

ROGER F. CRESSEY *Revision of the
Genus Alebion
(Copepoda: Caligoida)*

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Genus *Alebion*
(Copepoda:
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ABSTRACT

Cressey, Roger F. Revision of the Genus *Alebion* (Copepoda: Caligoida). *Smithsonian Contributions to Zoology*, number 123, 29 pages, 132 figures, 1972.—Eight species of *Alebion* are recognized as valid: *A. carchariae* Krøyer, *A. maculatus* Wilson, *A. elegans* Capart, *A. glaber* Wilson, *A. gracilis* Wilson, *A. lobatus* Cressey, and *A. pacificus*, new species. Other species have been placed in synonymy. The new species is described from the eastern Pacific Ocean where it is apparently endemic. The spermatophore attached to the female is shown to be a very useful character in recognizing the 8 species. The patterns of canaliculations on the surface of the postoral adhesion pad is also shown to be taxonomically important in both sexes. Keys to both sexes of the species are given.

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Roger F. Cressey

Revision of the Genus *Alebion* (Copepoda: Caligoida)

Introduction

Collections of copepods parasitic on shallow water sharks invariably contain members of the genus *Alebion*. Collections made in recent years from several geographic areas have resulted in sufficient material available to revise the genus and to redescribe the 8 species where needed. Thirteen species have been described in the genus since the first was described by Krøyer in 1863. The revision to follow recognizes 8 of these species as valid, including one described as new.

Members of the genus are found in all major oceans with the exception of the polar regions. Some species are geographically restricted while others are more ubiquitous. Both sexes seem to wander freely over the body surface of the host with females generally more abundant in collections than males.

All material is preserved in 70 percent alcohol and deposited in the collections of the Smithsonian Institution.

All figures were drawn with the aid of a Wild drawing tube.

The morphology of the spermatophore, a male structure, is discussed with the descriptions of the females since it is with this sex that the fully formed spermatophore is found.

Roger F. Cressey, Department of Invertebrate Zoology,
National Museum of Natural History, Smithsonian Institution,
Washington, D.C. 20560.

Unless otherwise stated all measurements are from a single specimen.

Acknowledgments

I thank Dr. Torben Wolff of the Copenhagen Museum for the loan of the type specimen of *Alebion carchariae* Krøyer.

Mrs. Molly Griffin assisted in the preparation of the figures.

Alebion Krøyer, 1863

Alebion Krøyer, 1863:165

Caligera van Beneden, 1892:258

DIAGNOSIS—Euryphoridae. Frontal plate separate, without lunules. Thoracic segments bearing legs 1–3 fused. Thoracic segment bearing legs 4 free and bearing bilobed dorsal plate in female. Abdomen 2-segmented. First antenna 2-segmented. Second antenna clawlike. Postoral adhesion pads present. Second maxilla with two terminal flagella. Sternal furca absent. Maxilliped clawlike. Legs 1–3 biramous; rami of leg 1 2-segmented, rami of legs 2 and 3 3-segmented. Leg 4 reduced, uniramous, 1-segmented. Leg 2 of male with two modified spines on exopod. Egg strings uniseriate.

Type-species, by monotypy, *Alebion carchariae* Krøyer. Gender masculine.

Key to the Known Species of *Alebia*

FEMALES

1. Genital segment with posterior processes 2
 Genital segment without posterior processes *A. glaber* Wilson
2. Genital segment without prominent lateral bulges (Figures 58, 100, and 111) 3
 Genital segment with prominent lateral bulges (Figures 1, 29, 44, and 88) 5
3. Posterior processes of genital segment (leg 5) not extending beyond caudal rami
 A. pacificus, new species 4
 Posterior processes extending well beyond caudal rami 4
4. Attached spermatophores divergent along entire length (Figure 60); surface of postoral adhesion pad without long canals (Figure 64) *A. elegans* Capart
 Attached spermatophores divergent in anterior half only (Figure 103); surface of postoral adhesion pad with long canals (Figure 104) *A. lobatus* Cressey
5. Attached spermatophores widely divergent (Figure 45); maxilliped claw with accessory process *A. crassus* Wilson
 Attached spermatophores not divergent (Figures 3, 30, and 89); maxilliped claw simple 6
6. Attached spermatophores with central sinus (Figure 3) or anterior end wider than posterior (Figure 4); central area of postoral adhesion pad with canals broken to form "islands" (Figure 9) *A. carchariae* Krøyer
 Attached spermatophores without central sinus and anterior end not widest (Figures 30 and 89); surface of postoral adhesion pad with long, straight canals (Figures 34 and 92) 7
7. Sclerotized ring lateral to anterior end of attached spermatophores (Figure 89); first abdominal segment with prominent lateral alae *A. gracilis* Wilson
 No sclerotized ring as above; first abdominal segment with only slight bulge at posterior corners *A. maculatus* Wilson

MALES

1. Modified spine on second segment of exopod of leg 2 extending beyond, to, or nearly to tip of modified spine of third segment (distalmost) 2
 Modified spine of second segment extending only to middle or less of modified spine of third segment 4
2. Modified spine of second segment at least twice as thick as modified spine of third segment 3
 Modified spine of second segment of about same thickness as that of third segment
 A. maculatus Wilson
3. Outermost of the two modified spines thumblike, tapered but not constricted along its length; innermost spine of uniform thickness throughout its length and reaching to tip of outer spine *A. crassus* Wilson
 Outermost spine swollen in basal half, distal half narrowed; innermost spine shorter than outer, distal fourth narrowed *A. glaber* Wilson
4. Canaliculations on surface of postoral pad long and straight, not forming "islands" (Figure 92) *A. gracilis* Wilson
 Canaliculations forming "islands" in part or on all of surface 5
5. Canaliculations forming islands over entire surface of postoral adhesion pad
 A. elegans Capart 6
 Canaliculations long and straight on part of adhesion pad surface 6
6. Canaliculations forming islands in middle of pad, long and straight near anterior and posterior borders *A. carchariae* Krøyer
 Canaliculations forming islands along posterior border, long and straight in anterior region only 7
7. Proximal modified spine on exopod of leg 2 bearing 20-30 heavy spinules and reaching to just beyond base of distalmost spine (Figure 110) *A. lobatus* Cressey
 Proximal spine bearing 50-100 spinules and reaching nearly to middle of distalmost spine (Figure 132) *A. pacificus*, new species

Alebion carchariae Krøyer, 1863

FIGURES 1-28

Alebion carchariae Krøyer, 1863:165.—Brady, 1883:135.—Bassett-Smith, 1899:462.—Brian, 1908:3; 1912:11.—Wilson, 1907:704; 1932:422.—Bere, 1936:593.—Capart, 1953:655.—Barnard, 1955:254.—Heegaard, 1955:49; 1962:175.—Vaissière, 1959:535.—Yamaguti, 1963:99.—Cressey, 1970:4.

Caligera difficilis van Beneden, 1892:258.—Wilson, 1907:703.

Alebion difficile Bassett-Smith, 1899:462.

Alebion fuscus Wilson, 1921:2, 1932:421.—Carvalho, 1940:275; 1951:137.—Vaissière, 1959:549.—Yamaguti, 1963:100.

Alebion difficilis Yamaguti, 1963:100.

Alebion gracilis.—Lewis, 1966:136.—Cressey, 1967:5.

MATERIAL EXAMINED.—Holotype female on loan from the Copenhagen Museum, 11 collections identified as *A. carchariae* in the Smithsonian collections (USNM 12664, 56596, 56603, 64051, 74303, 78956, 79157, 79455, 110819, 120747, and 120748), 3 collections [USNM 6083, 6210, and 32724 (co-types)], type specimens of *A. fuscus* (USNM 53559 and 53560), 5 previously unrecorded collections from the western Atlantic and Gulf of Mexico, M/V *Delaware* and M/V *Oregon II* cruises), 71 collections from the west coast of Florida, 8 collections from the western Indian Ocean.

FEMALE.—Body form as in Figure 1. Total length 8.1 mm (7.65–8.70) and greatest width 4.05 mm (3.60–4.50 mm) based on an average of 6 specimens from the north Atlantic. Genital segment 2.25 × 2.78 mm somewhat wider than long; widest in posterior third, lateral margin at widest part with prominent spines, posterior outer corners produced to form processes extending beyond caudal rami. Abdomen (Figure 2) 2-segmented; first segment with lateral processes extending nearly to junction of caudal rami. Spermatophores attached ventrally on genital segment near attachment of abdomen. Spermatophore of 2 forms. Most common form as in Figure 3, each with an inner median sinus so that when they are in position a central cavity is formed. Second form as in Figure 4, no resultant central cavity when they are in position. Caudal ramus (Figure 5) bears 4 plumose terminal setae and 2 smaller subterminal setae; each ramus longer than wide, 520 μ × 260 μ.

First antenna (Figure 6) 2-segmented, basal segment with several short plumose setae, terminal segment with 13 setae (2 fused at base), plumose setae indicated in figure. Second antenna (Figure 7) in form of claw; terminal claw with seta near middle, tip lightly pigmented. Tip of mouth tube with mandible blades within as in Figure 8. Adhesion pads lateral to mouth tube as in Figure 9, surface of pad canaliculate, forming islands at center. First maxilla represented by a group of 3 small setae lateral to mouth tube. Second maxilla (Figure 10) with 2 terminal flagella, shorter one about half the length of longer; second segment with patch of setules (Figure 11); longest flagellum with rows of spinules along its length, shorter flagella with serrate edge as in Figure 12. Maxilliped (Figure 13) in form of short stout claw, patches of scales on basal segment, seta on inner edge near base of terminal claw.

Legs 1–3 biramous. Leg 1 (Figure 14) exopod 2-segmented, basal segment with short spine on outer distal corner, second segment (Figure 15) with 3 terminal spines (median spine modified as a flattened paddlelike process) and 4 plumose setae along inner edge, distalmost seta much reduced. Leg 2 (Figure 16) exopod 3-segmented; basal segment with membranous outer sheath attached at outer margin and lying over most of ramus, toothed spine on outer distal corner with row of spinules near base; last 2 segments each bear an inwardly directed modified spine, palmate process near base of each, long plumose setae on all segments as indicated in the figure; endopod 3-segmented, each segment with long plumose setae as in the figure. Leg 3 (Figure 17) exopod similar to leg 2 except last segment bears 2 modified spines (Figure 18) instead of 1: endopod with second segment longer than other 2 combined. Leg 4 (Figure 19) uniramous and reduced, bearing 4 short setae (1 lateral, 3 terminal). Leg 5 (Figure 20) produced from outer distal corners of genital segment, spines along outer margin gradually increase in size posteriorly; 3 plumose setae present at tip in addition to stout spines (terminal spines usually 3 in number). Leg 6 absent.

MALE.—Body form as in Figure 21. Total length 6.0 mm and greatest width 2.85 mm based on a single specimen from the north Atlantic. Genital segment somewhat longer than wide (1.5 × 1.3 mm); edge of genital segment (Figure 23) with many spinules near lateral margins and a group of stouter

spines anterior to leg 5. Abdomen 2-segmented, each segment measures 0.55 mm and 0.69 mm respectively. Caudal ramus (Figure 24) armed as in female and about twice as long as wide (0.51×0.25 mm).

Cephalic appendages as in female except as noted below. Second antenna (Figure 25) in form of a stout claw; basal segment with large adhesion pad on surface, second segment with 2 smaller adhesion pads and stout inner spine, terminal claw with stout (but weak) spine near base, median seta and median accessory clawlike process. Second maxilla as in female except serrations on edge of shorter flagellum pointed rather than blunt as in female. Maxilliped (Figure 26) in form of stout claw; median segment with prominent patch of scalelike spinules as in figure, terminal segment with inner seta.

Legs 1–4 as in female except as noted below. Exopod spine at inner distal corner of last segment (Figure 27) bifid and bearing accessory spinule at tip. Leg 2 exopod (Figure 28) bearing modified spine on outer surface of each of last 2 segments; each spine with papillae on surface and clublike in appearance, these spines correspond to the 2 modified spines on female second leg exopod. Leg 5 (see Figure 23) represented by three plumose setae and another plumose seta near base along midmargin of genital segment. Leg 6 (see Figure 23) represented by 3 short plumose setae at outer distal corner of genital segment.

REMARKS.—This species, described by Krøyer in 1863, and recorded many times since by various authors is found in all major oceans and on a number of shark species. Examination of the type material was essential in correcting the identifications of several Smithsonian collections by various authors (Wilson, Lewis, and Cressey).

In an earlier paper (Cressey, 1970) I reported on the occurrence of 2 forms taken by the spermatophore of this species and *A. lobatus*. I will not repeat the discussion here but I should point out that the two forms occurred in the sample studied in the ratio of approximately 5:1. I could offer no explanation for the two forms at that time and I am still not able to do so.

Alebion pacificus, new species, described below from the eastern Pacific Ocean seems to be closely related to *A. carchariae* based on morphological characters.

Alebion maculatus Wilson, 1932

FIGURES 29–43

Alebion carchariae.—Bassett-Smith, 1898:366.

Alebion maculatus Wilson, 1932:423

Alebion alatus Gnanamuthu, 1951:1237.—Vaissière, 1959:548.—Yamaguti, 1963:99.—Cressey, 1967:5.—Pillai, 1967:1618.

Alebion spinosus Rangnekar, 1959:53.—Pillai, 1967:1617.

Alebion megacephalus Kirtesinghe, 1956:15; 1964: 82.—Yamaguti, 1963:100.—Pillai, 1967:1618.

MATERIAL EXAMINED.—Four females and 2 males collected by the author from the body surface of *Carcharinus limbatus* from Nosy Bé, Malagasy Republic.

FEMALE.—Body form as in Figure 29. Total length 4.88 mm and greatest width 2.63 mm based on a single specimen. Genital segment wider than long (2.06×1.67 mm), each lateral margin with prominent spinose bulge; posterior outer corners produced, extending well beyond caudal rami. Abdomen 2-segmented, first segment with short alate processes laterally. Spermatophores (Figure 30) slender, not divergent. Caudal ramus (Figure 31) armed as in *A. carchariae*; each ramus longer than wide, $170 \mu \times 92 \mu$.

Cephalic appendages as in *A. carchariae* except as noted. Second antenna (Figure 32) similar to that of other species in genus but with adhesion pads as shown in figure. Second maxilla similar to *A. carchariae*; short flagellum (Figure 33) with serrate edges as shown in figure. Adhesion pads lateral to mouth tube as in Figure 34. Maxilliped (Figure 35) in form of short, stout claw; basal segment with 2 scaly areas on inner surface and small raised adhesion pad near outer distal corner, short seta near inner edge of terminal segment.

Legs 1–3 biramous and as in *A. carchariae*. Terminal segment of leg 1 exopod armed as in Figure 36. Leg 4 as in *A. carchariae*. Leg 5 (Figure 37) with 2 plumose setae near tip.

