

## THE PLANKTONIC OSTRACODS OF THE CARIACO TRENCH AND ADJACENT WATERS<sup>1</sup>

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### Introduction

The Cariaco Trench is a depression up to 1,400 m deep in the continental shelf off the north coast of Venezuela, that is anaerobic beneath 320-375 m. Oxygen disappears and sulphides appear at between 300 and 400 m. Its waters are cut off from the Caribbean below 150 m. The water is essentially isothermal at 17°C and isohaline at 36.2‰ from ca. 400 m to the bottom (Richards and Vaccaro, 1956; Richards, 1965; Kato, 1961; Heezen, Menzies, Broecker and Ewing, 1959). Zoppi (1961) studied the vertical distribution of the zooplankton of the upper 500 m of the Cariaco Trench, and found highest volumes within the upper 100 m, but the total quantity of zooplankton was not as great as in the adjacent Gulf of Cariaco. All zooplankton groups were most abundant within the upper 100 m, although ostracods, polychaetes, copepods, and some larval forms were recorded between 100 and 300 m. Few specimens were caught between 300 and 500 m. The copepods of the upper 500 m have been studied by Legare (1964), who identified 102 species, of which 50 occurred commonly. Cervigon and Marcano (1965) collected plankton samples from the Cariaco Trench and also at a station north of the Trench between La Tortuga and Blanca Islands. From Station 11 in the Trench they enumerated the copepod species down to 500 m-depths from April 1964 to June 1965, and found maximum numbers in daytime at 50-100 m; copepods were very scarce below 150 m, except in June and July. In July oxygen was detected at all depths and copepods were more abundant at 500 m. However, living copepods were taken in minimal numbers at 500 m at all times, and it was believed that a few organisms were existing under anoxic conditions, temporarily or permanently. Cervigon and Marcano also studied the total zooplankton collected in February, March, and June 1965, and reported maximal numbers at the surface, but many species present down to 300 m, the greatest depth sampled. At Station 3 north of the Trench, comparable results were obtained for the upper 100 m, but between 100 and 300 m species not taken at Station 11 were noted.

In 1967-1968 Dr. Cervigon sampled at several stations off the Venezuelan coast: at Station 11 at 10°29'N, 64°26'W in the Cariaco Trench off Cumana, At Station 63, an inshore station, at 11°14'N, 65°00'W, and at Station 76, an offshore station, at 11°45'N, 66°56'W (see Fig. 1). The samples were collected with a giant Clarke-Bumpus sampler by horizontal tows at 0, 25,

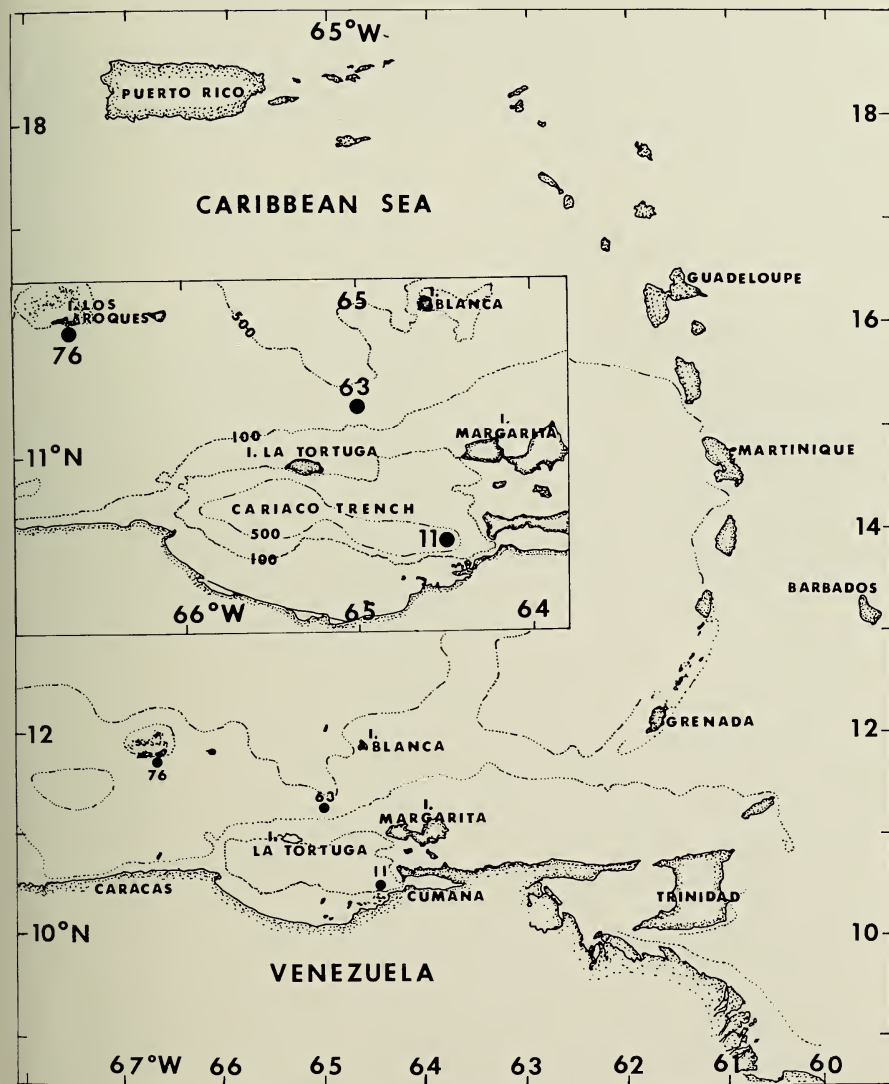


Fig. 1. Locations of Stations 11, 63, and 76 off the north coast of Venezuela. Depth contours in fathoms.

50, 100, 200, 500, and 700, 725 or 800 m; some tows were made at 1,000 or 1,200 m or from 800, 1,000, or 1,200 m to the surface. Six cruises were made to the 3 stations between September 1967 and July 1968. Dr. Cervigon very kindly allowed me to examine the ostracods in these samples, and in a visit in May 1973 to the Estacion de Investigaciones Marinas de Margarita

Table 1. Species of ostracods recorded from Station 11 in the Cariaco Trench, and from stations 63 and 76 off the north coast of Venezuela.

