ROGER F. CRESSEY

Copepods Parasitic on Sharks from the West Coast of Florida

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ABSTRACT

Cressey, Roger F. Copepods Parasitic on Sharks from the West Coast of Florida. *Smithsonian Contributions to Zoology,* 38:1–30. 1970.—Thirty-one species of parasitic copepods were taken from sixteen species of sharks caught off Sarasota, Florida. Of these, the following are described as new: *Alebion lobatus, Nesippus nana, Kroyeria longicauda, Kroyerina scottorum,* and *Nemesis spinulosus.* It was noted that the spermatophore attached to females of *Alebion* serve as one of the best taxonomic characters for separating females of this genus.

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Introduction

Between 1965 and 1970 over 400 collections of parasitic copepods representing 31 species were taken from 16 species of sharks, mostly from off Sarasota, Florida. The work was accomplished in cooperation with the Mote Marine Laboratory (formerly Cape Haze Marine Laboratory) while the laboratory was engaged in activities concerning shark biology. Larger species of sharks were caught on trot lines set from one to five miles off Siesta Key. Smaller species were caught by using a modified trot line set closer to shore off Siesta Key and also in various locations in Tampa Bay.

This paper represents an account of those species of parasites present on the 16 species of sharks collected. Five new species are described. No attempt has been made, in most cases, at redescribing the known species since it is my intention to do this later in revisionary works concerning several of the genera represented here. The large collection reported here, together with collections from other parts of the world, will enable me to more effectively do this revisionary work. *Paralebion elongatus* Wilson, however, has been redescribed since it does not fit into any proposed future revisionary work.

The material representing four species of *Alebion* reported here has enabled me to demonstrate the usefulness of the spermatophore as a taxonomic character in this genus.

The collection also adds much to the information previously known regarding the host specificity of many of the copepods.

All material is preserved in 70 percent alcohol and deposited in the Division of Crustacea, Smithsonian Institution.

All figures were drawn with the aid of a camera lucida.

In the spine-and-seta formula given for new species the Roman numerals refer to spines and the Arabic to setae.

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Acknowledgments

The author thanks Drs. Eugenie Clark, Sylvia Earle, and Perry Gilbert, directors of the Mote (Cape Haze) Marine Laboratory during various phases of the work. Special thanks are given to Roberta and Hugh Scott of the laboratory staff, who made several collections of copepods during periods when the author was not at the laboratory.

The holotype of *Alebion carchariae* Krøyer was loaned to me by Dr. Torben Wolff of the Copenhagen Museum.

Miss Rosalind Weil assisted in the preparation of the figures.

That portion of the research conducted between July 1966 and June 1968 was supported by a grant from the Office of Naval Research [Nonr- 1354 (12)].

Family CALIGIDAE Dana, 1852

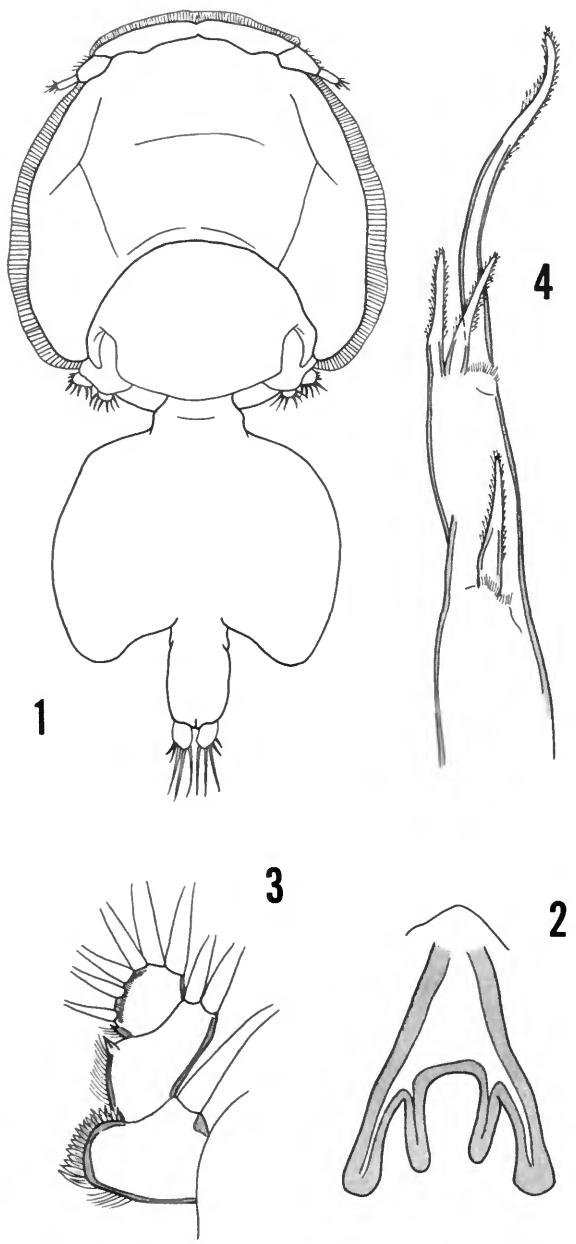
Lepeophtheirus eurus Bere, 1936

FIGURES 1–4

MATERIAL.—Two collections from gills of *Carcharinus limbatus:* one containing 8 ♀ ♀ collected

23 May 1963 and the other containing 1 ♀ collected 20 August 1965.

FEMALE.—Total length of 1 specimen 3.0 mm and greatest width 1.78 mm. Body form as in Figure 1. Sternal furca (Figure 2) with bifid tines; inner branch shorter than outer, outer branch with expanded tips. Endopod of leg 2 (Figure 3) first segment with row of prominent spines along outer edge, last segment with row of hairs internal to outer edge. Tip of leg 4 (Figure 4) armed with 3 setae; outer 2 equal in length, inner about 2.5 times as long as outer setae, all setae somewhat blunt at tips and bearing heavy fringe. The features described above will serve to distinguish this species from others in the genus.



FIGURES 1–4.—*Lepeophtheirus eurus* Bere, female: 1, dorsal; 2, sternal furca; 3, endopod of leg 2; 4, tip of leg 4.

REMARKS.—This copepod was originally described by Bere in 1936 from the "outer surface" of the same host reported here. These three collections from *C. limbatus* may indicate a possible specific association between this copepod and its host.

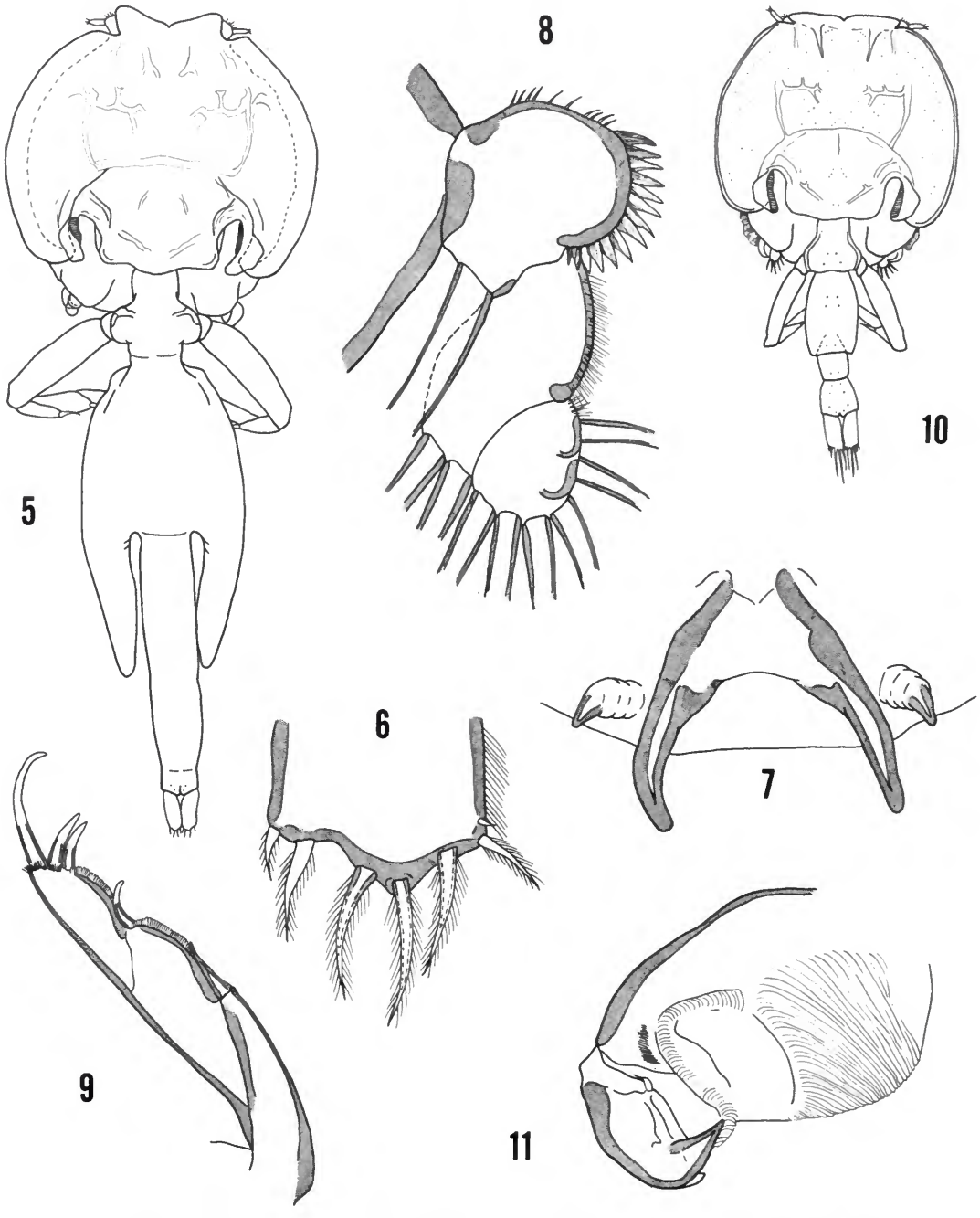
Family EURYPHORIDAE Yamaguti, 1963

Paralebion elongatus Wilson, 1911

FIGURES 5–11

MATERIAL.—Fifty-five collections from body surface of four hosts as follows (number of collections in parentheses): *Carcharinus milberti* (18), *C. leucas* (25), *C. limbatus* (3), and *Negaprion brevirostris* (9). No seasonal variation was noted in the abundance of this species since it was collected during all seasons.

FEMALE.—Body form as in Figure 5. Total length of 1 specimen 13.9 mm and greatest width 5.2 mm. In his original description Wilson (1911, p. 629) states that abdomen is 2-jointed and each segment is about equal in length. Near middle of abdomen there is a slight constriction; no suture or joint is visible at this point. There is, however, a separation near terminus which divides abdomen into 2 unequal segments, anterior several times longer than posterior. Caudal rami possess 6 terminal setae (Figure 6) rather than 4 as reported by Wilson (innermost very small). Sternal furca (Figure 7) double but bases of outer branches separated from common base of inner. Second leg endopod (Figure 8) first segment with row of spines along outer edge (similar in nature to those reported in previous species, *L. eurus*); terminal segment with 2 sickle-shaped sclerotized areas at base of 2 outermost setae.



FIGURES 5–11.—*Paralebion elongatus* Wilson, female: 5, dorsal; 6, caudal ramus; 7, sternal furca; 8, endopod of leg 2; 9, leg 4. Male: 10, dorsal; 11, second antenna.

Leg 3 with single well-developed spine at base of exopod. Leg 4 (Figure 9) exopod 3-segmented, last 2 segments each with comblike fringe on outer margin.

MALE.—Body form as in Figure 10. Total length 7.5 mm, greatest width 2.1 mm. Appendages as in female except for second antenna (Figure 11). Claw of second antenna short and heavily sclerotized, basal segment with corrugated areas as in Figure 11.

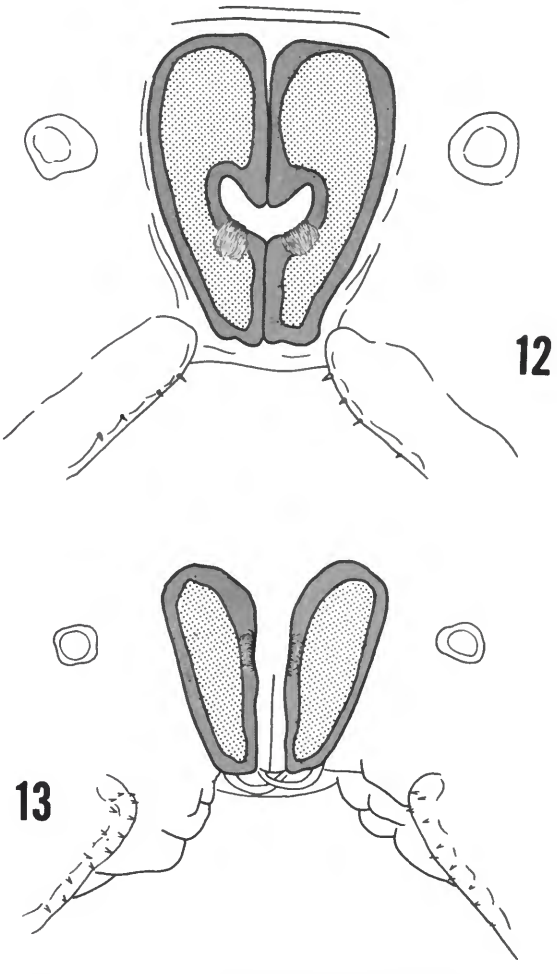
This genus was placed in the family Euryphoridae by Yamaguti (1963) because of the alleged relationship between it and *Alebion*. After examining material of both genera, it is apparent that they are not closely related and the inclusion of *Paralebion* in the Euryphoridae is questionable. I have continued Yamaguti's family assignment of this genus for the present. Future work, however, may show the *Paralebion* should be placed in another family.

Alebion carchariae Krøyer, 1863

FIGURES 12, 13

MATERIAL.—Seventy-one collections from body surface of 9 species of sharks as follows (number of collections in parentheses): *Carcharinus milberti* (37); *C. leucas* (11); *C. obscurus* (7); *C. limbatus* (7); *C. maculipinnis* (3); *Negaprion brevirostris* (3); *Galeocerdo cuvieri* (1); *Sphyrna mokarran* (1); and *S. lewini* (1). All collections made between 14 October and 27 May during the cooler season.

REMARKS.—This species of *Alebion* was the most common of the four reported here and as can be seen from the list above is a common parasite of the carcharinid sharks of the area. Other collections from various parts of the world attest to its ubiquitous nature and will be commented on in more detail in a subsequent work revising the genus. The females of this species can be easily separated from other members of the genus by the form of the spermatophore attached to the ventral surface of the genital segment. It should be pointed out, however, that the spermatophore has two forms (Figure 12 and 13). Both types of spermatophores were often present on different females in the same collection. Specimens bearing the different forms are otherwise indistinguishable. The form represented by Figure 12 was collected from each of the hosts recorded above, whereas the form represented by Figure 13 was collected only from *C. milberti, C. obscurus,* and *C. leucas.* In the 37 collections from *C. milberti* there are 140 spermatophore bearing females. Of these, 117 bear the type with the inner median sinus (Figure 12) and 23 bear the type shown in Figure 13. Since a similar situation was found in the new species, *A. lobatus,* described below, I do not feel that these four spermatophore forms indicate four species but that some other explanation is needed. Both spermatophore forms were distributed throughout the collections without regard to season,



FIGURES 12, 13.—*Alebion carchariae* Krøyer, female: spermatophore in place on genital segment.

host size, sex, or site of infestation. Consequently no explanation can be offered at this time.

