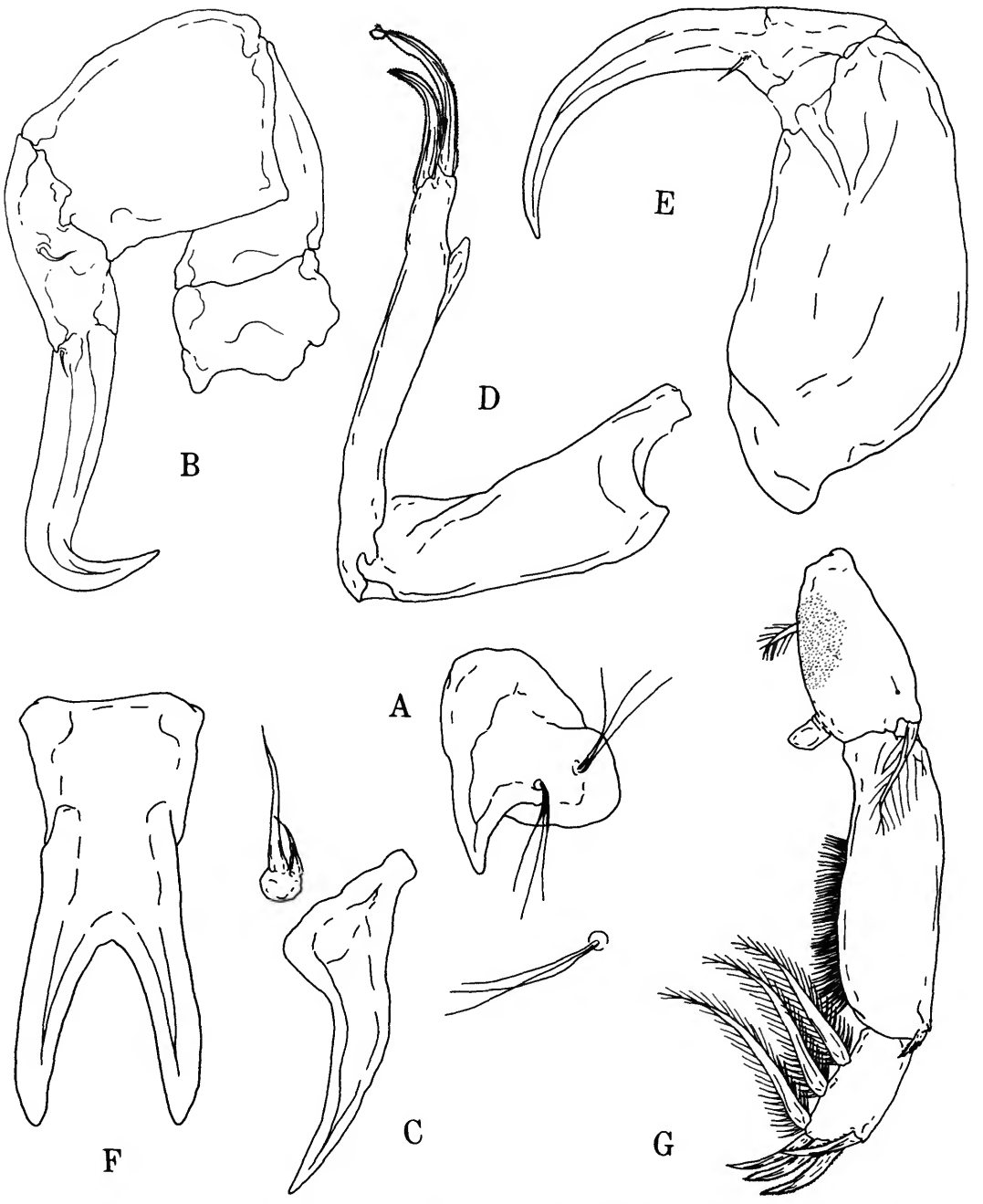

FIGURE 61.—*Caligus cybii* Bassett-Smith, female: *a*, postantennal process; *b*, second antenna; *c*, postoral process; *d*, second maxilla; *e*, maxilliped; *f*, sternal furca; *g*, leg 1.

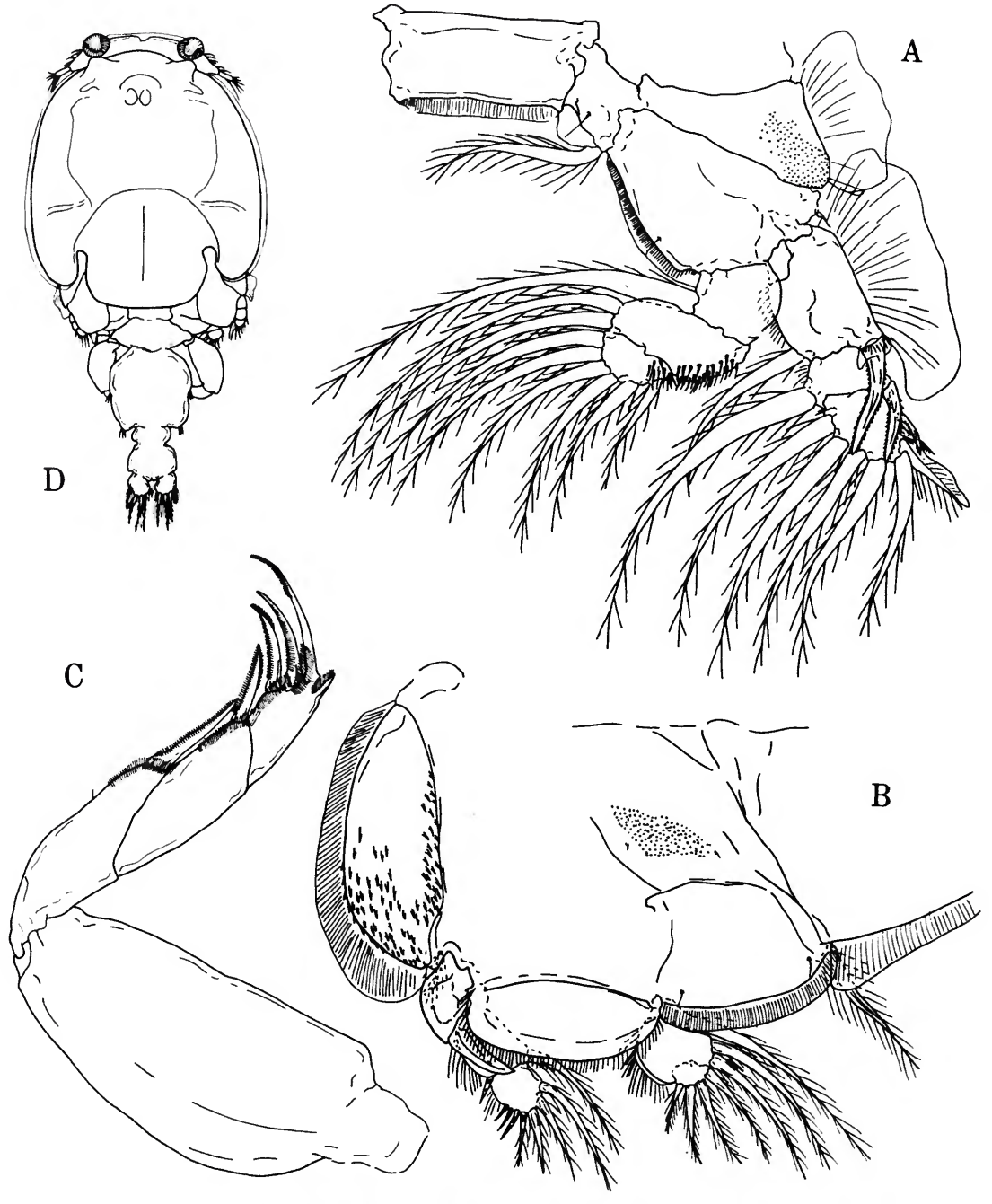

FIGURE 62.—*Caligus cybii* Bassett-Smith, female: *a*, leg 2; *b*, leg 3; *c*, leg 4; male: *d*, dorsal.

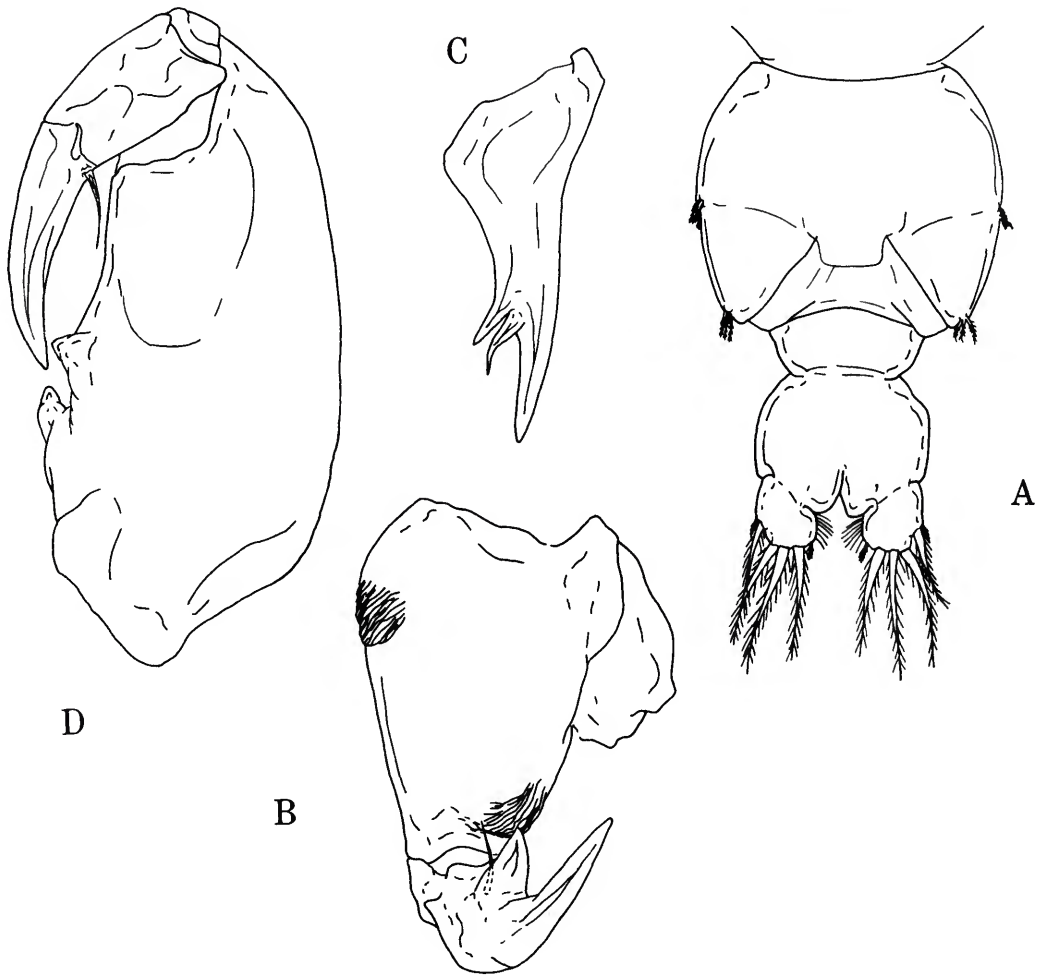

FIGURE 63.—*Caligus cybii* Bassett-Smith, male: *a*, genital segment and abdomen, ventral; *b*, second antenna; *c*, postoral process; *d*, maxilliped.

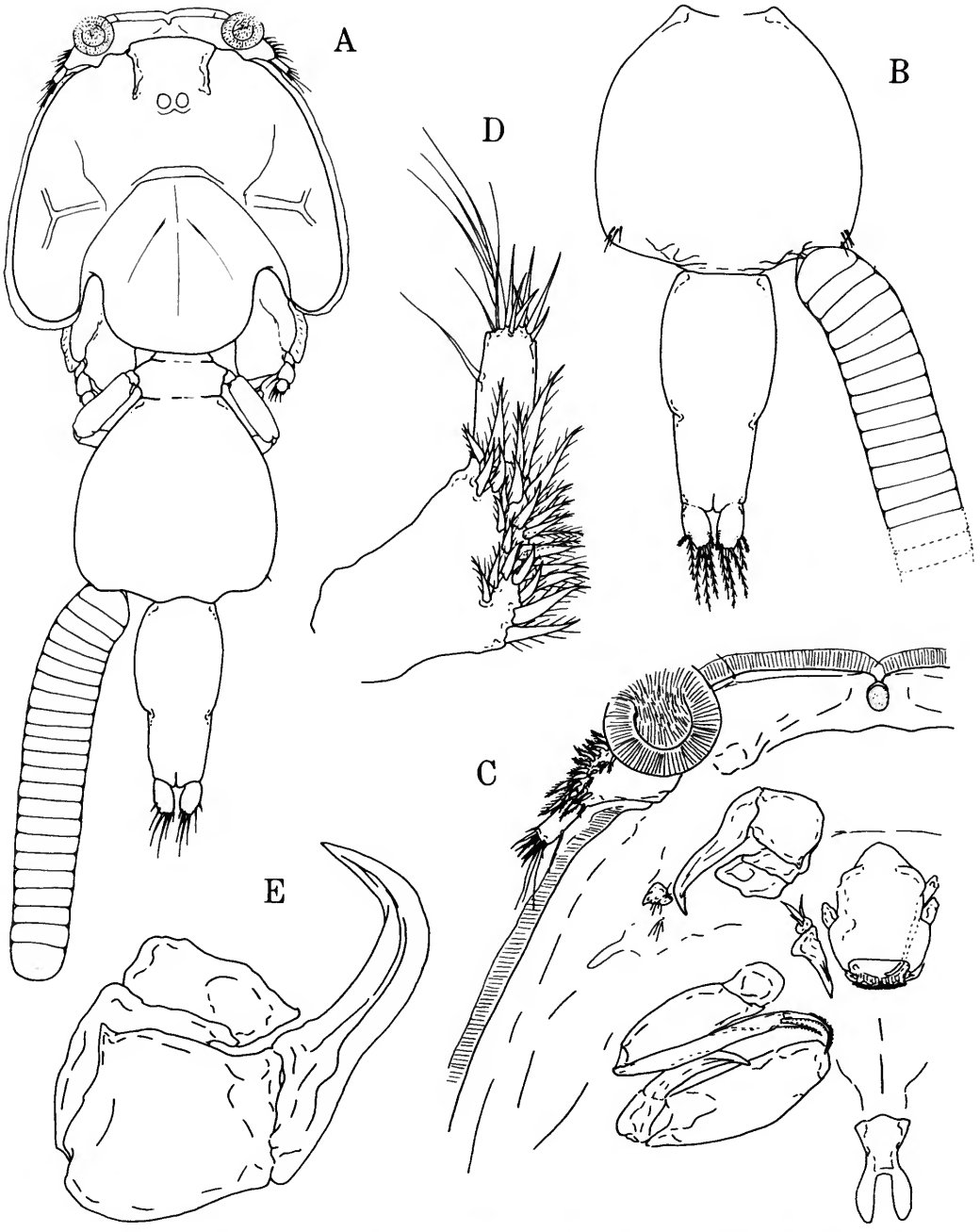

FIGURE 64.—*Caligus pelamydis* Kroyer, female: *a*, dorsal; *b*, genital segment and abdomen, ventral; *c*, oral area; *d*, first antenna; *e*, second antenna.

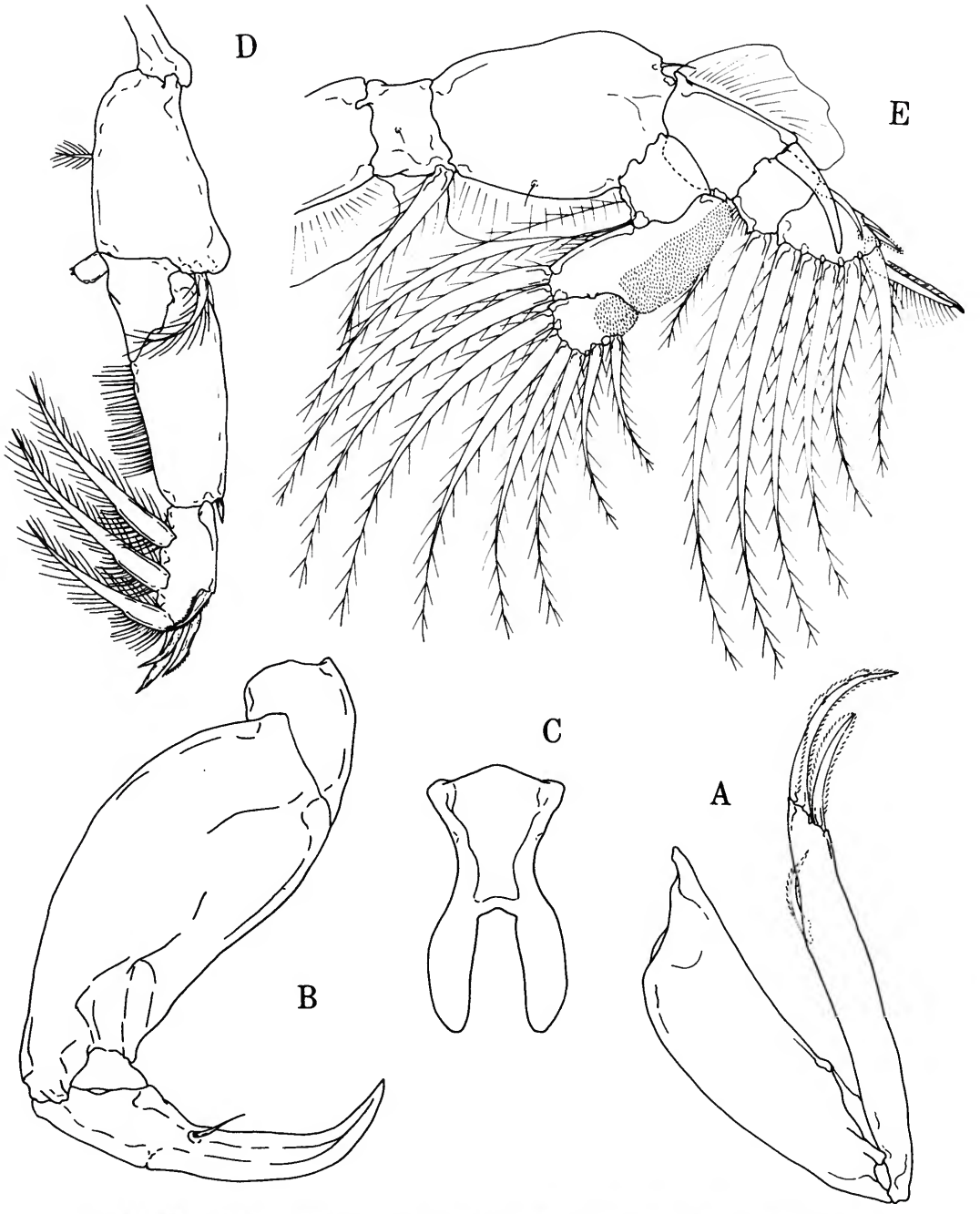

FIGURE 65.—*Caligus pelamydis* Kroyer, female: *a*, second maxilla; *b*, maxilliped; *c*, sternal furca; *d*, leg 1; *e*, leg 2.

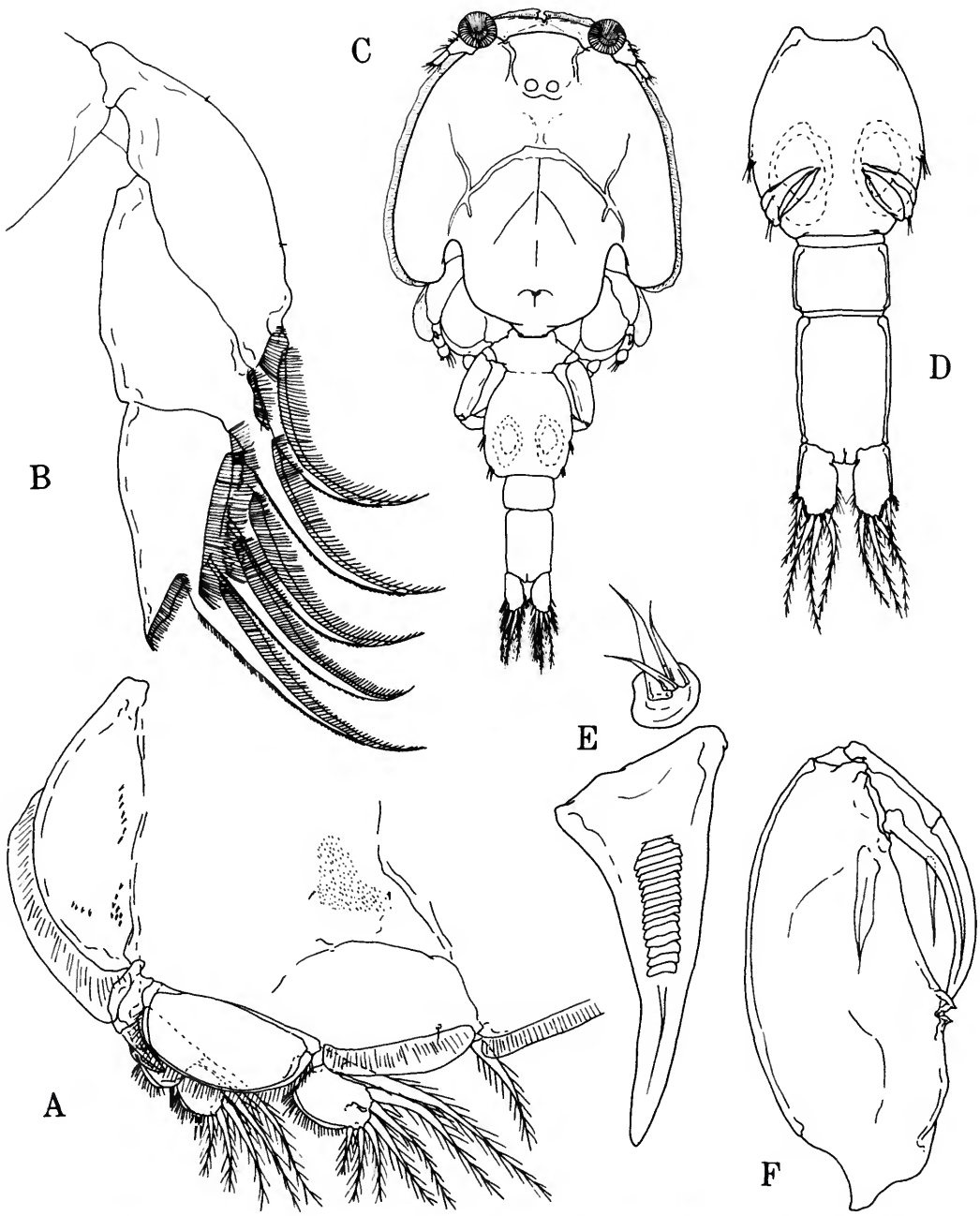

FIGURE 66.—*Caligus pelamydis* Kroyer, female: *a*, leg 3; *b*, leg 4; male: *c*, dorsal; *d*, genital segment and abdomen, ventral; *e*, postoral process; *f*, maxilliped.

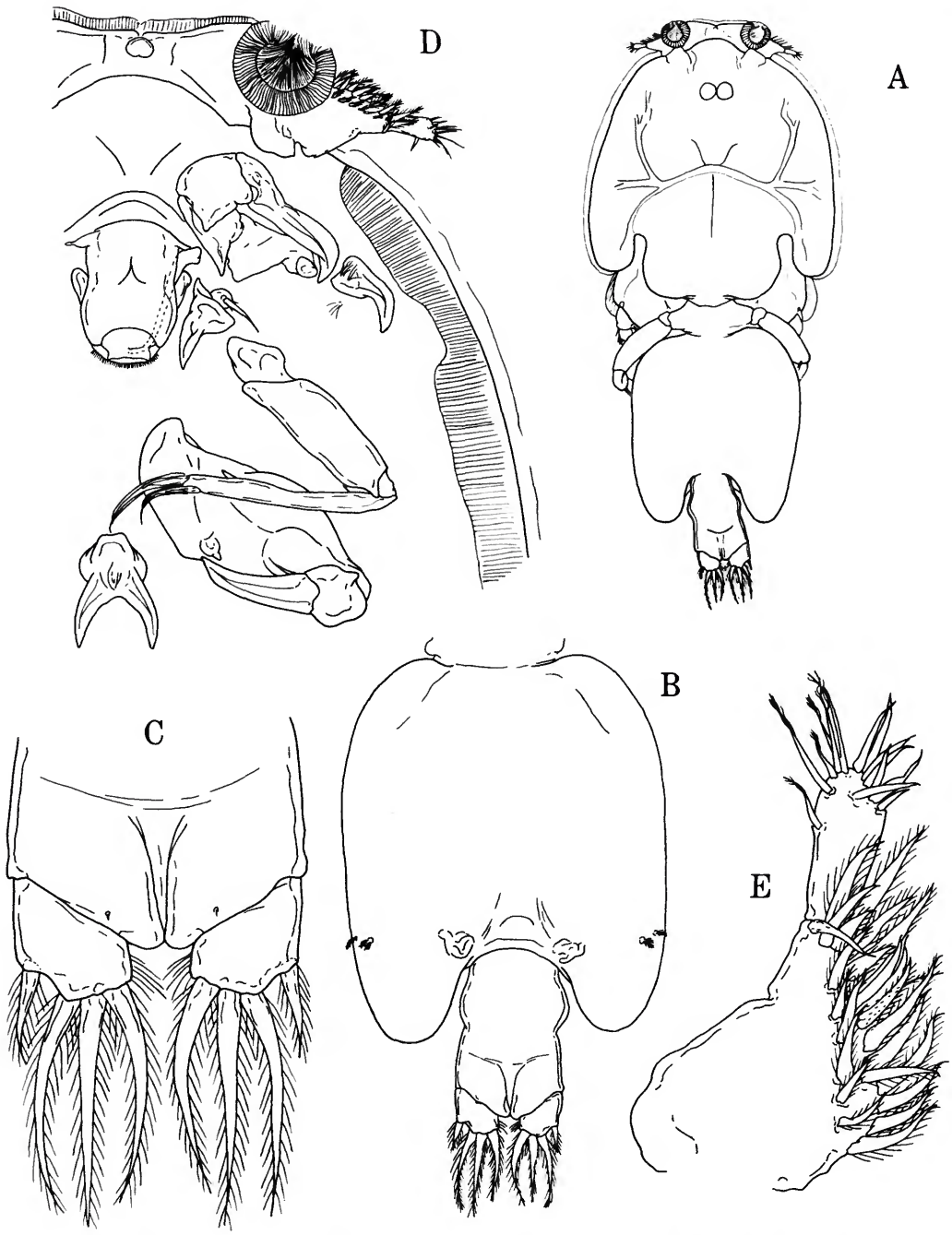

FIGURE 67.—*Caligus infestans* Heller, female: *a,* dorsal; *b,* genital segment and abdomen, ventral; *c,* last abdominal segment and caudal rami, ventral; *d,* oral area; *e,* first antenna.

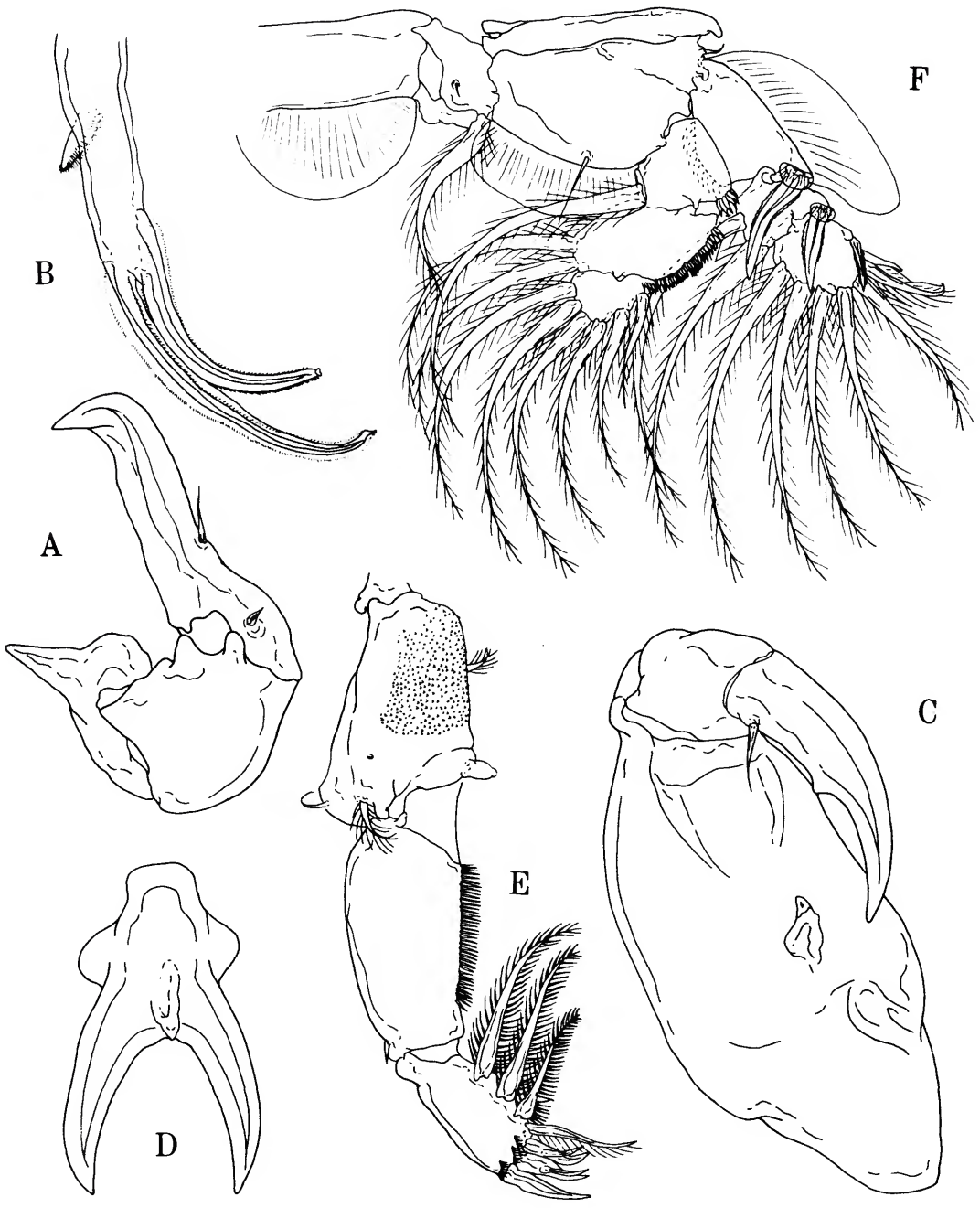

FIGURE 68.—*Caligus infestans* Heller, female: *a*, second antenna; *b*, tip of second maxilla; *c*, maxilliped; *d*, sternal furca; *e*, leg 1; *f*, leg 2.

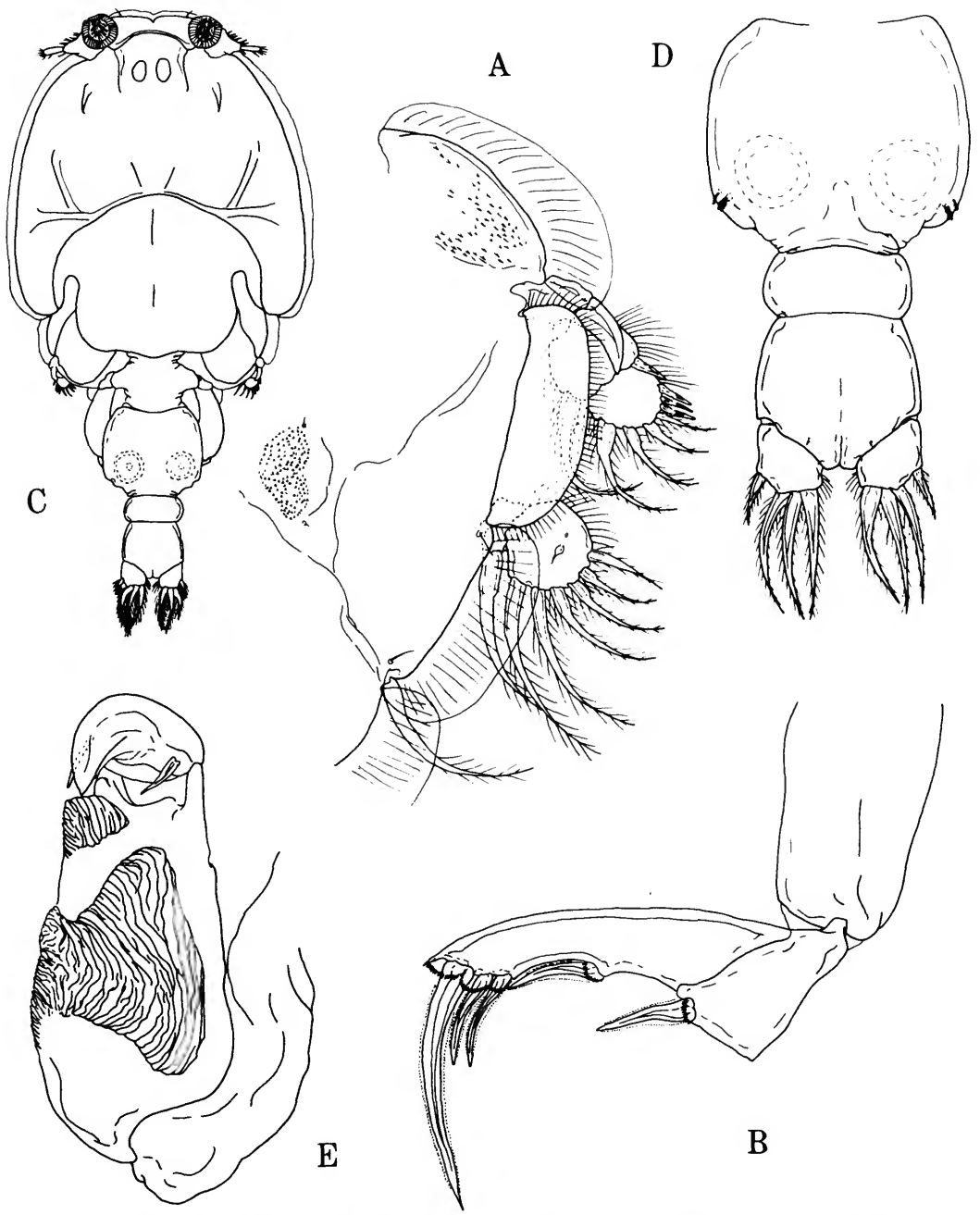

FIGURE 69.—*Caligus infestans* Heller, female: *a*, leg 3; *b*, leg 4; male: *c*, dorsal; *d*, genital segment and abdomen, ventral; *e*, second antenna.

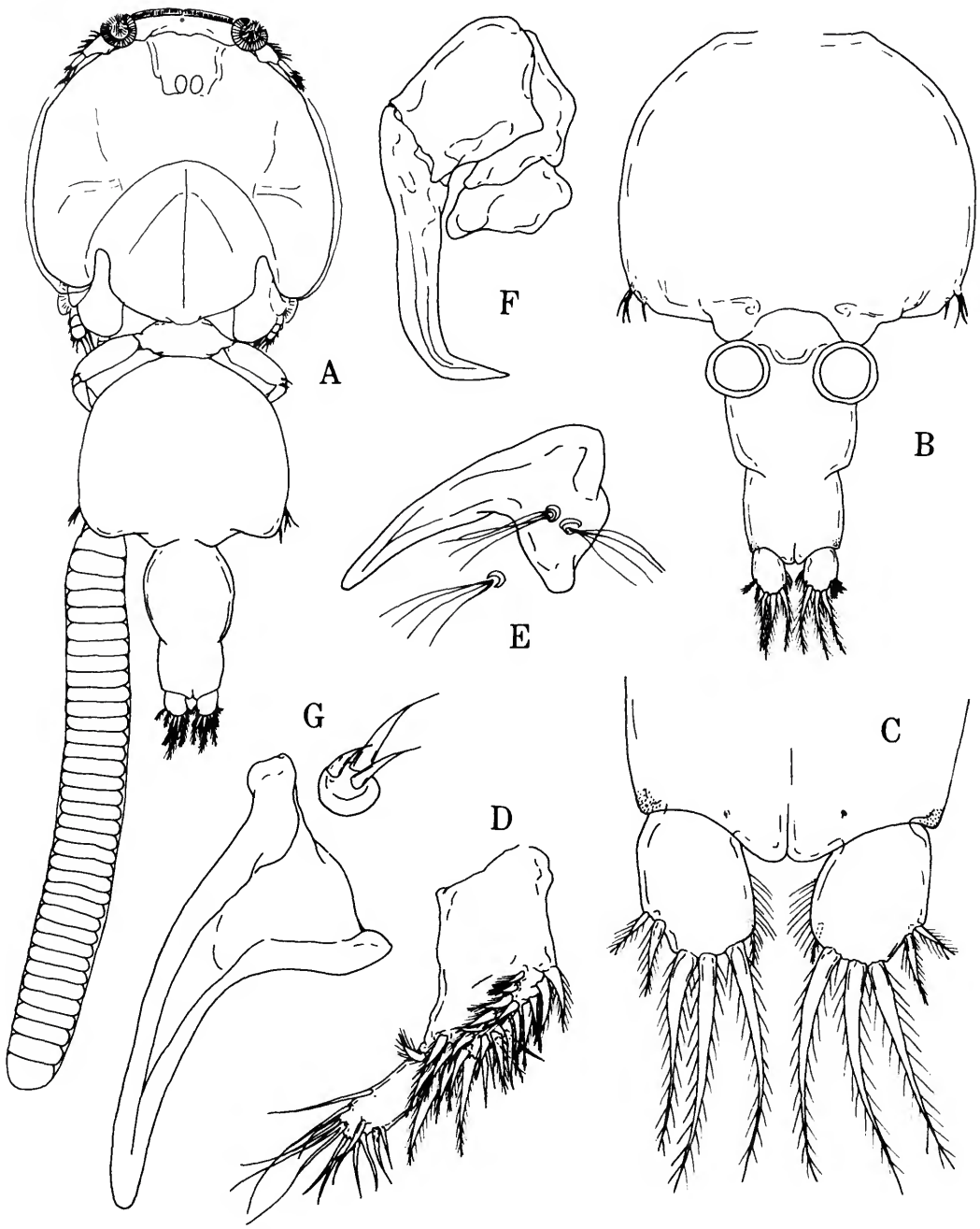

FIGURE 70.—*Caligus diaphanus* Nordmann, female: *a*, dorsal; *b*, genital segment and abdomen, ventral; *c*, distal end of abdomen and caudal rami, ventral; *d*, first antenna; *e*, postantennal process; *f*, second antenna; *g*, postoral process.