	Sta. 11	Sta. 63	Sta. 76
<i>Archiconchoecia cucullata</i> (Brady)	—	×	×
<i>A. fabiformis</i> , n. sp.	—	—	×
<i>A. ventricosa</i> Müller	—	—	×
<i>A. striata</i> Müller	—	×	×
<i>Euconchoecia chierchiae</i> Müller	×	×	×
<i>Fellia bicornis</i> (Müller)	—	×	×
<i>F. cornuta cornuta</i> (Müller)	—	×	×
<i>Halocypris brevirostris</i> (Dana)	—	×	×
<i>Conchoecia acuminata</i> (Claus)	×	×	×
<i>C. aequiseta</i> Müller	—	×	×
<i>C. allotharium</i> Müller	—	×	×
<i>C. ametra</i> Müller	—	×	—
<i>C. atlantica</i> (Lubbock)	—	×	×
<i>C. bispinosa</i> Claus	—	—	×
<i>C. brachyaskos</i> Müller	—	×	×
<i>C. concentrica</i> Müller	×	×	×
<i>C. convexa</i> Deevey	—	×	×
<i>C. curta</i> Lubbock	—	×	×
<i>C. daphnoides</i> (Claus)	—	×	×
<i>C. dentata</i> Müller	—	×	×
<i>C. echinata</i> Müller	—	×	×
<i>C. echinulata</i> (Claus)	—	—	×
<i>C. aff. edentata</i> Müller	—	×	—
<i>C. elegans</i> Sars	—	×	×
<i>C. imbricata</i> (Brady)	—	×	×
<i>C. incisa</i> Müller	—	×	—
<i>C. inermis</i> (Claus)	—	×	×
<i>C. kampta</i> Müller	—	×	—
<i>C. lophura</i> Müller	—	×	—
<i>C. loricata</i> (Claus)	—	×	×
<i>C. macrocheira</i> Müller	×	×	×
<i>C. macroprocera</i> Angel	—	—	×
<i>C. magna</i> Claus	—	×	×
<i>C. microprocera</i> Angel	×	×	×
<i>C. mollis</i> Müller	—	×	×
<i>C. oblonga</i> (Claus), Form B	×	×	×
<i>C. parthenoda</i> Müller	—	×	×
<i>C. parvidentata</i> Müller	—	×	—
<i>C. porrecta</i> Claus	×	×	×
<i>C. procera</i> Müller	×	×	×
<i>C. pusilla</i> Müller	—	×	×
<i>C. reticulata</i> Müller	—	×	×
<i>C. rotundata</i> Müller	×	×	×
<i>C. rhynchena</i> Müller	—	×	×
<i>C. discernenda</i> Vavra	—	×	×

Table 1. Continued.

	Sta. 11	Sta. 63	Sta. 76
<i>C. skogsbergi</i> Iles	—	×	×
<i>C. spinifera</i> (Claus)	—	×	×
<i>C. spirostris</i> Claus	×	×	×
<i>C. stigmatica</i> Müller	—	×	×
<i>C. subarcuata</i> Claus	—	×	×

at Boca del Rio on Isla Margarita specimens were counted and/or removed from some of these series of samples. Unfortunately, on this brief visit it was not possible to make a quantitative study of the depth distributions of the various species, but only to note the numbers and occurrence of species at various depths at the three stations. The data presented here were obtained by examining 20 samples from various depths and times of year from Station 11, 20 samples from Station 63, and 21 samples from Station 76. I am greatly indebted to Dr. Fernando Cervigon for the pleasure and privilege of visiting this laboratory and of examining the halocyprid ostracods from the Cariaco Trench and adjacent waters.

### The Ostracods

The waters of the Cariaco Trench contain an exceptionally impoverished ostracod fauna. Table 1 lists the 50 species, including one new species, recorded from the 3 stations. Of these only 10 were found at Station 11, and 5 of these (*Euconchoecia chierchiaie*, *Conchoecia concentrica*, *C. porrecta*, *C. procera* and *C. spirostris*) were numerous in the upper waters. The other 5 were represented by no more than several specimens, all recorded above 200 m, except for a single juvenile *C. macrocheira*, which was taken in a tow at 700 m. All the species noted from Station 11 normally live within the upper several hundred meters or less, and although the most abundant species were found throughout the water column, this was probably, though not certainly, due to contamination from the upper waters. Even species occurring at shallow depths at the other 2 stations were not noted in Cariaco Trench waters. For example, at 50 m-depths five species (*Archiconchoecia striata*, *Halocypris brevirostris*, *Conchoecia atlantica*, *C. parthenoda* and *C. secernenda*) were recorded, especially from Station 76, that were not taken at any depths in the Trench. Table 2 lists the species found at all depths at Station 11 together with species recorded from the upper 100 m at Stations 63 and 76, and shows that 9 species that were taken in the upper 100 m at the other stations were not found at Station 11. If the list is expanded to include the species caught within the upper 200 m at

Table 2. Ostracod species recorded from Station 11, and between the surface and 100 m from Stations 63 and 76.

	Sta. 11	Sta. 63	Sta. 76
<i>Archiconchoecia striata</i>	—	—	×
<i>Euconchoecia chierchiae</i>	×	×	×
<i>Halocypris brevirostris</i>	—	×	×
<i>Conchoecia acuminata</i>	×	×	×
<i>C. atlantica</i>	—	×	×
<i>C. concentrica</i>	×	×	×
<i>C. curta</i>	—	×	×
<i>C. echinata</i>	—	—	×
<i>C. elegans</i>	—	×	×
<i>C. macrocheira</i>	×	—	—
<i>C. magna</i>	—	—	×
<i>C. microprocera</i>	×	—	×
<i>C. oblonga</i>	×	×	×
<i>C. parthenoda</i>	—	×	×
<i>C. porrecta</i>	×	×	×
<i>C. procera</i>	×	×	×
<i>C. rotundata</i>	×	×	×
<i>C. secernenda</i>	—	×	×
<i>C. spirostris</i>	×	×	×

Stations 63 and 76, 9 more species are added, including *C. macrocheira*, to make a total of 27 species, compared with the 10 from Station 11.

Table 3 compares the numbers of species recorded per depth zone from the three stations. Some contamination of the deeper samples by species from shallower depths may have occurred, since some of the presumed epipelagic species were taken in samples from 700 or 800 m. At Station 76 the numbers of species increased down to 500 m, and at Station 63 numbers increased to 725 m. At both these stations highest numbers of species were caught in the vertical tows from 1,000 or 1,200 m to the surface. At Station 76 10 species were taken only from 500 m or greater depths, whereas 14 were recorded from Station 63. Nineteen species were noted only below 500 m or in the vertical tows from Station 76, and 20 from Station 63, but only one (the juvenile *C. macrocheira*) from Station 11. There is no doubt that the anoxic conditions in the Cariaco Trench limit the numbers of species of halocyprid ostracods living in the upper waters, and even exclude species which live at shallow depths in adjacent waters. According to Heezen et al. (1959), the waters of the Trench are cut off from the Caribbean below 80 fathoms or 150 m, but are largely isolated below 45 fathoms or 80 m-depths. The commonest and most abundant species in the Cariaco

Table 3. Number of ostracod species recorded per depth zone, with number of samples examined in parentheses.

Depth, m	Station 11	Station 63	Station 76
25	6 (2)	7 (1)	5 (2)
50	6 (2)	7 (1)	12 (2)
100	7 (3)	11 (1)	17 (2)
200	7 (3)	19 (3)	23 (3)
500	5 (4)	19 (4)	28 (5)
700	7 (2)	17 (2)	1 (1)
725	3 (1)	31 (2)	2 (1)
800	—	13 (1)	12 (1)
800-0	—	—	30 (1)
1,000-0	4 (1)	39 (4)	37 (2)
1,200-0	4 (1)	33 (1)	32 (2)
No. of species only from 500 m or deeper	1	14	10
No. of species from 500 m or in vert. tows	1	20	19

Trench (*E. chierchiae*, *C. concentrica*, *C. porrecta*, *C. procera*, and *C. spinirostris*) are all species usually found within the upper 50 m, whose numbers may be constantly recruited from the open waters of the Caribbean. Except for *C. procera*, they were most numerous at 50 m; *C. procera* was the most abundant species in the Trench and occurred in highest numbers from 100 to 200 m. The conditions in the Trench apparently favored the development of the *C. procera* population, which was unquestionably far more numerous in those waters than at the other two stations, where other species were present.