MALE.—Body form as in Figure 38. Total length 1.69 mm and greatest width .90 mm, based on a single specimen. Genital segment (Figure 39) nearly twice as long as wide ($.97 \times .58$ mm). Abdomen 2-segmented; segments measure .29 and .27 mm respectively. Caudal rami (Figure 40) about twice as long as wide ($230 \mu \times 110 \mu$).

Cephalic appendages as in female except as noted. Second antenna (Figure 41) with adhesion pads on

basal segment as shown in figure; accessory process on claw in addition to median seta. Maxilliped (Figure 42) basal segment with conical inner process bearing few serrations as shown in figure, terminal claw well-developed and bearing median seta.

Legs 1–4 as in female except for modified spines on exopod of leg 2 (Figure 43). Leg 5 represented by group of 3 setae near lateral midarea of genital segment. Leg 6 represented by 3 plumose setae near posterior outer corner of genital segment.

REMARKS.—This species was first figured by Bassett-Smith in 1898 as another record of *A. carchariae*. Wilson in 1932 noted differences in Bassett-Smith's description and the original description of *A. carchariae* and suggested that the material of Bassett-Smith from Aden actually represented another species for which he proposed the name *maculatus*. This rather obscure reference by Wilson has been largely unnoticed by later authors and Gnanamuthu and Rangnekar both described this species as new under the names *alatus* and *spinus* respectively. I identified specimens from Malagasy Republic as *alatus* in 1967. Reexamination of this material and the literature have convinced me that these are all one species and should now be referred to as *A. maculatus*.

The specimen described by Kirtesinghe as *A. megacephalus* is actually an immature female of *A. maculatus*.

This species appears to be restricted to the Indian Ocean.

Alembion crassus Wilson, 1932

FIGURES 44–57

Alembion crassus Wilson, 1932:423.—Vaissière, 1959:549.—Yamaguti, 1963:99.—Shiino, 1965:426.

Platyporinus alata Rao, 1950:306.

Alembion echinatus Capart, 1953:655.—Shiino, 1955:177.—Vaissière, 1959:544.—Yamaguti, 1963:100.—Lewis, 1966:130.—Pillai, 1967:1618.

MATERIAL EXAMINED.—Holotype female (USNM 56614) and paratypes (1 female and 1 male, USNM 56615), 2 collections from Hawaii (USNM 110817 and 110818, identified originally as *echinatus*) and a single collection from Florida (USNM 10174, previously unidentified).

FEMALE.—Body form as in Figure 44. Total length 14.4 mm, greatest width 10.0 mm (measure-

ments from holotype). Genital segment (Figure 45) about as long as wide (6.35 × 6.00 mm); lateral edges with prominent spinose bulge at posterior third, posterior corners produced. Abdomen 2-segmented, first segment with conspicuous lateral alae, second segment slightly swollen laterally. Caudal ramus (Figure 46) longer than wide (820 μ × 520 μ) and somewhat inflated, terminal setae plumose but much shorter in relation to length of ramus when compared with other species in the genus.

The excellent description and figures provided by Shiino in 1955 (as *A. echinatus*) make a complete redescription of this species unnecessary. The following points supplement Shiino's description.

Second maxilla (Figure 47) second segment with patch of broad scalelike setules; shorter terminal flagellum much shorter in relation to longer flagellum than in other species of genus and armed as in the figure. Postoral adhesion pad lateral to mouth tube (Figure 48) triangular and surface with canaliculations as in figure. Maxilliped (Figure 49) basal segment with 3 patches of scales as shown in figure (scales in inner patch larger than those in outer patches); claw with accessory process (Figure 50).

Last exopod segment of leg 1 as in Figure 51.

MALE.—Body form as in Figure 52. Total length 9.75 mm, greatest width 4.95 mm. Genital segment about twice as long as wide (2.78 × 1.35 mm). Abdomen 2-segmented; first segment 0.52 mm long, second segment 0.75 mm long and wider than first. Caudal rami (Figure 54) about twice as long as wide (0.75 × 0.37 mm) and armed as in figure.

Second antenna (Figure 55) with prominent adhesion pads as in figure. Maxilliped (Figure 56) basal segment with raised scale-covered area along inner edge, claw with stout accessory process.

Second leg exopod (Figure 57) with modified spine on each of last two segments; outermost spine thumblike, inner surface covered with papillae; innermost spine much thinner and bearing small papillose knob at tip.

REMARKS.—This species has been reported a number of times. Shiino redescribed the species in 1955 (as *A. echinatus*) from specimens of both sexes found on *Sphyrna zygaena* in Japanese waters. He commented on the similarity between Wilson's *A. crassus* and Capart's *A. echinatus* but maintains the integrity of the two species on the basis of Wilson's illustration of the male showing a constriction in the

fourth segment not found in the Japanese material. After examining the type male, I have determined that Wilson's figure misrepresents that character and that the two species are actually synonymous. The type male has been redrawn.

This species is apparently restricted to sharks of the genus *Sphyrna* and is worldwide in distribution.

Alebion elegans Capart, 1953

FIGURES 58-73

Alebion elegans Capart, 1953:656.—Vaissière, 1959:541.—Yamaguti, 1963:100.—Cressey, 1967:5; 1970:5.

MATERIAL EXAMINED.—Four collections from Sarasota, Florida, and one collection from the Indian Ocean.

FEMALE.—Body form as in Figure 58. Total length 9.9 mm, greatest width 5.7 mm based on a single specimen. Genital segment (Figure 59) about as long as wide (2.3 mm × 2.5 mm); spinose area on lateral margin but not noticeably bulging. Abdomen first segment with prominent lateral alae, second segment narrow anteriorly. Spermatophores (Figure 60) oval, widest in anterior third and divergent when in place on genital segment. Caudal rami (Figure 61) longer than wide (410 μ × 190 μ).

First antenna as in *A. carchariae*. Second antenna (Figure 62) without prominent adhesion areas, last segment in form of claw and bearing a seta near midinner margin. Second maxilla short flagellum with serrations as shown in Figure 63. Adhesion pad lateral to mouth tube (Figure 64) with canaliculations forming rounded islands on surface (see detail). Maxilliped (Figure 65) in form of stout claw, without noticeable adhesion areas, a small patch of scales near outer distal corner of basal segment (on underside of maxilliped shown in Figure 65).

First leg exopod last segment as in Figure 66. Legs 2, 3, and 4 as in *A. carchariae*. Leg 5 (Figure 67) with 3 short plumose setae at tip in addition to stout spines; fifth leg extends well beyond caudal rami.

MALE.—Body form as in Figure 68. Total length 5.55 mm, greatest width 3.10 mm, based on a single specimen. Genital segment (Figure 69) longer than wide (1.3 × 0.9 mm) with scattered spinules on anterior lateral margins. Abdomen 2-segmented, segments measure 0.52 and 0.46 mm long respectively.

Caudal ramus (Figure 70) about twice as long as wide (0.32 × 0.15 mm).

Appendages as in female except as noted below. Second antenna with conspicuous adhesion pads; claw with accessory process near midmargin, seta near base of process. Maxilliped (Figure 72) with bilobed, scale covered, raised area on inner margin opposing claw, claw with seta near midmargin.

Leg 2 exopod with modified spines (Figure 73) on last two segments, each spine with conspicuous papillae. Leg 5 represented by small process bearing 3 plumose setae near midmargin of genital segment. Leg 6 represented by 3 plumose setae at each distal corner of genital segment.

REMARK.—This species is a common parasite on sharks of the genus *Sphyrna* and so far has only been reported from the Atlantic and Indian Oceans.

Alebion glaber Wilson, 1905

FIGURES 74-87

Alebion glabrum Wilson, 1905:129.—Rathbun, 1905:93.
Alebion glaber Wilson, 1907:708.—Fowler, 1912:481.—Wilson, 1932:419.—Vaissière, 1959:548.—Yamaguti, 1963:100.

MATERIAL EXAMINED.—Type specimens (USNM 8123, both sexes, no holotype designated) and twenty additional collections in the Smithsonian Institution (USNM).

FEMALE.—Body form as in Figure 74. Total length 10.80 mm, greatest width 4.80 mm, based on a single specimen. Genital segment about as long as wide (2.63 × 2.55 mm), lateral margins without ornamentation and without long processes originating on outer posterior corners. Abdomen 2-segmented, first segment wider than second. Spermatophores (Figure 75) with anterior two-thirds slightly divergent, anteriormost portion more heavily sclerotized. Caudal ramus (Figure 76) only slightly longer than wide (300 μ × 240 μ) and armed as in other members of the genus.

First antenna as in *A. carchariae*. Second antenna similar to other members of the genus, claw (Figure 77) stout and heavily sclerotized. Second maxilla as in other species in the genus, shorter flagellum with serrations as in Figure 78. Maxilliped (Figure 79) a short, stout claw with patches of scales on basal segment as indicated in figure. Adhesion pad lateral

to mouth tube (Figure 80) with canaliculations on surface as in figure.

Legs 1–4 as in *A. carchariae* except for slight differences in exopod last segment (Figure 81). Leg 5 represented by small podomere bearing 3 short setae attached at outer posterior corner of genital segment. Leg 6 absent.

MALE.—Body form as in Figure 82. Total length 5.7 mm and greatest width 2.55 mm, based on a single specimen. Genital segment somewhat longer than wide (1.6×1.16 mm), edge of genital segment unarmed except for legs 5 and 6. Abdomen (Figure 83) 2-segmented, segments measuring 0.43 and 0.64 mm in length respectively. Caudal ramus (Figure 84) longer than wide ($383 \mu \times 248 \mu$) and armed as in other members of genus.

Cephalic appendages as in female except as noted below. Second antenna (Figure 85) with stout claw, tip of claw slightly bifid, adhesion pads present as indicated in figure. Maxilliped (Figure 86) in form of claw, basal segment with large patch of scalelike spinules on inner margin, tip of claw with fine striations.

Legs 1–4 as in female except for modified spines on exopod of leg 2 (Figure 87); spine on basal segment stout, bearing knoblike spinules and markedly narrowed in distal third; more proximal spine smaller and with spinules on distal tip only. Leg 5 located at midmargin of genital segment, consisting of small podomere bearing 3 short setae and basal seta. Leg 6 represented by 3 short setae at outer posterior corners of genital segment.

REMARKS.—This species differs noticeably from other members of the genus by the absence of the fifth leg process in the female. Its affinity to the other species can be seen by a comparison of the appendages, notably the modified spines on the second leg exopod of the male.

This species has been collected from the east coast of the United States. It seems to be restricted primarily to smaller inshore species of sharks, however, two Smithsonian collections are from rays.

Alebian gracilis Wilson, 1905

FIGURES 88–99

Alebian gracile Wilson, 1905:128.—Rathbun, 1905:93
Alebian gracilis Wilson, 1907:704; 1932:420.—Vaissière, 1959:549.—Yamaguti, 1963:100.—Cressey, 1970:5.

MATERIAL EXAMINED.—Holotype female (USNM 8122), 9 collections identified as *A. gracilis* in the Smithsonian collections, and a single collection made by the author off Sarasota, Florida.

FEMALE.—Body form as in Figure 88. Total length 9.3 mm (9.0–9.6 mm) and greatest width 5.4 mm (4.95–5.55 mm) based on an average of 5 specimens. Genital segment (Figure 89) somewhat wider than long (3.68×3.23 mm), widest in posterior third, lateral margin with prominent spinules as in *A. carchariae*; posterior outer corners produced and extending well beyond caudal rami. Abdomen 2-segmented, first segment with lateral expansions much shorter than in *A. carchariae*. Spermatophores slender, posterior half only slightly wider than anterior, anterior portions lie between two sclerotized rings on ventral surface of genital segment. Caudal ramus (Figure 90) nearly twice as long as wide ($370 \mu \times 200 \mu$), armed as in other members of the genus.

Cephalic appendages as in *A. carchariae* except as noted below. Tip of shorter flagellum of second maxilla with serrations as indicated in Figure 91. Adhesion pad lateral to mouth tube with canaliculations on surface as in Figure 92. Maxilliped (Figure 93) with short, stout claw and patch of fine scales on surface of basal segment.

Legs as in *A. carchariae*. Last exopod segment of leg 1 as in Figure 94.

MALE.—Body form as in Figure 95. Total length 5.7 mm (5.3–6.3 mm) and greatest width 3.4 mm (3.3–3.5 mm) based on an average of 5 specimens. Genital segment (Figure 96) longer than wide (1.5×1.1 mm), widest portion with a few spinules on lateral margin. Abdomen 2-segmented, each segment measures 0.44 and 0.55 mm respectively, second segment wider than first. Caudal ramus (Figure 97) longer than wide ($230 \mu \times 180 \mu$) and armed as in other members of genus.

Cephalic appendages as in female except as noted below. Second antenna (Figure 98) with stout claw bearing well-developed accessory process, adhesion pads as indicated in the figure.

Legs 1–4 as in the female except for the presence of modified spines on the exopod of leg 2 (Figure 99). Legs 5 and 6 as in *A. carchariae*.

REMARKS.—This copepod superficially resembles *A. carchariae* and has been confused with that species in recent years (Lewis, 1966 and Cressey, 1967).

Several collections in the Smithsonian identified by Wilson as *A. gracilis* are in fact *A. carchariae*. As a result of this revision and reassessment of the collections and literature it appears that *A. gracilis* is restricted to the east coast of North America and is relatively uncommon. Females of *A. gracilis* and *A. carchariae* can be easily separated by the nature of the attached spermatophores, the canaliculations on the postoral adhesive pad, and the lateral expansions on the first abdominal segment.

Alecion lobatus Cressey, 1970

FIGURES 100–110

Alecion lobatus Cressey, 1970:7.

MATERIAL EXAMINED.—Thirty collections (including types) from off west coast of Florida as previously reported (Cressey, 1970).

FEMALE.—A description of the female of this species will not be repeated here since it has been recently provided elsewhere (Cressey, 1970). Some illustrations are provided, however, to enable the reader to identify females of this species without consulting the previous work. The only feature here added to the original description of the female is the nature of the canaliculations on the surface of the postoral adhesion pad (see Figure 104).

MALE.—Body form as in Figure 105. Total length 6.2 mm (6.1–6.4 mm) and greatest width 3.2 mm (3.1–3.4 mm) based on an average of five specimens. Genital segment (Figure 106) longer than wide (1.50 × 1.16 mm); few scattered spinules on anterior lateral edge, widest anteriorly. Abdomen 2-segmented, segments measuring 0.54 and 0.70 mm long respectively. Caudal ramus (Figure 107) nearly twice as long as wide (940 μ × 580 μ), armed as in other members of genus.

