

Ostracoda (Myodocopina,  
Cladocopina, Halocypridina) Mainly  
from Anchialine Caves in Bermuda

LOUIS S. KORNICKER  
and  
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*Louis S. Kornicker and Thomas M. Iliffe*



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## ABSTRACT

Kornicker, Louis S., and Thomas M. Iliffe. Ostracoda (Myodocopina, Cladocopina, Halocypridina) Mainly from Anchialine Caves in Bermuda. *Smithsonian Contributions to Zoology*, number 475, 88 pages, 49 figures, 22 tables, 1989.—Ostracoda in the suborders Myodocopina (4 species in 4 genera: *Parasterope muelleri* (Skogsberg, 1920), *Rutidermata sterreri* Kornicker, 1981, *Pseudophilomedes kylix*, new species, and *Sarsiella styx*, new species), Cladocopina (4 species in 3 genera: *Metapolycope duplex*, new species, *Micropolycope eurax*, new species, *M. styx*, new species, and *Polycopissa anax*, new species), and Halocypridina (*Spelaeoecia bermudensis* Angel and Iliffe, 1987) from anchialine caves in the Bermuda Islands are described and illustrated. Two species of Cladocopina and the single species of Halocypridina are interpreted as troglobitic, 1 species of Cladocopina and 2 of Myodocopina are interpreted as trogliphilic, and 1 species of Cladocopina and 2 of Myodocopina are interpreted as accidental cave inhabitants. Accidental inhabitants, few in number, are mostly in caves having strong to moderate currents close to the coast; trogliphilic species are fairly abundant in caves with moderate currents close to the coast, and also in caves having weak currents farther from the coast; troglobites inhabit isolated caves without currents usually farther from the coast. A new locality (Jane's Cave) is reported for the troglobitic halocyprid ostracode *Spelaeoecia bermudensis* Angel and Iliffe, 1987. It is concluded that *Pseudophilomedes kylix* has 4 juvenile instars, *Metapolycope duplex* has 6, and *Polycopissa anax* has 5. The first instar of Cladocopina has 5 appendages, the same number as on the adult (first and second antennae, mandible, maxilla, and fifth limb). The male is described for the first time for the myodocopid *Eusarsiella absens* (Kornicker, 1981), collected from Harrington Sound, Bermuda. Specimens from the continental shelves of North America (Atlantic and Gulf of Mexico) that had previously been referred to *Pseudophilomedes ferulanus* Kornicker, 1958, are described as a new species, *Pseudophilomedes darbyi*.

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# Ostracoda (Myodocopina, Cladocopina, Halocypridina) Mainly from Anchialine Caves in Bermuda

*Louis S. Kornicker and Thomas M. Iliffe*

## Introduction

The Bermuda Islands have numerous anchialine caves supporting a diverse marine fauna (Sket, 1979; Băcescu, 1980; Karaman, 1980a, 1980b; Yeatman, 1980; Sket and Iliffe, 1980; Hart and Manning, 1981, 1986; Sterrer and Iliffe, 1982; Bowman and Iliffe, 1983, 1985; Manning and Hart, 1984; Barnard and Clark, 1985; Bartsch and Iliffe, 1985; Fosshagen and Iliffe, 1985; Gutu and Iliffe, 1985; Băcescu and Iliffe, 1986; Boxshall and Iliffe, 1986; Erseus, 1986; Hill et al., 1986; Small et al., 1986; Stock, Holsinger, et al., 1986; Stock, Sket, and Iliffe, 1987; Wägele and Brandt, 1985). Ostracoda from the caves in the order Podocopa (32 species) have been studied recently by Maddocks and Iliffe (1986), and in the suborder Halocypridina (1 species) by Angel and Iliffe (1987). In the present study ostracodes in the suborder Cladocopina (4 species, all new, in 3 genera) and in the suborder Myodocopina (4 species, 2 new, in 4 genera) are described, and new records are given for Halocypridina. In addition, the male is described for the first time for the myodocopid *Eusarsiella absens* Kornicker, 1981, from a sample collected in Harrington Sound, Bermuda; also, specimens from the continental shelves of North America (Atlantic and Gulf of Mexico) that had been referred previously to *Pseudophilomedes ferulanus* Kornicker, 1958, by many authors are described as a new species, *P. darbyi*. The authors of new cave species are Kornicker and Iliffe; the author of *P. darbyi*, which was not collected in Bermudan caves, is Kornicker.

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Paul Hobbs, Robert Power, and Mary van Soeren (all of the Bermuda Biological Station for Research, Inc.). We thank Jan H. Stock (University of Amsterdam, Netherlands) for a specimen from Cathedral Cave. We also thank the following people for their help: V.G. Chavtur (USSR Academy of Sciences, Vladivostok) for reviewing for errors an English translation from Russian by Dr. Ervin Otvos (Gulf Coast Marine Laboratory) of his key to genera of the Polycopidae; Jack Schroeder (Schroeder Prints, Inc., Crisfield, Maryland) for inking the illustrations; Thomas E. Bowman (Smithsonian Institution, S.I.), John W. Neale (University of Hull, England), and I.G. Sohn (U.S. Geological Survey) for reviewing the manuscript; Elizabeth Harrison-Nelson (S.I.) for general assistance; and Joan Horn (S.I.) for final editing and preparation of the manuscript for publication. This paper is Contribution Number 1137 of the Bermuda Biological Station for Research.

## Samples

With the exception of a sample collected by Jan H. Stock, the samples were collected by the junior author. Most of the samples were sent initially to Rosalie Maddocks who separated the various ostracode taxa and with Iliffe reported upon them (Maddocks and Iliffe, 1986). The Myodocopa were identified by Maddocks as Cladocopina (as *Polycope* spp) and Myodocopina. Those specimens were then forwarded to the senior author. The present publication is based mainly on those specimens, as well as additional samples collected by the junior author, some of which belong to the suborder Halocypridina. The counted numbers of specimens from the same samples of Cladocopina and Myodocopina reported herein and in Maddocks and Iliffe (1986:30–33, 73) differ. Therefore, the numbers reported in each study are listed in Table 1 (which excludes samples not listed in Maddocks and Iliffe (1986:31)).

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TABLE 1.—Comparison of numbers of specimens of Cladocopina and Myodocopina in Bermudan Caves reported from same samples by Maddocks and Iliffe (1986:31–33) and herein.

Cave and collecting date	Cladocopina (1986*/herein)	Myodocopina (1986*/herein)
Bee Pit Cave, 23 Jan 1984	1/1	0/0
Cathedral Cave, 15 Feb 1984	0/0	3/3
Cherry Pit Cave, 23 Jun 1982	14/12	56/57
Cherry Pit Cave, 12 Jan 1984	22/8	19/18
Christie's Cave, 24 Nov 1982	3/4	1/0
Cripplegate Cave, 21 Oct 1981	0/0	1/1
Deep Blue Pool**, 23 Mar 1982	3/5	1/1
Deep Blue Cave, 20 Feb 1984	2/2	5/5
Emerald Sink, 16 Nov 1983	2/0	0/0
Fern Sink, 25 Feb 1982	1/1	0/0
Fern Sink, 24 Jul 1984	7/4	1/0
Green Bay Cave, 18 Nov 1981	6/5	0/1
Long Rock Sink, 8 Jul 1984	1/0	0/0
Myrtle Bank Cave, 7 Feb 1982	0/0	1/1
Palm Cave, 20 Jan 1982	27/11	0/0
Palm Cave, 13 and 16 Mar 1982	10/17	8/8
Roadside Cave, 27 Aug 1982	20/20	0/0
Roadside Cave, 12 Nov 1982	12/11	0/0
Sailors Choice Cave, 6 Jul 1982	12/6	0/0
Straw Market Cave, 12 Jan 1984	1/1	3/3
Tucker's Town Cave, 8 Sep 1982		
From algal-covered wall	7/8	0/0
From sand bottom	27/0	0/0
Tucker's Town Cave, 16 Mar 1984	5/6	0/0
Walsingham Cave, 18 Feb 1982	15/8	4/4
Walsingham Cave, 13 Jul 1984	4/3	0/1
Walsingham Sink Cave, 7 Feb 1982	0/0	1/0
Walsingham Sink Cave, 13 Aug 1982	3/2	0/0

\* Data from Maddocks and Iliffe (1986:31-33).

\*\* Listed as Deep Blue Cave in Maddocks and Iliffe (1986) on p. 31 but not on p. 73. Deep Blue Pool considered entrance pool of Deep Blue Cave herein.

Almost all samples were collected with a fine-meshed hand net drawn through the substrate or water column at various places and depths within the caves. The particular method of collecting each sample is given in the appendix.

The cave numbering system used by Maddocks and Iliffe (1986:tab. 1, fig. 1) is used herein on species distribution maps (Figures 3, 17, 25, 28, 41, 45): 1, Bee Pit Cave; 2, Castle Grotto; 3, Cathedral Cave; 4, Cherry Pit Cave; 5, Christie's Cave; 6, Cripplegate Cave; 7, Deep Blue Cave; 8, Emerald Sink Cave; 9, Fern Sink Cave; 10, Green Bay Cave; 11, Grenadier Pool; 12, Little River Cave; 13, Long Rock Sink; 14, Myrtle Bank Cave; 15, Palm Cave; 16, Prospero's Cave; 17, Roadside Cave; 18, Sailor's Choice Cave; 19, Small Fish Pond Cave; 20, Straw Market Cave; 21, Tucker's Town Cave; 22, Walsingham Cave; 23, Walsingham Sink Cave; 24, Wonderland Cave. Additional caves not covered in Maddocks and Iliffe are: 25, Crystal Cave, 26, Jane's Cave, and 27, Red Bay Cave. No Myodocopa were found in samples from caves 2, 11, 12, 16, 19 (herein and Maddocks and Iliffe, 1986:31,

32). Maddocks and Iliffe (1986:31) had reported 2 Cladocopina in (8) Emerald Sink Cave, but Kornicker could find no specimens in the vial; the cladocopids are probably lost. Maddocks and Iliffe (1986:32) also reported 1 Cladocopina in (13) Long Rock Sink, but only a podocopid and some debris were found in the vial when studied by the senior author. Additional collecting in both caves is warranted.

### Descriptions of Caves

The locations of the caves are shown in species distribution maps herein (Figures 3, 17, 25, 28, 41, 45). The depths of the cave waters range from 2–24 m. The surface waters are generally brackish with a salinity range of 6.9–36.1 ‰. The salinities increase rapidly with depth and, where myodocopids were collected, are probably not lower than about 20 ‰. The substrates within the caves are quite variable (silt, soil, sand, gravel, rock). Some characteristics of the caves are presented in Tables 2 and 3. Unfortunately, salinity and temperature measurements were not taken at each site when collections were made. Where these data are lacking, salinities and temperatures from the nearest pool are given. For caves containing more than 1 pool, it is possible for salinities and temperatures to vary. For each pool salinities and temperatures were taken at the same time at surface and 1-m depths.

Those Bermuda caves from which Halocypridina, Cladocopina, and Myodocopina were collected can be grouped primarily into four systems based on geographical setting and/or proven or inferred interconnections.

The Palm Cave System is a complex series of underwater chambers and collapse entrances. Cripplegate Cave, a tidal spring on Harrington Sound, is the primary coastal entrance to the Palm System. Myrtle Bank is the closest entrance to Cripplegate and thus has moderate to strong tidal currents passing through it. Progressing farther inland through the underwater cave and away from Harrington Sound, the Palm, Sailor's Choice, and Straw Market entrances are reached in that order. With increasing distance from Harrington Sound, the velocity of water currents in the cave declines together with the abundance of encrusting sponges, hydroids, and bryozoans. Cherry Pit Cave, located not far from Straw Market Cave, has yet to be shown to be connected to the Palm System. The 30 m long collapse entrance of Cherry Pit Cave provides access to an underwater silt-floored chamber with moderate currents. Emerald Sink Cave is situated south of the Palm Cave System and may or may not be part of it. A large horseshoe-shaped collapse at Emerald Sink has left 3 shaded, silt-floored pools that have considerable currents in their deeper parts. No specimens are reported from Emerald Sink Cave in the present study although 2 Cladocopina were reported by Maddocks and Iliffe (1986:31).

The Walsingham Cave System is another complex system located to the north of and possibly hydrologically connected with the Palm Cave System. The main route of water flow



TABLE 2.—Selected chemical and physical characters of water in caves (temperatures (°C) and salinities (‰) taken at surface and 1 m between 28 Oct 1981 and 10 Nov 1981; nd = no data; questionmark indicates doubtful association with cave system).

Cave	Maximum depth (m)	Salinity (surface:1 m)	Temperature (surface:1 m)	Water current	Light level	Substrate
<b>PALM CAVE SYSTEM</b>						
Cripplegate	2	36.0:nd	23.7:nd	strong	shaded	rock, gravel
Myrtle Bank	20	32.2:33.4	23.3:23.6	moderate- strong	dark	silt
Palm	20	26.3:35.8	22.7:24.1	weak- moderate	dark	silt
Sailor's Choice	20	21.5:35.1	21.7:24.6	weak- moderate	dark	silt
Straw Market	20	19.3:35.7	22.3:24.1	weak	dark	silt
Cherry Pit(?)	12	28.5:35.4	23.1:24.5	weak- moderate	dark	silt, sand
<b>WALSINGHAM CAVE SYSTEM</b>						
Walsingham	20	18.9:32.6	21.8:23.8	weak- moderate	dark	silt
Deep Blue	23	27.2:35.3	22.2:23.9	weak	shaded	silt, rock
Fern Sink	24	18.0:26.7	21.6:22.2	none	dark	silt, rock
Crystal	20	16.5:23.7	21.4:22.2	none	dark	rock
Wonderland	16	11.3:21.4	20.0:21.0	none	dark	rock
Bee Pit	3	21.8:32.9	22.1:23.5	none	dim	soil
Walsingham Sink	18	17.9:33.3	22.2:23.5	none	dark	soil, silt
Roadside(?)	6	30.2:31.8	23.0:23.7	none	dark	rock
<b>SHELLY BAY AREA CAVES</b>						
Green Bay	20	20.3:27.9	20.3:23.9	none-strong	dark	silt, rock
Red Bay	16	36.1:nd	23.0:nd	strong	dark	silt
<b>TUCKER'S TOWN AREA CAVES</b>						
Christie's	8	6.9:19.5	18.2:20.4	none	dim	rock
Jane's	16	7.4:25.4	19.7:20.7	none	dark	rock
Tucker's Town	24	21.4:28.6	19.0:20.6	none	dim	sand, detritus
<b>OTHER CAVES</b>						
Cathedral	6	15.9:26.0	21.3:21.9	none	dark	soil, silt

though the Walsingham System is apparently from Castle Harbor through Walsingham and Deep Blue caves and then possibly into the back sections of the Palm Cave System. Walsingham Cave consists of a pool under the edge of a cliff, which extends back through underwater fissures and past several air-filled chambers to connect with Deep Blue Cave. The shaded pool of Deep Blue Cave is situated at the base of a cliff and extends down into one of the largest submerged chambers in Bermuda. The presence of marine algae including abundant *Caulerpa* and crustose corallines in the open pool of Deep Blue reflects a different environment from the lightless underwater caves. An arm of the Walsingham System that includes Fern Sink, Crystal, and Wonderland caves is much more isolated from contact with the sea and shows no evident water currents. Fern Sink Cave contains a pool in total darkness, which inclines steeply down a breakdown slope to the main level of the cave at 18 m depth. Crystal Cave is a commercially operated tourist cave containing a cave lake crossed by a pontoon bridge (see Bowman and Iliffe, 1985:69 for a description of the cave). Large underwater stalactites and stalagmites, deposited during low sea stands in the Pleistocene

TABLE 3.—Salinity, temperature, and dissolved oxygen of water in selected Bermudan Caves from which *Myodocopa* were collected (nd = no data).

Cave, water depth, date	Salinity (‰)	Temperature (°C)	Dissolved oxygen (ml/l)
Palm Cave, 20 m, 16 Mar 1982	36.2	19.0	4.56
Deep Blue Cave, 16 m, 5 Dec 1981	36.2	21.8	3.73
Crystal, 20 m, 25 Mar 1982	36.1	18.9	3.85
<b>Wonderland</b>			
2.5 m, 24 Nov 1981	28.5	21.1	4.88
16 m, 3 Sep 1987	35.2	nd	nd
Green Bay, 18 m, 22 Mar 1982	36.3	18.7	3.81
Tucker's Town, 21 m, 26 Nov 1981	35.5	21.5	2.97

when the caves were dry, are present at all depths in this as well as other caves of the Walsingham System. A clear pool in total darkness in Wonderland Cave reaches a depth of 16 m before ascending to an isolated air-filled room (see Bowman and Iliffe, 1983:293 for description of the cave). Two other caves, Bee Pit and Walsingham Sink caves, located in the immediate area of the submerged passages connecting

Walsingham and Deep Blue caves are probably part of the system. Bee Pit Cave contains a small, shallow soil-floored pool situated just inside the entrance in dim light. A deep pool in Walsingham Sink Cave slopes steeply down a soil and rock slope to 18 m depth. Roadside Cave is more remote from the Walsingham System and questionably part of it (see Boxshall and Iliffe, 1986:55–56 for a description of the cave).

The Shelly Bay area cave system is in a peninsula separating the almost totally enclosed Harrington Sound from the North Lagoon. Caves in this area are extensive and show transverse development across the peninsula. Considerable tidal currents pass through some sections of these caves and provide a significant contribution to the tidal exchange in Harrington Sound. The totally underwater Green Bay Cave, the longest cave in Bermuda, is more than 2 km in length (see Bowman and Iliffe, 1985:69–72 for map and description of cave). The degree of isolation from the sea varies considerably in different sections of this cave, giving rise to a highly diverse fauna. Red Bay Cave is entered through a tidal spring on the coast of Harrington Sound. The initial section of the cave is a low bedding plane that enlarges after about 40 m to a complex of passages 5 m or more in diameter.

Tucker's Town area caves are located at the southwestern corner of Castle Harbor. All are isolated caves with no water currents noted and typically containing only troglobitic taxa. Diving investigations of these cave pools have yet to find any interconnected cave systems. Christie's Cave contains a clear pool just inside a collapse cave entrance. Although situated within 30 m of Castle Harbor, the cave shows no evidence of any direct connections with open water. Jane's Cave, located on the edge of the golf course of the Castle Harbor Hotel, is a large collapse chamber containing 3 anchialine pools (see Boxshall and Iliffe, 1986:61, for description of cave). Tucker's Town Cave, on the Tucker's Town peninsula, contains a steep entrance shaft reaching an isolated pool with a large underwater chamber (see Hart and Manning, 1981:441 for description of cave).

Two other caves do not fit within the groups listed above. Cathedral Cave, along with a number of other caves, is located on the grounds of the Grotto Bay Hotel. The pool within the cave is currently used by guests of the hotel as an 'indoor' swimming pool during inclement weather. Long Rock Sink is an open, sediment-filled collapse pool on a small islet off the east end of Bermuda. No specimens were reported from this cave in the present study but 1 Cladocopina was reported by Maddocks and Iliffe (1986:32). Descriptions of additional caves having Podocopa and Platycopa but no Myodocopa are given in Maddocks and Iliffe (1986:27–30).

A number of caves in Bermuda, especially those in the Palm and Shelly Bay area cave systems, serve as important tidal conduits for Harrington Sound, an almost totally enclosed inshore body of water. Approximately 50% of the tidal volume of Harrington Sound is exchanged through caves. Other caves, such as parts of the Walsingham Cave System, also are important vectors for tidal exchange. Current velocity in any

given cave is affected by the complex branching nature of many Bermuda caves with both continuous and dead-end passages, the alternation between large underwater chambers and tight restrictions, the directness of the cave connection to the sea, and the location of the cave between bodies of water with differing tidal periodicities. In general, the strongest currents are observed in tidal springs, entrances along the coastline where water floods in or out depending upon the state of the tide. The degree of biological encrustation by sponges, hydroids, bryozoans, and mollusks serves as an excellent bioindicator of tidal currents. Walls and ceilings of cave entrances near the coast with strong currents are typically completely covered with encrusting organisms. Cave passages with moderate and weak currents have progressively less bioencrustation, while rocks in passages with no noticeable current are completely bare. Only qualitative estimates of current velocity have so far been made. Strong currents are those in which a diver would have to exert extra effort to move against them, i.e., about 1 knot or greater. Moderate currents, about less than 1 knot, can easily be directly observed but do not impede swimming progress. Weak currents are only observed in restrictions of the cave passage or where suspended silt particles slowly move with the current. Although, owing to their tidal nature, water currents must exist in all Bermuda's anchialine caves, those inland caves most isolated from the sea and not on direct routes of tidal exchange, lack any apparent visible evidence of currents.

The currents within caves vary from no visible flow to strong flow, but generally are fairly constant at any particular collecting site. The current may differ among different sites within a cave; for example, in Green Bay Cave. The current flows observed at each collecting site are presented in the appendix, Station Data with Specimens Collected; they differ somewhat from those listed by Maddocks and Iliffe (1986, table 1). Although such observations are subjective, the junior author believes those presented herein to be more accurate. The current flow appears to be a function of relationship of the cave pool or passage with the sea. A strong current indicates a close connection, whereas absence of flow indicates a distant relationship. Observed currents at collecting sites in the caves are as follows.