Table 4 lists the percentages obtained for the several species at Station 11 in March 1968 from samples collected at 50, 100 and 200-m depths, and shows that *E. chierchiae*, *C. concentrica*, *C. porrecta*, and *C. spinirostris* were all most numerous at 50 m. These species were also present at 25 m. At 100 m *C. procera* constituted 79% of the total numbers, and increased to 96.4% at 200 m. Total numbers appeared to be highest at 200 m, although quantitative counts were not made due to lack of time. At Station 76 at the same time, *C. procera* accounted for only 12.3% of the total numbers at 200 m, and species not found at Station 11 were equally abundant. These included *Archiconchoecia striata* (11.1%), *Conchoecia curta* (16.4%), and *C. oblonga* (17.0%).

In an analysis of the vertical and geographic distributions of abundant species of planktonic ostracods in the northeast Atlantic, between 10½-11°N, 18°, 30°, 40°, 53° and 60°N, and ca. 20°W, Angel and Fasham (1975) found that highest numbers of ostracods were found at progressively deeper levels

Table 4. Percentage composition of ostracod species at 3 depths at Station 11 in March 1968.

	50 m	100 m	200 m
<i>Euconchoecia chierchiai</i>	14.3	6.0	0
<i>Conchoecia acuminata</i>	0.9	0	0
<i>C. concentrica</i>	20.5	7.5	0.3
<i>C. microprocera</i>	0	4.0	2.2
<i>C. oblonga</i>	0	0.5	0
<i>C. porrecta</i>	32.2	3.0	0.8
<i>C. procera</i>	1.8	79.0	96.4
<i>C. rotundata</i>	0	0	0.3
<i>C. spinirostris</i>	28.5	0	0
Unidentified juveniles	1.8	0	0

in going from lower to higher latitudes; at  $10\frac{1}{2}^{\circ}\text{N}$  the main population of ostracods was predominantly epipelagic and was found in the upper 100 m, both in day and nighttime, indicating little or no vertical diurnal migrations of the species at this latitude. It is therefore baffling that epipelagic species that presumably could have survived the conditions within the upper 200 m or so of the Cariaco Trench, and that could have been constantly carried in above the maximum sill depths of ca. 150 m, were not noted at Station 11. If there is little or no vertical migration of species at this latitude, none should have been excluded by this factor. However, the oxygenated surface waters contain minute amounts of methane, continually rising from the depths below. According to Wiesenburg (1974), the surface waters contain  $10^{-4}$  ml of methane per liter of sea water, and below 320 m the quantity steadily increases with depth. This, together with associated conditions, may be sufficient to exclude many ostracod species from these waters.

Many more species of copepods are epipelagic. As noted, Legare (1964) listed 102 species from the upper 500 m of the Cariaco Trench. Cervigon and Marcano (1965) reported 96 species or categories of copepods. Cervigon's unpublished data on the copepods collected down to 1,000 or 1,200 m at Stations 11, 63 and 76 give totals of 83 species for Station 11, 141 for Station 63, and 123 for Station 76, with a total of 162 species for the three stations. Therefore, at Station 11, 51% of the total numbers of copepod species recorded from the region were present, compared with only 20% of the total numbers of ostracod species. Also, only 37% of the ostracod species present in the upper 200 m at Stations 63 and 76 were noted at Station 11. The copepods not recorded from Station 11 include species of genera, such as *Candacia*, *Euchirella*, *Gaetanus*, *Lophothrix*, *Metridia*, *Pleuromamma*, *Scottocalanus*, and *Undeuchaeta*, which normally live at greater depths. Apparently the epipelagic copepods are better able to thrive in the upper waters of the Cariaco Trench than are the ostracods.

The Species of Ostracods  
Subfamily ARCHICONCHOECINAE

The two commonly recorded species of *Archiconchoecia*, *A. striata* Müller and *A. cucullata* (Brady), were taken at both Station 63 and 76, but not at Station 11. *A. striata* was found over a depth range of 800–50 m at Station 76 and also in a 1,000–0 m sample at Station 63, and was present throughout the year. *A. cucullata* was noted only in September 1967 and January 1968 in a 500 m and a 1,000 m sample at Station 76; at Station 63 it was found at 500 m and at 725 m in March 1968.

Two specimens of the rarely recorded *A. ventricosa*-type were caught at Station 76. One is here described as a new species. The other, a male, is redescribed as *A. ventricosa* Müller. Müller (1906) gave only a brief description of the shell and first and second antennae of *A. ventricosa*, and this male agrees with Müller's specimen in these respects. Poulsen (1969) has also described as *A. ventricosa* a 1.8 mm long female which differs from Müller's description in several details. Unfortunately, specimens of this type are rarely caught, and no others have been described, although Angel and Fasham (1975) have reported this species from 10½–53°N, ca. 20°W in the eastern North Atlantic, and Poulsen (1969) and Angel (1971/72) have listed it as occurring in the Atlantic, Pacific and Indian Oceans. Either *A. ventricosa* is very variable, or there are a number of species of very similar shape, with a strongly swollen anterior margin. In more than one instance I know the latter to be the case, since I have several as yet undescribed species from the Sargasso Sea, which have the *A. ventricosa* shape but differ from Müller's species in a variety of ways. The only way to untangle this species complex is to describe all specimens sufficiently so that the various species of this type may be clearly distinguished. It should also be noted that my brief key to the species of *Archiconchoecia* (Deevey, 1968:23) is incorrect in separating *A. ventricosa* from *A. cuneata* by the shape of the frontal organ, since rounded, pointed, and bifurcate frontal organs are found in *A. ventricosa*-shaped ostracods.

*Archiconchoecia fabiformis*, new species

Figs. 2 and 3

*Holotype*.—Female, 1.05 mm long by 0.55 mm high. One slide, deposited in the National Museum of Natural History, Smithsonian Institution, USNM 169062.

*Type-locality*.—Station 76: 11°45'N, 66°56'W, in the Caribbean Sea. From a 1,200–0 m tow, collected 27 March 1968.

*Etymology*.—The specific name is derived from the Latin "faba" plus "formis," meaning bean-shaped, and refers to the shape of the shell, viewed laterally.