Cephalic appendages as in female except as noted below. Second antenna (Figure 108) with stout terminal claw bearing small accessory spine near middle of inner curved margin; prominent adhesion pads as indicated in figure. Maxilliped (Figure 109) with stout claw; inner margin of basal segment with raised scale-covered areas opposing claw.

Legs 1–4 as in female except for modified spines on exopod of leg 2 (Figure 110); proximal spine stout and bearing several heavy spinules, distal spine narrowed in basal fourth and continuing same width to tip. Leg 5 represented by small podomere

bearing three setae near midlateral margin of genital segment. Leg 6 represented by three setae at posterior outer corners of genital segment.

REMARKS.—This species so far has been reported only from *Carcharinus milberti* in the Gulf of Mexico.

Alecion pacificus, new species

FIGURES 111–132

Alecion gracilis.—Shiino, 1959:316.

MATERIAL EXAMINED.—Holotype female (USNM 139170), allotype (USNM 139171), and 4 paratypes females (USNM 139172) from the body surface of *Carcharinus malpeloensis* caught near Tres Madres Is. Four additional collections from *C. azureus*, *C. galapagensis*, and *C. malpeloensis* (2) from the eastern Pacific off Mexico and Lower California. An additional collection was found in the British Museum labeled *A. gracilis* from “sand shark” off Baija Honda, Panama.

FEMALE.—Body form as in Figure 111. Total length 9.6 mm (9.0–10.2 mm) and greatest width 4.5 mm (4.3–4.8 mm) based on an average of 5 specimens. Cephalon only slightly longer than wide 4.5 × 4.6 mm) and comprising nearly one-half total length. Thoracic segments bearing legs 1–3 fused. Thoracic segment bearing leg 4 with dorsal bilobed plate. Genital segment (Figure 112) about as long as wide (2.5 × 2.5 mm), a row of spinules along anterolateral edge; genital segment with slight lateral bulge, superficially resembling form produced in *A. elegans* and *lobatus*, posterior outer corners produced. Abdomen 2-segmented, segments incompletely divided; first segment with prominent lateral wing-like expansions, second segment narrowed anteriorly. Spermatophores (Figure 113) each with anterior outwardly directed lobe, widest anteriorly, the two spermatophores joined along most of midline and lying nearly parallel with each other, central sinus between them similar to that seen in *A. carchariae*. Caudal ramus (Figure 114) longer than wide (630 μ × 410 μ) and armed as in figure.

First antenna (Figure 115) as in other members of genus except for two terminal setae with blunt tips. Second antenna (Figure 116) in form of claw with small rugose areas as indicated in figure. Mandible and first maxilla as in *A. carchariae*. Second maxilla (Figure 117) having same general form as other

members of genus with rows of setae near middle of terminal segment (Figure 118) and edge of shorter flagellum as in Figure 119. Postoral adhesion pad with canaliculations as indicated in Figure 120. Maxilliped (Figure 121) in form of stout claw, claw incompletely divided proximal to seta.

Legs 1–3 biramous. Leg 1 (Figure 122) exopod 2-segmented, basal segment with small spine on outer distal corner and row of hairs along inner edge, second segment (Figure 123) with three terminal spines, middle one modified as in other members of genus, and four inner setae, distalmost one short; endopod 2-segmented, first segment unarmed, second segment with three setae. Leg 2 (Figure 124) exopod 3-segmented, first segment with mantlelike membrane (not shown in figure) covering most of exopod; endopod 3-segmented; both rami armed as in *A. carchariae*. Leg 3 (Figure 125) rami 3-segmented and armed as in *A. carchariae*. Leg 4 as in *A. carchariae*. Leg 5 (Figure 126) produced as an extension of posterior outer corners of genital segment, tip armed with two short spines and three stout plumose setae. Leg 6 absent.

Egg strings uniseriate.

MALE.—Body form as in Figure 127. Total length 6.45 mm and greatest width 3.23 mm based on a single specimen. Cephalon slightly wider than long (3.23 × 3.10 mm). Genital segment (Figure 128) longer than wide (1.12 × 0.90 mm), widest in anterior third and bearing many small spinules laterally. Abdomen 2-segmented; first segment 0.45 mm long, second segment 0.64 mm long. Caudal ramus (Figure 129) about twice as long as wide (560 μ × 295 μ), and armed as in the figure.

Cephalic appendages as in female except as noted below. Second antenna (Figure 130) with stout claw bearing prominent accessory claw, inner surface of basal segment with prominent adhesion pad, outer edge with rugose area. Maxilliped (Figure 131) basal segment with raised area covered with blunt spinules as indicated in the figure.

Legs 1–4 as in female except for modified spines on exopod of leg 2 (Figure 132).

ETYMOLOGY.—The name *pacificus* refers to the geographic area to which this species is restricted.

REMARKS.—Females of this species can be separated from all other species except *A. elegans* and *lobatus* by the shape of the genital segment (lack of prominent lateral bulge). It can be separated from

these two species by the length of the fifth leg process which extends well beyond the caudal rami in *A. elegans* and *lobatus* and does not in *pacificus*. When the spermatophore is attached it can be separated from all species by the nature of its form. The pattern of the canaliculations on the surface of the postoral adhesion pad further serves to separate both sexes of this species from all others. Males can be separated by the nature of the modified spines on the exopod of leg 2.

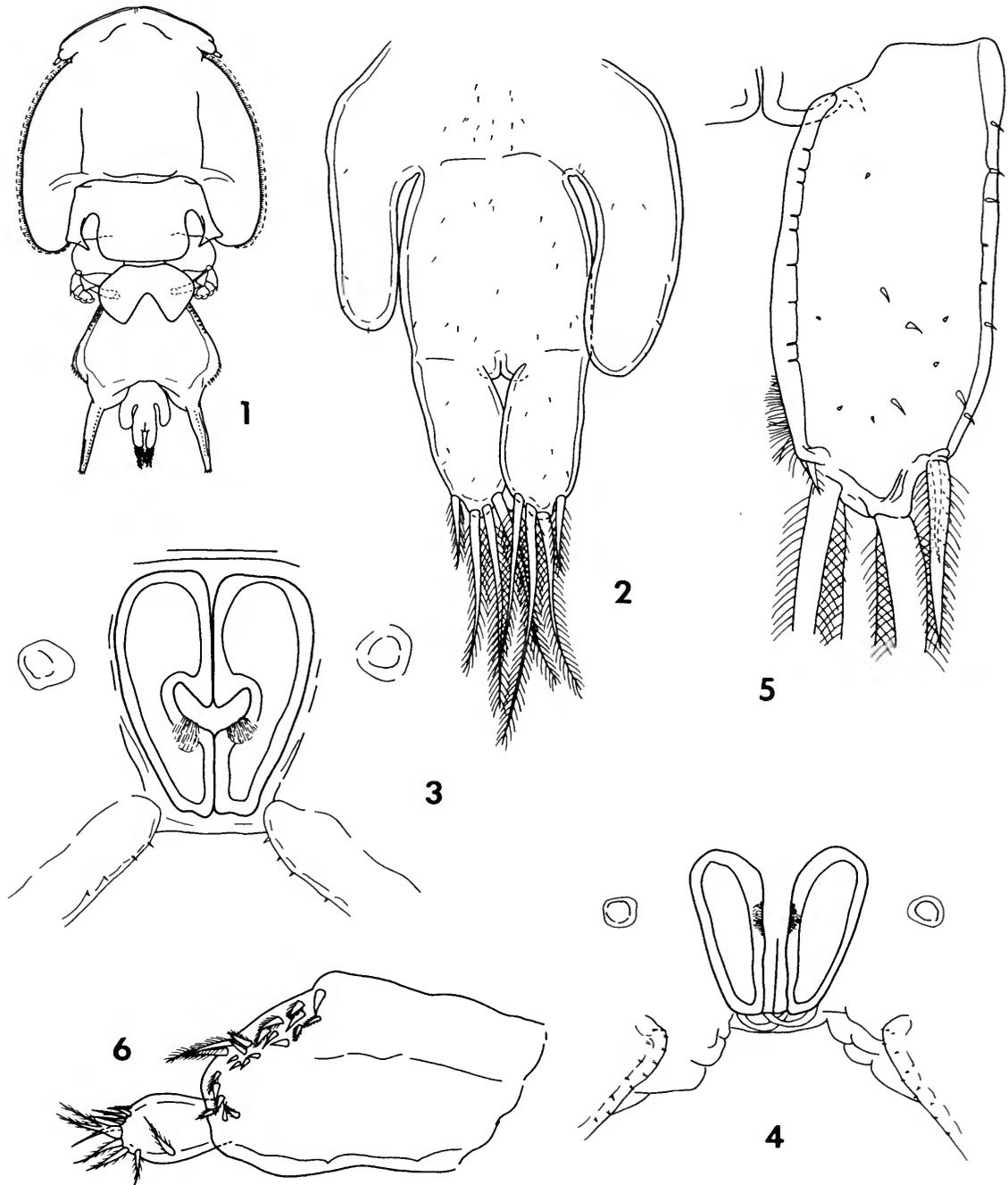
On the basis of its morphology it seems most closely related to *A. carchariae*.

This species is probably endemic to the eastern Pacific.

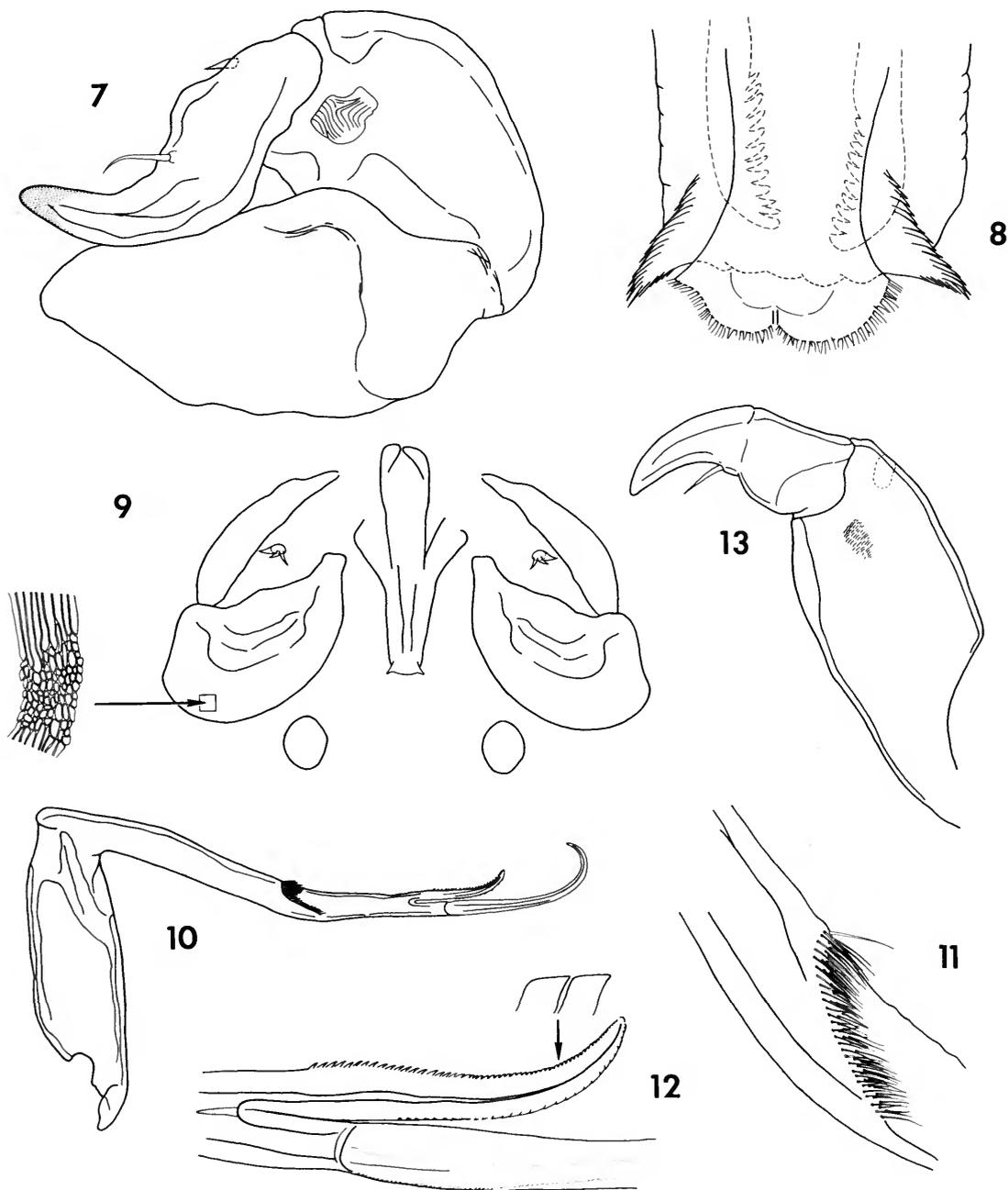
Literature Cited

- Barnard, K. H.
1955. South African Parasitic Copepoda. *Annals of the South African Museum*, 41(5):223–312.
- Bassett-Smith, P. W.
1898. Some New or Rare Parasitic Copepods Found on Fish in the Indo-Tropic Region. *Annals and Magazine of Natural History*, 2(7):359–372.
1899. A Systematic Description of Parasitic Copepoda found on Fishes, with an Enumeration of the Known Species. *Proceedings of the Zoological Society of London*, 2:438–507.
- Beneden, P. J. van.
1892. Quelques Nouveaux Caligides de la Côte d'Afrique, et de l'Archeipel des Açores. *Bulletins de l'Académie Royale des Sciences, des Lettres et des Beaux-arts de Belgique*, 24(3):241–262.
- Bere, R.
1936. Parasitic Copepods from Gulf of Mexico Fish. *The American Midland Naturalist*, 17(3):577–625.
- Brady, G. S.
1883. Report on the Copepoda Collected by H.M.S. *Challenger* during the years 1873–76. Part 23 of Volume 8 in *Zoology in Report on the Scientific Results of the Voyage of H.M.S. Challenger, 1873–76*.
- Brian, A.
1908. Note Preliminaire sur les Copépodes Parasites des poissons Provenant des Campagnes Scientifiques de S.A.S. le Prince Albert Ier de Monaco ou Déposés dans les Collections du Musée Oceanographique. *Bulletin de l'Institut Oceanographique*, 110:1–19.
1912. Copépodes Parasites des Poissons et des Échinides Provenant des Campagnes Scientifiques de S.A.S. le Prince Albert Ier de Monaco. *Résultats des Campagnes Scientifique*, 38:1–58.

