NOTES ON MARINE COPEPODA OF RHODE ISLAND

LEONARD WORCESTER WILLIAMS

WORK upon the non-parasitic Copepoda of America is very fragmentary. In recent years the papers of Wheeler, of Giesbrecht, and of Herdman, Thompson, and Scott record a relatively small number of forms from what is apparently an extremely rich fauna. Miss Rathbun's check-list of the Crustacea of New England records twelve free-swimming marine Copepoda. None of these, however, is reported in the waters of Rhode Island.

This list records twenty-six free-swimming Copepoda, one parasitic form, and a metanauplius of a parasitic copepod. Of the free-swimming Copepoda eleven have been reported previously: eight by Herdman, Thompson, and Scott from the Gulf of St. Lawrence and six by Wheeler from the Wood's Hole region. We also describe three new species.

The material upon which this paper is based was obtained in Narragansett Bay. Winter collections were made above Rocky Point and summer collections near Wickford, and in Charlestown Pond during the entire summer. The latter is situated in southern Rhode Island and is a large shallow inlet (six miles long by one broad) from the Atlantic. It is slightly brackish but the copepod fauna is much the same as that of the bay.

I am indebted to Dr. A. D. Mead of Brown University for the use of preserved material collected at Wickford by the Rhode Island Commission of Inland Fisheries; to Professor C. B. Wilson for kind assistance; and to Mr. Samuel Henshaw for the use of books from the Museum of Comparative Zoölogy at Harvard.

Type specimens of the new species have been deposited in the museum of the Boston Society of Natural History.

Calanus finmarchicus (Gunnerus)

1765. *Monoculus finmarchicus* Gunnerus.
1863. *Cetochilus helgolandicus* Claus.

1864. *Calanus finmarchicus* Boeck.
1878. *Calanus finmarchicus* Brady.
1892. *Calanus finmarchicus* Giesbrecht.
1903. *Calanus finmarchicus* Sars.

This is a species widely distributed in the North Atlantic and Arctic Oceans, having been taken by Nansen's expedition above 85° north latitude. It has been twice reported from American waters, by Thompson and Scott ('98) and by Wheeler (:00). It appeared abundantly in tows taken in Narragansett Bay in January but was found at no other time. The specimens agree with those taken by Wheeler in lacking the marked concavity of the inner border of the basal joint of the fifth pair of legs of the female.

Pseudocalanus elongatus (Boeck)

1864. *Clausia elongata* Boeck.
1878. *Pseudocalanus elongatus* Brady.
1892. *Pseudocalanus elongatus* Giesbrecht.
1898. *Pseudocalanus elongatus* Thompson and Scott.
1903. *Pseudocalanus elongatus* Sars.

Narragansett Bay, January, February. This is a decidedly northern form, its southern European limit being the northern coast of France.

Centropages hamatus (Lilljeborg)

1853. *Ichthyophorba hamata* Lilljeborg.
1863. *Ichthyophorba angustata* Claus.
1864. *Centropages hamatus* Boeck.
1892. *Centropages hamatus* Giesbrecht
1898. *Centropages hamatus* Thompson and Scott.
1900. *Centropages hamatus* Wheeler.
1903. *Centropages hamatus* Sars.

Narragansett Bay, January, February. Wickford, summer.

PSEUDODIAPTOMUS Herrick

1884. *Pseudodiaptomus* C. L. Herrick.
1890. *Schmackeria* Poppe and J. Richard.
1894. *Heterocalanus* T. Scott.
1894. *Weismannella* Dahl.

Head separated from, or fused with the first thoracic segment; fourth and fifth segments of the thorax fused (or not). Abdomen of the female 4- or 3-jointed. Furca at least two and a half times as long as broad, with six setæ. First antenna 20- to 22-jointed. Terminal section of the grasping antenna of the male usually 2-jointed. The second antenna with a long outer ramus of two to four joints. Outer ramus of mandible 3- or 4-jointed; inner ramus inconspicuously 2-jointed, its second joint curved outward strongly. The first joint of the basipodite of the second maxilla is divided into two sections. Basipodite of the maxilliped short and strong, inner ramus 4- or 5-jointed, some of its bristles branched. The inner and outer rami of the first to fourth leg 3-jointed, terminal joint of the outer ramus with two outer spines and a terminal spine serrated externally. The inner ramus of the fifth limb of the female rudimentary or absent, outer branch 2- or 3-jointed. Inner ramus of the left fifth limb of male usually rudimentary, rarely absent or transformed into a grasping organ; outer ramus 2-jointed, occasionally reduced to a claw-shaped process of the basipodite. Inner ramus of the right fifth limb rudimentary or lacking; outer ramus 2- or 3-jointed with an end claw. One or two egg sacs.

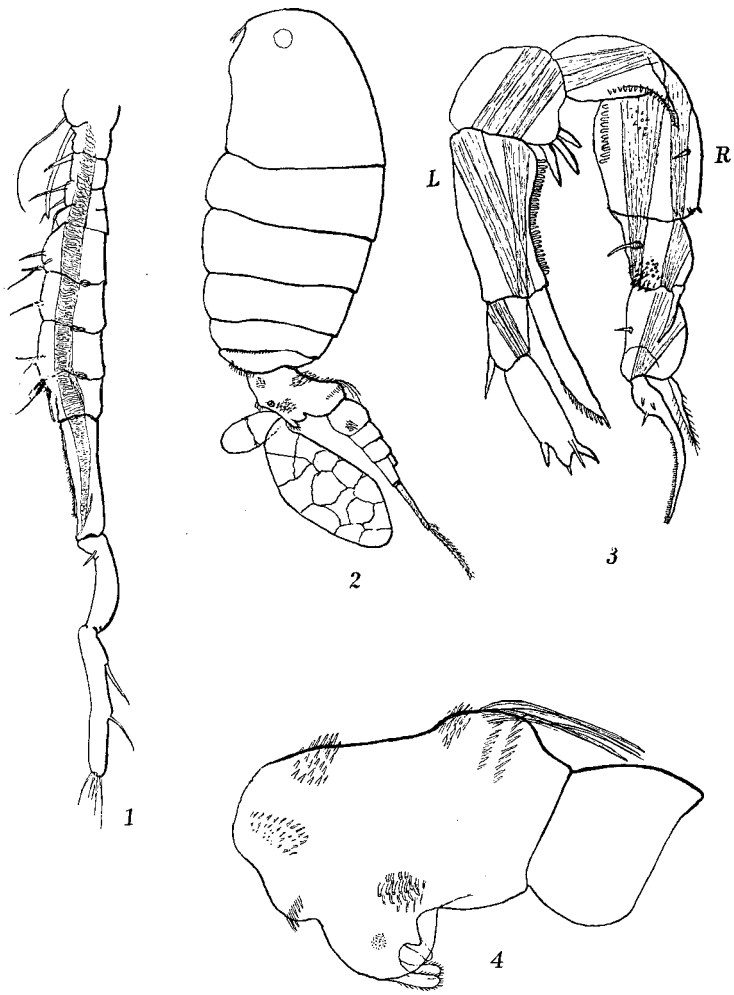
Pseudodiaptomus coronatus n. sp.