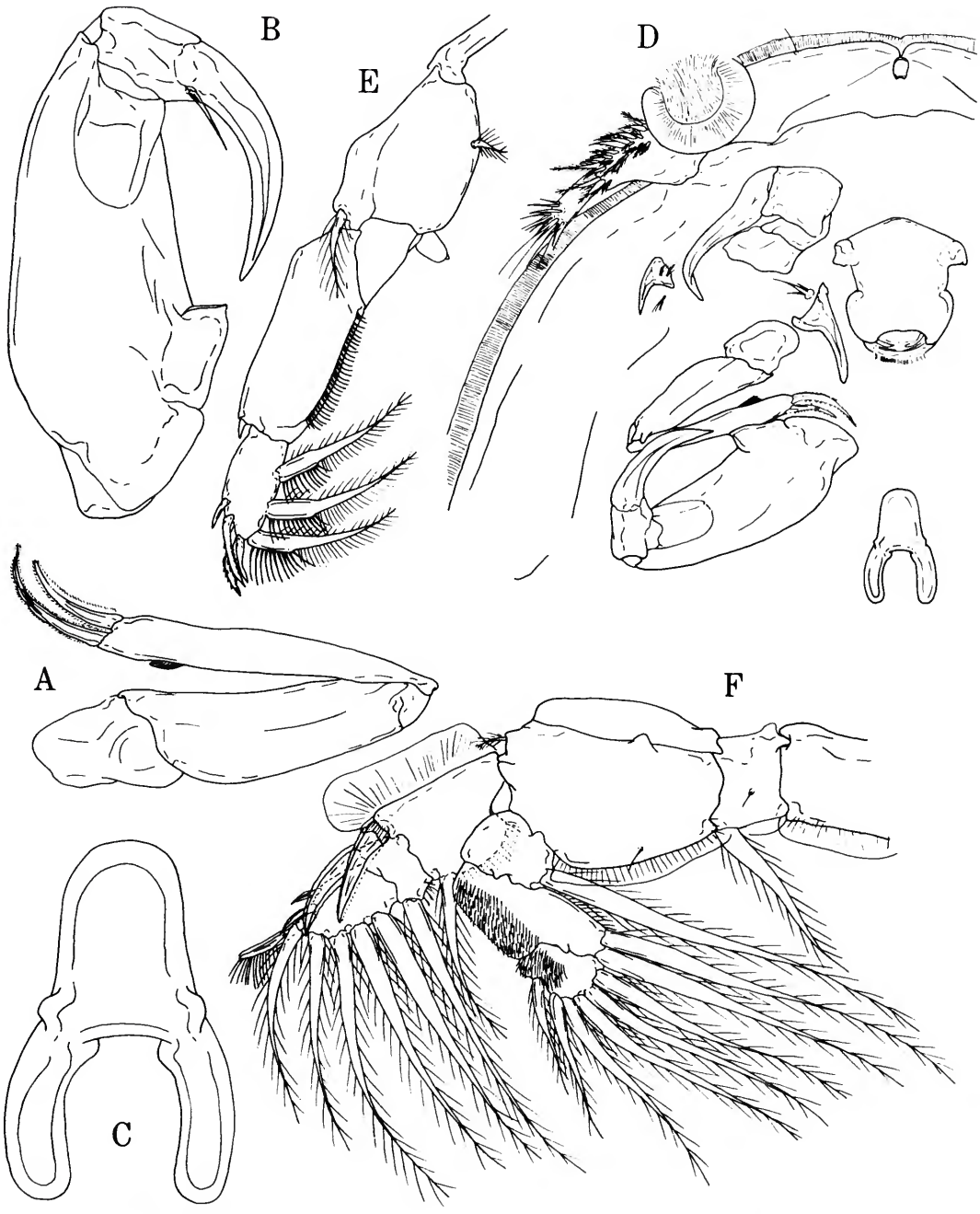

FIGURE 71.—*Caligus diaphanus* Nordmann, female: *a*, second maxilla; *b*, maxilliped; *c*, sternal furca; *d*, oral area; *e*, leg 1; *f*, leg 2.

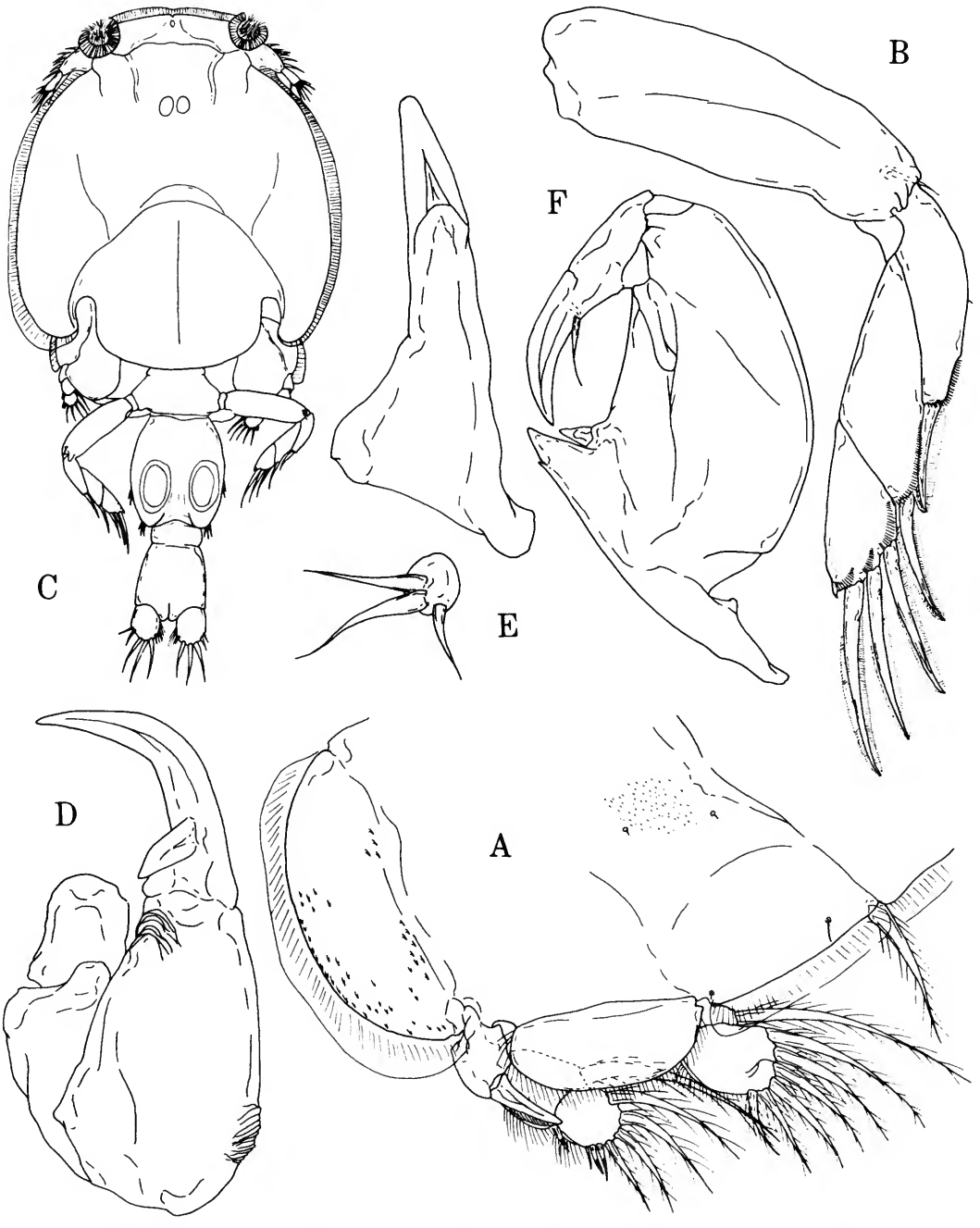

FIGURE 72.—*Caligus diaphanus* Nordmann, female: *a*, leg 3; *b*, leg 4; male: *c*, dorsal; *d*, second antenna; *e*, postoral process; *f*, maxilliped.

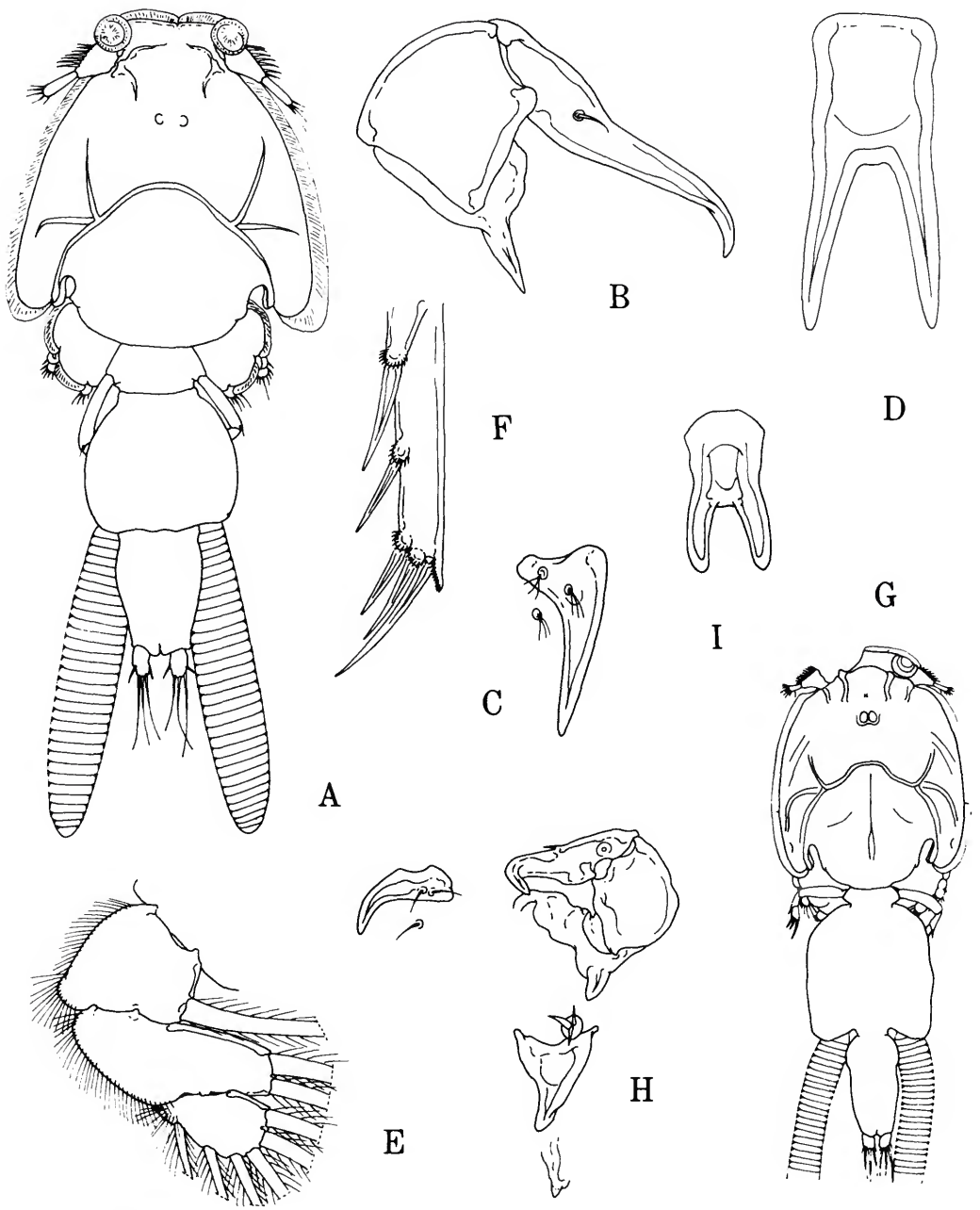

FIGURE 73.—*Caligus savala* Gnanamuthu, female: *a*, dorsal; *b*, second antenna; *c*, postantennal process; *d*, sternal furca; *e*, leg 2 endopod; *f*, leg 4 exopod last segment. *Caligus macarovi* Gussev, female: *g*, dorsal; *h*, second antenna, postantennal process, postoral process; *i*, sternal furca. (*C. macarovi* after Shiino 1959.)

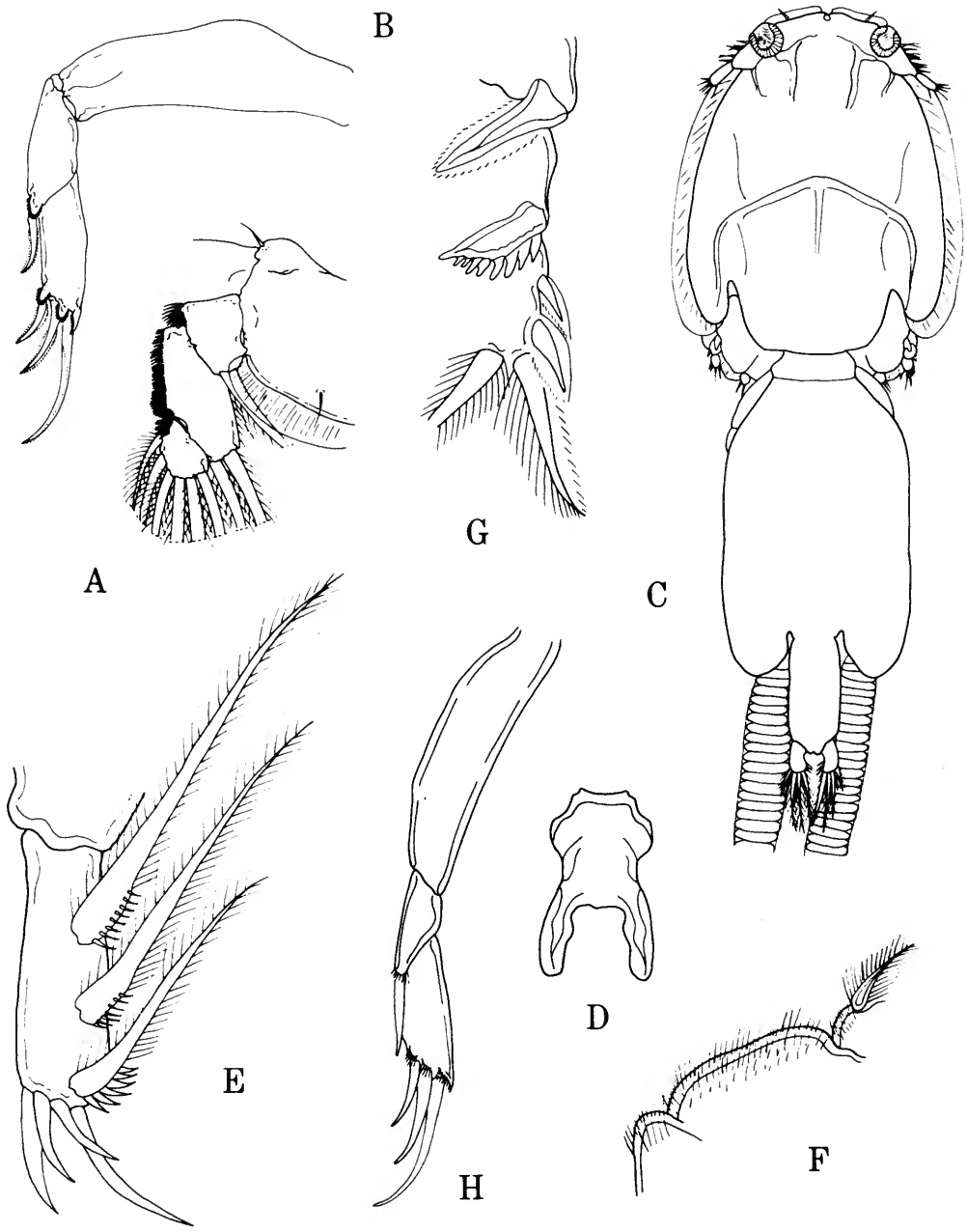

FIGURE 74.—*Caligus macarovi* Gussev, female: *a*, leg 2 endopod; *b*, leg 4. *Caligus amblygenitalis* Pillai, female: *c*, dorsal; *d*, sternal furca; *e*, leg 1; *f*, leg 2 endopod edge; *g*, leg 2 exopod; *h*, leg 4. (*C. macarovi* after Shiino 1959, *C. amblygenitalis* after Pillai 1961.)

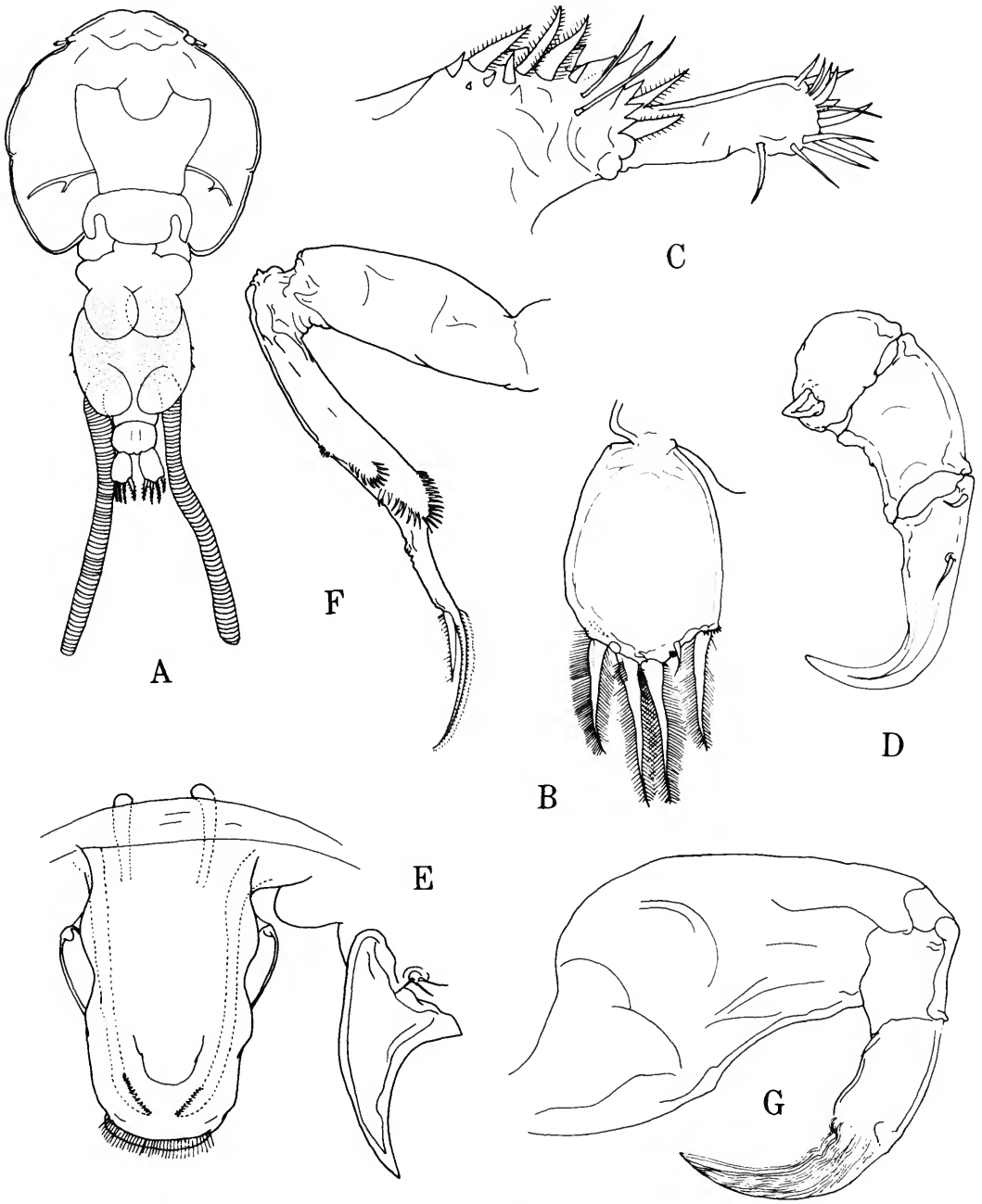

FIGURE 75.—*Elytrophora brachyptera* Gerstaecker, female: *a*, dorsal; *b*, caudal ramus; *c*, first antenna; *d*, second antenna; *e*, mouth tube and postoral process; *f*, second maxilla; *g*, maxilliped.

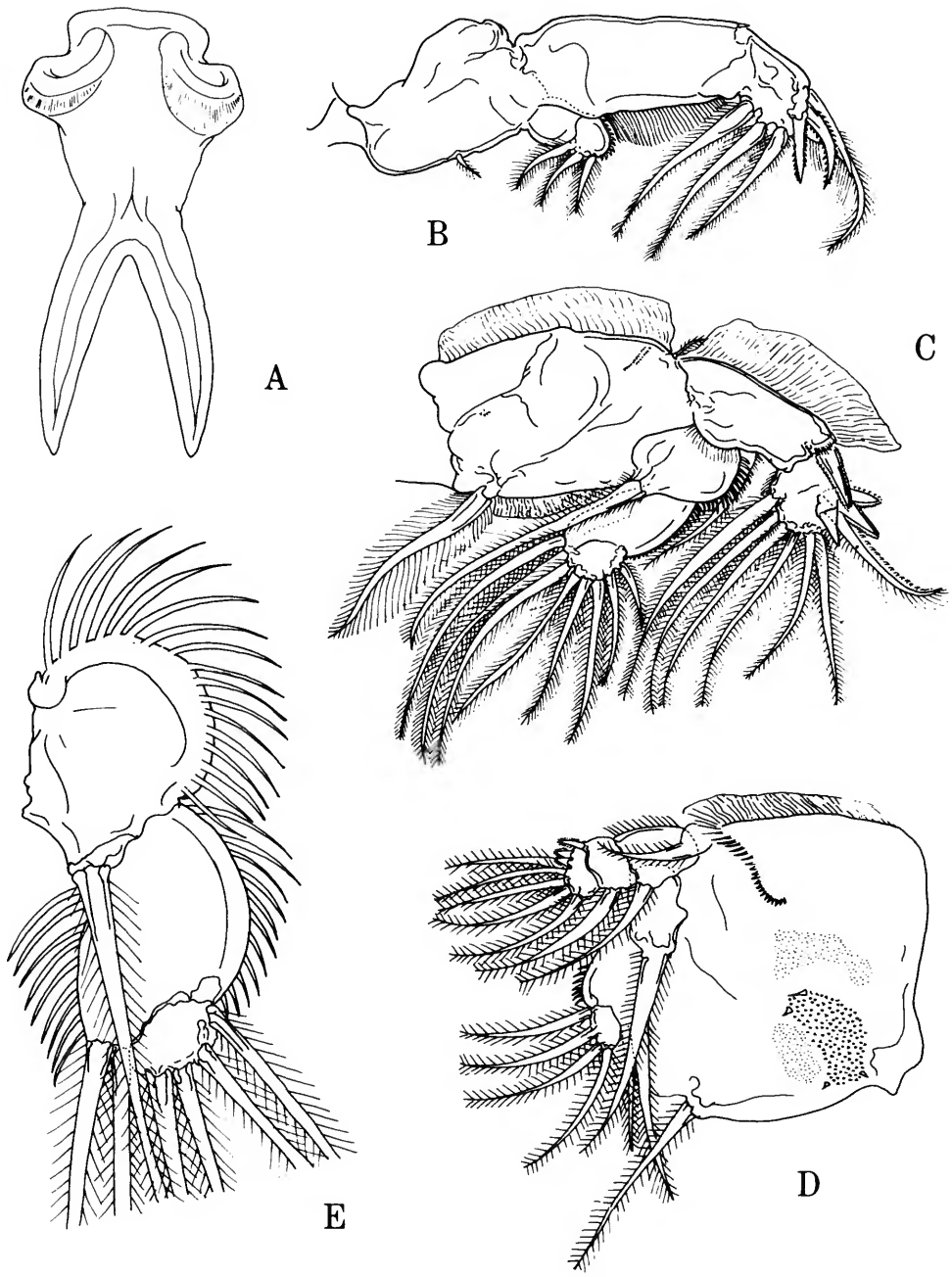

FIGURE 76.—*Elytrophora brachyptera* Gerstaecker, female: *a*, sternal furca; *b*, leg 1; *c*, leg 2; *d*, leg 3; *e*, leg 3 endopod.

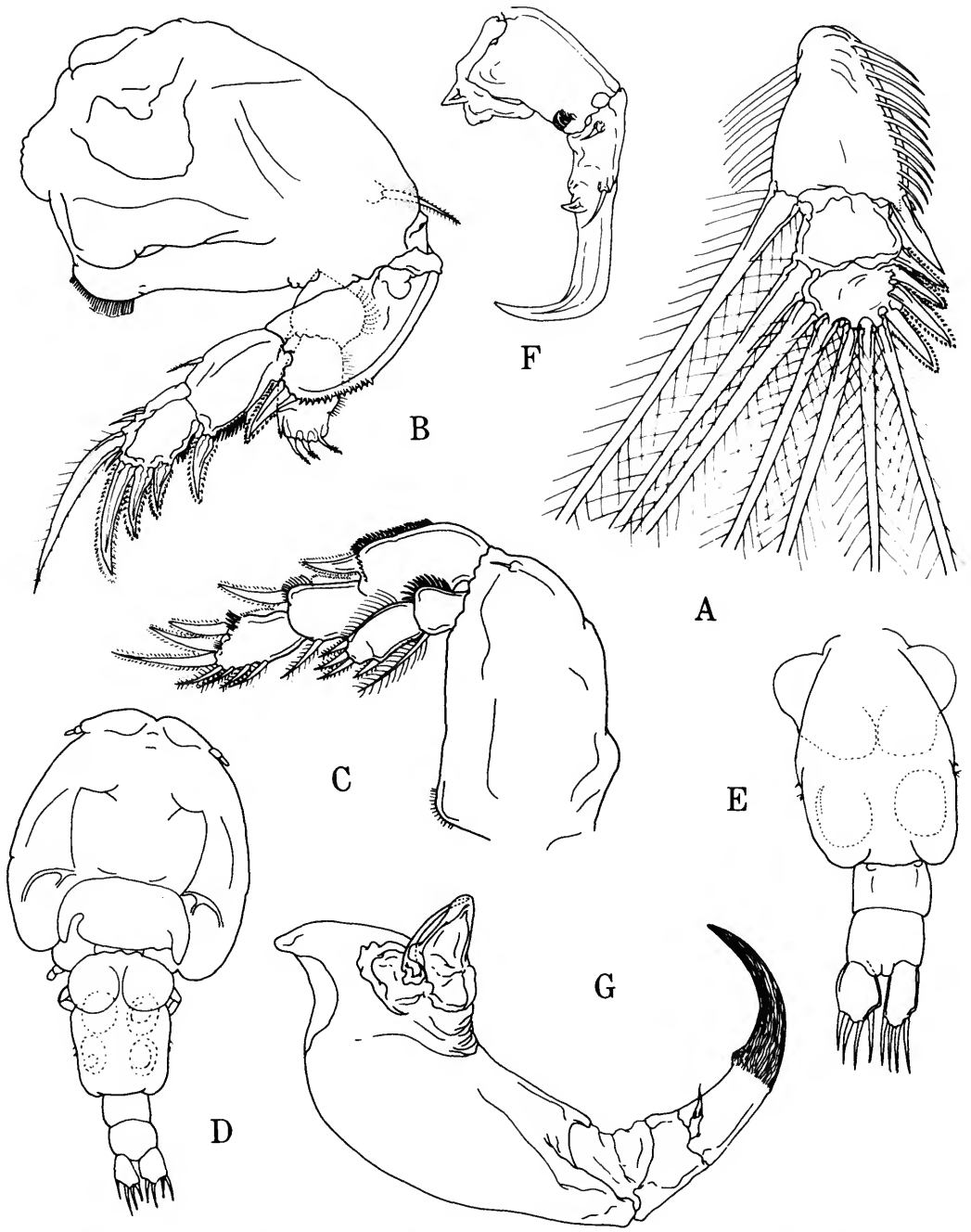

FIGURE 77.—*Elytrophora brachyptera* Gerstaecker, female: *a*, leg 3 exopod; *b*, leg 4 (cold water; *c*, leg 4 (warm water); male: *d*, dorsal; *e*, genital segment and abdomen, ventral; *f*, second antenna; *g*, maxilliped.

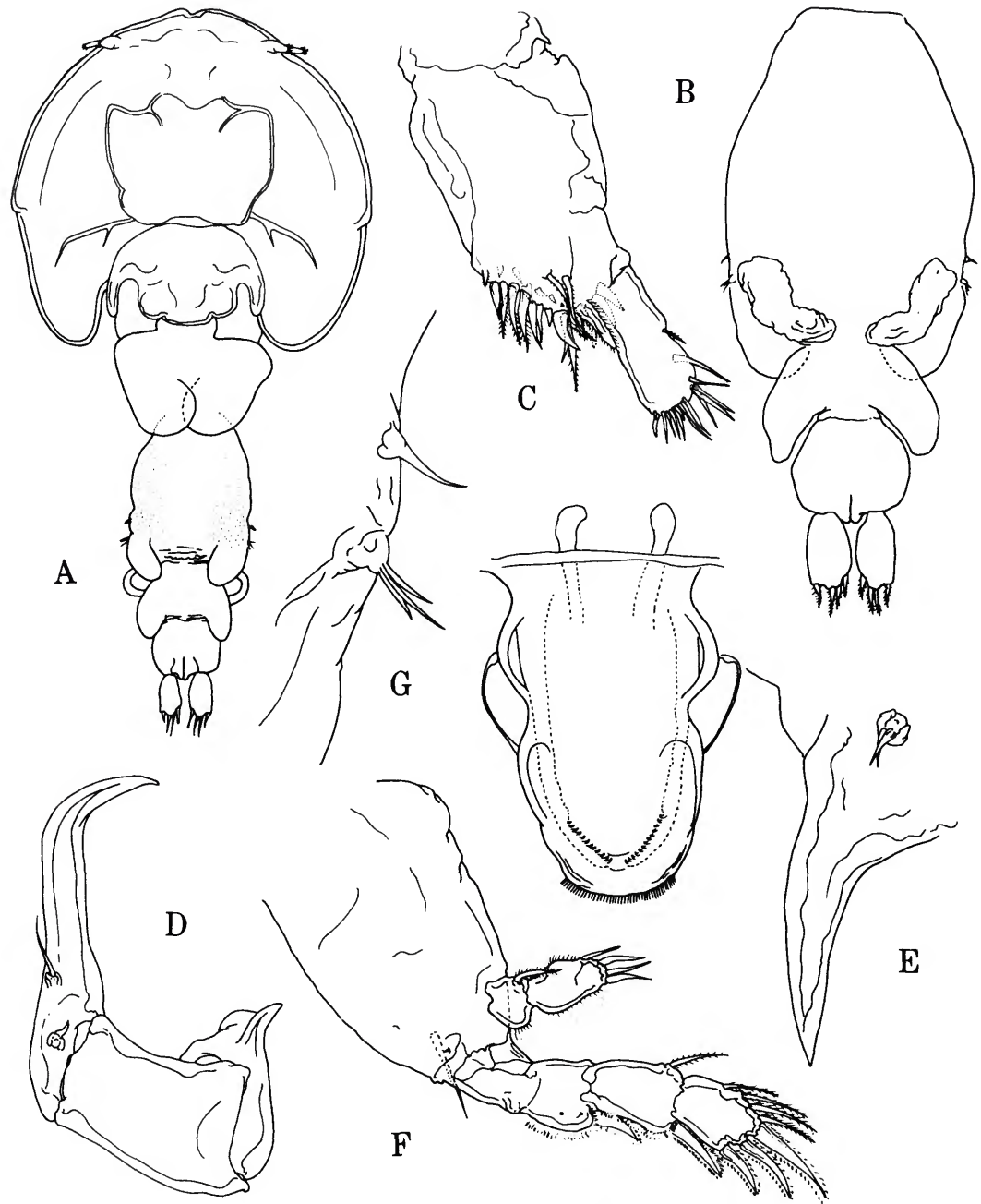

FIGURE 78.—*Elytrophora indica* Shiino, female: *a*, dorsal; *b*, genital segment and abdomen, ventral; *c*, first antenna; *d*, second antenna; *e*, mouth tube and postoral process; *f*, leg 4; *g*, leg 6.

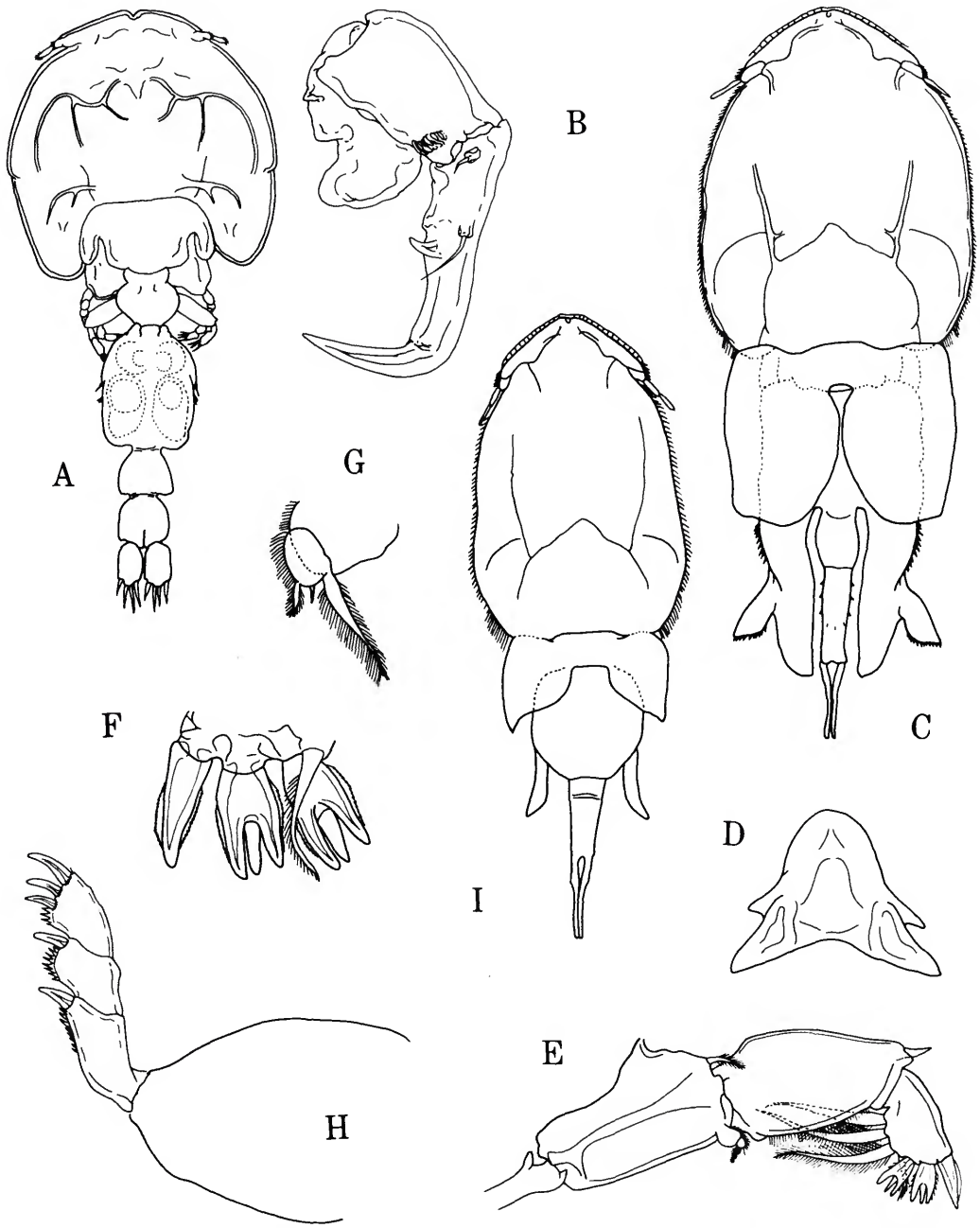

FIGURE 79.—*Elytrophora indica* Shiino, male: *a*, dorsal; *b*, second antenna. *Gloiopotes hygomianus* Steenstrup and Lütken, female: *c*, dorsal; *d*, sternal furca; *e*, leg 1; *f*, tip of exopod of leg 1; *g*, endopod of leg 1; *h*, leg 4; male: *i*, dorsal.