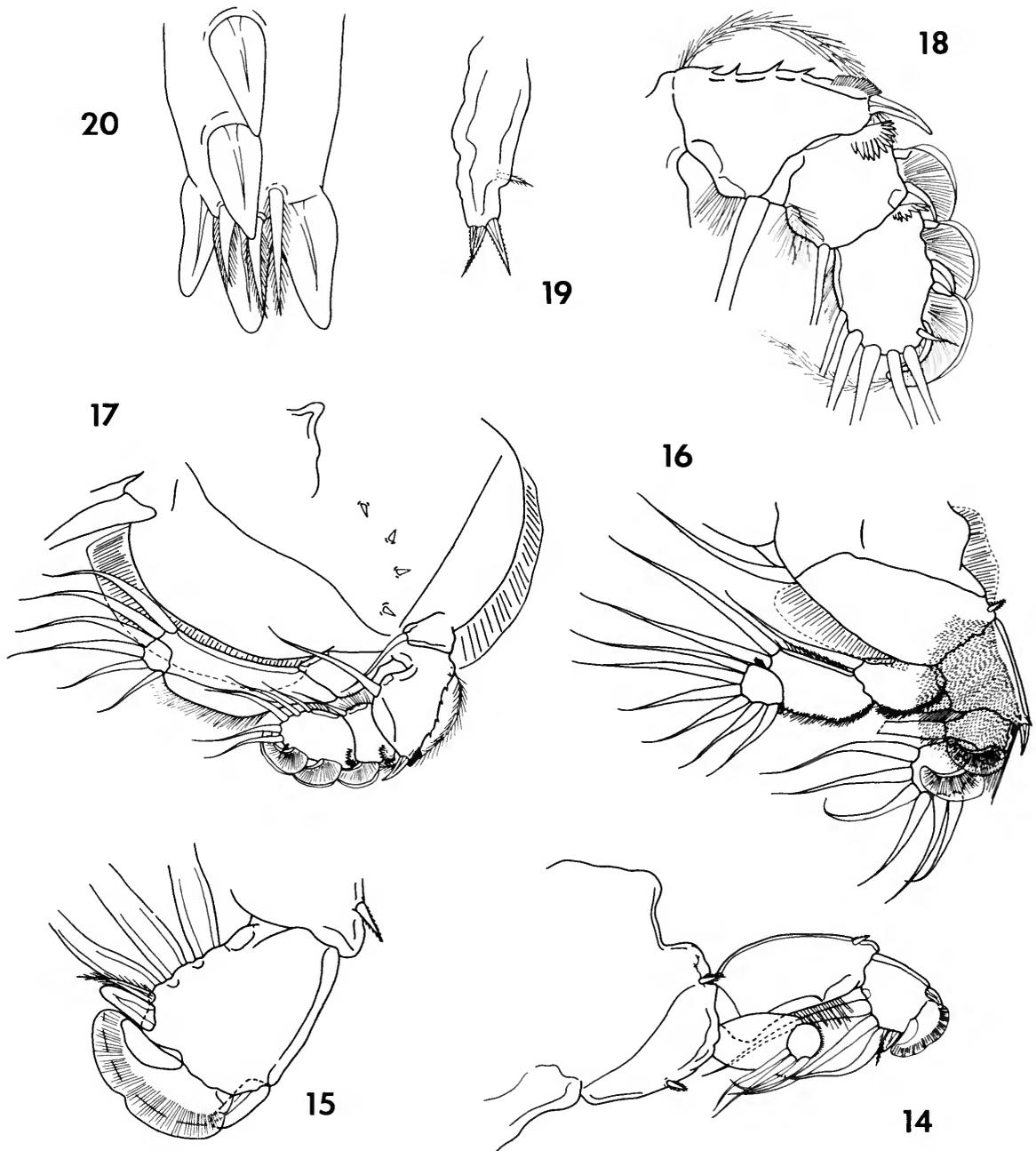
- Capart, A.
1953. Quelques Copépodes Parasites de Poissons Marins de la Région de Dakar. *Bulletin de l'Institut français d'Afrique noire*, 15(2):647-671.
- Carvalho, J. P.
1940. Notas Sobre alguns Caligoida com a Descrição de *Pandarus marcus*, sp. nov. *Universidade de Sao Paulo. Boletins de Faculdade de Filosofia, Ciências e Letras XIX Zoologia*, 4:271-302.
1951. Notas Sobre alguns Copépodos Parasitos de Peixes Marítimos da Costa do Estado de Sao Paulo. *Boletim do Instituto Paulista de Oceanografia*, 2(2):135-144.
- Cressey, R. F.
1967. Caligid Copepods Parasitic on Sharks of the Indian Ocean. *Proceedings of the United States National Museum*, 121(3572):1-21.
1970. Copepods Parasitic on Sharks from the West Coast of Florida. *Smithsonian Contributions to Zoology*, 38:1-30.
- Fowler, H. W.
1912. The Crustacea of New Jersey. Annual Report. New Jersey State Museum with a report of the Crustacea of New Jersey, pages 9-650.
- Gnanamuthu, C. P.
1951. New Copepod Parasites of Sharks. *Annals and Magazine of Natural History*, 4(12):1236-1256.
- Heegaard, P.
1955. Parasitic Copepods from Tropical West Africa. Atlante Report No. 3. Scientific Results of the Danish Expedition to the Coasts of Tropical West Africa, 1945-1946, pages 41-56.
1962. Parasitic Copepoda from Australian Waters. *Records of the Australian Museum*, 25(9):149-234.
- Kirtesinghe, P.
1956. Parasitic Copepods of Fish from Ceylon. IV. *Parasitology*, 46(3):14-21.
1964. A Review of the Parasitic Copepods of Fish recorded from Ceylon with Description of Additional Forms. *Bulletin of the Fisheries Research Station, Ceylon*, 17(1):45-132.
- Krøyer, H.
1863. Bidrag til kundskab om snyltekrebsene. *Naturhistorisk Tidsskrift*, 3(2):75-426.
- Lewis, A. G.
1966. Copepod Crustaceans Parasitic on Elasmobranch Fishes of the Hawaiian Islands. *Proceedings of the United States National Museum*, 118(3524):57-154.
- Pillai, K.
1967. Copepods Parasitic on Indian Fishes—A Review. *Proceedings of Symposium on Crustacea*, 5:1556-1680.
- Rangnekar, M. P.
1959. Parasitic Copepods from Fishes of the Western Coast of India with Description of One New and Redescription of Four Known Species. *Journal of the University of Bombay*, 28(3):43-58.
- Rao, T. S. S.
1950. On a New Caligid Parasite from the Indian Hammerhead Shark. *Proceedings of the Indian Academy of Sciences*, 31(5) section B:302-307.
- Rathbun, M. J.
1905. Fauna of New England. 5. List of the Crustacea. *Occasional Papers of the Boston Society of Natural History*, VII, pages 1-117.
- Shiino, S. M.
1955. *Alebion echinatus* Capart from Japanese Waters, with Observations on the Newly Found Male Form. *Pacific Science*, 9(2):177-182.
1959. Ostpazifische Parasitierende Copepoden. *Report of the Faculty of Fisheries, Prefectural University of Mie*, 3(2):267-333.
1965. Parasitic Copepods of the Eastern Pacific Fishes 6. Euryphoridae. *Report of Faculty of Fisheries, Prefectural University of Mie*, 5(2):421-433.
- Vaissière, R.
1959. Parasites de Poissons de mer ouest-africains recoltés par J. Cadenet. II. Copepodes. *Bulletin de l'Institut Francais Afrique Noire*, 21, series A (2):534-553.
- Wilson, C. B.
1905. New Species of Parasitic Copepods from the Massachusetts Coast. *Proceedings of the Biological Society of Washington*, 18(20):127-132.
1907. North American Parasitic Copepods Belonging to the Family Caligidae. Part 2. The Trebinae and Euryphorinae. *Proceedings of the United States National Museum*, 31(1504):669-720.
1921. New Species and a New Genus of Parasitic Copepods. *Proceedings of the United States National Museum*, 59(2354):1-17.
1932. The Copepods of the Woods Hole Region, Massachusetts. *United States National Museum Bulletin*, 158:1-635.
- Yamaguti, S.
1963. *Parasitic Copepods and Branchuria of Fishes*. Interscience Publications, pages 1-1104. New York: John Wiley and Sons.



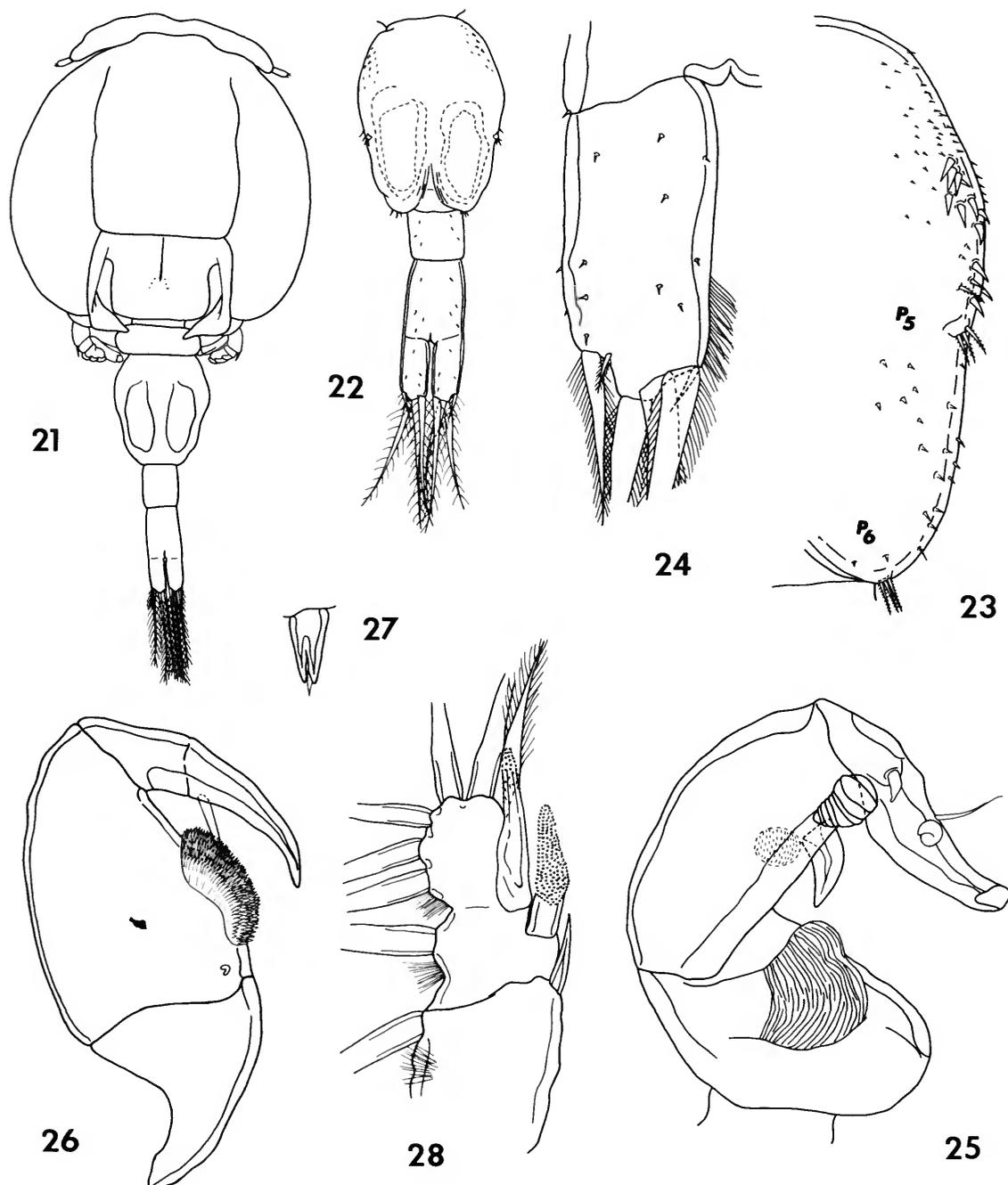
FIGURES 1-6.—*Alebion carchariae* Krøyer, female: 1, dorsal; 2, genital segment, ventral; 3, spermatophores attached; 4, spermatophores attached; 5, caudal ramus, ventral; 6, first antenna.



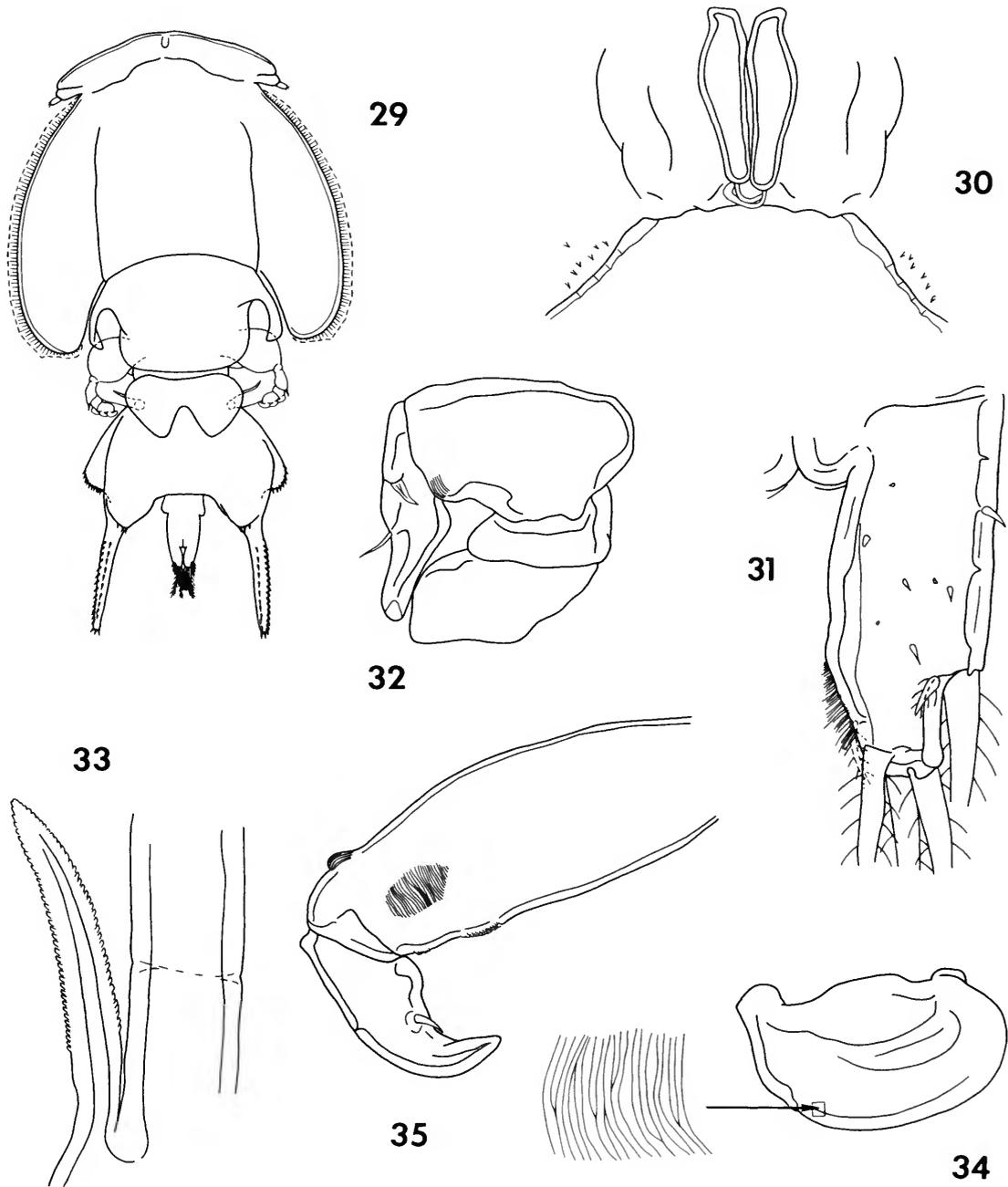
FIGURES 7-13.—*Alebion carchariae* Krøyer, female: 7, second antenna; 8, tip of mouth tube; 9, postoral adhesion pads and mouth tube; 10, second maxilla; 11, row of setules on second maxilla; 12, flagella of second maxilla; 13, maxilliped.