Since this species was absent from collections made during the summer months, a clear preference is indicated for the winter inhabitants. Several individuals of those hosts present were examined during summer collecting periods.

Alebion gracilis Wilson, 1905

FIGURE 14

MATERIAL.—A single collection containing 1 ♀ from body surface of *Galeocerdo cuvieri* 16 August 1965.

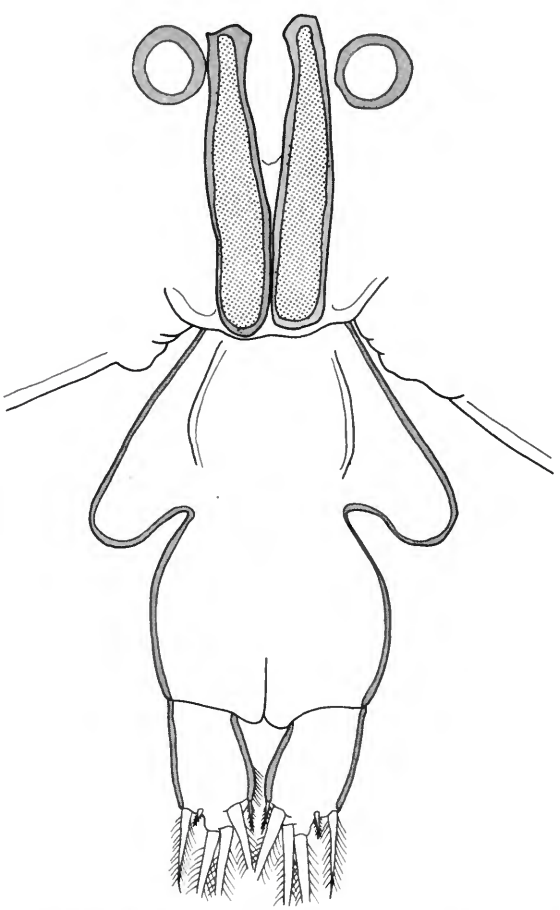


FIGURE 14.—*Alebion gracilis* Wilson, female: spermatophore in place on genital segment.

REMARKS.—This copepod has been reported from various parts of the world. Examination of the type specimen of this species and a comparison with the type of *A. carchariae* leads me to suspect that many of these records are in error and that *A. gracilis* is actually quite rare and *A. carchariae* quite common. My own report of *A. gracilis* from Madagascar (Cressey, 1967b) is in error as well as that of Lewis (1967) in his report on copepods parasitic on Hawaiian sharks. This confusion will be dealt with in more detail in my forthcoming revision of the genus *Alebion*.

The female is easily identified by the form of the attached spermatophore (Figure 14).

Alebion elegans Capart, 1953

FIGURE 15

MATERIAL.—Three collections from *Sphyrna mokarran* and one from *S. lewini*.

REMARKS.—As in other species of the genus, the females can be easily identified by the shape and position of the attached spermatophore (Figure 15). The genital segment lacks the prominent lateral bulges found on both *A. carchariae* and *A. gracilis* and bears fewer spinules. The four collections that are reported here were made at various

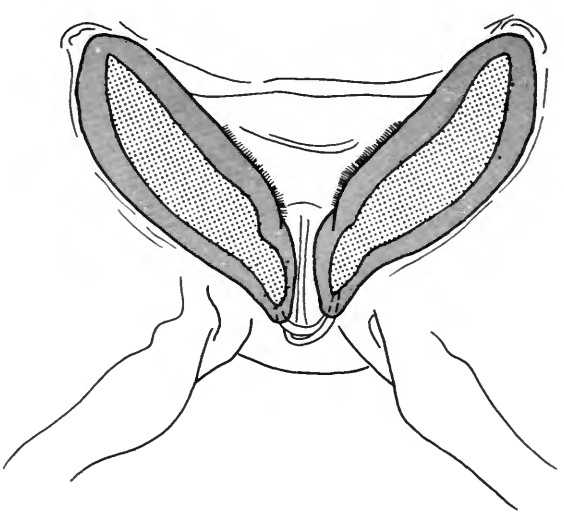
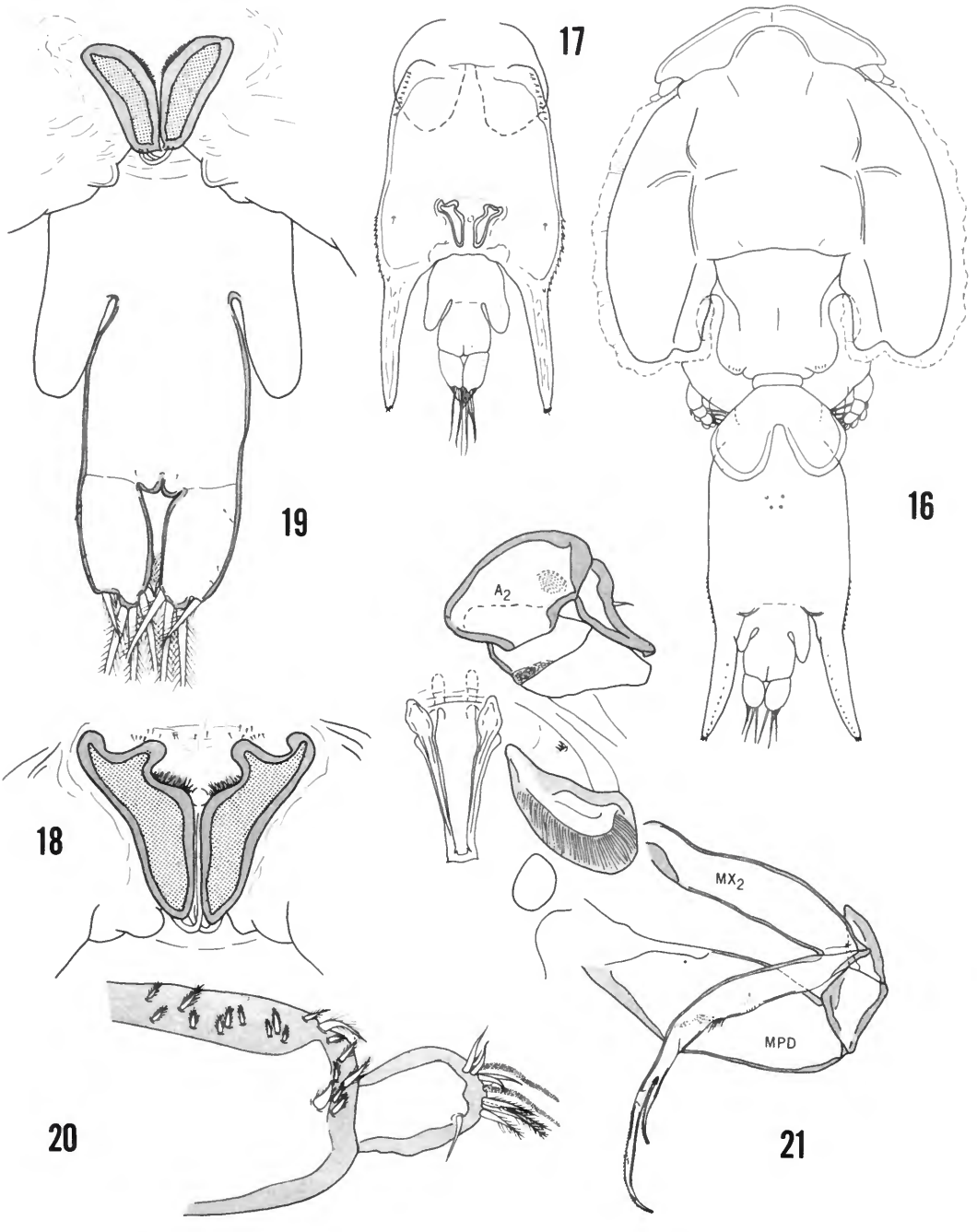


FIGURE 15.—*Alebion elegans* Capart, female: spermatophore in place on genital segment.



FIGURES 16–21.—*Alebion lobatus*, new species, female: 16, dorsal; 17, genital segment and abdomen; 18, spermatophore in place on genital segment; 19, spermatophore in place on genital segment, abdomen, and caudal rami; 20, first antenna; 21, oral area.

times of the year and show no seasonal preference. This copepod, however, has been reported only from hammerhead sharks.

Alebion lobatus, new species

FIGURES 16–28

MATERIAL.—Thirty collections from body surface of *Carcharinus milberti*. Holotype ♀ (USNM 128492) and 7 paratype ♀ ♀ (USNM 128493) collected from above host 25 February 1967 at Sarasota, Florida.

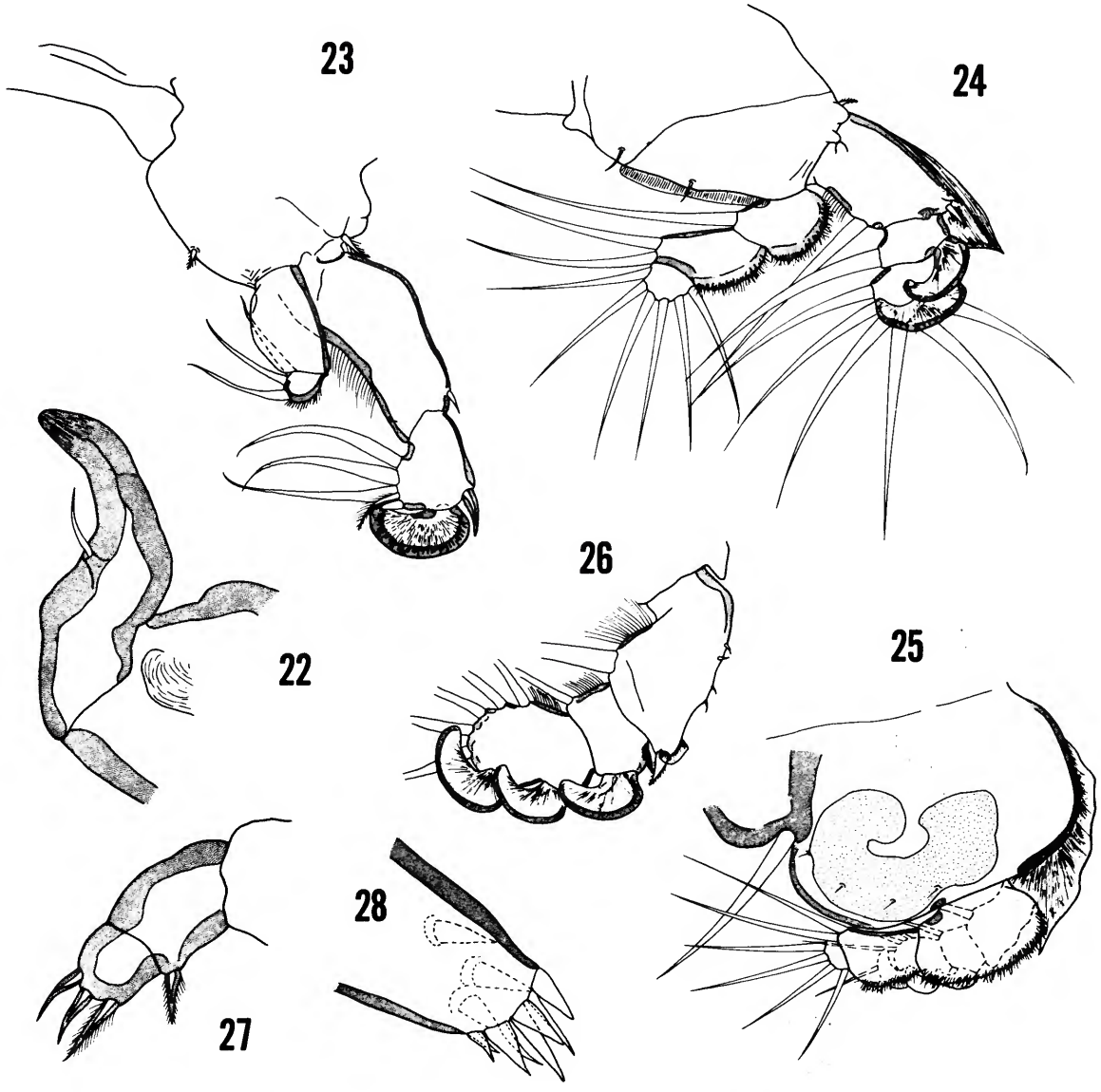
FEMALE.—Body form as in Figure 16. Total length 9.45 mm (9.30–9.90 mm) and greatest width 4.37 mm (4.20–4.50 mm) based on an average of 5 type specimens. Cephalon slightly longer than wide (4.50 x 4.95 mm, holotype), about one-half total length. Thoracic segments bearing legs 1–3 fused, articulating with cephalon. Thoracic segment bearing leg 4 free and bearing prominent dorsal bilobed plate, characteristic of other species in genus. Genital segment (Figure 17) only slightly longer than wide, measured from anterior border to abdomen (2.25 x 2.52 mm); genital segment 4.20 mm long when leg 5 is included (posterior processes). Row of small spines along anterolateral edge and another lateral row of small spines along posterior edge (segment bulges slightly at this part). Spermatophores attached ventrally near attachment of abdomen. Spermatophore of 2 forms. In the most common form encountered in the collection reported here, each spermatophore bears 2 prominent anterior lobes (Figure 18); inner surface of each with pilose area at about midmargin; anterior halves divergent, posterior halves parallel. Alternate form of spermatophore (Figure 19) without lobes and generally smaller but still exhibiting divergent nature (see Remarks). Abdomen (Figure 19) 1-segmented and 1.62 mm long; anterior segment with prominent lateral winglike processes. Caudal rami (Figure 19) bear 4 plumose terminal setae and 2 smaller subterminal setae, each ramus somewhat longer than wide (652 μ × 420 μ).

First antenna (Figure 20) 2-segmented, basal segment with several small plumose setae, terminal segment with 13 setae (2 in form of aesthetes and 2 fused at base), 4 setae plumose as indicated in figure. Oral area as in Figure 21. Second antenna in form of claw, first 2 segments each with rugose area, terminal claw with small seta near midpoint. Mandible of usual caligoid type with 11 teeth. First maxilla represented by group of 3 small setae lateral to mouth tube and anterior to prominent flangelike process. Second maxilla as in other species of genus, second segment with patch of hairs near distal end; terminal processes with lateral rows of spinules, spinules on longest process in incomplete spiral rows. Maxilliped in form of stout claw; tip of claw (Figure 22) thicker than in other species of genus, bearing seta near midpoint.