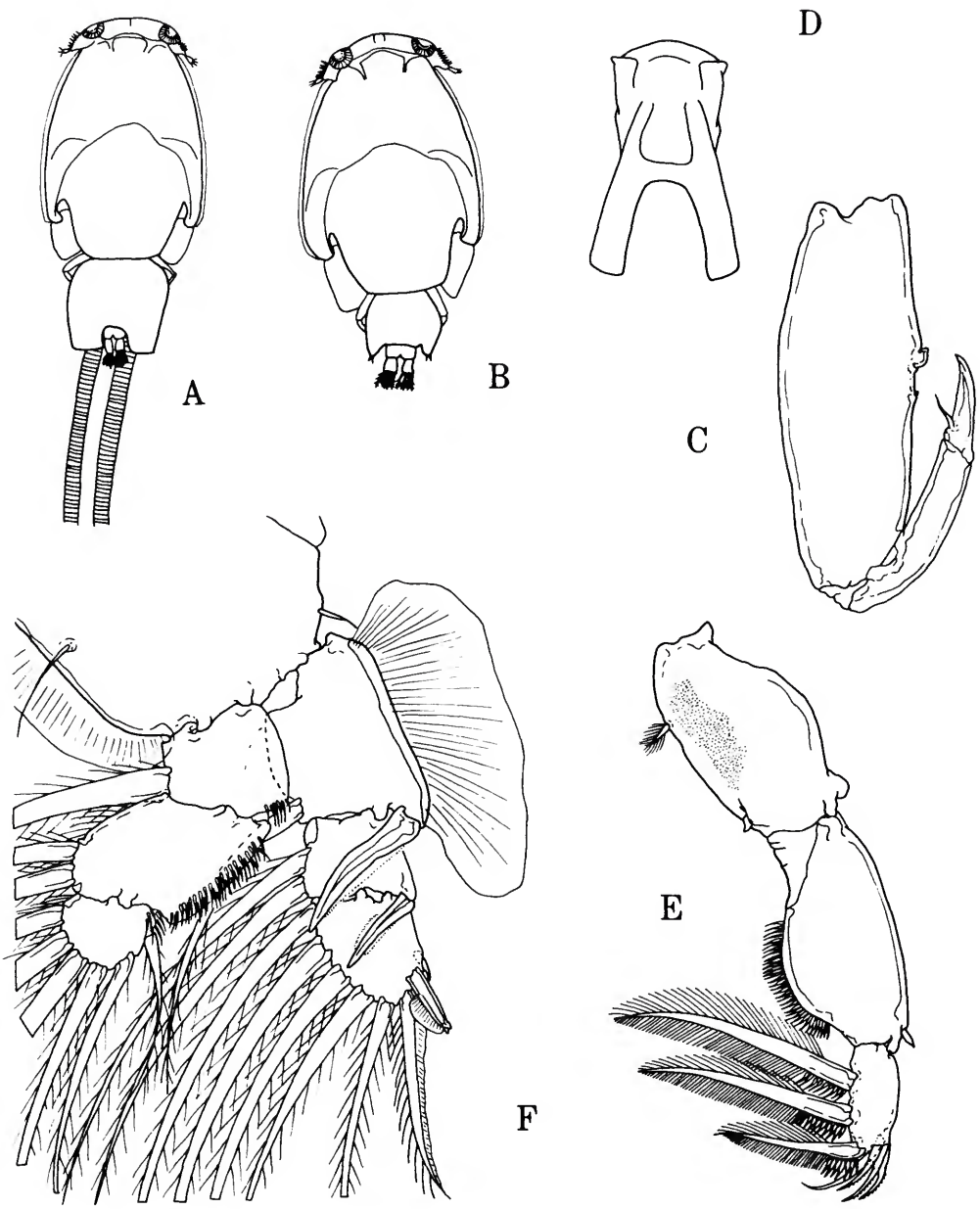

FIGURE 80.—*Caligulus longispinosus* Heegaard, female: *a*, dorsal; male: *b*, dorsal; *c*, maxilliped; *d*, sternal furca; *e*, leg 1; *f*, leg 2 (female after Heegaard, 1962).

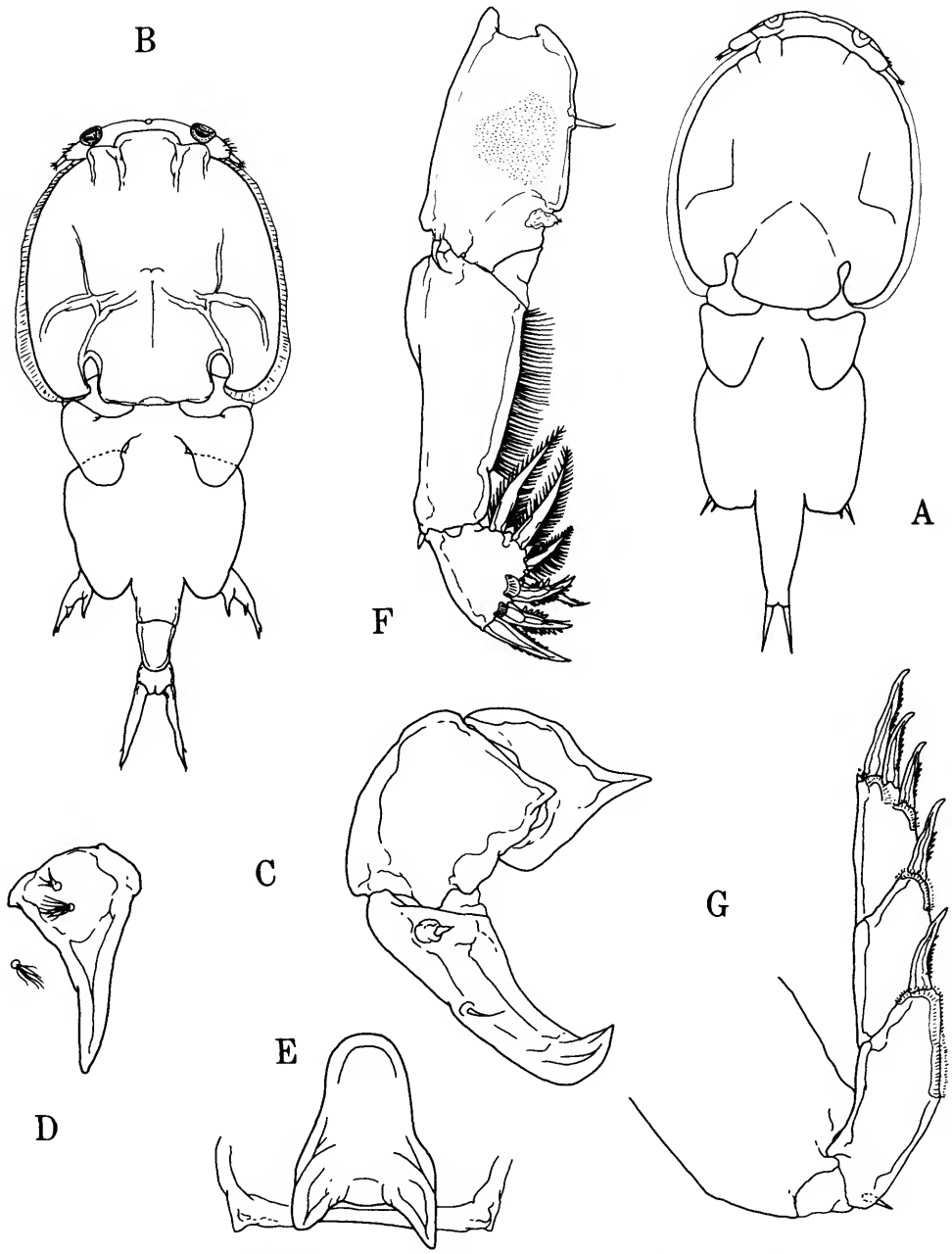

FIGURE 81.—*Tuxophorus cybii* Nunes-Ruivo and Fourmanoir, female: *a*, dorsal. *Tuxophorus cervicornis* Heegaard, female: *b*, dorsal; *c*, second antenna; *d*, postantennal process; *e*, sternal furca; *f*, leg 1; *g*, leg 4. (*T. cybii* after N.-R and Fourmanoir, 1956.)

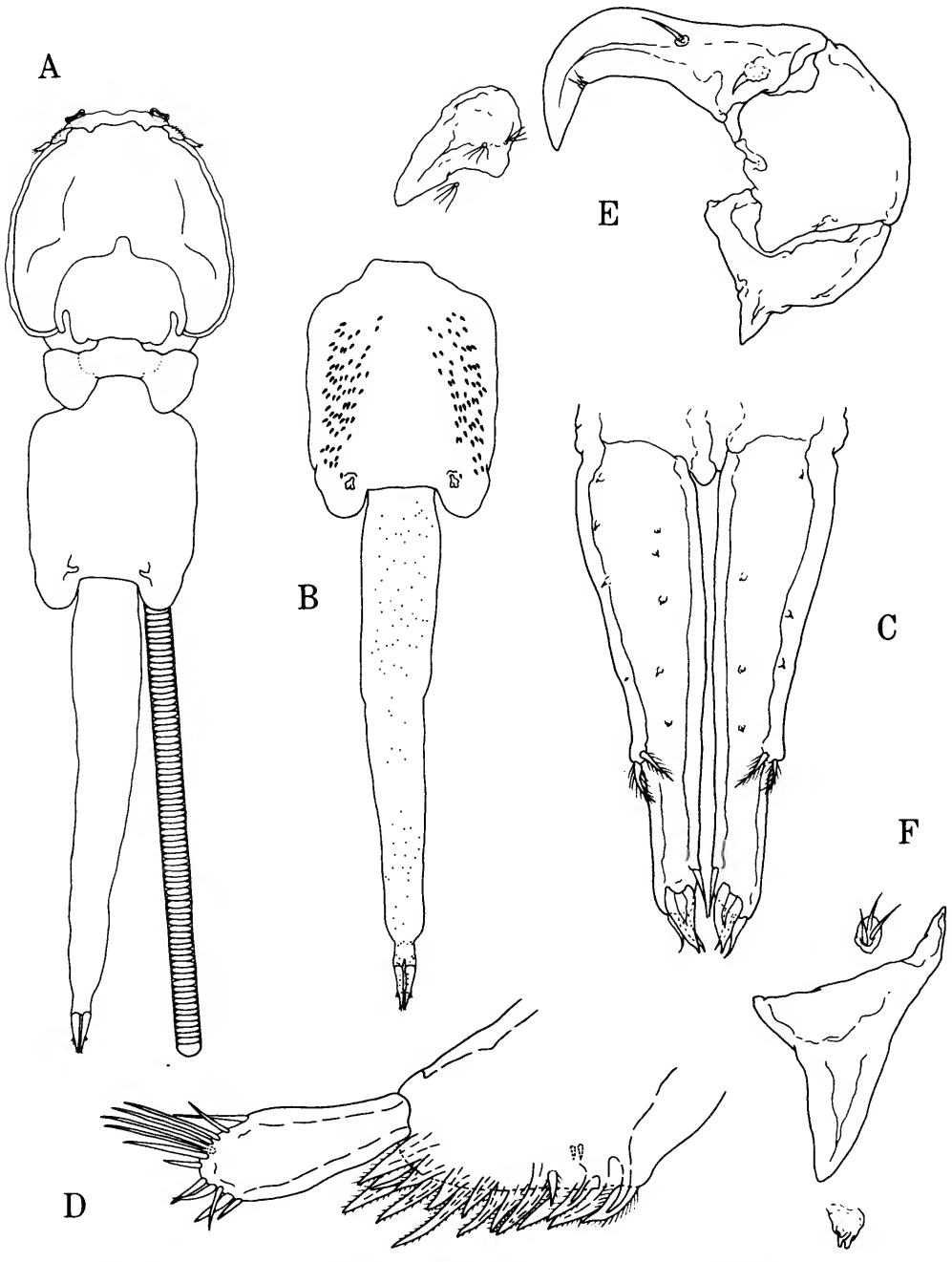

FIGURE 82.—*Tuxophorus collettei*, new species, female: *a*, dorsal; *b*, genital segment and abdomen, ventral; *c*, caudal rami, ventral; *d*, first antenna; *e*, second antenna and postantennal process; *f*, postoral process.

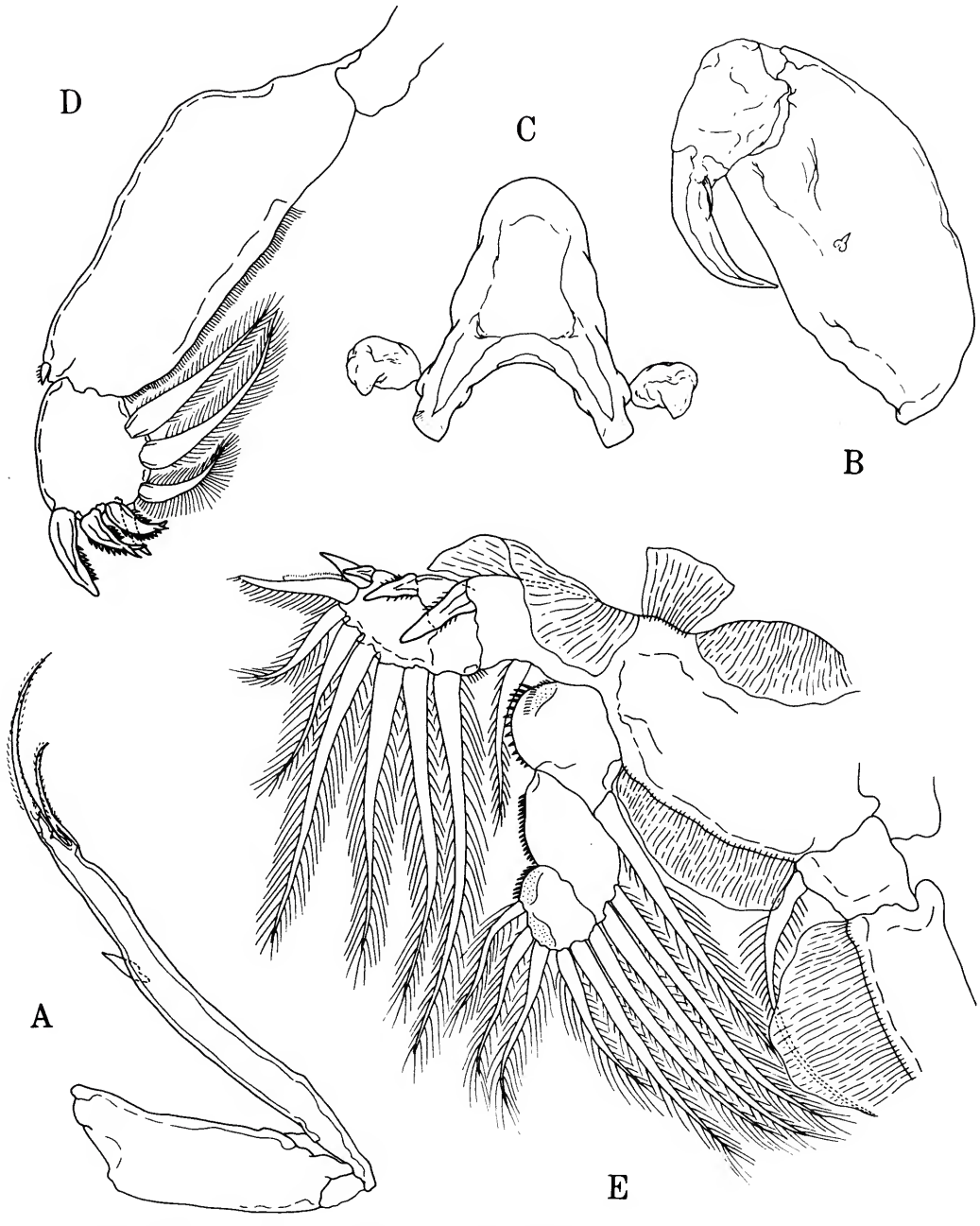

FIGURE 83.—*Tuxophorus collettei,* new species, female: *a,* second maxilla; *b,* maxilliped; *c,* sternal furca; *d,* leg 1; *e,* leg 2.

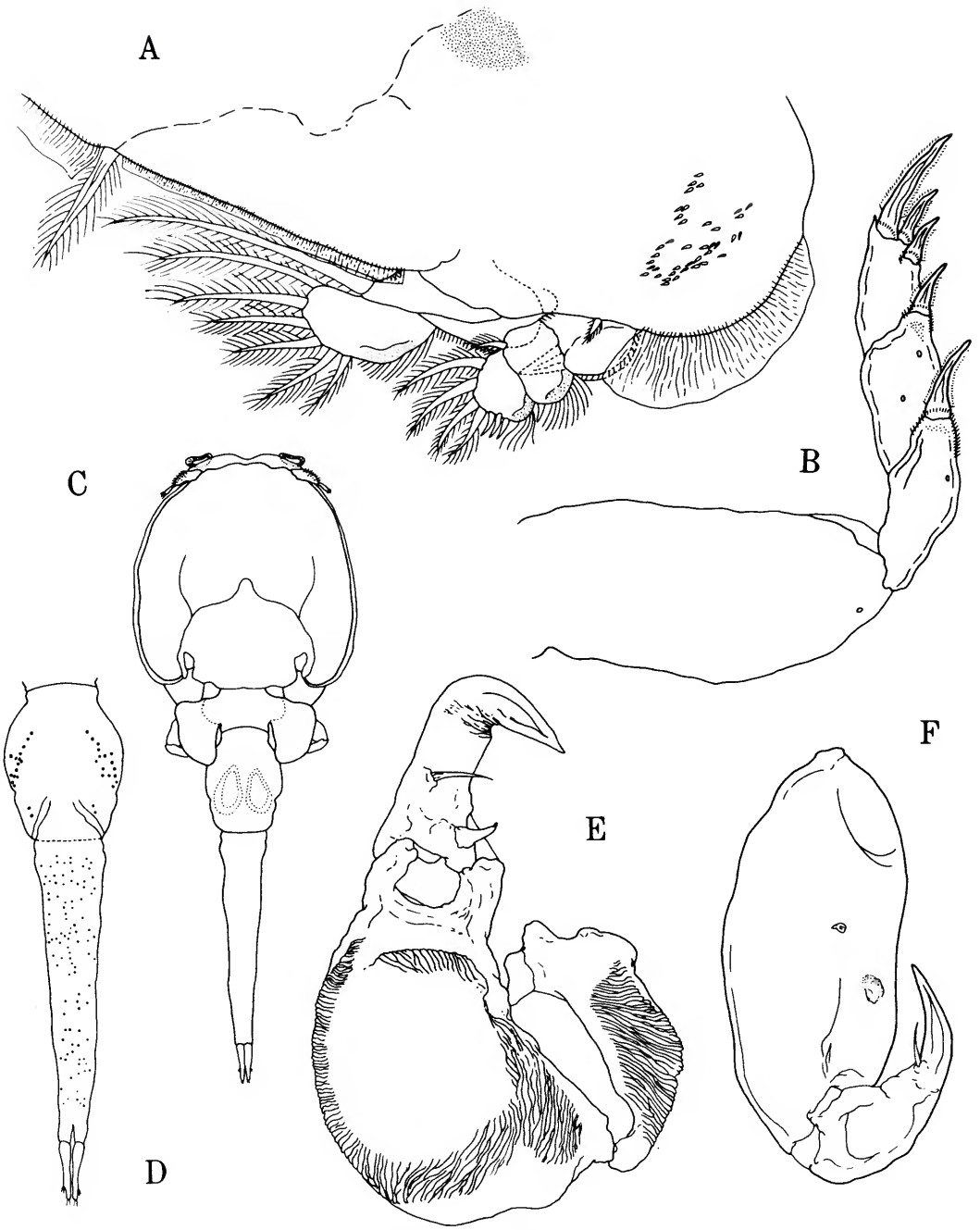

FIGURE 84.—*Tuxophorus collettei*, new species, female: *a*, leg 3; *b*, leg 4; male: *c*, dorsal; *d*, genital segment and abdomen, ventral; *e*, second antenna; *f*, maxilliped.

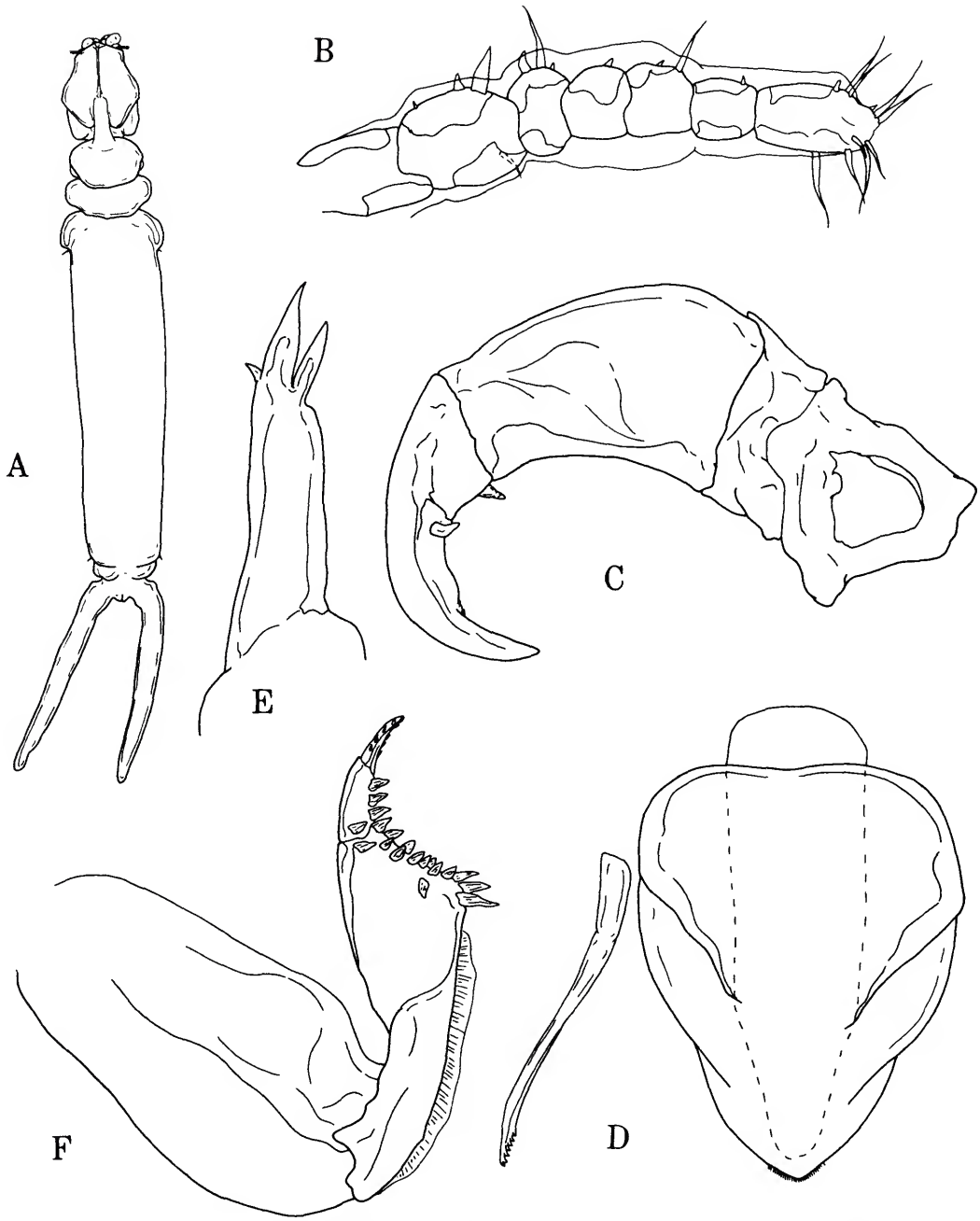

FIGURE 85.—*Pseudocycnus appendiculatus* Heller, female: *a*, dorsal; *b*, first antenna; *c*, second antenna; *d*, mouth tube and mandible; *e*, first maxilla; *f*, second maxilla.

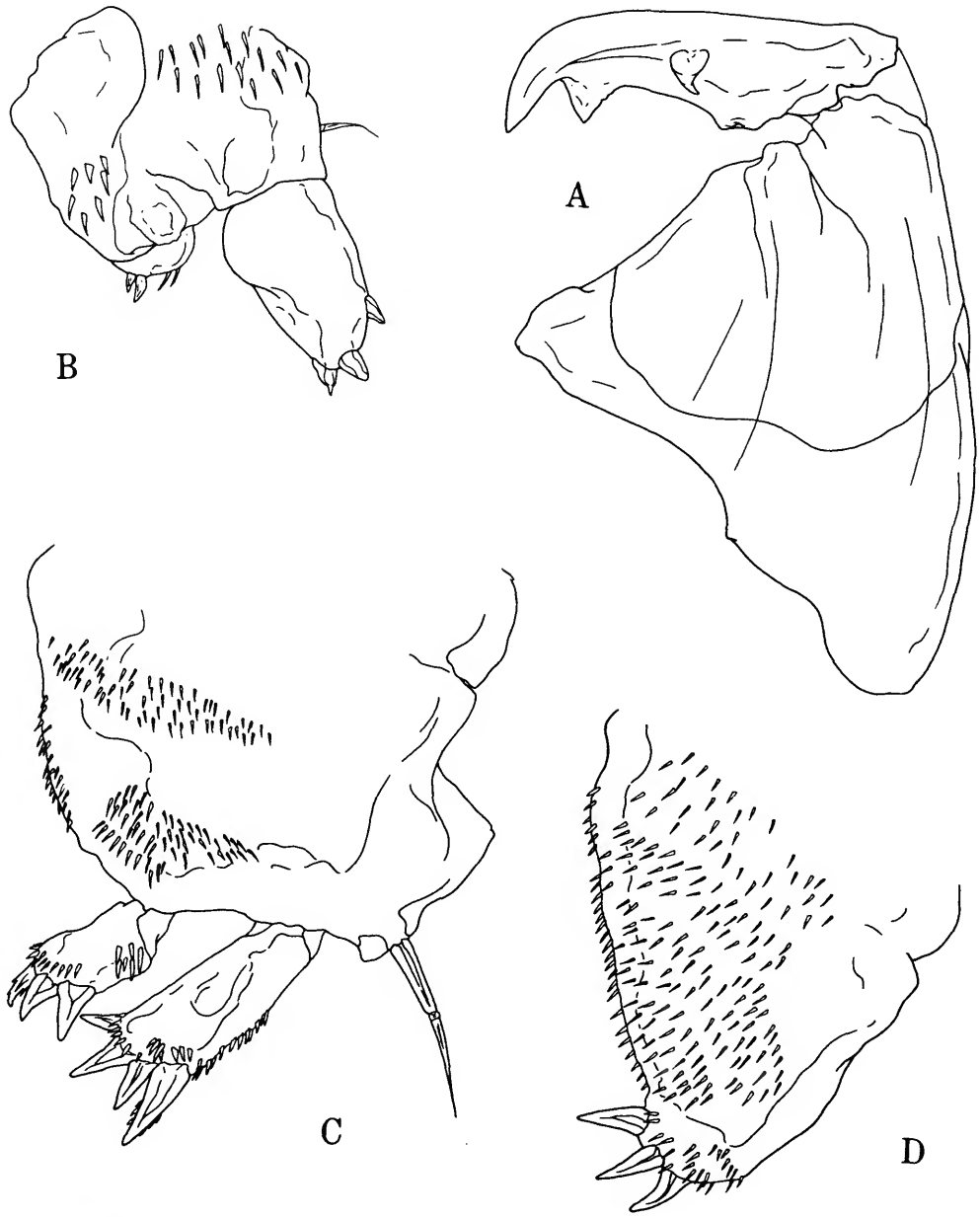

FIGURE 86.—*Pseudocycnus appendiculatus* Heller, female: *a*, maxilliped; *b*, leg 1; *c*, leg 2; *d*, leg 3.

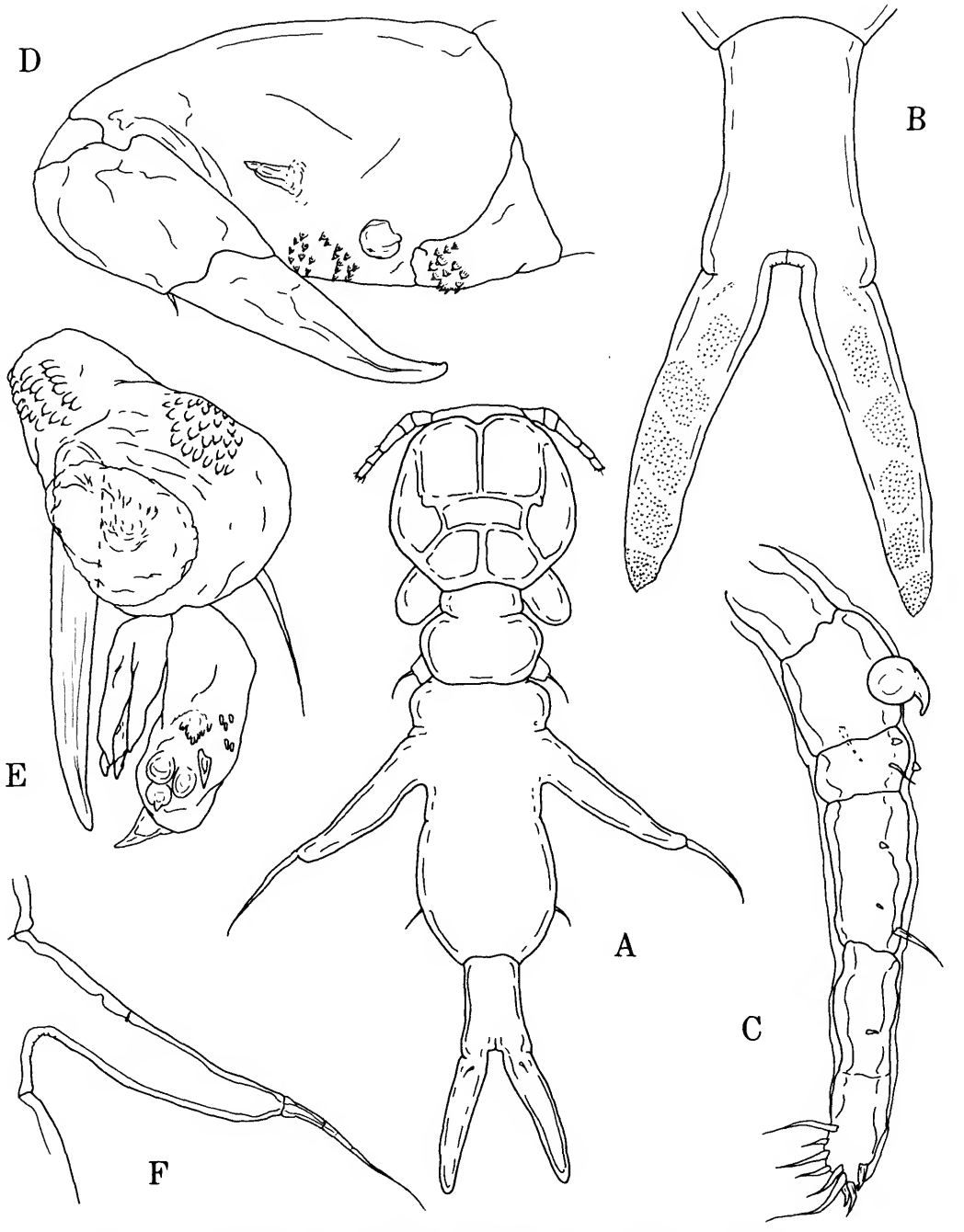

FIGURE 87.—*Pseudocycnus appendiculatus* Heller, male: *a,* dorsal; *b,* abdomen and caudal rami, ventral; *c,* first antenna; *d,* maxilliped; *e,* leg 1; *f,* leg 4.

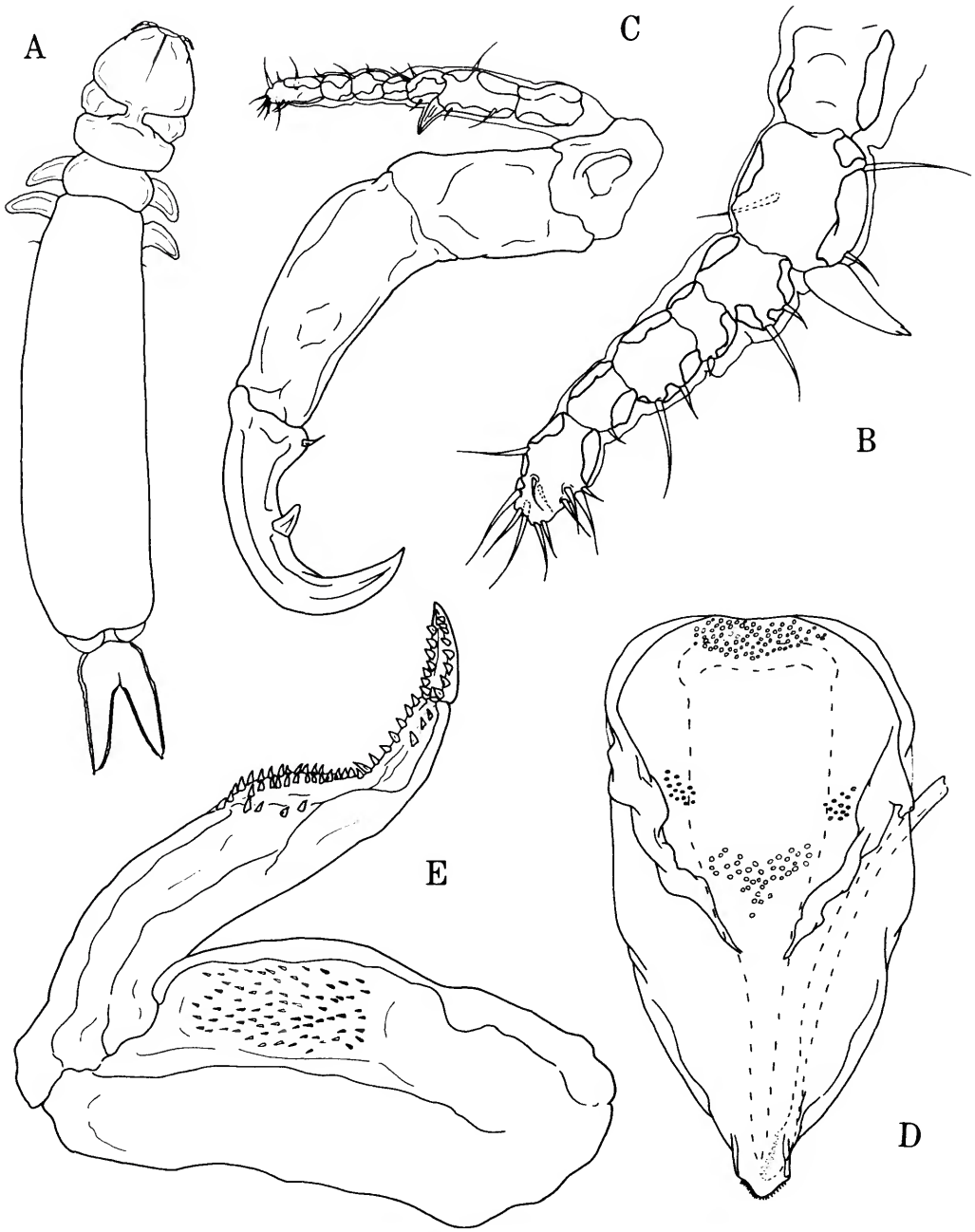

FIGURE 88.—*Pseudocycnoides armatus* (Bassett-Smith), female: *a*, dorsal; *b*, first antenna; *c*, first and second antennae; *d*, mouth tube; *e*, second maxilla.