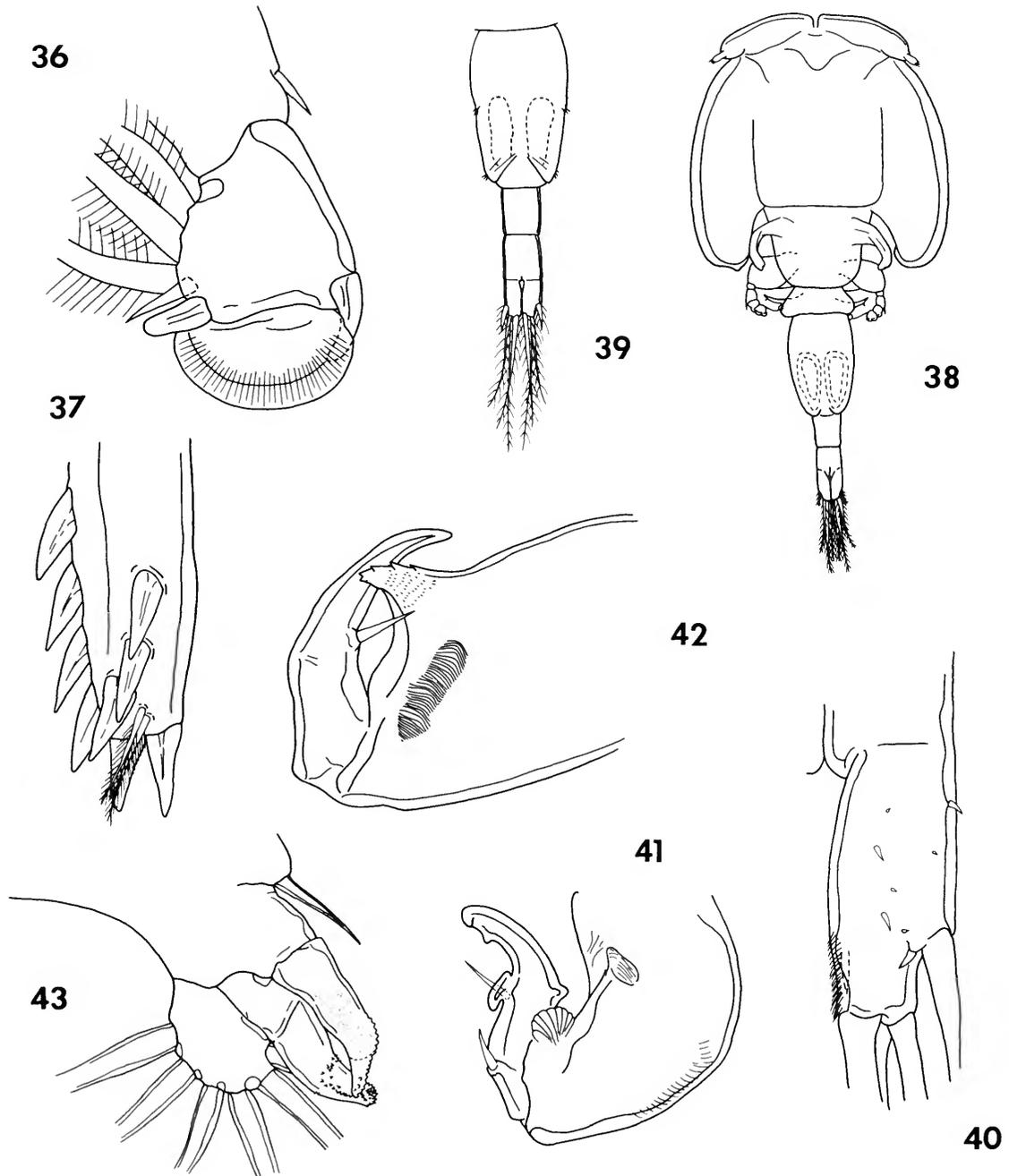
FIGURES 14-20.—*Alebion carchariae* Krøyer, female: 14, leg 1; 15, last exopod segment of leg 1; 16, leg 2; 17, leg 3; 18, exopod of leg 3; 19, leg 4; 20, tip of leg 5.



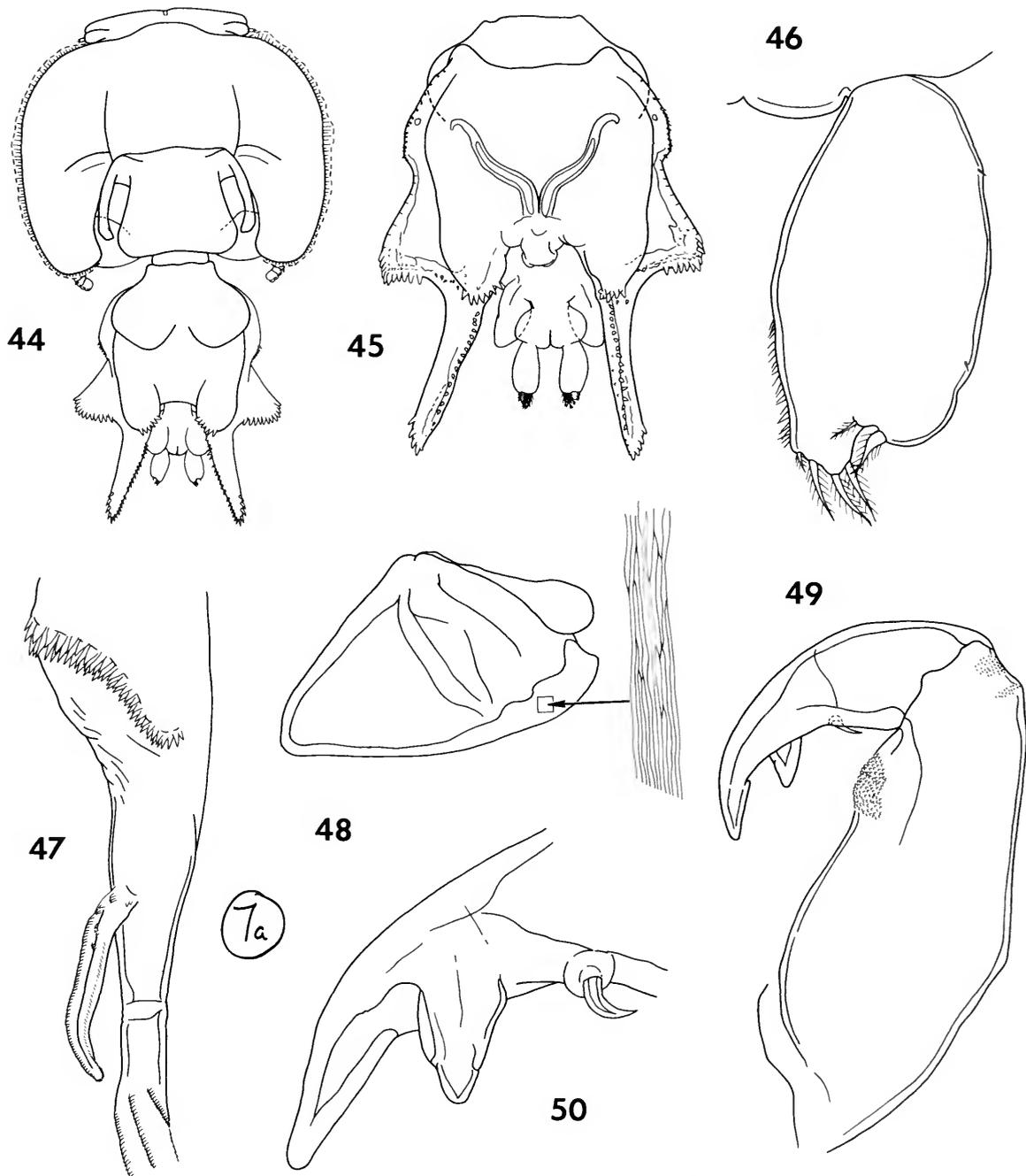
FIGURES 21-28.—*Alebion carchariae* Krøyer, male: 21, dorsal; 22, genital segment and abdomen; 23, ventral edge of genital segment; 24, caudal ramus, ventral; 25, second antenna; 26, maxilliped; 27, exopod spine of leg 1; 28, exopod of leg 2.



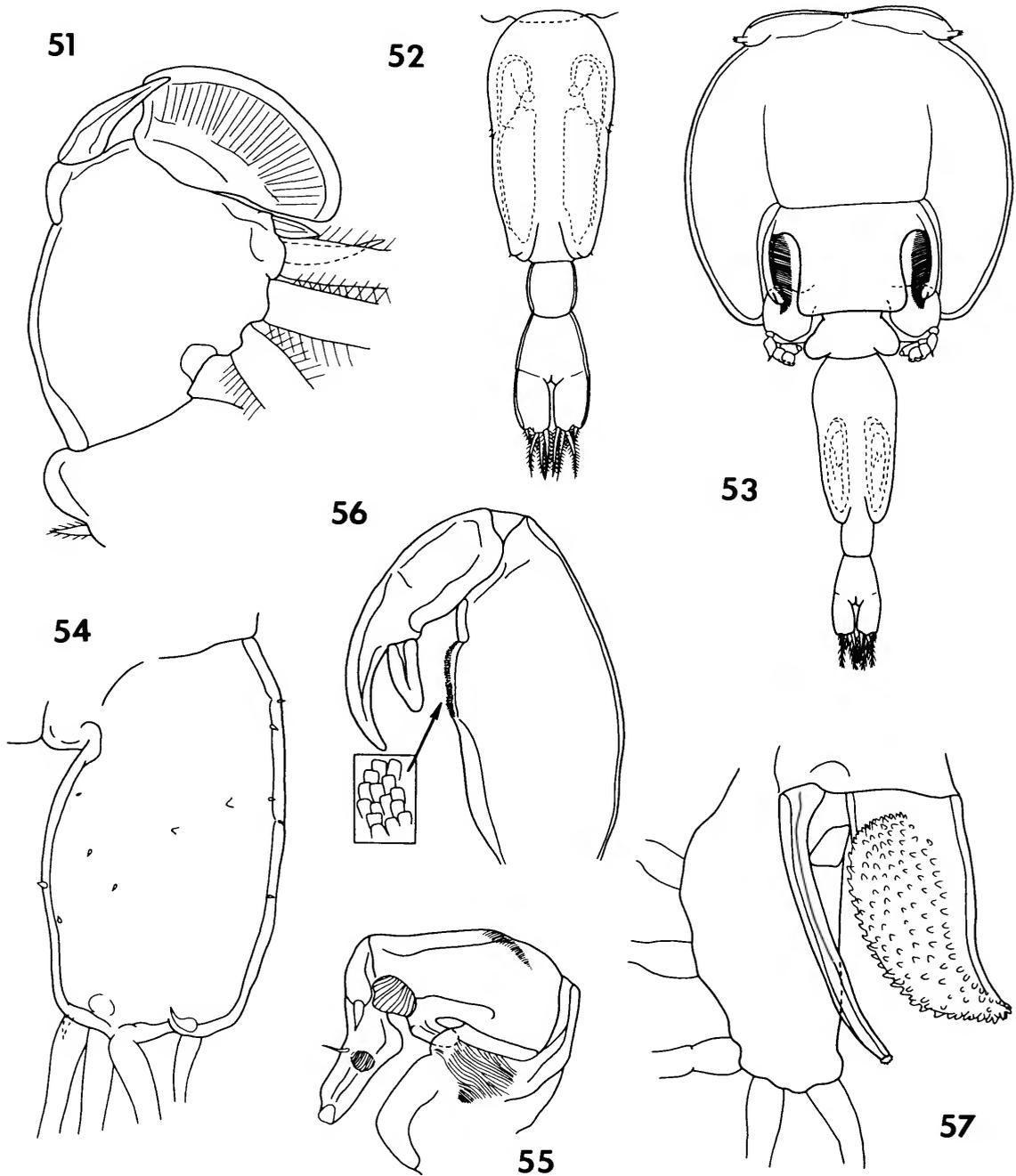
FIGURES 29-35.—*Alebion maculatus* Wilson, female: 29, dorsal; 30, spermatophores attached; 31, caudal ramus, ventral; 32, second antenna; 33, short flagellum of second maxilla; 34, postoral adhesion pad; 35, maxilliped.