Legs 1–3 biramous. Leg 1 (Figure 23) exopod 2-segmented, basal segment with small spine on outer distal corner, terminal segment with 3 spines and 4 setae, terminal spine in form of broad blade directed toward mid-axis of body; terminal seta much shorter than other 3 and all setae plumose; endopod 2-segmented, terminal segment with 3 inwardly directed plumose setae. Leg 2 (Figure 24) exopod 3-segmented, basal segment with membranous outer sheet enveloping outer margin, last 2 segments each bear an inwardly directed modified spine (as in leg 1) and setae as indicated in figure; endopod 3-segmented, outer margins of first 2 segments pilose and each with inner setae as indicated in figure, terminal segment with 6 setae. Leg 3 (Figure 25) basipod in form of broad flange; exopod (Figure 26) 3-segmented, basal segment with few small spinules on outer edge and spine on outer distal corner, second segment with modified spine, terminal segment with 2 modified spines, each segment with setae as in figure; endopod first 2 segments with outer edges pilose, terminal segment small and bearing 4 setae; rami closely appressed and one overlapping the other (broad fringe on basipod lies over rami, not shown in Figure 25). Leg 4 (Figure 27) small, 2-segmented; basal segment with outer plumose spine, terminal segment with 3 spines (plumosities seen on outermost only). Leg 5 represented by 2 long processes on outer distal corner of genital segment, each tipped with several short spines (Figure 28) and row of short spines on dorsal surface. Leg 6 absent.

Egg strings uniseriate.

MALE.—Unknown. Because of the lack of understanding of the diagnostic features of males of *Alebion* coupled with the fact that this species commonly occurs in the same collections as *A. carchariae*, I have deferred description of the male



FIGURES 22–28.—*Alebion lobatus,* new species, female: 22, maxilliped; 23, leg 1; 24, leg 2; 25, leg 3; 26, endopod of leg 3; 27, leg 4; 28, tip of leg 5.

until I have completed a comprehensive revision of the genus with a better understanding of the male distinguishing characters.

ETYMOLOGY.—The name *lobatus* refers to lobes present on spermatophore.

REMARKS.—Females of the new species can be separated easily from other species of the genus by the form of the attached spermatophore. They can be further separated from all species, except *A. elegans,* by the shape of the genital segment. In *A. lobatus* and *A. elegans* the genital segment lacks the prominent lateral bulges and is much less spinose. The new species can be separated from *A. elegans* by the following: the fifth legs of *A. elegans* extend

well beyond the caudal rami, whereas those of *A. lobatus* extend only slightly beyond; the last segments of the second antenna and of the maxilliped of *elegans* are much longer and more delicate than those of *lobatus;* the spermatophores in position on the females of *elegans* diverge from their posteriormost part, whereas in *lobatus* the divergence is only in the anterior half.

The occurrence of two forms of the spermatophore is similar to the situation encountered in *A. carchariae*. Of the 77 females bearing spermatophores, 62 were of the knobbed type and 15 of the smooth type. This ratio (1:4.1) is close to the ratio between the types found in *A. carchariae* (1:5). It seems reasonable to assume that the same mechanisms are operating in both species. It could not be determined if this situation exists in other species of *Alebion* because of the small sample size in the other species.

All of the collections are from *Carcharinus milberti,* indicating a much stronger host specificity than in most other species of *Alebion*. The host is a common winter resident of the Sarasota area. Consequently, this copepod was not collected in the summer.

Family PANDARIDAE Edwards, 1840

Descriptions of the eight species of this family cited below have been omitted, except for the one new species, since they were provided earlier in the revision of the family (Cressey, 1967a). I have, however, included a figure of each species (female) so that identifications of shark copepods from the west coast of Florida can be made without reference to the earlier paper. For other than coastal species, the more comprehensive treatment should be consulted.

Pandarus cranchii Leach, 1819

FIGURE 29

MATERIAL.—Two collections from pectoral fin and tail of *Carcharodon carcharias,* 21 January 1966 and 20 February 1967; one collection from *Carcharinus leucas,* 22 March 1967; and one collection from *C. obscurus,* 8 November 1966.

Pandarus smithii Rathbun, 1886

FIGURES 30, 31

MATERIAL.—Five collections from body surface of *Carcharinus milberti;* two collections from *Carcharodon carcharias;* one collection from *Carcharinus obscurus;* and one collection from *C. leucas*. All collections made during winter months except that from *C. leucas* (25 July 1967).

Pandarus floridanus Cressey, 1967

FIGURE 32

MATERIAL.—Two collections from body surface of *Carcharodon carcharias,* 21 January 1966 and 20 February 1967.

Pandarus sinuatus Say, 1817

FIGURE 33

MATERIAL.—Sixteen collections from *Carcharinus milberti;* ten collections from *C. leucas;* five collections from *Negaprion brevirostris;* two collections from *Ginglymostoma cirratum;* one collection from *Mustelus norrisi;* and one collection from *C. acronotus*.

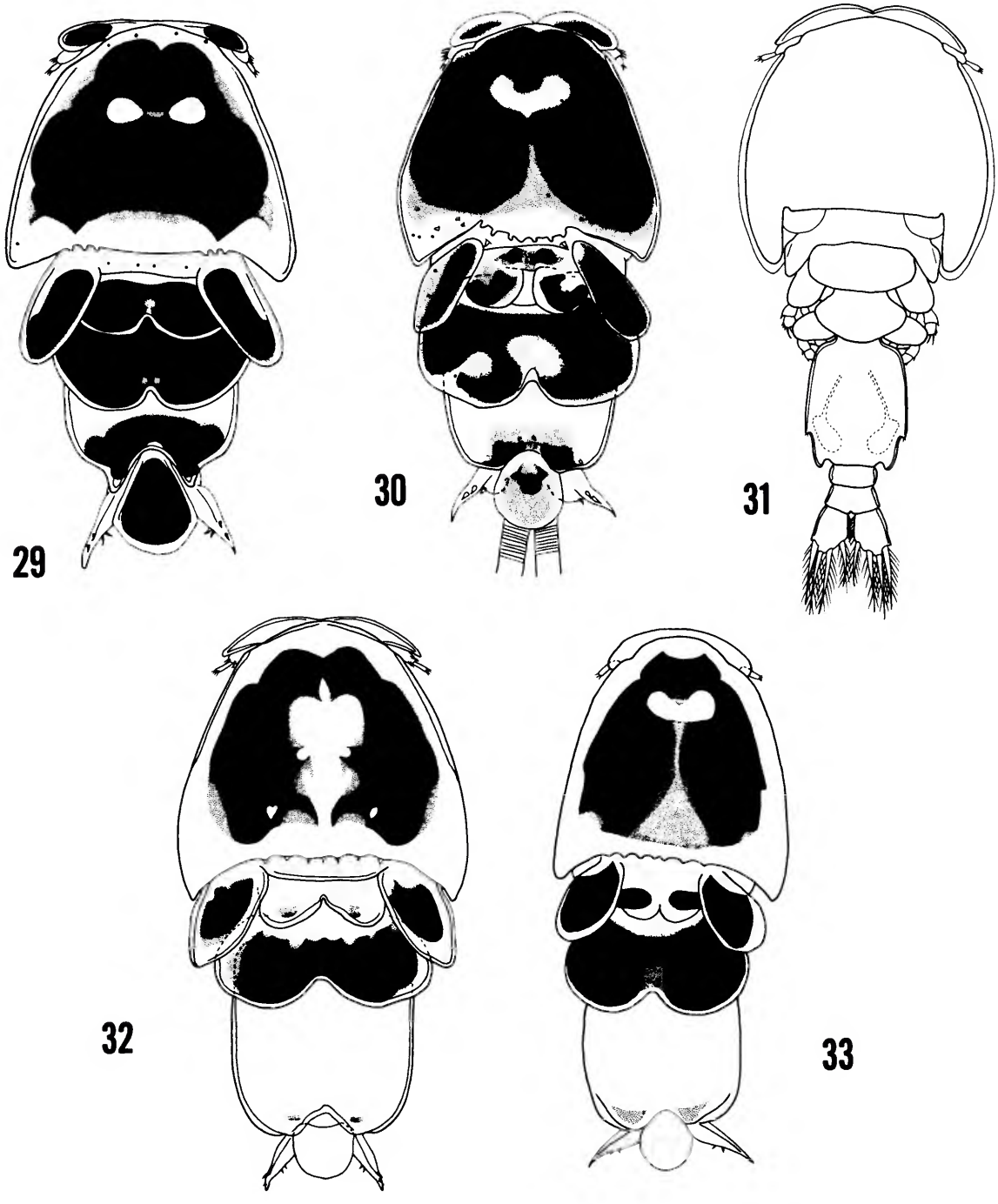
REMARKS.—This parasite occurs on the body surface of its host and was collected during all seasons of the year.

Perissopus dentatus Steenstrup and Lütken, 1861

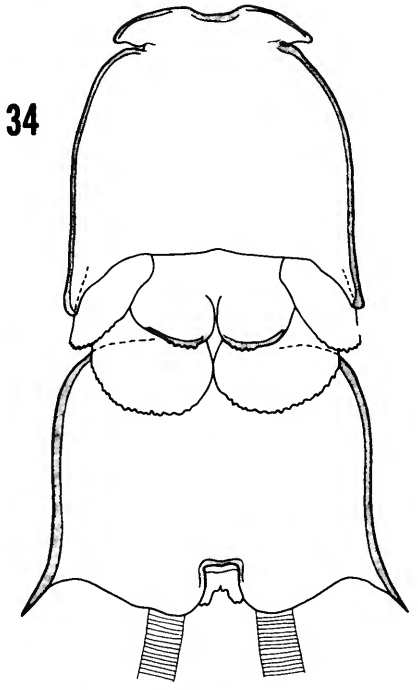
FIGURES 34, 35

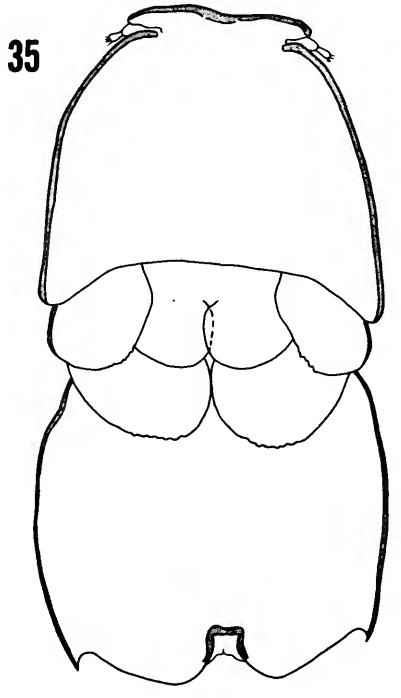
MATERIAL.—Eighty-eight collections from nine species of hosts as follows: *Carcharinus milberti* (47), *C. leucas* (17), *Negaprion brevirostris* (5), *Carcharinus acronotus* (4), *Mustelus norrisi* (4), *Carcharinus maculipinnis* (3), *C. limbatus* (3), *Sphyrna tiburo* (2) and *Scoliodon terranovae* (1).

REMARKS.—In my 1967 paper (Cressey, 1967a), I discussed the possible variation in body form of this species and whether or not this indicated more than one species. At that time there was not enough available material on which to base definite conclusions. The large collection reported here, however, has confirmed my earlier conclusion that only one species is involved and no evidence to support establishing more than one could be found. The

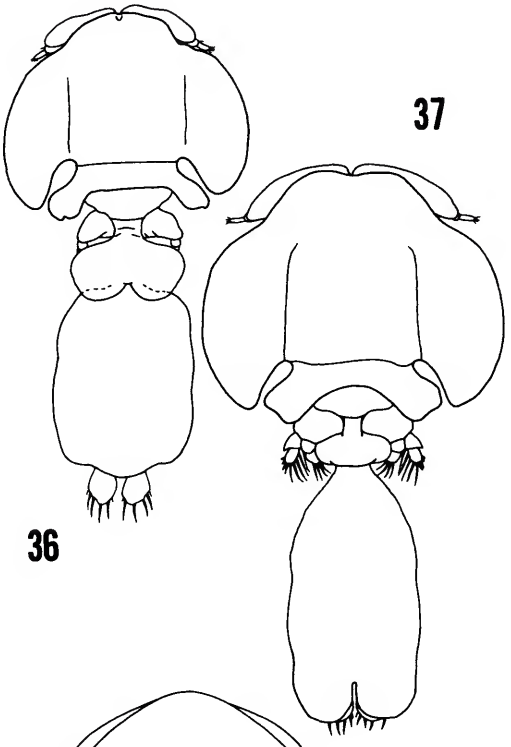


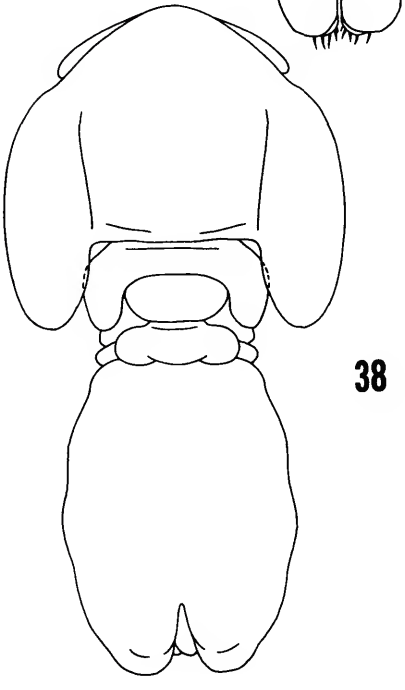
FIGURES 29–33.—*Pandarus cranchii* Leach, female: 29, dorsal. *Pandarus smithii* Rathbun, female: 30, dorsal. Male: 31, dorsal. *Pandarus floridanus* Cressey, female: 32, dorsal. *Pandarus sinuatus* Say, female: 33, dorsal.





FIGURES 34, 35.—*Perissopus dentatus* Steenstrup and Lütken, female: dorsal.





FIGURES 36–38.—*Nesippus orientalis* Heller, female: 36, dorsal. *Nesippus crypturus* Heller, female: 37, dorsal. *Nesippus tigris* Cressey, female: 38, dorsal.

two principal body forms are illustrated in Figures 34 and 35. These two forms, plus intermediates, were found distributed randomly regardless of host or site of attachment on the host. The parasite is most often found attached near the external nares or on the trailing edges of the fins. Those collected from the external nares were predominantly of the type represented in Figure 34, while both forms were found on the fins, frequently side by side on the same animal.

This species was collected during all seasons and its seasonal distribution was dependent on the seasonal occurrence of the various host species.

Nesippus orientalis Heller, 1868

FIGURE 36

MATERIAL.—Ninety-six collections from 11 species of hosts as follows: *Carcharinus milberti* (39), *C. leucas* (26), *C. obscurus* (6), *C. maculipinnis* (6), *Galeocerdo cuvieri* (6), *Carcharinus limbatus* (5), *C. acronotus* (2), *Negaprion brevirostris* (2), *Carcharodon carcharias* (2), *Ginglymostoma cirratum* (1), and *Sphyrna mokarran* (1).

REMARKS.—This species is very common, occurring in 11 of the 16 species of sharks reported here. The copepod is always found in the mouth or on the gill arches of the host, often in clusters of 25 or more individuals.