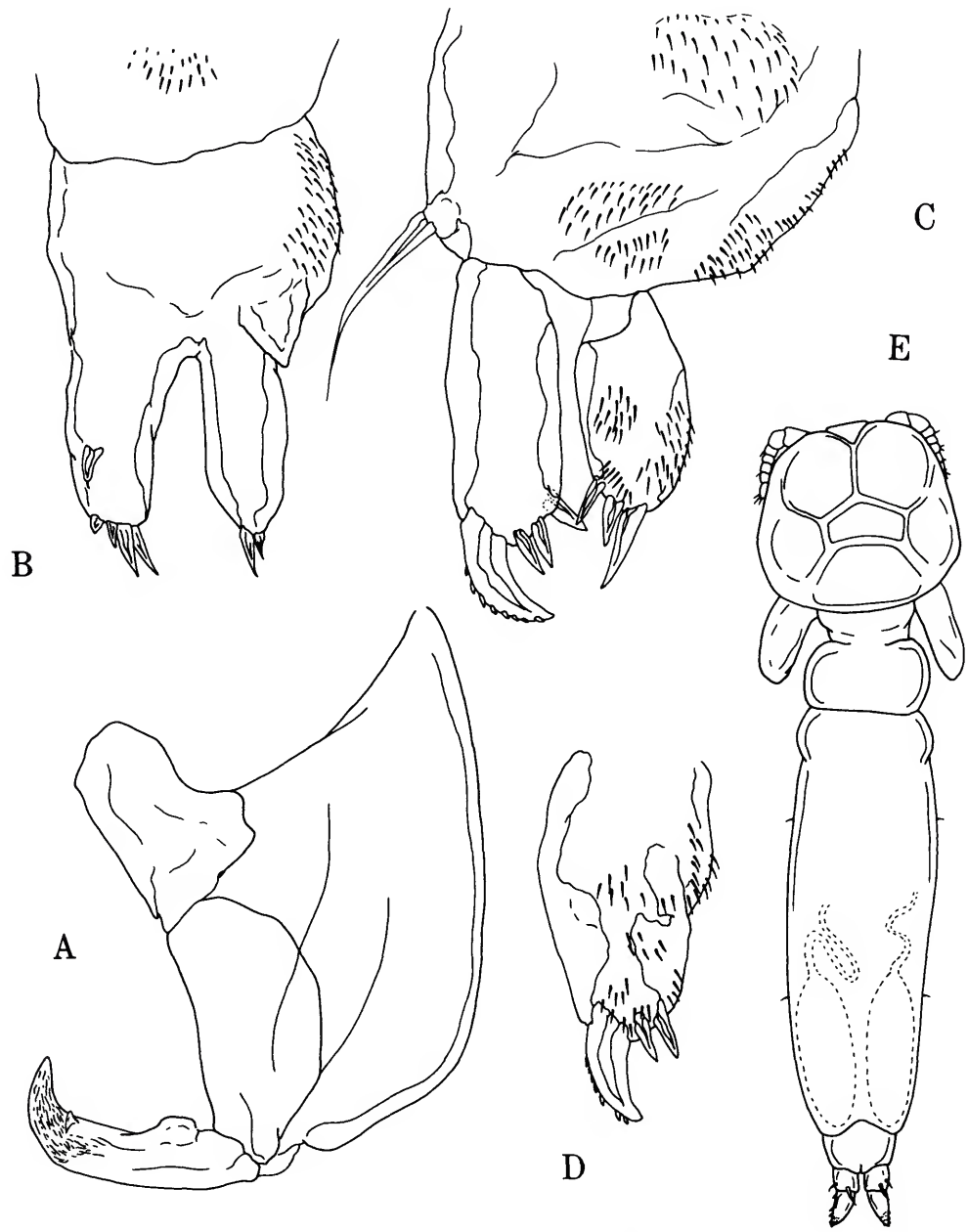

FIGURE 89.—*Pseudocycnoides armatus* (Bassett-Smith), female: *a*, maxilliped; *b*, leg 1; *c*, leg 2; *d*, leg 3; male: *e*, dorsal.

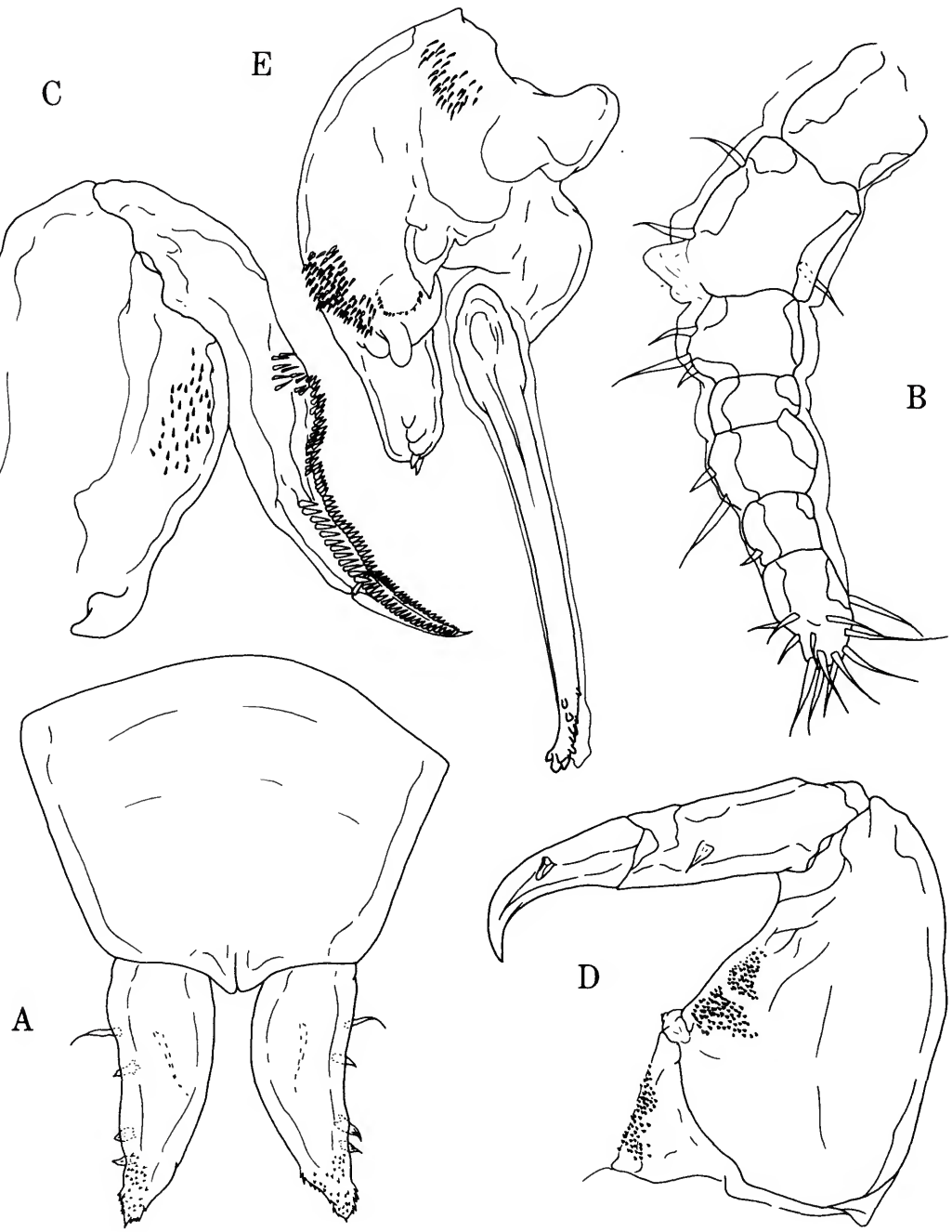

FIGURE 90.—*Pseudocycnoides armatus* (Bassett-Smith), male: *a*, abdomen and caudal rami; *b*, first antenna; *c*, second maxilla; *d*, maxilliped; *e*, leg 1.

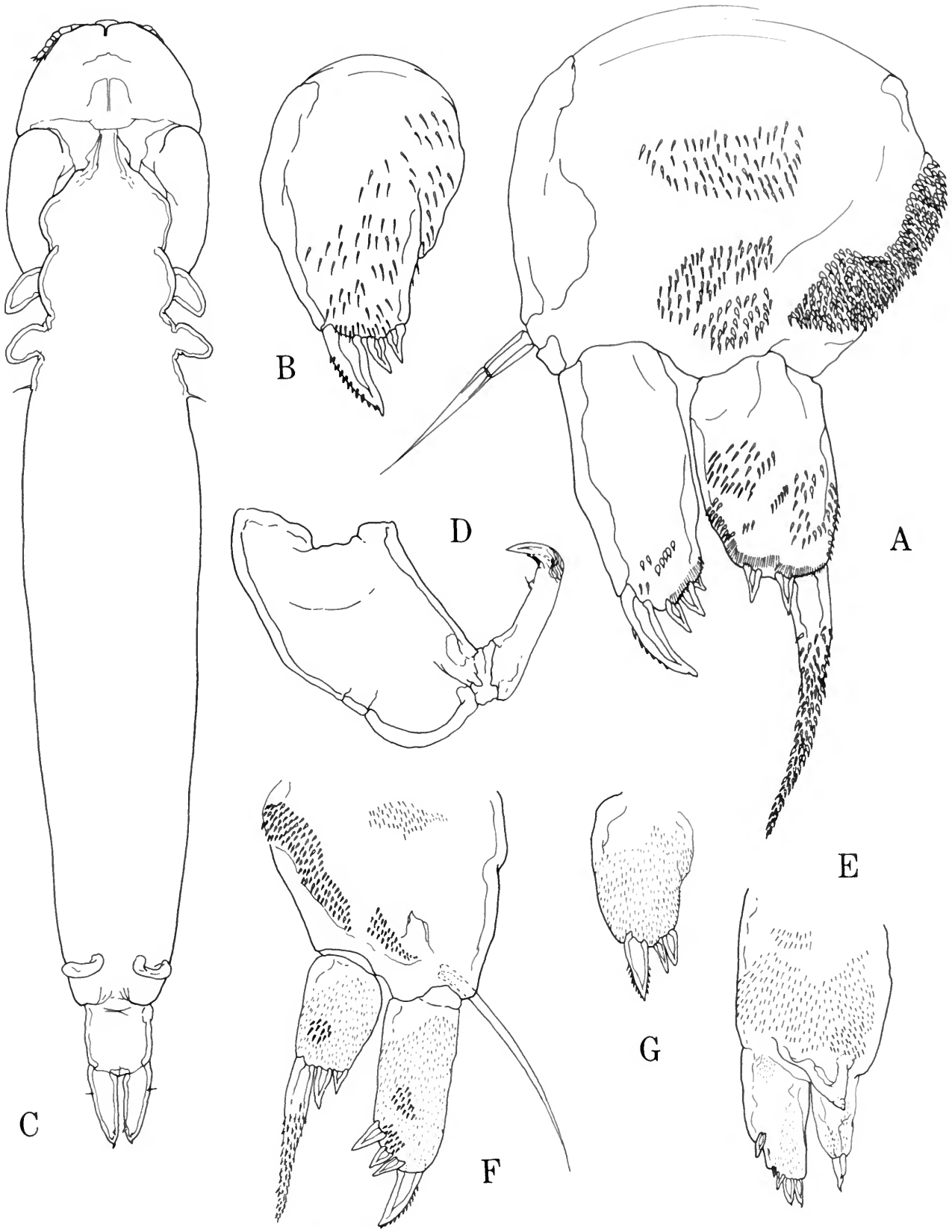

FIGURE 91.—*Pseudocycnoides armatus* (Bassett-Smith), male: *a*, leg 2; *b*, leg 3. *Pseudocycnoides scomberomori* (Yamaguti), female: *c*, dorsal; *d*, maxilliped; *e*, leg 1; *f*, leg 2; *g*, leg 3.

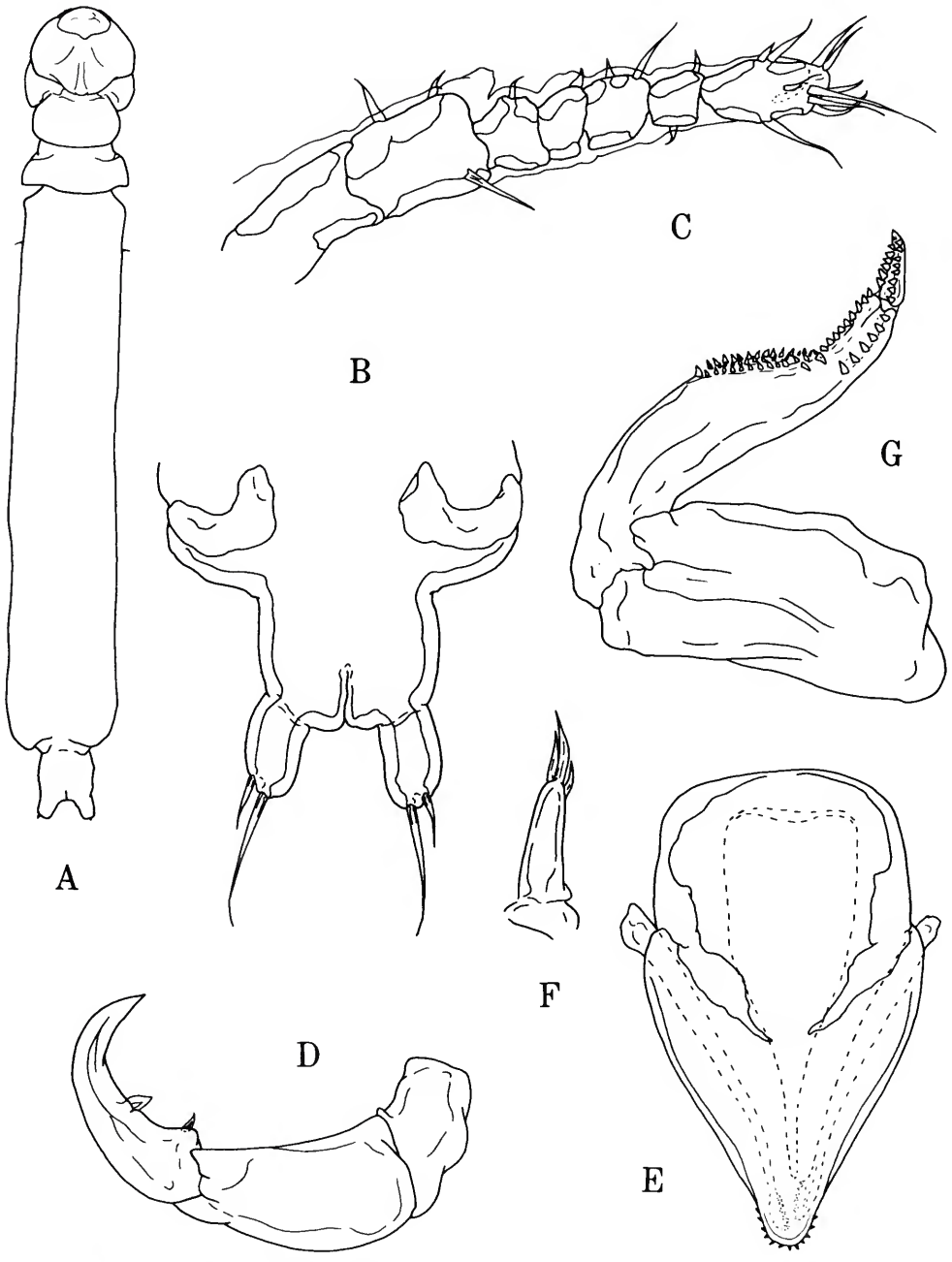

FIGURE 92.—*Pseudocycnoides buccata* (Wilson), female: *a*, dorsal; *b*, abdomen and caudal rami, young female, ventral; *c*, first antenna; *d*, second antenna; *e*, mouth tube; *f*, first maxilla; *g*, second maxilla.

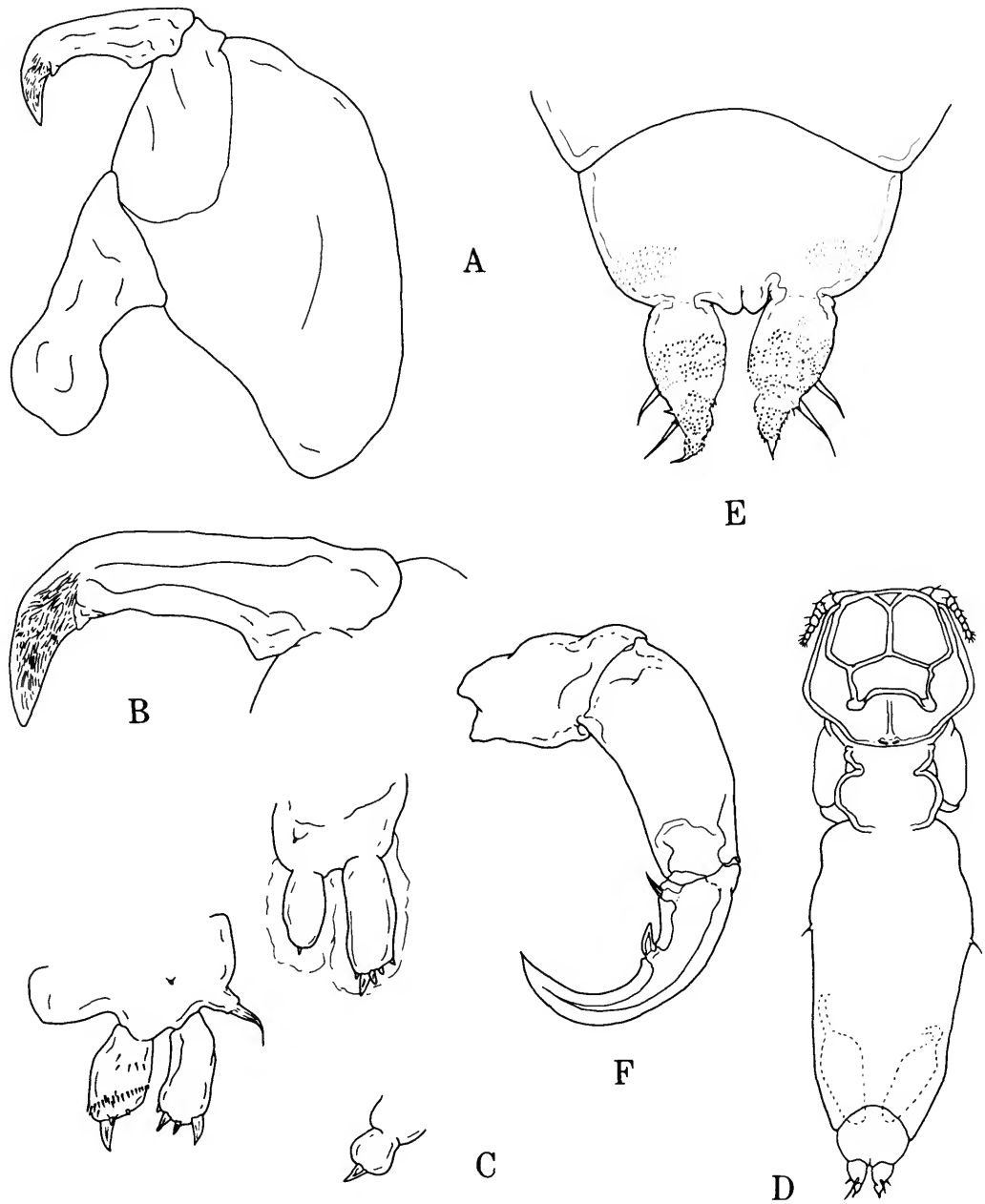

FIGURE 93.—*Pseudocycnoides buccata* (Wilson), female: *a*, maxilliped; *b*, claw of maxilliped; *c*, legs 1–3; male: *d*, dorsal; *e*, abdomen and caudal ramus, ventral; *f*, second antenna.

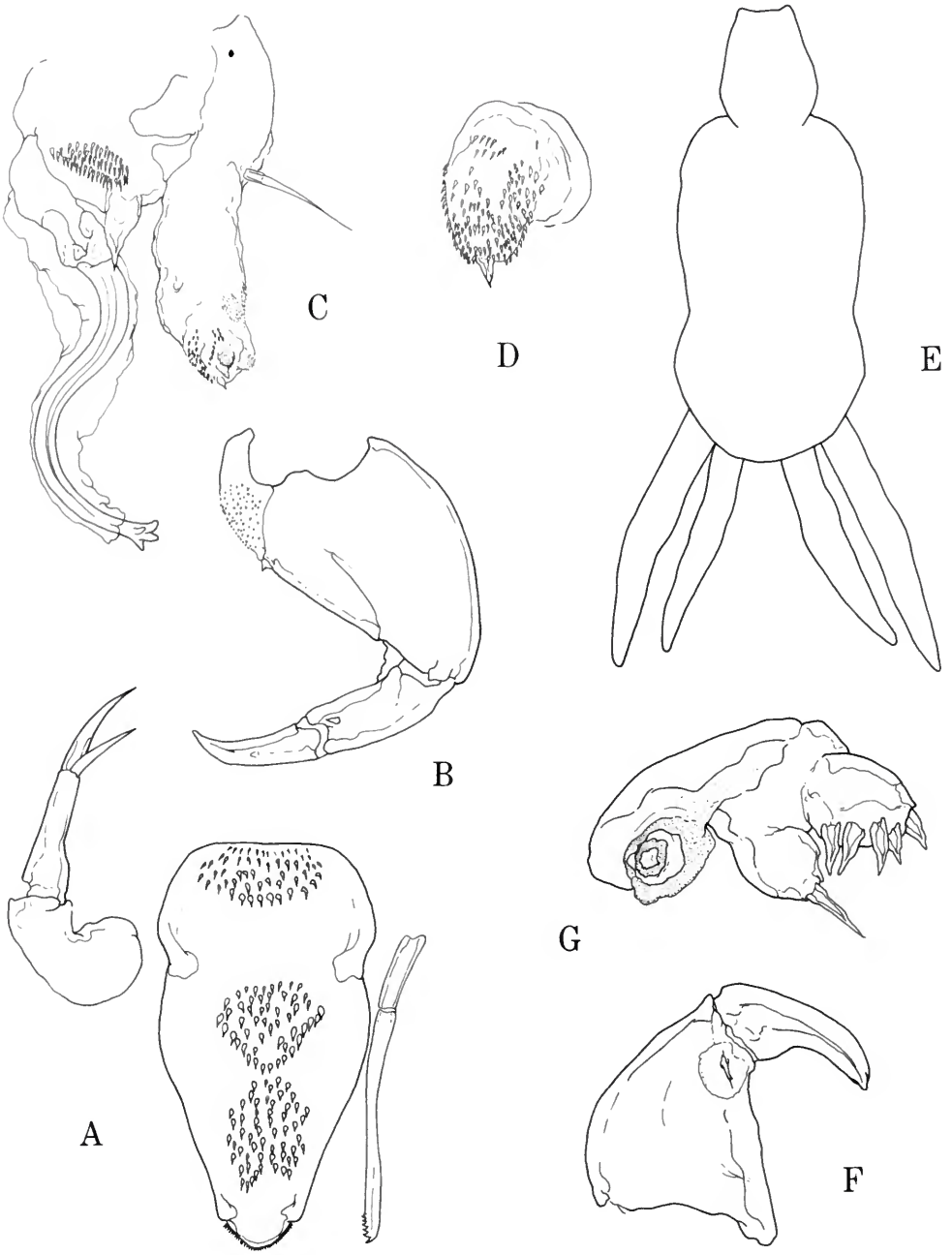

FIGURE 94.—*Pseudocycnoides buccata* (Wilson), male: *a*, first maxilla, mandible and mouth tube; *b*, maxilliped; *c*, leg 1; *d*, leg 3. *Lernanthropus kanagurta* Tripathi, female: e, dorsal; *f*, second antenna; *g*, leg 1.

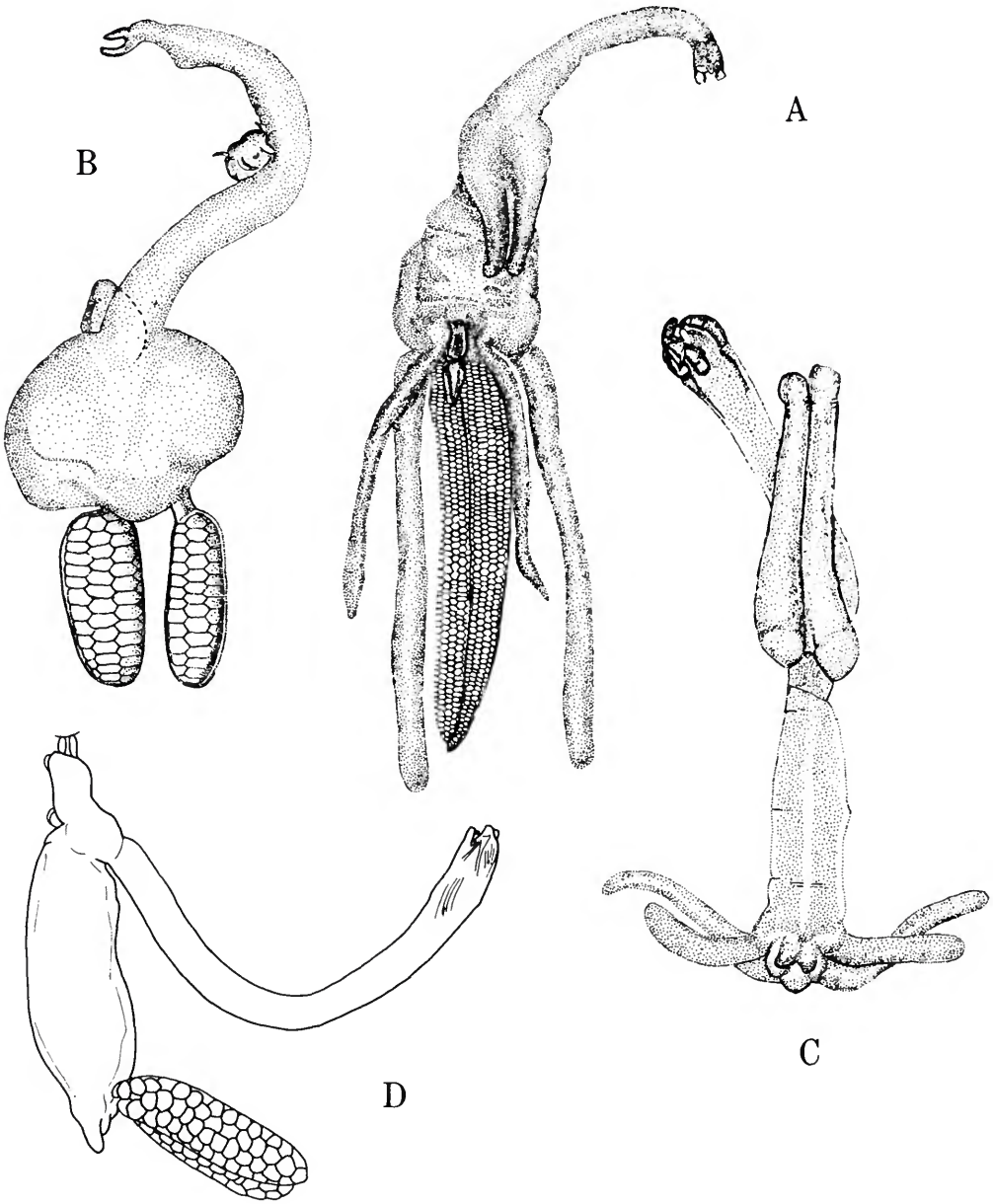

FIGURE 95.—*Brachiella thynni* Cuvier, female: *a*, ventral. *Brachiella magna* Kabata: *b*, dorsal. *Clavellisa scombri* (Kurz), female: *c*, ventral. *Clavelliopsis saba* Yamaguti, female: *d*, lateral. (*B. thynni* after Shiino, 1956; *C. saba* after Shiino, 1959c.)

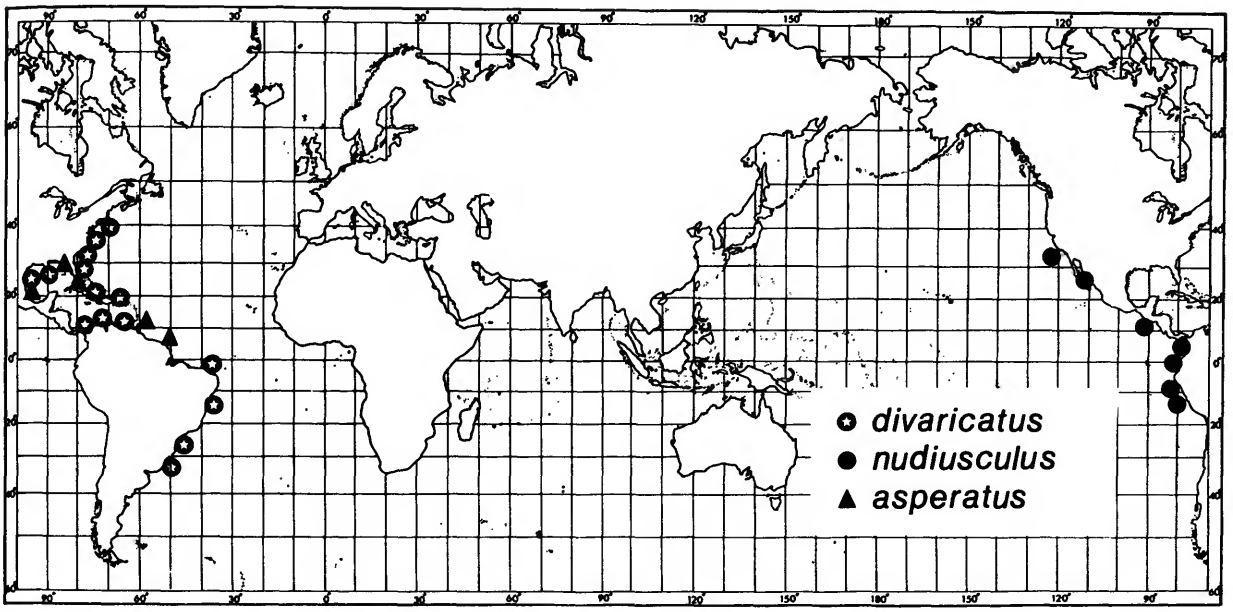

FIGURE 96.—Distribution of *Holobomolochus divaricatus*, new species, *H. nudiusculus*, new species, and *H. asperatus*, new species.

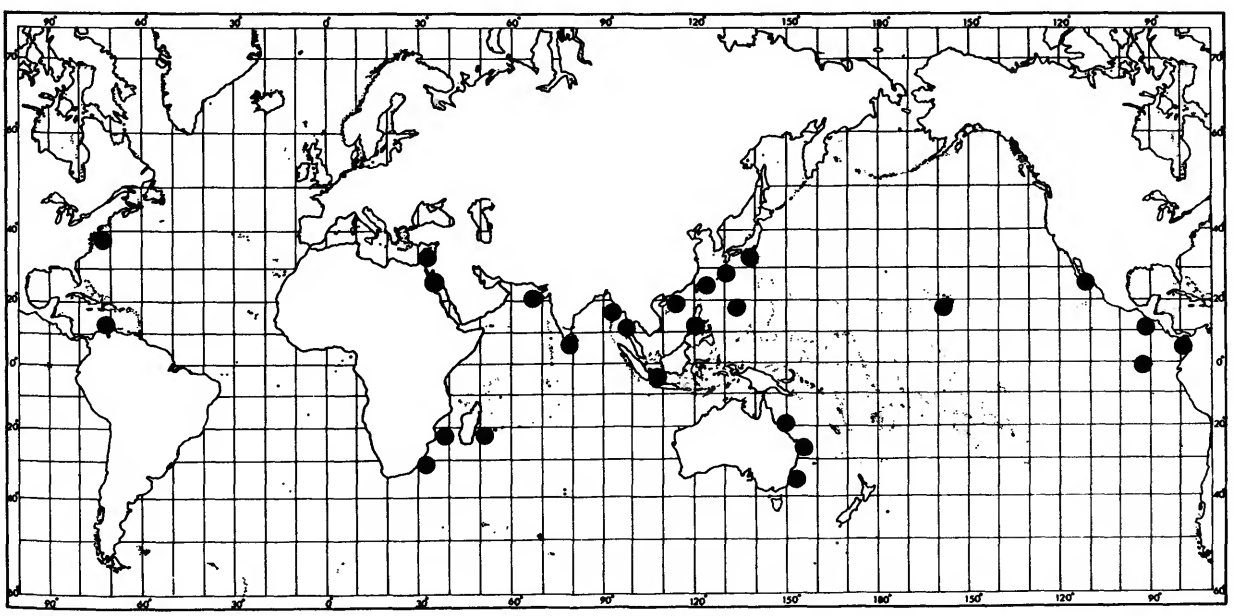

FIGURE 97.—Distribution of *Unicolax collateralis*, new species.

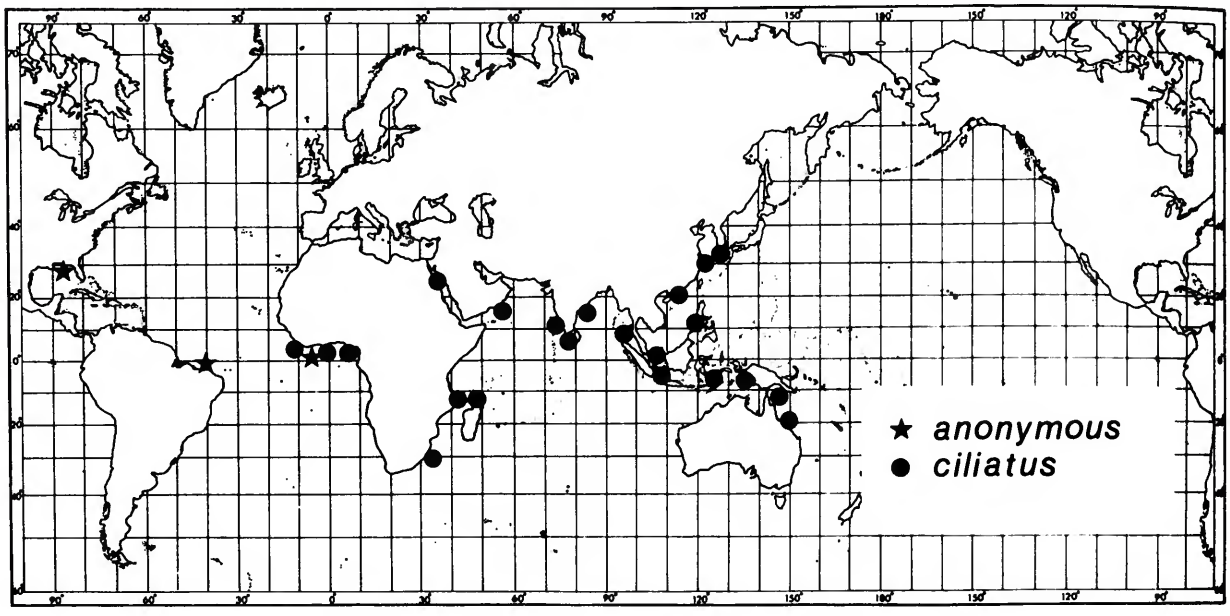

FIGURE 98.—Distribution of *Unicolax anonymous* (Vervoort) and *U. ciliatus*, new species.

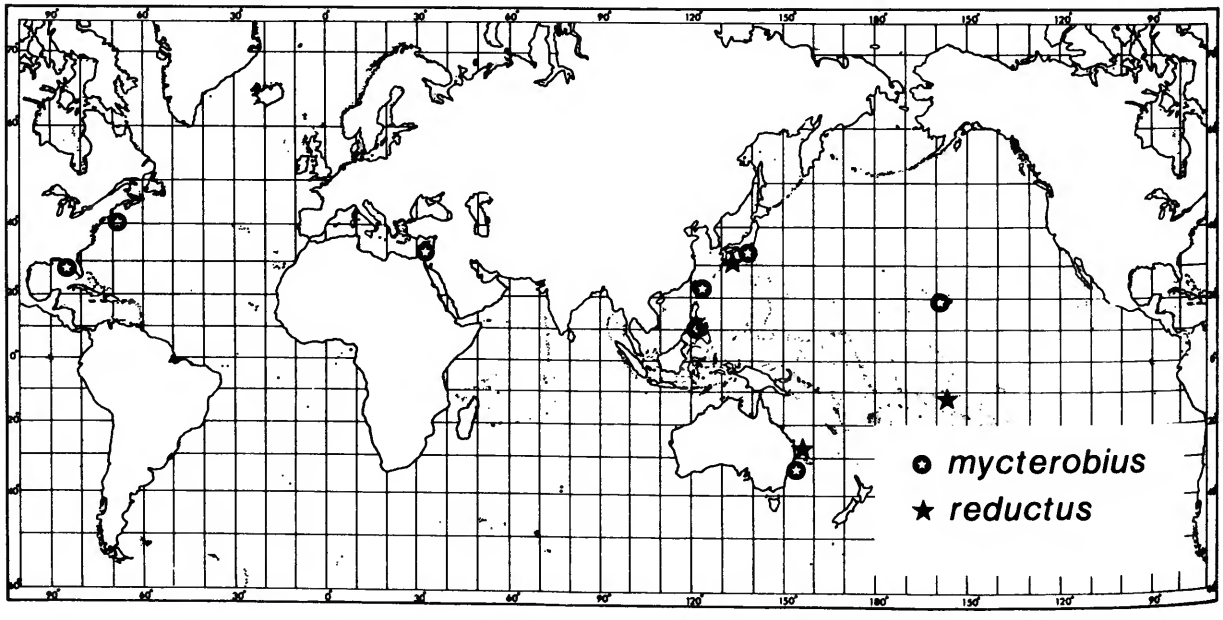

FIGURE 99.—Distribution of *Unicolax mycterobius* (Vervoort) and *U. reductus*, new species.