Figs. 1–7

The generic description must be modified slightly to admit this species: the fourth and fifth thoracic segments are not fused and the seventh and eighth segments of the first antenna are not completely fused and if they are considered separate the first antenna is 23-jointed. In other respects the species agrees with the generic description. The last thoracic segment (Fig. 2) is rounded posteriorly and is naked in the male and haired in the female. The fourth thoracic segment is spined in the female and naked in the male. Abdomen of male 5-jointed; of female 4-jointed. Almost all bristles of the feet and furca are jointed some distance from their bases (Fig. 7).

Female.— First segment of abdomen much swollen with spines

and bristles arranged asymmetrically, and with a pair of spatulate flaps (Figs. 4 and 5) extending over the genital aperture. The bristles of the left side of the genital segment in both areas are

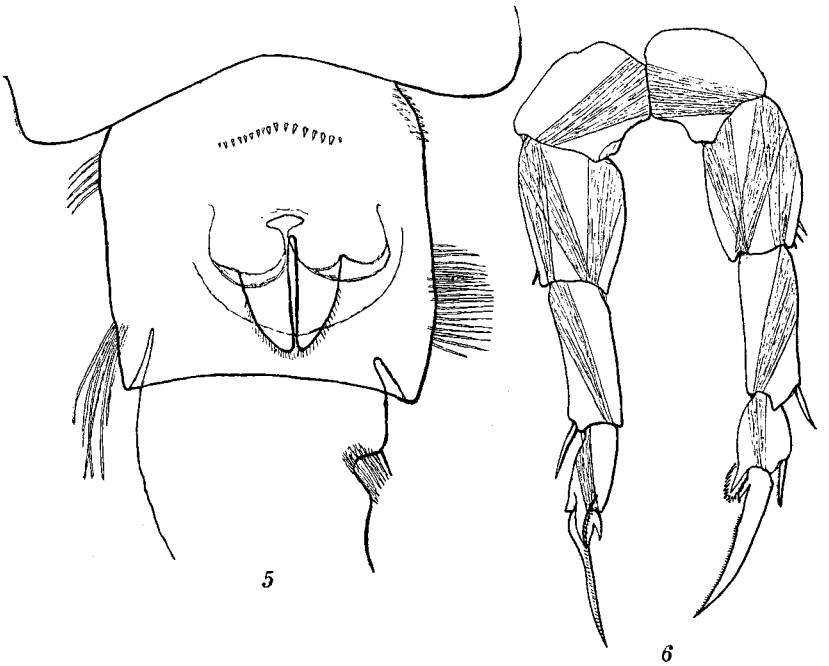


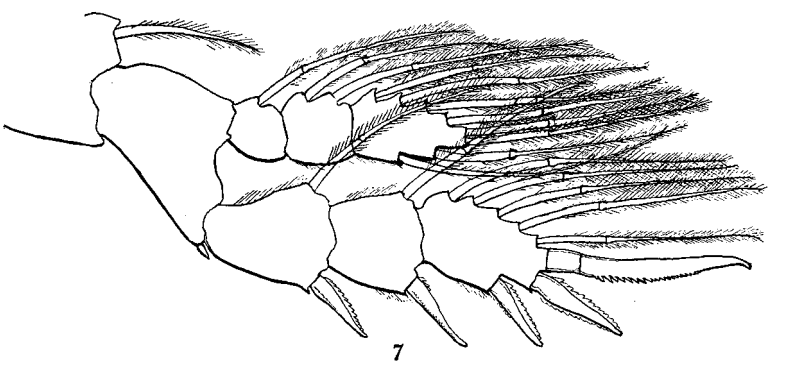
Pseudodiaptomus coronatus

FIG. 1.— Right antenna of male. x 150.
FIG. 2.— Lateral view of female. x 50.
FIG. 3.— Fifth limbs of male, posterior surface. x 130.
FIG. 4.— Left side of the genital segment of female. x 175.

respectively much longer than those of the right side. A small tuft of very long soft bristles near the posterior edge of the dorsal

surface projects almost across the second segment. The left side of the second segment of the abdomen has a small depression filled with heavy bristles while the right side is convex and bears a few spines (below the middle and so not shown in the drawing). The last segment has a crown of spines, on the posterior edge. The furca is slightly asymmetrical and each ramus is five times as long





Pseudodiaptomus coronatus

FIG. 5.— Genital segment of female, ventral surface. x 175.
FIG. 6.— Fifth limbs of female, posterior surface. x 175.
FIG. 7.— Third swimming foot, female. x 280.

as broad and has long delicate bristles on the inner edge and shorter and stronger bristles on the outer edge. The fifth limbs are alike (Fig. 6) and 4-jointed. The terminal joint is prolonged at the inner angle into a toothed lamella and has a spine at the outer angle. The terminal claw is toothed along its inner (concave) border and has a naked lamella on the inner side at base. One large and one (right) small egg case.

