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CALANOID COPEPODA FROM THE BERMUDA ISLANDS.

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With Four Plates.

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CALANOID COPEPODA FROM THE BERMUDA ISLANDS.[1]

By Calvin O. Esterly.

Presented by E. L. Mark, May 10, 1911. Received May 12, 1911.

The copepods mentioned in this paper were collected during June, July, and August, 1907. A small "open" plankton net was used, and both vertical and horizontal (surface) towings were made, but there is no special significance in vertical collecting with a non-closing net. Most of the collections were made close to Agar's Island. In addition, four hauls were made about two miles north of North Rock, three of these being vertical from about twelve fathoms.

The calanoid copepods are represented in Bermuda by five genera, one of which is new, and six species of which four are new. The list is as follows: *Acartia bermudensis* n. sp., *Acartia spinata* n. sp., *Calanopia americana* Dahl, *Clausocalanus furcatus* Brady, *Lampoidopus marki* n. gen., n. sp., *Pseudocyclops magnus* n. sp. I have given here very brief characterizations of the species previously described by others, as a basis for comparison with similar forms from other localities, and drawings of certain parts have been included for the same purpose. New forms are described and illustrated more fully.

Lampoidopus[2] marki[3] n. gen., n. sp.

Plate 1, Figure 4; Plate 2, Figures 13, 14, 20, 21; Plate 3, Figures 25, 26, 28, 29, 30, 31, 34; Plate 4, Figures 35, 38, 42.

The head and posterior margin of the last thoracic segment are smoothly rounded in both sexes (Plate , Figure 4; Plate 2, Figures 14, 21). There are five segments in the cephalothorax of both male and female, the head being fused with the first segment of the thorax. The rostrum is present and consists of a fleshy rounded plate, which at its

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[1] Contributions from the Bermuda Biological Station for Research, No. 21.

[2] Λαμπάς, *torch*, εἶδος, *like*, πούς, *foot*, in allusion to the fancied resemblance of the last two joints of the outer ramus of the left fifth foot to the conventional representation of the flames of a torch (see Plate 3, Figure 34).

[3] The species is named for my teacher, Dr. E. L. Mark.

base occupies nearly the entire distance between the bases of the anterior antennae (Plate **2**, Figures 20, 21).

The abdomen of the female is 3-segmented, the genital segment being as long as the other two; the second segment is a little longer than the third (Plate **1**, Figure 4; Plate **2**, Figure 13). The abdomen of the male (Plate **2**, Figure 14) is apparently 4-segmented. The four segments are of about equal lengths. The furcal rami in both sexes are about three and one half times as long as broad.

The anterior antennae reach to the end of the furca. Both antennae in the female are 25-jointed. The right one in the male is a grasping organ (Plate **4**, Figure 35) and is 23-jointed; the left is 25-jointed. The terminal portion of the grasping antenna is 4-jointed.

The other cephalic appendages are alike in the sexes. The posterior antennae have the inner ramus shorter than the outer; the former is 2-jointed and the latter 8-jointed. The blade of the mandible (Plate **3**, Figure 26) is well developed and has numerous rather fine teeth of irregular form on the cutting edge. The outer ramus is 4-jointed, the first three joints having each one bristle, the fourth joint having two; the inner ramus is 2-jointed, the first joint carrying three bristles and the second carrying eleven, as shown in Plate **3**, Figure 31. The maxilla (Plate **3**, Figure 25) has the rami and lobes well developed. The "outer border lobe" bears a group of three small bristles and a group of seven that are much larger. The outer ramus carries bristles of about equal sizes; the inner ramus has fourteen bristles altogether, disposed, as shown, in two groups of three bristles each and two of four bristles each. The masticatory lobe has ten of the very heavy spinose bristles and three delicate smooth bristles. The second lobe of the inner margin has five bristles, the third has four, and the second basal has five. The anterior maxilliped is rather short and broad (Plate **3**, Figure 28). There are seven lobes on the inner margin; the number of bristles on the lobes in order is 6, 3, 3, 3, 4, 2, 4. The posterior maxilliped (Plate **4**, Figure 38) is slender and weakly developed; it is 7-jointed, the endopodite containing five joints. The endopodite is as long as the second basal; the greatest breadth of the first basal is twice that of the second. The first basal has the bristles on the inner margin disposed in four groups, consisting of 1, 2, 4, and 3, respectively, beginning at the base. The joints of the inner ramus have the following number of bristles on the inner margin, beginning with the first joint: 4, 4, 3, 4, 4.