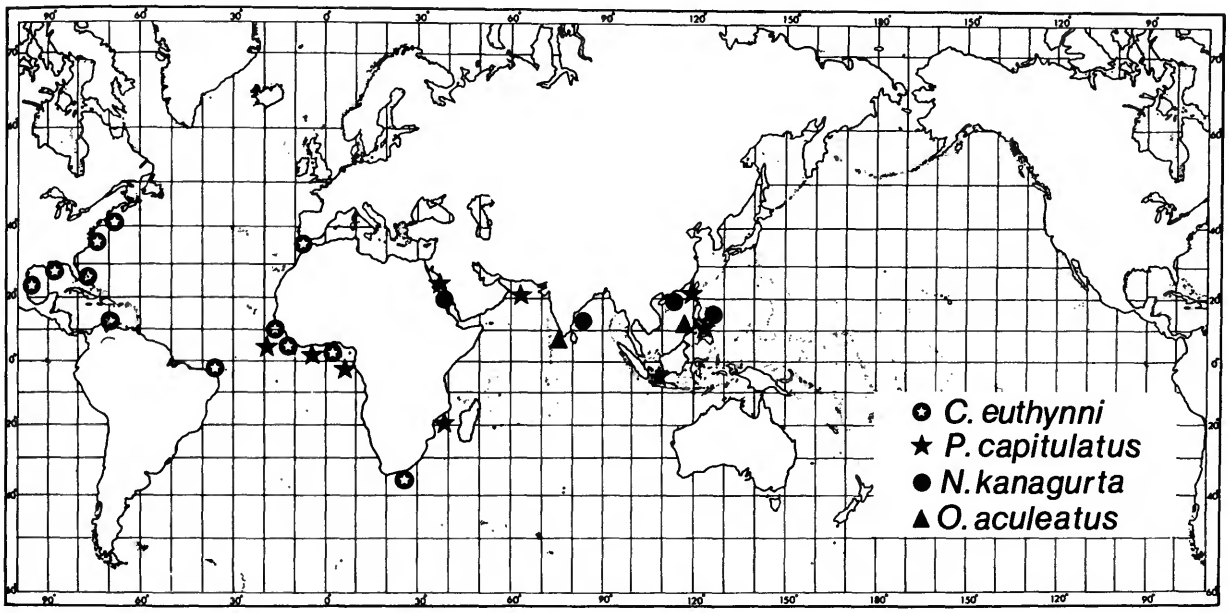

FIGURE 100.—Distribution of *Ceratacolax euthynni* Vervoort, *Pumiliopes capitulatus* Cressey and Boyle, *Nothobomolochus kanagurta* Pillai, and *Orbitacolax aculeatus* (Pillai).

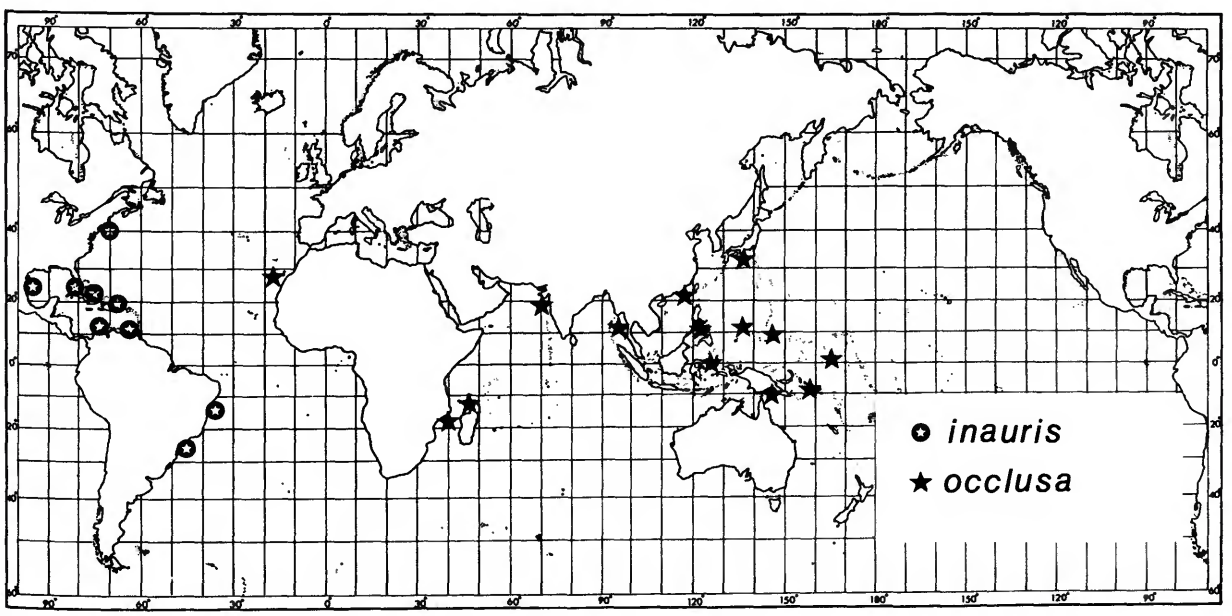

FIGURE 101.—Distribution of *Shiino inauris* Cressey and *S. occlusa* Kabata.

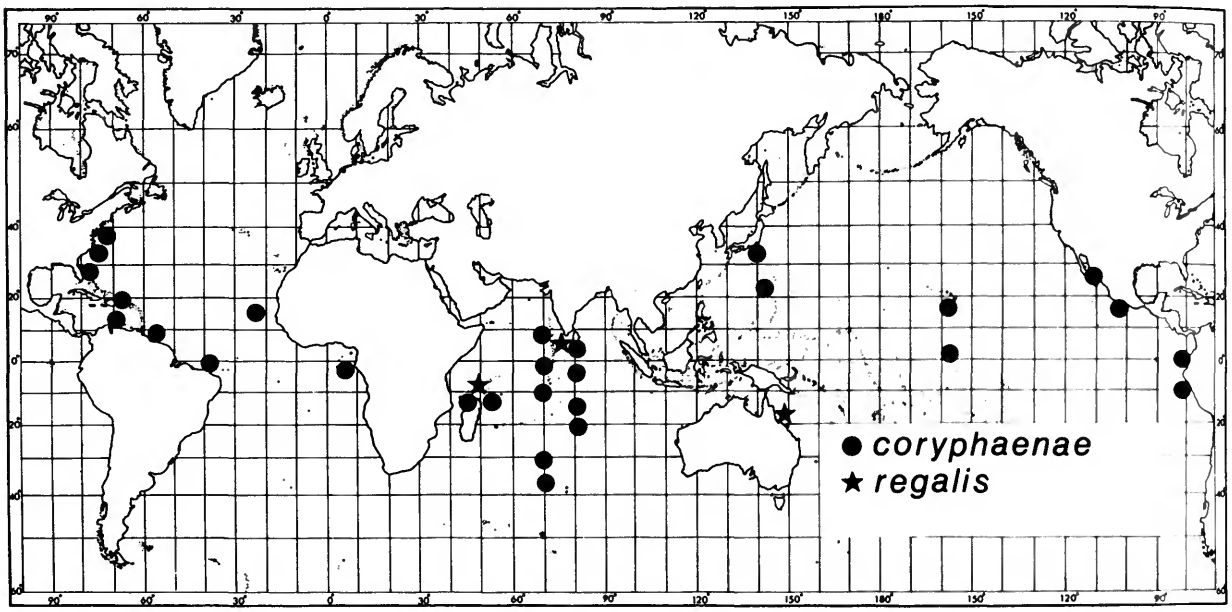

FIGURE 102.—Distribution of *Caligus coryphaenae* Steenstrup and Lütken, and *C. regalis* Leigh-Sharpe. (Includes some records of Lewis, et al. 1969; Shiino 1959a, 1973; Kabata and Gussev, 1966; Pillai, 1963.)

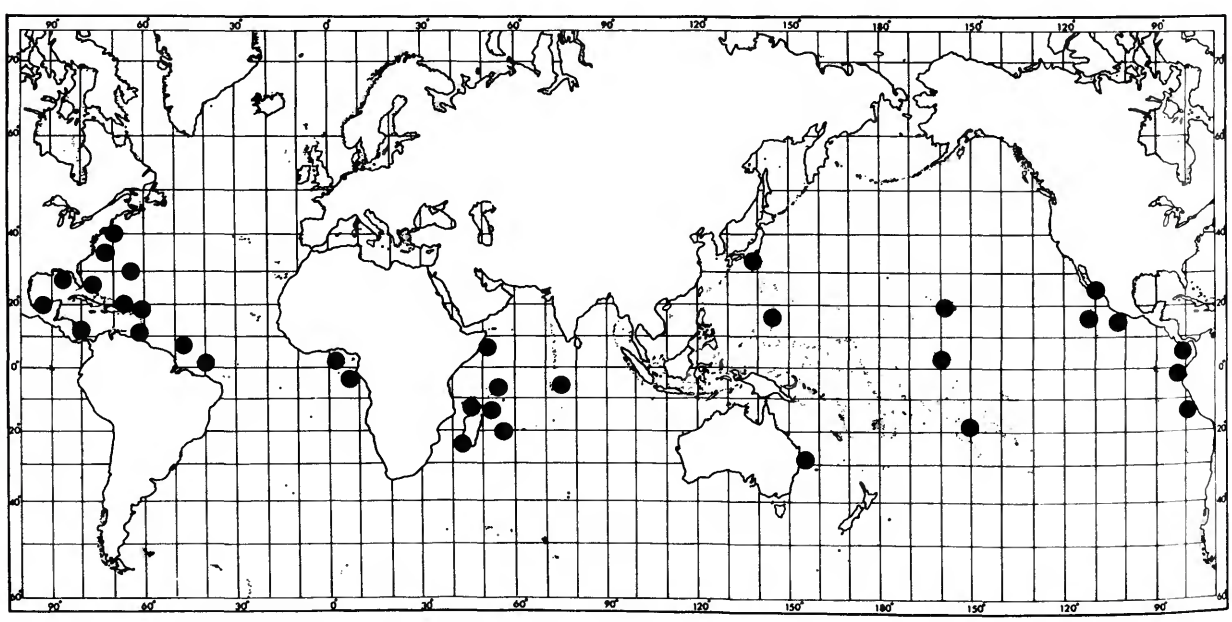

FIGURE 103.—Distribution of *Caligus productus* Muller.

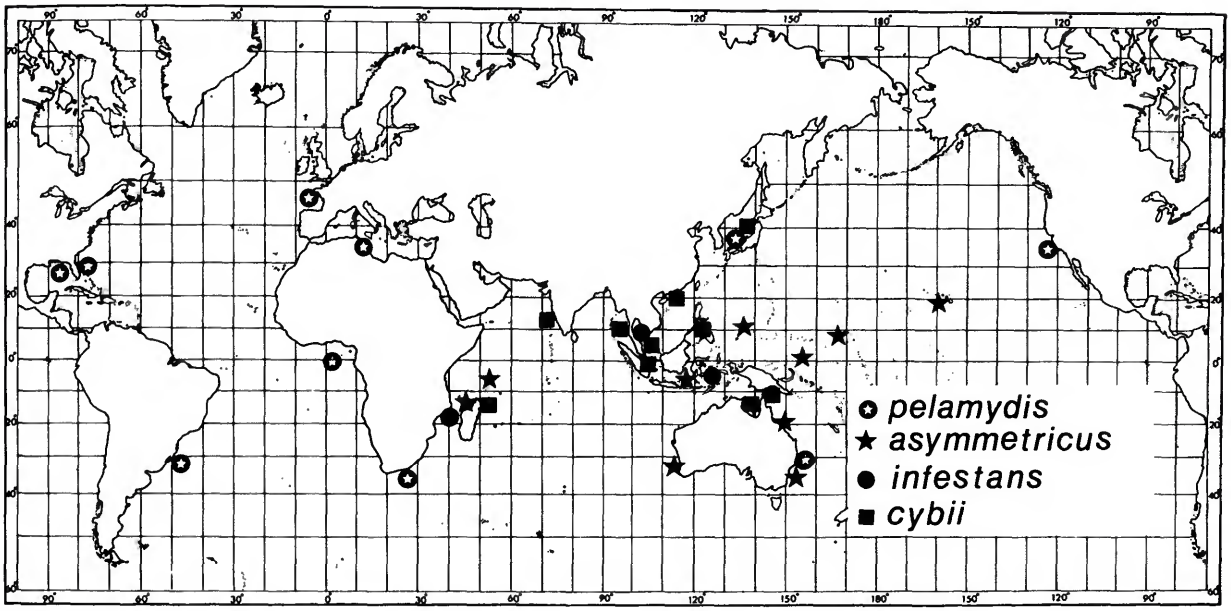

FIGURE 104.—Distribution of *Caligus pelamydis* Kroyer, *C. asymmetricus* Kabata, *C. infestans* Heller, and *C. cybii* Bassett-Smith.

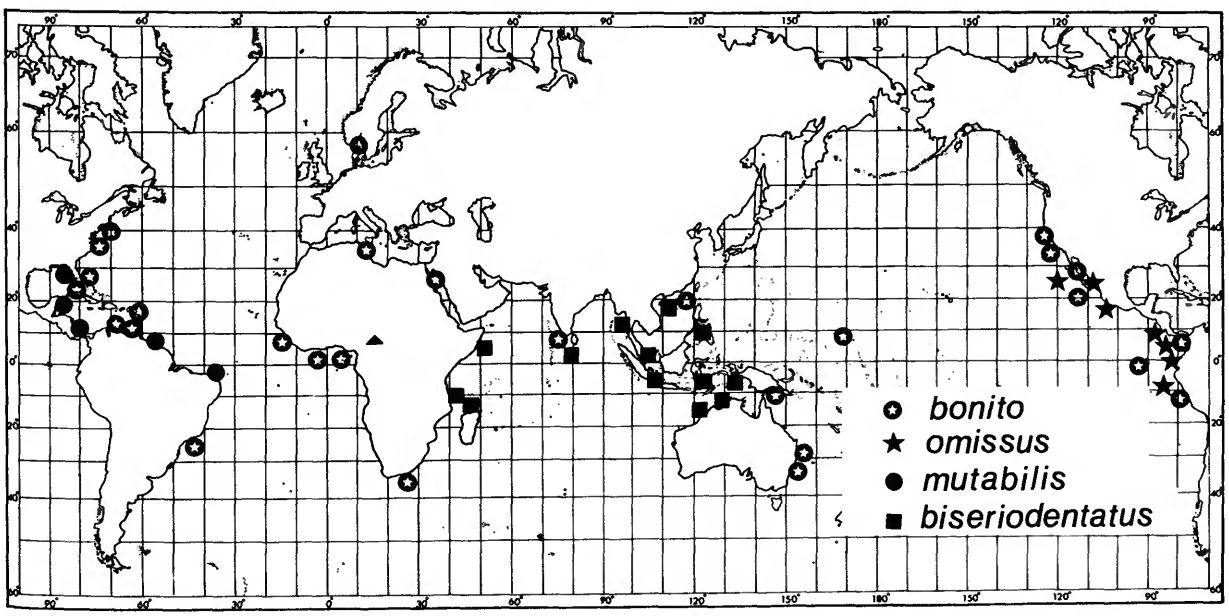

FIGURE 105.—Distribution of *Caligus bonito* Wilson, *C. omissus*, new species, *C. mutabilis* Wilson, and *C. biseriodentatus* Shen.

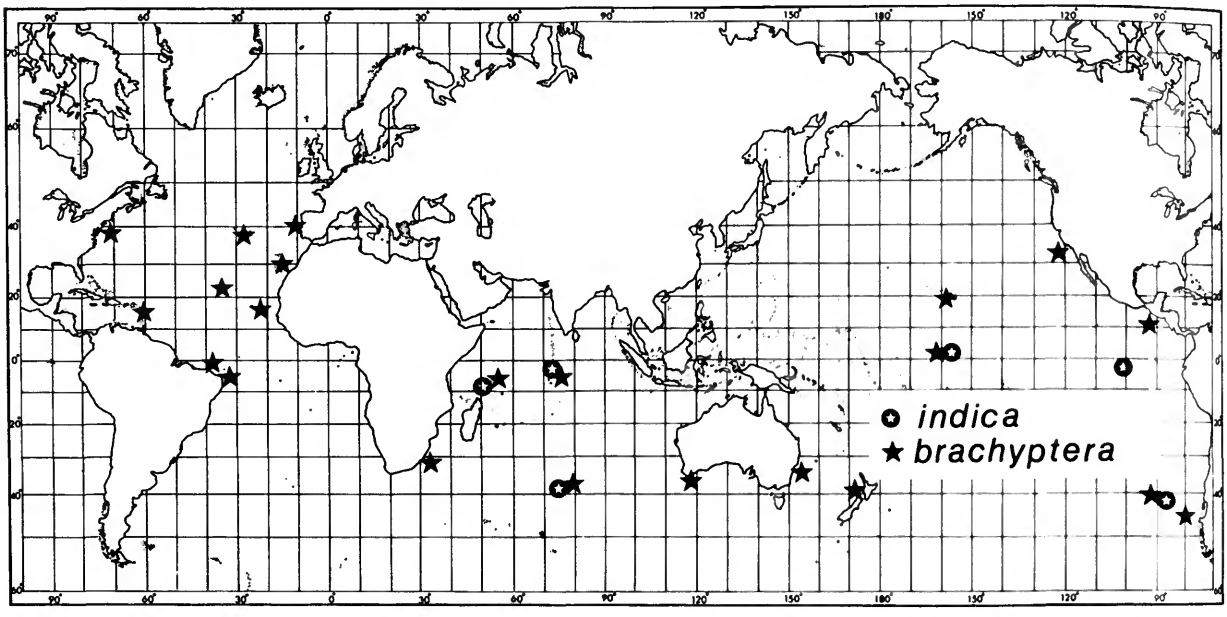

FIGURE 106.—Distribution of *Elytrophora indica* Shiino, and *E. brachyptera* Gerstaecker. (Includes Shiino, 1958 and 1965 *E. indica*.)

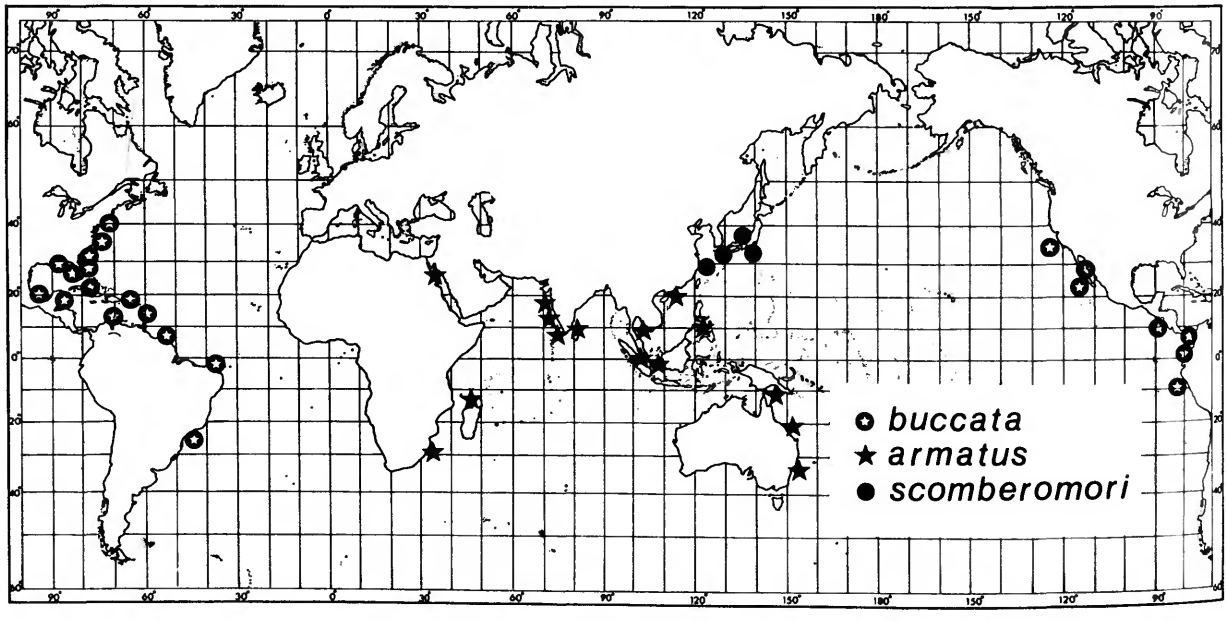

FIGURE 107.—Distribution of *Pseudocycnoides buccata* (Wilson), *P. armatus* (Bassett-Smith), and *P. scomberomori* (Yamaguti).

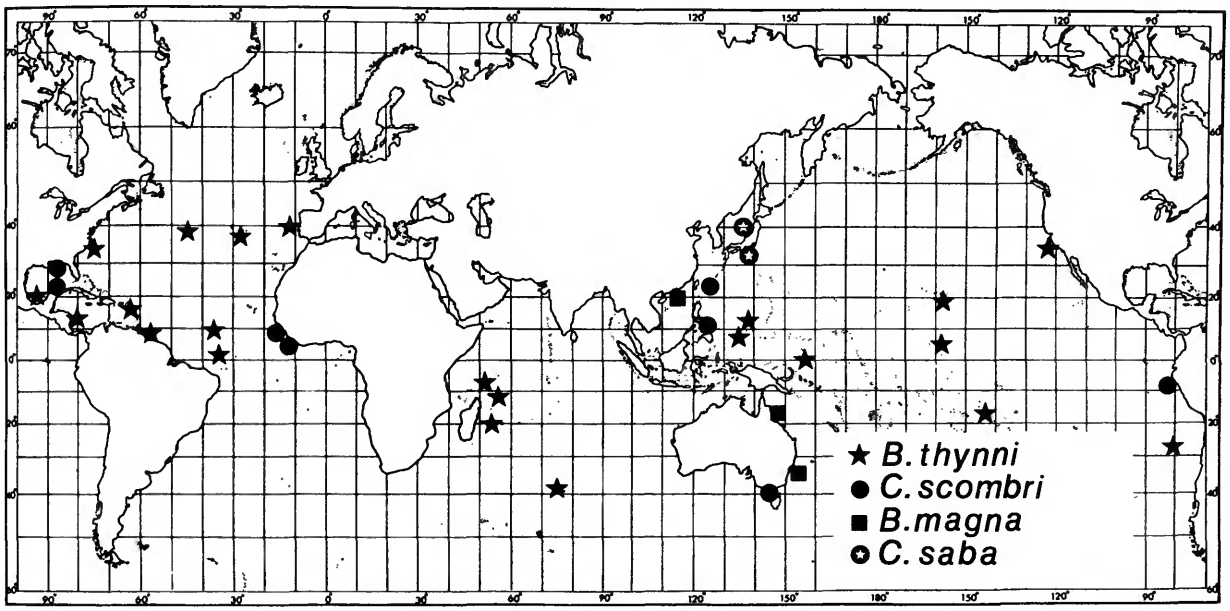

FIGURE 108.—Distribution of *Brachiella thynni* Cuvier, *Clavellisa scombri* (Kurz), *B. magna* Kabata, and *Clavellopsis saba* Yamaguti. (Includes Kabata, 1968b *B. magna*.)

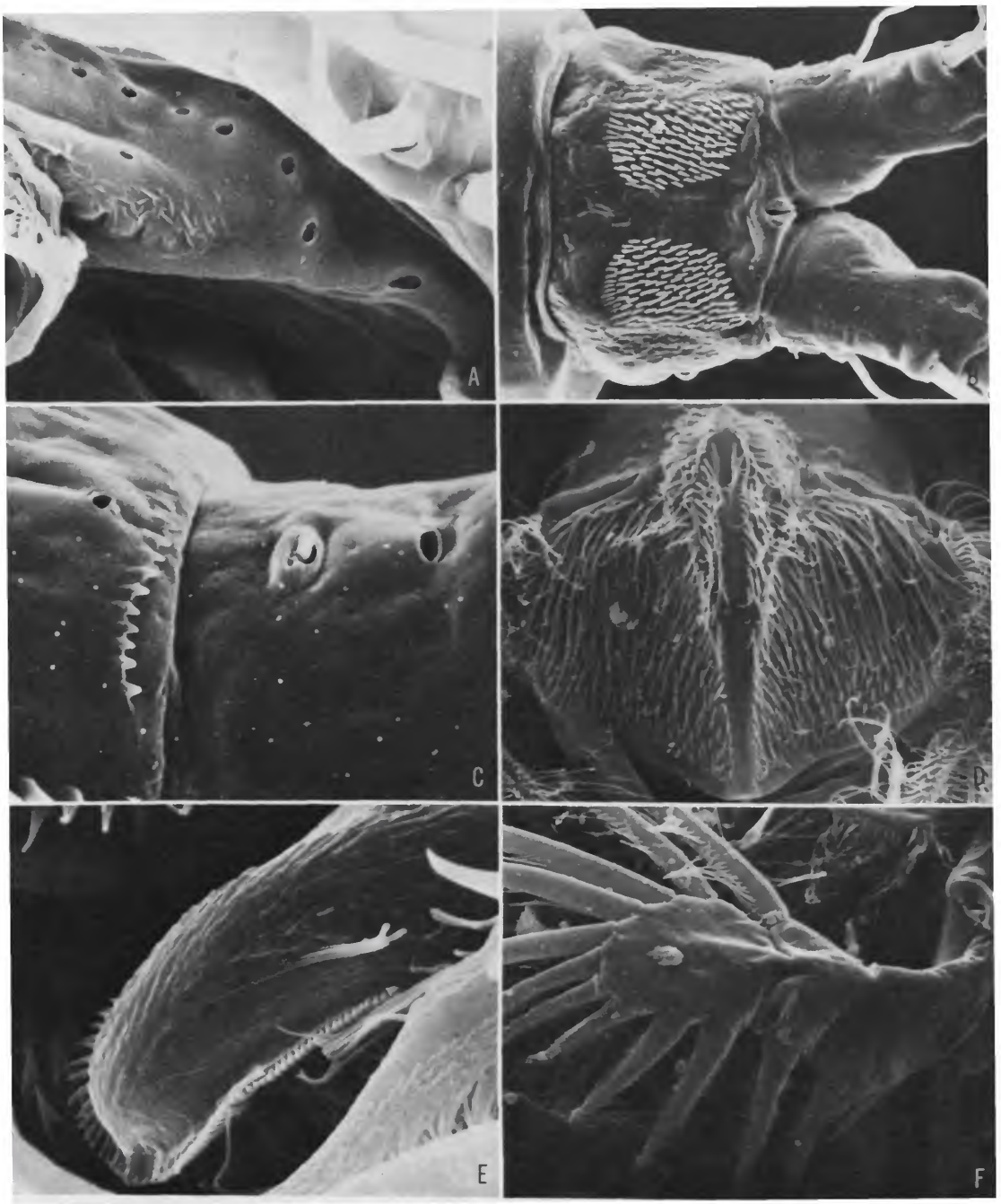

FIGURE 109.—*Holobomolochus divaricatus,* new species, female: *a,* rostral area (1775×); *b,* abdomen and caudal rami, ventral (540×); *c,* abdomen, outer distal corner (2950×); *d,* labrum (1000×); *e,* paragnath (3145×); *f,* leg 2 exopod (500×).

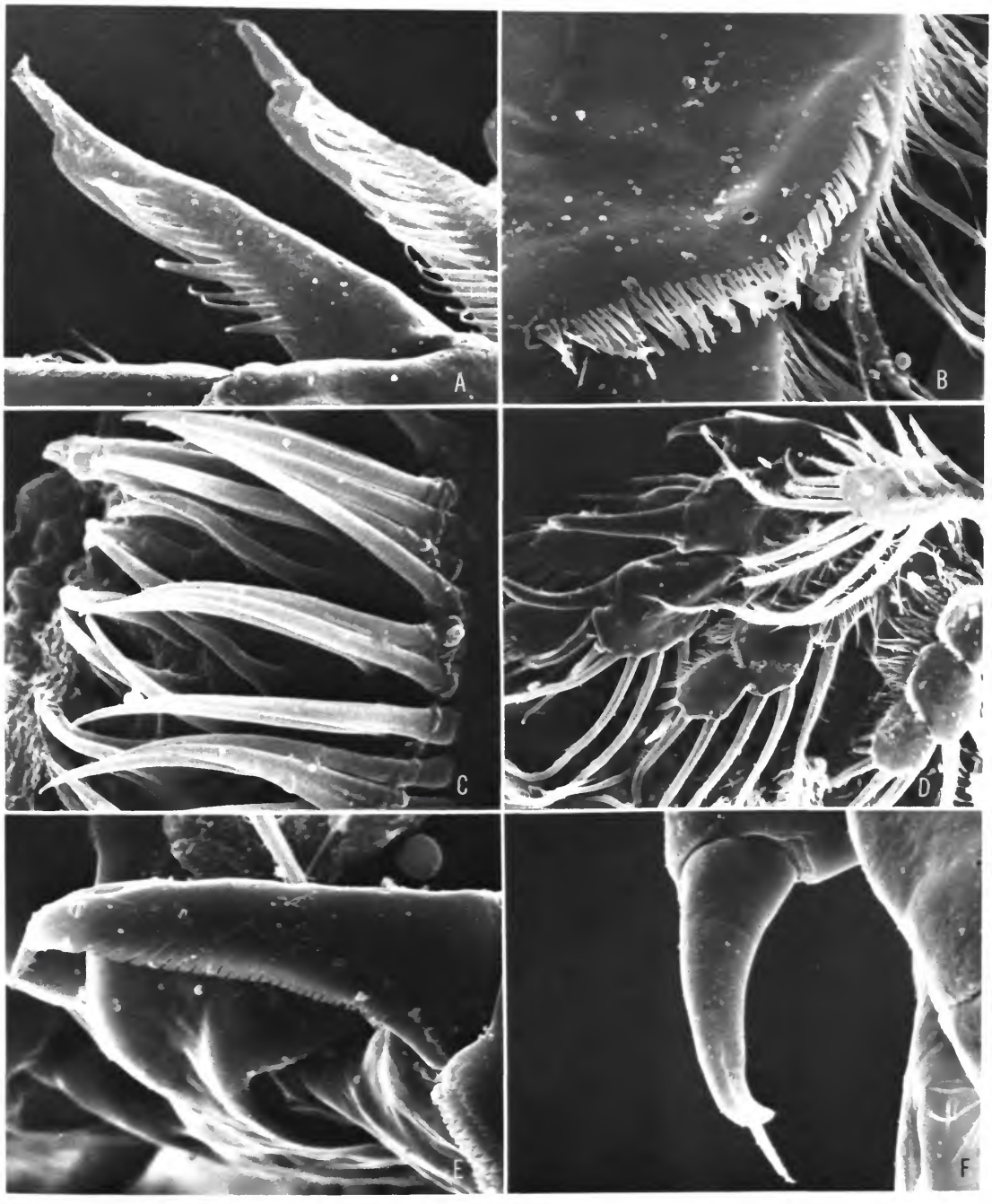

FIGURE 110.—*Holobomolochus divaricatus*, new species, female: *a*, leg 2 exopod spines (2850); *b*, leg 2 endopod first segment (1500×); *c*, leg 2 armature of interpodal plate (3750×); *d*, leg 2 (above) and leg 3 (below) (200×); *e*, leg 3 exopod first segment outer spine (1400×); *f*, same, lateral view (1315×).

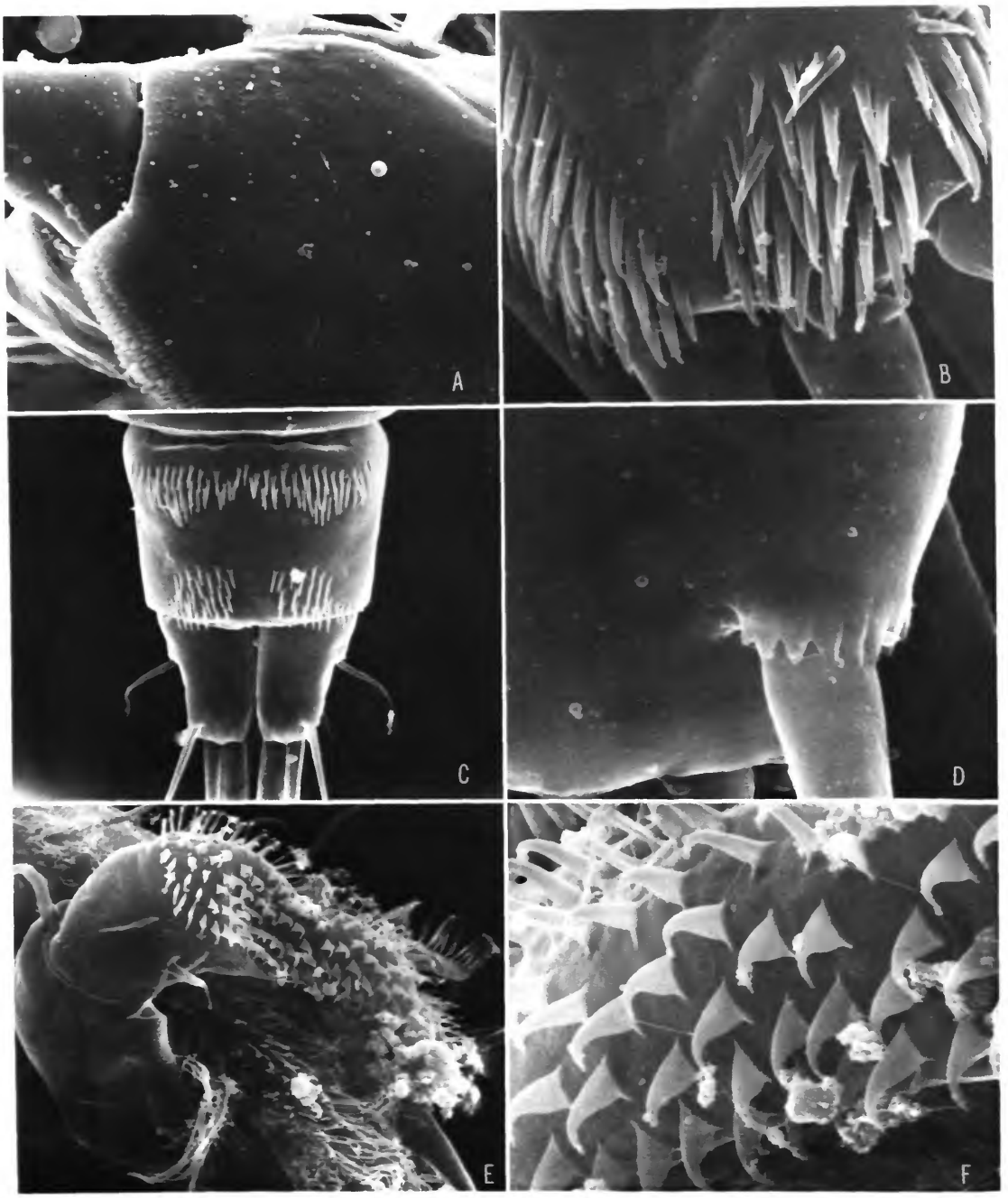

FIGURE 111.—*Holobomolochus divaricatus,* new species, female: *a,* leg 3 exopod first segment base of outer spine (1400×); *b,* leg 4 tip of endopod (2000×); male: *c,* abdomen and caudal ramus, ventral (500×); *d,* caudal ramus outer distal corner (5000×); *e,* second antenna (350×); *f,* hooks on second antenna (3000×).