Male.—Abdomen long and slender. First joint bristled along the upper part of its posterior edge and with a semicircle of bristles on the lower surface. The upper part of the hinder edge of the second joint and the entire posterior edge of the third, fourth, and fifth joints have a crown of triangular spikes. The furca is three times as long as broad and lacks marginal bristles. The right fifth limb (Fig. 3) has no inner ramus; outer ramus 2-jointed with a terminal claw. First joint of basipodite has a slender curved process coarsely toothed along its inner edge, the second joint and the first joint of the outer ramus are toothed inside. The second joint of the inner ramus has a bristled spine and a curved terminal claw toothed on the inner edge and swollen at base. The left fifth limb biramous. The first joint of the basipodite has a cluster of three or four broad radiating spines. The second joint has coarse teeth on its inner edge. The inner ramus is a blade toothed along the distal half of its curved outer edge. The outer ramus is 2-jointed; the first joint has an outer terminal spine and the second joint ends irregularly in four spines. The right antenna (Fig. 1) has a terminal section of two joints and has the third joint from the end toothed along its anterior edge.

Length of female 1.5 mm.; of male 1.2 mm.

Narragansett Bay and Charlestown Pond.

Temora longicornis (O. F. Müller)

1785. *Cyclops longicornis* Müller.
1850. *Temora finmarchica* Baird.
1865. *Temora longicornis* Boeck.
1878. *Temora longicornis* Brady.
1892. *Temora longicornis* Giesbrecht.
1898. *Temora longicornis* Thompson and Scott.
1900. *Temora longicornis* Wheeler.
1903. *Temora longicornis* Sars.

Narragansett Bay, January, February.

EURYTEMORA Giesbrecht

1881. *Eurytemora* Giesbrecht.
1881. *Temorella* Claus.

Body moderately slender, rostrum with small, soft lappets. Fifth thoracic segment free, often expanded laterally. Abdomen slender, genital segment slightly protruding downward. Furca elongated, symmetrical. Anterior antenna in female comparatively short, scarcely longer than the cephalothorax, 24-jointed. Right antenna of male geniculate, terminal portion of two (three?) joints. Posterior antenna with outer ramus longer than inner and 7-jointed. Mouthparts similar to those of Temora except that the posterior maxillipeds are shorter and stouter. Inner ramus of the first leg 1-jointed, of the second to the fourth, 2-jointed. Fifth legs of female 4-jointed, penultimate joint produced on the inside into a strong, pointed process; terminal joint small. Fifth legs of male 4- or 5-jointed, about equal; terminal joint of right leg claw-shaped, of left, spatulate or dilated.

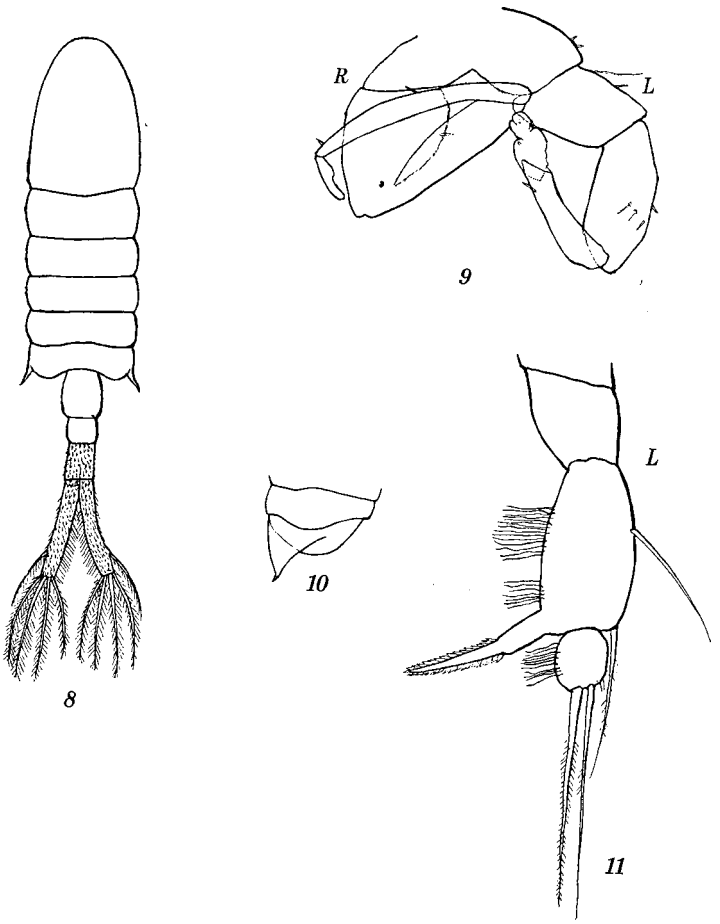
Marine, brackish, and fresh water.

Eurytemora americana n. sp.

Figs. 8–11

Female.— The lateral angles of the last segment of the thorax (Figs. 8 and 10) are drawn out into conspicuous triangular wings which are distinct from the rounded posterior surfaces of the segment. The wing arises from the lower two thirds of the outer side of the segment and its upper edge is slightly concave, and its lower edge slightly convex. In lateral view it forms, with the hinder edge of the segment, an S-shaped outline. The abdomen is 3-jointed; the genital segment is evenly rounded at the sides and above but projects below; the genital opening is covered by a broad, cordate flap. The upper surface of the anal segment and furca is covered with short, strong spines. The furcal arm is eight times as long as broad, curved outward a little, and slightly tapering. The furcal setæ, except the dorsal ones, are as long as the furca, coarse, and swollen at the base. The dorsal seta is short and

jointed near the base. First antenna as long as the trunk and strong. The fifth limb (Fig. 11) is similar to that of *E. lacustris* but the penultimate joint is longer, and its inner process is more slender and is finely bristled on both edges. The terminal joint



Eurytemora americana

FIG. 8.— Dorsal view of female. x 40.
FIG. 9.— Fifth limbs of male, anterior surface. x 350.
FIG. 10.— Left side of the fourth and fifth segments of female.
FIG. 11.— Left fifth limb of female, anterior surface. x 350.

bears two setæ of nearly equal length, but the inner one is heavier and is more distinctly bristled. The inner edges of the last and next to the last joints bear long, slender bristles. Eggs light green.