<i>No currents</i>	<i>Weak currents</i>	<i>Moderate currents</i>	<i>Strong currents</i>
Bee Pit	Deep Blue	Cherry Pit	Cripplegate
Cathedral	Palm (entrance slope)	Green Bay	Red Bay
Christie's	Sailor's Choice	(past rat trap)	
Crystal	Straw Market	Myrtle Bank	
Fern Sink		Palm (Pumpkin Passage and Palm Cave room)	
Green Bay (Dungeon area)		Walsingham	
Jane's			
Roadside			
Tucker's Town			
Walsingham Sink			
Wonderland			

(Three samples were collected in Cherry Pit Cave. The current was moderate during 1 collection and weak to moderate during 2 collections; it is expedient to treat all as moderate, herein.)

### Distribution of Ostracodes

The distribution of ostracodes in the cave systems of Bermuda is given in Table 4. The troglobite *Spelaeoecia bermudensis* was collected in the Walsingham Cave System, the Shelly Bay area caves, and in the Tucker's Town area caves, but not in the Palm Cave System. A second species, *Polycopissa anax*, interpreted to be troglotic herein, was collected in the Walsingham Cave System and the Tucker's Town area caves, but not in the Palm Cave System and Shelly Bay area caves. A third species, *Micropolycope styx*, interpreted to be troglitic was represented in the collection by only 1 specimen collected in a Tucker's Town area cave. The 3 species interpreted herein as trogliphilic, *Metapolycope duplex*, *Eusarsiella styx*, and *Pseudophilomedes kylix*, were collected in the Palm Cave System, the Walsingham Cave System, and the Shelly Bay area caves, but not in the Tucker's Town area caves.

The range of selected characteristics of the caves in which Myodocopa were collected is given in Table 5. Specimens were collected from a broad depth range within each cave. Because each collecting effort generally encompassed several meters depth, the precise depths at which the specimens were captured is not known. Surface salinities are usually considerably lower than those at 1 m (Table 2). It is not known for certain if ostracodes were netted in the low salinity surface water. Myodocopa in open water generally live in waters having a salinity of more than about 20 ‰ but whether they are capable of living at lower salinities in anchialine caves has not been determined. All the Myodocopa species collected in the present study are capable of swimming as well as burrowing, and specimens were collected in both the water column and bottom substrate. The diversity of substrates encountered in the caves suggests that the type of substrate is not limiting (Table 5).

The occurrence of ostracodes at the sites within caves arranged according to current flow is shown in Table 6. Each "X" represents the occurrence of a species at a site, regardless of the number of times that species may have been encountered there.

TABLE 4.—Species occurrence of Halocypridina, Cladocopina, and Myodocopina in Bermudan caves arranged according to cave system (beginning at entrance) (questionmark indicates doubtful association with cave system).

Cave	Halocypridina		Cladocopina			Myodocopina			
	<i>S. bermudensis</i>	<i>M. duplex</i>	<i>P. anax</i>	<i>M. styx</i>	<i>M. eurax</i>	<i>P. kylix</i>	<i>E. styx</i>	<i>R. sterreri</i>	<i>P. muelleri</i>
<b>PALM CAVE SYSTEM</b>									
Cripple Gate	—	—	—	—	—	—	—	1	—
Myrtle Bank	—	—	—	—	—	1	—	—	—
Palm	—	30	—	—	—	—	6	—	2
Sailor's Choice	—	4	—	—	2	—	—	—	—
Straw Market	—	1	—	—	—	—	3	—	—
Cherry Pit	—	53	—	—	—	7	144	1	—
<b>WALSINGHAM CAVE SYSTEM</b>									
Walsingham	—	15	—	—	—	2	19	—	—
Deep Blue	—	2	—	—	5	—	5	—	1
Fern Sink	1*	1	4	—	—	—	—	—	—
Crystal	4*	—	—	—	—	—	—	—	—
Wonderland	3*	—	—	—	—	—	—	—	—
Bee Pit	—	—	1	—	—	—	—	—	—
Walsingham Sink	1*	1	1	—	—	—	—	—	—
Roadside(?)	22*	—	31	—	—	—	—	—	—
<b>SHELLY BAY AREA CAVES</b>									
Green Bay	17*	5	—	—	—	1	—	—	—
Red Bay	—	—	—	—	—	—	1	—	—
<b>TUCKER'S TOWN AREA CAVES</b>									
Christie's	1*	—	4	—	—	—	—	—	—
Jane's	7	—	—	—	—	—	—	—	—
Tucker's Town	7*	—	13	1	—	—	—	—	—
<b>OTHER CAVE</b>									
Cathedral	—	—	—	—	—	4	—	—	—

\*Data from Angel and Iliffe (1987).

TABLE 5.—Range of salinities at 1 m, substrates, and maximum depths of water in Bermudan caves inhabited by species of Cladocopina and Myodocopina (measurements not obtained at time of collections).

Species	Salinities (‰)	Substrate type	Maximum depths (m)	Capture depths (m)
CLADOCOPIA				
<i>Metapolycope duplex</i>	33.3–35.4	rock, soil, silt	12–24	0–18
<i>Micropolycope eurax</i>	35.1–35.3	rock, silt	20–23	0–2
<i>Micropolycope styx</i>	28.6–35.7	silt, sand, detritus	20–24	16–18
<i>Polycopissaanax</i>	19.5–31.8	rock, soil, silt	6–24	0–18
MYODOCOPINA				
<i>Eusarsiella styx</i>	32.6–35.4	rock, silt	12–23	0–16
<i>Parasterope muelleri</i>	35.3–35.8	rock, silt	20–23	1–16
<i>Pseudophilomedes kylix</i>	26.0–33.4	rock, soil, silt	6–20	0–21
<i>Rutiderma sterreri</i>	about 36	rock, gravel	2–10	1–10

Collections upon which the present study of Myodocopina and Cladocopina is based were made during the period 1981–1987, and nine caves were sampled more than once (see appendix). This provided the opportunity to compare populations within the several caves from which more than one collection had been made. The data for five caves is presented in Table 7. The samples are not quantitative and may not have been collected from the same location within a cave, so that comparisons must be considered to be approximations. The data suggest that at least some species have long-standing populations within the caves.

Of the 10 caves from which Myodocopina were collected, 6 had 1 species, 3 had 2 species, 1 had 3 species, but none had all 4 cave species (Table 8). Of the 13 caves having Cladocopina, 8 had 1 species, 5 had 2 species, and none all 4 species (Table 9).

### Discussion

Two species encountered in the caves, *Parasterope muelleri* and *Rutiderma sterreri*, represented by a total of 5 specimens

TABLE 6.—Occurrence of species of Halocypridina, Cladocopina, and Myodocopina in Bermudan caves arranged according to water movement (X = a single cave pool at which the species was collected).

Species	No current	Weak current	Moderate current	Strong current
<i>Spelaeoecia bermudensis</i>	XXXXXXXXXX			
<i>Polycopissaanax</i>	XXXXXX			
<i>Micropolycope styx</i>	X			
<i>Metapolycope duplex</i>	XX	XXXX	XXXX	
<i>Pseudophilomedes kylix</i>	X		XXXX	
<i>Micropolycope eurax</i>		XX	X	
<i>Parasterope muelleri</i>		X	X	
<i>Eusarsiella styx</i>		XX	XXX	X
<i>Rutiderma sterreri</i>			X	X

in 4 caves at sites having weak to strong currents, also have been collected in open water outside the caves (Kornicker, 1981b:5, 8; Maddocks and Kornicker, 1986:282, 283) and are interpreted herein to be accidental inhabitants of the caves. Three species, *Spelaeoecia bermudensis*, *Polycopissaanax*, and *Micropolycope styx*, were collected only in sections of isolated caves having no observable currents and are interpreted herein to be troglobites. *Pseudophilomedes kylix* has eyes commonly present on shallow water species of the genus and is unlikely to be troglitic. It was present at sites with moderate currents in Cherry Pit Cave in both 1982 and 1987, and in Walsingham Cave in both 1982 and 1986, but in small numbers, and it was collected in an isolated pool in Cathedral Cave. The data suggest that the species could be trogliphilic, having populations both in the caves as well as outside, although as yet not collected in open water. *Metapolycope duplex* is widespread in the caves at 2 sites having no observable current, at 4 sites with weak currents, and at 4 sites with moderate currents. The populations in Cherry Pit Cave and Walsingham Cave appear long lasting, and it seems likely that the species is trogliphilic, and possibly troglitic. *Eusarsiella styx* has eyes similar to those of shallow water species of the genus and it is unlikely that it is a troglitic. It was collected at sites having weak and moderate currents, and appears to have a long lasting population in Cherry Pit Cave. We tentatively conclude that it is trogliphilic, although as yet not collected in open water. Only 7 specimens of *Micropolycope eurax* were collected, and in only 3 sites in 2 caves having weak or moderate currents; we think it likely that it is an accidental occupant of the caves, but it could be trogliphilic.

### Classification

Kornicker (1975:81) and Kornicker and Sohn (1976:4) observed that the position of the furca relative to the anus is a character useful for dividing Recent Ostracoda into 2 groups: Group 1, the superorder Myodocopa (which includes the

TABLE 7.—Number of specimens of Cladocopina and Myodocopina collected from five representative Bermudan caves on different dates and depths.

Cave and species	Collecting date and depth			
CHERRY PIT CAVE	23 Jun 1982 (5 m)	12 Jan 1984 (3–12 m)	22 Mar 1987 (3–10 m)	
<i>Eusarsiella styx</i>	54	18	72	
<i>Metapolycope duplex</i>	12	8	33	
<i>Pseudophilomedes kylix</i>	3	0	4	
<i>Rutiderma sterreri</i>	0	0	1	
FERN SINK CAVE	25 Feb 1982 (18 m)	24 Jul 1984 (18 m)		
<i>Metapolycope duplex</i>	1	0		
<i>Polycopissa anax</i>	0	4		
ROADSIDE CAVE	27 Aug 1982 (0–1.5 m)	12 Nov 1982 (4–8 m)		
<i>Polycopissa anax</i>	20	11		
TUCKER'S TOWN CAVE	8 Sep 1982 (0–2 m)	16 Mar 1984 (16–18 m)		
<i>Micropolycope styx</i>	0	1		
<i>Polycopissa anax</i>	8	5		
WALSINGHAM CAVE	18 Feb 1982 (6–8 m)	14 Jun 1982 (5 m)	13 Jul 1984 (6 m)	22 Oct 1986 (3–5 m)
<i>Eusarsiella styx</i>	3	15	1	0
<i>Metapolycope duplex</i>	8	4	3	0
<i>Pseudophilomedes kylix</i>	1	0	0	1

suborders Myodocopina, Halocypridina, and Cladocopina) and Group 2, the orders Podocopida and Platycopida. Studies of Myodocopina (Kornicker, 1969a, 1981b; Hiruta, 1977, 1979a, 1979b; Cohen, 1983) and Halocypridina (Kornicker and Iliffe, in press) have shown that the 1st instars of those taxa have at least 5 appendages. The 1st instars of Podocopida have only 3

TABLE 8.—Occurrence of Myodocopina in Bermudan caves.

<i>P. kylix</i>	<i>E. styx</i>	<i>P. muelleri</i>	<i>R. sterreri</i>
Cathedral Cave			
Green Bay Cave			
Myrtle Bank Cave			
Walsingham Cave	Walsingham Cave		
Cherry Pit Cave	Cherry Pit Cave		Cherry Pit Cave
	Straw Market Cave		
	Red Bay Cave		
	Deep Blue Cave	Deep Blue Cave	
	Palm Cave	Palm Cave	
			Cripplegate Cave

TABLE 9.—Occurrence of Cladocopina in Bermudan caves.

<i>M. styx</i>	<i>P. anax</i>	<i>M. duplex</i>	<i>M. eurax</i>
Tucker's Town Cave	Tucker's Town Cave		
	Bee Pit Cave		
	Christie's Cave		
	Roadside Cave		
	Fern Sink Cave	Fern Sink Cave	
	Walsingham	Walsingham	
	Sink Cave	Sink Cave	
		Walsingham Cave	
		Cherry Pit Cave	
		Green Bay Cave	
		Palm Cave	
		Straw Market Cave	
		Deep Blue Cave	Deep Blue Cave
		Sailor's Choice Cave	Sailor's Choice Cave

appendages (Kesling, 1951:94). It is apparent that in the Myodocopina and Halocypridina the 4th and 5th appendages develop within the egg. Therefore, we consider 5 or more appendages on 1st instars to be synapomorphic. In the present study the 1st instars of 2 Cladocopina (*Metapolycope duplex* and *Polycopissa anax*) were observed to have 5 appendages. This supports the inclusion of the suborders Myodocopina, Halocypridina, and Cladocopina in the superorder Myodocopa. The number of appendages on the 1st instars of Platycopida is unknown, so that the possibility of its having more than the 3 appendages cannot be excluded. The 1st instars have been described for about 28 species of myodocopid ostracodes (Table 20), and the 1st instars of 2 species of *Azygocypridina* are partly known (Hiruta, 1983:667).

In the classification proposed by Kornicker and Sohn (1976:6) the suborders Halocypridina and Cladocopina form the order Halocyprida, which together with the order Myodocopida form the superorder Myodocopa. The Halocypridina and Cladocopina are related by having 2 synapomorphies: (1) absence of a medial eye (present in most Myodocopina), and (2) presence of an unpaired copulatory organ (paired in Myodocopina) (Kornicker and Sohn, 1976:5). Kozur (1985:2, 7) recognized the superorder Myodocopomorphes Kozur, 1972, comprising the orders Cladocopida and Myodocopida. In that classification the Cladocopida comprise the suborders Cladocopina and Thaumatoocypridina; and the Myodocopida comprise the suborders Myodocopina and Halocypridina. The carapace of thaumatoocyprids resembles those of cladocopids more than those of typical halocyprids, which generally are thin-walled and have well-developed rostra. However, the shell of the halocyprid genus *Deeveya* Kornicker and Iliffe, 1985, at least superficially, resembles those of thaumatoocyprids. Except for the furca, which is typical of halocyprids, *Deeveya* has appendages and a copulatory organ similar to those of thaumatoocyprids. These characteristics seem to bridge thaumatoocyprids and halocyprids. Also, the halocyprid genus *Spelaeoecia* Angel and Iliffe, 1987, has appendages almost identical to those of *Deeveya*, but a carapace with a rostrum typical of other halocyprids. Therefore, we conclude that the Thaumatoocypridoidea should be referred to the Halocypridina, not to the Cladocopina. We follow herein the classification of Kornicker and Sohn (1976:6).

Because the Cladocopina and Halocypridina are related by only 2 synapomorphies, a more conservative classification might be to consider Cladocopida, Halocyprida, and Myodocopida of equal rank in the superorder Myodocopa. This classification is similar to that used by Kornicker (1975:84), Hartmann (1975:667), and Maddocks (1982:228, table 1), except for their ranking the 3 orders as suborders; however, no taxonomic action on this consideration is made herein.

#### Superorder MYODOCOPA Sars, 1866

COMPOSITION.—The Myodocopa comprise 2 orders: Myodocopida Sars, 1866, and Halocyprida Dana, 1853.

#### Order MYODOCOPIDA Sars, 1866

COMPOSITION.—The Myodocopida comprise the suborder Myodocopina Sars, 1866.

#### Suborder MYODOCOPINA Sars, 1866

COMPOSITION.—This suborder comprises 5 families of which 4 (Philomedidae, Sarsiellidae, Rutidermatidae, and Cylindroleberididae) are known from Bermuda. The family Philomedidae is reported in Bermuda for the first time herein. The absence of members of the Cypridinidae is probably a matter of insufficient collecting.

#### Superfamily SARSIELLOIDEA Brady and Norman, 1896

COMPOSITION.—The Sarsielloidea comprise 3 families: Sarsiellidae Brady and Norman, 1896, Rutidermatidae Brady and Norman, 1896, and Philomedidae Müller, 1906. Members of all families are represented in Bermudan caves.

#### Family PHILOMEDIDAE Müller, 1906

The Philomedidae comprise 2 subfamilies: Philomedinae Müller (1906:12) and Pseudophilomedinae Kornicker (1967:5). Neither subfamily has been reported previously from Bermuda, and only the Pseudophilomedinae was represented in the collections.

#### Subfamily PSEUDOPHILOMEDINAE Kornicker, 1967

Five genera in this subfamily have been reported from the western Atlantic (Kornicker, 1984:32), but only the genus *Pseudophilomedes* was in the present collections.

#### *Pseudophilomedes* Müller, 1893

TYPE SPECIES.—*Pseudophilomedes foveolatus* Müller, 1894.

DISCUSSION.—Kornicker (1958:235) described *P. ferulanus* from the Great Bahama Bank, and later (1984:34) presented a short supplementary description of the holotype. Several investigators (Darby, 1965:26; Kornicker, 1967:8; 1969b:119; 1977:792; 1984:33; Bowen et al., 1979, fig. 3) incorrectly referred specimens collected on the Atlantic and Gulf of Mexico continental shelves off North America to *P. ferulanus*. A new species, *Pseudophilomedes darbyi*, is proposed for those specimens, and its diagnosis is presented herein. No specimens of *P. darbyi* were collected in the present study, but proposal of the new species is necessary because of a closely related new species described herein from Bermudan caves.

The new species, *P. kyllix*, from Bermudan caves, is close to *P. ferulanus* from the Bahamas. The latter is known from only a few specimens and should be studied further when more

specimens become available. The carapaces of the adult male and female *P. kylix* bear posterior nodes not shown on photographs of the holotype of *P. ferulanus* (Kornicker, 1958, fig. 46:2a,b), nor are they on the dried carapace of the holotype (USNM 113287). Specimens from the continental shelves of North America, which have been referred to *P. ferulanus*, as detailed above, are not conspecific with either *P. ferulanus* or *P. kylix*. It is less certain that *P. ferulanus* and *P. kylix* are not conspecific, but it is expedient to keep them separate at this time.

**DISTRIBUTION.**—Members of *Pseudophilomedes* have been reported from the Gulf of Naples (Müller, 1894:212), the Great Bahama Bank (Kornicker, 1958:212), the Atlantic continental shelf from New Jersey to Florida (Darby, 1965:26; Kornicker, 1967:8, 1984:33), the continental shelf of the Gulf of Mexico off Florida, Louisiana, and Texas (Kornicker, 1984:33), and off the western coast of Africa (Spanish Sahara, Mauritania) (Kornicker and Caraion, 1977:47). The genus has not been reported previously either from Bermuda or from caves. In the open sea the known depth range is 6–534 m (Kornicker, 1984:33). In Bermudan caves specimens were collected at depths of 0–21 m.

*Pseudophilomedes darbyi* Kornicker, new species

FIGURES 1, 2a

*Pseudophilomedes ferulana*.—Darby, 1965:26, fig. 10, pls. 11, 12.

*Pseudophilomedes ferulanus*.—Kornicker, 1967:8, figs. 1–6, pl. 1; 1969b:119, figs. 3, 4, pl. 2; 1977:792; 1984:33, figs. 14d–k, 15, 16.—Bowen et al., 1979, fig. 3.

Not *Pseudophilomedes ferulana* Kornicker, 1958:235, figs. 46:1a,b, 2a,b; 56A–D.

Not *Pseudophilomedes ferulanus*.—Kornicker, 1984:34, fig. 14a–c.

**ETYMOLOGY.**—Named for David G. Darby.

**HOLOTYPE.**—USNM 193396, undissected ovigerous female in alcohol.

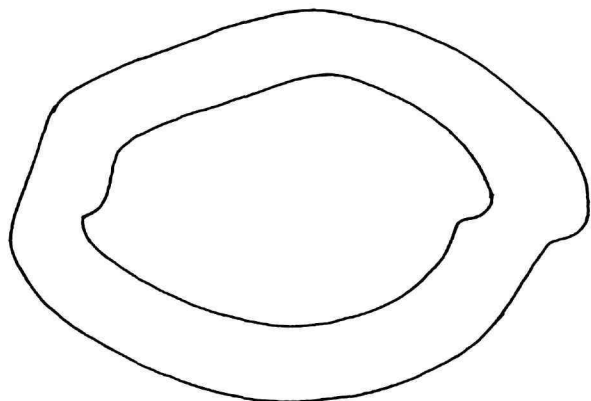


FIGURE 1.—Outline of carapace of adult female *Pseudophilomedes kylix*, new species, USNM 193384, paratype, length 1.13 mm, within outline of adult female carapace of *P. darbyi*, new species, USNM 113020, paratype, length 1.66 mm, both drawn at same magnification ( $\times 4$  objective,  $\times 15$  ocular).

**TYPE LOCALITY.**—Beaufort Shelf Transect, off Beaufort, North Carolina, BST 245N, sta VIII, 30 Nov 1965, 34°23'00"N, 75°55'42"W; 120 m depth.

**MATERIAL.**—USNM 193396 (holotype), undissected ovigerous female in alcohol; this specimen is 1 of 2 identified as *P. ferulanus* and previously assigned USNM 156792 by Kornicker, 1984:2). USNM 156792, 1 juvenile from same sample as holotype. USNM 113020, 3 adult females + 3 ovigerous females, from North Carolina Continental shelf, 130 m (Kornicker, 1984:2).