Nesippus crypturus Heller, 1868

FIGURE 37

MATERIAL.—Forty-five collections from mouths of seven species of sharks as follows: *Carcharinus leucas* (13), *C. milberti* (12), *Galeocerdo cuvieri* (11), *Sphyrna mokarran* (5), *S. lewini* (2), *C. limbatus* (1), and *Carcharodon carcharias* (1). Collections made during all seasons.

REMARKS.—This species is very common, frequently occurring with *N. orientalis* in a variety of inshore species of sharks.

Nesippus tigris Cressey, 1967

FIGURE 38

MATERIAL.—Four collections from nasal sinuses of *Galeocerdo cuvieri*. Two collections made during July 1965, one in December 1966, and the last in January 1967, indicating no seasonal preference.

REMARKS.—This copepod was previously recorded from the same host in Malagasy Republic. It appears to be widely distributed, occurring wherever the host occurs.

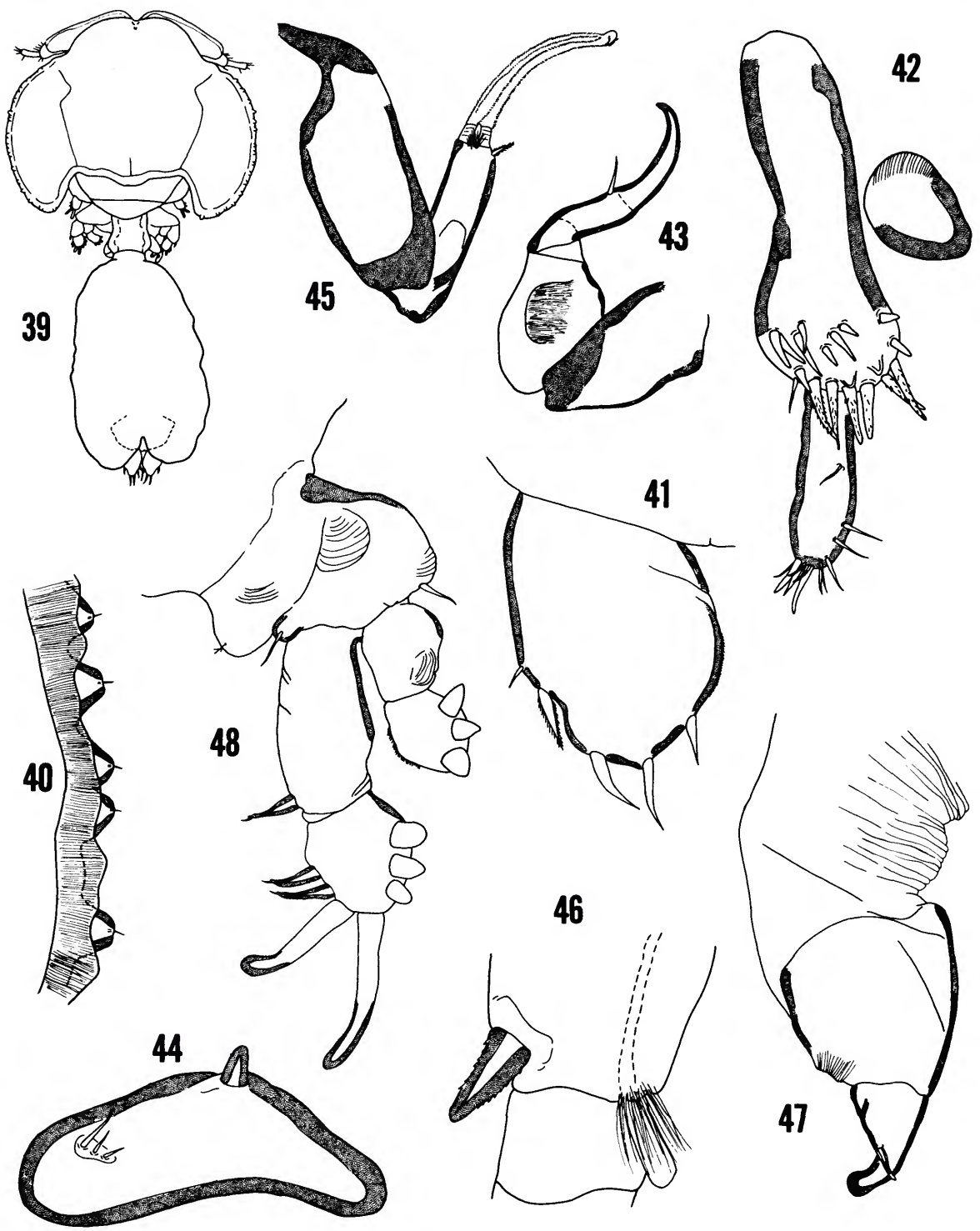
Nesippus nana, new species

FIGURES 39–51

MATERIAL.—Nine collections from gill arches of *Carcharinus milberti*. Holotype ♀ (USNM 128494) and 10 paratype ♀ ♀ (USNM 128495) collected 20 December 1966 at Sarasota, Florida.

FEMALE.—Body form as in Figure 39. Total length 3.77 mm (3.68–3.83 mm) and greatest width 2.12 mm (2.03–2.18 mm) based on an average of 5 specimens. Cephalon wider than long (2.10 × 1.58 mm in 1 specimen). Dorsal surface of cephalon border with conspicuous papillae, each bearing short hair (Figure 40). First thoracic segment fused with cephalon. Segments 2–4 free. No dorsal plates present on segment 4 and not expanded laterally. Abdomen 1-segmented, wider than long (650 μ × 472 μ). Genital segment baglike and about one-half total length, longer than wide (1.58 × .90 mm). Caudal rami (Figure 41) extending beyond posterior edge of genital segment, longer than wide (336 μ × 207 μ), bearing 5 setae, all but one of which is naked; short row of fine spinules along posterior portion of inner edge.

Oral area as in other species of genus. Adhesion pads associated with first antenna, second antenna, and maxilliped; maxilliped pad lateral to mouth tube and very conspicuous. First antenna (Figure 42) 2-segmented, 6 terminal spines of first segment with bristles scattered over surface, all other spines and setae naked. Second antenna (Figure 43) with clawlike terminal segment bearing single seta near midpoint along inner edge, weak articulation at this point suggesting fusion of 2 segments; penultimate segment with adhesion pad. Mouth tube and mandible as in other members of genus, mandible with 10 teeth. First maxilla (Figure 44) with group of 3 small setae near anterior end and short stout spine near outer midmargin. Second maxilla (Figure 45) with terminal segment in form of weak claw, tip bulbous, entire segment bearing longitudinal rows of fine spinules; penultimate segment



FIGURES 39–48.—*Nesippus nana*, new species, female: 39, dorsal; 40, edge of cephalon; 41, caudal ramus; 42, first antenna; 43, second antenna; 44, first maxilla; 45, second maxilla; 46, distal portion of second segment of second maxilla; 47, maxilliped; 48, leg 1.

bearing short spine and patch of hairs at distal end (Figure 46); an internal canallike structure present within segment and terminating at distal patch of hairs. Maxilliped (Figure 47) with terminal segment in shape of thumblike claw; when chela is closed, claw fits into depression on opposing segment.

Legs 1–4 biramose. Spine and seta formula as follows:

	Leg 1		*Leg 2*		*Leg 3*		*Leg 4*	
	exo	*end*	*exo*	*end*	*exo*	*end*	*exo*	*end*
Seg. 1	I:0	0:0	I:1	0:1	I:1	0:1	IV	0
Seg. 2	IV:3	3	IV:5	7	IV:4	4		

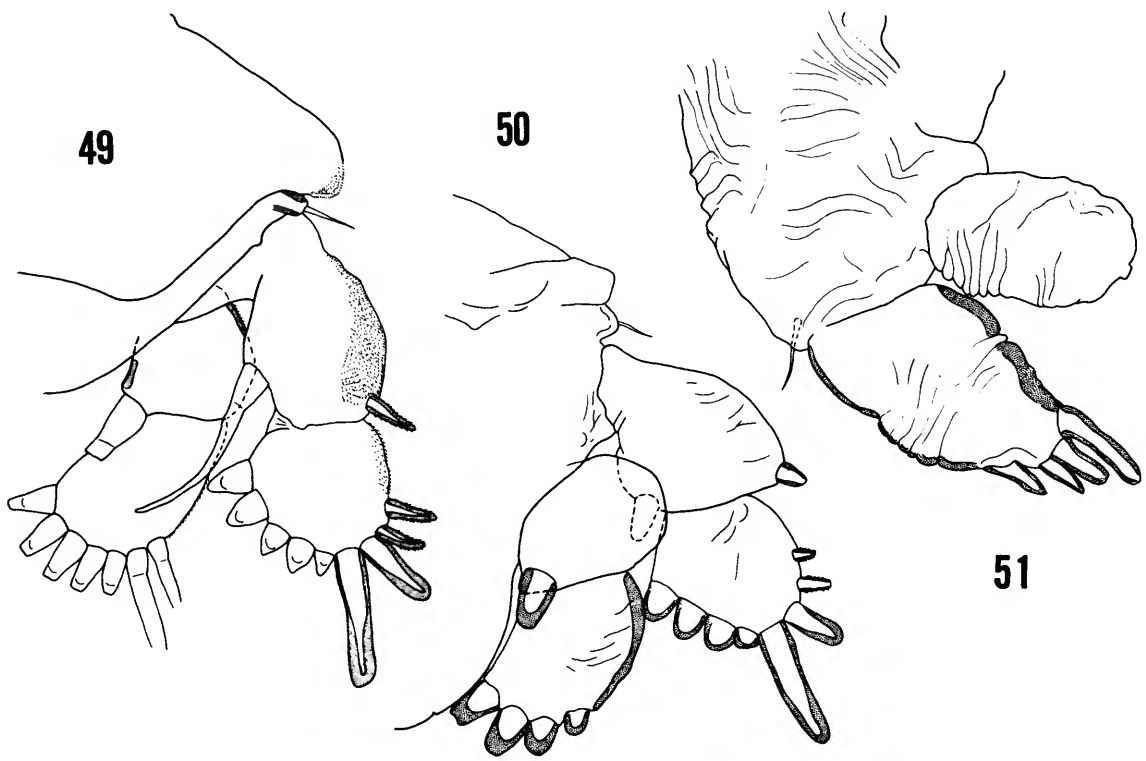
Leg 1 (Figure 48) exopod 2-segmented; spine on outer terminal corner of first segment with subdistal accessory spinule, proximal 2 spines of terminal segment same, 2 terminal spines fingerlike, setae pinched off and shortened: endopod 2-segmented, terminal setae shortened. Leg 2 (Figure 49) rami 2-segmented; exopod with patch of spinules on outer margins of both segments, no accessory spinule on outer spines, setae shortened. Leg 3 (Figure 50) similar to leg 2 except for lack of spinules along outer edges of exopod segments and reduction in number of setae. Leg 4 (Figure 51) rami 1-segmented, surface of leg wrinkled and with many folds; exopod bearing 4 fingerlike spines distally, endopod unarmed except for small knob at tip. Leg 5 represented by 2 setae located lateral to abdomen. Leg 6 absent. Most setae present on legs 1–3 shortened. Those setae still entire have conspicuous constriction near base. Apparently distal portion breaks off at this point and seta is reduced to short blunt process. Blunt processes would function more effectively by aiding animal in movement over rough surface (gill bar) of host.

Egg strings long and straight.

MALE.—Unknown.

ETYMOLOGY.—The species name *nana* refers to small size of this species when compared with others of genus, except *N. vespa*.

REMARKS.—This species is most closely related to *N. crypturus*. It can, however, be separated from



FIGURES 49–51.—*Nesippus nana*, new species, female: 49, leg 2; 50, leg 3; 51, leg 4.

it by the form of the thoracic segment bearing leg 4. In *crypturus* this segment is expanded laterally near the area of attachment of the leg, whereas in *nana* it is not. It can be further separated from *crypturus* by the presence in *crypturus* of a plumose seta on the exopod of leg 4 and the pointed tips on the four spines; *in nana* there is no plumose seta present and the spines are fingerlike. In *crypturus* the caudal rami usually do not extend beyond the genital segment, whereas in *nana* they extend well beyond. It can be separated from *orientalis* by the presence of dorsal plates on the fourth thoracic segment of *orientalis,* from *tigris* by the absence of fingerlike spines on legs 1–4 of *tigris,* from *vespa* by the presence of setae on the fourth leg endopod of *vespa.*

Family EUDACTYLINIDAE Yamaguti, 1963

Eudactylina pollex Cressey, 1967

FIGURES 52, 53

MATERIAL.—Three collections from gills of *Sphyrna mokarran* and one collection from *S. lewini.*

REMARKS.—This species was described by Cressey (1967b) from Malagasy Republic from the gills of *S. mokarran.* Its occurrence in Florida indicates that it may be worldwide in distribution and specific to hammerhead sharks.

The dorsal aspect of the female is represented by Figure 52. The species can be separated from the others of the genus found in Florida Gulf of Mexico waters by the nature of the exopod of leg 2 (Figure 53); in *E. pollex* it is relatively short, whereas in the other species it is very long (Figure 56).

Eudactylina longispina Bere, 1936

FIGURE 54

MATERIAL.—A single collection from gill filaments of *Sphyrna tiburo* collected in Tampa Bay 15 January 1968.

REMARKS.—This species was reported by Bere (1936) and Pearse (1952a) from the same host as cited above, indicating a possible host specificity. So far it has been collected only in the Gulf of Mexico.

Females of *E. longispina* superficially resemble *E. pollex* in dorsal aspect. Consequently no habit figure of *longispina* is included here. It can be most easily distinguished from *E. pollex* and other species of the genus by the unusually long spine on the endopod of leg 4 (Figure 54). Like *E. pollex* the first antenna of *E. longispina* does not bear the clawlike spine on the second segment found in the other species of *Eudactylina* reported here.

Eudactylina pusilla Cressey, 1967

FIGURES 55, 56

MATERIAL.—Eight collections from gill filaments of *Galeocerdo cuvieri.*

REMARKS.—This species is characterized by the presence of spinules on the body surface (Figure 55) and the prominent lobe on the exopod of leg 2 (Figure 56).

This copepod was previously reported (Cressey 1967b.) from the same host in Malagasy Republic, indicating a probable circumglobal distribution and definite host specificity.

The species was collected during all seasons of the year.