Male.— Lateral angles of the last thoracic segment rounded.

Abdomen slender, 5-jointed. Anal segment with few spines and furca without spines on the upper surface. Furca six times as long as broad, inner edge with long slender bristles. Furcal setæ as in the female, therefore longer than the furca. The left first antenna is relatively longer than in the female, reaching to the second segment of the abdomen. Right first antenna as in *E. herdmani, i. e.*, about as long as left antenna, very heavy, and with the terminal portion composed of two long segments and a minute terminal segment; seventeenth and eighteenth joints with a comb-like ridge; nineteenth joint with a notch on the anterior side at base and two toothed ridges beyond the notch. The right fifth limb (Fig. 9) is 5-jointed, the last two not being fused and the next to the last slightly swollen at base. Left fifth limb 5-jointed, the last joint separated from the fourth joint by an oblique hinge and ending in three lobes, each with a spine upon its apex.

The first to fourth limbs of both sexes are very similar to those of *E. velox*.

Length of ♀, 1.8 mm.; cephalothorax, 1.07 mm.

Length of ♂, 0.9 mm.; cephalothorax, 0.68 mm.

Narragansett Bay, January to April; Charlestown Pond, summer.

Males and females of this species were brought through the last molt to sexual maturity. The males happened to molt earlier than the females, and for some days each carried a spermatophore by its stalk in the fifth limb, another spermatophore being almost or quite fully formed within the body.

Eurytemora hirunoides (Nordquist)

1888. *Temorella affinis* var. *hirunoides* Nordquist.
1898. *Eurytemora affinis* var. *hirunoides* Giesbrecht and Schmeil.
1903. *Eurytemora hiruno des* Sars.

Narragansett Bay, January; Charlestown Pond, July.

The specimens agree very closely with Sars' description and plates of the Norwegian form.

Eurytemora herdmani Thompson and Scott

1898. *Eurytemora herdmani* Thompson and Scott.
1898. *Eurytemora herdmani* Giesbrecht and Schmeil.

Narragansett Bay at Wickford. This species has been reported previously from the Gulf of St. Lawrence only.

Acartia tonsa Dana

1849. *Acartia tonsa* Dana.
1892. *Acartia tonsa* Giesbrecht.
1900. *Acartia tonsa* Wheeler.

Charlestown Pond. Abundant throughout the summer. The predominant copepod in the tow. The fifth limbs of the female are symmetrical in all the specimens examined and not as in Wheeler's figure.

Acartia clausii Giesbrecht

1892. *Acartia clausii* Giesbrecht.
1895. *Acartia clausii* Thompson.
1898. *Acartia clausii* Thompson and Scott.
1903. *Acartia clausi* Sars.

Narragansett Bay. Abundant in January and February. This species has a very wide distribution, occurring in the Atlantic, Mediterranean, the Black Sea, and the Gulf of Guinea (Scott, '94). Thompson and Scott found it in the Gulf of St. Lawrence but this is the first report of its occurrence in New England waters.

TORTANUS Giesbrecht

1883. *Corynura* Brady.
1892. *Corynura* Giesbrecht.
1898. *Tortanus* Giesbrecht and Schmeil.

Head without lateral hooks; eye large, without cuticular lens; no rostrum; a horseshoe-shaped fringed lamella in front of the upper lip. Thorax symmetrical, last segment separate or fused with the preceding. Abdomen of female often laterally compressed, 2- or 3-jointed. First antenna like that of Acartia, but the middle section of the gripping antenna is thicker. Two rami of the second antenna of nearly equal length; terminal segment of outer ramus rudimentary. Two rami of the mandible inserted at the end of the elongated second joint of the basipodite. First maxilla consisting of the first joint of the basipodite and the two much bristled

inner border lobes. Proximal lobes of the second maxilla much reduced. Maxillipeds 3-jointed. Inner ramus of first to fourth swimming feet 2-jointed (or the first with 3 joints). Fifth limb with one ramus in female, 2- or 3-jointed in the male, similar to Acartia, but stronger.

Tortanus setacaudatus n. sp.