The four anterior pairs of swimming feet are alike in the sexes. Both rami in all the pairs are 3-jointed, and the first basal in all has one inner marginal bristle.

Table I, which follows, shows the number of bristles or thorns on the joints of the rami of the first four pairs of feet. The abbreviations are as follows: *Se.*, a bristle or thorn on the outer margin; *Si.*, a similar structure on the inner margin of any joint; *St.*, a bristle on the distal end of a terminal joint.

TABLE I.

Pair.	Joint.	Outer Ramus.			Inner Ramus.		
		Se.	*Si.*	*St.*	*Se.*	*Si.*	*St.*
I.	1	1	1	0	0	1	0
	2	3	1	0	0	2	0
	3	2	4	1	1	4	1
II.	1	1	1	0	0	1	0
	2	1	1	0	0	2	0
	3	2	5	1	2	5	1
III.	1	1	1	0	0	1	0
	2	1	1	0	0	2	0
	3	3	5	1	2	3	0
IV.	1	1	1	0	0	1	0
	2	1	1	0	0	1	0
	3	3	5	1	2	4	

The fifth pair of feet shows most marked peculiarities. These feet are symmetrical in the male. Each inner ramus is 1-jointed, that of the right foot being club-shaped (Plate **3**, Figure 30), that of the left foot (Plate **3**, Figure 34) shorter and broader. The outer ramus of the right foot is 2-jointed, that of the left foot 3-jointed with the terminal joint peculiarly modified (Plate **3**, Figure 34). It is split up into three or four parts, or slender processes, one of which branches and carries a very delicate lamellar structure that ends distally in fine hair-like divisions. The figure gives a better idea of the structure of this foot than is possible in a description. The end joint of the outer ramus of the left foot is of the same structure in all the specimens I have examined.

The right and left fifth feet of the female are symmetrical; the inner ramus is 2-jointed, the outer 3-jointed (Plate **3**, Figure 29). A peculiarity is the attachment of the terminal joint of the outer ramus at the middle of the inner margin of the second joint.

The average length of the males is 1.05 mm., of the females 1 mm.

The color of both sexes is brownish buff; the pigment is generally distributed through the body and appendages.

The only place where I found this copepod was in a cave in the small ledge-like island across from the bathing place at Agar's Island (see the map in Mark, : **09**, p. 2). The cave is a small one and is at the south-west end of the ledge. I have never seen a specimen of Lampoidopus that was taken anywhere else and it is my belief that the animals are not found outside the cave, at least, not any distance from it. Collections were not made in the water between Agar's Island and the ledge, but there were some from the ship channel, and this is rather close to the place where the cave is located in the ledge. The animals were very abundant in the cave; young in all stages of development as well as adults were taken. The only haul was made at high tide. A small net was fastened to the end of a pole and swept through the water inside the cave.

The most interesting thing connected with the finding of this copepod is that, so far as I know, the small cave is the only place near Agar's Island where the "hat" or "shade" coral (*Agaricia fragilis*) is found. Furthermore the coloration of the copepod is strikingly like that of the coral, the same brownish tint characterizing both. It is my belief that this is an example of protective coloration. If so it offers a new case among Copepoda especially, and plankton animals generally.

According to Steuer (: **10**, p. 282), complete lack of color, and hyalinity, is the best adaptation to a plankton life. Blue and violet are adaptive to the blue water of warm seas, and red, brown-red or dark violet belong to the abyssal zoöplankton. Steuer also states (p. 283) that creeping or swimming animals from the Sargasso Sea are characterized by brown or green shades. Taking these general observations into consideration with the circumscribed distribution of Lampoidopus, and the fact that the other copepods obtained are transparent and colorless or else bluish, it seems reasonable to regard the color of Lampoidopus as protective. It is certainly suggestive of this that these little copepods should have a coloration that is unusual in the group as a whole, that their distribution should be so limited, and that at the same time their colors should be so similar to that of the corals. I did not make collections in other caves, but it would be interesting to know if these copepods are found elsewhere and, if so, whether they are found generally with Agaricia.