Eudactylina spinifera Wilson, 1932

FIGURE 57

MATERIAL.—Five collections from gills of *Carcharinus milberti* and one collection from *C. acronotus.*

REMARKS.—This copepod was described by Wilson from material collected from *C. milberti.* Bere (1936) reported the species collected in the Gulf of Mexico from *C. obscurus.*

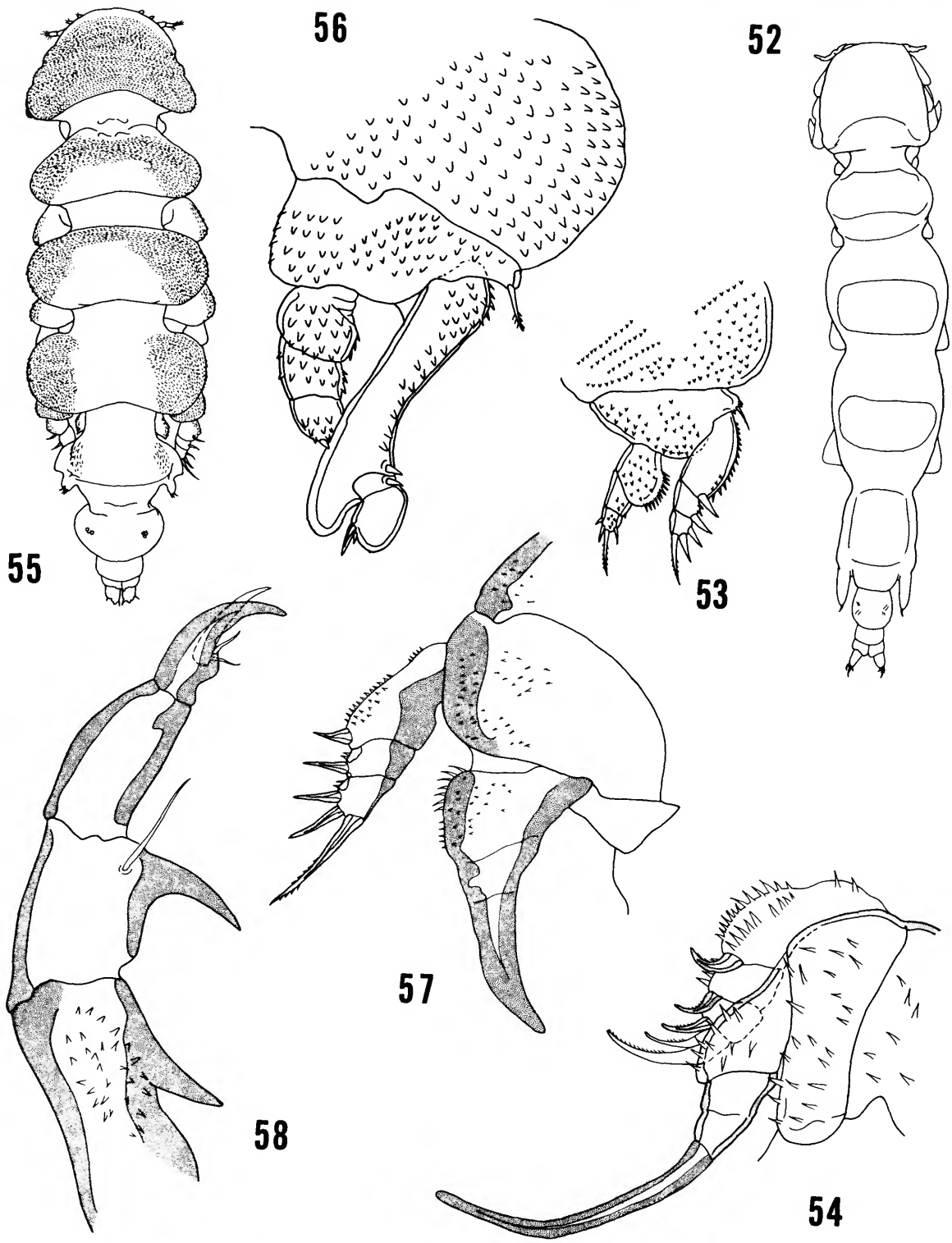
This species can be separated from the others of the genus cited in this paper by the clawlike nature of the leg 4 endopod (Figure 57).

Eudactylina aspera Heller, 1868

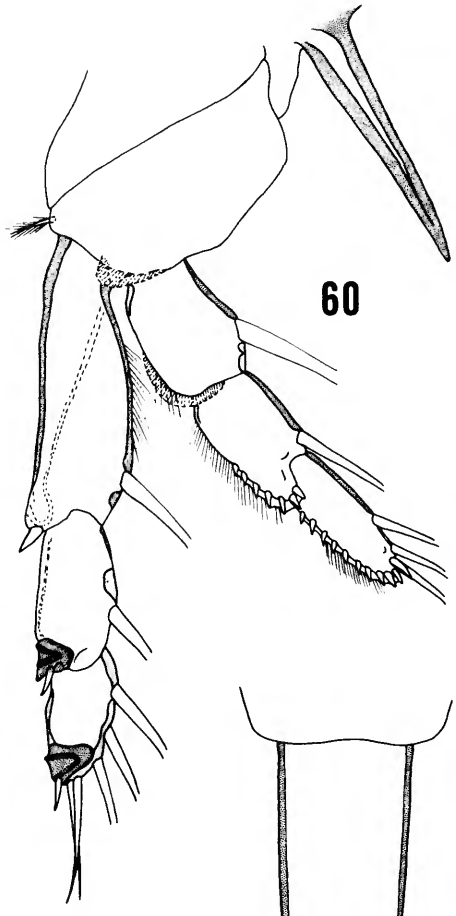
FIGURE 58

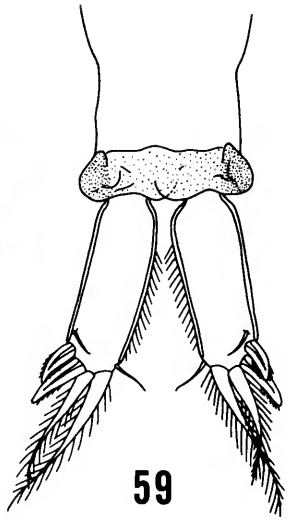
MATERIAL.—A single collection from gill filaments of *Carcharinus limbatus* during September 1966.

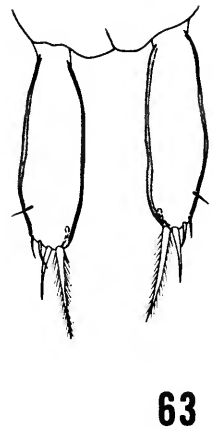
REMARKS.—This species looks superficially similar to *E. pusilla,* but can be characterized by the nature of the second antenna (Figure 58) with accessory

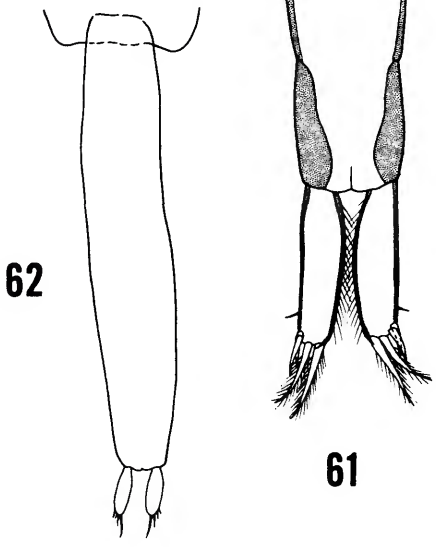


FIGURES 52–58.—*Eudactylina pollex* Cressey, female: 52, dorsal; 53, leg 2. *Eudactylina longispina* Bere, female; 54, leg 4. *Eudactylina pusilla* Cressey, female: 55, dorsal; 56, leg 2. *Eudactylina spinifera* Wilson, female: 57, leg 4. *Eudactylina aspera* Heller, female: 58, second antenna.









FIGURES 59–63.—*Kroyeria gemursa* Cressey, female: 59, end of abdomen and caudal rami. *Kroyeria spatulata* Pearse, female: 60, leg 4. *Kroyeria dispar* Wilson, female: 61, abdomen and caudal rami. *Kroyeria papillipes* Wilson, female: 62, abdomen and caudal rami; 63, caudal rami.

spiniform processes on the first two segments and a patch of prominent spinules on the basal segment.

Kroyeria gemursa Cressey, 1967

FIGURE 59

MATERIAL.—Four collections from between gill filaments of *Sphyrna mokarran.*

REMARKS.—This species was described from the same host cited above, collected in the Indian Ocean. This indicates a possible host specificity and cosmopolitan distribution.

Kroyeria gemursa can be separated from other members of the genus by the sclerotized area at the posterior end of the abdomen (Figure 59).

Kroyeria gracilis Wilson, 1932

MATERIAL.—A single collection from between gill filaments of *Carcharinus obscurus.*

REMARKS.—This species has been reported from a variety of shark species from the Atlantic and Gulf of Mexico by Wilson (1932) and Bere (1936) respectively, and apparently is not very host specific.

Additional material is needed, however, before a definitive conclusion can be drawn.

The species is characterized by bearing only a few lateral spines on the inner edges of the last two endopod segments of legs 1–4 (similar to *Kroyeria longicauda,* new species, Figures 70–73). It can be easily separated from *longicauda* by the length-width ratio of the caudal rami (Table 1) and by the presence of a hyaline fringe on the rami of the new species.

Kroyeria spatulata Pearse, 1948

FIGURE 60

MATERIAL.—Nine collections from between gill filaments of *Carcharinus leucas* and a single collection from *Negaprion brevirostris.*

REMARKS.—This species reported from *Scoliodon terraenovae, Carcharias littoralis,* and *Carcharinus limbatus* by Pearse (1948 and 1952b) is apparently common on many shark species of the western Atlantic and Gulf of Mexico.

This species is characterized by the saddlelike sclerotizations on the outer distal corners of segments 2 and 3 of the fourth leg exopod (Figure 60).

Kroyeria dispar Wilson, 1935

FIGURE 61

MATERIAL.—Fifteen collections from between gill filaments of *Galeocerdo cuvieri* collected during all seasons.

REMARKS.—This species was reported by Cressey (1967b) from the same host as above from Malagasy Republic. In that paper (1967) I stated that the species had been previously described by Wilson (1935) from *Squalus.* This record was cited in Yamaguti (1963). Subsequent investigation has revealed that Wilson's (1935) original host designation was "shark," hence no host name should be associated with that record. Consequently, the only records citing a specific host name record this species from *G. cuvieri,* the tiger shark.

As in the following species, there are no prominent spines on the interpodal plates of legs 1–4 of *K. dispar.* On the basis of this character and the sclerotized distal portion of the abdomen (Figure 61), *K. dispar* can be separated from the other members of the genus.

This species occurs during all seasons, frequently in combination with *K. papillipes.* An analysis of the occurrence of these two species shows *K. dispar* to be predominantly a winter inhabitant and *K. papillipes* to occur in heavier infestations during the early summer.

It was also evident that for *K. dispar* and *K. papillipes* the average size of individuals of each species is generally greater during periods when infestations are heaviest. The average size varies by as much as 2 mm from one season to the other. Because collections were not made with this analysis in mind and were made by more than one collector, the absolute data may be unreliable and is not presented here. A cursory analysis, however, revealed the trends cited above.

Kroyeria sphyrnae Rangnekar, 1957

MATERIAL.—Two collections from between gill filaments of *Carcharinus acronotus.*

REMARKS.—This species, described by Rangnekar (1957) from *Sphyrna* sp. in India, is easily separated from the other species cited from Florida by its small size (Table 1) and because the last two segments of the fourth leg endopod bear only two or three lateral spinules.

The two recorded host species suggest that this copepod is not very host specific.

Kroyeria papillipes Wilson, 1932

FIGURES 62, 63

MATERIAL.—Seventeen collections from between gill filaments of *Galeocerdo cuvieri.*

REMARKS.—This species described from the same host as reported here may well be specific to that species of shark. Wilson also records a single female from *Sphyrna zygaena.* This specimen was not deposited in the Smithsonian collections, but a specimen from the same host collected in 1911 and identified by Wilson as *K. lineata* is on deposit. It seems possible that Wilson's record of *K. papillipes* from the hammerhead shark is in error.

In the collections of *Kroyeria* from *Galeocerdo cuvieri,* this species occurred with *K. dispar* in 9 of 23 collections. It seems apparent that both of these species are quite host specific and, since both species lack the prominent interpodal spines found on all

other species of *Kroyeria,* that they are closely related. *Kroyeria papillipes* can be easily separated from *K. dispar* by the nature of the abdomen and caudal rami (compare Figures 61, 62, and 63). *Kroyeria papillipes* occurred in collections made during all seasons of the year.

Kroyeria longicauda, new species

FIGURES 64–77

MATERIAL.—Two collections containing 10 ♀ ♀ collected from between gill filaments of *Carcharinus limbatus.* Holotype (USNM 128496) and 8 paratypes (USNM 128497) from above host collected 20 August 1965 at Sarasota, Florida.

FEMALE.—Body form as in Figure 64. Total length 3.7 mm. Greatest width 0.6 mm measured at widest part of cephalon. Cephalon slightly wider than long (0.6 × 0.5 mm). Thoracic segments bearing legs 2–4 free. Segment bearing leg 1 (fused with cephalon) with well-developed aciculum 475 μ in length and bearing a subapical accessory process (Figure 65). Genital segment long (2.3 mm), comprising about two-thirds body length. Abdomen 3-segmented, last 2 segments incompletely divided; entire abdomen 0.45 mm long. Caudal rami (Figure 66) about 5 times as long as wide (224 μ × 45 μ), each ramus with outer lateral fringe and bearing 6 setae, 3 naked subterminal and 3 plumose terminal, longest seta 51 μ long.

Oral area as in other members of genus. First antenna (Figure 67) 8-segmented, each armed as in the figure; terminal segment with 12 setae and an aesthete at its tip (Figure 68). Second antenna (Figure 69) of usual chelate type; movable claw fits within cup-shaped tip on immovable claw (Figure 70), short spine on inner border of movable claw. Mouth tube without lateral lobes. Mandible (Figure 71) with few teeth, prominent apical tooth, 2 small subapical teeth, and 2 larger proximal teeth. Second maxilla (Figure 72) with fringed apical process, spinose subapical knob, and subapical patch of hairs. Maxilliped (Figure 73) terminal segment in form of prominent recurved claw.

Legs 1–4 biramose. Rami 3-segmented. Spine and seta formula as follows:

	Leg 1		*Leg 2*		*Leg 3*		*Leg 4*	
	exo	*end*	*exo*	*end*	*exo*	*end*	*exo*	*end*
Seg. 1	I:1	0:1	I:1	0:1	I:1	0:1	I:1	0:1
Seg. 2	0:1	0:0	I:1	0:0	I:1	0:0	I:1	0:1
Seg. 3	II:4	6	III:4	6	III:4	4	II:4	3

First leg (Figure 74) exopod armed as in figure; endopod first segment with fringe (usually row of hairs on other species) on outer margin, 5 spinules on outer margin of second segment, and 4 small spinules on outer margin of terminal segment. Leg 2 (Figure 75) armed as in leg 1 except for outer spine on second exopod segment and additional spine on last segment. Leg 3 (Figure 76) armed as in leg 2 except for reduced number of setae on terminal segment of exopod. Leg 4 (Figure 77) as in leg 3 except for inner seta present on second segment of exopod and 1 less seta on terminal segment. Leg 5 represented by group of 4 setae on lateral midmargin of genital segment; setae in 2 groups of 2 each. Leg 6 in other species represented by a single seta at posterior corner of genital segment. No seta at this site could be found in the examined specimens of this species, but it could have been broken off.

Egg strings uniseriate.

MALE.—Unknown.

ETYMOLOGY.—The name *longicauda* refers to length of caudal rami relative to width.

REMARKS.—This species can be separated from the other members of the genus by the 5:1 length-to-width ratio of the caudal rami, the hyaline fringe on outer lateral margin of each ramus, and the nature of the lateral spinules on the last two segments of the endopods of legs 1–4.