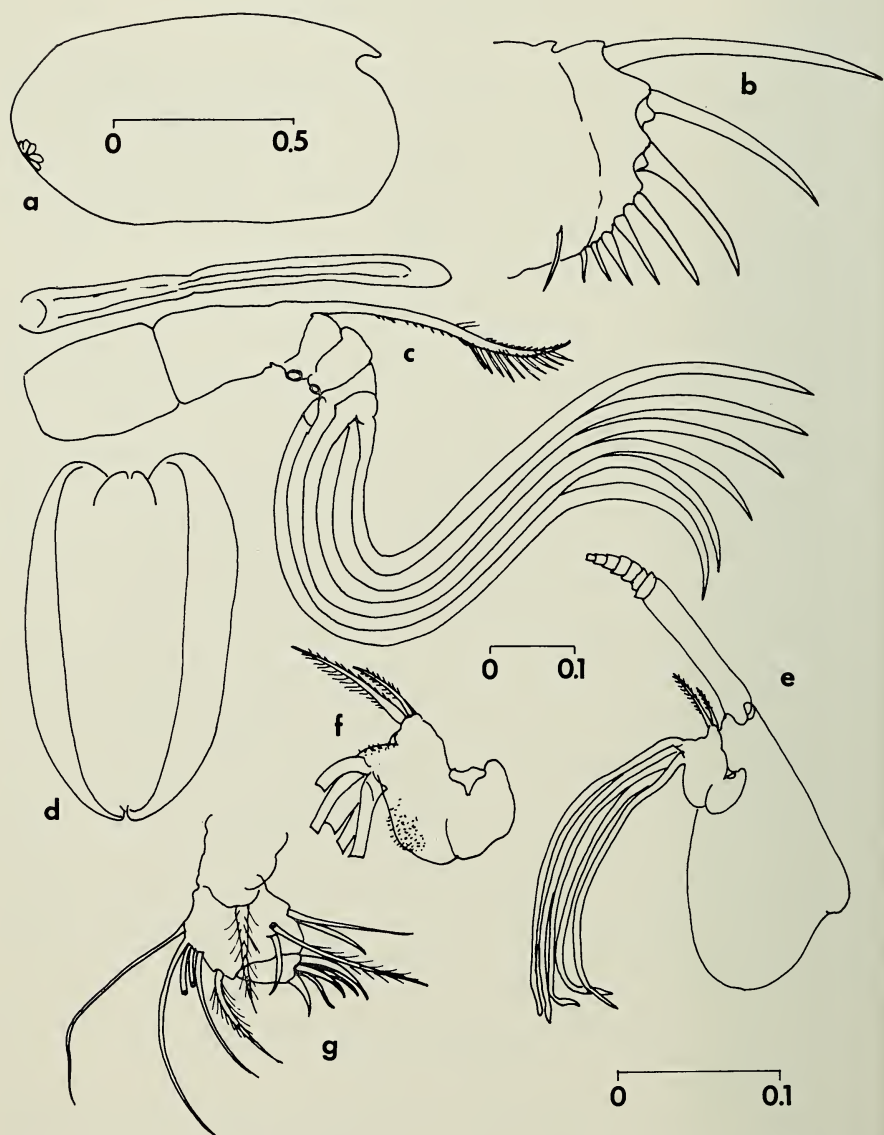


Fig. 2. *Archiconchoecia fabiformis*, female. a, Lateral view of female; b, Furca; c, Frontal organ and 1st antenna; d, Ventral view of shell; e, Second antenna, exopodite setae not drawn; f, Endopodite of 2nd antenna, setae and filaments cut off; g, Endopodite of maxilla. Scales, in mm, on a for a and d, near e for e, at bottom right for b, c, f, g.

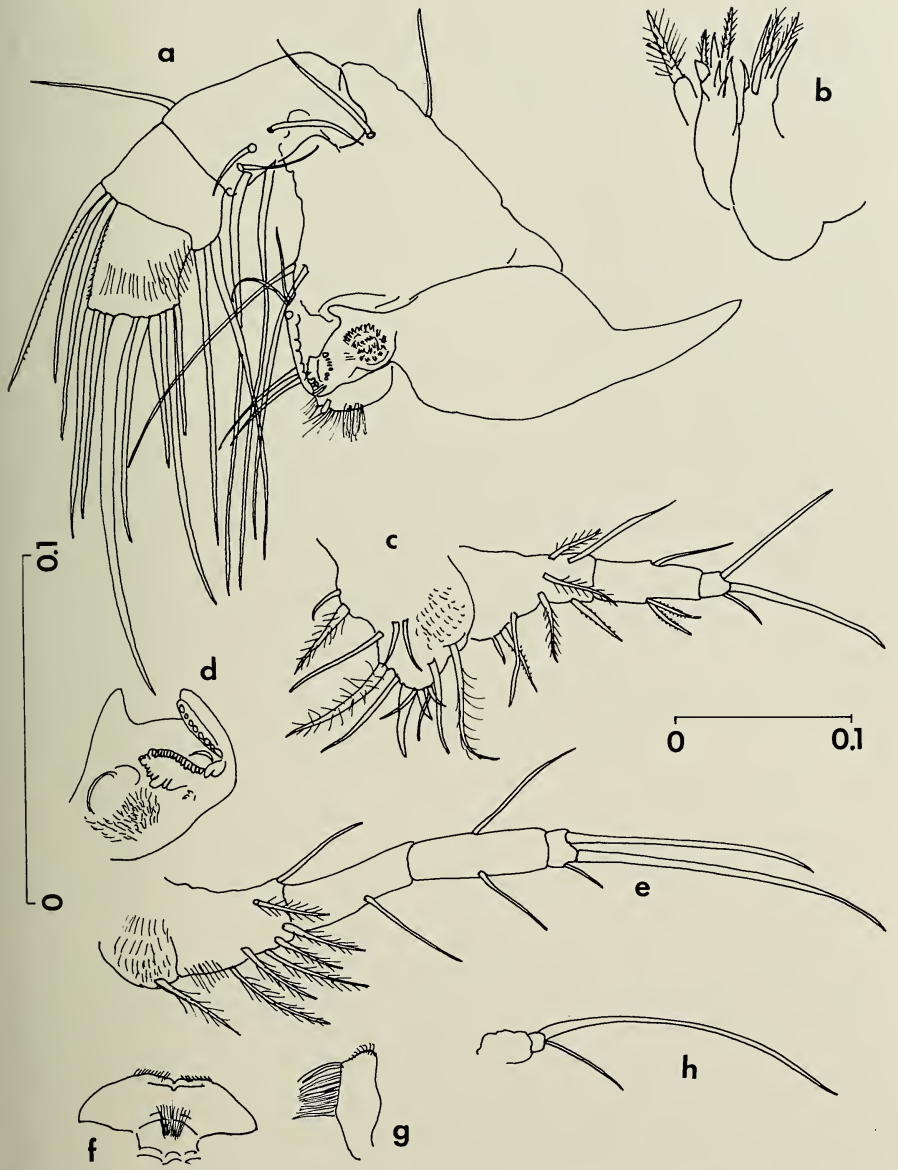


Fig. 3. *Archiconchoecia fabiformis*, female. a, Mandible; b, Basale, and coxal and precoxal endites of maxilla; c, Fifth limb; d, Tooth rows and masticatory surface of coxa of mandible; e, Sixth limb; f, Labrum; g, Paragnath; h, Seventh limb. Scale, in mm, on left margin for d, at right for a-c, e-h.

*Description of female.*—Shell (Fig. 2a, d): Height a little over 50% of length. Anterior margin swollen and rounded, posterior margin rounded, ventral margin almost straight. Right asymmetrical gland ca.  $\frac{1}{3}$  of the way up the posterior margin; no indication of left asymmetrical gland. Shoulder vaults not developed, shell rounded in anterior or posterior view. There is a faint indication anteriorly of lines on the shell, more or less parallel to the ventral margin.

First antenna and frontal organ (Fig. 2c): The frontal organ, rounded at the tip and bare of hairs or spinules, hardly extends beyond the distal segments of the 1st antenna. Second segment of 1st antenna bears dorsally a large seta, strongly spined distally. The 5th segment bears 2 filaments and the 6th segment 4 filaments, all of equal length and pointed at the tips. No hairs or spinules were visible on the 6 segments of the 1st antenna.