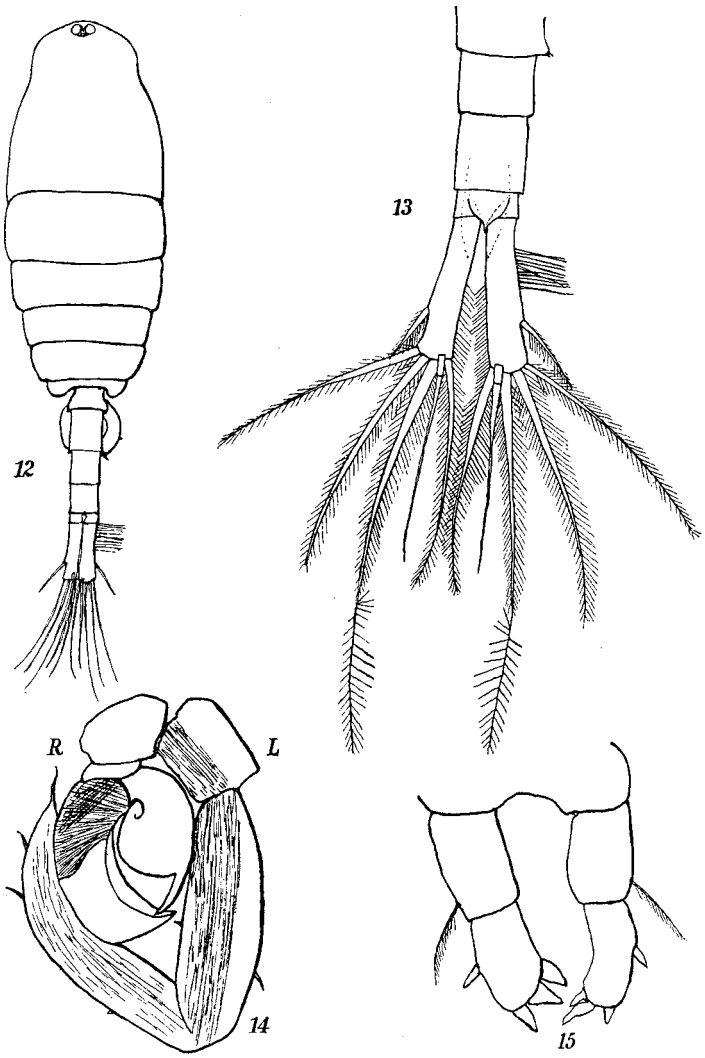
Figs. 12–15

Last thoracic segment free. First antenna long, 17-jointed, reaching beyond the end of the furca by one or two joints. The maxillipeds are extraordinarily large and are carried in a very characteristic manner, *i. e.*, horizontally and at right angles to the sagittal axis, so that the long curved, bristled, and toothed setæ point forward. Abdomen and furca long.

Female.—Abdomen 3-jointed, slightly compressed laterally. The left arm of the furca is sharply compressed laterally at its base; otherwise the furca and abdomen are symmetrical. Genital segment enlarged, slightly rounded with a rounded prominence on each side of the genital opening. Anal segment with an acute strong dorsal spine. Each arm of the furca is fringed with soft bristles along the distal half of its inner edge, and has the full number of setæ. Five of these are plumose and unjointed, and one, the dorsal seta, projects upward from the plane of the others and is naked and jointed near the base. The third seta from the inside is longer than the majority and its projecting end bears stiff, long bristles which are more scattered than the others, and are attached at different angles. Feet of the fifth pair 2-jointed, alike (Fig. 15). First joint oblong with a plumose bristle on the outer edge near the end; terminal joint slightly narrower than the first, with four short, broad spines, one near the middle of the outer edge and three at the apex.

Male.— Gripping antenna powerful; distal section of two joints, middle section of six joints; of these, the second and fourth have a seta at the distal end, and the fifth and sixth and the first joint beyond the hinge have each a ridge which is finely toothed

which bears one or two minute spines. The anal segment is very short and has a dorsal spine similar to that of the female (Fig. 13). The right arm of the furca is slightly broader and longer than the left and bears upon its outer edge near the middle a tuft of from



Tortanus setacaudatus

FIG. 12.— Dorsal surface of male. x 75.
FIG. 13.— Dorsal surface of male abdomen. x 172.
FIG. 14.— Fifth feet of male, anterior surface. x 272.
FIG. 15.—Fifth feet of male, posterior surface. x 395.

12 to 20 stiff, slender bristles which form a conspicuous brush. The furcal setæ and the hairs on the inner edge of the furca are as in the female. Left fifth limb 3-jointed, more than twice the length of the right (Fig. 14). Basal joint nearly as broad as long; the second joint long, with one or more bristles on the inner and outer edges; distal joint arcuate, pointed, nearly as long as the other two, and with three recurved bristles on the outer and one on the inner edge. Right fifth limb is 3-jointed, the last two joints forming a heavy pincer; the second joint is spoon-shaped and receives a curved spine borne on the lower (anterior) side of the end of the swollen terminal joint.

Length of female 1.40 mm., of male 0.94 mm.

Abundant in Narragansett Bay and Charlestown Pond.

This is the second species of Tortanus to be described from the eastern coast of North America. *T. discaudatus* Thompson and Scott ('98) from the Gulf of St. Lawrence is very similar to this species. *T. bumpusii* Wheeler (:00) was found in Vineyard Sound and is apparently *T. discaudatus*.

Oithona plumifera Baird

1843. *Oithona plumifera* Baird.
1892. *Oithona plumifera* Giesbrecht.
1900. *Oithona plumifera* Wheeler.

Narragansett Bay, February.

Oithona similis Claus

1866. *Oithona similis* Claus.
1892. *Oithona similis* Giesbrecht.
1900. *Oithona similis* Wheeler.

Narragansett Bay at Wickford, June.

Longipedia coronata Claus

1863. *Longipedia coronata* Claus.
1880. *Longipedia coronata* Brady.
1898. *Longipedia coronata* Thompson and Scott.
1903. *Longipedia coronata* Sars.

Narragansett Bay and Charlestown Pond, summer. We have found no American record for this species.

Ectinosoma normani T. and A. Scott

1896. *Ectinosoma normani* T. and A. Scott.
1903. *Ectinosoma normani* Sars.

Charlestown Pond, summer. A species recorded from Norway, Scotland, and Ceylon.

Ectinosoma curticorne Boeck

1872. *Ectinosoma curticorne* Boeck.
1895. *Ectinosoma curticorne* Thompson.
1903. *Ectinosoma curticorne* Sars.

Charlestown Pond. One of the most common copepods in July and August. It has been previously reported from Norway, Scotland, and Spitzbergen.

Microsetella norvegica (Boeck)

1864. *Setella norvegica* Boeck.
1873. *Ectinosoma atlanticum* Brady and Robertson.
1890. *Ectinosoma atlanticum* Brady.
1892. *Microsetella atlantica* Giesbrecht.
1898. *Ectinosoma atlanticum* Thompson and Scott.
1903. *Microsetella norvegica* Sars.

Narragansett Bay, March. This species is cosmopolitan, with a wide distribution in the Atlantic Ocean and occurs in the Arctic, the Pacific, the Mediterranean, the Red Sea, and the Indian Ocean.

Tachidius littoralis Poppe

1881. *Tachidius littoralis* Poppe.
1895. *Tachidius littoralis* Thompson.

Narragansett Bay. Abundant in March and April.

Tachidius brevicornis (Müller)

1776. *Cyclops brevicornis* Müller.
1853. *Tachidius brevicornis* Lilljeborg.
1880. *Tachidius brevicornis* Brady.
1882. *Tachidius discipes* Giesbrecht.

Charlestown Pond, summer.

Parategastes sphæricus (Claus)

1863. *Amymone sphærica* Claus.
1866. *Amymone sphærica* Claus.
1880. *Amymone sphærica* Brady.
1903. *Tegastes sphæricus* Norman.
1904. *Parategastes sphæricus* Sars.