**DISTRIBUTION.**—Atlantic continental shelf between New Jersey (38°44'08"N) and Florida (27°20'40"N), and Gulf of Mexico continental shelf off Florida, Louisiana, and east Texas. Known depth range 6–190 m (Kornicker, 1984:33).

**DIAGNOSIS.**—Carapace oval in lateral view with well developed rostrum and caudal process (Figure 1); ventral margin of rostrum forming right-angle with valve margin ventral to rostrum. Surface of carapace with shallow fossae but without nodes or ridges.

**Size:** Females: length 1.52–1.73 mm. Male: length 1.47 mm.

**Second Antenna:** Medial surface and anterior margin of protopodite with clusters of slender spines. Endopodite with 2 short proximal anterior bristles and 1 long spinous terminal bristle. Exopodial bristles of juveniles as well as adults with natatory hairs.

**Maxilla:** End joint with long stout process with distal annulations and rough surface of small pustules.

**Fifth Limb:** 1st exopodial joint with 2 teeth: proximal tooth with 3 prongs, distal tooth with 2 prongs. 2nd exopodial joint: inner margin of long saber-like tooth with 3 teeth having 3, 3, and 1 prongs; posterior side of joint with 2 stout hirsute bristles (Figure 2a).

**Seventh Limb:** Absent on male. Female limb with 6 (rarely 4) terminal bristles, and 6–8 (rarely 4) proximal bristles.

**Furca:** Each lamella with 8 claws followed by small process fused to lamella; 3rd claw thinner than 4th but about same length; claw 5 thinner than claw 6 on some but not all specimens (not on holotype).

**COMPARISONS.**—The appendages of *P. ferulanus*, *P. ambon*, *P. kylix*, and *P. darbyi* are quite similar, so only those species are compared here. The carapace of *P. darbyi* is without the verticle posterior ridge present on *P. ambon*, and without the posterior nodes present on *P. kylix*. The medial surface and anterior edge of the protopodite of the 2nd antenna of *P. darbyi* (also *P. ambon*) are spinous, but are bare on *P. ferulanus* and *P. kylix*. The 2 stout posterior bristles on the 2nd exopodial joint of the female 5th limb of *P. darbyi* (also *P. ambon*) are hirsute, but are bare on *P. ferulanus* and *P. kylix* (Figure 2). The claws of the furca of some specimens of *P. darbyi* are stouter than those of the other species; also, unlike other species, the 5th claw of some specimens is thinner than the 6th (not on the holotype). The carapace of *P. darbyi* (also *P. ambon*) is larger than those of *P. kylix* and *P. ferulanus* (Table 10) (Figure 1). (Kornicker (1984, fig. 14) in the legend to an

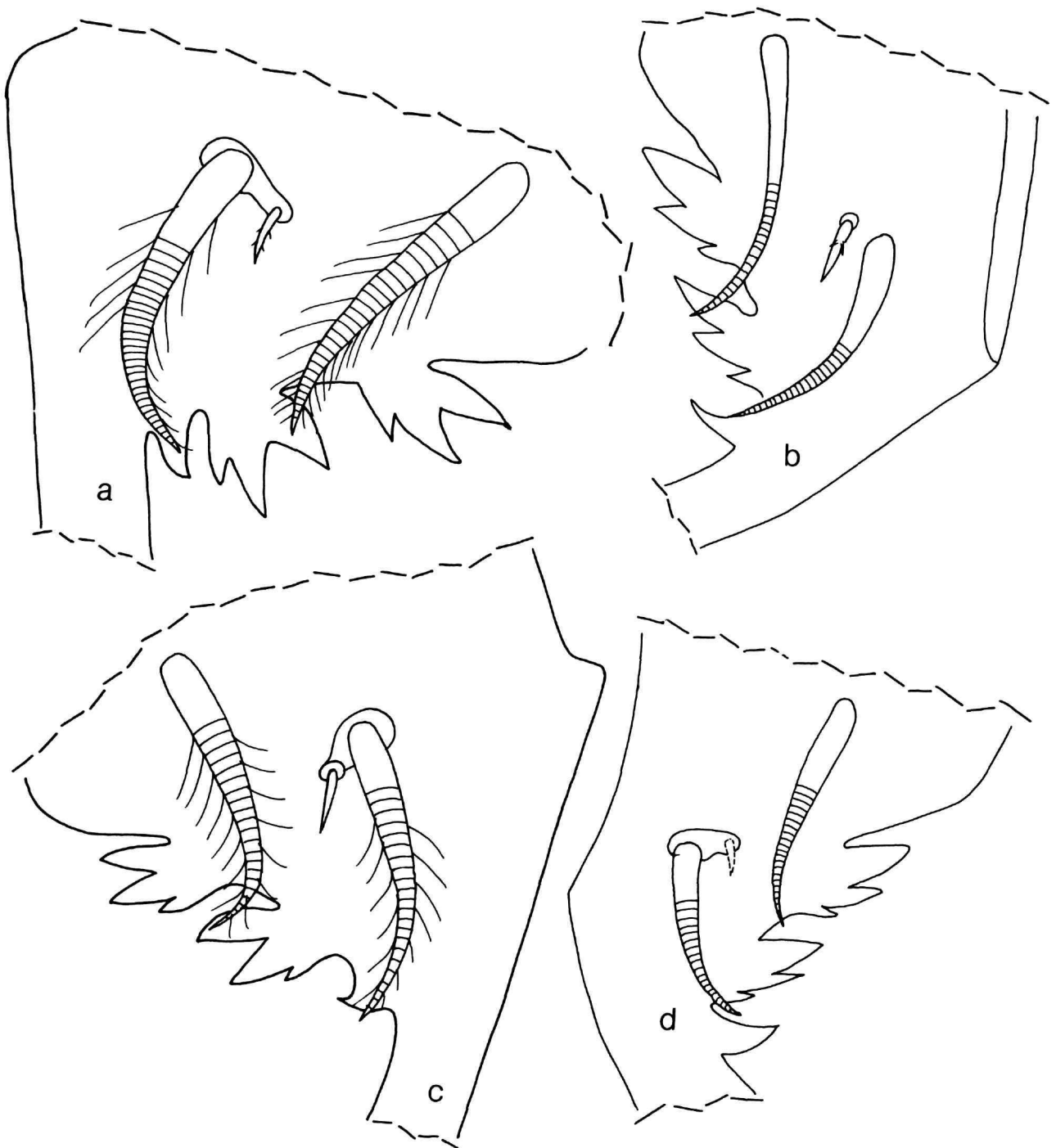


FIGURE 2.—Posterior bristles of 2nd exopodial joint of female 5th limb: a, *Pseudophilomedes darbyi*, new species, USNM 158406, paratype, left limb; b, *P. kyllix*, new species, USNM 193154, paratype, right limb; c, *P. ambon* Kornicker, USNM 156911, paratype, right limb; d, *P. ferulanus* Kornicker, USNM 113287, holotype, left limb. (All limbs drawn at same magnification:  $\times 100$  oil immersion objective,  $\times 15$  ocular.)



illustration gave the length of the holotype of *P. ferulanus* as 1.5 mm; it should have been 1.15 mm as previously given in Kornicker (1958:236). The dry right valve of the holotype (USNM 113287) was measured herein: length 1.11 mm, height 0.70 mm.).

REMARKS.—Some specimens referred to *P. darbyi* have stouter furcal claws than on others, and on those the 6th claw is stouter than the 5th. This suggests that 2 species might be included in *P. darbyi*; the differences are attributed herein to intraspecific variability.

***Pseudophilomedes kylix*, new species**

FIGURES 1, 2b, 3–13

ETYMOLOGY.—From the Greek *kylix* (cup).

HOLOTYPE.—USNM 193395, 1 undissected adult female in alcohol.

TYPE LOCALITY.—Bermuda: Cathedral Cave, 6–8 m, 1984.

MATERIAL.—*Cathedral Cave*: 15 Feb 1984: USNM 193386, 1 adult male in alcohol; USNM 193393, 1 instar III male on slide and in alcohol; USNM 193394, 1 instar IV male on slide and in alcohol. 2 Oct 1984: USNM 193395, 1 undissected adult female in alcohol (holotype). *Cherry Pit Cave*: 23 Jun 1982: USNM 193155, 1 adult male on slide and in alcohol; USNM 193154, 1 adult female on slide and in alcohol; USNM 193385, 1 adult male in alcohol. 22 Mar 1987: USNM 193384, 1 adult female in alcohol; USNM 193391, 1 instar I (sex unknown) on slide; USNM 193396, 1 instar III female in alcohol; USNM 193392, 1 instar IV male in alcohol. *Green Bay Cave*: 18 Nov 1981: USNM 193389, 1 instar I (sex

unknown) in alcohol. *Myrtle Bank Cave*: 7 Feb 1982: USNM 193387, 1 instar III female in alcohol. *Walsingham Cave*: 18 Feb 1982: USNM 193388, 1 instar IV male in alcohol. 22 Oct 1986: USNM 193390, 1 adult male in alcohol.

DISTRIBUTION (Figure 3).—Bermuda: Cathedral Cave, 15 Feb 1984. Cherry Pit Cave, 23 Jun 1982, 22 Mar 1987. Green Bay Cave, 18 Nov 1982. Myrtle Bank Cave, 7 Feb 1982. Walsingham Cave, 18 Feb 1982, 22 Oct 1986.

REMARKS.—The lateral eyes of *P. kylix* are well developed indicating that the species is not troglotic. Because juveniles as well as adults are in the caves, it is tentatively concluded that the species is trogliphilic, and probably lives also outside the caves, although it has thus far been collected only in the caves.

DESCRIPTION OF ADULT FEMALE (Figures 1, 2b, 4–6).—Carapace elongate (Figure 4a,b); dorsal margin evenly rounded, but depressed straight posterodorsal hingeline generally visible through shell; valve greatest height at anterior end of hinge; slightly concave posterior margin with projecting caudal process; anterodorsal and ventral margins convex; ventral edge of rostrum forming obtuse angle with anterior margin of valve ventral to rostrum (Figure 4a–d). Each valve with narrow, vertical, depressed sulcus with dorsal end just posterior to anterior end of hinge (Figure 4b).

Ornamentation (Figure 4a,b,f): Carapace with small round fossae (only few fossae near ventral margin shown on illustrated carapace); under high resolution (X20 objective) and in transmitted light, fossae either ovoid or rectangular and bordered by minute spines or papillae (Figure 4f); long and short undivided bristles widely scattered on lateral surface and

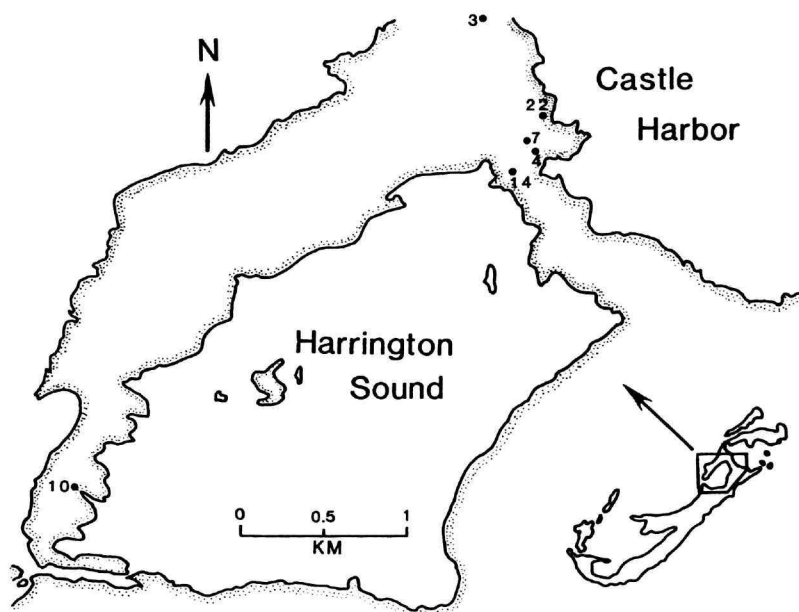


FIGURE 3.—Distribution of caves from which *Pseudophilomedes kylix*, new species, was collected (3 = Cathedral Cave; 4 = Cherry Pit Cave; 7 = Deep Blue Cave; 10 = Green Bay Cave; 14 = Myrtle Bank Cave; 22 = Walsingham Cave).

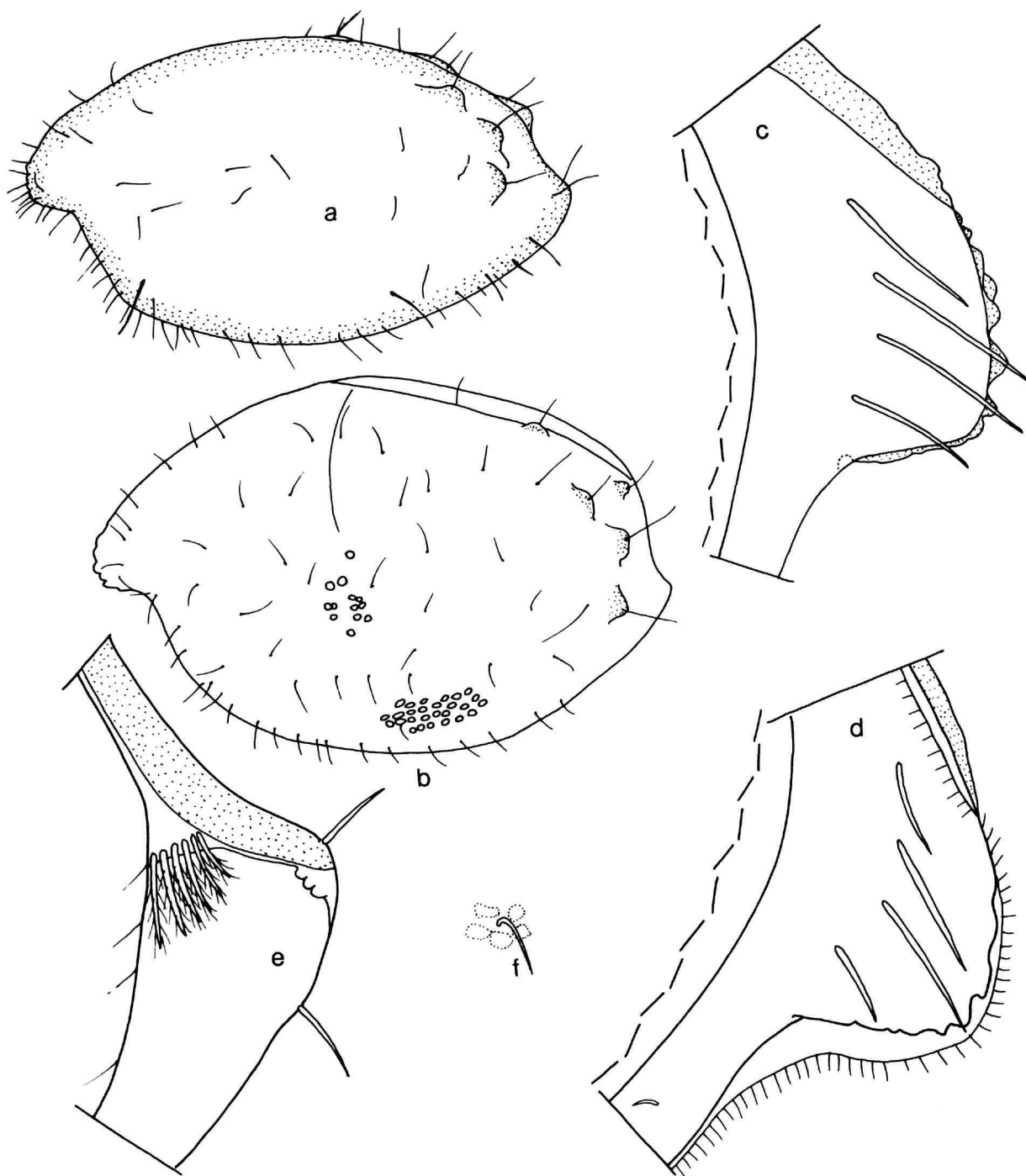


FIGURE 4.—*Pseudophilomedes kylix*, new species, adult female: *a*, USNM 193395, holotype, length 1.08 mm, complete specimen from left side, anterior to left. USNM 193384, paratype, length 1.13 mm: *b*, lateral view of complete specimen, anterior to left (circles at midheight represent location of central adductor muscle attachments; those at midlength near ventral margin represent minute pits of shell surface); *c*, *d*, inside view of rostrum of left valve (fringed lamellar prolongation of selvage shown in *d*); *e*, inside view of caudal process of right valve. *f*, USNM 193154, paratype, length 1.06 mm, bristle and reticulations on decalcified left valve viewed with transmitted light and  $\times 20$  objective.

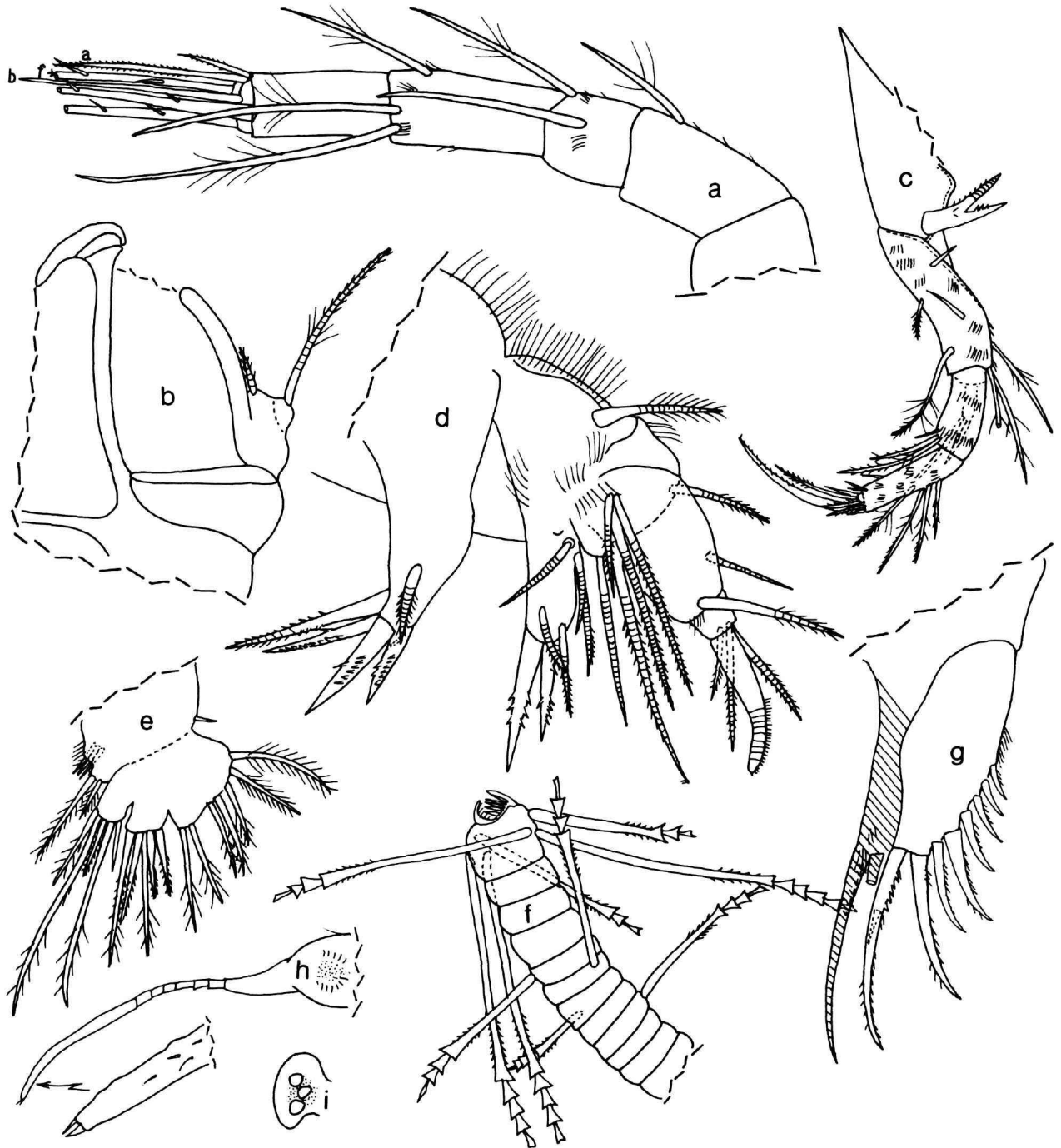


FIGURE 5.—*Pseudophilomedes kyllix*, new species, USNM 193154, paratype, adult female, length 1.06 mm: *a*, right 1st antenna, medial view (d- and e-bristles of 8th joint not shown; limb drawn while not under cover slip); *b*, distal part of protopodite and endopodite of left 2nd antenna, medial view; *c*, left mandible, medial view (not under cover slip); *d*, right maxilla, lateral view; *e*, left 6th limb, lateral view; *f*, 7th limb; *g*, left lamella of furca and claws 1 and 2 of right lamella (lined); *h*, medial eye and Bellonci organ; *i*, left lateral eye.

more abundant along ventral and anterior margins (not all shown on illustrated carapace); valves with several protuberances (each bearing long bristle) in posterior part of valve (Figure 4a,b).