Second antenna (Fig. 2e, f): The 1st segment of the exopodite is around 60% the length of the shaft. The basal segment of the endopodite has some tiny spinules and bears 2 long, densely spined bristles on a rounded protuberance. The proximal bristle is 60% the length of the longer distal bristle. The 5 long filaments of the distal segment of the endopodite are of equal length.

Mandible (Fig. 3a, d): The incisor surface of the basale has 6 (?) finely serrated but not completely separated teeth and 2 larger teeth. There are 6 setae near the distal end of the basale and 1 near the articulation of the endopodite; the 1st segment of the endopodite has 6 setae, the 2nd segment 5 setae, and the distal segment, partially covered with hairs, has 7 setae. The coxa has a chitinized knob-like articular process; there are several tooth-rows, difficult to distinguish (Fig. 3d), and a masticatory pad of small spines.

Maxilla (Figs. 2g, 3b): The 1st segment of the endopodite has 10 setae, of which 2 are plumose. The distal segment has 2 claws and 3 short setae, 1 larger than the other 2. The coxal and precoxal endites have each at least 8 bristles, several of which are long and spinous.

Fifth limb (Fig. 3c): The protopodite and endopodite have a total of 12 setae or bristles and 2 claws. The 1st segment of the exopodite has 8 setae, of which 3 are plumose, the 2nd segment 3 setae, and the distal segment 2 long slim claw-setae and a short seta. The epipodial appendage has 3 groups of 4-4-5 setae each.

Sixth limb (Fig. 3e): The 1st segment of the exopodite has 6 plumose setae and a bare dorsal seta. There are some fine hairs on the protopodite and 1st exopodite segment. The 2nd exopodite segment has 1 seta, the 3rd 2 setae, and the distal segment 2 exceptionally long slim claw-setae and a short seta. The epipodial appendage has 3 groups of 5-5-6 plumose setae each.

Seventh limb (Fig. 3h): This has 2 setae, the shorter of which is about  $\frac{1}{2}$  the length of the longer seta.

Furca (Fig. 2b): This has 8 fairly straight claws, and a single unpaired bristle.

*Remarks.*—This species is similar in size and shape to Müller's (1906) female *A. ventricosa*, but differs most notably in having a rounded frontal organ and also in the relative lengths of the 2 bristles on the proximal segment of the endopodite of the 2nd antenna. Müller's female had a pointed frontal organ, and the 2 bristles on the proximal segment of the endopodite of the 2nd antenna were of about the same length, whereas in the *A. fabiformis*, n. sp., female, one bristle was noticeably longer, the shorter being 60% the length of the longer one. Unfortunately, Müller described only the shell and the 1st and 2nd antennae, and did not even mention how many claws were on the furca. Poulsen's (1969) female *A. ventricosa* was 1.8 mm long, had a pointed bifurcate frontal organ and 7 claws on the furca. One of the 2 bristles on the proximal segment of the endopodite of the 2nd antenna was almost twice as long as the other, as in *A. fabiformis*. The setation of the appendages of Poulsen's *A. ventricosa* differs in some respects from that of *A. fabiformis*. In the latter, the basale of the mandible has 2 more setae, the endopodite of the mandible is also somewhat different, as well as the setation of the 5th and 6th limbs. Two of the setae on the distal segment of the 5th limb are longer and one is shorter than in Poulsen's *A. ventricosa*; similarly, 2 of the setae on the distal segment of the 6th limb are much longer and the other seta much shorter than described by Poulsen. Poulsen's female should be ascribed to a new species, and *A. fabiformis* differs sufficiently from Müller's *A. ventricosa* to be considered a new species of the *ventricosa*-type.

*Archiconchoecia ventricosa* Müller

Figs. 4 and 5

*Archiconchoecia ventricosa* Müller, 1906:45, Pl. 7, figs. 1-6.

*Material.*—Male, 0.84 mm long by 0.50 mm high at the anterior end. One slide, deposited in the National Museum of Natural History, Smithsonian Institution, USNM 169063. From a 500 m horizontal tow collected in September 1967 at Station 76:11°45'N, 66°56'W.

*Redescription of male.*—Shell (Fig. 4a-c): Anterior margin swollen, ventral margin almost straight, posterior margin rounded. As in the male described by Müller, the height of the shell is greatest at the anterior end and decreases posteriorly to around  $\frac{2}{3}$  of the anterior height. The left asymmetrical gland, invisible on this specimen, but discernible on 3 hitherto undescribed specimens from the Sargasso Sea, is at the top of the left posterior margin, just below the hinge. The right asymmetrical gland is approximately  $\frac{1}{3}$  of the way up the posterior margin. The shell is rounded laterally, with no indication of shoulder vaults (Fig. 4c). Slight