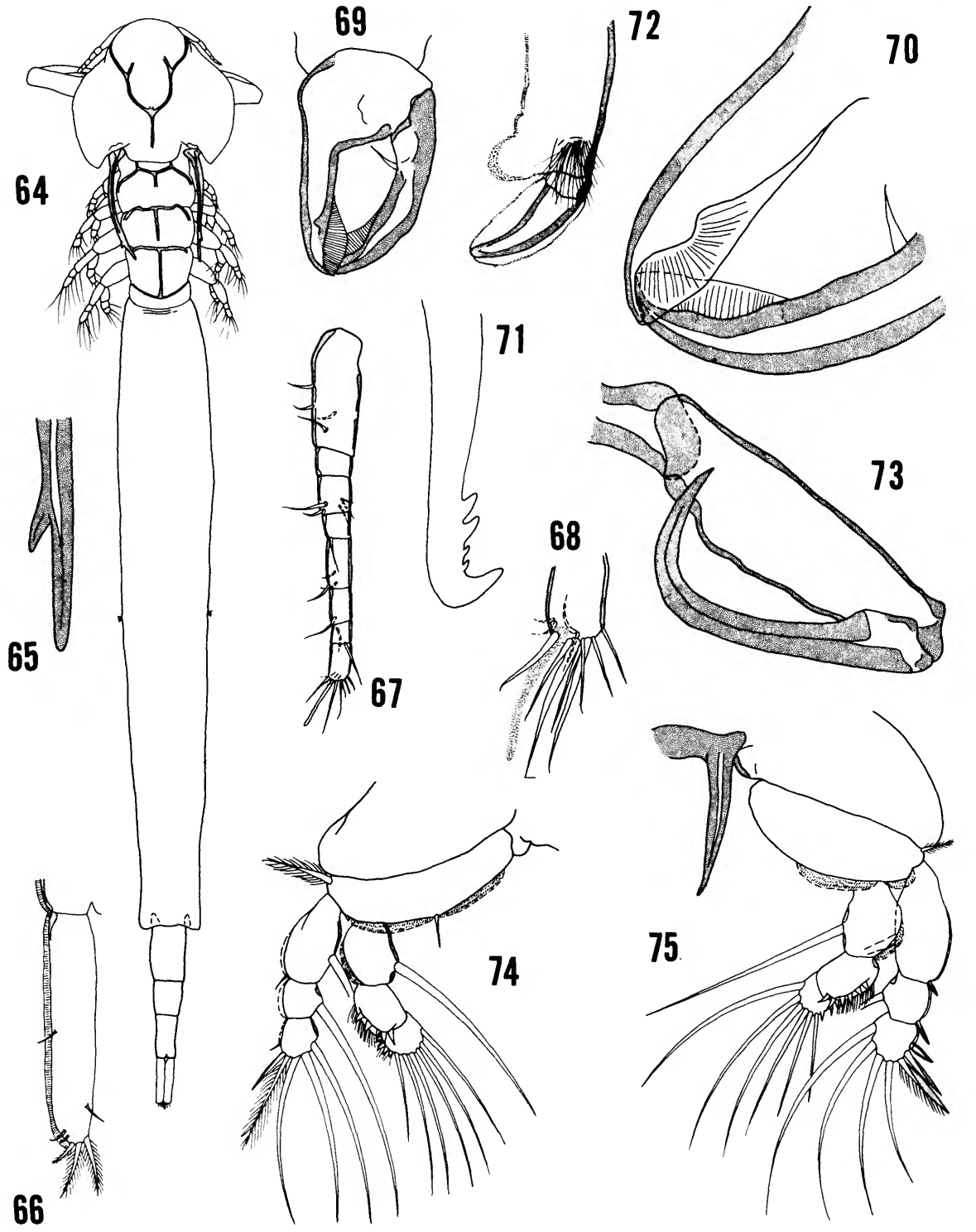
TABLE 1.—*Total length and caudal rami measurements of representative females of the Florida species of* Kroyeria

Species	*Total length* (mm)	*Caudal rami* length - width(μ) - ratio
dispar	10.5	421 x 131 3.2:1
papillipes	10.0	200 x 59 3.4:1
gemursa	9.7	264 x 94 2.8:1
spatulata	7.3	280 x 65 4.3:1
gracilis	6.5	266 x 74 3.6:1
longicauda	3.7	224 x 45 5:1
sphyrna	2.2	121 x 30 4.1:1

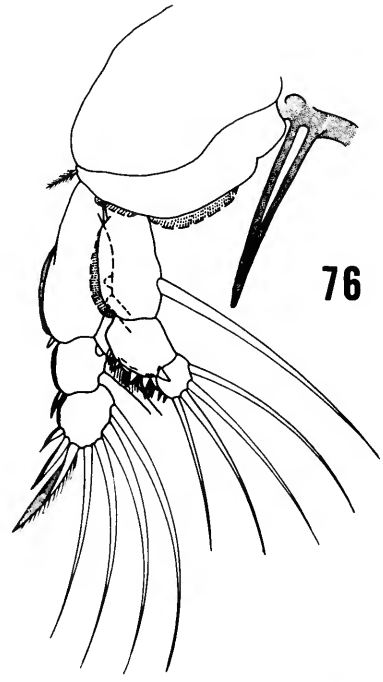
Kroyerina scottorum, new species

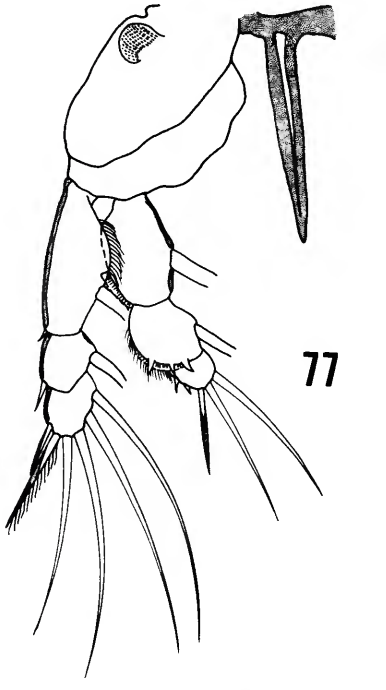
FIGURES 78–92

MATERIAL.—Holotype ♀ (USNM 128498) and 7 paratypes (USNM 128499) from nasal fossae of a



FIGURES 64–75.—*Kroyeria longicauda*, new species, female: 64, dorsal; 65, tip of aciculum; 66, caudal ramus; 67, first antenna; 68, tip of last segment of first antenna; 69, second antenna; 70, tip of second antenna chela; 71, mandible; 72, distal end of second maxilla; 73, maxilliped; 74, leg 1; 75, leg 2.





FIGURES 76–77.—*Kroyeria longicauda*, new species, female: 76, leg 3; 77, leg 4.

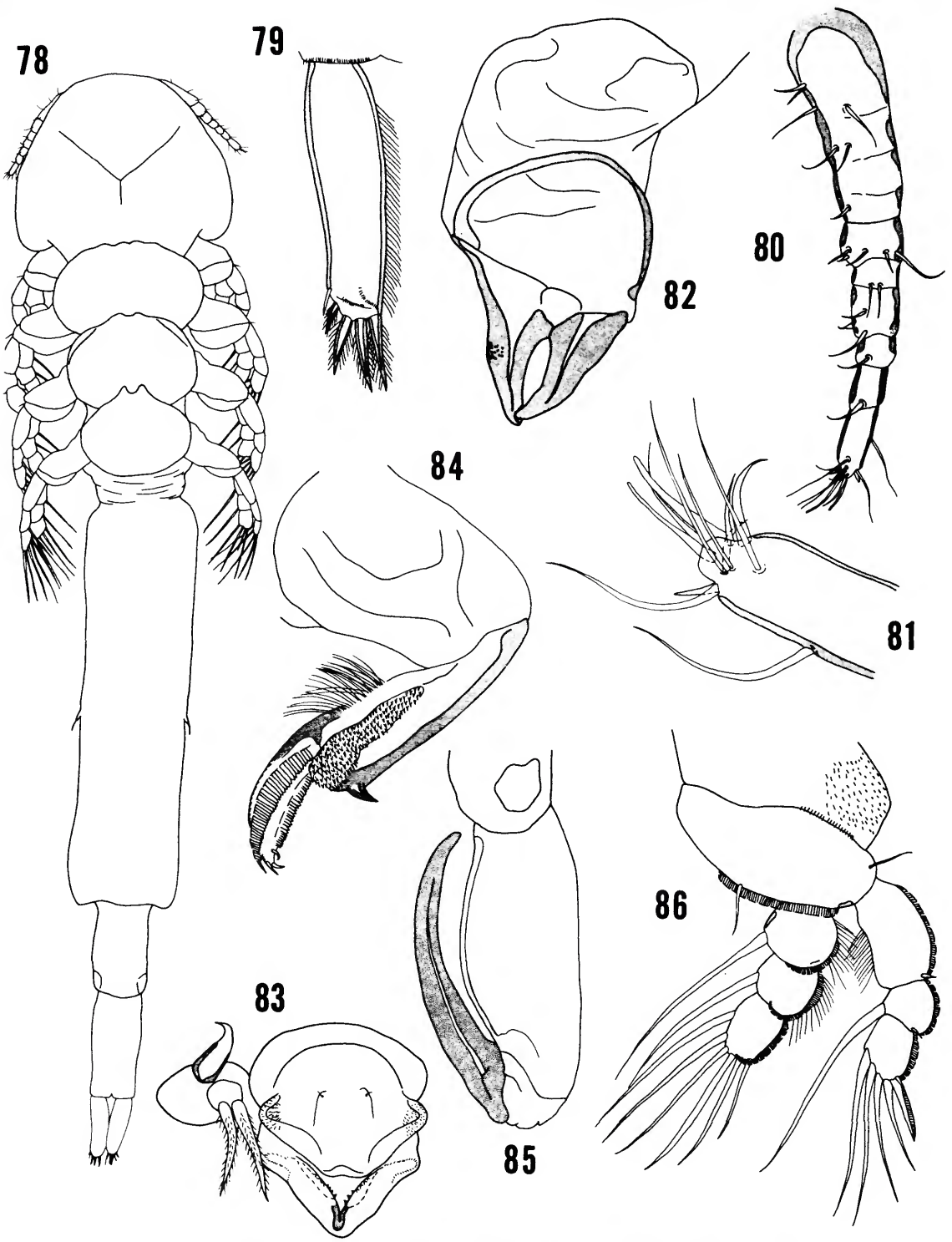
single *Sphyrna lewini* collected at Sarasota, Florida, 10 August 1965.

FEMALE.—Body form as in Figure 78. Total length 4.1 mm. Greatest width 0.8 mm measured at widest part of cephalon. Cephalon slightly wider than long. Thoracic segment bearing first pair of legs fused with head. Thoracic segments bearing legs 2–4 free, each about equal in length, but second and third slightly narrower than the one before. Genital segment comprising nearly half total length (1.9 mm) and of uniform width along entire length (0.65 mm). Abdomen 2-segmented; each segment measuring 0.37 mm and 0.51 mm in length respectively, second segment only slightly narrower than first. Caudal rami (Figure 79) nearly 4 times as long as wide (312 μ × 83 μ) and bearing 3 terminal and 2 outer subterminal spines, innermost terminal spine longest (88 μ); 2 rows of fine spinules present near distal end of ventral surface, 4 terminal spines slightly bifid at tip.

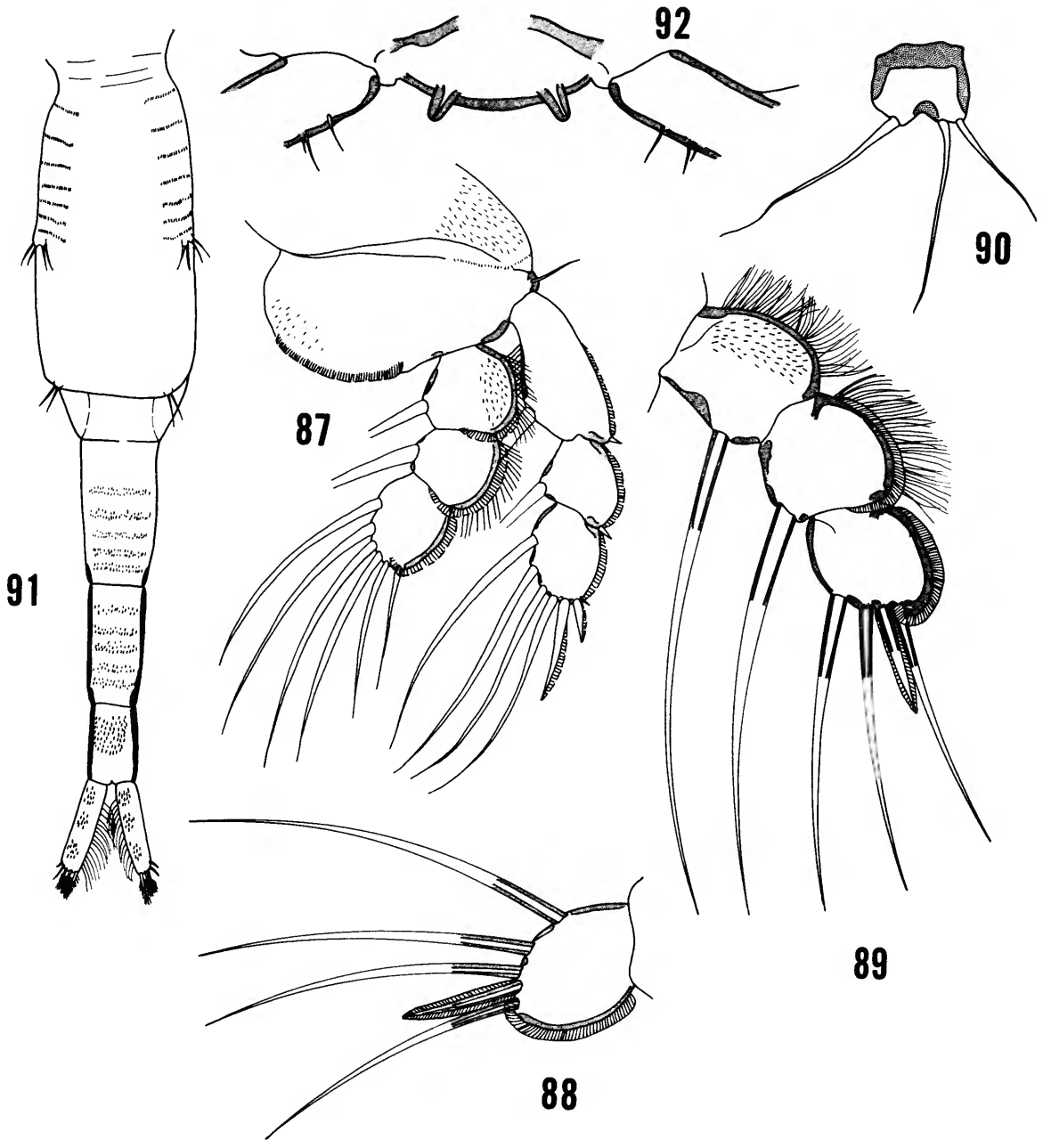
First antenna (Figure 80) with 7 distinct segments, basal segment partially subdivided into 4 segments, each segment with short setae as in figure; tip of antenna (Figure 81) with 3 blunt-tipped setae in addition to normally shaped setae as in figure. Area between bases of first antenna with 2 short hornlike processes. Second antenna (Figure 82) strongly chelate, entire appendage relatively short and stout, strongly developed; tip of movable claw inserts into depression on tip of immovable claw, immovable claw with pigment spots as indicated in figure and short seta on inner edge. Mouth area (Figure 83) with short cone, labrum with lateral spinose knobs. Mandible of usual caligoid type, with 8 teeth. First maxilla (Figure 83) with anteriorly directed hook and posteriorly directed palp, bearing 2 spinulose setae. Second maxilla (Figure 84) apparently 3-segmented, second segment with distal spinose area, patch of long hairs, and broad spine, terminal segment with both edges bearing row of lamellae and tip bearing 3 short spines. Maxilliped (Figure 85) in form of claw as in the figure.