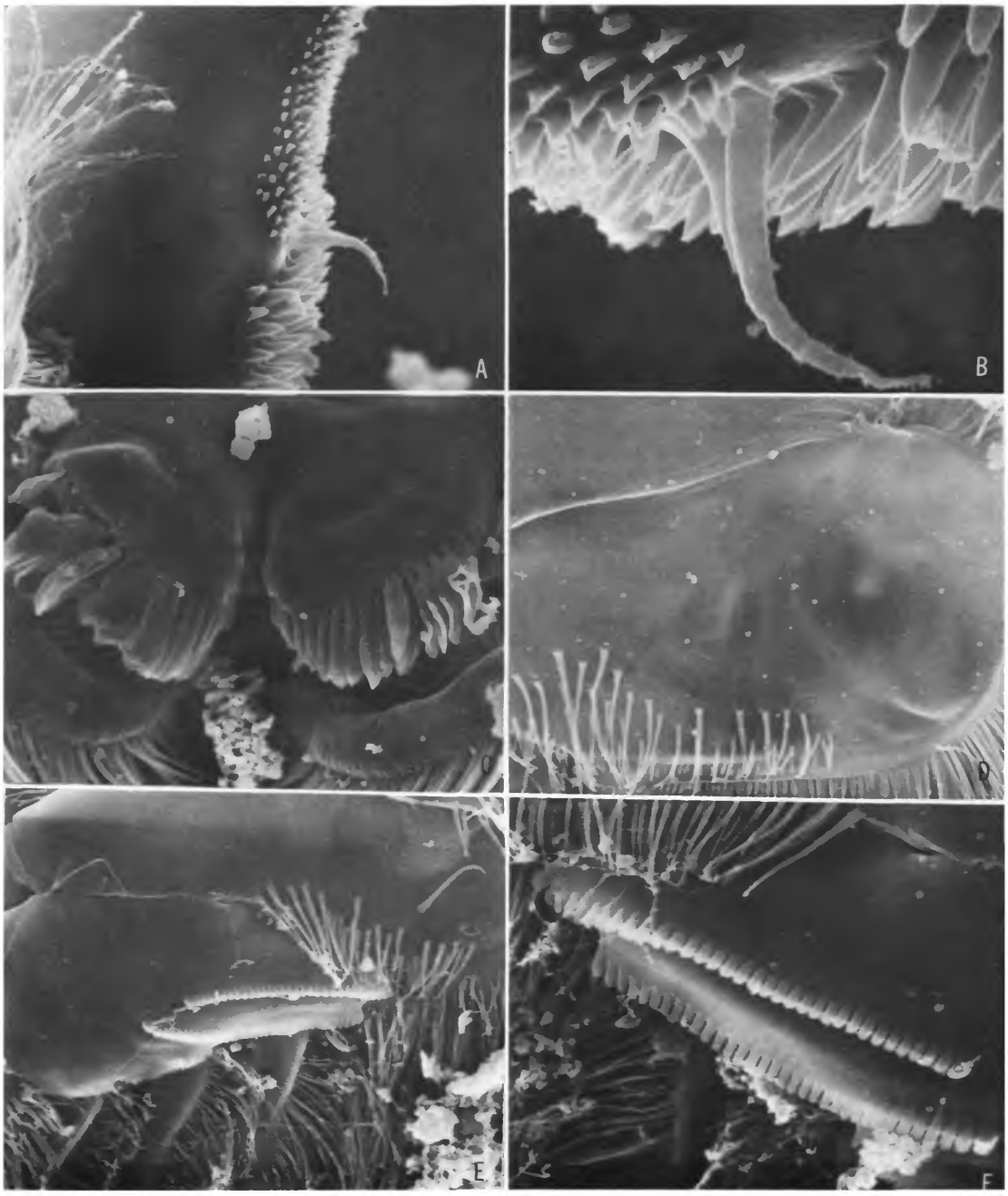

FIGURE 112.—*Holobomolochus divaricatus,* new species, male: *a,* inner edge of maxilliped (1250×); *b,* same (3750×); *c,* leg 1 interpodal plate (2000×); *d,* leg 1 basipod (1500×); *e,* leg 1 exopod third segment (1500×); *f,* same, outer edge (3000×).

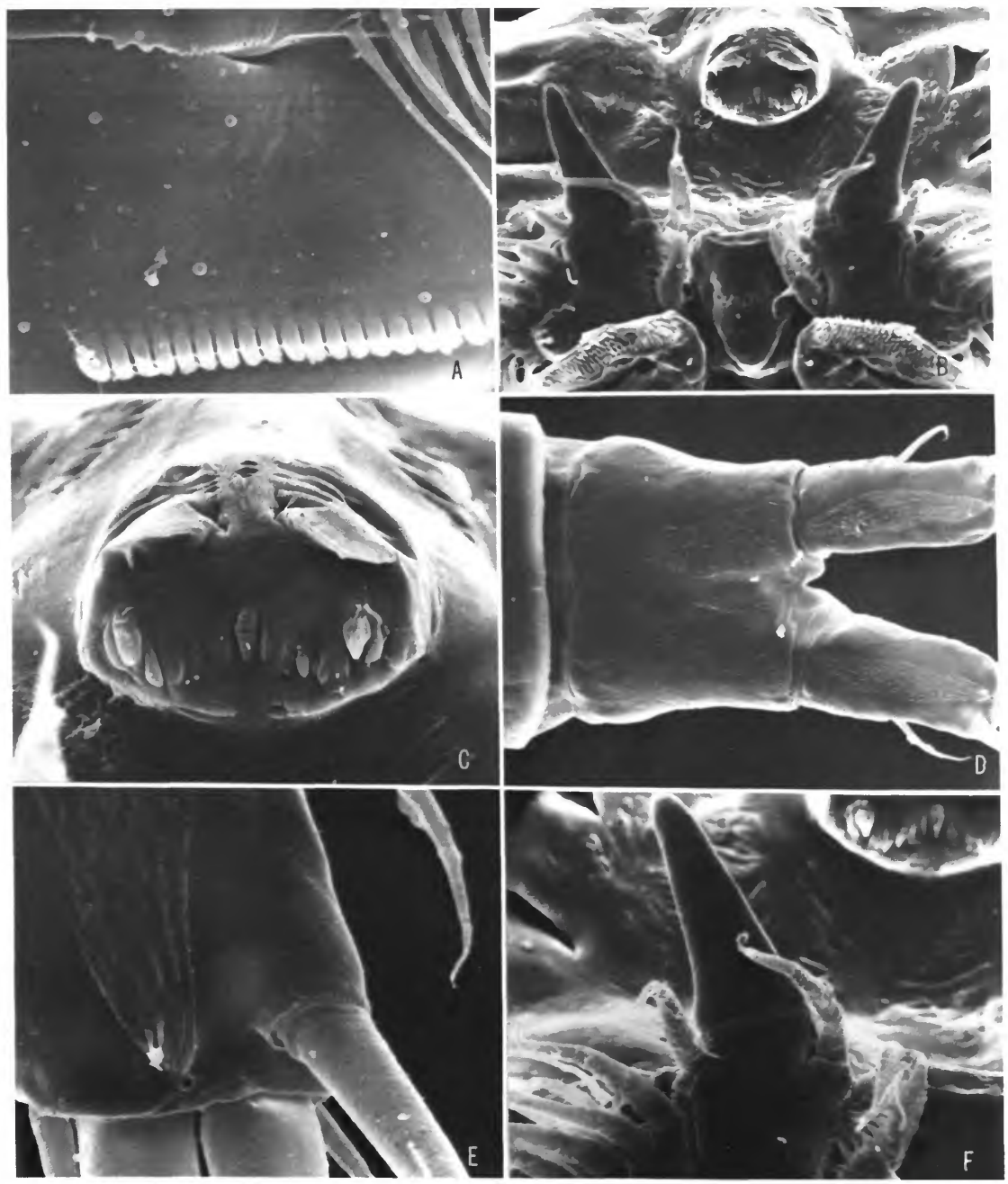

FIGURE 113.—*Holobomolochus divaricatus,* new species, male: *a,* leg 1 exopod third segment outer edge (5000×). *Unicolax collateralis,* new species, female: *b,* cephalon, anterior view (300×); *c,* same (900×); *d,* abdomen and caudal rami, ventral (440×); *e,* tip of caudal ramus, ventral (2000×); *f,* modified seta of first antenna (600×).

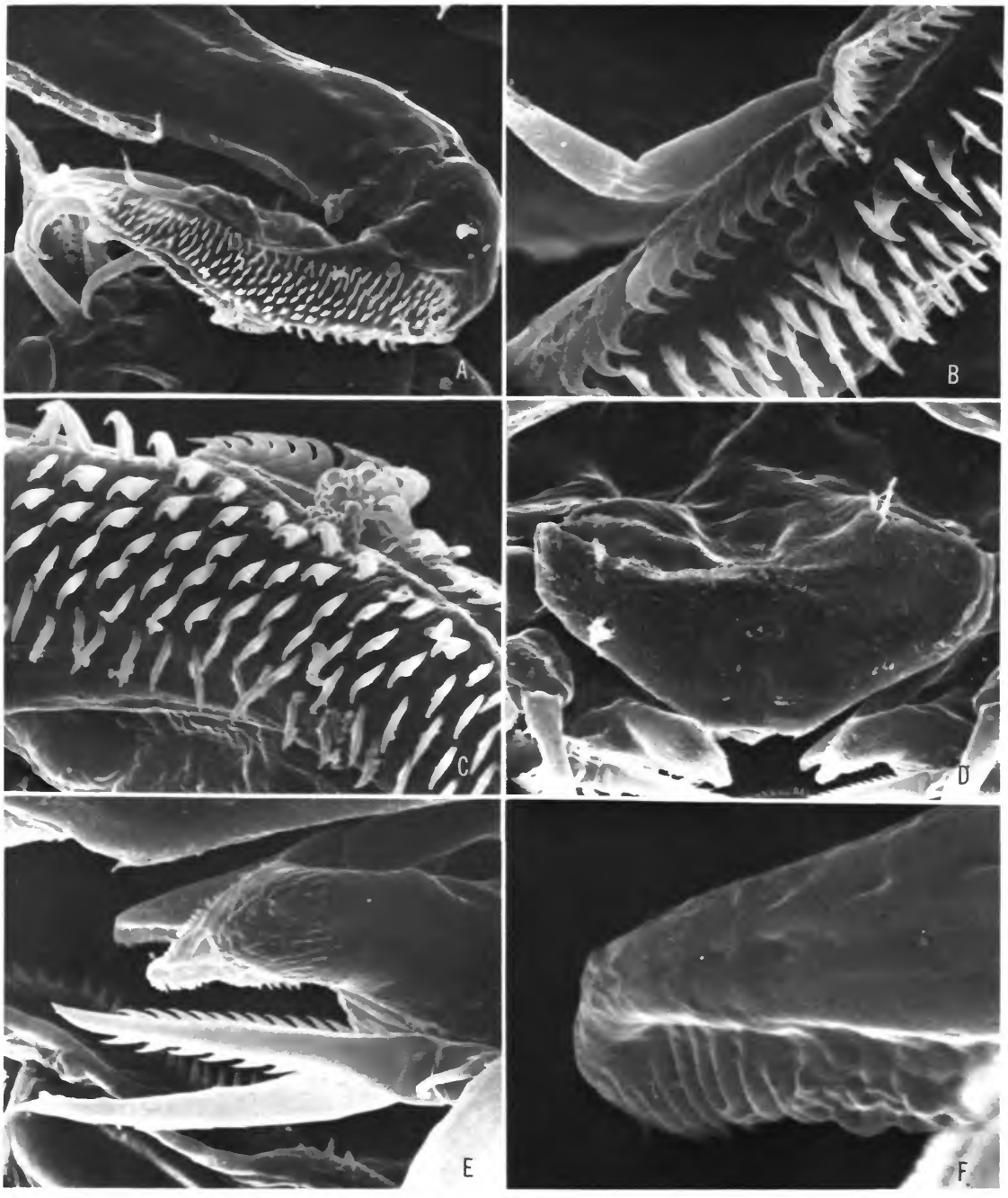

FIGURE 114.—*Unicolax collateralis,* new species, female: *a,* second antenna (750×); *b,* hooks on second antenna (2400×); *c,* same (2600×); *d,* labrum (600×); *e,* oral area (1500×); *f,* tip of mandible (10,000×).

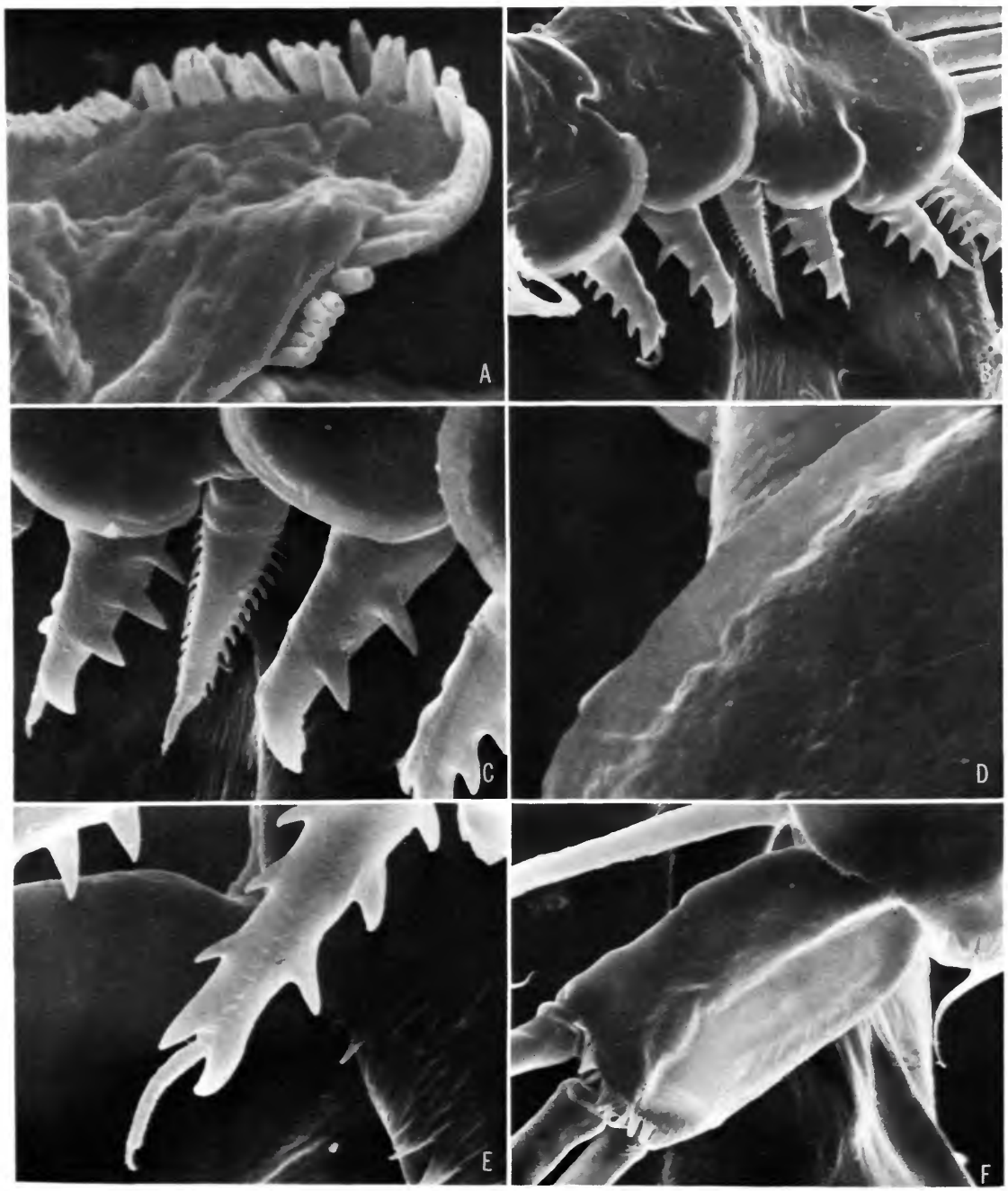

FIGURE 115.—*Unicolax collateralis*, new species, female: *a*, tip of paragnath (10,000×); *b*, leg 2 exopod (1000×); *c*, spines on leg 2 exopod (2000×); *d*, hyaline fringe of leg 2 exopod outer edge (8000×); *e*, spine on leg 2 exopod (2500×); *f*, leg 4 endopod last segment (1000×).

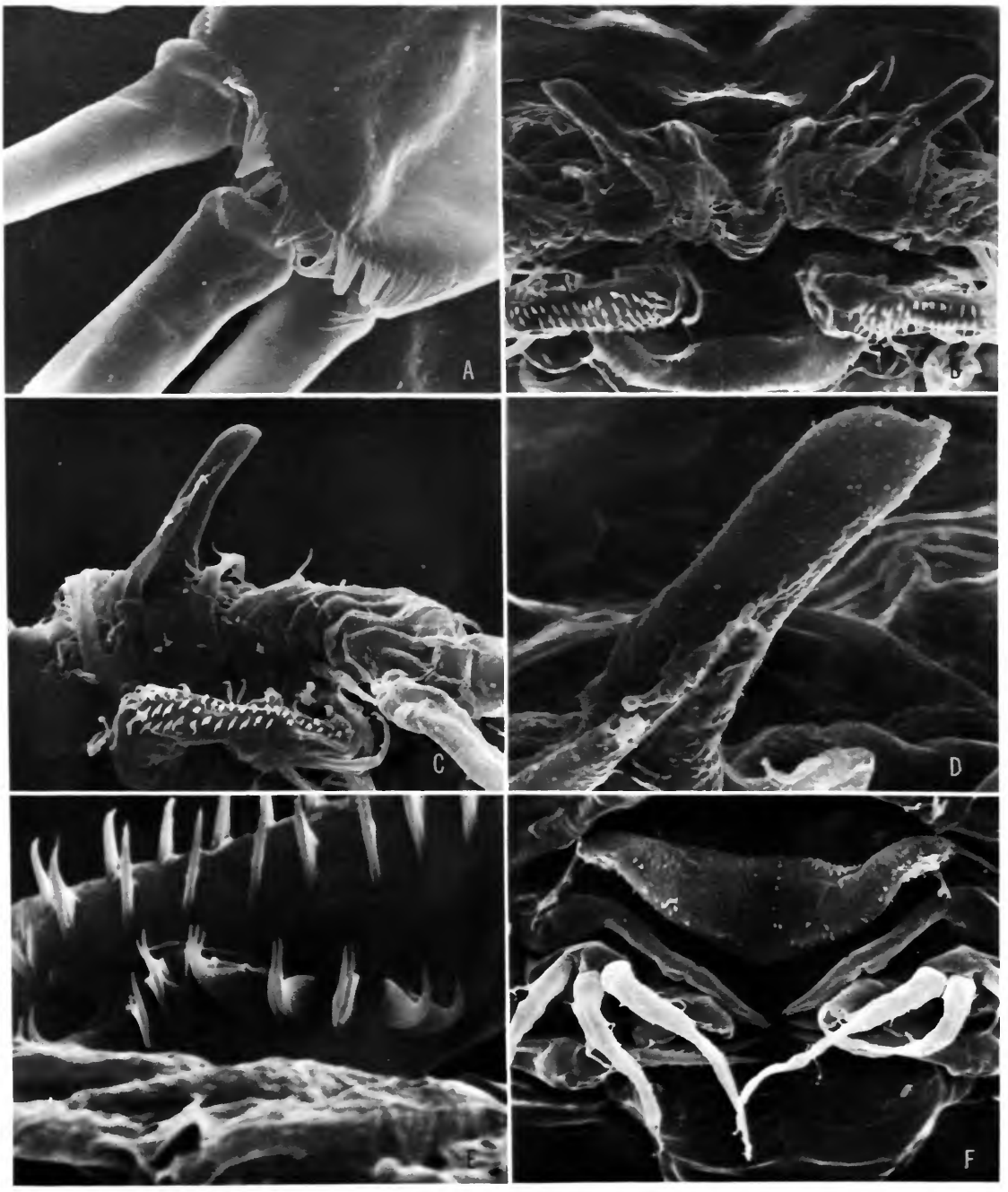

FIGURE 116.—*Unicolax collateralis*, new species, female: *a*, tip of leg 4 endopod (2000×). *Unicolax anonymous* (Vervoort), female: *b*, cephalon, anterior view (600×); *c*, first and second antenna, anterior view (700×); *d*, modified seta of first antenna (2300×); *e*, hooks on second antenna (7500×); *f*, oral area (750×).

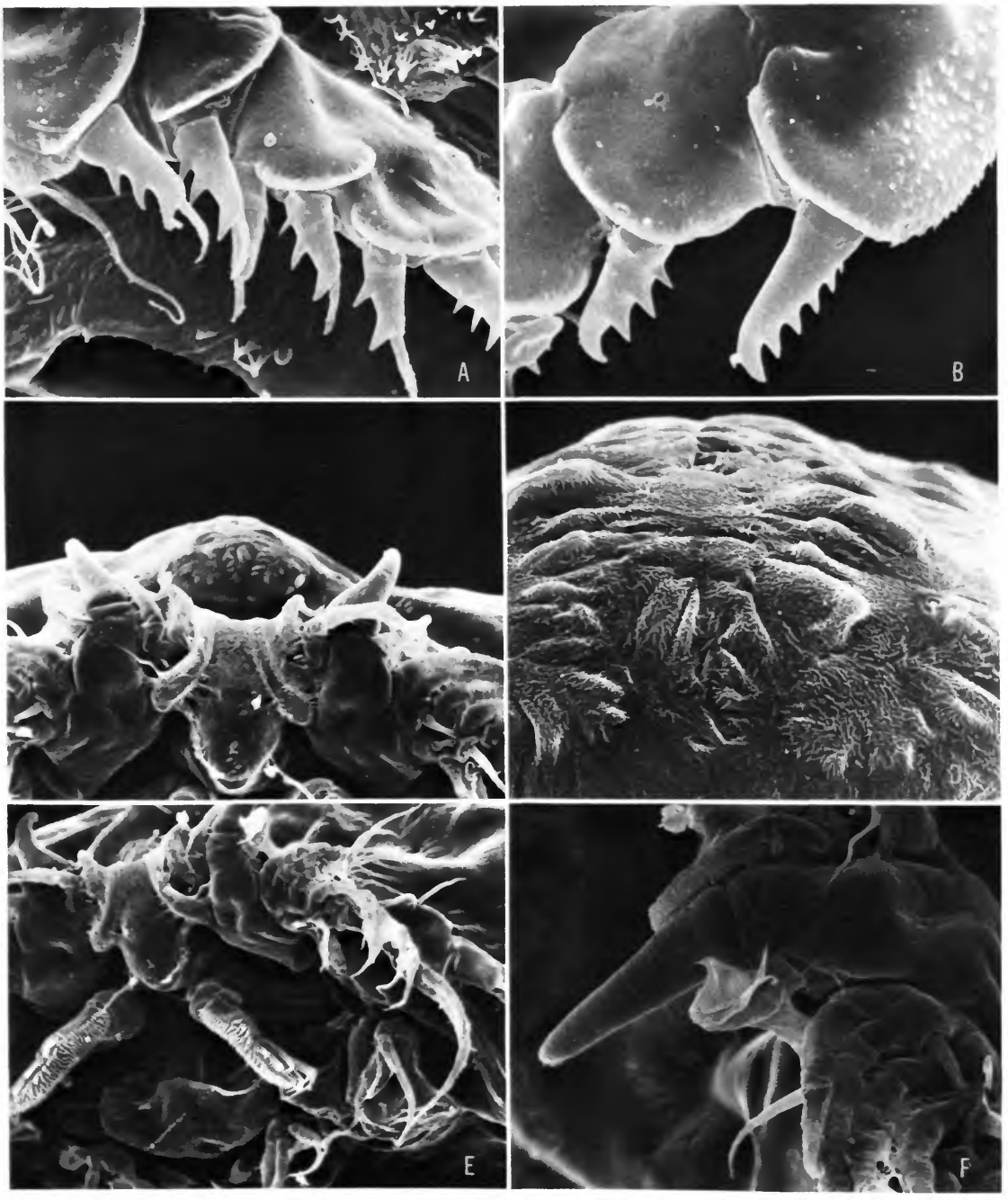

FIGURE 117.—*Unicolax anonymous* (Vervoort), female: *a*, leg 2 exopod (1650×); *b*, leg 3 exopod outer edge (1750×). *Unicolax mycterobius* (Vervoort), female: *c*, cephalon, anterior view (200×); *d*, surface of cephalon dorsal to insertion of first antennae (1400×); *e*, cephalon, anteroventral view (200×); *f*, modified seta of first antenna (400×).

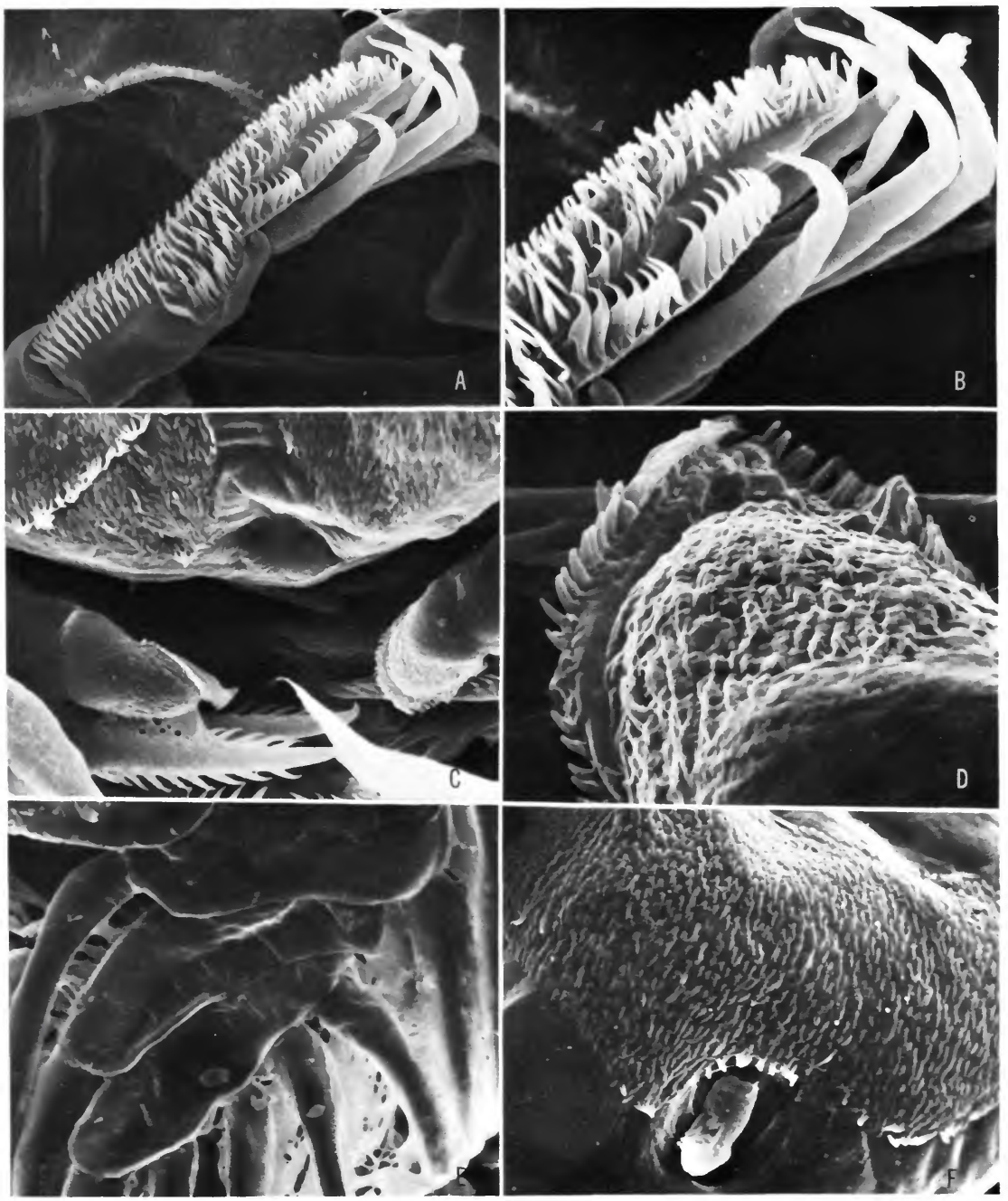

FIGURE 118.—*Unicolax mycterobius* (Vervoort), female: *a*, second antenna (750×); *b*, tip of second antenna (1400×); *c*, oral area (1050×); *d*, tip of paragnath (5250×); *e*, leg 1 exopod (500×); *f*, leg 1 basipod (1000×).

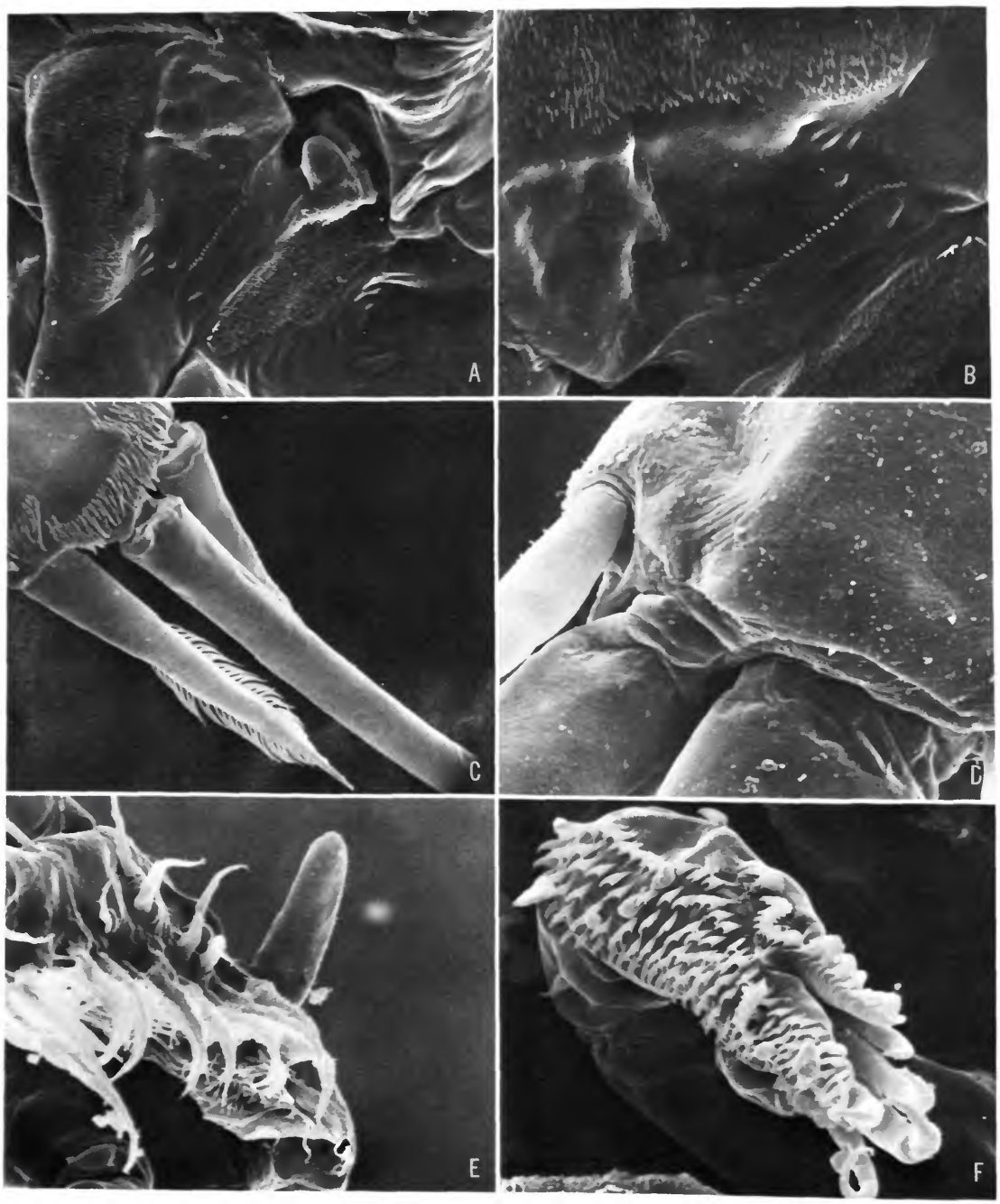

FIGURE 119.—*Unicolax mycterobius* (Vervoort), female: *a*, leg 1 exopod first segment (700×); *b*, leg 1 basipod and exopod insertion (1050×); *c*, leg 4 endopod tip (750×). *Unicolax reductus*, new species, female: *d*, distal end of caudal ramus (1500×); *e*, modified seta of first antenna (500×); *f*, second antenna (1000×).

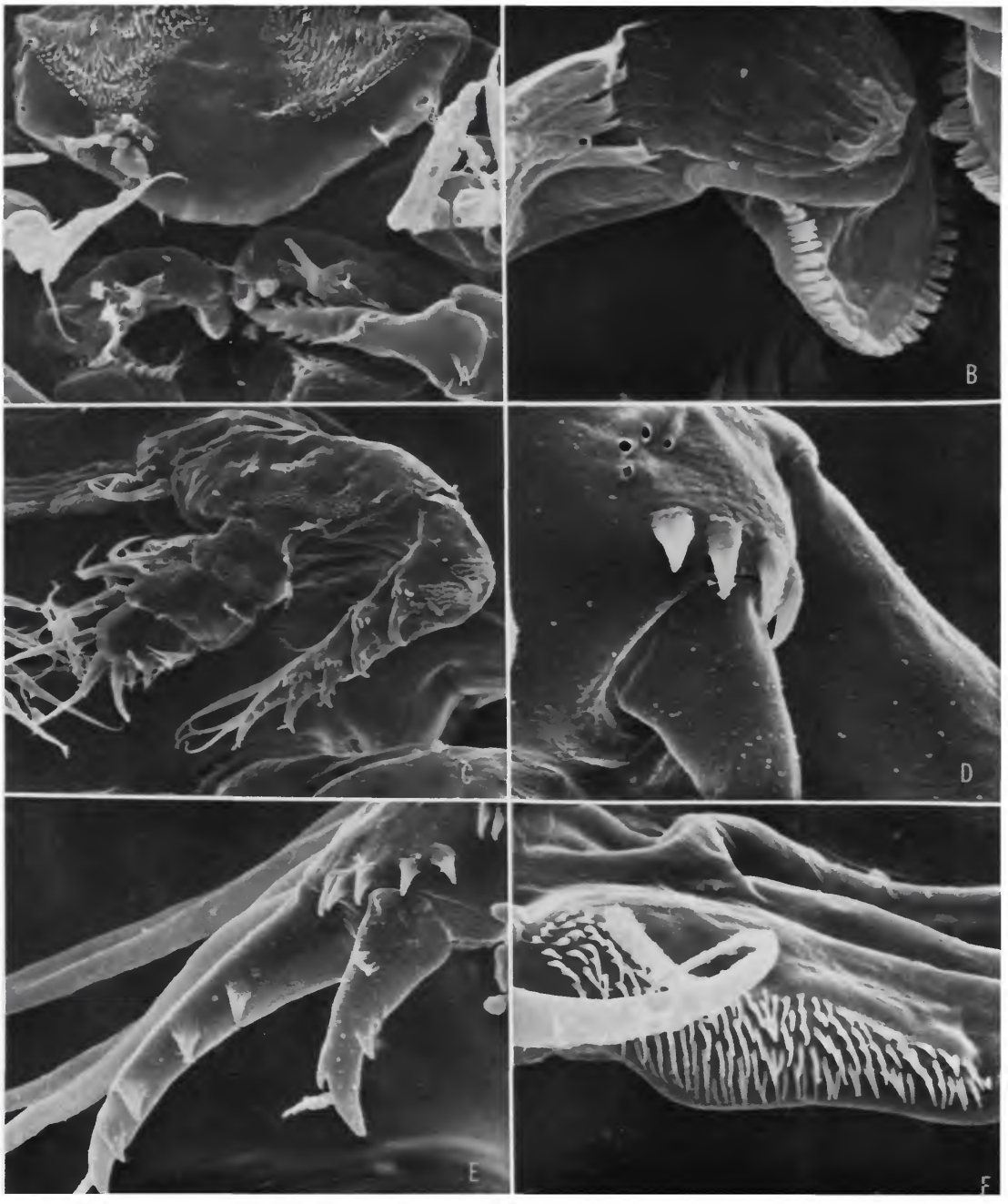

FIGURE 120.—*Unicolax reductus*, new species, female: *a*, oral area (700×); *b*, paragnath (3400×); *c*, leg 2 (260×); *d*, leg 2 exopod first segment outer corner (2000×); *e*, leg 2 exopod last segment tip (1200×); *f*, leg 2 interpodal plate (1400×).