Calanopia americana Dahl.

Plate **2**, Figures 12, 15; Plate **3**, Figures 27, 32; Plate **4**, Figure 39.

These copepods are very abundant around Agar's Island and very rare in the locality of North Rock. They may be easily recognized by their comparatively large size, the pointed posterior borders of the thorax

(Plate 2, Figure 15), and the heavy, grasping antenna (the right) of the male (Plate 3, Figure 32). The cephalothorax is twice as long in the mid-dorsal line as its greatest breadth (Plate 2, Figure 12). The rostrum (Plate 2, Figure 15) is very stout, and bifid, in both sexes. So far as the figures of Dahl ('94, Taf. 1, Fig. 23–26) are concerned, this seems to be the same species, though identification from his figures is not easy.

The length of the male is 1.2–1.3 mm., that of the female 1.4 mm.

The eye-spot is red; most specimens are otherwise colorless and transparent, but a few have red pigment in the mouth region, along the flanks and ventral surface of the body, and in the bases of the appendages.

Clausocalanus furcatus Brady.

Plate 1, Figures 2, 7, 9; Plate 2, Figure 11; Plate 3, Figure 33; Plate 4, Figures 36, 40, 44.

These copepods are small, but easily recognized by the heavy, bifid rostrum (Plate 1, Figures 7, 9). The distal border of the second basal in the third and fourth pairs of feet is toothed in a way that is characteristic of the genus (Plate 3, Figure 33). I think there is little doubt of the correctness of the identification of this species, though the proportions of the abdominal segments in the male (Plate 2, Figure 11), or in the female, do not agree precisely with other accounts (Giesbrecht und Schmeil, '98, p. 27; Scott, : 02, p. 403).

The animals are colorless and very transparent. The length of the males averages 0.8 mm., that of the females 1.14 mm. This species was much more abundant at North Rock than in any other place where collections were made.

Pseudocyclops magnus n. sp.

Plate 1, Figures 6, 8; Plate 3, Figure 23; Plate 4, Figure 41.

The head and posterior borders of the last thoracic segment are smoothly rounded (Plate 1, Figures 6, 8), and the rostrum is stout. The anterior antennae of the female (Plate 3, Figure 23) are 17-jointed and about one-fifth as long as the entire body. The inner ramus of the fifth foot (Plate 4, Figure 41) is 2-jointed, the first and second joints (of the original three) being fused; the end joint carries a stout, feathered bristle.

It is fairly safe to say that this form is new, though I found but one specimen, a female. The fifth foot differs from that of the species described before, and the size (length 1.1 mm.) is greater than that of *P. obtusatus*, the largest of the hitherto described species.

The animal was colorless and transparent, with a red eye-spot. It was taken in a haul at Agar's Island.

Acartia spinata n. sp.

Plate 1, Figures 3, 5; Plate 2, Figures 16, 19; Plate 3, Figure 24; Plate 4, Figures 37, 45.

The forehead is smoothly rounded in each sex, as are the posterior margins of the last thoracic segment; these margins are provided, in both the male and female, with heavy spines disposed in two sets (Plate 2, Figures 16, 19). The posterior borders of the abdominal segments and likewise the furca are spinose on the dorsal side, and in the male (Figure 16) there are little spines on the sides of the second segment. The length of the cephalothorax along the mid-dorsal line is $3\frac{1}{2}$ times its greatest width (Plate 1, Figure 3). The genital segment of the female is about as long as the rest of the abdomen including the furca, and the second and third abdominal segments are of about equal lengths. In the male the genital segment is about one-third the length of the second segment, which is twice the length of the third. Rostral filaments are present (Plate 1, Figure 5).

The anterior antennae reach back in the females to the end of the anal segment, and in the males about to the posterior border of the third thoracic segment. The second joint of the antenna in the female (Plate 4, Figure 45) has a prominent spine on the ventral surface, and the third joint has a similar spine on the anterior margin at the base of the joint. That feature will distinguish this species from the other species (bermudensis) described here.

The fifth feet in each sex are of the usual form for the genus, but exhibit specific characters. Those of the male are shown in Plate 3, Figure 24; those of the female in Plate 4, Figure 37.