*Infold*: Rostral infold with 4 long bristles (Figure 4c,d); infold of caudal process with 6 plumose bristles forming row near upper edge (Figure 4e). Posterior infold in vicinity of caudal process with small bristles along inner margin (Figure 4e); anteroventral infold with single bristle ventral to incisur (Figure 4d).

*Selvae*: Fairly broad unsegmented lamellar prolongation with fringe of long hairs present along anterodorsal, anterior, anteroventral, ventral, and posterior margins but not observed along posterior edge of caudal process; prolongation undivided at incisur (Figure 4d).

*Central Adductor Muscle Attachments* (Figure 4b): Comprising about 13 minute oval attachments just anterior and ventral to valve middle.

*Carapace Size*: USNM 193154, length 1.06 mm, height 0.68 mm; USNM 193384, length 1.13 mm, height 0.73 mm; USNM 193395, holotype, length 1.08 mm, height 0.65 mm.

*First Antenna* (Figure 5a): 1st joint bare. 2nd joint with few dorsal spines, lateral spines forming row along distal margin, and 1 dorsal bristle with few long spines. 3rd joint short, with spines forming short rows on dorsal and ventral margins and on medial and lateral distal surfaces near margins, and 2 bristles (1 dorsal with long spines, 1 ventral, bare). 4th joint with spines on dorsal and ventral margins and on distal medial surface, and 3 bristles (1 dorsal, 2 ventral, all with long spines). 5th joint long; sensory bristle about same length as combined lengths of joints 2–8, with 2 short proximal filaments and 2 minute terminal filaments. 6th joint fused to 5th, with medial bristle (about half length of joint 5 and with short spines) near dorsal margin. 7th joint: a-bristle about 3 times length of bristle of 6th joint, with short marginal spines; b-bristle slightly longer than a-bristle, with minute distal marginal filament and minute filament at tip; c-bristle about same length as d- and e-bristles, with 4 short filaments (3 proximal, 1 distal) and 2 minute filaments at tip. 8th joint: d- and e-bristles bare, with blunt tips reaching just past tip of sensory bristle of 5th joint (not shown in Figure 5a); f-bristle slightly shorter than d- and e-bristles, with 4 short marginal filaments (2 proximal, 2 distal) and 2 minute filaments at tip; g-bristle about same length as d- and e-bristles, with 3 short filaments (2 proximal, 1 distal) and 2 minute filaments at tip. (Ventral bristles and spines of joints 2–5 appear medially on illustrated right limb drawn without cover slip, and medial bristle of 6th joint appears closer to dorsal margin than when limb compressed under cover slip.)

*Second Antenna* (Figure 5b): Protopodite bare. Endopodite single jointed (or could be interpreted to have small incipient 2nd joint), with short proximal anterior bristle (on both limbs of 2 specimens examined), and terminal bristle with long proximal and short distal spines. Exopodite: 1st joint with small tube-formed medial bristle on terminal margin; bristle of 2nd joint with ventral spines (becoming more slender

distally along bristle) followed by natatory hairs; bristles of joints 3–8 with few proximal dorsal hairs, ventral spines becoming more slender distally along bristle, and distal natatory hairs; 9th joint with 3 bristles: middle and ventral bristles (ventral longer) with ventral spines (becoming more slender distally along bristle) followed by natatory hairs, and slender dorsal spines just proximal to natatory hairs; dorsal bristle short, with short slender spines. Distal margins of joints 2–8 with short slender spines forming row.

*Mandible* (Figure 5c): Coxale endite elongate, bifurcate; both terminal prongs with stout spines, also few spines proximal to prongs; proximal prong annulate distally; dorsal margin of coxale in vicinity of endite with bulge sclerotized along edge. Basale: dorsal margin with distal spines and 3 bristles (1 distal to midlength, 2 terminal, all with few long proximal spines); ventral margin with 2 bristles (1 at midlength short, with short marginal spines, 1 distal long, with long spines at midlength and short hairs distally); medial surface with 2 short bristles (with short marginal spines), and long spines forming rows. Exopodite reaching midlength of 1st endopodial joint, with terminal bristle reaching just past 1st endopodial joint and subterminal bristle reaching midlength of 2nd endopodial joint, both with short marginal spines. 1st endopodial joint with medial spines forming rows, and 3 ventral bristles (longest bristle with long spines at midlength and short spines distally; shorter bristles with short marginal spines). 2nd endopodial joint: medial surface with spines forming rows; ventral margin with 3 short ringed bristles forming 2 distal groups (1 in proximal group, 2 in terminal group; lateral bristle in terminal group with base set inward from ventral edge of joint); dorsal margin with 4 bristles (proximal with few short spines, 3 distal with long proximal and short distal spines). End joint with 6 claws and bristles: 3 forming medial row (ventral bristle short, unringed, claw-like with ventral spines and knife-like curving tip; middle bristle slightly shorter, slender, ringed, with short spines; dorsal bristle short, tapering to pointed tip, but not claw-like, unringed, with short dorsal spines); 3 forming terminal row (ventral bristle short, ringed, with short ventral spines; middle bristle long, ringed, with short ventral spines; dorsal bristle long, unringed, claw-like, with ventral spines and knife-like curving tip). (Medial bristles of basale of illustrated limb drawn without cover slip are closer to ventral margin when limb compressed under cover slip.)

*Maxilla* (Figure 5d): Precoxale: dorsal margin with long hairs forming fringe; endite I with 3 pectinate claws and 2 bristles (proximal ringed; distal longer and partly ringed, both bristles with short marginal spines). Coxale: dorsal margin and lateral surface with long hairs; dorsal margin with ringed plumose bristle; endite II with proximal hairs, 1 bare ringed bristle, 2 terminal pectinate claws, and 2 subterminal ringed bristles, both with short marginal spines; endite III represented by 2 short ringed bristles with bases directly on endite II (not on small lobe). Basale with dorsal hairs and 3 ringed spinous bristles (2 ventral, 1 dorsal about half length of 2 ventral).

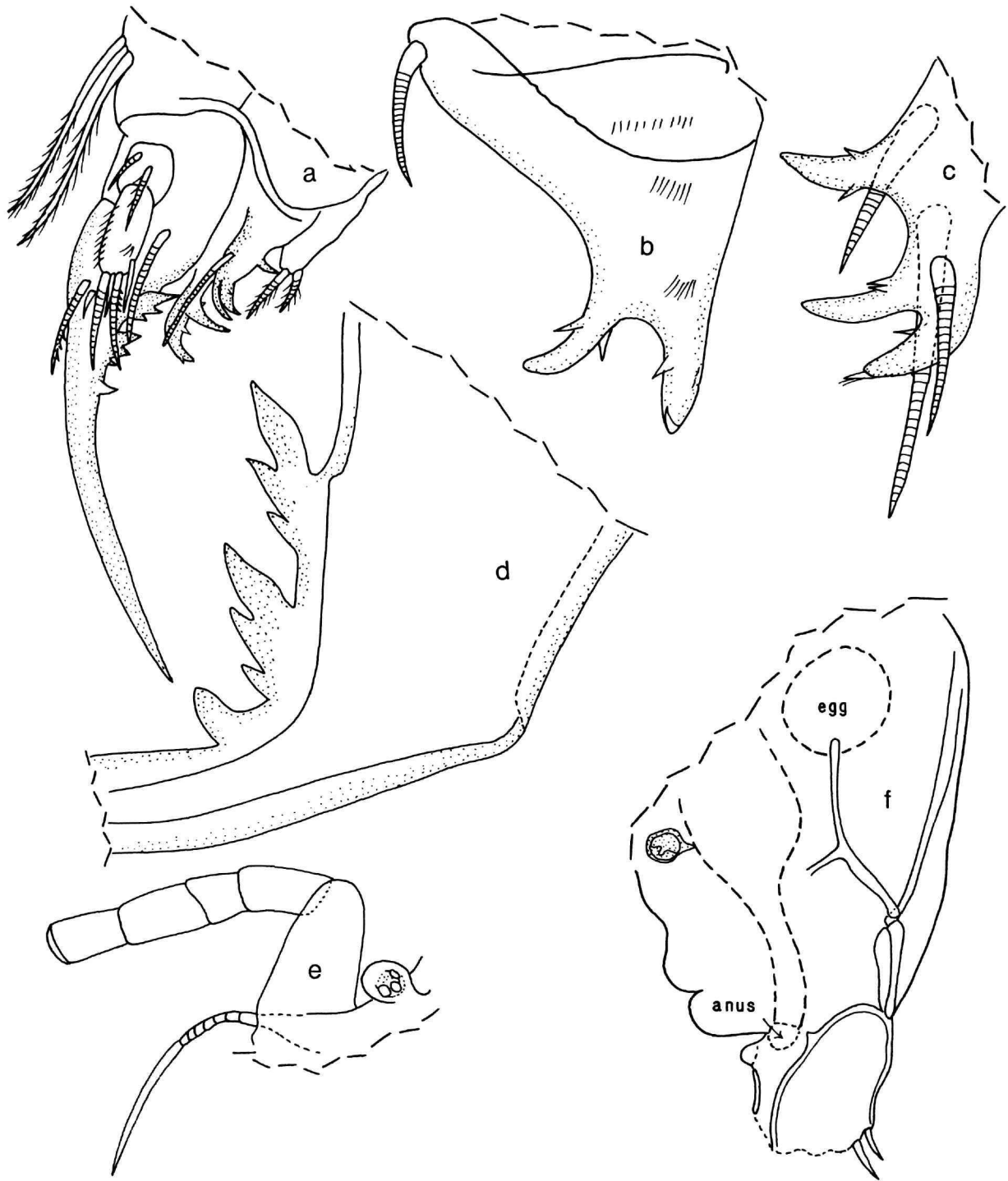


FIGURE 6.—*Pseudophilomedes kylix*, new species, USNM 193154, paratype, adult female, length 1.06 mm: *a-d*, left 5th limb: *a*, posterior view (drawn while not under cover slip); *b*, distal tooth of 1st exopodial joint, anterior view; *c*, proximal tooth of 1st exopodial joint, anterior view; *d*, part of 2nd exopodial joint, anterior view. *e*, lateral view of head region showing left 1st antenna (bristles omitted), left lateral eye, medial eye and Bellonci organ; *f*, posterior of body showing left genital organ (stippled), left Y-sclerite, egg (dashed circle), anus, and posterior 2 claws of left furcal lamella.

Exopodite comprising 3 ringed spinous bristles (1 less than half length of others). Endopodite: 1st joint with hairs on distal margin, and 2 ringed bristles (1 slender at midlength, 1 stout, terminal, with short marginal spines); end joint with stout terminal process ringed distally, and 3 slender ringed spinous bristles.

*Fifth Limb* (Figure 6a-d): Epipodite with 40 plumose bristles. Single endite with 2 short bristles. 1st exopodial joint with 2 teeth: proximal tooth with 3 prongs and 3 bristles (Figure 6c); distal tooth with 2 prongs and 1 proximal bristle (Figure 6b). 2nd exopodial joint: inner margin of long saber-like tooth with 3 proximal teeth with 3, 3, and 1 prongs (Figure 6d); posterior side with 3 bristles (proximal longer, inner of 2 distal bristles minute, indistinct). 3rd exopodial joint with 2 small bristles. 4th and 5th exopodial joints fused, hirsute along outer side, with 4 bristles (2 short, 2 longer; inner longer bristle with stout proximal spines).

*Sixth Limb* (Figure 5e): Endite I with 2 or 3 short, hirsute, medial, proximal bristles; endite II with 1 long terminal bristle (with long proximal hairs and distal spine-like hairs) and 1 short subterminal bristle (with long proximal hairs and short distal spines); endite III with 4 or 5 terminal bristles (2 or 3 long with long distal spines except near tip, 2 with short spines); endite IV broader than endite III, with 5 terminal bristles (2 long with long distal spines except near tip, 3 shorter, with short marginal spines). End joint with 7 bristles along margin (anterior 5 with long proximal and short distal spines, posterior 2 hirsute to tip). Epipodite represented by short bristle. Medial surface of limb hirsute; lateral surface of endites III and IV and distal part of end joint hirsute (hairs not shown on illustrated limb).

*Seventh Limb* (Figure 5f): Proximal group with 4 bristles (2 on each side) with distal spines and 3 or 4 bells; terminal group with 6 bristles (3 on each side) with distal spines and 2-5 bells. Terminus with opposing combs, each with 4-6 teeth (2 specimens examined).

*Furca* (Figures 5g, 6f): Right lamella slightly anterior to left; each lamella with 7-9 claws; claw 3 more slender but about same length as claw 4; claw 5 about same width as claw 6, or slightly broader. (USNM 193154 with 8 claws on right lamella and 9 on left; USNM 193384 with 9 claws on each lamella; USNM 193395 with 7 claws on left lamella and 8 on right).

*Bellonci Organ* (Figures 5h, 6e): Elongate, with about 6 segments in proximal half and minute distal spines, and 2 minute spines at tip.

*Eyes*: Medial eye tapering distally, with concentration of reddish brown pigment near middle when viewed in transmitted light (Figures 5h, 6e). Lateral eye small, with 3 ommatidia and brownish amber pigment (Figure 5i, 6e).

*Genitalia* (Figure 6f): Small oval ring on each side of body.

*Y-Sclerite* (Figure 6f): With dorsal and ventral branch.

*Eggs*: USNM 193154 with 4 large unextruded eggs, USNM 193384 with 5 large unextruded eggs (Figure 6f).

*Gut Content*: Brown unrecognizable mass.

DESCRIPTION OF ADULT MALE (Figures 7, 8).—Carapace shape similar to that of female except posterior more acuminate dorsally (some specimens more than others; Figure 7a,b).

*Ornamentation* (Figure 7a): Posterior without posterior protuberances; shallow oval fossae on surface indistinct and not observed on all specimens. Some bristles differing from those of female in being divided into 2 or rarely 3 branches (not all bristles shown on illustrated carapace).

*Infold*: Bristles similar in number and position to those of female.

*Selvage*: Similar to that of female.

*Central Adductor Muscle Attachments* (Figure 7a): Similar type as those of female (only 9 observed on illustrated specimen).

*Carapace Size*: USNM 193155, length 0.95 mm, height 0.61 mm; USNM 193385, length 0.93 mm, height 0.57 mm; USNM 193386, length 0.95 mm, height 0.62 mm.

*First Antenna* (Figure 7c, 8c,d): 1st joint bare. 2nd joint with few lateral spines along distal margin, and 1 dorsal bristle with few short spines. 3rd joint short, with 2 bristles (1 dorsal, 1 ventral), both with few short marginal spines. 4th joint with 1 dorsal bristle with long proximal and short distal spines. 5th joint small, wedged ventrally between 4th and 6th joints; sensory bristle with broad base with backward pointing proximal end, and with abundant sensory filaments; stem of sensory bristle with 2 long proximal filaments and 2 short distal filaments and bifurcate tip. 6th joint long, with few distal medial spines and 1 medial bristle (with short spines) near dorsal margin. 7th joint: a-bristle almost twice length of bristle of 6th joint, with short marginal spines; b-bristle with tip not reaching that of sensory bristle, with 2 marginal filaments and bifurcate tip; c-bristle about 3 times length of b-bristle, with 10 marginal filaments and bifurcate tip (some filaments with marginal spines). 8th joint: d- and e-bristles almost twice length of b-bristle, bare with blunt tips; f-bristle similar to c-bristle, with about 12 marginal filaments, some with small marginal spines; g-bristle about same length as d-bristle, with 5 marginal filaments and bifurcate tip. (Each filament bears spine at tip.)

*Second Antenna*: Protopodite bare (Figure 8d). Endopodite 3-jointed (Figure 7d): 1st joint short with 2 anterior bristles; 2nd joint elongate with 1 spinous ventral bristle; 3rd joint elongate, reflexed, with 2 spinous bristles near recurved tip; tip with few ridges. Exopodite: 1st joint elongate with small tube-formed medial bristle on terminal margin; joints 2-9 short, decreasing in length distally along limb; bristles of joints 2-8 long with natatory hairs; 9th joint with 4 bristles (2 long with natatory hairs, 1 medium and 1 short, both with slender spines; joints 2-8 with few spines along distal margins).

*Mandible* (Figure 7e-g): Coxale endite comprising small bifurcate process (Figure 7e). Basale: dorsal margin with 3 long bristles (1 near midlength broken off on illustrated limb, 2 terminal); ventral margin with 1 proximal bristle (with few short distal spines) and 1 distal bristle (with long spines near midlength and few short spines distally); medial side with long hairs forming rows and 2 short bristles. Exopodite about half

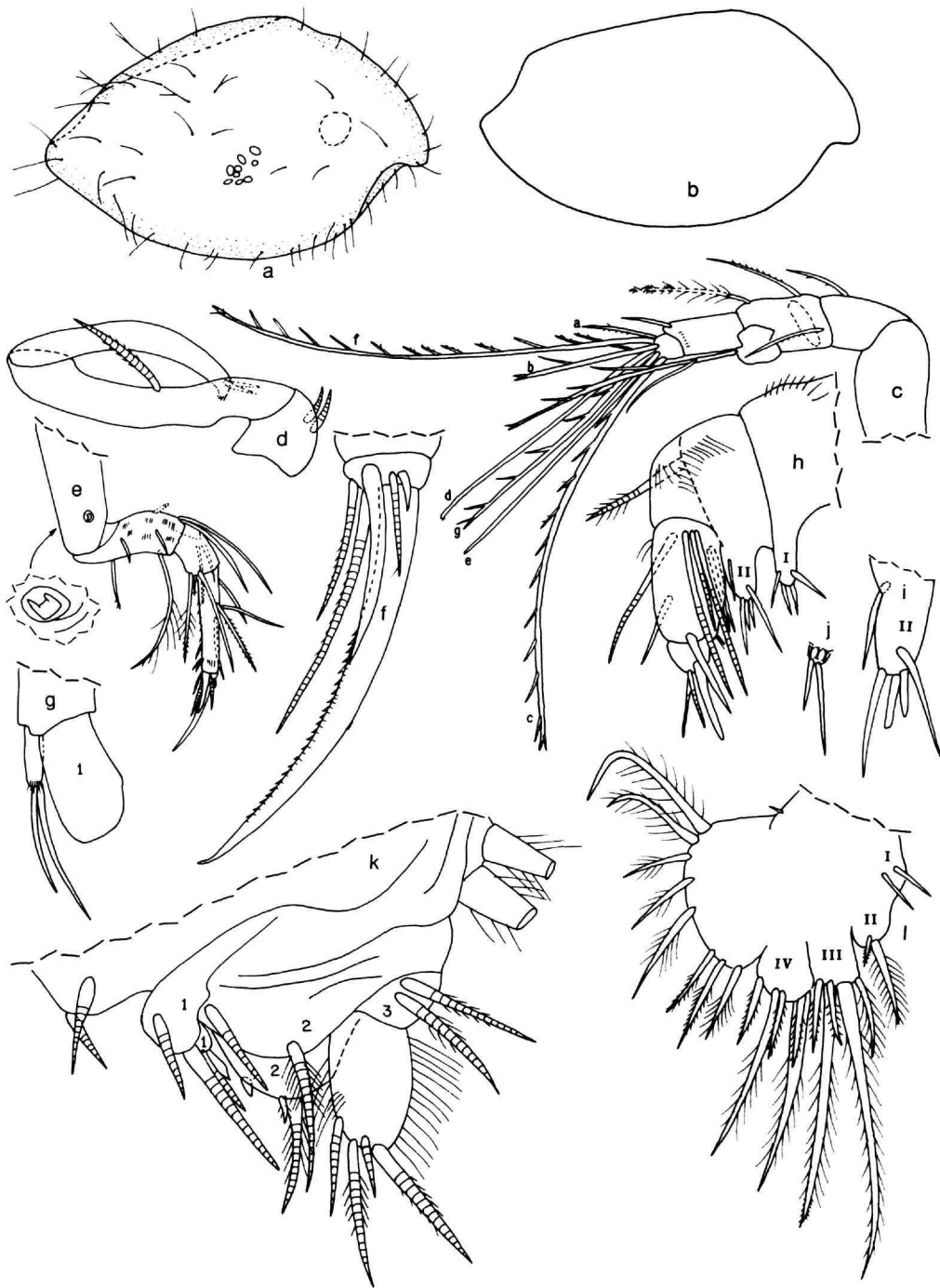


FIGURE 7.—*Pseudophilomedes kyllix*, new species, paratype, adult male: *a*, USNM 193386, length 0.95 mm, complete specimen from right side, anterior to right (dashed line represents hinge, dashed circle indicates lateral eye, small circles at midlength represent some central adductor muscle attachments). *b*, USNM 193385, length 0.93 mm, lateral outline of valve, anterior to left. USNM 193155, length 0.95 mm: *c*, right 1st antenna, medial view; *d*, endopodite of right 2nd antenna, medial view; *e*, left mandible, medial view; *f*, detail of bristles of end joint, from *e*; *g*, basale, exopodite and 1st endopodial joint (bristles shown only on exopodite) of right mandible, medial view; *h*, left maxilla, lateral view (endite III not shown); *i, j*, endites II and III of left maxilla, lateral view; *k*, right 5th limb, posterior view; *l*, left 6th limb, medial view.