Charlestown Pond, abundant in July. The hand of the second maxilliped in these specimens is somewhat heavier than in the European species and resembles that of *Tegastes grandimanus*. Otherwise the agreement is complete.

Diosaccus tenuicornis (Claus)

1863. *Dactylopus tenuicornis* Claus.
1872. *Diosaccus tenuicornis* Boeck.
1873. *Nitokra tenuicornis* Brady and Robertson.
1880. *Diosaccus tenuicornis* Brady.

Charlestown Pond, July.

Dactylopusia vulgaris G. O. Sars.

1850. *Canthocamptus stromii* Baird.
1863. *Dactylopus cinctus* Claus.
1880. *Dactylopus stromii* Brady.
1903. *Dactylopusia vulgaris* Sars.

Charlestown Pond, July.

Thalestris serrulata Brady

1880. *Thalestris serrulata* Brady.
1895. *Thalestris serrulata* Thompson.
1898. *Thalestris serrulata* Thompson and Scott.

One female of this somewhat rare species was taken by scraping piles at high tide at Rocky Point in Narragansett Bay. Thompson and Scott have reported it from the American coast.

Harpacticus uniremis Kröyer

1845. *Harpacticus uniremis* Kröyer.
1903. *Harpacticus uniremis* Sars.

Narragansett Bay, abundant in February, March, and April; Charlestown Pond, July. Females in egg were found in both the summer and winter tows, though the largest number of specimens in copula were taken in March and April. The species was found in great abundance in shallow water and not, as Sars reports of the Norwegian specimens, confined to depths of from twenty to a hundred fathoms.

Harpacticus chelifer (Müller)

1776. *Cyclops chelifer* Müller.
1834. *Harpacticus chelifer* Milne-Edwards.
1880. *Harpacticus chelifer* Brady.
1903. *Harpacticus chelifer* Sars.

Charlestown Pond, July.

Idya furcata (Baird)

1837. *Cyclops furcatus* Baird.
1863. *Tisbe furcata* Claus.
1864. *Idya furcata* Boeck.
1880. *Idya furcata* Brady.
1903. *Idya furcata* Sars.

Narragansett Bay, spring. This is a very common Norwegian copepod and is "ubiquitous in the British seas" to quote Dr. Brady. It is also found in the Mediterranean, the Red Sea, and in New Zealand.

Argulus laticauda Smith

1874. *Argulus laticauda* Smith.
1903. *Argulus laticauda* Wilson.
1904. *Argulus laticauda* Wilson.

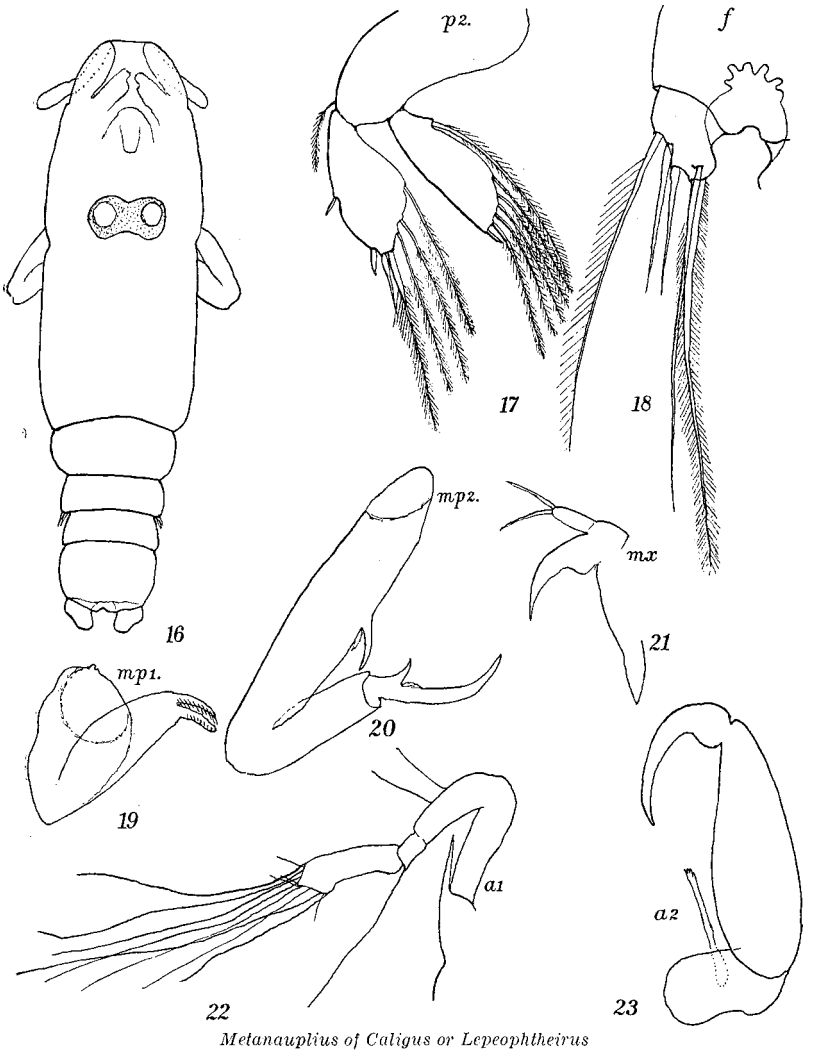
Charlestown Pond on tautog (*Tautoga onitis*).