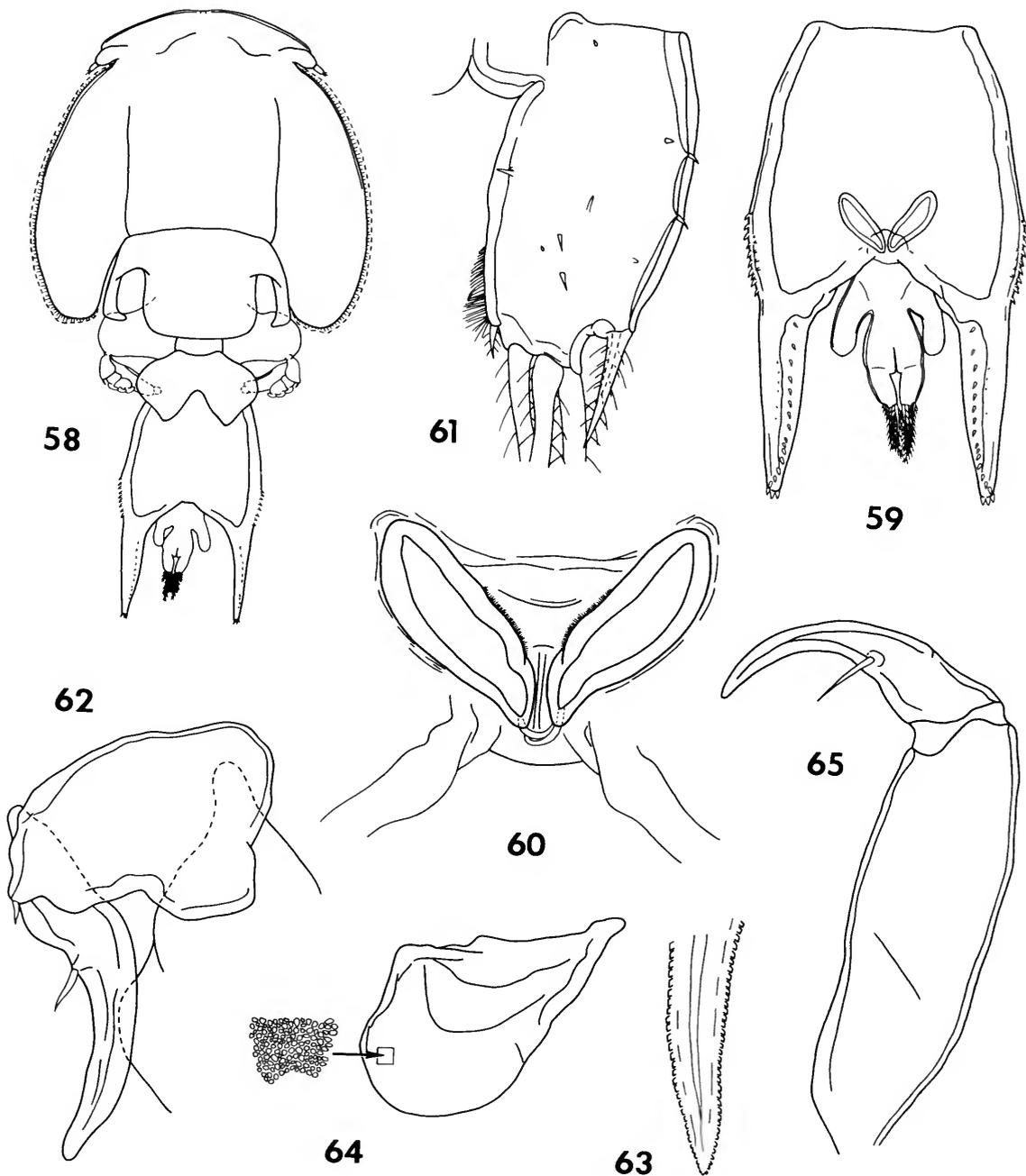
FIGURES 36-43.—*Alebion maculatus* Wilson, female: 36, last exopod segment of leg 1; 37, tip of leg 5. Male: 38, dorsal; 39, genital segment and abdomen; 40, caudal ramus, ventral; 41, second antenna; 42, maxilliped; 43, exopod of leg 2.



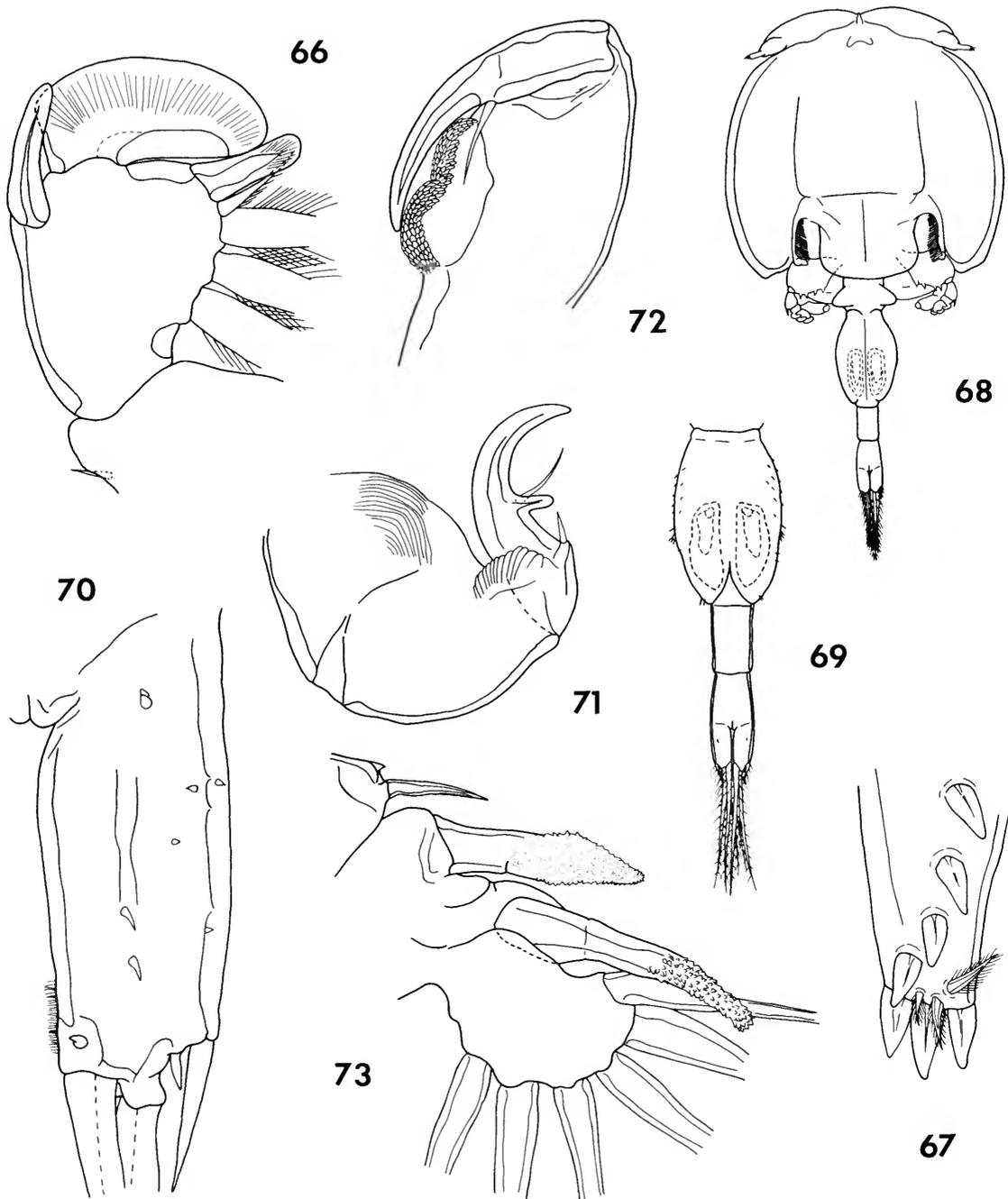
FIGURES 44-50.—*Alebion crassus* Wilson, female: 44, dorsal; 45, genital segment ventral; 46, caudal ramus, ventral; 47, second maxilla, area near flagella; 48, postoral adhesion pad; 49, maxilliped; 50, tip of claw of maxilliped.



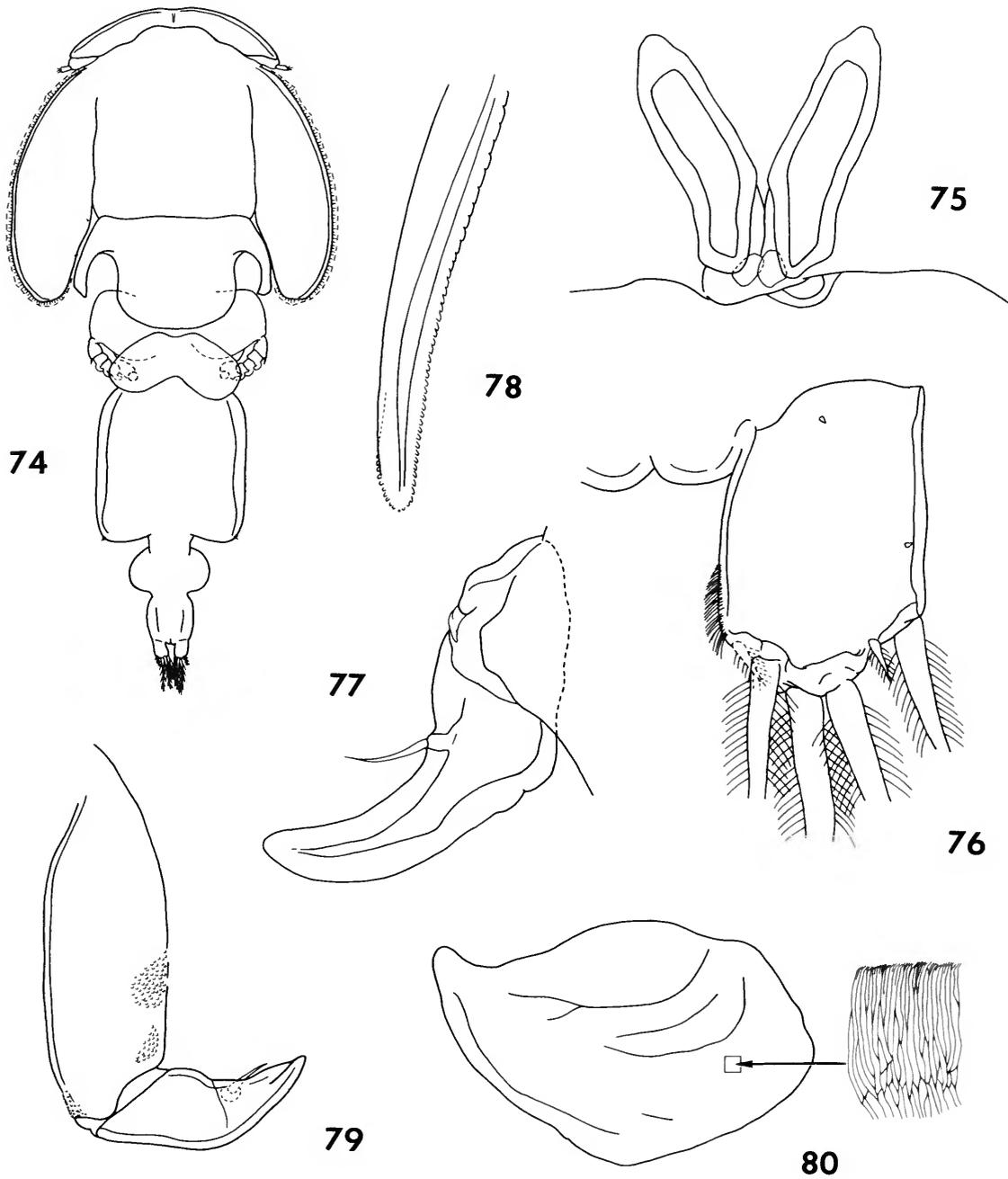
FIGURES 51-57.—*Alebion crassus* Wilson, female: 51, last exopod segment of leg 1. Male: 52, dorsal; 53, genital segment and abdomen, ventral; 54, caudal ramus; 55, second antenna; 56, maxilliped; 57, exopod of leg 2.



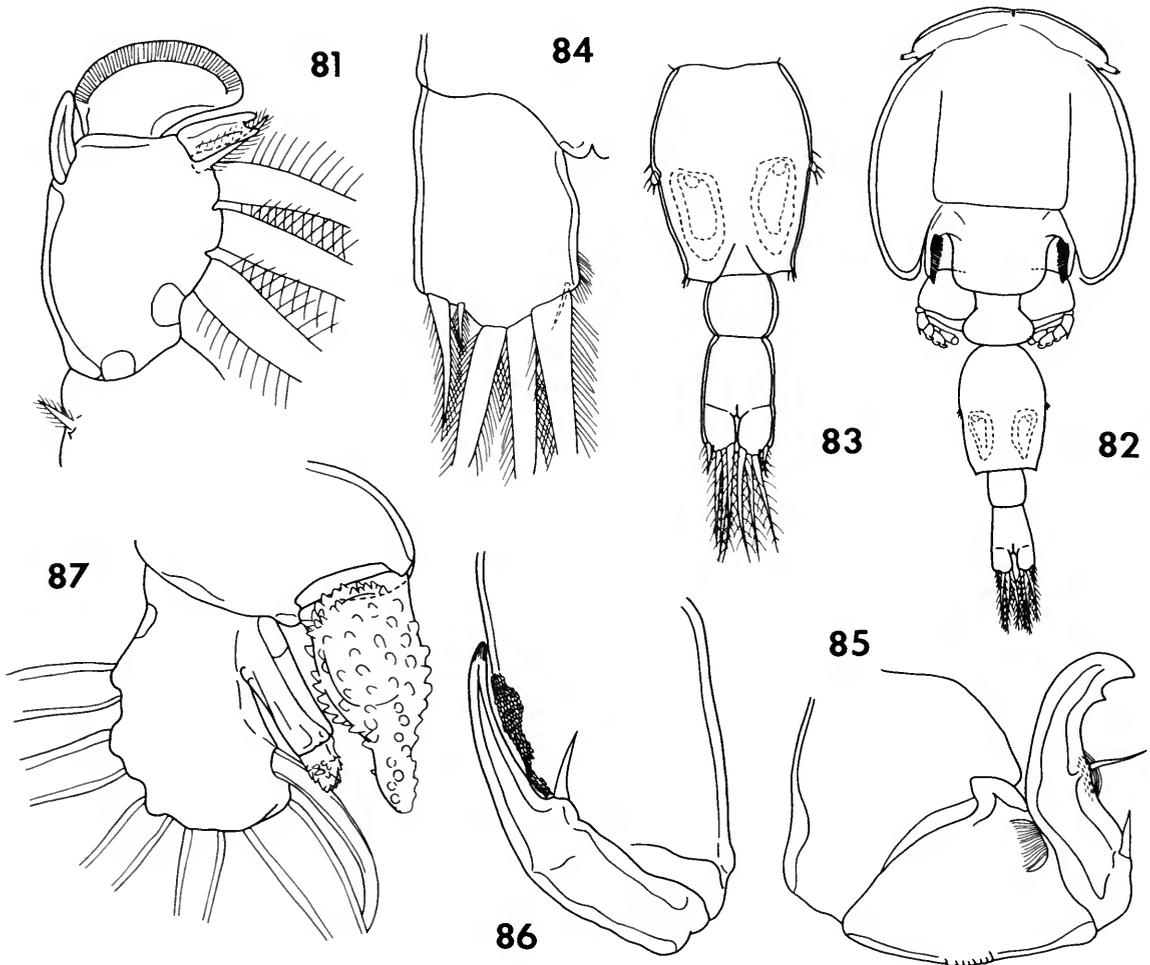
FIGURES 58-65.—*Alebion elegans* Capart, female: 58, dorsal; 59, genital segment and abdomen, ventral; 60, spermatophores attached; 61, caudal ramus, ventral; 62, second antenna; 63, tip of short flagellum of second maxilla; 64, postoral adhesion pad; 65, maxilliped.