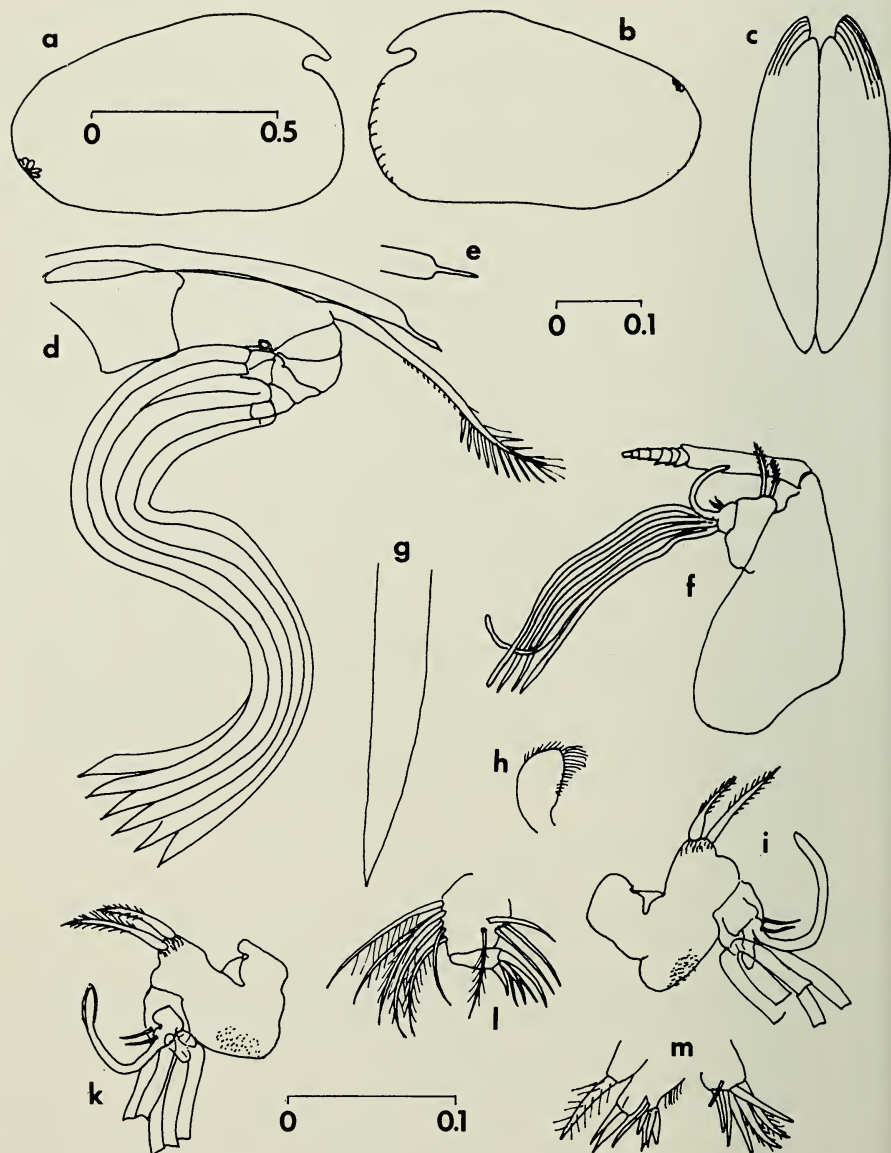


Fig. 4. *Archiconchoecia ventricosa*, male. a-c, Lateral and ventral views; d, Frontal organ and 1st antenna; e, Dorsal view of tip of frontal organ; f, Second right antenna, exopodite setae missing; g, Distal end of one of filaments of 1st antenna; h, Paragnath; i, Endopodite of right 2nd antenna, setae and filaments cut off; k, Endopodite of left 2nd antenna, setae and filaments cut off; l, Endopodite of maxilla; m, Basale and coxal and precoxal endites of maxilla. Scales, in mm, on a for a-c, at upper right for f, at bottom for d, e, g-m.

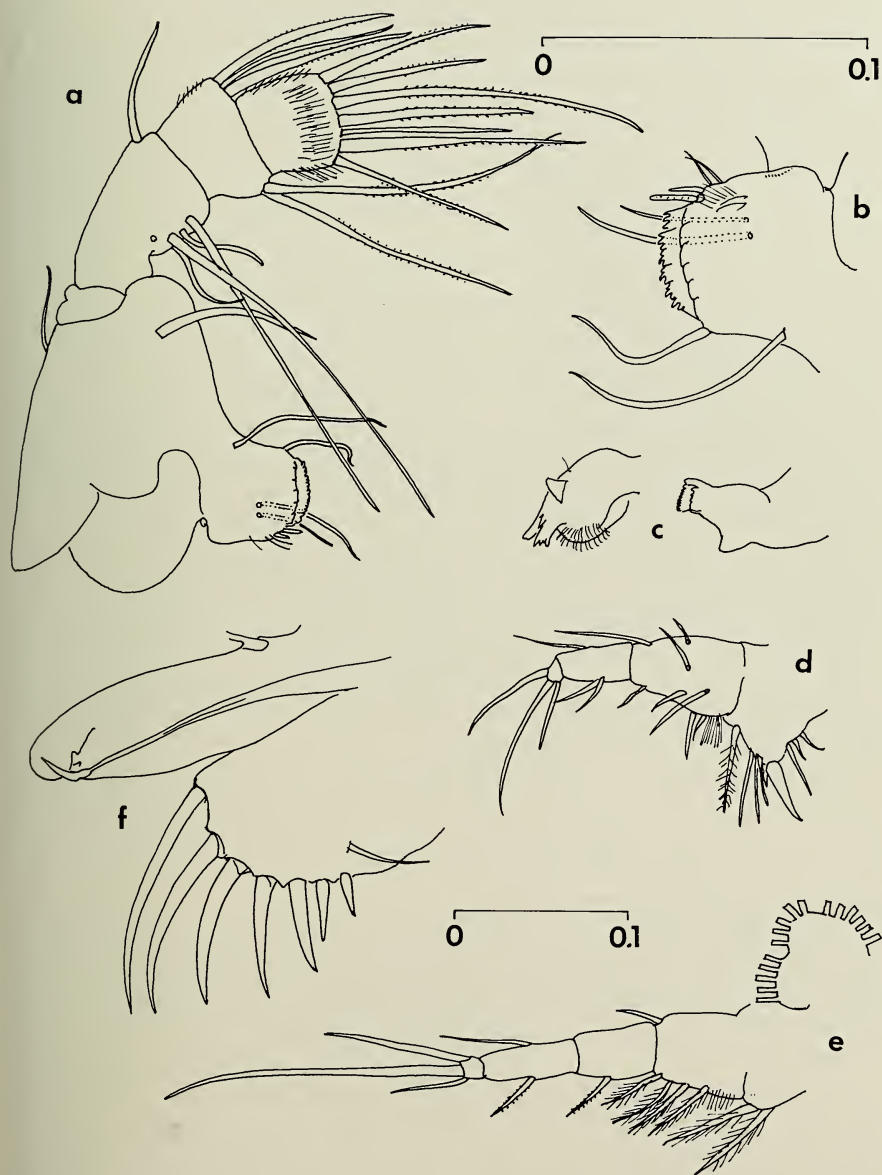


Fig. 5. *Archiconchoecia ventricosa*, male. a, Basale and endopodite of mandible; b, Incisor surface of basale of mandible; c, Two views of incisor and molar surfaces of coxa of mandible; d, Fifth limb; e, Sixth limb; f, Penis and furca. Scales, in mm, at top right for b, above e for a, c-f.

sculpturing was visible anteriorly, especially in dorsal view, as lines approximately paralleling the ventral margin (Fig. 4b, c).

First antenna and frontal organ (Fig. 4d, e, g): The frontal organ barely exceeds in length the down-curving distal segments of the 1st antenna, and has a long fine point, which in dorsal view is a long thin needle-like projection (Fig. 4e). The 1st antenna has a large strongly spined dorsal seta on the 2nd segment; the 5th segment bears 2 long filaments and the 6th segment 4, all of equal length and pointed at the tip. The filaments are quite wide (Fig. 4g). No hairs or spinules were noted on the segments of the 1st antenna.

Second antenna (Fig. 4f, i, k): The 1st exopodite segment is relatively short, 44–48% the length of the shaft. The 2 bristles on the basal segment of the endopodite are unequal in length, the proximal bristle being 73–77% the length of the distal bristle, and are coarsely spined and borne on a rounded protuberance. Ventrally there are some tiny spinules on the basal segment and also around the bases of the bristles. The right and left clasping organs are fairly similar, both slim and rounded, the right slightly larger than the left. The 5 filaments of the distal segment are almost equal in length (Fig. 4f).

Mandible (Fig. 5a–c): The incisor surface of the basale has presumably 6 finely serrated, but ill defined teeth, and 2 large long teeth (Fig. 5b). There are 4 setae near the distal end of the basale, and 1 near the articulation of the endopodite. The 1st segment of the endopodite has 5 setae, the 2nd segment 5 setae and some hairs, and the 3rd segment, partly covered with hairs, has 7 setae. The coxa has at least 2 tooth rows, very difficult to distinguish, and a masticatory pad of small spines.

Maxilla (Fig. 4m, l): The 1st segment of the endopodite of the maxilla has 10 long setae, of which 5 anterior and 1 posterior are plumose. The distal segment bears the 2 claws and 3 setae, one of which is larger, the other 2 slimmer. The coxal and precoxal endites have each at least 7 spines of varying lengths, some quite long.