The males average 1.13 mm. in length, the females 1.18 mm.

The animals have a faint bluish tinge in the body when alive, while the eye is very dark blue, this being a noticeable feature of the species. These copepods are very abundant at North Rock and rather uncommon elsewhere, though taken about Agar's Island. The species belongs to the *bifilosa-tonsa-giesbrechti* group, but differs from all the other species in ways that are distinctive.

Acartia bermudensis n. sp.

Plate 1, Figure 1; Plate 2, Figures 10, 17, 18; Plate 3, Figure 22; Plate 4, Figure 43.

The females may be easily distinguished from those of the preceding species by the absence of spines on the anterior antennae. Another

point is the character of the spines on the posterior border of the last thoracic segment; in *bermudensis* (Plate 2, Figure 17) these are much smaller, shorter and more numerous than in *spinata* (Figure 16). In the males of *bermudensis* the ventral group of spines on the border of the last thoracic segment is replaced by hairs (Plate 2, Figure 18). The distribution of spines and hairs on the abdominal segments is shown in Figures 17 and 18 of Plate 2.

This species lacks the rostral filaments. In the females the anterior antennae reach back to the end of the genital segment, in the males to the posterior border of the third thoracic segment.

The genital segment in the females is almost as long as the rest of the abdomen (Plate 2, Figures 10, 17), and the furca is about a third longer than wide. In the male the genital segment (Plate 2, Figure 18) is three-fifths as long as the second segment; the second is a little longer than the third and three times as long as the fourth. The length of the cephalothorax along the mid-dorsal line is three times its greatest width (Plate 1, Figure 1).

The fifth feet show specific characters. In the female (Plate 4, Figure 43) the middle joint of the fifth foot carries a blunt flap-like process on the inner margin, which reminds one of an inner ramus. The fifth feet of the male are shown in Plate 3, Figure 22.

This Acartia was common in hauls around Agar's Island, while *spinata* is quite rare in that locality; the reverse is the case in collections taken from the vicinity of North Rock. *A. bermudensis* belongs to the *clausi-discaudata* group.

The males average .93 mm. in length, the females .86 mm. The animals are transparent and practically colorless.

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PLATE 1.

Figure 1. Acartia bermudensis n. sp. Female, cephalothorax and part of abdomen, dorsal. × 113.

Figure 2. Clausocalanus furcatus Brady. Female, cephalothorax and part of abdomen, dorsal. × 113.

Figure 3. Acartia spinata n. sp. Female, cephalothorax and part of abdomen dorsal. × 113.

Figure 4. Lampoidopus marki n. gen., n. sp. Female, lateral. × 80.

Figure 5. Acartia spinata n. sp. Female, forehead from below. × 245.

Figure 6. Pseudocyclops magnus n. sp. Female, last two thoracic segments and abdomen, lateral. × 266.

Figure 7. Clausocalanus furcatus Brady. Female, forehead to show rostrum, lateral. × 266.

Figure 8. Pseudocyclops magnus n. sp. Female, forehead showing rostrum, lateral. × 266.

Figure 9. Clausocalanus furcatus Brady. Female, lateral. × 93.