Metanauplius of Caligus or Lepeophtheirus

Figs. 16–23

Two specimens of this metanauplius were taken near the surface, one on January 13 on the east side of the upper part of

Narragansett Bay (Crescent Park), the other a week later on the opposite side of the bay (Pawtuxet). They resemble in general the metanauplius raised from the eggs of *Caligus bonito* by C. B. Wil-



Metanauplius of Caligus or Lepeophtheirus

FIG. 16.— Dorsal view. x 123.
FIG. 17.— Second foot, left. x 345.
FIG. 18.— Left arm of furca. x 345.
FIG. 19.— Right first maxilliped. x 345.
FIG. 20.— Right second maxilliped. x 345.
FIG. 21.— Right maxilla or mandible. x 345.
FIG. 22.— Left first antenna. x 345.
FIG. 23.— Left second antenna. x 345.

son (*Proc. U. S. Nat. Mus.*, vol. 28, figs. 40–45, 1905). Professor Wilson says of my specimens it is "the first instance on record where one has been obtained in its free habitat." The capture proves his inference that the metanauplius is free-swimming. However, even the genus cannot be positively identified since Professor Wilson's metanauplius is the only one as yet recognized. (The two specimens described by Brady ('99) from Otago, New Zealand, and named provisionally *Centromma thomsoni*, are very like my specimens and must belong to the Caligidæ rather than to the Corycæidæ.)

Length 0.63 mm.; breadth 0.157 mm.

The carapace is moderately slender and is marked near the middle by a slight notch on each side (Fig. 16). In front of these notches lie the eyes, the two pairs of antennæ, the protrusive toothed proboscis, the maxilla (?), and two maxillipeds. There seems to be a groove or depression in the dorsal surface of the carapace which runs backward from the front almost to the eyes. The ruby-red eyes are fused and lie just in front of the notches of the carapace. The first antenna (Fig. 22) arises some distance from the anterior end of the carapace and passes forward to its tip, then turns backward and downward towards its origin, and finally outward. The first portion seems to consist of two joints: a basal joint which is not clearly marked off from the carapace and which bears at its outer distal angle a strong spine, and a distal joint which is about twice the length of the first. The second portion is formed of two joints: a long one which bears two bristles and a short joint whose end is drawn out on the side next the carapace (outer side) into a long bristle. The distal portion of the antenna is a single joint which seems to be held almost at right angles to the sagittal axis of the metanauplius. Its end bears ten or twelve (or more) bristles, most of which are long and all non-plumose and flaccid. The second antenna (Fig. 23) is biramous. The basal joint is short and broad, and lies just inside that of the first antenna. The inner ramus is slender and relatively short, and ends in a tuft of four or more unjointed spines. The outer ramus is 2-jointed. The proximal joint is moderately swollen at the base but tapers distally. The distal joint is a hook swollen at the base.

On each side of the mouth there is the structure represented in Fig. 21 whose identity is not clear but which probably represents the maxilla. It is a ridge which bears in front a 2-jointed appendage and ends posteriorly in a strong spine. The basal joint of the appendage is drawn out posteriorly into a curved spine, swollen at base. It is possible that this represents the outer ramus and the basal portion of the appendage. The distal joint is oval, outwardly directed, and ends in two strong bristles. The first maxilliped (Fig. 19) is 2-jointed, heavy and short. The distal joint terminates in two claws, of which the outer is bristled and the inner finely toothed or bristled. The second maxilliped (Fig. 20) is 3-jointed. The basal joint bears near the middle of its inner surface a strong, backwardly directed spine. The second joint is about one half as long as the first. The distal joint is a sickle-shaped hook with a spine at base. The mouth is supplied with a protrusible proboscis which is a truncated cone armed at the apex with a circle of inwardly directed spines. This suggests that the metanauplius is ready to attach itself to a host.

At the posterior end, the carapace bears a pair of swimming legs. The first of the free thoracic segments bears a pair of legs and the second has on each side two spines. Two segments follow, the first without appendages, and the second, the anal segment, with the short furca. The two pairs of legs are very similar. Each has a single basal joint and two 1-jointed rami. There is a feathered bristle on the tip of the outer edge of each basal joint. The outer ramus of the first pair of swimming feet has four spines, one at the outer side and three at the end, and three long feathered bristles. The inner ramus has a smooth outer edge which bears an unjointed spine at the end. The inner edge has six (or seven) long feathered bristles. The second pair of legs (Fig. 17) is similar except that the outer ramus has three spines and four bristles and the inner ramus is broader than in the first pair. Each anal lamella (Fig. 18) (ramus of the furca) is short and irregular, and bears five bristles. The outer furcal seta is plumose on the outer side and the inner seta is plumose on both edges.

BIBLIOGRAPHY

BAIRD, W.

'37. History of the British Entomostraca. *Mag. Zool. and Bot.*, vol. 1.

'43. Notes on British Entomostraca. *Zoologist*, vol. 1, pp. 193–197.

'50. The Natural History of British Entomostraca. Ray Society, London, 364 pp., 36 pls.

BOECK, A.

'64. Oversigt over de ved Norges Kyster iagttagne Copepoder. *Christiania Selsk. Forh.*, pp. 226–282.

'72. Nye Slægter og Arter af Saltvands-Copepoder. *Christiania Selsk. Forh.*, pp. 35–60.

BRADY, G. S.

'78–80. A Monograph of the Free and Semi-parasitic Copepoda of the British Islands. Ray Society, London, 3 vols., 413 pp., 93 pls.

'83. Report on the Copepoda collected by H. M. S. *Challenger* during the years 1873–76. *Report of the Challenger*, Zoology, vol. 8, pt. 23, 142 pp., 45 pls.

'99. On the Marine Copepoda of New Zealand. *Trans. Zool. Soc. London*, vol. 15, pt. 2, pp. 31–54, pls. 9–13.

BRADY, G. S., AND ROBERTSON, D.

'73. On Marine Copepoda taken in the West of Ireland. *Ann. Mag. Nat. Hist.*, ser. 4, vol. 12, pp. 126–142, pls. 8, 9.

CLAUS, C.

'63. Die freilebenden Copepoden mit besonderer Berücksichtigung der Fauna Deutschlands, der Nordsee und des Mittelmeeres. Leipzig, x + 230 pp., 37 pls.

'66. Die Copepoden-Fauna von Nizza. *Schriften Ges. Naturw. Marburg*, 1 supplm.-heft, 34 pp., 5 pls.

'81. Ueber die Gattungen Temora und Temorella. *Sitzungsber. Akad. Wien*, vol. 83, abth. 1, pp. 482–492, pl. 2.