FIGURE 8.—*Pseudophilomedes kyllix*, new species, USNM 193155, paratype, adult male, length 0.95 mm: *a*, posterior of body showing right lamella of furca, right copulatory limb, Y-sclerite and other sclerites (lined), posterior spines, and location of central adductor muscle attachments (stippled circle); *b*, medial eye and Bellonci organ, ventral side to bottom (elements drawn not under cover slip); *c*, anterior of body showing joints 1 and 2 of right 1st antenna, outline of right lateral eye (stippled), Bellonci organ, and outline of anterior process; *d*, anterior of body showing 1st and 2nd joints of 1st antenna, protopodite of right 2nd antenna, right lateral eye (stippled), sclerite (lined) and encysted nematode above lateral eye; *e*, posterior of body showing left lamella of furca (claws not drawn), left copulatory organ, Y-sclerite and other sclerites (lined), posterior spines, and encysted nematode; *f*, right and left copulatory organ, lateral view (organ drawn not under cover slip, not all bristles shown, right organ at top); *g*, tip of left copulatory organ, medial view; *h*, tip of right copulatory organ, lateral view.



length of dorsal margin of 1st endopodial joint, hirsute terminally, with 2 long terminal bristles (outer reaching past midlength of inner) (Figure 7g). 1st endopodial joint with 3 ventral bristles (1 short and 1 long (medial) with short marginal spines, 1 long (lateral) with long spines at midlength and short spines distally). 2nd endopodial joint: ventral margin with spines and bristles forming 2 groups (1 in proximal group, 2 in distal group); dorsal margin with 4 bristles (1 proximal, 3 at midlength); medial surface with spines forming rows. End joint with 3 claws (medial claw about half length of longest claw on illustrated limb but shorter on opposite limb of same specimen, dorsal claw minute, longest claw with ventral teeth; Figure 7f).

*Maxilla* (Figure 7h–j): Limb reduced, precoxale, coxale, and basale with fringe of long hairs along dorsal margin. Endite I comprising elongate lobe with 2 thumb-like unringed bristles and 2 pointed bristles; endite II comprising elongate lobe with 2 thumb-like bristles and 3 pointed bristles (1 proximal, 2 terminal; Figure 7i); endite III forming small lobe at base of endite II, with 2 bristles (Figure 7j). Coxale with 1 stout spinous bristle near dorsal margin. Basale with 3 distal bristles (1 dorsal, 2 ventral). Exopodite comprising 3 bristles (2 long, 1 shorter) with base on 1st exopodial joint close to distal margin of basale. Endopodite: 1st joint with hairs and 2 bristles (alpha and beta); 2nd joint with stout, unringed, terminal bristle and 2 short slender ringed bristles.

*Fifth Limb* (Figure 7k): Limb reduced. Epipodite with 38 plumose bristles. Single endite with 2 small bristles. 1st exopodial joint with 2 indistinct lobes: proximal lobe with 2 ringed bristles; distal lobe with 2 bristles (1 ringed, 1 unringed). 2nd exopodial joint with 2 ringed proximal bristles on posterior side (1 close to 1st joint, bare; 1 at joint midwidth, hirsute proximally), 1 small unringed tooth-like bristle on inner edge, and 2 terminal bristles (1 ringed, hirsute, 1 minute). 3rd exopodial joint with 2 ringed bristles on outer lobe. Fused 4th and 5th exopodial joints hirsute along inner and outer edges, with 4 ringed bristles. (Segmentation interpreted to conform with that of adult female limb; this interpretation differs from that of Kornicker (1984:38, 45, 53) for the male 5th limb of other species mainly in placing on the 2nd exopodial joint a bristle he interpreted to be on the inner lobe of the 3rd joint.)

*Sixth Limb* (Figure 7l): Size similar to that of female. Endite I with 2 short medial proximal bristles, bare or with few hairs; endite II with 1 terminal bristle (with long spines becoming more slender near tip of bristle) and 1 short medial subterminal bristle with few short marginal spines; endite III with 1 short and 2 long terminal bristles (with long hairs except near tip where hairs shorter) and 2 short medial subterminal bristles with short marginal spines; endite IV with 2 long terminal bristles (with long hairs except near tip where hairs shorter) and 3 short medial subterminal bristles with short marginal spines. End joint with 7 or 8 marginal bristles (anterior bristle plumose, following 1 or 2 bristles with short marginal spines, following 3 bristles with long spines followed by short spines; posterior 2 bristles stouter than others,

plumose. Epipodite represented by short bristle. Limb hirsute in same manner as that of female (hairs not shown on illustrated limb).

*Seventh Limb*: Absent.

*Furca* (Figure 8a,e): Right lamella slightly anterior to left; each lamella with 9 claws; claw 3 more slender but about same length as claw 4; remaining claws decreasing in length and width posteriorly along lamella; all claws with teeth along posterior margin (proximal teeth stouter; teeth not shown on illustrated limb); minute prong with 5 terminal spines on lamella following last claw; prong followed by spines forming row (detail in Figure 8a); anterior margin of lamellae with few spines. Claw 1 differs from that of female in not having large medial tooth at midlength.

*Bellonci Organ* (Figure 8b,c): 3 or 4 indistinct sutures proximal to midlength; distal half broad with spines more numerous at tip than elsewhere; tip also with 2 minute processes.

*Eyes*: Medial eye without pigment (Figure 8b). Lateral eye well developed and with black pigment; several ommatidia visible along edge, others obscure because of pigment (Figure 8c,d).

*Genitalia* (Figure 8e–h): Complex copulatory organs with sclerotized hooked tip and several bristle-bearing lobes.

*Posterior of Body* (Figure 8e): Posterodorsal corner with small spines.

*Y-Sclerite* (Figure 8e): With dorsal and ventral branch.

*Parasites*: USNM 193155 with several coiled juvenile nematodes scattered throughout body (Figure 8d,e).

DESCRIPTION OF INSTAR I (sex unknown) (Figures 9, 10).—Carapace similar in shape to that of adult female (Figures 9a, 10h).

*Ornamentation*: Without posterior processes present on carapaces of adult male and female. Surface bristles undivided as on adult female (Figure 9a).

*Infold*: Rostral infold with 3 bristles on right valve and 4 on left (Figure 9b); single bristle on anteroventral infold just ventral to incisor (not shown on illustration); caudal infold with 1 or 2 plumose bristles, 2 single bristles near inner margin, and 2 small single bristles at midwidth of infold near ventral margin of valve.

*Selvage*: Similar to that on adult.

*Carapace Size*: USNM 193389, length 0.54 mm, height 0.36 mm; USNM 193391, length 0.57 mm, height 0.38 mm.

*First Antenna* (Figure 9c): 1st joint bare. 2nd joint with spines forming lateral row along distal margin; medial side with few spines forming discontinuous row along distal margin and distal cluster of spines near dorsal margin. 3rd joint short, with 2 bristles (1 ventral, 1 dorsal). 4th joint with distal spines forming row on dorsal margin extending on to lateral and medial sides. Sensory bristle of long 5th joint with terminal spine, no marginal filaments. 6th joint fused to 5th, with short medial bristle (with marginal spines) near dorsal margin. 7th joint: a-bristle about twice length of bristle of 6th joint, with several indistinct marginal spines; b-bristle about twice length



FIGURE 9.—*Pseudophilomedes kylix*, new species, USNM 193391, paratype, instar I, length 0.57 mm: a, complete specimen from left side, anterior to left; b, inside view of anterior of left valve showing bristles of rostral infold; c, right 1st antenna, lateral view; d, protopodite and endopodite of right 2nd antenna, medial view (sclerites stippled); e, right mandible, lateral view; f, left mandible, medial view; g, right maxilla (not all bristles shown); h, right lateral eye, medial eye and Bellonci organ, anterior to right (drawn not under cover slip).

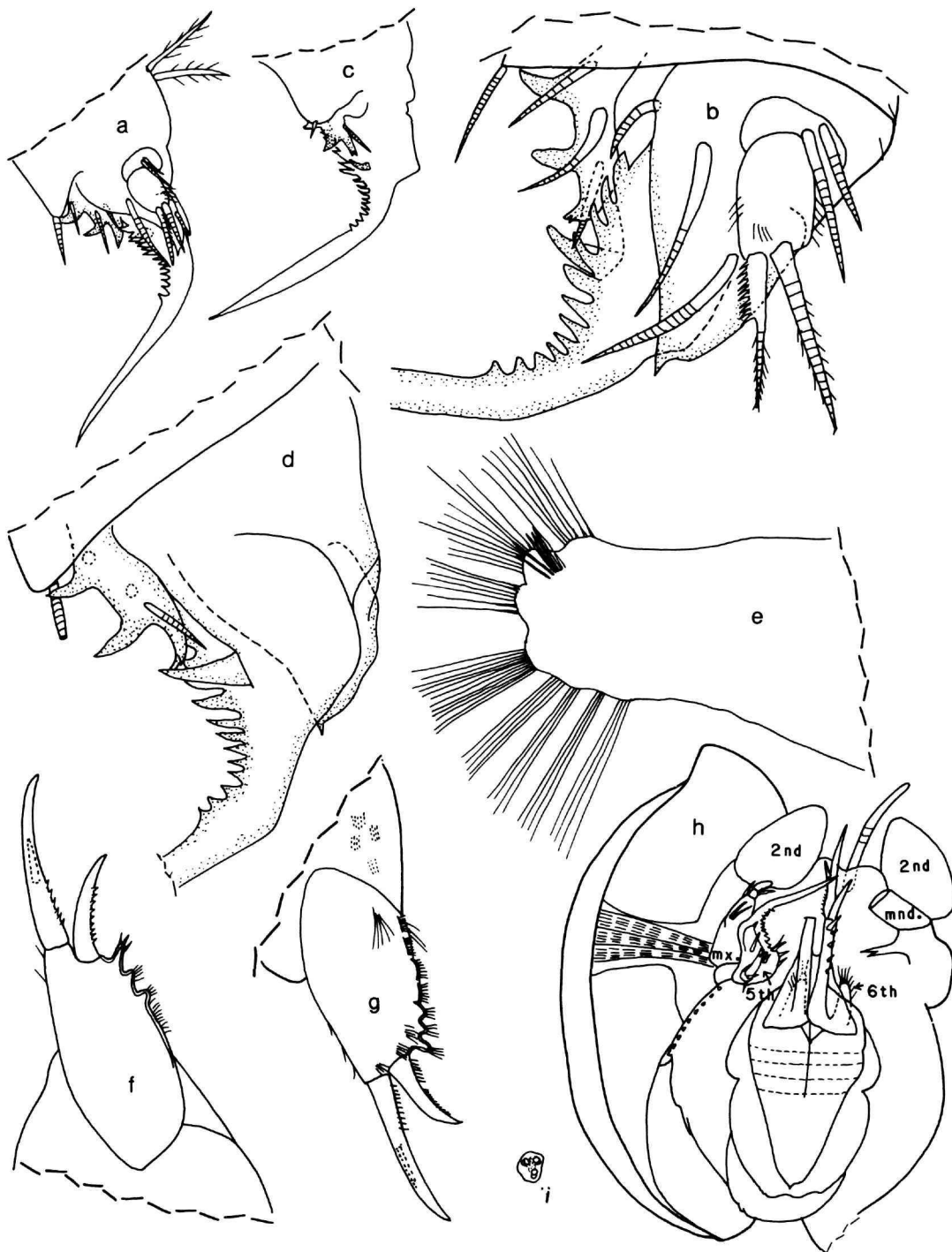


FIGURE 10.—*Pseudophilomedes kyllix*, new species, USNM 193391, paratype, instar I, length 0.57 mm: *a*, Right 5th limb, posterior view (limb drawn not under cover slip); *b*, detail from *a*; *c*, left 5th limb, anterior view (limb drawn not under cover slip); *d*, detail from *c* (only 1 of 3 bristles of 3-pronged tooth shown); *e*, 6th limb; *f, g*, lateral views of right and left furcal lamellae. USNM 193389, paratype, length 0.54 mm: *h*, ventral view of specimen (left valve and some appendages and bristles not shown) (mnd = mandible, mx = maxilla); *i*, left lateral eye (dorsal view through shell).

of a-bristle, with spine at tip; c-bristle slightly longer than sensory bristle, with spine at tip. 8th joint: d- and e-bristles about same length as sensory bristle, sides parallel except at broadly pointed tips; f-bristle about  $\frac{1}{3}$  longer than b-bristle, with spine at tip; g-bristle about same length as sensory bristle, with spine at tip. (Terminal spine of sensory bristle and b-, c-, f-, and g-bristles could be interpreted to be a minute filament.)

**Second Antenna:** Protopodite bare (Figures 9d, 10h). Endopodite with single joint bearing bare subterminal bristle (Figure 9d). Exopodite similar to that of adult male except 9th joint with only 2 bristles (dorsal bristle small with slender spines or hairs; ventral bristle with stout proximal ventral spines becoming more slender distally along bristle and followed by natatory hairs, dorsal margin with slender spines just proximal to natatory hairs).

**Mandible** (Figures 9e,f, 10h): Coxale endite similar to that of adult female. Basale: dorsal margin with 3 bristles (1 distal to midlength, 2 terminal, all bare or with few short spines); medial side with 1 or 2 short bristles (with short marginal spines) and spines forming rows. Exopodite similar to that of adult female. 1st endopodial joint with medial spines forming rows and 1 or 2 ventral bristles. 2nd endopodial joint: medial and lateral surfaces with spines forming rows; ventral margin with short ringed terminal bristle; dorsal margin with 3 bristles at midlength, all bare or with few short marginal spines. End joint with 2 claws (medial claw about half length of lateral claw, both with ventral teeth) and 2 ringed bristles.

**Maxilla** (Figures 9g, 10h): Endites and exopodite similar to those of adult female. Precoxale and coxale with fringe of dorsal hairs. Coxale with plumose dorsal bristle. Basale with 2 ventral bristles. 1st endopodial joint with slender ringed bristle (with short marginal hairs) at midlength. End joint similar to that of adult female.

**Fifth Limb** (Figure 10a-d,h): Epipodite with 26 plumose bristles. Single endite with 1 short bristle. 1st exopodial joint with single tooth with 3 prongs and 3 bristles. 2nd exopodial joint: inner margin of long saber-like tooth with 13 or 14 teeth, each with single prong; anterior side of joint with stout tooth adjacent to 4th marginal tooth (Figure 10c,d); posterior side of joint with flat plate with small terminal tooth and 2 bristles (this plate absent on adult female) (Figure 10a,b); small proximal bristle on inner margin of plate; on outer edge plate appearing to be fused with posterior surface of joint just distal to base of 4th exopodial joint (dashed curve beneath 4th exopodial joint in Figure 10b,d); on inner edge plate appearing to be fused with posterior surface of joint in vicinity of small proximal bristle (Figure 10b). 3rd joint with 2 bristles on outer lobe. 4th and 5th joints fused, hirsute along edges, with 2 terminal bristles (inner bristle with stout proximal spines; Figure 10b).

**Sixth Limb** (Figure 10e,h): Elongate without bristles or well-defined endites. 3 anterior lobes interpreted herein to be endites II, III, and IV: endite II with 7 spines, endite III with 10 spines, endite IV with 7 spines. End joint with spines forming 5 clusters: anterior cluster with about 12 spines

slightly more slender than endite spines; following 4 clusters with numerous hair-like spines (only few shown on illustrated limb). 5 long and 2 short spines forming row proximal to endite III.

**Seventh Limb:** Absent.

**Furca** (Figure 10f-h): Claws 1 and 2 stout, separated from lamella by suture; 3 processes fused to lamella follow claw 2; each process with terminal spines forming row (spines decrease in stoutness posteriorly); 2 short ridges bearing spines (spines decreasing in stoutness posteriorly) follow last fused process; spines forming row just proximal to edge of lamella follow spinous ridges. Claw 1 with stout medial tooth at midlength; claws 1 and 2 with teeth along posterior margin (proximal teeth stouter); lateral spines forming row proximal to claws 1 and 2 and anterior fused process; tuft of long lateral hairs near posteroventral corner of lamella; additional medial hairs along ventral margin of lamella; anterior margin of lamella with few spines forming rows.

**Bellonci Organ** (Figure 9h): Similar to that of adult female, with 8 or 9 fairly well-defined sutures in proximal half; tip with 2 stout spines and several hairs.

**Eyes:** Medial eye without pigment (Figure 9h). Lateral eye with light amber pigment: USNM 193391 with 6 ommatidia (Figure 9h), USNM 193389 with 3 ommatidia (Figure 10i).

**Posterior of Body:** Lateral surface just dorsal to furcal lamellae with minute spines forming clusters (Figure 10g); additional longer spines forming rows in posterodorsal corner.

**Y-Sclerite:** Not observed (may not be formed).

**DESCRIPTION OF INSTAR III MALE** (Figure 11).—Carapace similar in shape to that of adult female (Figure 11a).

**Ornamentation:** Surface of carapace with shallow oval fossae with rim of minute spines or papillae. Long undivided bristles scattered over surface; bristles rarely with 2 branches.

**Infold:** Rostral infold with 4 bristles; 1 small bristle on anteroventral infold just ventral to incisur; caudal process with 4 plumose bristles forming row.

**Selvage:** Similar to that of adult.

**Carapace Size:** USNM 193393, length 0.79 mm, height 0.51 mm.

**First Antenna** (Figure 11b): Except for 4th joint having only 1 ventral bristle, joints 1–4 similar to those of adult female. Sensory bristle of 5th joint with 1 small proximal filament and 2 minute filaments at tip. Medial bristle of 6th joint short with small marginal spines. 7th joint: a-bristle about 4 times length of bristle of 6th joint, with short marginal spines; b-bristle about  $\frac{1}{3}$  longer than a-bristle, with minute filament just distal to midlength, and with terminal spine; c-bristle slightly longer than sensory bristle, with minute proximal filament and 1 near tip, tip with 2 minute filaments. 8th joint: d- and e-bristles about same length as sensory bristle, bare with parallel sides and blunt tips; f-bristle slightly shorter than sensory bristle, with 3 short filaments distal to midlength and 2 minute filaments at tip; g-bristle slightly longer than f-bristle, with 1 short proximal filament, 1 near tip, and 2 minute filaments at tip.



FIGURE 11.—*Pseudophilomedes kyllix*, new species, USNM 193393, paratype, male instar III, length 0.79 mm: a, complete specimen from left side, anterior to left; b, body of specimen from right side showing in place the right lateral eye, right 1st antenna, adductor muscle scars (m.s.), right mandible (mnd.), right maxilla (mx.), and right 5th limb (not all bristles shown); c, distal end of protopodite and endopodite of right 2nd antenna, medial view; d, right 5th limb, posterior view (limb drawn not under cover slip); e, left 6th limb, lateral view; f, posterior of body showing right lamella of furca, Y-sclerite and other sclerites, and posterior spines; g, furcal claws 1-5 of left lamella and claw 1 of right lamella; h, medial eye and Bellonci organ, ventral margin to bottom; i, j, anterior and posterior views of upper lip showing position of coxale endite of left mandible (esoph. = esophagus); k, foreign growth attached to inside of carapace.

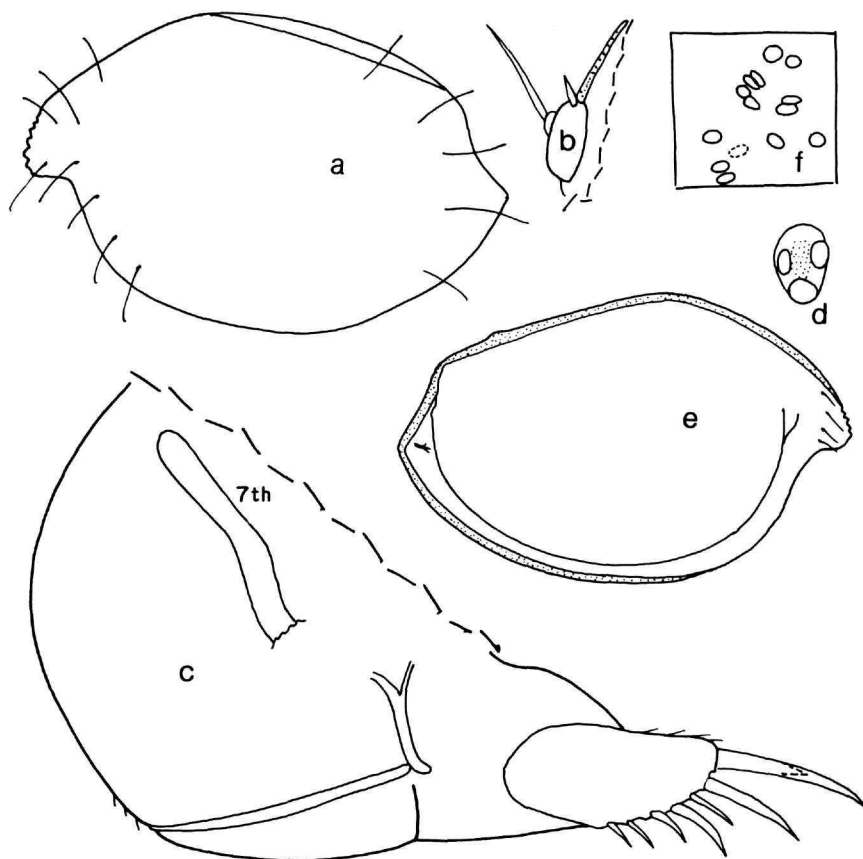


FIGURE 12.—*Pseudophilomedes kylix*, new species, USNM 193387, paratype, female instar III, length 0.85 mm: a, complete specimen from left side, anterior to left (not all bristles shown); b, distal part of protopodite and endopodite of right 2nd antenna, medial view; c, posterior of body showing right 7th limb, right lamella of furca, Y-sclerite, and sclerite of girdle; d, lateral eye. USNM 193396, paratype, length 0.77 mm: e, inside view of left valve; f, outside view of central adductor attachments of right valve, anterior to right.