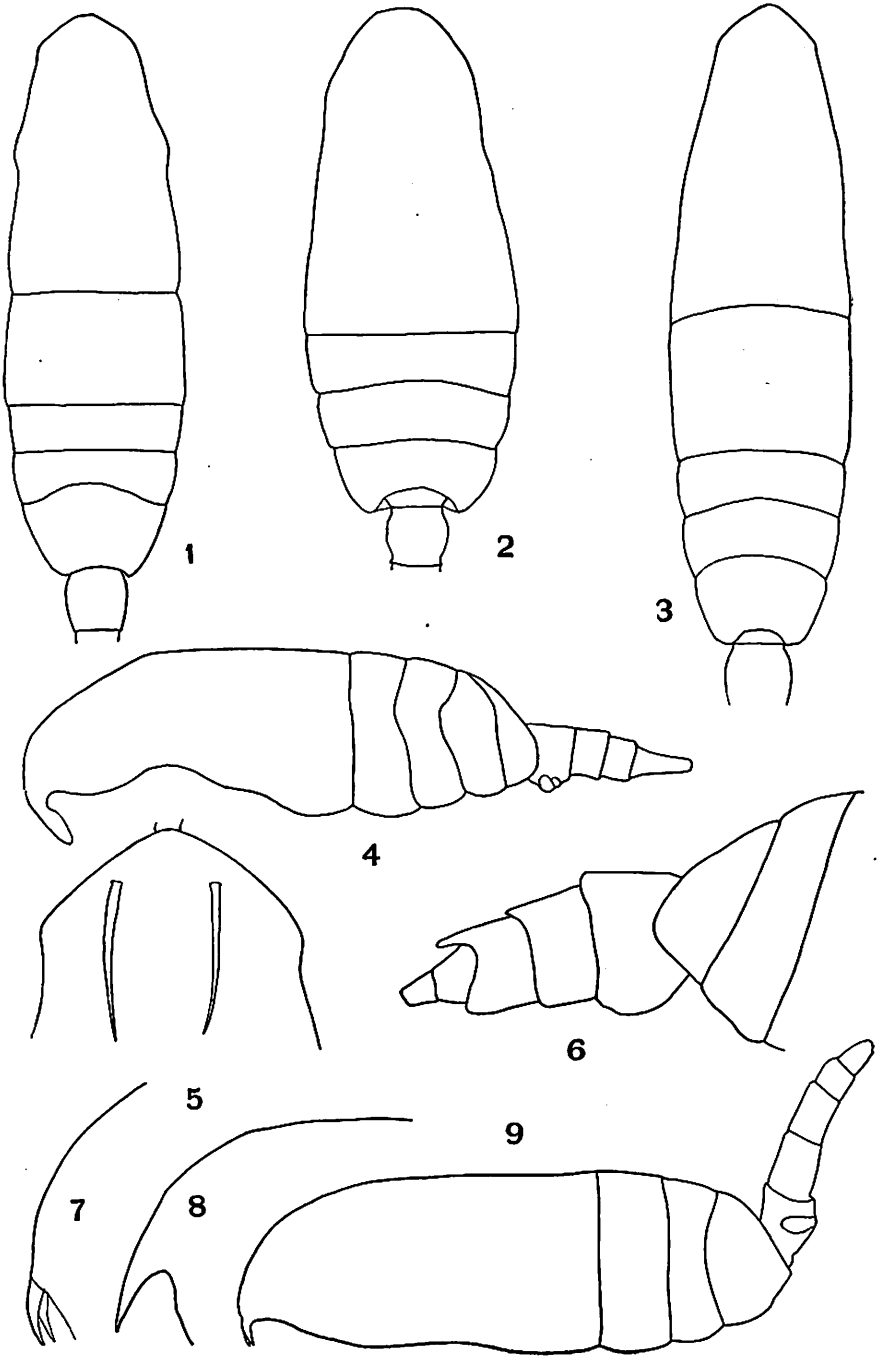

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PLATE 2.

Figure 10. Acartia bermudensis n. sp. Female, abdomen and part of last thoracic segment, dorsal. × 200.

Figure 11. Clausocalanus furcatur Brady. Male, abdomen and part of last thoracic segment (on left side), dorsal. × 183.

Figure 12. Calanopia americana Dahl. Female, cephalothorax and part of genital segment, dorsal. × 85.

Figure 13. Lampoidopus marki n. gen., n. sp. Female, abdomen and part of last thoracic segment, dorsal. × 200.

Figure 14. Lampoidopus marki n. gen., n. sp. Male, abdomen and last two thoracic segments, lateral. × 183.

Figure 15. Calanopia americana Dahl. Male, lateral. × 60.

Figure 16. Acartia spinata n. sp. Male, last thoracic segment and abdomen lateral. × 170.

Figure 17. Acartia bermudensis n. sp. Female, last thoracic segment and abdomen, lateral. × 390.

Figure 18. Acartia bermudensis n. sp. Male, last thoracic segment and abdomen, lateral. × 200.

Figure 19. Acartia spinata n. sp. Female, part of last thoracic segment, and the abdomen, lateral. × 200.

Figure 20. Lampoidopus marki n. gen., n. sp. Male, forehead showing rostrum, ventral. × 183.

Figure 21. Lampoidopus marki n. sp., n. gen. Female, anterior half of head, lateral. × 200.