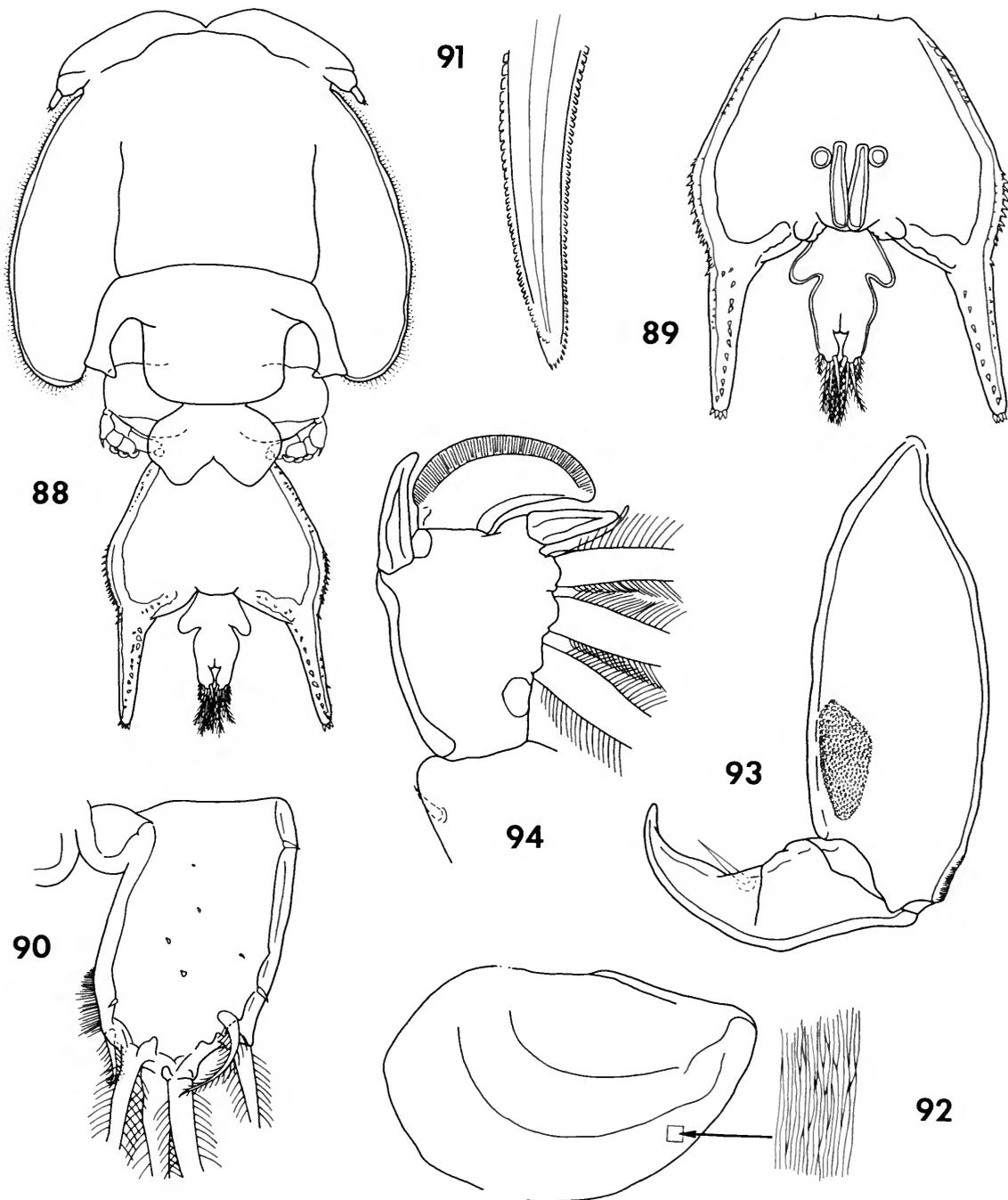
FIGURES 66-73.—*Alebion elegans* Capart, female: 66, last exopod segment of leg 1; 67, tip of leg 5. Male: 68, dorsal; 69, genital segment and abdomen, ventral; 70, caudal ramus, ventral; 71, second antenna; 72, maxilliped; 73, exopod of leg 2.



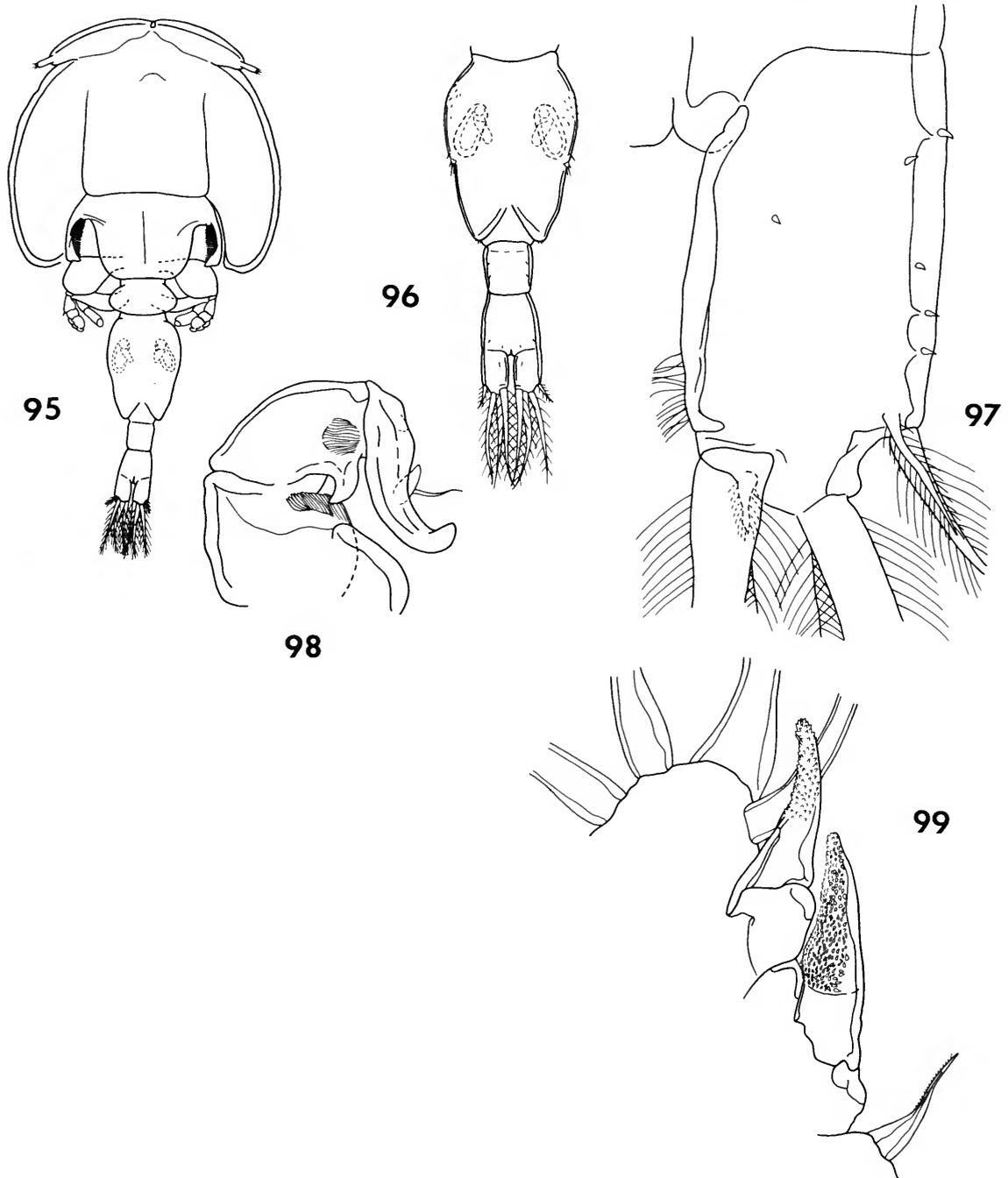
FIGURES 74-80.—*Alebion glaber* Wilson, female: 74, dorsal; 75, spermatophores attached; 76, caudal ramus, ventral; 77, claw of second antenna; 78, tip of short flagellum of second maxilla; 79, maxilliped; 80, postoral adhesion pad.



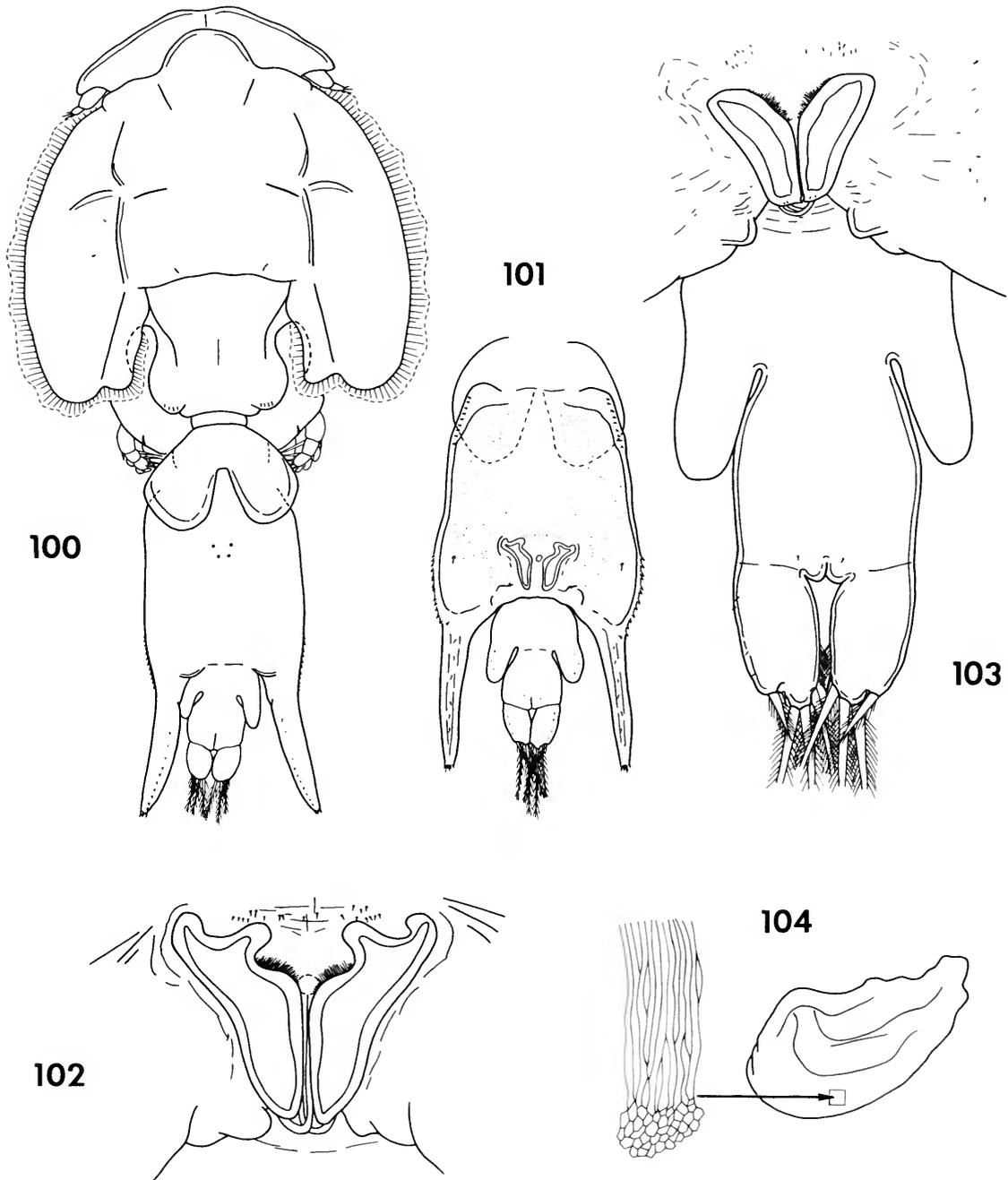
FIGURES 81-87.—*Alebion glaber* Wilson, female: 81, last exopod segment of leg 1. Male: 82, dorsal; 83, genital segment and abdomen; 84, caudal ramus, ventral; 85, second antenna; 86, maxilliped; 87, exopod of leg 2.



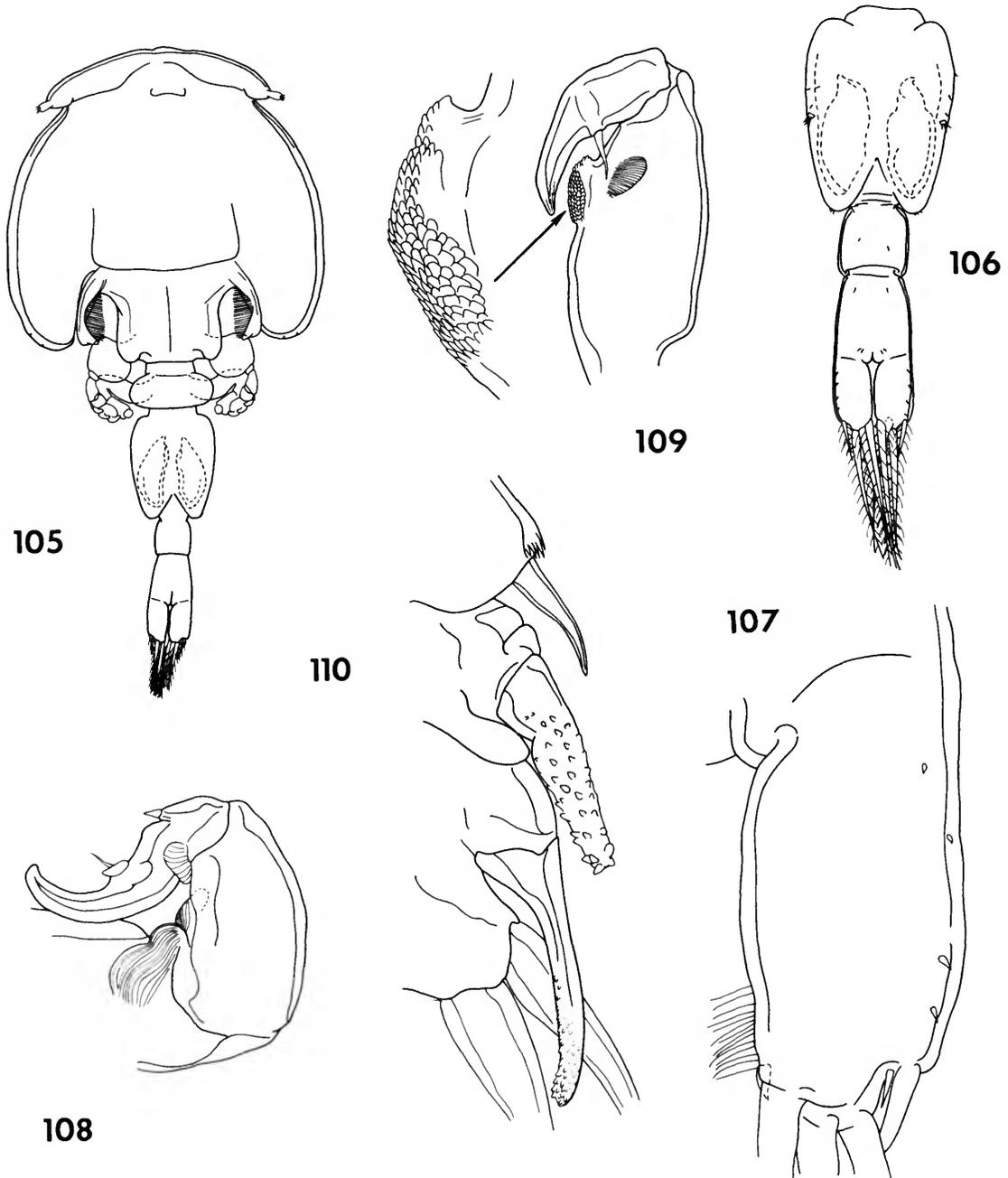
FIGURES 88-94.—*Alebion gracilis* Wilson, female: 88, dorsal; 89, genital segment and abdomen, ventral; 90, caudal ramus, ventral; 91, tip of short flagellum of second maxilla; 92, postoral adhesion pad; 93, maxilliped; 94, last exopod segment of leg 1.