**Second Antenna** (Figure 11c): Protopodite bare. Endopodite 3-jointed: 1st joint with short anterior bristle; long 2nd joint with long proximal bristle; short 3rd joint with short terminal bristle. Exopodite similar to that of adult female, except left limb of USNM 193393 with only 2 bristles on 9th joint, right limb with 3.

**Mandible** (Figure 11b): Except for proximal bristle of dorsal margin of 2nd endopodial joint being about half length of distal bristles, limb similar to that of adult female. (Only main terminal claw shown on illustrated limb.)

**Maxilla** (Figure 11b): Limb of same type as on adult female. (Not all bristles shown on illustrated limb.)

**Fifth Limb** (Figure 11b,d): Similar to that of adult female.

**Sixth Limb** (Figure 11e): Endite I with 1 short bristle; endite 2 with 2 terminal bristles (1 long, 1 short); endite III with 5 bristles (2 long, 3 short); endite IV with 4 terminal bristles (3 long, 1 short). End joint with 5 bristles (2 posterior bristles plumose, others with long spines at midlength, then short

spines). Limb with medial and lateral hairs and spines (not shown on illustrated limb). Spinosity of bristles as shown in illustration.

**Seventh Limb**: Absent.

**Furca** (Figure 11f,g): Each lamella with 7 claws; claw 3 narrower and shorter than claw 4; claw 4 much broader than claw 5; claw 1 with large medial tooth at midlength and about 6 small proximal teeth; all claws with teeth along posterior margins (not all shown on illustration); claws 1 and 2 with distal hairs along anterior margin; spines at base of claw 1 and following claws; tuft of long lateral hairs near posteroventral corner of lamella.

**Bellonci Organ** (Figure 11h), **Posterior of Body** (Figure 11f): Similar to those of adult male.

**Eyes**: Medial eye without pigment (Figure 11h). Lateral eye fairly large, with 2 ommatidia and several amber cells (ommatidia?) (Figure 11b). **Lips** (Figure 11i,j): Spines forming row ventral and dorsal to mouth; ventral spines stouter.

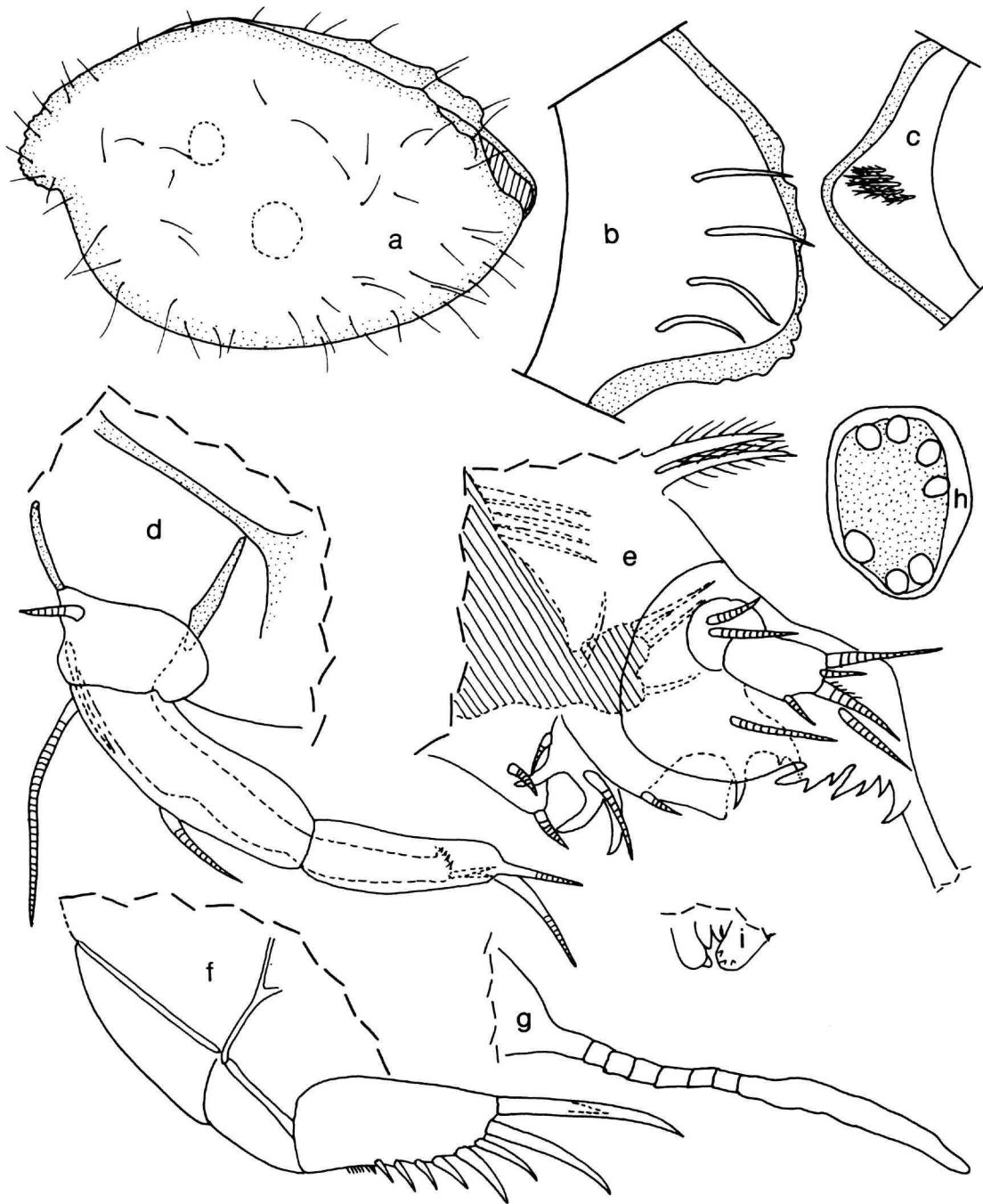


FIGURE 13.—*Pseudophilomedes kylix*, new species, USNM 193394, paratype, male instar IV, length 0.91 mm: a, complete specimen from left side, anterior to left (valves open slightly); b, inside view of rostrum of left valve; c, inside view of posterior of left valve; d, distal part of protopodite and endopodite of right 2nd antenna, medial view (dashed lines represent endopodite of adult visible within limb of instar IV); e, right 5th limb, posterior view (lined pattern represents 5th limb of adult visible within 5th limb of instar IV, not all bristles shown); f, posterior of body showing right lamella of furca, Y-sclerite and other sclerites (only 1 furcal tooth shown); g, medial eye and Bellonci organ, ventral margin to bottom); h, right lateral eye; i, right and left copulatory organs, anterior view (drawn not under cover slip).

*Genitalia*: None observed.

*Y-Sclerite* (Figure 11f): With ventral and dorsal branch.

*Foreign Growth*: Inside of carapace with numerous unidentified filaments (Figure 11k).

DESCRIPTION OF INSTAR III FEMALE (Figure 12).—Carapace similar in shape to that of adult female (Figure 12a,e).

*Ornamentation*: Similar to that of adult female, only undivided bristles on shell.

*Infold* (Figure 12e): Rostral infold with 4 bristles; anteroventral infold with 1 small bristle ventral to incisur. Bristles of caudal process obscure on specimens examined, only 1 shown in illustration, probably more present.

*Central Adductor Muscle Attachments* (Figure 12f): Comprising about 14 ovoid scars.

*Carapace Size*: USNM 193387, length 0.85 mm, height 0.53 mm; USNM 193396, length 0.77 mm, height 0.52 mm.

*First Antenna, Mandible, Maxilla, 5th and 6th Limbs*: Not examined in detail but appearing similar to those of male instar III.

*Second Antenna*: Endopodite with 1 short proximal anterior bristle and small terminal protuberance with long bristle (Figure 12b). Protopodite and exopodite similar to those of male instar III.

*Seventh Limb* (Figure 12c): Elongate without bristles.

*Furca* (Figure 12c): Similar to that of male instar III, with 7 claws.

*Bellonci Organ*: Similar to that of male instar III.

*Eyes*: Medial eye unpigmented. Lateral eye with 3 ommatidia and light brown pigment (Figure 12d).

*Genitalia*: None observed.

*Posterior of Body and Y-Sclerite* (Figure 12c): Similar to those of adult female.

DESCRIPTION OF INSTAR IV MALE (Figure 13).—Carapace similar in shape to that of adult female (Figure 13a).

*Ornamentation* (Figure 13a) and *Selva*: Similar to those of adult female, bristles undivided.

*Infold*: Rostral infold with 4 bristles (Figure 13b); infold of caudal process with 4 plumose bristles (Figure 13c).

*Carapace Size*: USNM 193388, length 0.99 mm, height 0.54 mm; USNM 193392, length 0.85 mm, height 0.58 mm; USNM 193394, length 0.91 mm, height 0.60 mm.

*First Antenna*: Joints 1-6 with same number of bristles as on adult female. Bristles of joints 7 and 8 not examined in detail but appearing similar to those of adult female. (First antenna of USNM 193394 with adult 1st antenna bearing filamentous sensory bristle visible inside.)

*Second Antenna*: Endopodite 3-jointed: short 1st joint with 1 small anterior bristle; elongate 2nd joint with 2 bristles (1 proximal, 1 shorter at midlength); 3rd joint elongate with 2 short terminal bristles (Figure 13d; illustrated endopodite with endopodite of adult male shown inside as dashed outline). Protopodite bare. Exopodite similar to that of adult male, with 4 bristles on 9th joint.

*Mandible, Maxilla, Fifth Limb* (Figure 13e): Similar to those of adult female. (The 5th limb of the adult male is shown

within the illustrated 5th limb.)

*Sixth Limb*: One limb of USNM 193394 with similar number of endites and bristles as limb of adult female; other limb with 3rd and 4th endites fused (aberrant); fused endites with total of 8 bristles.

*Seventh Limb*: Absent.

*Furca* (Figure 13f): Similar to that of adult female: USNM 193388, 193392, 193394, all with 8 claws on each lamella.

*Bellonci Organ* (Figure 13g), *Posterior of Body*, and *Y-Sclerite* (Figure 13f): Similar to those of adult female.

*Eyes*: Medial eye unpigmented (Figure 13g). Lateral eye large, with black pigment and 7 visible ommatidia (others masked by pigment) (Figure 13h).

*Genitalia* (Figure 13i): Represented by small lobes.

COMPARISONS.—*Pseudophilomedes kylix* differs from *P. ferulanus* in having posterior protuberances on the adult carapace (female only). *P. kylix* differs from both *P. darbyi* and *P. ambon* in not having medial spines on the protopodite of the 2nd antenna, and in not having long hairs or spines on the 2 long posterior bristles of the 2nd exopodial joint of the female 5th limb (Figure 2). The endopodites of the 2nd antenna of the 2 adult females of *P. kylix* that were examined had 1 proximal anterior bristle, compared to 2 on other species, but the variability in number of bristles is unknown. The furcal claws of *P. darbyi* are mostly stouter than those of *P. kylix*, and unlike the claws of *P. kylix* the 5th claw tends to be narrower than the 6th, but not on all specimens. *P. darbyi* is without the posterior protuberances on the carapace of *P. kylix*, and *P. ambon* bears a vertical ridge in place of the protuberances. Both *P. darbyi* and *P. ambon* are larger than *P. kylix* (Table 10).

NUMBER OF GROWTH STAGES.—Instar I is represented in the collection by 2 specimens of undetermined sex. Identification of the instar is based on the morphology of the 1st antenna (absence of bristles on the 2nd and 4th joints; absence of marginal filaments on the sensory bristle and b-, c-, f-, and g-bristles), and absence of bristles on the 6th limb. Instar II is absent from the collection. Instar III is represented by 1 female and 2 males. Instar IV is represented by 3 males. Adults are represented by 3 females and 3 males. The male of the species is without a 7th limb so it cannot be used to estimate male stage of development. The following 3 combined characters were used in identifying the female instar III (Hiruta, 1983:673): (1) absence of bristles on the female 7th limb; (2) presence of a bristle on the ventral margin of the 4th joint of the 2nd antenna; and (3) presence of many bristles on the 6th limb. The juvenile male USNM 193393 is considered an instar III because it is similar to the female instar III in carapace size, distribution of bristles on the 1st antenna, and number of claws on the caudal furca. There can be no doubt that the juvenile males referred to instar IV are A-1 males because appendages of the adult male are visible within appendages of USNM 193394. According to this analysis, *P. kylix* has 4 juvenile instars. Prior studies of the Philomedidae in which the number of instars has been estimated were all in the subfamily Philomedinae, in



TABLE 10.—Localities and carapace lengths (mm) of adults of *Pseudophilomedes kyllix*, *P. ferulanus*, *P. darbyi*, and *P. ambon*.

Species	Female	Male	Locality
<i>P. kyllix</i>	1.06–1.13	0.93–0.95	Bermuda (caves)
<i>P. ferulanus</i>	1.15	no data	Great Bahama Bank
<i>P. darbyi</i>	1.52–1.73	1.47	Continental shelf (Atlantic and Gulf of Mexico)
<i>P. ambon</i>	1.36–1.64	1.18–1.20	Continental shelf (Gulf of Mexico)

TABLE 11.—Order of appearance of appendages of *Pseudophilomedes kyllix* (Characters present = 1st and 2nd antennae, mandible, maxilla, 5th limb, furca, Bellonci organ; x = present; 0 = absent; anlage = appendage present but without bristles; nd = no data).

Growth stage	Characters present	Sixth limb	Seventh limb	
			male	female
I	x	anlage	0	0
II	nd	nd	nd	nd
III	x	x	0	anlage
IV	x	x	0	nd
V (adult)	x	x	0	x

TABLE 12.—Number of bristles on joints of first antenna of *Pseudophilomedes kyllix* (d = dorsal; v = ventral; nd = no data).

Growth stage & sex	1st joint	2nd joint (d)	3rd joint (v/d)	4th joint (v/d)	5th joint	6th joint	7th joint	8th joint
I	0	0	1/1	0	1*	1	3*	4*
II	nd	nd	nd	nd	nd	nd	nd	nd
III	0	1	1/1	1/1	1	1	3	4
IV	0	1	1/1	2/1	1	1	3	4
V (adult)								
female	0	1	1/1	2/1	1	1	3	4
male	0	1	1/1	0/1	1	1	3	4

\*Bristles without marginal filaments.

TABLE 13.—Carapace lengths and distribution of claws on each lamella of furca of *Pseudophilomedes kyllix* (X = claw separated from lamella by suture; C = claw separated from lamella and narrower than following claw; x = claw fused to lamella).

Growth stage & sex	Carapace length (mm)	Distribution of claws <sup>1</sup>								
		1	2	3	4	5	6	7	8	9
I (sex?)	0.54–0.57	X	X	x	x	x				
II					no data for this stage					
III male	0.79	X	X	C	X	X	X	X		
female	0.77–0.85	X	X	C	X	X	X	X		
IV male	0.85–0.99	X	X	C	X	X	X	X	X	
V (adult)										
female <sup>2</sup>	1.06–1.13	X	X	C	X	X	X	X		
		X	X	C	X	X	X	X	X	
		X	X	C	X	X	X	X	X	X
male	0.93–0.95	X	X	C	X	X	X	X	X	X

<sup>1</sup>Each number represents the position of a claw counting from distal end of lamella.<sup>2</sup>Of 3 adult females examined, 3 lamellae have 9 claws, 2 have 8, and 1 has 7.

which 5 species in 3 genera (*Philomedes*, *Euphilomedes*, and *Scleroconcha*) were determined to have 5 juvenile instars (Hiruta, 1983:675). Because the number of instars in the Pseudophilomedinae is known for only *P. kylix*, it would be premature to conclude that all members of the subfamily have fewer instars than do the Philomedinae.

**ONTOGENY AND SEXUAL DIMORPHISM.**—Except for having fewer plumose bristles on the infold of the caudal process, the carapaces of juveniles are similar to that of the adult female. Some bristles on the carapace of the adult male have 2 (rarely 3) branches, whereas, bristles of the adult female are unbranched. A few bristles with 2 branches were observed on male instar III (USNM 193393) but only single bristles were observed on other instars. The adult male is smaller than the adult female. It is only slightly larger than the A-1 male, and the lengths at each stage may overlap.

The order of appearance of appendages of *P. kylix* is similar to that found in previous studies of the Myodocopina (Hiruta, 1980) (Table 11).

**First Antenna** (Table 12): The number of bristles on each joint is given in Table 12. Significant changes during ontogeny in the number of bristles on joints 2 and 4 and in the number of filaments on selected bristles are as follows. On instar I no bristles are present on joints 2 and 4, and except for a small terminal filament or spine, no marginal filaments are present on either the sensory bristle of the 5th joint or the b-, c-bristles of the 7th joint and f- and g-bristles of the 8th joint. Instar II is not represented in the collection. A dorsal bristle is present on the 2nd and 4th joints of Instar III as well as of the following instar. One ventral bristle is present on the 4th joint of instar III, 2 on the 4th joint of both instar IV and the adult female, and none on the adult male. Instar III and following instars have marginal filaments on the sensory bristle of the 5th joint, as well as on the b-, c-, f-, and g-bristles of the 7th and 8th joints.

**Second Antenna:** The protopodite is bare on all instars. The endopodite of instar I has a single joint bearing a subterminal bristle. The endopodites of both instar III and the adult female have a short proximal anterior bristle and a small terminal protuberance with a long bristle. The endopodite of the instar III male has a short anterior bristle on the 1st joint, a long 2nd joint with a long proximal bristle, and a short 3rd joint with a short terminal bristle. The endopodite of the instar IV male differs in having an additional short bristle on the 2nd joint, and a longer 3rd joint with 2 terminal bristles. The endopodite of the adult male has 2 short anterior bristles on the 1st joint, only 1 bristle on the long 2nd joint, and a recurved 3rd joint with 2 short subterminal bristles and terminal ridges. The exopodite of instars differs mainly in the number of bristles on the 9th joint: instar II with 2, instar III with 2 or 3, instar IV male and adult male with 4, adult female with 3.

**Mandible:** The mandible of instar I has fewer bristles on the basale, 1st and 2nd endopodial joints, and only 2 claws and

2 bristles on the end joint. The mandibles of instars III and IV are similar to that of the adult female. The adult male mandible differs mainly in having a much smaller coxale endite.

**Maxilla:** The maxilla of juveniles is similar to that of the adult female. That of adult male is reduced, and the endite bristles as well as the main bristle of the 2nd endopodial joint is more weakly developed.

**Fifth Limb:** The limb of instar I is different from those of later instars: the distal bilobed tooth of the 1st exopodial joint present on later instars is absent, the inner edge of the long saber-like tooth of the 2nd exopodial joint has 13 or 14 teeth (not 7 as on later instars), the anterior side of the joint bears a stout tooth adjacent to the 4th marginal tooth, and the posterior side of the joint has a flat plate with a small terminal tooth. The plate is absent on later instars, and unless the tooth of the anterior side is later modified and becomes one of the teeth along the inner edge, it too is not present on later instars. The limb is fully developed in instar III. The limb of the adult male is reduced and without large teeth on the 1st and 2nd exopodial joints.

**Sixth Limb:** The limb on instar I is a flat plate with the endites and end joint represented by spinous lobes. (On instar II, missing in the present collection, the limb on other Myodocopina generally bears a single anterior bristle.) The limb is well developed with many bristles in female instar III. The 6th limb of the adult male and female are fairly similar.

**Seventh Limb:** Absent on juvenile and adult males. None was present on the 2 specimens of instar I in the collection. Their sex is unknown and, if they are males, a 7th limb would not be expected; however, because the 7th limb is almost always absent on instar I females of Myodocopina, it would not be expected on instars I of *P. kylix* even should one or both of the specimens on hand be females. The 7th limb of the female instar III is elongate, without bristles; whereas, the adult female has many cylindrical bristles (no female instar IV in collection).

**Furca** (Table 13): On instar I claws 1 and 2 are stout and separated from the lamella by a suture. Following claw 2 are 3 spinous processes (1st much longer than others), which may be enlargers of claws that develop in later instars. The furca of instar III bears 7 claws on each lamella, each with suture at base. The male instar IV has 8 claws on each lamella, and the adult male 9. The adult female has 7-9 claws on each lamella.

**Lateral Eyes:** Of the 2 specimens of instar I studied, USNM 193391 has 5 ommatidia (more than the 3 ommatidia observed in the adult female), suggesting that it might be a male; but no differences were observed in the endopodites of the 2nd antennae of that specimen and USNM 193389, which has only 3 ommatidia. It is possible, however, that the endopodites of the male and female instar I are identical. The lateral eyes of male instars III and IV, as well as those of the adult, all have more ommatidia than that of female instar III and adult (instar IV female not in collection).