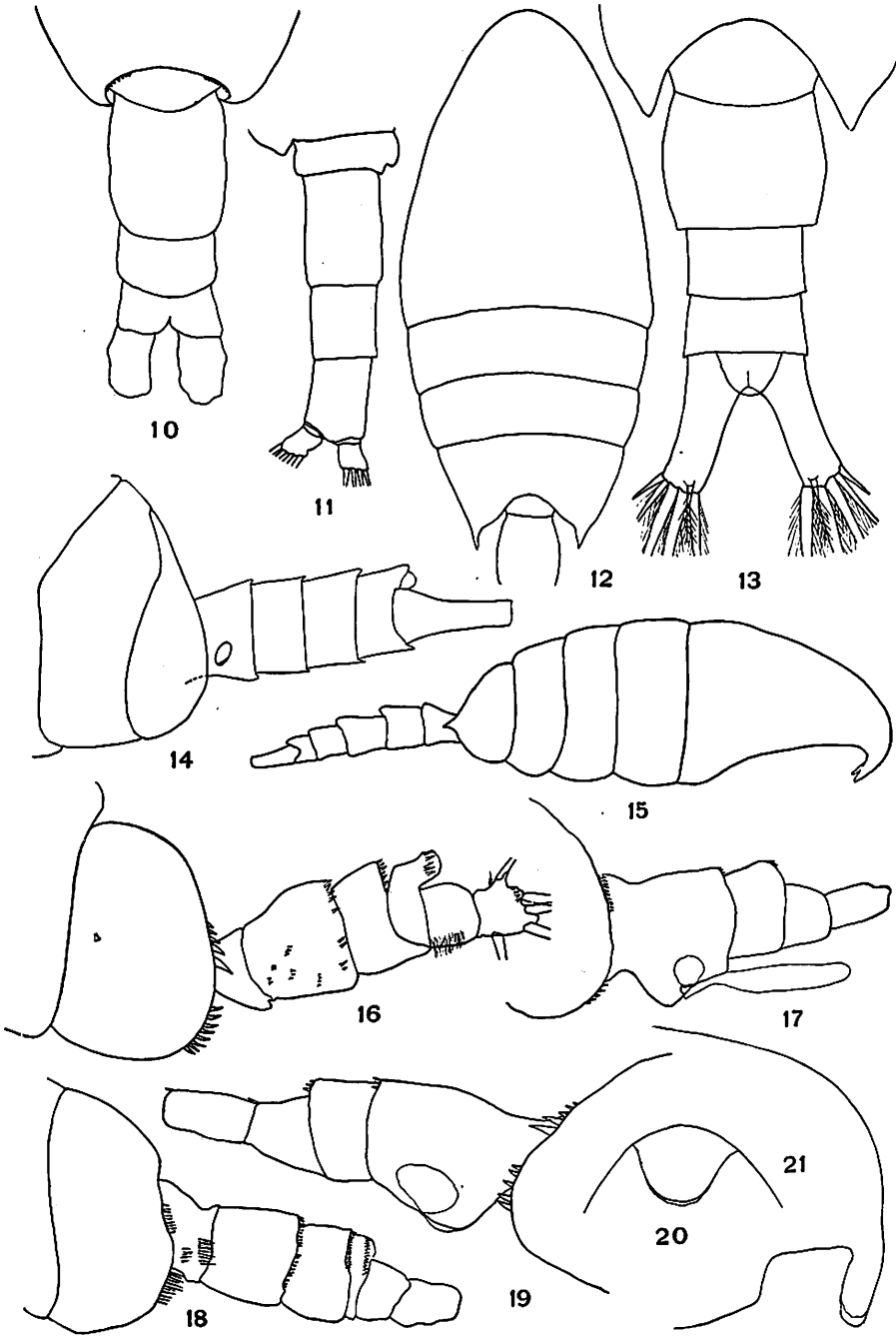

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PLATE 3.