Legs 1–4 biramose. Spine and seta formula as follows:

	Leg 1		*Leg 2*		*Leg 3*		*Leg 4*	
	exo	*end*	*exo*	*end*	*exo*	*end*	*exo*	*end*
Seg. 1	I:0	0:1	I:1	0:1	I:1	0:1	I:1	0:1
Seg. 2	I:1	0:1	I:1	0:1	I:1	0:1	I:1	0:1
Seg. 3	II:4	6	III:4	6	III:4	1:I:3	III:4	1:I:2



FIGURES 78–86.—*Kroyerina scottorum*, new species, female: 78, dorsal; 79, caudal ramus; 80, first antenna; 81, tip of first antenna; 82; second antenna; 83, first maxilla and mouth tube; 84, second maxilla; 85, maxilliped; 86, leg 1.



FIGURES 87–92.—*Kroyerina scottorum*, new species, female: 87, leg 2; 88, last endopod segment of leg 3; 89, leg 4 endopod; 90, leg 5. Male: 91, genital segment, abdomen, and caudal rami, ventral; 92, rostral area, ventral.

Leg 1 (Figure 86) coxopod with patch of spinules on outer distal corner; basipod with outer and inner setae; both rami with striated fringe on outer edge of each segment, no patches of spinules, setae arranged as in figure. Leg 2 (Figure 87) coxopod with patch of spinules as in leg 1; basipod with outer seta only and fringe and patch of spinules along inner margin; rami with fringes on each segment as in leg 1, setae arranged as in figure and each sclerotized on basal one-third, proximal two-thirds areolate in appearance, path of spinules on first endopod segment. Leg 3 similar to leg 2 except last endopod segment (Figure 88) with terminal fringed spine between an outer seta and 3 inner setae. Leg 4 similar to leg 2 except endopod (Figure 89) first segment lateral hairs in 2 separate groups and terminal segment with fringed spine between outer seta and 2 inner setae. Leg 5 (Figure 90) short sclerotized segment bearing 3 setae, inserted on midlateral margin of genital segment (Figure 78). Leg 6 absent.

No specimens were ovigerous.

MALE.—Body form generally as in female. Total length 3.4 mm. Greatest width 0.6 mm, measured at widest part of cephalon. Genital segment (Figure 91) relatively shorter than in female (measuring 1087 $\mu \times 508\ \mu$) and bearing 7 rows of fine spinules along each edge anterior to leg 5 as shown in figure. Abdomen (Figure 91) 3-segmented, each segment measuring 464 μ, 363 μ, and 247 μ in length respectively, each bearing patches of spinules as in figure. Caudal rami as in female except for patches of spinules on ventral surface as in figure.

Cephalic and thoracic appendages as in female except leg 5 of male bears 4 long setae rather than 3. Leg 6 represented by 2 long setae at posterior outer corners of genital segment. Area between bases of first antennae (Figure 92) with 2 hornlike processes as in female.

ETYMOLOGY.—This species is named for Roberta and Hugh Scott, whose collecting efforts at times when the author was not at the Mote Marine Laboratory significantly added to the material incorporated in this paper.

REMARKS.—This third member of the genus *Kroyerina* can be separated from the other two by the following facts. The ratio of the length to width of the caudal rami of the three species is as follows: *K. scottorum* 4:1 ($312\mu \times 83\mu$), *K. elongata* 2.5:1 ($295\mu \times 112\mu$), *K. nasuta* 3:1 ($192\mu \times 62\mu$). The inner terminal spine on the caudal ramus of *K. nasuta* is twice as long as the next one to it, the outermost of the three terminal setae is spinelike. The labrum of *K. nasuta* has no lateral spinose lobes (present in both *K. elongata* and *scottorum*).

Nemesis lamna Risso, 1826

FIGURE 93

MATERIAL.—Two collections from *Carcharodon carcharias* and a single collection from *Cetorhinus maximus*?. (According to Stewart Springer, U.S. Bureau of Commercial Fisheries, there is some question regarding the specific determination of this shark.)

This copepod is worldwide in distribution and has been reported many times from lamnid sharks. It has been recently redescribed by Cressey (1968).

Nemesis atlantica Wilson, 1922

MATERIAL.—Fourteen collections from gills of *Carcharinus leucas,* four collections from *C. limbatus,* two collections from *C. maculipinnis,* one collection from *C. acronotus,* and one collection from *Sphyrna mokarran.*

REMARKS.—This copepod has been reported a number of times from several species of sharks. It was collected in Florida throughout the year, showing no seasonal preference.

Nemesis pilosus Pearse, 1951

MATERIAL.—Nine collections from gills of *Negaprion brevirostris,* one collection from *Carcharinus maculipinnis,* and one collection from *C. limbatus.*

REMARKS.—This copepod was described by Pearse (1951) from *Carcharias littoralis* from the Bahamas and has not been reported since.

This species can be separated from *N. atlantica* by the armature of leg 3. In *N. pilosus* the last endopod segment bears five spines, whereas in *N. atlantica* this same segment bears only four. The spines on legs 2 and 3 of *N. pilosus* are much longer than those of *N. atlantica.*

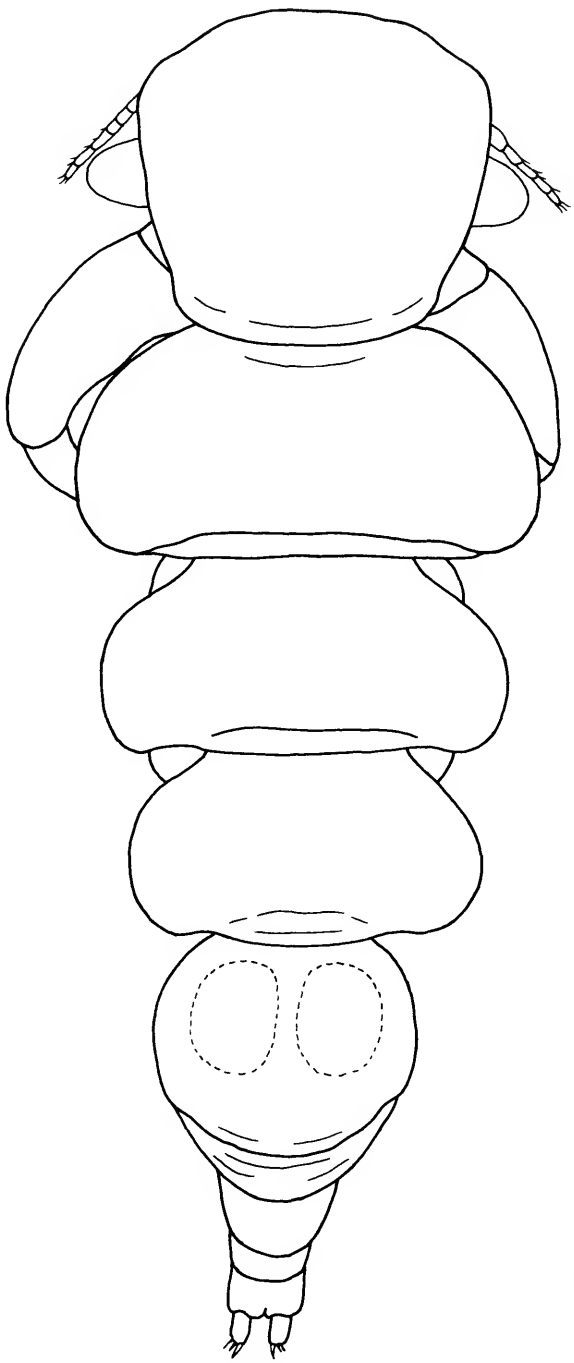


FIGURE 93.—*Nemesis lamna* Risso, female: dorsal.

Nemesis spinulosus, new species

FIGURES 94–110

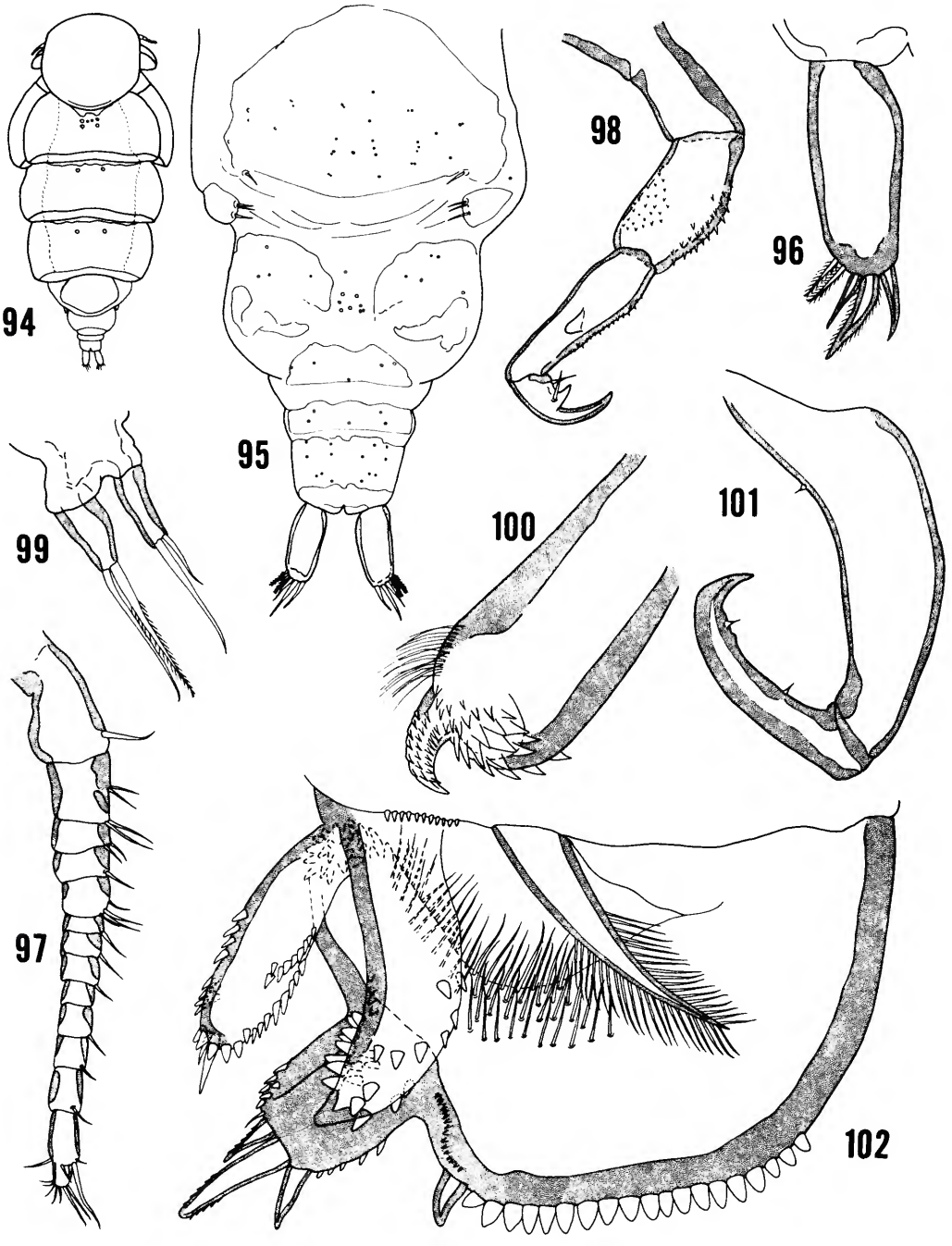
MATERIAL.—Three hundred and six specimens (303 ♀♀, 3 ♂♂) collected from gills of 27 *Carcharinus milberti;* an additional 2 ♀♀ from gills of a single *Carcharinus obscurus.* Holotype ♀ (USNM 128500) and 31 paratype ♀♀ (USNM 128501) collected 17 December 1966 from *C. milberti,* Sarasota, Florida.

FEMALE.—Body form as in Figure 94. Total length 2.98 mm, based on an average of 4 specimens (2.93–3.00 mm). Greatest width 1.18 mm (1.12–1.20 mm). Cephalon only slightly longer than wide (1.2 × 1.1 mm), posterior margin overlapping first free thoracic segment. Thoracic segments bearing legs 2–5 free and measuring 1.5, 1.5, 1.3, and .87 mm in width respectively. Genital segment (Figure 95) wider than long (.54 × .35 mm). Abdomen 3-segmented, segments measuring .35, .29, and .25 mm in width respectively; third segment about as long as first and second combined. Caudal rami (Figure 96) each with 5 terminal setae, inner 3 much stouter than outer 2; each ramus about twice as long as wide (188μ × 94μ) and bearing row of hairs on inner margin (not seen on all specimens examined).