### Family SARSIELLIDAE Brady and Norman, 1896

This family comprises 2 subfamilies, Sarsiellinae Brady and Norman, 1896, and Dantyninae Kornicker and Cohen, 1978. Only the Sarsiellinae have been reported in Bermuda.

### Subfamily SARSIELLINAE Brady and Norman, 1896

Four genera in this subfamily have been reported from the western Atlantic (Kornicker, 1986a), but of these only the genus *Eusarsiella* has been reported from Bermuda (Kornicker, 1981:2). A new species (*E. styx*) of the genus was collected in caves in this study.

### *Eusarsiella* Cohen and Kornicker, 1975

**TYPE SPECIES.**—*Sarsiella tumida* Scott, 1905, by subsequent designation in Cohen and Kornicker (1975, table 1).

**COMPOSITION.**—Only 1 species has been reported previously from Bermuda, *Eusarsiella absens* (Kornicker, 1981b). A new species, *E. styx*, from Bermudan caves is described herein.

**REMARKS.**—The original description of *E. absens* was based on 2 adult females and 1 juvenile from Castle Harbor. No specimens were collected in caves in the present collection but specimens that had been collected in open water in Harrington Sound, including adult males, are reported upon herein.

**CORRECTION.**—In the 'Key to the Species of *Eusarsiella*' in Kornicker (1986a:46) couplet 28 should be as follows.

28. First antenna without ventral bristle on 3rd joint . . . 29  
 First antenna with ventral bristle on 3rd joint . . . . 30

### *Eusarsiella absens* (Kornicker, 1981)

#### FIGURES 14–16

*Sarsiella absens* Kornicker, 1981a:2, figs. 1, 2.—Maddocks and Kornicker, 1986:283, pl. 90.

*Eusarsiella absens*.—Kornicker, 1986a:46 [key], 54, fig. 25, tables 1, 4.

**HOLOTYPE.**—USNM 158116, adult female.

**TYPE LOCALITY.**—Castle Harbor, Bermuda.

**MATERIAL.**—Harrington Sound, collected 1980–1981: USNM 193401, 1 adult male; USNM 193402, 3 adult males; USNM 193403, 15 ovigerous females, 4 adult females without eggs, 5 juveniles.

**DISTRIBUTION.**—Bermuda: Castle Harbor (Kornicker, 1981a:2), Harrington Sound.

**DESCRIPTION OF ADULT MALE** (Figures 14–16).—Carapace elongate with distinct rostrum in lateral view and shallow incisur; caudal process forming right-angle (Figure 14).

**Ornamentation** (Figure 14, 15b): Carapace with 2 horizontal ribs: ventral rib broad over central adductor muscle attachment area, becoming narrow posteriorly, and terminating near caudal process (Figure 14); dorsal horizontal rib

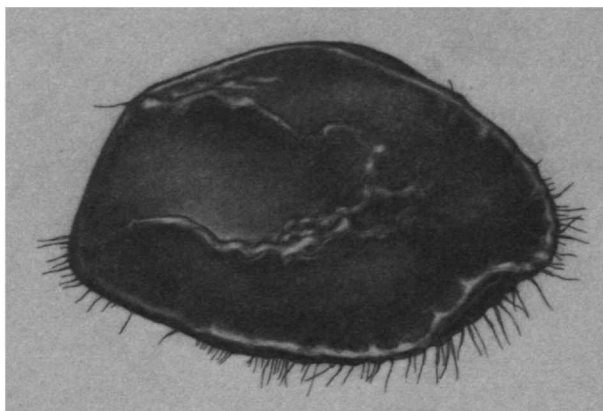


FIGURE 14.—*Eusarsiella absens* Kornicker, USNM 193401, adult male, length 1.04 mm, complete specimen, anterior to right.

terminating at posterodorsal corner of valve and joining indistinct vertical rib just anterior to valve midlength; ventral end of vertical rib joining anterior end of ventral rib. Long bristles, some with broad basal part, abundant along anterior and ventral margins and along edge of caudal process (Figure 15b), but very sparse on lateral surface. No gelatinous coating on valves. Valves weakly calcified; USNM 193401 with oval plate-like concretions within shell.

**Infold:** Anterior infold with 1 minute bristle just ventral to valve midheight (Figure 15a); midwidth of infold of caudal process with 6 small bristles forming row (Figure 15b); 9 small bristles forming row along inner edge of infold anterior to caudal process and posterior valve edge; 2 setal bristles on infold dorsal to caudal process.

**Selvaige:** Broad lamellar prolongation without marginal fringe present along anterior, ventral, and posterior margins of each valve.

**Carapace Size:** USNM 193401, disarticulated valves: left valve, length 1.04 mm, height 0.71 mm; right valve, length 1.02 mm, height 0.68 mm. USNM 193402, 3 specimens: length 1.09 mm, height 0.77 mm; length 1.06 mm, height 0.76 mm; length 0.96 mm, height 0.65 mm. (Slightly smaller than 3 females described in Kornicker (1981a:3), which range in length from 1.17 to 1.22 mm.)

**First Antenna** (Figure 15c): 1st joint bare. 2nd joint with dorsal bristle with long proximal marginal spines. 3rd joint fused to 4th joint, with long dorsal bristle and no ventral bristle. 4th joint with short dorsal bristle and 2 long, slender, ventral bristles. 5th joint wedged ventrally between 4th and 6th joints; stem of sensory bristle with 4 distal marginal filaments and bifurcate tip. 6th joint long, with small medial bristle (length about equal to width of joint near dorsal margin. 7th joint: a-bristle bare, slightly shorter than length of 6th joint; b-bristle about twice length of a-bristle, with distal marginal filament and bifurcate tip; c-bristle long, with 5 marginal filaments and bifurcate tip. 8th joint: d- and e-bristles long, bare, with blunt tips; f-bristle long, with 4 distal marginal filaments and



FIGURE 15.—*Eusarsiella absens* Kornicker, USNM 193401, adult male, length 1.04 mm: a, inside view of anterior of right valve; b, inside view of posterior of left valve; c, left 1st antenna, medial view; d, distal part of protopodite and endopodite of left 2nd antenna, medial view; e, left mandible, lateral view; f, coxale, basale, exopodite, and proximal part of 1st endopodial joint of right mandible, medial view; g, endopodial joints 1-3 of right mandible, medial view.

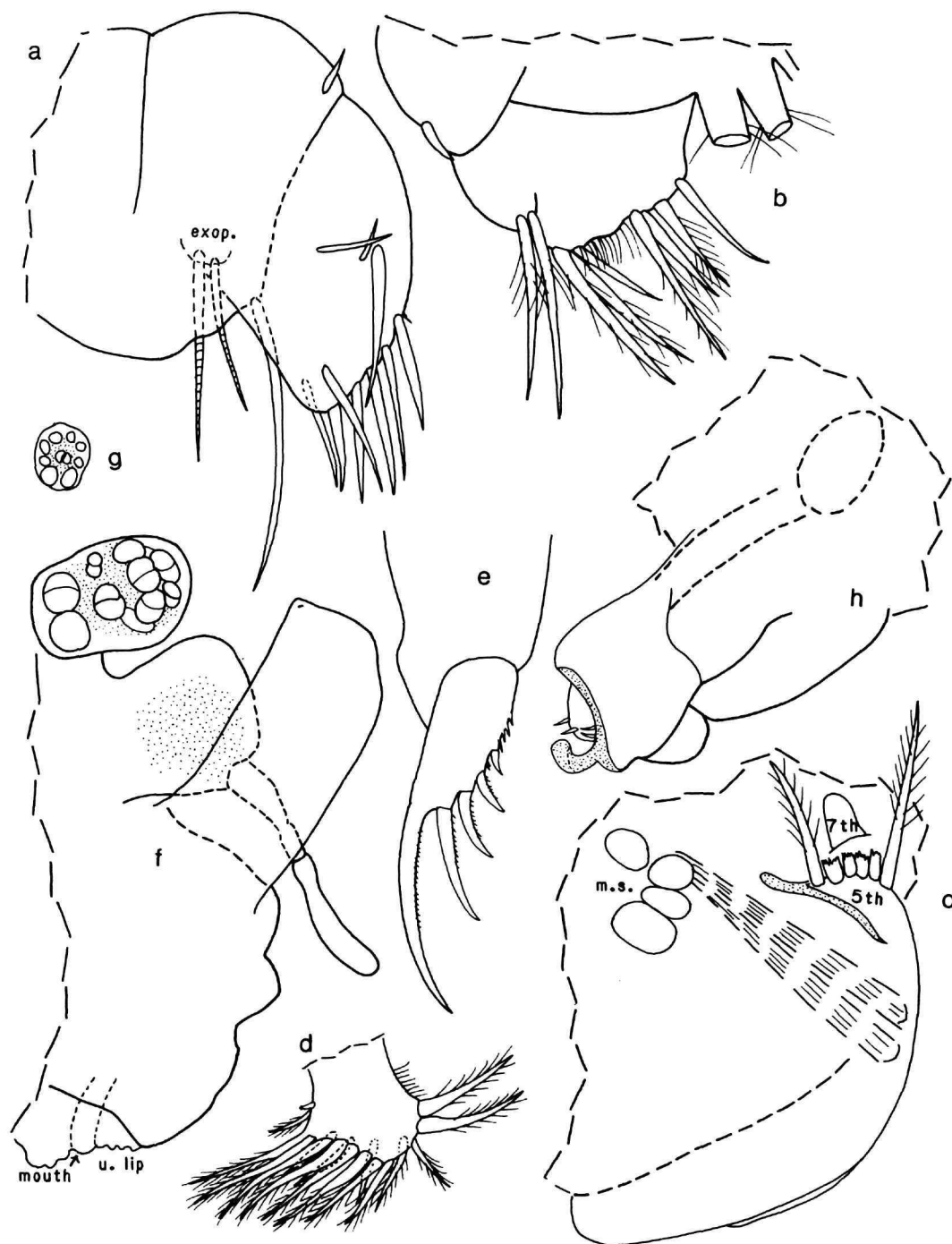


FIGURE 16.—*Eusarsiella absens* Kornicker, USNM 193401, adult male, length 1.04 mm: *a*, maxilla (exop. = exopodite); *b*, 5th limb (bristles difficult to resolve and drawing may be inaccurate); *c*, posterior of body showing left 7th limb, few bristles of epipodite of left 5th limb, 4 central adductor muscle attachments (circles) (ms. = adductor muscle scars), and 2 internal muscles; *d*, left 6th limb, lateral view; *e*, left lamella of furca; *f*, anterior of body showing right lateral eye, 1st joint of right 1st antenna, medial eye and Bellonci organ, convex anterior process ventral to 1st antenna, upper lip (u.lip) and mouth area (dashed lines indicate anterior end of esophagus leading from mouth); *g*, left lateral eye; *h*, lateral view of left copulatory organ and left seminal vesicle (dashed oval).

bifurcate tip; g-bristle long, with 5 short distal filaments and bifurcate tip.

*Second Antenna* (Figure 15d): Protopodite bare. Endopodite 2-jointed: 1st joint with medial spines forming rows, and 1 short, proximal, anterior bristle; 2nd joint short, with 2 terminal bristles. Exopodite: 1st joint with small, terminal, medial bristle forming right angle; bristles of joints 2–8 long, with ventral spines proximal to middle (spines on bristles of joints 2–4 stouter than on bristles of joints 5–8) and distal natatory hairs; small 9th joint with 2 bristles (dorsal bristle short; ventral bristle long with proximal ventral spines and distal natatory hairs).

*Mandible* (Figure 15e–g): Coxale: endite comprising a small spine (Figure 15f); lateral side near distal ventral corner with 4 minute spine-like processes (Figure 15e) (not previously reported on Sarsiellidae). Basale: dorsal margin with 3 distal bristles; ventral margin with 2 short bristles near midlength; medial surface with 4 bristles (3 forming group near proximal ventral corner; 1 closer to midlength; tips of bristles knife-like). Exopodite short, hirsute (Figure 15f). 1st endopodial joint: medial surface with long proximal hairs and shorter distal spines forming rows; ventral margin with 2 short bristles; dorsal margin with distal spines forming rows. 2nd endopodial joint: ventral margin with long terminal bristle; dorsal margin with small spines, and short bristle distal to midlength; medial and lateral surfaces with spines forming rows. End joint with stout claw-like bristle (with proximal medial spines forming row), 1 short ventral bristle, and 2 minute medial bristles near base of claw-like bristle (Figure 15g).

*Maxilla* (Figure 16a): Extremely reduced. Coxale with short dorsal bristle. Exopodite with 2 ringed bristles. Endites with weakly developed bristles, some hirsute. Basale with short dorsal bristle and long ventral bristle. No suture observed separating 1st and 2nd endopodial joints. (Bristles of illustrated limb indistinct, endites and not all bristles shown.)

*Fifth Limb* (Figure 16b): Epipodite of illustrated limb with 27 bristles but several may be missing. Single endite with 1 short bristle. Exopodite reduced: 1st joint with 2 bristles. 2nd–5th joints not well defined, with total of 7 bristles.

*Sixth Limb* (Figure 16d): Single endite with 3 bristles (2 minute, 1 longer). End joint with 11–13 bristles forming 2 rows (medial row with 4 bristles with long proximal and short distal spines; lateral row with 7–9 plumose bristles) closely followed by 2 plumose bristles; limb hirsute.

*Seventh Limb* (Figure 16c): Minute, bare.

*Furca* (Figure 16e): Furca with 5 claws (claw 1 fused to lamella) followed by several minute spines.

*Bellonci Organ* (Figure 16f): Elongate, with weak suture near middle and rounded tip.

*Eyes* (Figure 16f,g): Medial eye with dark amber pigment. Lateral eye with dark amber pigment and 9–10 ommatidia.

*Upper Lip* (Figure 16f): In lateral view not projecting anteriorly, with crenulations anterior to mouth.

*Genitalia* (Figure 16h): Elongate copulatory organ on each side of body terminating in sclerotized hook; lobes proximal

to hook with small bristles.

*Anterior of Body* (Figure 16f): Broadly rounded with projecting convex process at midlength.

*Y-Sclerite*: Similar to that of female.

### *Eusarsiella styx*, new species

FIGURES 17–24

ETYMOLOGY.—From the Latin and Greek *Styx*, name of the river in the nether world.

HOLOTYPE.—USNM 193369, 1 ovigerous female in alcohol.

TYPE LOCALITY.—Bermuda: Cherry Pit Cave.

MATERIAL.—*Cherry Pit Cave*: 23 Jun 1982: USNM 193367, 1 ovigerous female on slide and in alcohol; USNM 193369, 1 ovigerous female in alcohol (holotype); USNM 193370, 1 adult female in alcohol; USNM 193371, 5 adult females (2 ovigerous) in alcohol; USNM 193377, 46 juveniles in alcohol. 12 Jan 1984: USNM 193382, 4 adult females and 14 juveniles in alcohol. 22 Mar 1987: USNM 193374A, 70 adult females and juveniles in alcohol; USNM 193374B, 1 instar III female; USNM 193375, 1 adult male on slide and in alcohol. *Deep Blue Cave*: 20 Feb 1984: USNM 193383: 1 adult female and 4 juveniles in alcohol. *Palm Cave*: 13 and 16 Mar 1982: USNM 193378, 1 ovigerous female and 5 juveniles in alcohol. *Red Bay Cave*: 23 Oct 1986: USNM 193373, 1 adult female in alcohol. *Straw Market Cave*: 12 Jan 1984: USNM 193381, 3 juveniles. *Walsingham Cave*: 18 Feb 1982: USNM 193372A,B,C, 1 instar I, 1 female instar II, 1 male instar IV, in alcohol. 14 Jun 1982: USNM 193376, 15 females and juveniles in alcohol. 13 Jul 1984: USNM 193380, 1 juvenile.

DISTRIBUTION (Figure 17).—Bermuda: Cherry Pit Cave, 23 Jun 1982, 12 Jan 1984, 22 Mar 1987; Deep Blue Cave, 20 Feb 1984; Palm Cave, 13 and 16 Mar 1982; Red Bay Cave, 23 Oct 1986; Straw Market Cave, 12 Jan 1984; Walsingham Cave, 14 Jun 1982, 13 Jul 1984.

DESCRIPTION OF ADULT FEMALE (Figures 18–20).—Carapace oval in lateral view with triangular and projecting caudal process (Figure 18). Surface coated by gelatinous film.

*Ornamentation* (Figure 18): Surface with wide U-shaped rib opening to posterior, with each branch terminating in small knob-like process at each end, and with smaller knob-like processes distributed along rib; 3 knob-like processes forming oblique row near posterior edge of valve; surface with abundant shallow fossae and minute indistinct spines. Long bristles sparsely distributed over valve surface, more abundant along anterior and ventral margins and along caudal process (not shown on illustration).

*Infold*: Anterior infold with minute bristle near midheight of valve. Infold of caudal process with 4–6 bristles near middle, and 1 smaller bristle near inner edge (Figure 19a,b). Posterior infold with 2 setal bristles dorsal to caudal process (Figure 19a).

*Carapace Size* (length includes caudal process): USNM

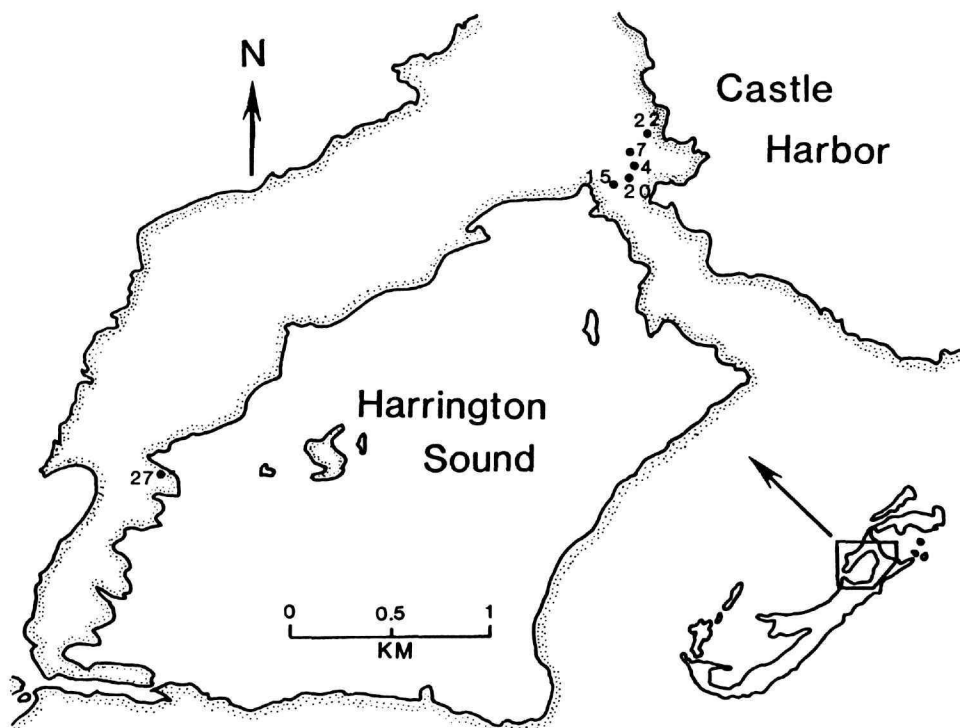


FIGURE 17.—Distribution of caves from which *Eusarsiella styx*, new species, was collected (4 = Cherry Pit Cave; 7 = Deep Blue Cave; 15 = Palm Cave; 20 = Straw Market Cave; 22 = Walsingham Cave; 27 = Red Bay Cave).

193367 (separated left valve), length 1.15 mm, height 0.94 mm; USNM 193369 (holotype), length 1.20 mm, height 0.97 mm; USNM 193370, length 1.14 mm, height 0.87 mm; USNM

193371, 2 specimens, length 1.17 mm, height 0.99 mm, length 1.23 mm, height 1.01 mm.

*First Antenna* (Figures 19i, 20a): 1st joint bare. 2nd joint with few distal dorsal spines and 1 dorsal bristle with few spines. 3rd and 4th joints fused: 3rd joint with 2 bristles (1 dorsal and 1 ventral; 4th joint with 2 or 3 terminal bristles (1 dorsal, 1 or 2 ventral; base of dorsal bristle stouter than that of ventral bristle) with indistinct marginal spines. 5th joint long; sensory bristle with 1 minute distal filament on dorsal margin. 6th joint fused to 5th, with small medial bristle with indistinct spines. 7th joint: a-bristle more than twice length of bristle of 6th joint; b-bristle longer than a-bristle, bare; c-bristle about same length as sensory bristle of 5th joint, with minute distal filament on dorsal margin. 8th joint: d- and e-bristles long, bare, with blunt tips; f-bristle slightly shorter than d-bristle, with 1 minute, proximal, dorsal filament; g-bristle long, with 3 minute dorsal filaments. Tips of sensory bristle of 5th joint and b-, c-, f-, and g-bristles with minute triangular process.