Figure 22. Acartia bermudensis n. sp. Male, fifth pair of feet. × 352.
Figure 23. Pseudocyclops magnus n. sp. Female, anterior antenna. × 375.
Figure 24. Acartia spinata n. sp. Male, fifth pair of feet. × 375.
Figure 25. Lampoidopus marki n. gen., n. sp. Female, maxilla. × 352.
Figure 26. Lampoidopus marki n. gen., n. sp. Female, mandibular blade. × 352.
Figure 27. Calanopia americana Dahl. Male, two terminal joints of right fifth foot. × 375.
Figure 28. Lampoidopus marki n. gen., n. sp. Female, anterior maxilliped. × 352.
Figure 29. Lampoidopus marki n. gen., n. sp. Female, fifth foot. × 352.
Figure 30. Lampoidopus marki n. gen., n. sp. Male, right fifth foot; outer ramus at left of figure. × 352.
Figure 31. Lampoidopus marki n. gen., n. sp. Female, rami of mandible. × 352.
Figure 32. Calanopia americana Dahl. Male, the grasping portion of right anterior antenna. × 325.
Figure 33. Clausocalanus furcatus Brady. Female, second basal, first and second joints of the outer ramus, and the inner ramus of the third foot. × 352.
Figure 34. Lampoidopus marki n. gen., n. sp. Male, left fifth foot; outer ramus at left of figure. × 352.