Fifth limb (Fig. 5d): The endopodite has 7 bristles and 2 claws. The 1st segment of the exopodite has 8 setae and some long hairs, the 2nd segment 3 setae, and the distal segment 2 long slim claw-setae and a seta. The epipodial appendage is in 3 groups of 4-4-4 setae each.

Sixth limb (Fig. 5e): The 1st segment of the exopodite has 4 plumose ventral setae and some long hairs and a small bare dorsal seta, the 2nd segment 1 ventral seta, the 3rd segment 2 setae, and the distal segment the 2 claw-setae and a shorter seta. The shorter claw-seta is not quite half as long as the longer one. The epipodial appendage is in 3 groups of 5-5-6 long plumose setae each.

Penis (Fig. 5f): This is relatively slim and rounded at the tip.

Furca (Fig. 5f): This has only 7 pairs of claws and a single unpaired bristle.

*Remarks.*—This male is similar in size, shape, in the shape of the frontal

organ and clasping organs, and in the relative lengths of the 2 bristles on the basal segment of the endopodite of the 2nd antenna to Müller's *A. ventricosa* male. Although the left asymmetrical gland was not visible on this specimen, and in general is much less developed than the right gland, on the 3 specimens (2 females and 1 male) from the Sargasso Sea which agreed in every other detail, this gland was at the left postero-dorsal corner, as described by Müller. Unfortunately, Müller did not mention the number of claws on the furca, but all 4 specimens were mature, and had only 7 pairs of claws. *A. ventricosa* differs from *A. fabiformis*, n. sp., and from the other as yet undescribed *ventricosa*-shaped forms in the shape of the frontal organ, the setation of some of the appendages, and in having 7 claws on the furca. It differs from Poulsen's (1969) female *A. ventricosa* also in the shape of the frontal organ and the setation of some of the appendages. In general, the *ventricosa*-shaped species differ most notably from each other in the shape of the frontal organ, in the relative lengths of the basal segment of the exopodite to the shaft, and of the 2 bristles of the 2nd antenna, and in the lengths of the setae of the distal segments of the 5th and 6th limbs. There is little sexual dimorphism, males differing somewhat in shape from females, and in having clasping organs and a penis. *A. ventricosa* is a small species. Müller's female was 1.0 mm long, his males 0.80–0.85 mm in length. The 2 females from the Sargasso Sea were 0.90 and 0.94 mm long, the male 0.80 mm in length. The 3 specimens were all caught between 500 and 1,000 m-depths.

*Distribution*.—Müller's specimens were caught between 0°20'N and 2°36'N in the Atlantic, and at 7°N in the Indian Ocean. The present data extend the range to 11°45'N in the Caribbean Sea and to 32°10'N in the Sargasso Sea off Bermuda.

#### Subfamily EUONCHOECINAE

*Euonchoecia chierchiae* Müller occurred throughout the year at all 3 stations, and was caught at every depth and over every depth range sampled. As already noted, it was numerous in the upper waters at Station 11. This is a shallow-living species and constituted over 80% of the total numbers taken at 25 m at Station 76 in March 1968.

#### Subfamily HALOCYPRINAE

*Halocypris brevirostris* (Dana) was also recorded over a wide depth range at Stations 76 and 63, but was most common in the upper waters at Station 76 from January to July 1968. Both species of *Fellia*, *F. bicornis* (Müller) and *F. cornuta cornuta* (Müller), were taken at Stations 76 and 63, usually in the deeper tows or in the 1,000 or 1,200–0 m hauls. *Fellia cornuta* was found from January to July 1968 and *F. bicornis* also in September 1967. *Fellia bicornis* was noted more frequently at Station 76 and *F. cornuta* at



Station 63. *Fellia cornuta* females were 3.4–3.7 mm long, *F. bicornis* females 2.0 mm in length. Most of the specimens noted were juveniles.

### Subfamily CONCHOECINAE

Poulsen (1973) divided the genus *Conchoecia* into 17 genera. In this report, Müller's (1906) system of grouping species together into more or less natural groups of related forms will be followed, and Poulsen's genera will be listed in parentheses as subgenera.

#### *Spinifera* Group Müller

Seven species of this group were recorded, all of which Poulsen put in the genus *Paraconchoecia*. *Conchoecia spinifera* (Claus) was found year-round at Stations 76 and 63 over all depths below 100 m; it did not occur at Station 11. *Conchoecia oblonga* (Claus) also was found throughout the year at Stations 76 and 63, over all depths below 100 m, and was also recorded once in March 1968 at 100 m at Station 11. Only Form B specimens (Angel, 1969), with the right asymmetrical gland moved forward on the ventral margin, were present. Females were 1.66–1.70 mm long, males 1.44–1.54 mm in length. A single male *C. allotherium*, 1.54 mm long, was identified from a 725 m sample collected at Station 63 in March 1968. It is virtually impossible to distinguish females of this species from female *C. oblonga*, but a specimen, probably a female *C. allotherium*, 1.60 mm long, was caught at Station 76 in a 800–0 m haul in September 1967. All the specimens of *C. oblonga* noted had the right asymmetrical gland moved forward on the ventral margin, but this specimen had the gland at the postero-ventral corner as in *C. allotherium*.

*Conchoecia echinata* Müller was noted year-round at Stations 76 and 63, but only as occasional specimens, usually in the deeper samples although a juvenile specimen was taken at 100 m in May. It did not occur at Station 11. *Conchoecia inermis* (Claus) was found in January and March 1968 in samples from below 500 m at Stations 76 and 63, and was also taken in an 800–0 m haul in September 1967. *Conchoecia aequisetata* Müller was recorded throughout the year at Station 63 in samples from 700 m or deeper; at Station 76 it was recorded from January to May from 500 m or from 1,000 or 1,200–0 m hauls. Females and males were present, although females were more frequently noted. *Conchoecia reticulata* Müller was taken year-round in the deep vertical tows at Stations 76 and 63. Most of the specimens were juveniles, but a male was 3.1 mm long.

#### *Elegans* Group Müller

Specimens of *C. (Paraconchoecia) elegans* Sars, 1.2–1.35 mm long, were caught throughout the year at Stations 76 and 63, over most of the depths sampled below 100 m. None were recorded from Station 11.

*Procera* Group Müller

Several species of this group were noted, all of which belong in Poulsen's genus *Paraconchoecia*. *Conchoecia procera* Müller and *C. microprocera* Angel occurred year-round over a wide depth range at Stations 63 and 76, and were also taken at Station 11, where, as previously noted, *C. procera* was the most abundant species. *Conchoecia macroprocera* Angel was noted only once, in a 1,000–0 m sample collected in July 1968 at Station 76. A female was 1.34 mm long, a male 1.24 mm in length. The male had 30–31 pairs of long slim teeth on the principal seta of the first antenna, as described by Angel (1971). *Conchoecia brachyaskos* Müller was taken throughout the year at Stations 76 and 63 at 500 m-depths or deeper or in the 1,000 or 1,200–0 m tows. Males were 1.25–1.30 mm long, females 1.35–1.40 mm in length, as recorded from the Sargasso Sea (Deevey, 1968). Several specimens of a recently described species, *C. convexa* Deevey (1977), which seems most closely related to this group, were noted at Stations 76 and 63, in hauls from 800–0 m, 1,000 or 1,200 m or 1,000 or 1,200–0 m. Females were 1.55–1.70 mm long, a single male 1.40 mm long, and 2 juveniles were 1.05 and 1.30 mm in length.