DAHL, F.

'94. Die Copepoden-Fauna des unteren Amazonas. *Ber. naturf. Ges. Freiburg i. B.*, vol. 8, pp. 1–14, pl. 1.

DANA, J. D.

'52. Crustacea of the U. S. Exploring Expedition during the Years 1838–42. Philadelphia, vol. 13, pt. 2, pp. 1019–1262, atlas (1855), pls. 70–88.

GIESBRECHT, W.

'81. Vorläufige Mittheilung aus einer Arbeit über die freilebenden Copepoden des Kieler Hafens. *Zool. Anz.*, vol. 4, pp. 254–258.

'82. Die freilebenden Copepoden der Kieler Foehrde. *4. Ber. Commiss. Wiss. Unters. Deutschen Meere, Kiel,* 1877–1881, Jahrg. 7–11, pp. 87–168, pls. 1–12.

'92. Fauna und Flora des Golfes von Neapel. XIX Monographie; Pelagische Copepoden. Berlin. 831 pp., 54 pls.

'96. Ueber pelagische Copepoden des Roten Meeres. *Zool. Jahrb.,* Abth. f. Syst., vol. 9, pp. 315–328, pls. 5, 6.

GIESBRECHT, W., UND SCHMEIL, O.

'98. Das Tierreich. Lief. 6. Crustacea, Copepoda, I Gymnoplea. Berlin. xvi + 169 pp., 31 text-figs.

GUNNER, J. E.

1765. Nogle smaa rare, mestendelen nye norske, Södyr, beskrevene. *Skrifter Kjoebenhavnske Selsk.,* vol. 10, p. 175.

HERRICK, C. L.

'84. Final Report on the Crustacea of Minnesota. 12 *Ann. Rep. Geol. Nat. Hist. Surv. Minnesota,* 192 pp., 29 pls.

HERRICK, C. L., AND TURNER, C. H.

'95. Synopsis of the Entomostraca of Minnesota. *Rep. Geol. Nat. Hist. Surv. Minnesota,* zoöl. ser. 2, 337 pp., 81 pls.

KRÖYER, H.

'42–45. Crustacés, Gaimard's Voyage en Scandinavie, 1838–40. Paris, atlas, pls. 41–43.

LILLJEBORG, W.

'53. De Crustaceis ex Ordinis tribus Cladocera, Ostracoda, et Copepoda in Scania occurentibus. Lund, 222 pp., 27 pls.

MILNE-EDWARDS, H.

'34–40. Histoire Naturelle de Crustacés. Paris, 3 vols., vol. 3, pp. 411–529.

MÜLLER, O. F.

1776. Zoölogiæ Danicæ Prodromus. Havniæ.

1785. Entomostraca seu Insecta Testacea quæ in Aquis Daniæ et Norvegiæ reperit. Lipsiæ.

NORDQUIST, O.

'88. Die Calaniden Finnlands. *Bidr. Kanned. Finl. Nat. Folk.,* heft 47, 86 pp., 10 pls.

NORMAN, A. M.

:03a. New Generic Names for some Entomostraca and Cirripedia. *Ann. Mag. Nat. Hist.,* ser. 7, vol. 11, pp. 367–369.

:03b. Natural History of East Finnmark. *Ann. Mag. Nat. Hist.,* ser. 7, vol. 11, pp. 1–32, pl. 4.

POPPE, S. A.

'81. Ueber einen neuen Harpacticiden. *Abh. Ver. Bremen,* vol. 7, pp. 55–60, pl. 3.

POPPE, S. A., AND RICHARD, J.

'90. Description du *Schmackeria forbesi* n. g. & n. sp. *Mém. Soc. Zool. France,* vol. 3, p. 396, pl. 10.

RATHBUN, M. J.

:05. Fauna of New England. Crustacea. *Occ. Papers Boston Soc. Nat. Hist.*, vol. 7, no. 5, 117 pp.

SARS, G. O.

'98. The Cladocera, Copepoda, and Ostracoda of the Iana Expedition. *Ann. Mus. Zool. Acad. St. Petersburg*, pp. 324–359.

:03. The Crustacea of Norway. Bergen, vol. 4, 171 pp., 102 + 6 pls.; vol. 5, 132 pp., 80 pls. (Incomplete.)

SCOTT, T.

'94. Report on the Entomostraca from the Gulf of Guinea. *Trans. Linn. Soc. London*, zool., n. s., vol. 6, pp. 1–161, pls. 1–15.

SCOTT, T., AND SCOTT, A.

'96. Revision of British Copepoda belonging to the Genera Bradya and Ectinosoma. *Trans. Linn. Soc. London, zool.*, n. s., vol. 6, pp. 419–446, pls. 35–38.

THOMPSON, I. C.

'95. Revised Report on the Copepoda of Liverpool Bay. *Fauna of Liverpool Bay, Rep.* 4, pp. 81–136, pls. 15–35.

THOMPSON, I. C., AND SCOTT, A.

'98. Notes on New and Other Copepoda in Plankton collected continuously during two Traverses of the North Atlantic. *Proc. and Trans. Liverpool Biol. Soc.*, vol. 12, pp. 71–82, pls. 5–7.

VERRILL, A. E., AND SMITH, S. I.

'74. Report upon the Invertebrate Animals of Vineyard Sound. *Rept. U. S. Fish Comm. for* 1871–72, 478 pp., 38 pls.

WHEELER, W. M.

:00. Copepoda of the Wood's Hole Region. *Bull. U. S. Fish Comm. for* 1899, vol. 19, pp. 157–192, 30 text-figs.

WILSON, C. B.

:03. American Parasitic Copepoda of the Family Argulidae. *Proc. U. S. Nat. Mus.*, vol. 25, pp. 635–742, pls. 8–27.

:04. Fish Parasites of the Genus Argulus from the Wood's Hole Region. *Bull. U. S. Bureau of Fisheries*, vol. 24, pp. 117–131.

:05. North American Parasitic Copepods. *Proc. U. S. Nat. Mus.*, vol. 28, pp. 479–672, pls. 5–29.

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