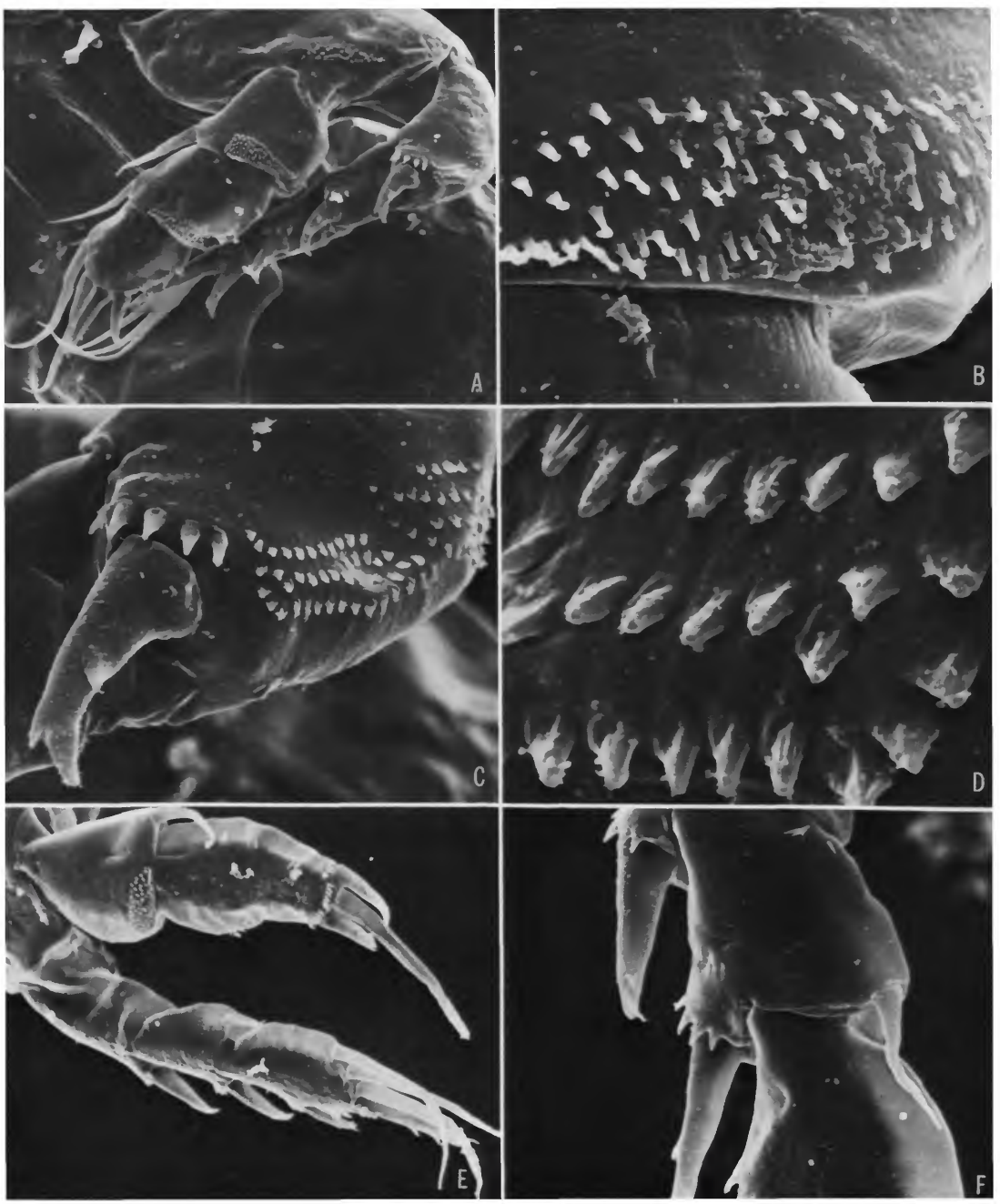

FIGURE 121.—*Unicolax reductus*, new species, female: *a*, leg 3 (260×); *b*, leg 4 endopod first segment spinules (2000×); *c*, leg 3 exopod first segment (1000×); *d*, leg 3 exopod first segment spinules (5000×); *e*, leg 4 (240×); *f*, leg 4 exopod (650×).

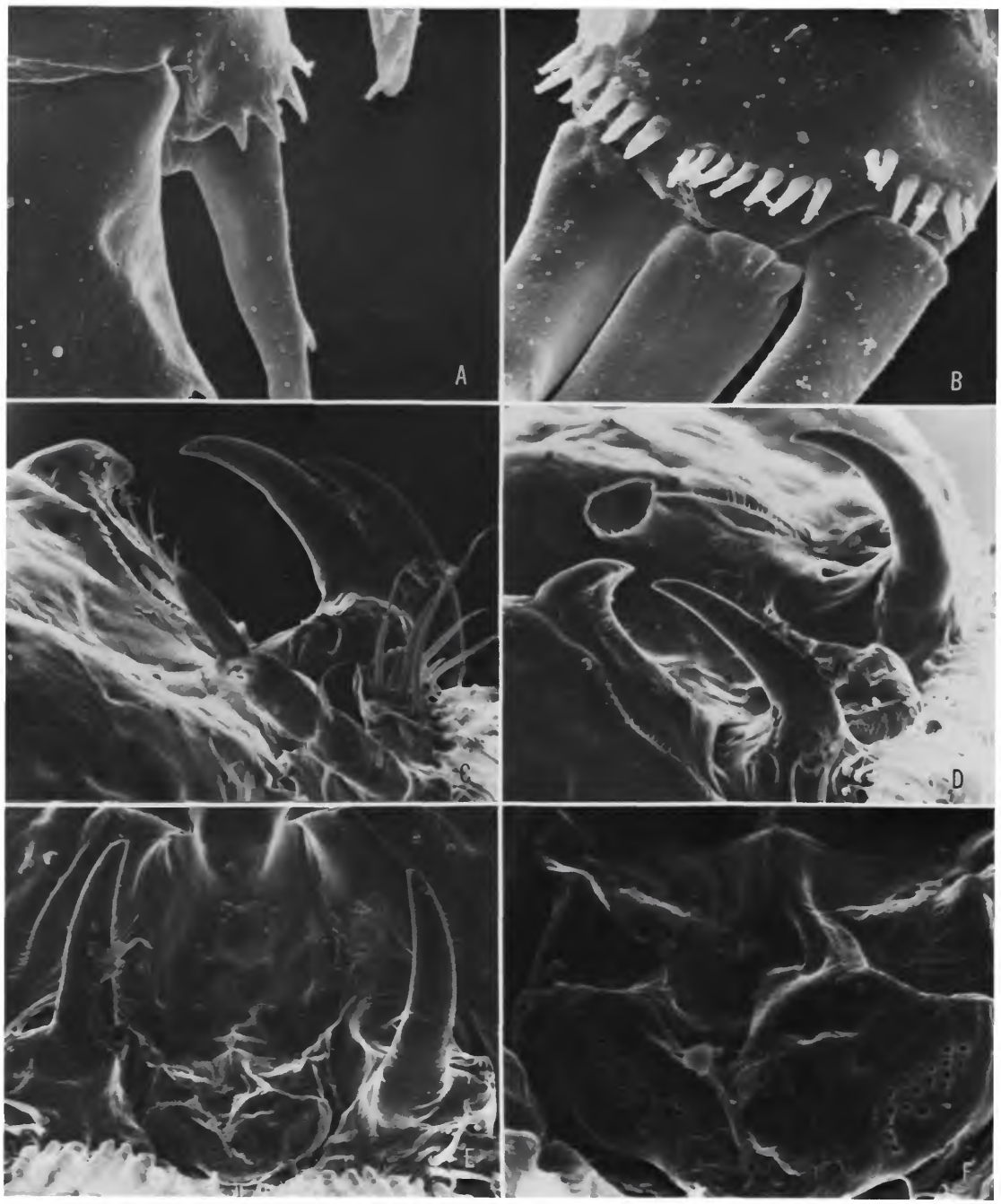

FIGURE 122.—*Unicolax reductus,* new species, female: *a,* leg 4 exopod second segment outer corner (1200×); *b,* leg 4 endopod tip (1600×). *Ceratacolax euthynni* Vervoort, female: *c,* cephalon, anterolateral view (230×); *d,* same, oblique view (185×); *e,* same, anterior view (200×); *f,* rostrum (600×).

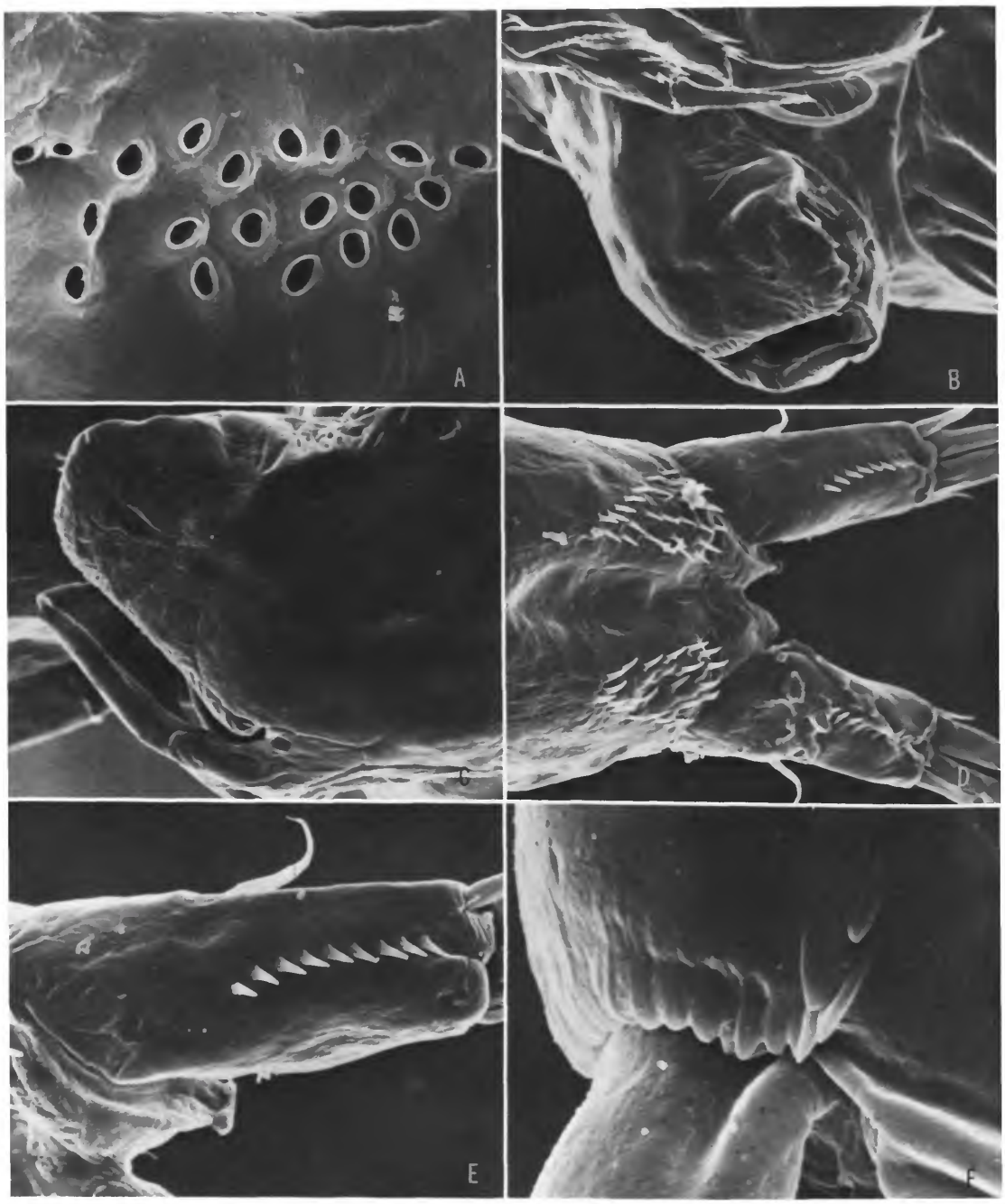

FIGURE 123.—*Ceratacolax euthynni* Vervoort, female: *a*, rostrum detail (2280×); *b*, posterior corner of genital segment (260×); *c*, same, lateral view (370×); *d*, abdomen and caudal rami, ventral (300×); *e*, caudal ramus, ventral (500×); *f*, caudal ramus posterior corner, ventral (5000×).

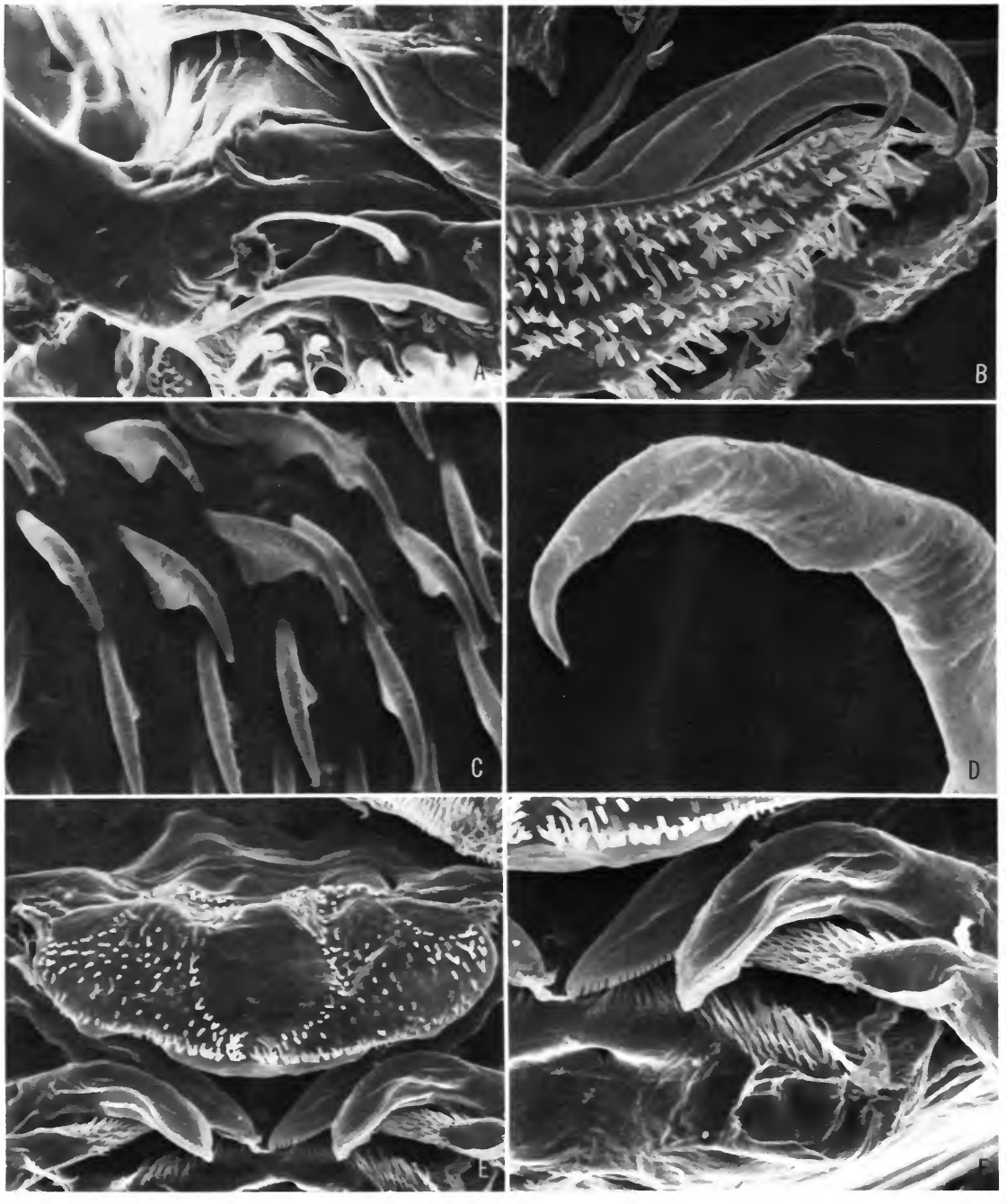

FIGURE 124.—*Ceratacolax euthynni* Vervoort, female: *a,* base of modified seta on first antenna, rostrum on left (420×); *b,* second antenna, distal half (1000×); *c,* hooks on second antenna (5000×); *d,* terminal seta of second antenna (4000×); *e,* oral area (400×); *f,* oral area, detail (650×).

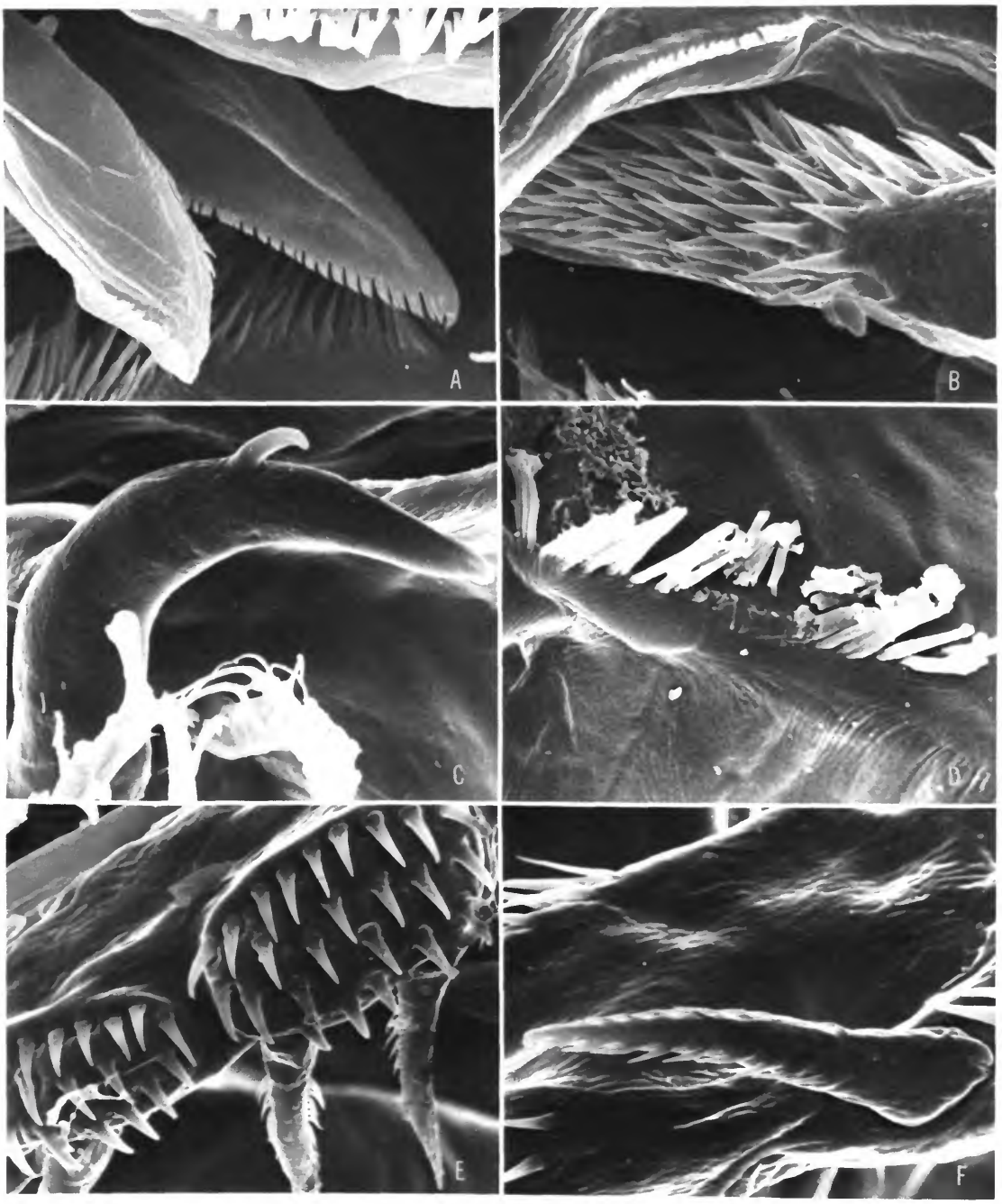

FIGURE 125.—*Ceratacolax euthynni* Vervoort, female: *a*, tip of mandible and paragnath (1350×); *b*, detail of second maxilla terminal flagellum (2000×); *c*, maxilliped claw (900×); *d*, fringe of leg 1 endopod (1900×); *e*, leg 2 exopod outer edge (800×); *f*, leg 5 lateral spine (750×).

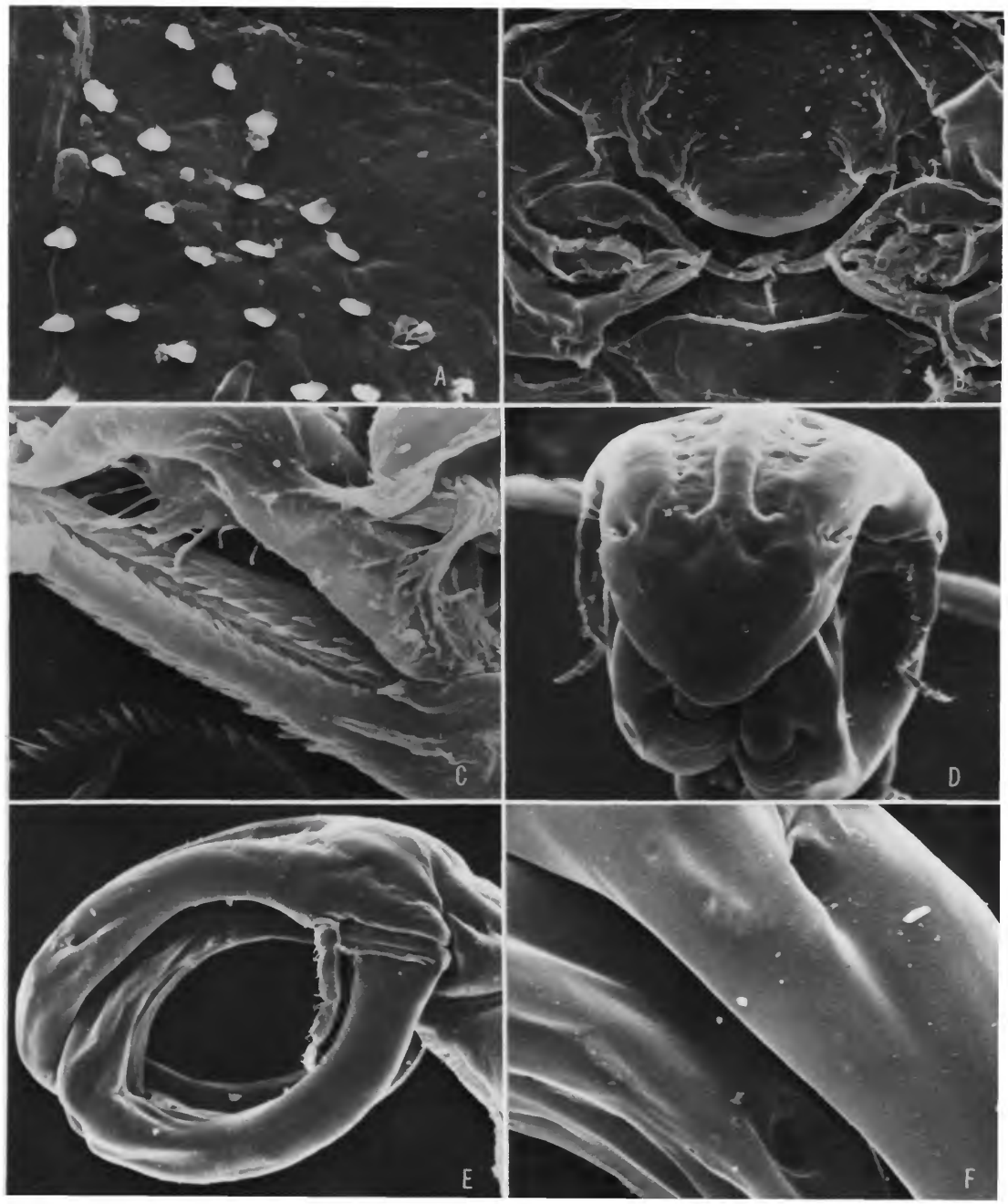

FIGURE 126.—*Pumiliopes capitulatus* Cressey and Boyle, female: *a,* spinules on abdomen, ventral (2800×); *b,* oral area (300×); *c,* flagellum of second maxilla and labium below (2000×). *Shiinoa occlusa* Kabata, female: *d,* rostral area, anterior view (100×); *e,* rostrum above and second antenna below, lateral view (75×); *f,* detail of pores on rostrum and second antenna, lateral view (280×).

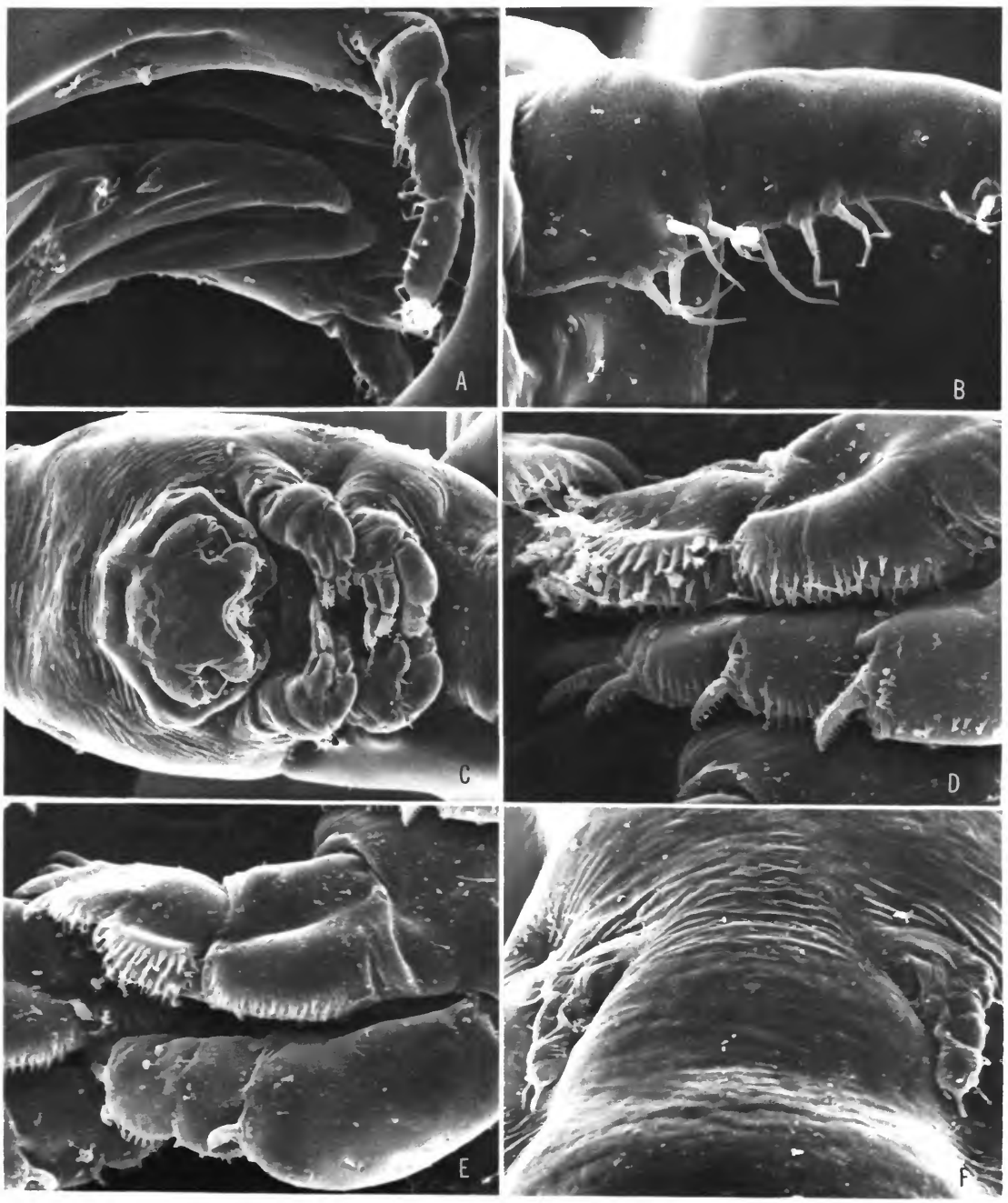

FIGURE 127.—*Shiinoa occlusa* Kabata, female: *a*, tip of second antenna and first antenna (200×); *b*, base of first antenna (500×); *c*, oral area and legs 1 and 2 (90×); *d*, leg 1 (660×); *e*, leg 2 (440×); *f*, legs 3 (180×).

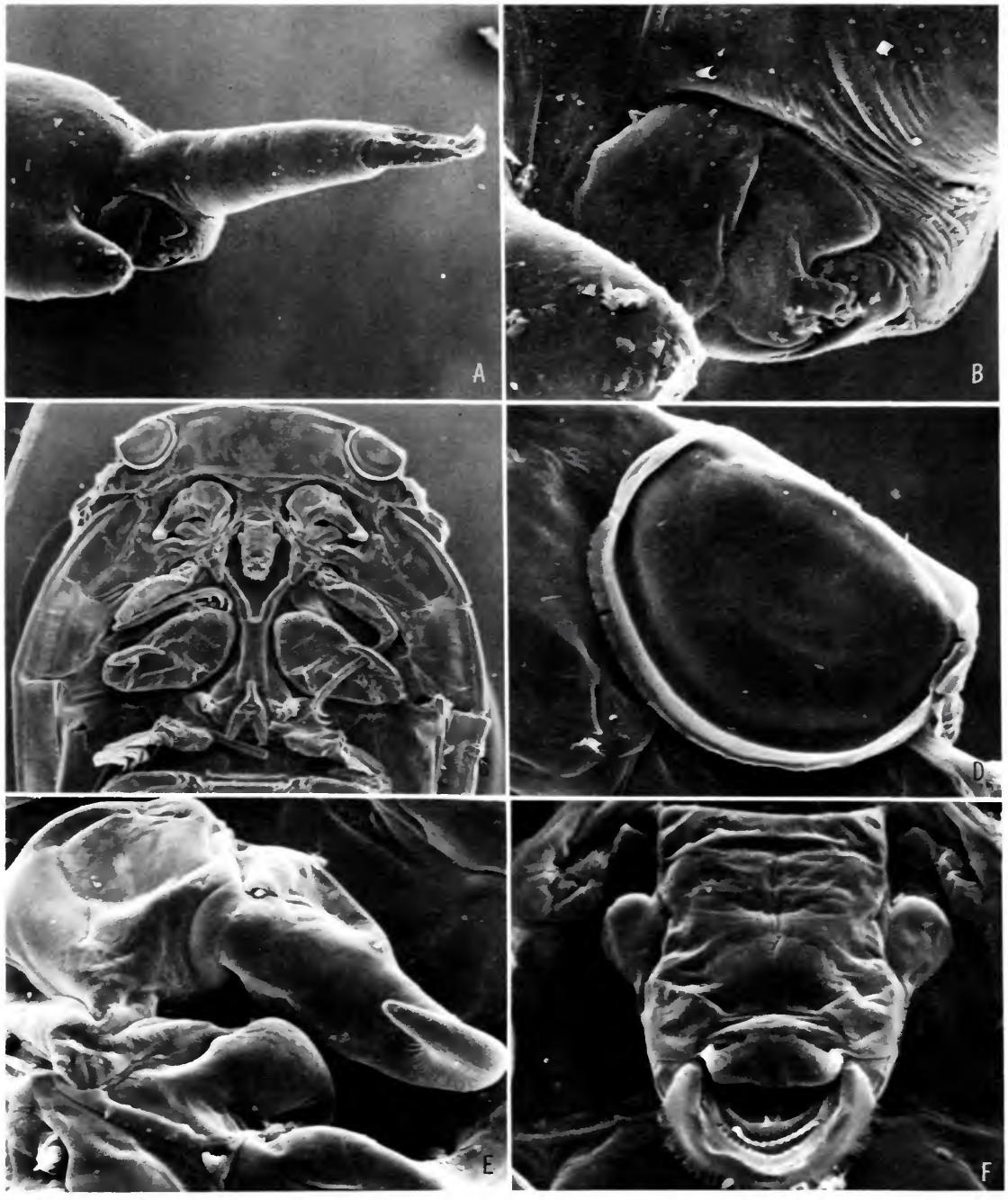

FIGURE 128.—*Shiinoa occlusa* Kabata, female: *a*, tip of genital segment, abdomen, and caudal rami, lateral view (70×); *b*, detail of genital area (240×). *Caligus coryphaenae* Steenstrup and Lütken, female: *c*, cephalon, ventral (30×); *d*, frontal lunule (200×); *e*, second antenna (200X); *f*, a happy mouth tube (280×).

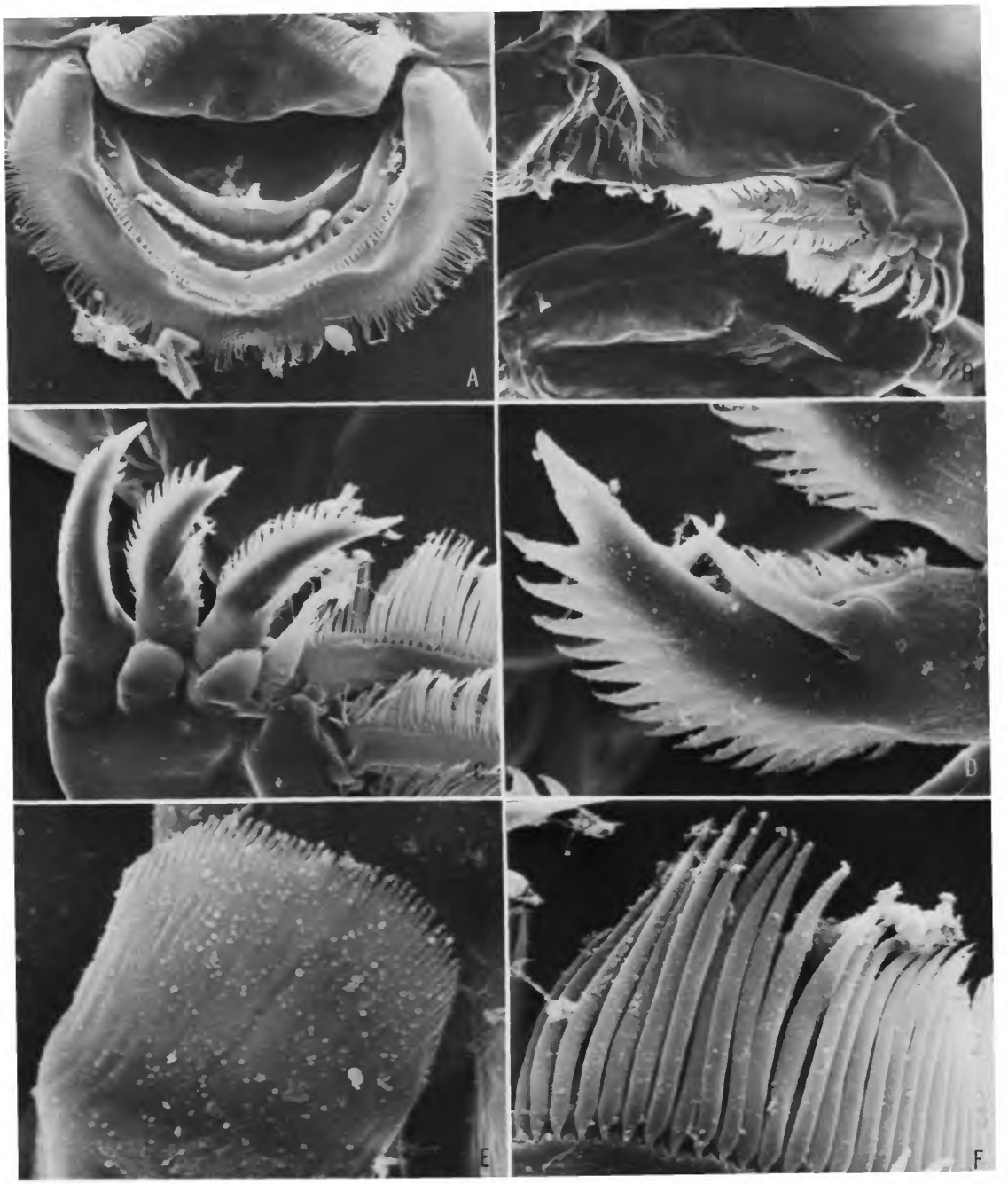

FIGURE 129.—*Caligus coryphaenae* Steenstrup and Lütken, female: *a*, tip of mouth tube, labrum above (550×); *b*, leg 1 (150×); *c*, tip of leg 1 exopod (500×); *d*, midterminal spine on leg 1 exopod (1300×); *e*, fringe at base of midterminal spine on leg 1 exopod (2800×); *f*, plumosities on leg 1 lateral seta (1300×).

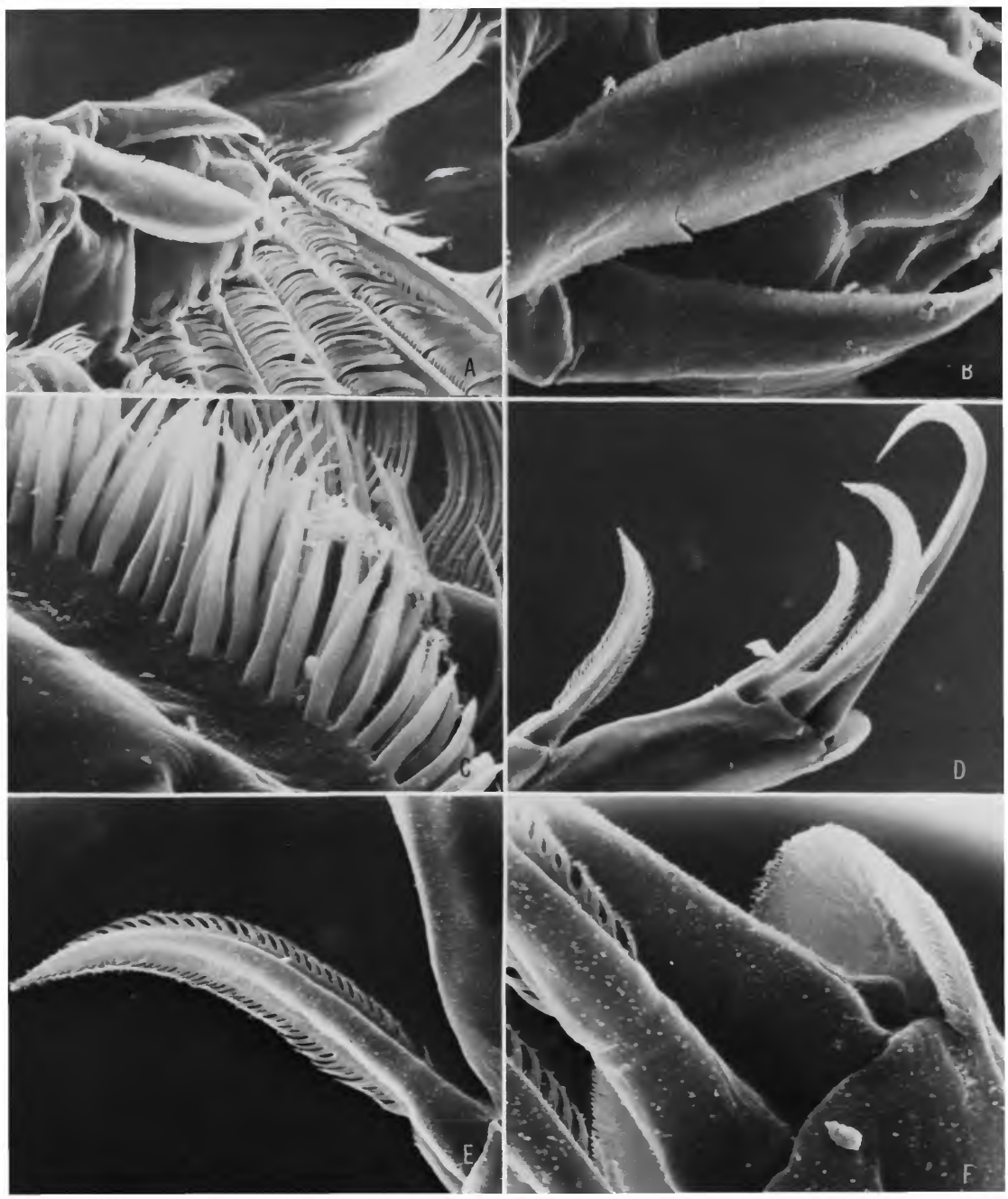

FIGURE 130.—*Caligus coryphaenae* Steenstrup and Lütken, female: *a*, leg 2 exopod (260×); *b*, spine on leg 2 first segment (650×); *c*, spinules on outer edge of leg 2 endopod (1000×); *d*, tip of leg 4 (290×); *e*, spine on leg 4 second segment (600×); *f*, fringe at base of terminal seta on leg 4 (1200×).