*Dentata* Group Müller

Several specimens of *C. (Paraconchoecia) dentata* Müller were noted. This species was recorded only once from Station 76 from a 1,000–0 m haul in July 1968, but it occurred for most of the year in the deep tows from Station 63, from 700 m, 1,000–0, and 1,200 m tows. Females were 1.85–2.0 mm long, males 1.80–1.85 mm in length.

*Acuminata* Group Müller

Occasional specimens of *C. (Conchoecetta) acuminata* (Claus) were noted year-round at Stations 63 and 76, from the upper waters and from the 1,000–0 m tows. *Conchoecia acuminata* was also taken in 3 samples from Station 11, in a 50 m tow in March and in 25 and 50 m samples in July 1968, so this is one of the few species taken in the Cariaco Trench. A female was 3.2 mm long, a male 2.4 mm in length.

*Rotundata* Group Müller

Poulsen (1973) placed the members of this group in the genus *Metaconchoecia*. *Conchoecia pusilla* Müller occurred year-round at Stations 63 and 76 in the samples collected at 500 m or deeper or in the vertical tows from 1,000 or 1,200–0 m. The other 2 species of this group, *C. rotundata* Müller and *C. skogsbergi* Iles, are the forms I described from the Sargasso Sea (Deevey, 1968). A revision of the *rotundata-skogsbergi* species complex has been made (Gooday, personal communication), and these forms have

been separated into a number of different species. Until this work is published, it is necessary to refer to these forms as previously described. Two sizes of *C. rotundata* were present; males were 0.90–0.95 mm long and also larger, 1.1 mm long. The specimens of *C. skogsbergi* were similar to those from the Sargasso Sea, 1.1–1.3 mm long. *Conchoecia skogsbergi* occurred year-round, especially at Station 63, at all depths below 200 m. *Conchoecia rotundata* was more numerous than *C. skogsbergi*, and was present throughout the year at depths below 50 m at Stations 76 and 63. A single male was caught in a 200 m sample at Station 11 in March 1968.

#### *Bispinosa* Group Müller

Three common species belonging to this group, which Poulsen (1973) put in the genus *Orthoconchoecia*, were noted. *Conchoecia bispinosa* Claus was taken only at Station 76 in four tows from 200, 800, 1,000 and 1,200–0 m. Females were 1.9 mm long, males 1.75–1.80 mm in length. *Conchoecia secernenda* Vavra occurred year-round at all depths below 50 m at Stations 63 and 76. *Conchoecia atlantica* (Lubbock) was also commonly recorded, except in July 1968, at both these stations at all depths below 50 m. Females were 3.1–3.2 mm long, males 3.2–3.4 mm long.

#### *Curta* Group Müller

Poulsen placed the members of this group in the genus *Microconchoecia*. *Conchoecia curta* Lubbock was the most abundant member of this group, and was taken year-round at Stations 76 and 63, over all depths below 100 m. The very similar species, *C. echinulata* (Claus), was noted only once, in a 200 m sample from Station 76, collected in March 1968. *Conchoecia stigmatica* Müller was recorded throughout the year from 500 m and deeper and in the vertical tows, although juvenile specimens were noted from 100 and 200 m depths. The first 2 species are small, ca. 0.8–0.9 mm long; *C. stigmatica* is larger, 1.0–1.2 mm in length.

#### *Edentata* Group Gooday

Gooday (1976) has separated the *edentata* forms from *C. gaussi* and *C. incisa*, all of which Poulsen (1973) put in the genus *Gaussicia*, and which were previously placed in the *Gaussae* Group Skogsberg. A single male, 1.5 mm long, of *C. aff. edentata* Müller was caught in a 1,000 m sample at Station 63 in January 1968.

#### *Gaussi* Group Skogsberg

A single immature female of *C. (Gaussicia) incisa* Müller, 2.0 mm long, was taken in a 1,200 m tow at Station 63 in March 1968.

*Loricata* Group Müller

Occasional specimens of *C. (Loricoecia) loricata* Müller were noted throughout the year at Stations 63 and 76, in samples from 500 m or greater depths or the deep vertical tows. Males were 1.8–1.9 mm long, females 1.9–2.0 mm in length.

*Serrulata* Group Skogsberg

*Conchoecia (Pseudoconchoecia) concentrica* Müller was one of the few species that occurred in some numbers at Station 11 in the Cariaco Trench, and also was found year-round at depths below 25 m at Stations 63 and 76.

*Magna* Group Müller

Eight members of this group were recorded, of which 3 were found at Station 11. *Conchoecia (Conchoecia) magna* Claus was noted year-round at Stations 63 and 76, at 100 m and greater depths. Two size ranges were noted, but few of the smaller specimens were seen. Females were 1.75 mm and 2.0–2.25 mm long, and males were 1.60 mm and 1.90 mm in length. *Conchoecia (Conchoecia) lophura* Müller was caught only at Station 63 at 500 and 725 m depths in March 1968. *C. (Conchoecia) macrocheira* Müller was taken from September to May at Station 76 and from March to July at Station 63 at 100 m and greater depths. A single juvenile of this species was noted at Station 11 in a 700 m sample collected in July 1968. One female *C. (Conchoecia) parvidentata* Müller, 2.75 mm long, was recorded only from a 1,000 m sample from Station 63 in January 1968. *Conchoecia (Conchoecia) subarcuata* Claus was taken in September and March at Station 76 and in January and July at Station 63, usually in the deep or vertical tows, although it was recorded at 200 m in March. *Conchoecia (Spinoecia) parthenoda* Müller occurred throughout the year at Stations 76 and 63 at all depths below 100 m. *Conchoecia (Spinoecia) porrecta* Claus and *C. (Spinoecia) spinirostris* Claus were common throughout the region and were present year-round at all 3 stations at 25 m and greater depths.

*Mollis* Group Müller

*Conchoecia (Mollicia) mollis* Müller was recorded year-round from the deeper waters and vertical tows at Stations 76 and 63. Females were 3.10–3.25 mm long, males 2.8–3.1 mm in length. A single male, 2.8 mm long, of *C. (Mollicia) kampta* Müller was taken at Station 63 in July in a 1,000–0 m tow. Several specimens of *C. (Paramollicia) rhynchena* Müller were noted from March to July at Station 76 and in March at Station 63 at 500 m and

greater depths. Females were 2.55–2.60 mm long, the one male 2.4 mm in length.

#### *Imbricata* Group Müller

A single juvenile of *C. (Conchoecissa) ametra* Müller was recorded from a 1,000–0 m tow at Station 63 in July 1968. *Conchoecia (Conchoecissa) imbricata* (Brady) was found year-round except in May at Stations 76 and 63 in samples from 200 m or deeper or in the vertical tows. Females were 3.0 mm long, males 2.4 mm in length.

#### *Daphnoides* Group Müller

*Conchoecia (Conchoecilla) daphnoides* (Claus) was recorded infrequently, in September and July at Station 76 and in March and July at Station 63 in a 725 m sample and in the deep vertical tows. A female was 5.05 mm long, a male 2.86 mm in length.

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#### Footnote

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