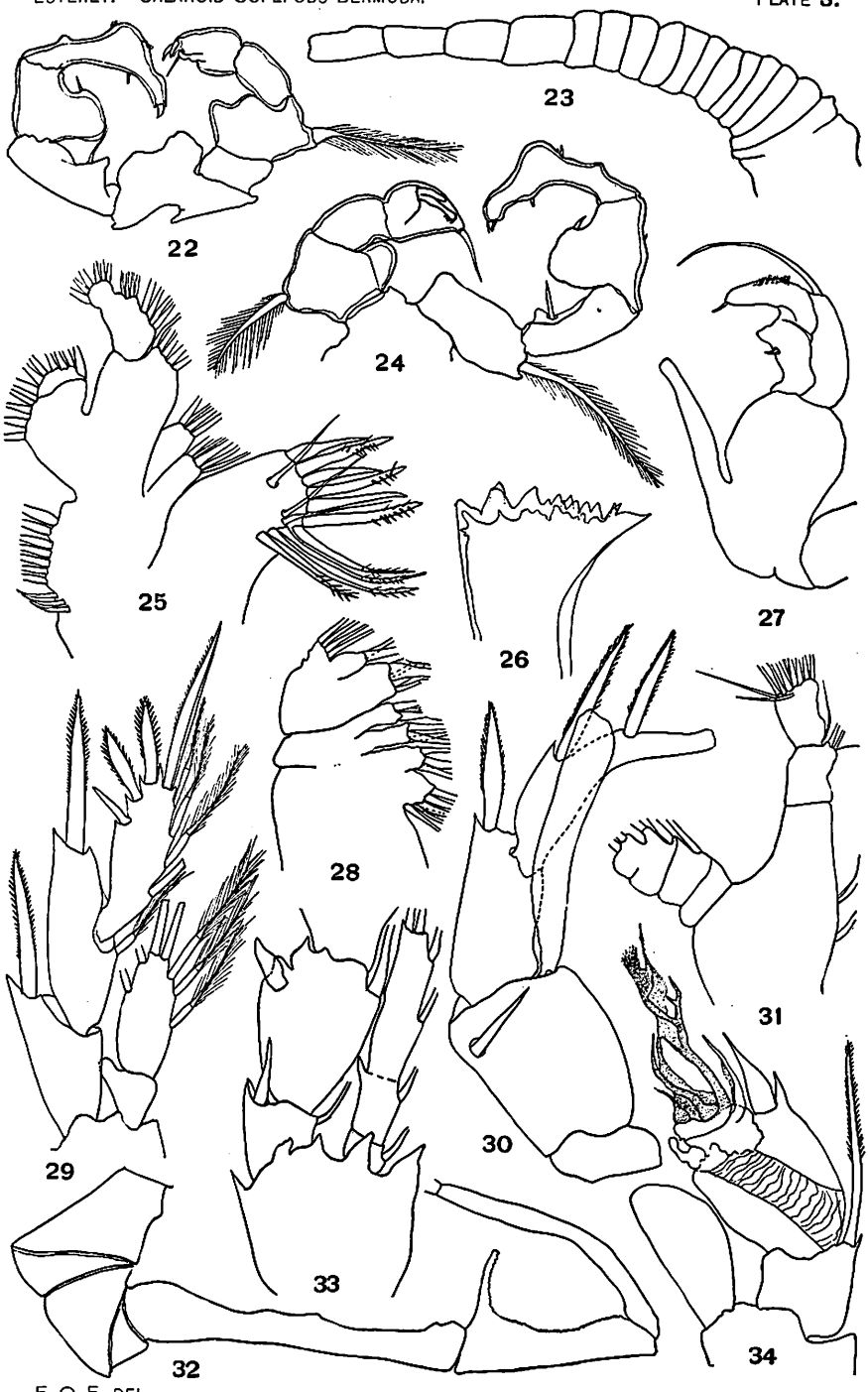

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PLATE 4.

Figure 35. Lampoidopus marki n. gen., n. sp. Male, geniculating part of right anterior antenna. × 470.

Figure 36. Clausocalanus furcatus Brady. Male, right foot of fifth pair. × 470.

Figure 37. Acartia spinata n. sp. Female, fifth foot. The bristle on the outer margin of the second joint is not shown entire. × 500.

Figure 38. Lampoidopus marki n. gen., n. sp. Female, posterior maxilliped. The bristles are not shown. × 113.

Figure 39. Calanopia americana Dahl. Female, fifth foot. × 500.

Figure 40. Clausocalanus furcatus Brady. Male, left foot of fifth pair. × 470.

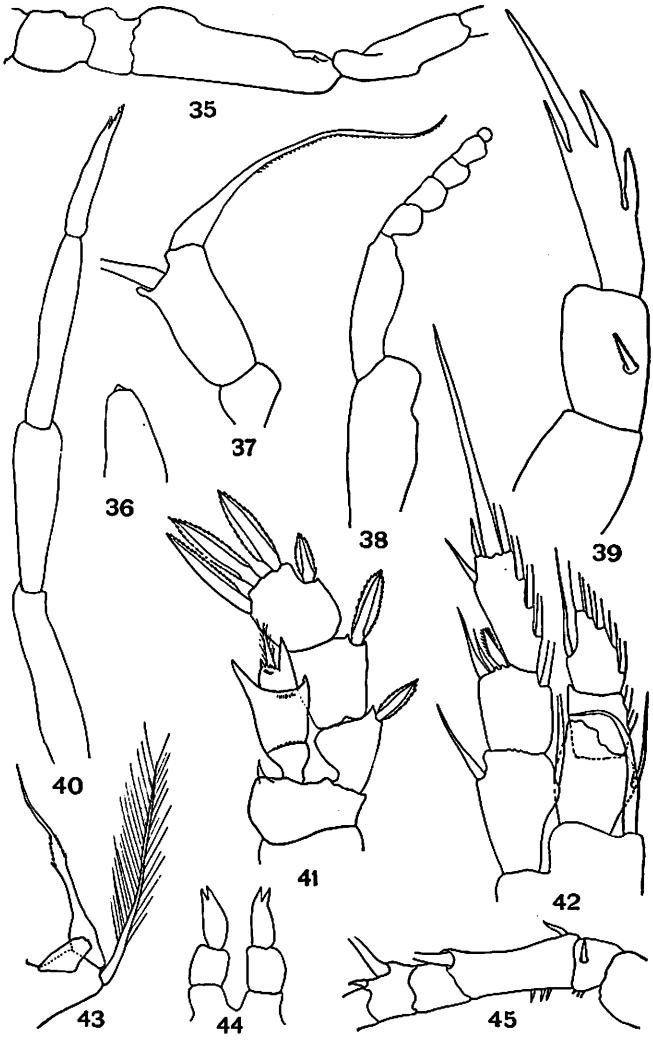
Figure 41. Pseudocyclops magnus n. sp. Female, fifth foot. × 500.

Figure 42. Lampoidopus marki n. gen., n. sp. Female, first foot. × 470.

Figure 43. Acartia bermudensis n. sp. Female, fifth foot. × 500.

Figure 44. Clausocalanus furcatus Brady. Female, fifth pair of feet. × 470.

Figure 45. Acartia spinata n. sp. Female, first five joints of anterior antenna from below. × 93.



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