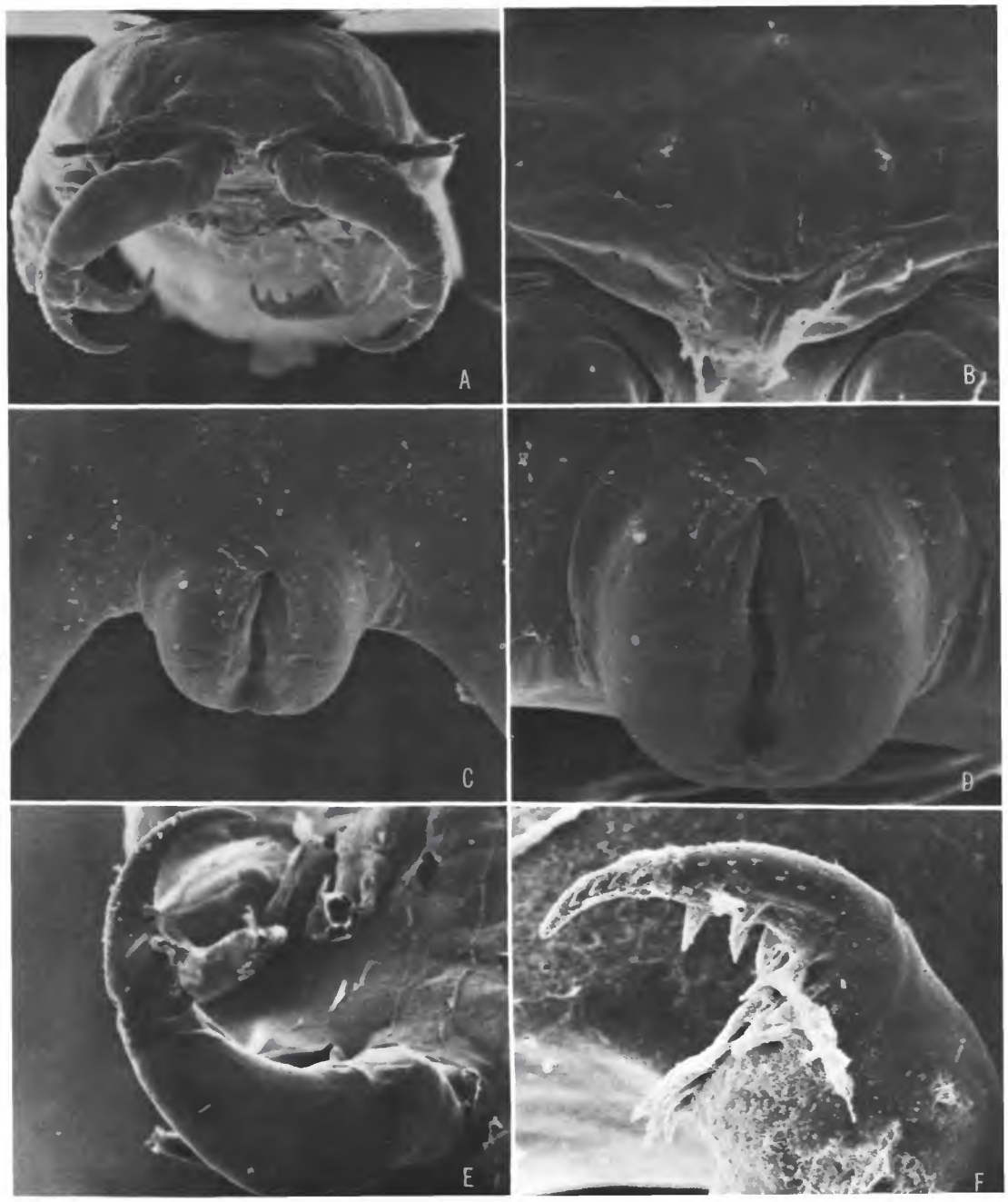

FIGURE 131.—*Pseudocycnus appendiculatus* Heller, female: *a*, cephalon, anterior view (55×); *b*, same, between bases of first antennae (300×); *c*, anal opening (240×); *d*, same (373×); *e*, second antenna (105×); *f*, second maxilla (500×).

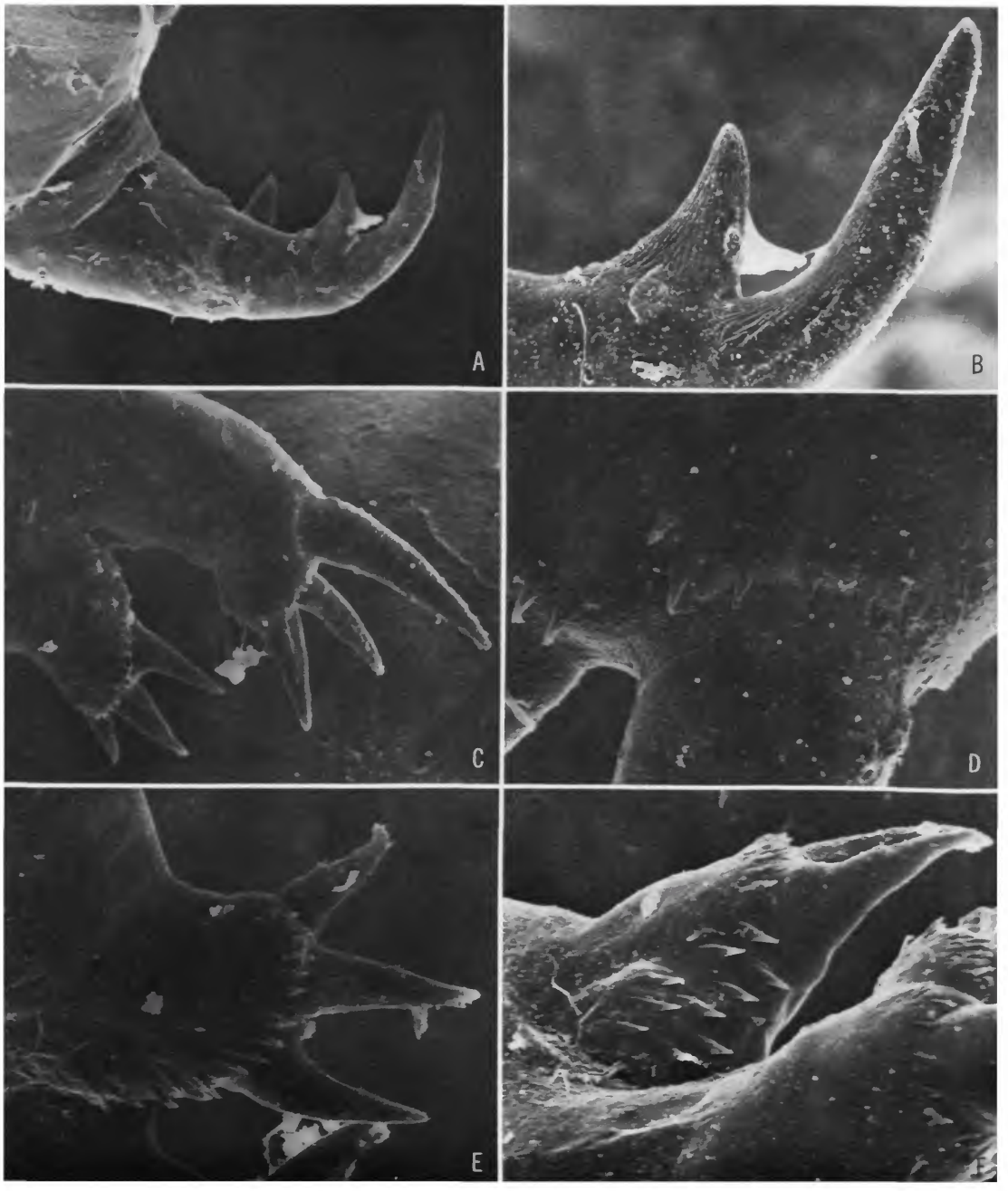

FIGURE 132.—*Pseudocycnus appendiculatus* Heller, female: *a*, maxilliped (200×); *b*, tip of maxilliped (500×); *c*, leg 1 (420×); *d*, leg 1 exopod base of terminal spine (1800×); *e*, leg 1 endopod (750×); *f*, same, lateral view (800×).

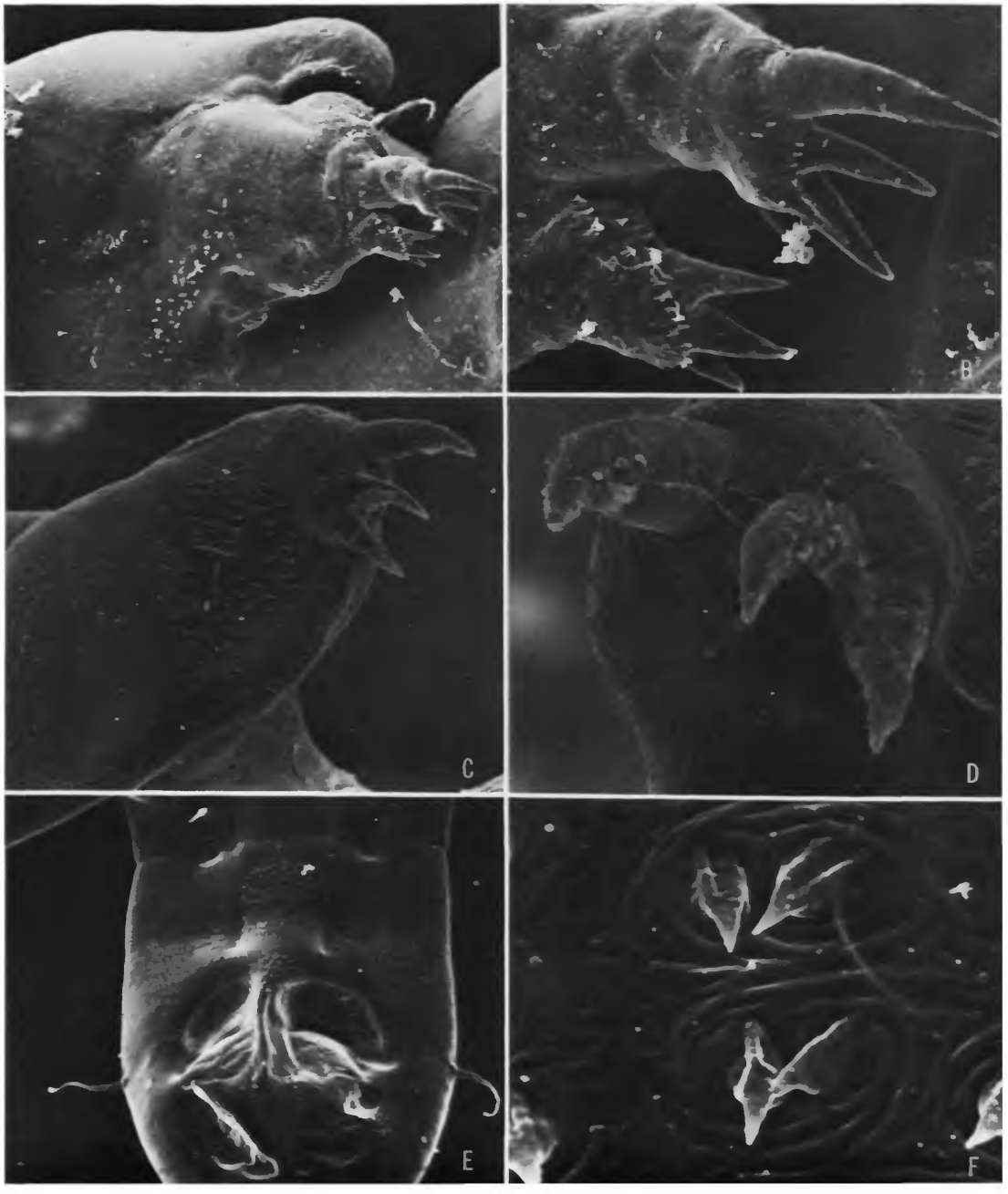

FIGURE 133.—*Pseudocycnus appendiculatus* Heller, female: *a*, leg 2 (125×); *b*, same (500×); *c*, leg 3 (400×); *d*, tip of leg 3 (1200×); male: *e*, genital segment, ventral (150×); *f*, spinules on genital segment, ventral (5000×).

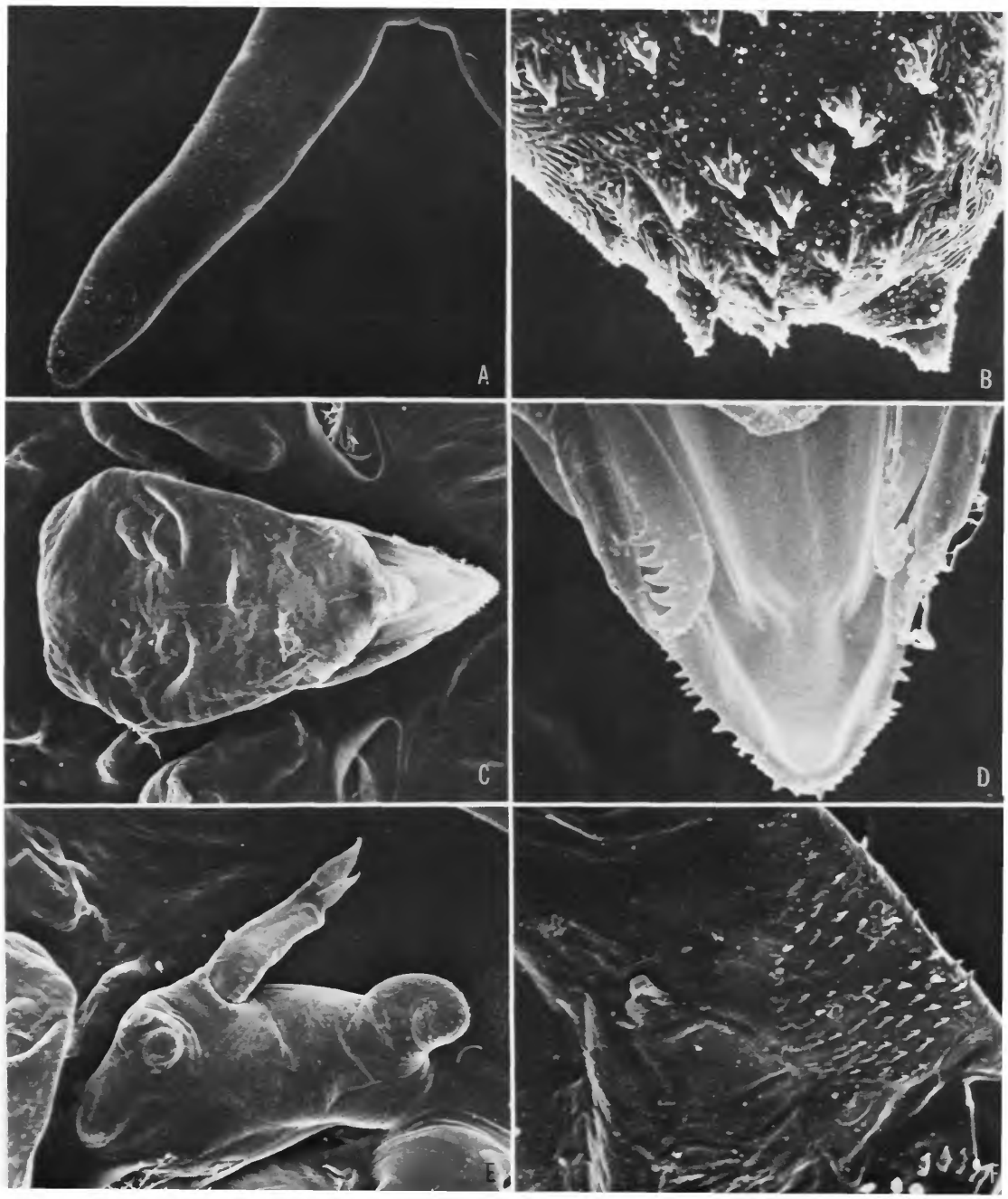

FIGURE 134.—*Pseudocycnus appendiculatus* Heller, male: *a*, caudal ramus, ventral (200×); *b*, spinules on caudal ramus (2000×); *c*, mouth tube (400×); *d*, tip of mouth tube (2000×); *e*, first maxilla (400×); *f*, base of maxilliped (500×).

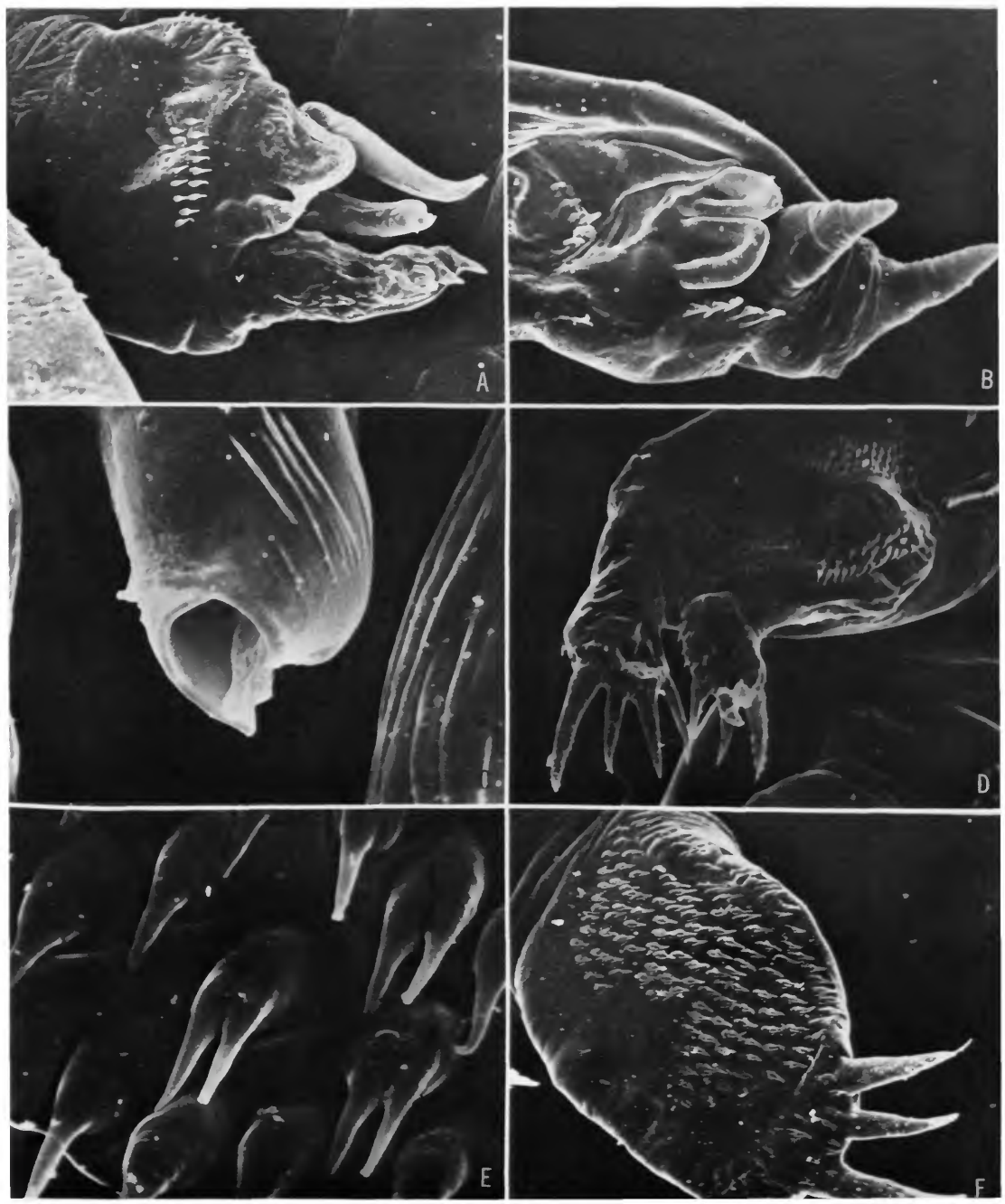

FIGURE 135.—*Pseudocycnus appendiculatus* Heller, male: *a*, leg 1 (400×); *b*, leg 1 exopod (2000×); *c*, leg 1 endopod (4000×); *d*, leg 2 (400×); *e*, spinules on leg 2 basipod (5500×); *f*, leg 3 (625×).

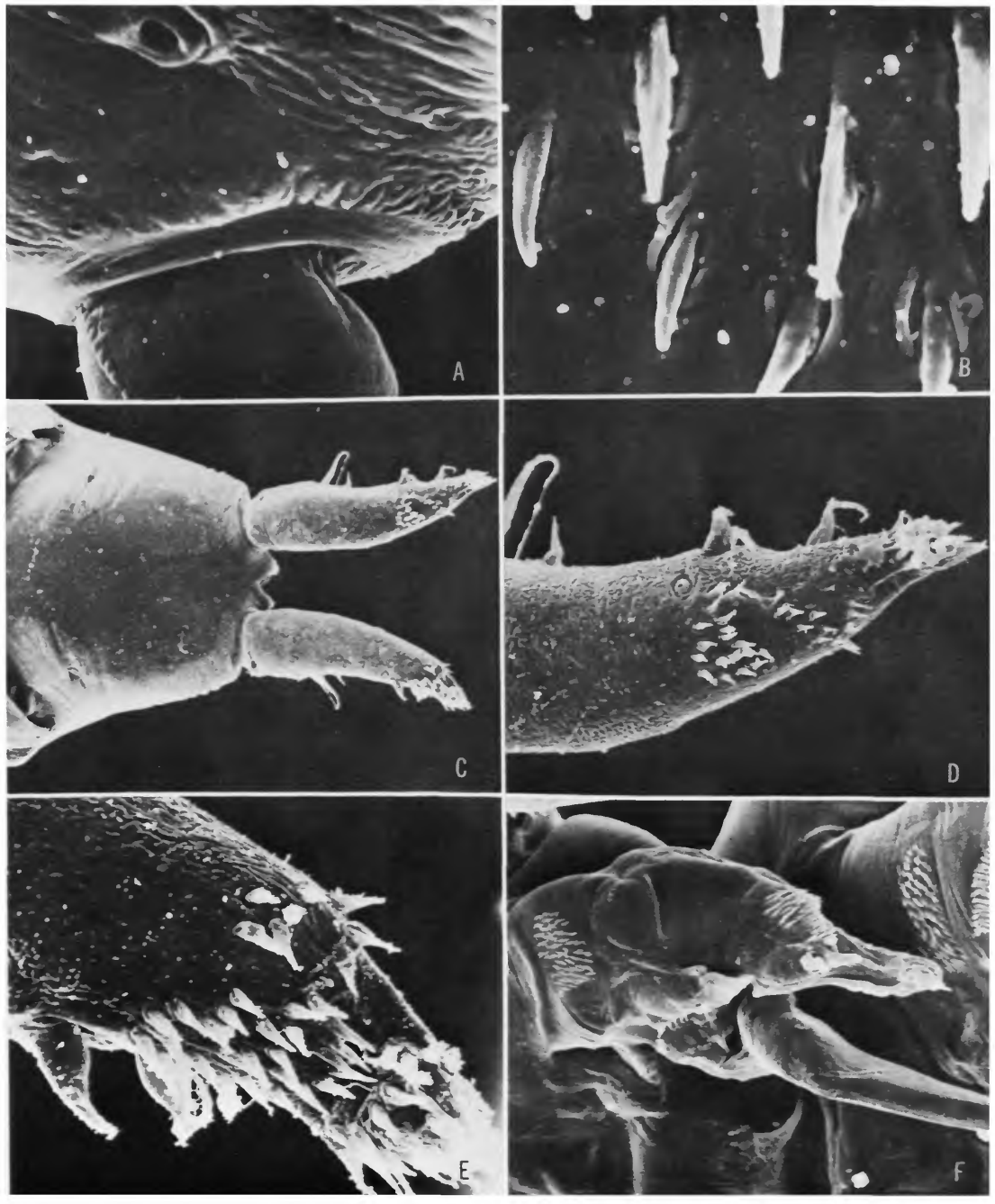

FIGURE 136.—*Pseudocycnus appendiculatus* Heller, male: *a,* base of leg 5 (5000×). *Pseudocycnoides armatus* (Bassett-Smith), male: *b,* spinules on genital segment (6550×); *c,* abdomen and caudal rami, ventral (250×); *d,* caudal ramus, ventral (750×); *e,* tip of caudal ramus, ventral (1600×); *f,* leg 1 (500×).

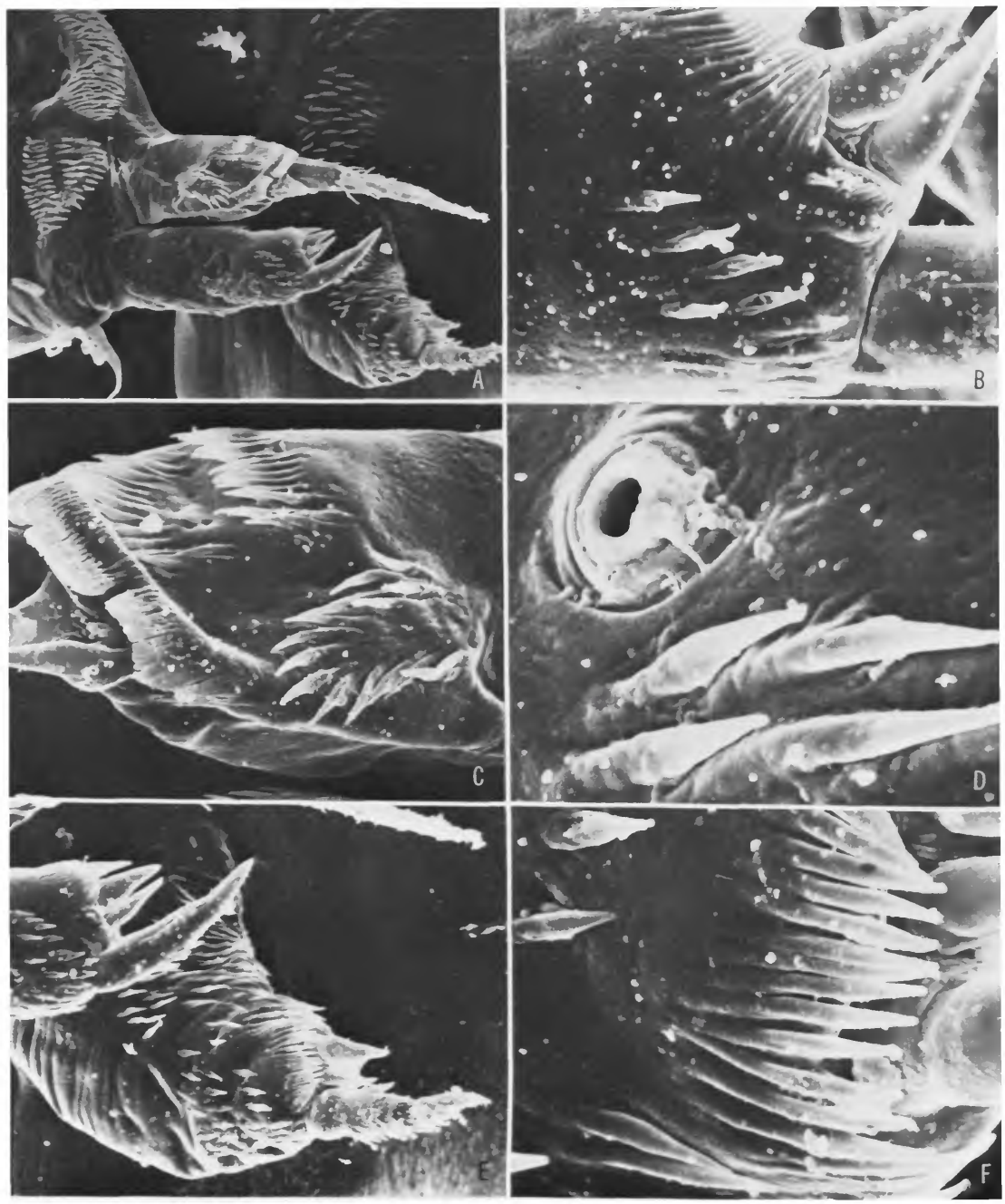

FIGURE 137.—*Pseudocycnoides armatus* (Bassett-Smith), male: *a*, legs 2 and 3 (500×); *b*, leg 2 tip of exopod (3100×); *c*, leg 2 tip of endopod (2000×); *d*, leg 2 endopod spinules (7000×); *e*, leg 2 exopod tip and leg 3 (1050×); *f*, tip of leg 3 (5250×).

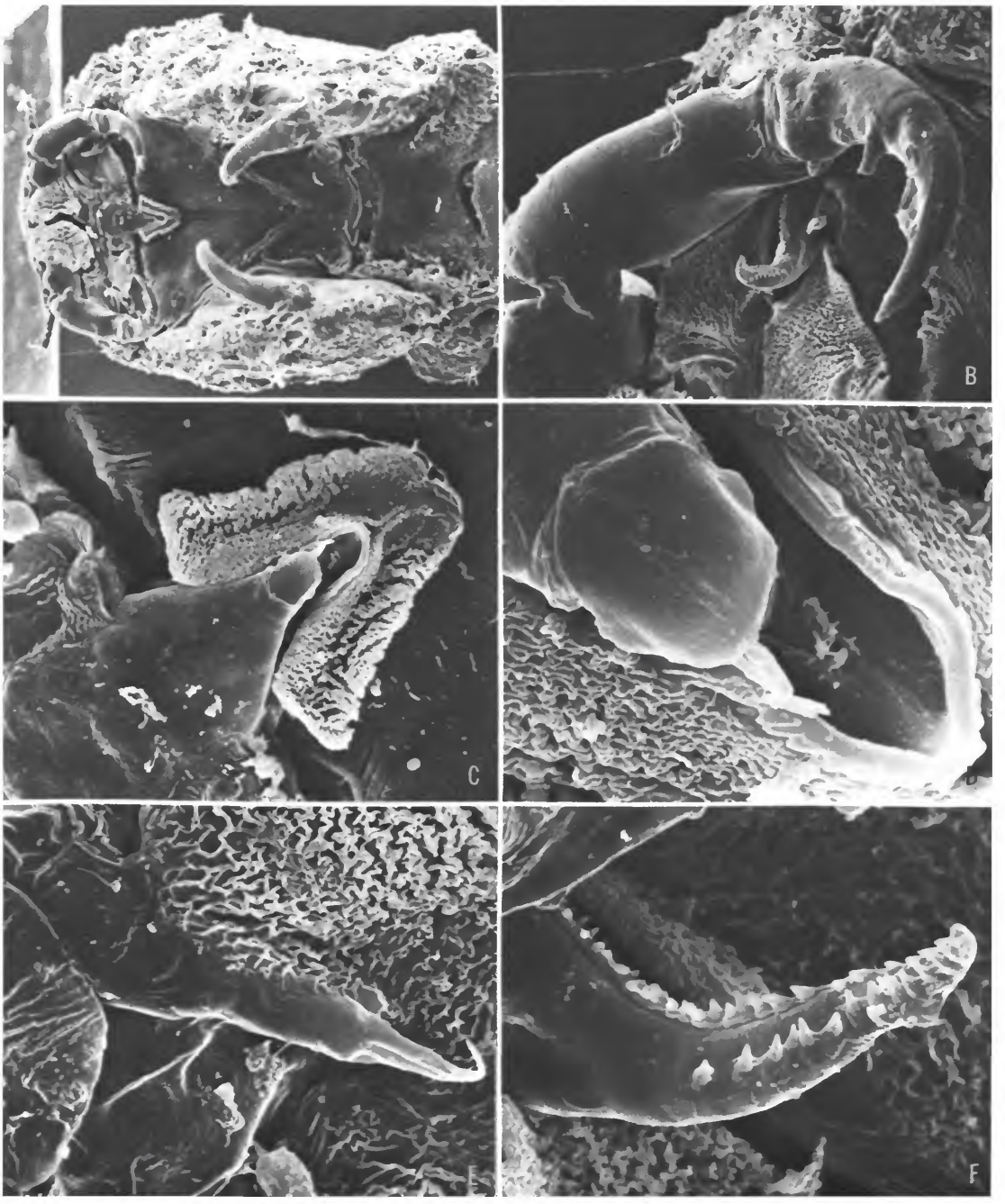

FIGURE 138.—*Pseudocycnoides buccata* (Wilson), female: *a,* cephalon, ventral (75×); *b,* second antenna (370×); *c,* mouth tube (600×); *d,* tip of mouth tube (2500×); *e,* first maxilla (1250×); *f,* tip of second maxilla (1450×).

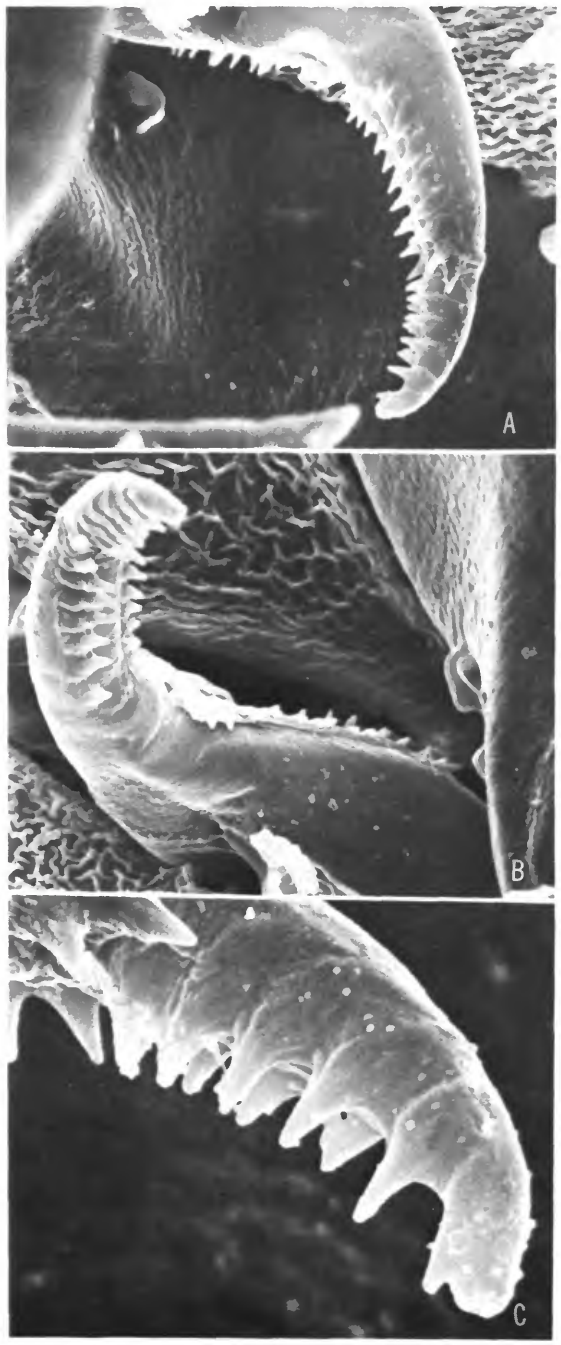

FIGURE 139.—*Pseudocycnoides buccata* (Wilson), female: *a*, tip of second maxilla (1225×); *b*, same (1450×); *c*, same (4400×).

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