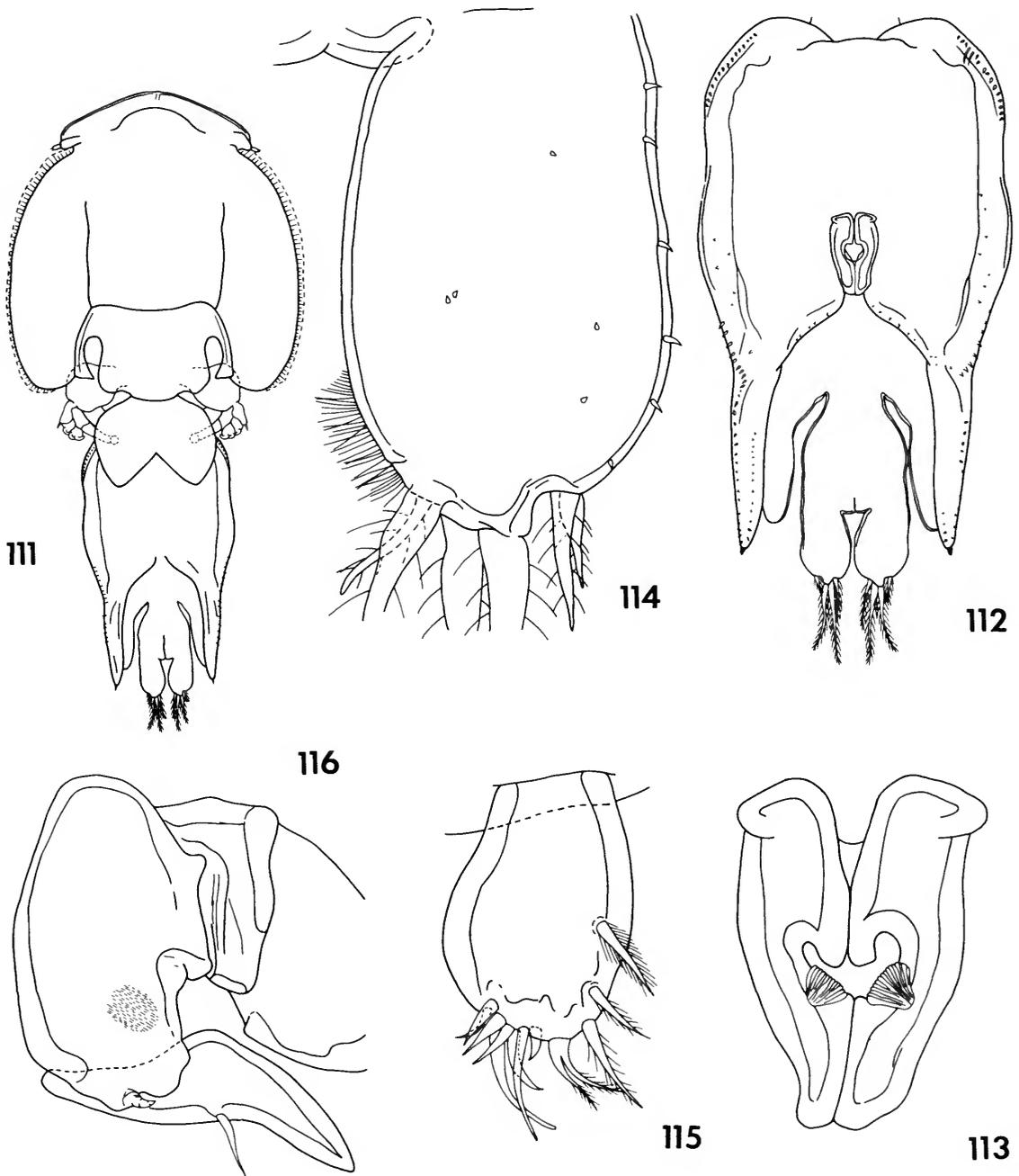
FIGURES 95-99.—*Alebion gracilis* Wilson, male: 95, dorsal; 96, genital segment and abdomen, ventral; 97, caudal ramus; 98, second antenna; 99, exopod of leg 2.



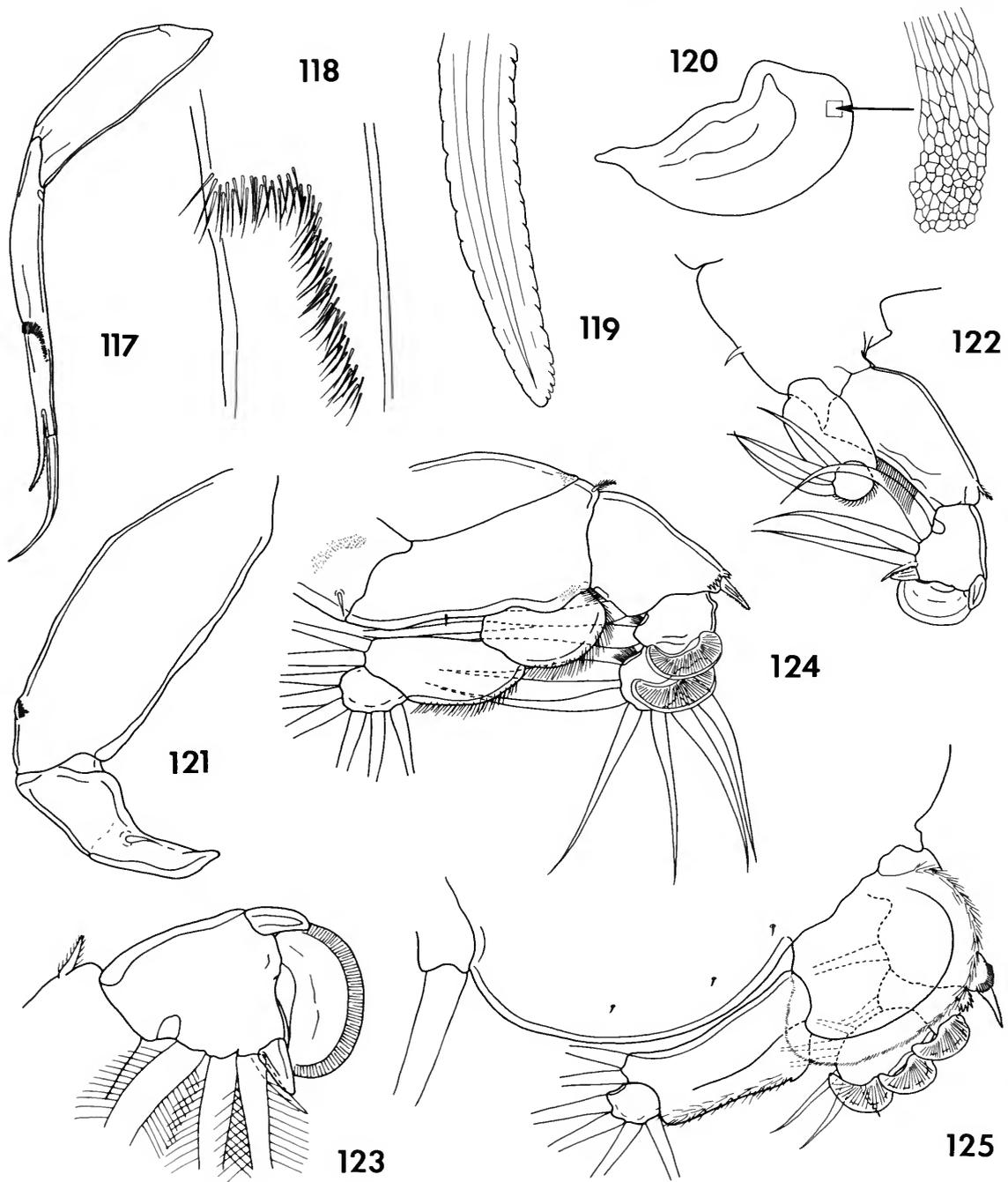
FIGURES 100-104.—*Alebion lobatus* Cressey, female: 100, dorsal; 101, genital segment and abdomen, ventral; 102, spermatophores attached; 103, posterior portion of genital segment and abdomen, ventral; 104, postoral adhesion pad.



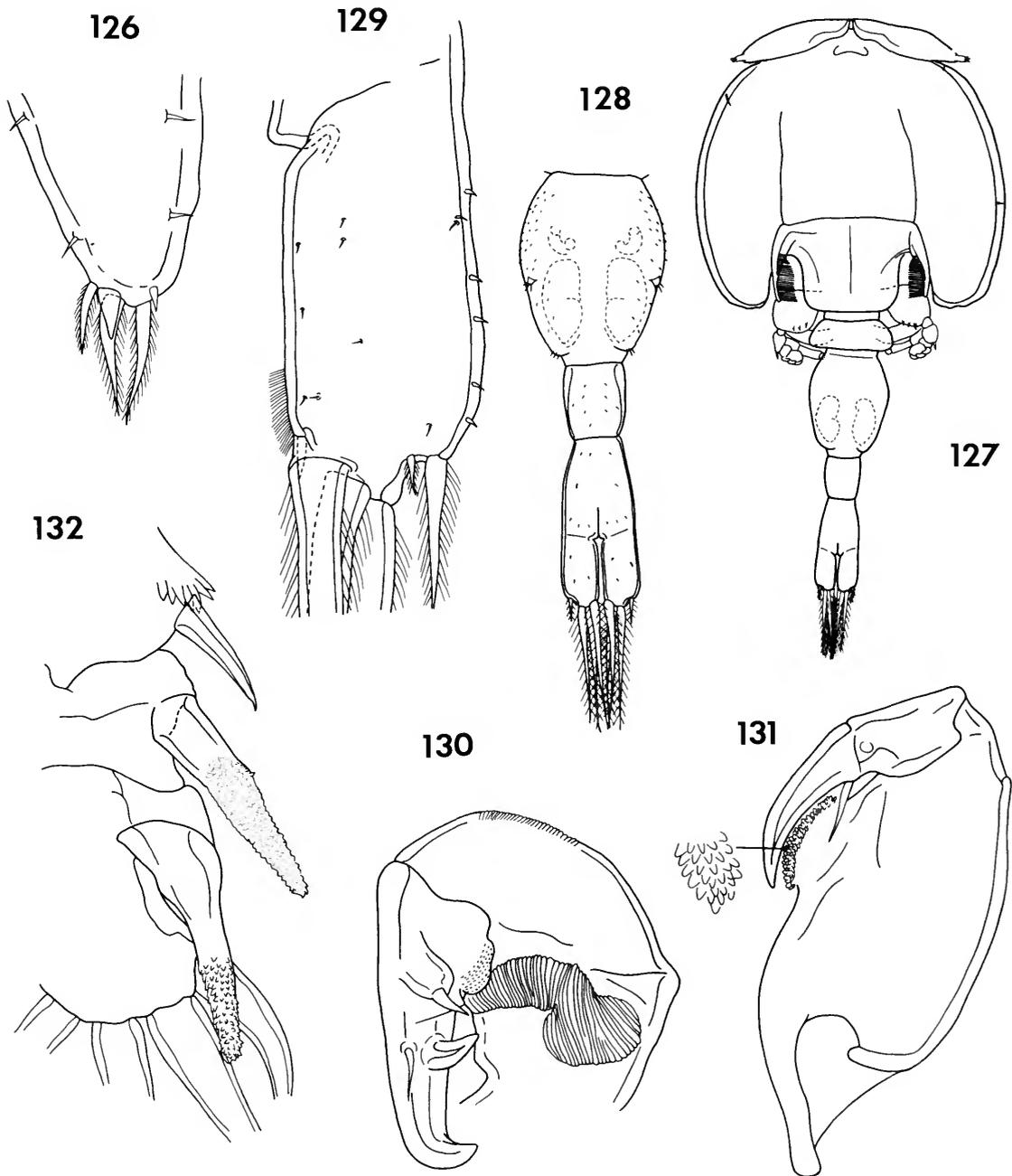
FIGURES 105-110.—*Alebion lobatus* Cressey, male: 105, dorsal; 106, genital segment and abdomen, ventral; 107, caudal ramus; 108, second antenna; 109, maxilliped; 110, exopod of leg 2.



FIGURES 111–116.—*Alebion pacificus*, new species, female: 111, dorsal; 112, genital segment and abdomen, ventral; 113, spermatothores; 114, caudal ramus, ventral; 115, last segment of first antenna; 116, second antenna.



FIGURES 117-125.—*Alebion pacificus*, new species, female: 117, second maxilla; 118, row of setules on second maxilla; 119, tip of short flagellum of second maxilla; 120, postoral process; 121, maxilliped; 122, leg 1; 123, last exopod segment of leg 1; 124, leg 2; 125, leg 3.



FIGURES 126-132.—*Alebion pacificus*, new species, female: 126, tip of leg 5. Male: 127, dorsal; 128, genital segment and abdomen, ventral; 129, caudal ramus, ventral; 130, second antenna; 131, maxilliped; 132, exopod of leg 2.

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