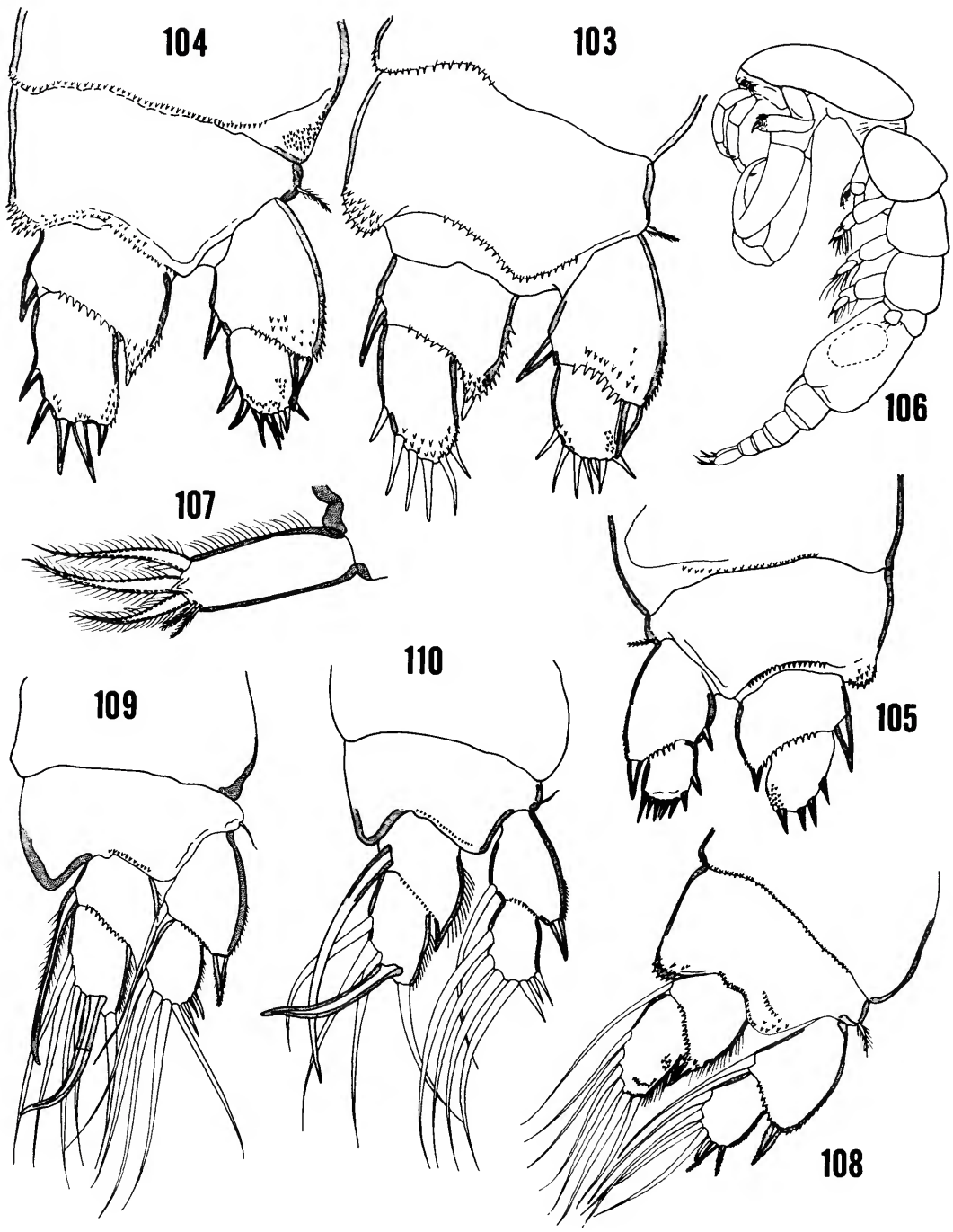
First antenna (Figure 97) 13–14 segmented (terminal segment incompletely divided) and armed as in figure. Second antenna (Figure 98); second segment with 2 patches of spinules, inner patch composed of heavier spinules than outer patch; third segment with patch of spinules along inner border; terminal segment in form of claw bearing 2 short setae and median accessory process. Mandible of usual caligoid type, bearing 9 teeth at tip. First maxilla (Figure 99) biramose, each ramus armed with 2 setae as in figure; each seta sclerotized about three-fourths of its length, distal fourth weak. Second maxilla with inner patch of heavy spines, outer patch of hairs, and short spinose claw at tip (Figure 100). Maxilliped (Figure 101) in form of stout claw, both segments with broad-based setae as in figure.

Legs 1–4 biramose, all rami 2-segmented. Spine and seta formula as follows:

	Leg 1		*Leg 2*		*Leg 3*		*Leg 4*	
	exo	*end*	*exo*	*end*	*exo*	*end*	*exo*	*end*
Seg. 1	I:0	0:I	I:I	0:I	I:I	0:I	I:I	0:I
Seg. 2	III	II	VII or VIII	VI	VII or VIII	V	VII or VIII	IV



FIGURES 94–102.—*Nemesis spinulosus*, new species, female: 94, dorsal; 95, genital segment and abdomen, ventral; 96, caudal ramus; 97, first antenna; 98, second antenna; 99, first maxilla; 100, tip of second maxilla; 101, maxilliped; 102, leg 1.



FIGURES 103–110.—*Nemesis spinulosus*, new species, female: 103, leg 2; 104, leg 3; 105, leg 4. Male: 106, lateral; 107, caudal ramus; 108, leg 2; 109, leg 3; 110, leg 4.

Leg 1 (Figure 102) modified as in other species of genus: exopod 2-segmented, each segment bearing broad spinules as in figure; endopod first segment recurved toward exopod bearing row of broad spinules along outer border, patch of setules on inner border, and spinose knob at tip; second segment short, bearing 3 stout spines terminally and few spinules on each lateral margin. Leg 2 (Figure 103) with rows and patches of spinules on all segments as in figure; each ramus bearing long terminal spines. Leg 3 (Figure 104) similar to leg 2 except that terminal spines on each ramus are shorter and more heavily sclerotized. Leg 4 (Figure 105) as in preceding 2 legs except for fewer spinules on rami and shorter terminal spines. Leg 5 (Figure 95) 1-segmented; plumose seta arising near base of free segment, free segment bearing 3 small, terminal setae. Leg 6 absent.

Egg strings uniseriate, long.

MALE.—Body form as in Figure 106. Total length 2.63 mm. Greatest width 0.68 mm measured at widest part of cephalon. Cephalon slightly longer than wide (0.82 × 0.68 mm), comprising about one-fourth body length. Thoracic segments bearing legs 2–4 free, measuring 0.60, 0.60, and 0.56 mm in width respectively, each segment somewhat overlapping anterior portion of following segment. Genital segment as long as wide (0.52 × 0.52 mm), narrowest anteriorly. Abdomen 4-segmented, measuring 354 μ, 271 μ, 201 μ and 201 μ in width and 295 μ, 177 μ, 130 μ, and 130 μ in length respectively. Caudal ramus (Figure 107) armed as in female, but each ramus somewhat longer in relation to width (207 μ × 83 μ), all spines and setae plumose.

Cephalic appendages as in female except second segment of second antenna of male has fewer spines and no spinules on third segment.

Leg 1 as in female. Legs 2–4 with spine and seta formula as follows:

	Leg 2		*Leg 3*		*Leg 4*	
	exo	*end*	*exo*	*end*	*exo*	*end*
Seg. 1	I:1	0:1	I:1	0:1	I:1	0:1
Seg. 2	III:4	6	III:5	6	III:	5

Leg 2 (Figure 108) with patches of spinules as indicated in figure, all setae unmodified and plumose. Leg 3 (Figure 109) exopod with unmodified spines and setae as figured; endopod first segment inner seta heavily sclerotized and thick throughout entire length, last segment bearing terminal inwardly curved, naked, sclerotized seta in addition to 5 unmodified plumose setae of usual type. Leg 4 (Figure 110) with modified setae on endopod as in leg 3, in addition to usual unmodified setae. Leg 5 (Figure 106) broad lobate segment, bearing 3 terminal setae as in female. Leg 6 broad lobe on outer distal corner of genital segment, bearing 3 setae, innermost longest.

ETYMOLOGY.—The specific name *spinulosus* alludes to presence of spinules on second antenna.

REMARKS.—This species differs from all others of the genus, except *tiburo* Pearse (1952a), by the presence of spinules on the third segment of the second antenna. The holotype of *N. tiburo* (USNM 93702) was compared to this new species and the following differences were noted: only one patch of spinules on the second segment of the second antenna of *N. tiburo,* as compared with two in *N. spinulosus;* only four spines on the endopod of leg 3 of *N. tiburo,* as compared with five in *N. spinulosus;* caudal rami of *N. tiburo* are tear shaped and spaced wide apart with proximal portion narrow, whereas in *N. spinulosus* the rami are close together and of uniform width throughout their lengths.

The variation in number of terminal spines on the exopods of legs 2–4 of 14 females on *N. spinulosus,* all from the same sample, was as follows:

	Leg 2		*Leg 3*		*Leg 4*	
	6 spines	*7 spines*	*7 spines*	*8 spines*	*7 spines*	*8 spines*
No. of specimens	2	12	8	6	3	11

The number of terminal endopod spines was constant.

List of Shark Species and the Copepod Parasites

(Number in parentheses after host name refers to number of sharks from which copepods were removed. Number following copepod name indicates number of collections.)

Carcharinus milberti (69)
- *Alebion lobatus* (30)
- *Alebion carchariae* (37)
- *Paralebion elongatus* (18)
- *Nesippus orientalis* (39)
- *Nesippus crypturus* (12)
- *Nesippus nana* (9)
- *Perissopus dentatus* (47)

Pandarus smithii (5)
Pandarus sinuatus (16)
Nemesis spinulosus (27)
Eudactylina spinifera (5)
Carcharinus obscurus (9)
Alebion carchariae (7)
Nesippus orientalis (6)
Pandarus smithii (1)
Pandarus cranchii (1)
Kroyeria gracilis (1)
Nemesis spinulosus (1)
Carcharinus leucas (42)
Alebion carchariae (11)
Paralebion elongatus (25)
Nesippus orientalis (26)
Nesippus crypturus (13)
Perissopus dentatus (17)
Pandarus smithii (1)
Pandarus cranchii (1)
Pandarus sinuatus (10)
Kroyeria spatulata (9)
Nemesis atlantica (14)
Carcharinus maculipinnis (10)
Alebion carchariae (3)
Nesippus orientalis (6)
Perissopus dentatus (3)
Nemesis pilosus (1)
Nemesis atlantica (2)
Carcharinus limbatus (16)
Alebion carchariae (7)
Paralebion elongatus (3)
Lepeophtheirus eurus (2)
Nesippus orientalis (5)
Nesippus crypturus (1)
Perissopus dentatus (3)
Kroyeria longicauda (2)
Nemesis pilosus (1)
Nemesis atlantica (4)
Eudactylina aspera (1)
Carcharinus acronotus (7)
Nesippus orientalis (2)
Perissopus dentatus (4)
Pandarus sinuatus (1)
Kroyeria sphyrnae (2)
Nemesis atlantica (1)
Eudactylina spinifera (1)
Galeocerdo cuvieri (29)
Alebion carchariae (1)
Alebion gracilis (1)
Nesippus orientalis (6)
Nesippus crypturus (11)
Nesippus tigris (4)
Kroyeria papillipes (17)
Kroyeria dispar (15)
Eudactylina pusilla (8)
Negaprion brevirostris (19)
Alebion carchariae (3)
Paralebion elongatus (9)
Nesippus orientalis (2)
Perissopus dentatus (5)
Pandarus sinuatus (5)
Kroyeria spatulata (1)
Nemesis pilosus (9)
Ginglymostoma cirratum (3)
Nesippus orientalis (1)
Pandarus sinuatus (2)
Sphyrna mokarran (9)
Alebion carchariae (1)
Alebion elegans (3)
Nesippus orientalis (1)
Nesippus crypturus (5)
Kroyeria gemursa (4)
Nemesis atlantica (1)
Eudactylina pollex (3)
Sphyrna lewini (2)
Alebion carchariae (1)
Alebion elegans (1)
Nesippus crypturus (2)
Kroyerina scottorum (1)
Eudactylina pollex (1)
Sphyrna tiburo (3)
Perissopus dentatus (2)
Eudactylina longispina (1)
Mustelus norrisi (4)
Perissopus dentatus (4)
Pandarus sinuatus (1)
Scoliodon terranovae (1)
Perissopus dentatus (1)
Carcharodon carcharias (2)
Nesippus orientalis (2)
Nesippus crypturus (1)
Pandarus smithii (2)
Pandarus cranchii (2)
Pandarus floridanus (2)
Nemesis lamna (2)
Cetorhinus maximus? (1)
Nemesis lamna (1)

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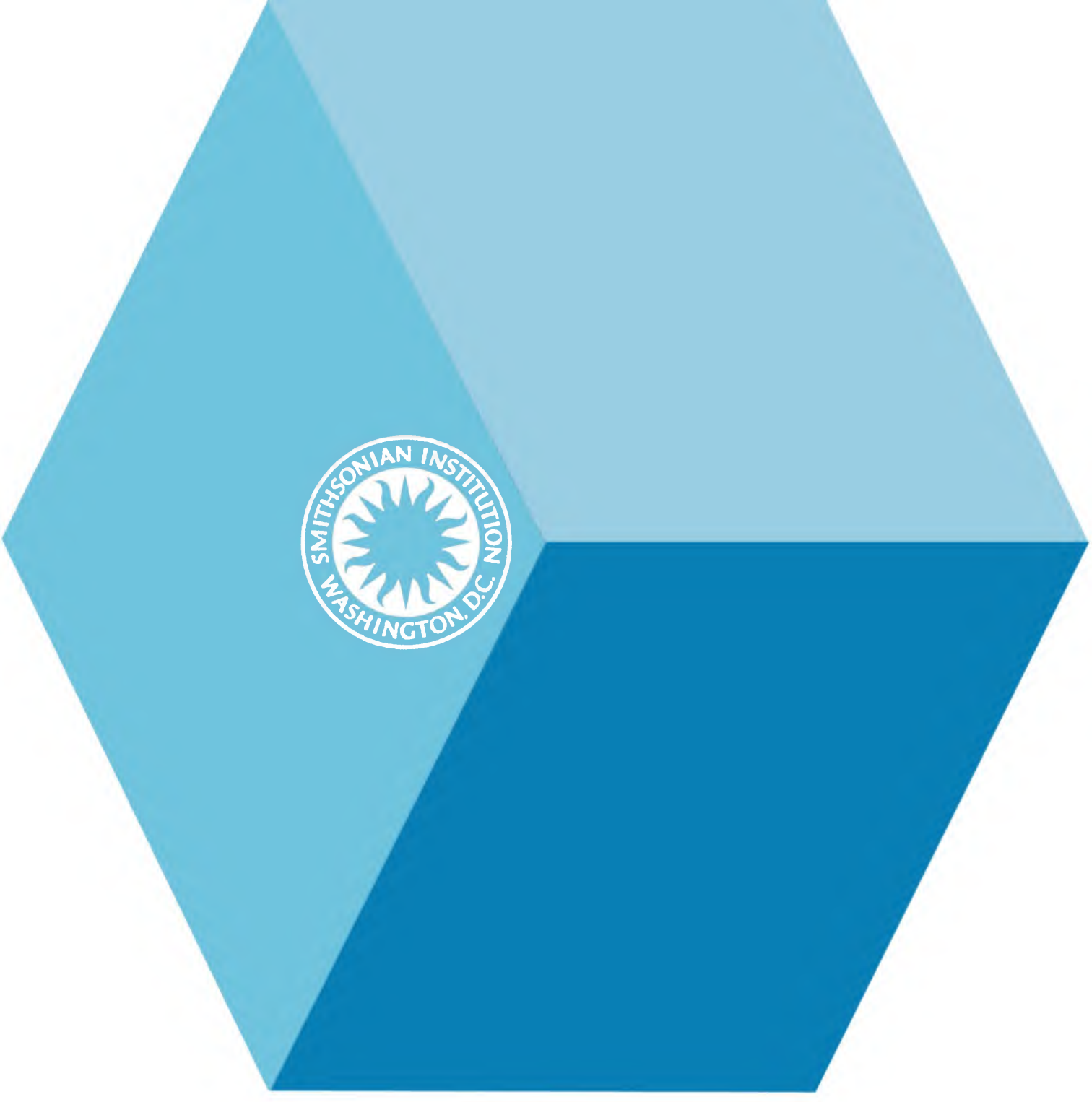
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