*Second Antenna*: Protopodite bare (Figure 20b). Endopodite with 2 small proximal bristles and terminal protuberance (protuberance could be considered small 2nd joint) (Figure 20c). Exopodite: 1st joint with small, straight, tubular bristle; bristles of joints 2–8 long with ventral spines and natatory hairs; small 9th joint with 2 bristles (dorsal bristle short with

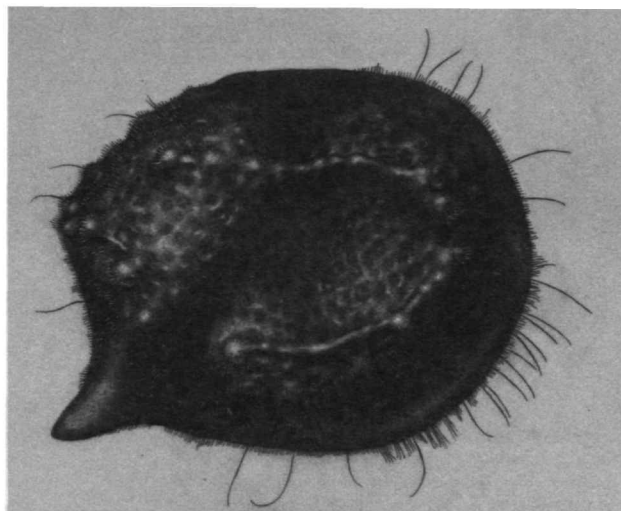


FIGURE 18.—*Eusarsiella styx*, new species, USNM 193367, paratype, adult female, length 1.15 mm, complete specimen, anterior to right.



FIGURE 19.—*Eusarsiella styx*, new species, USNM 193367, paratype, adult female, length 1.15 mm: *a*, inside view of posterior of left valve; *b*, inside view of caudal process of right valve; *c*, left mandible, lateral view; *d*, coxale, basale, and 1st endopodial joint of right mandible, medial view; *e*, left maxilla, lateral view (limb drawn not under cover slip, not all bristles shown); *f*, endites I-III of right maxilla, medial view (not all bristles shown); *g, h*, endites I and II of right maxilla; *i*, anterior of body showing medial eye and Bellonci organ, left lateral eye, proximal part of 1st joint of left 1st antenna, anterior process, upper lip, esophagus leading from mouth (dashed) (stippling in lateral eye indicates pigment, elsewhere sclerotization).



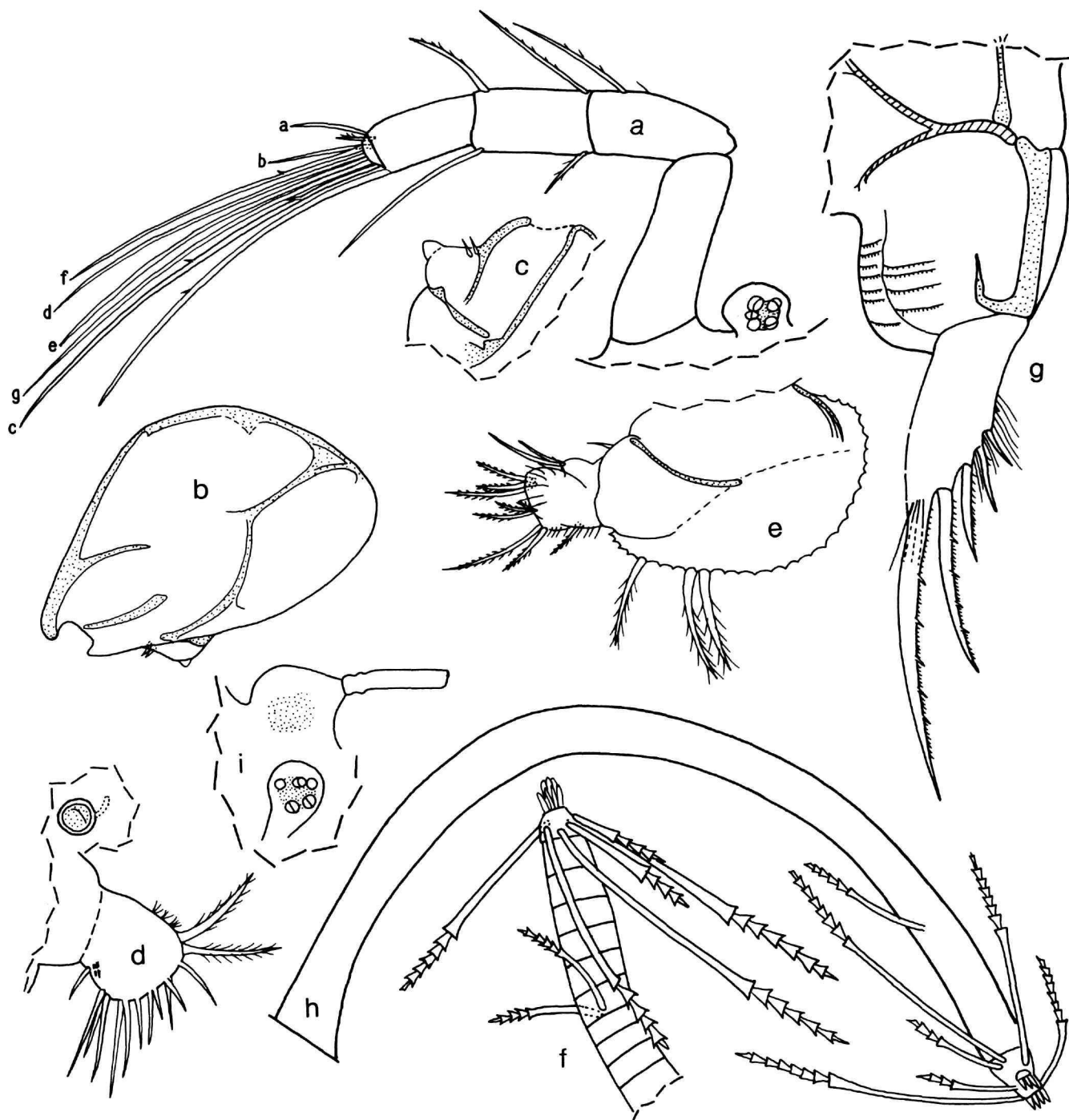


FIGURE 20.—*Eusarsiella styx*, new species. USNM 193367, paratype, adult female, length 1.15 mm: *a*, left lateral eye and left 1st antenna, lateral view; *b*, protopodite and endopodite of left 2nd antenna, lateral view; *c*, endopodite of right 2nd antenna, medial view; *d*, left genital organ (stippled circle) and left 6th limb (all marginal spines not shown); *e*, left 5th limb, lateral view (only 3 of 33 epipodial bristles shown); *f*, 7th limb; *g*, posterior of body showing left lamella of furca, Y-sclerite (lined) and other sclerites (stippled). *h*, USNM 193369, holotype, adult female, complete 7th limb. *i*, USNM 193370, paratype, adult female, length 1.14 mm, right lateral eye, medial eye and Bellonci organ.

few hairs; ventral bristle long, with few proximal ventral spines and distal natatory hairs.

**Mandible** (Figure 19c,d): Coxale: endite represented by small spine; ventral margin with straight hairs or spines forming row (bases on lateral side of joint). Basale: ventral margin with 6 small bristles (4 medial, 2 minute, lateral); dorsal margin with 1 small, spine-like, subterminal bristle. Exopodite absent. 1st endopodial joint: medial surface with spines forming 2 groupings (spines of distal group stouter) at midwidth, spines forming row along dorsal  $\frac{1}{3}$  of distal margin, and minute spine-like bristle near base of stout ventral claw; dorsal margin with stout spines forming terminal row; ventral margin with stout terminal claw with minute dorsal spines along proximal edge. 2nd endopodial joint with minute, spine-like, terminal, dorsal bristle, and stout ventral claw (claw broader than claw of 1st joint). 3rd endopodial joint with 2 minute ventral bristles at base of stout terminal claw (claw without suture at base).

**Maxilla** (Figure 19e-h): Endites I-III with 6, 5, and 5 bristles, some claw-like, pectinate (Figure 19f-h). Coxale with 1 short dorsal bristle and long hairs along margin proximal to bristle. Basale with 1 slender bristle near exopodite. Exopodite with 2 fairly long bristles. 1st endopodial joint with short hairs along outer edge proximal to alpha-bristle; alpha- and beta-bristles pectinate distally. 2nd endopodial joint with 2 fairly long a-bristles, shorter c-bristle, and usual 5 stout, pectinate, terminal bristles (only outer bristle pectinate to tip; middle bristle shorter).

**Fifth Limb** (Figure 20e): Epipodite with 33 plumose bristles. Single endite with small bristle. 1st exopodial joint with 2 bare bristles; 2nd joint with 3 spinous bristles; joints 3-5 fused, hirsute; 3rd joint with 4 spinous bristles (3 inner, 1 outer); 4th + 5th joints with 2 spinous bristles.

**Sixth Limb** (Figure 20d): Single endite with 3 or 4 bristles (1 marginal, short, 2 medial, short, 1 medial (when present), minute). End joint with 10 or 11 bristles (with short marginal spines) forming 2 rows, followed by 2 stouter plumose bristles; no broad space between spinous and plumose bristles; posterior margin with long hairs forming 3 clusters.

**Seventh Limb** (Figure 20f,h): Proximal group with 1 or 2 bristles (1 on each side) with 4 or 5 bells; terminal group with 6 bristles (3 on each side; 2 short with 3 or 4 bells, 4 longer with 6 or 7 bells). Terminus with opposing combs, each with 3 or 4 teeth.

**Furca** (Figure 20g): Each lamella with 5 claws; only claw 1 fused to lamella; claw 1 with 5 or 6 stout teeth separated by many minute teeth; claw 2 with fewer stout teeth separated by minute teeth; claws 3 and 4 with 2 small teeth near base followed by minute teeth; claw 5 bare. Left lamella with several minute teeth and clusters of long hairs following claws, right lamella with only 1 tooth and no hairs. Inner side of lamellae near claws 1, 4, and 5 with very long hairs.

**Bellonci Organ**: Elongate, slightly narrower near medial eye, tip square (Figure 20i) or rounded (Figure 19i).

**Eyes** (Figures 19i, 20i): Medial eye light amber with

horizontal brown line at midheight (internal structure not shown in illustration). Lateral eye much smaller than medial eye, with 5 light amber ommatidia near middle of eye and along periphery of light brownish matrix.

**Upper Lip** (Figure 19i): Elongate with paired sclerotized anterior processes with squarish tips.

**Anterior Process** (Figure 19i): Single triangular process about midway between medial eye and upper lip.

**Genitalia** (Figure 20d): Small oval proximal and anterior to furca and on each side of body.

**Y-Sclerite** (Figure 20g): Typical for genus.

**Eggs**: USNM 193367 with 2 in marsupium; USNM 193369 with 1 egg in marsupium; USNM 193370 with 1 large unextruded egg; USNM 193371, 2 specimens with 1 and 3 eggs in marsupium.

**Gut Content**: Posterior part of gut of USNM 193370 with food ball comprising unrecognizable mass, but with no animal fragments usually found in gut of members of genus.

**DESCRIPTION OF ADULT MALE** (Figures 21-23).—Carapace more elongate than that of adult female, with rostrum, incisur, and backward oriented caudal process (Figure 21). Surface coated with gelatinous film reaching tips of short spine-like bristles.

**Ornamentation** (Figures 21, 22b): In general similar to that of female except ribs more continuous; rib at posterior part of valve less well developed but traceable by high density of short spine-like bristles on rib. Shallow fossae, spines and bristles similar to those of adult female (not shown on illustrated carapace); some medium length bristles with terminal thread (Figure 22b); bristle at posterodorsal corner with striations at base and longer than bristles elsewhere (Figure 22b). (Surface texture not shown in Figure 21.)

**Infold**: Anteroventral infold with small bristle ventral to rostrum. Infold of caudal process with 4 bristles (Figure 22a); indistinct minute bristles along inner edge of infold in vicinity

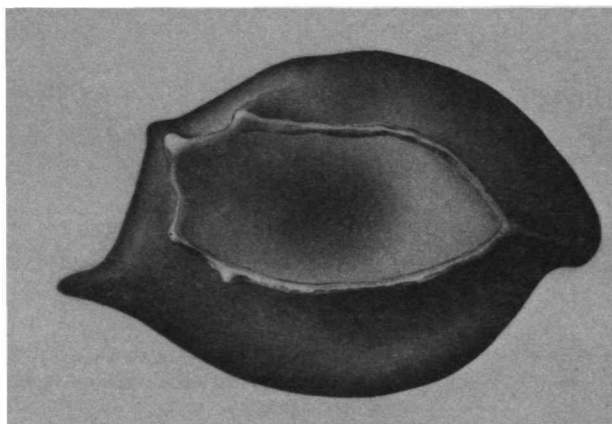


FIGURE 21.—*Eusarsiella styx*, new species, USNM 193375, paratype, adult male, length 1.10, complete specimen, anterior to right (surface texture not shown).



FIGURE 22.—*Eusarsiella styx*, new species, USNM 193375, paratype, adult male, length 1.10 mm: *a*, inside view of posterior of right valve showing 3 bristles (stippling indicates outer surface of shell); *b*, inside view of posterodorsal corner of right valve showing 3 bristles (stippling indicates outer surface of shell); *c*, anterior of body showing left lateral eye, left 1st antenna, prodopodite and endopodite of left 2nd antenna, and left mandible; *d, e*, medial views of endopodites of right and left 2nd antennae; *f*, left mandible, medial view; *g*, posterior of body showing left lamella of furca, left copulatory organ and seminal vesicle (stippled), and Y-sclerite.

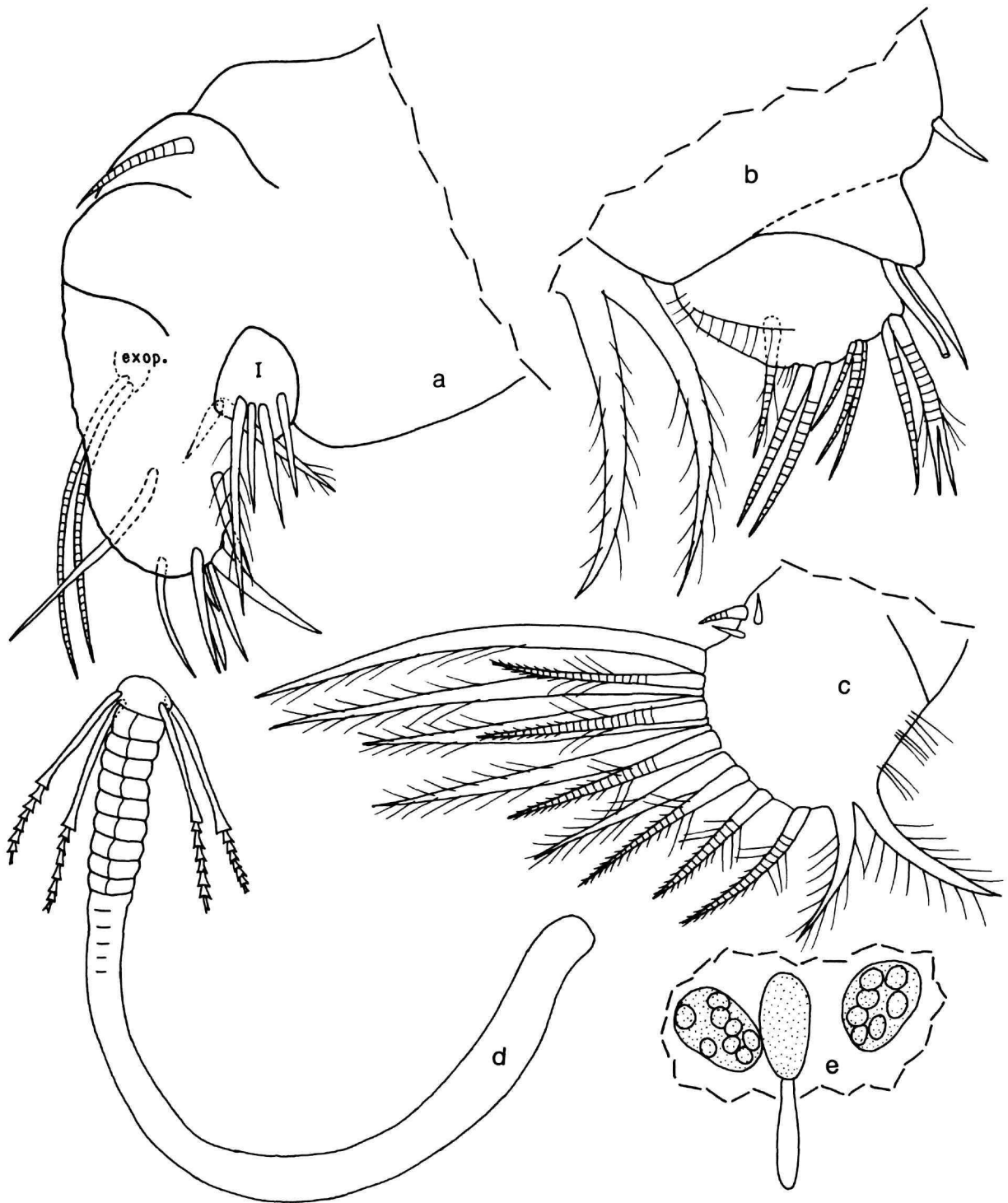


FIGURE 23.—*Eusarsiella styx*, new species, USNM 193375, paratype, adult male, length 1.10 mm: *a*, maxilla (exop. = exopodite, endites II and III not shown); *b*, 5th limb (only 2 epipodial bristles shown); *c*, right 6th limb, medial view; *d*, complete left 7th limb, lateral view; *e*, anterior view of head region showing lateral eyes, medial eye and Bellonci organ, ventral side to bottom.

of caudal process; posterior infold with 2 setal bristles dorsal to caudal process.

*Selvae*: Broad lamellar prolongation with smooth edge; prolongation continuous along incisur.

*Carapace Size*: USNM 193375, length 1.10 mm, height 0.74 mm.

*First Antenna* (Figure 22c): 1st joint bare. 2nd joint with long dorsal bristle. 3rd joint with short dorsal bristle and minute slender ventral spines (spines not shown in Figure 22c). 4th joint with short dorsal terminal bristle (with short marginal spines) and 2 long slender ventral bristles. 5th joint wedged ventrally between 4th and 6th joints; stem of sensory bristle with 4 short distal filaments and bifurcate tip; base of bristle flaring and with abundant thin filaments. 6th joint long, with small medial bristle (length about equal to width of joint) near dorsal margin. 7th joint: a-bristle bare, about same length as length of 6th joint; b-bristle bare, slightly longer than a-bristle; c-bristle long, with 4 short marginal filaments. 8th joint: d- and e-bristles long, bare, with blunt tips; f-bristle about same length as d-bristle, with 3 short distal filaments; g-bristle about same length as f-bristle, with 5 short distal filaments.

*Second Antenna* (Figure 22c-e): Protopodite bare. Endopodite 2-jointed (could be interpreted to be weakly 3-jointed with short 3rd joint fused to 2nd): 1st joint with 2 short proximal anterior bristles; 2nd joint elongate with 2 or 3 short terminal bristles. Exopodite: 1st joint with small bristle bent to form right angle; bristles of joints 2–8 long with ventral spines proximal to midlength and distal natatory hairs; small 9th joint with 2 bristles (dorsal bristle small; ventral bristle long with ventral spines and distal natatory hairs).

*Mandible* (Figure 22c,f): Coxale endite comprising small spine. Basale: dorsal margin with 2 distal bristles; ventral margin with 2 proximal bristles; medial surface with 4 bristles (3 forming group in proximal ventral corner; 1 slightly distal to proximal group and near midheight of joint; tips of bristles knife-like and slightly curved). Exopodite well developed, about  $\frac{1}{3}$  length of dorsal margin of 1st endopodial joint, bifurcate distally with short outer branch; both branches hirsute; inner tip longer, folding over medial surface of joint (Figure 22f). 1st endopodial joint: medial surface hirsute and also with short distal spines forming rows; ventral margin with 3 bristles (1 very short); dorsal margin with minute spines forming terminal row. 2nd endopodial joint with 1 terminal ventral bristle and 1 dorsal bristle at joint midlength. End joint with stout bare terminal claw-like bristle, 1 minute dorsal terminal bristle, and 2 ventral bristles (medial bristle minute).

*Maxilla* (Figure 23a): Extremely reduced. Coxale with 1 short dorsal bristle. Exopodite with 2 long ringed bristles. Endites with weakly developed bristles, some hirsute. Surface of endopodite crinkled, and boundary separating 1st and 2nd joints not observed. (Not all bristles shown in illustrated limb.)

*Fifth Limb* (Figure 23b): Epipodite with 32 plumose bristles. Single endite with 1 short bristle. Exopodite reduced: 1st joint with 2 bristles. 2nd–5th joints not well defined, with total of 8 bristles.

*Sixth Limb* (Figure 23c): About same size as that of female. Single endite with 3 small bare bristles. End joint with 11 spinous bristles forming 2 rows (medial row with 6 bristles with long proximal and short distal spines; lateral row with 5 bristles with only long spines) followed by 2 plumose bristles; no broad space between spinous and plumose bristles; limb hirsute.

*Seventh Limb* (Figure 23d): Well developed with about 56 segments; 9 distal segments broader, separated by more distinct sutures, and divided into quarters; terminus with 4 long bristles (2 on each side), each with 7 bells and without marginal spines.

*Furca* (Figure 22g): Furca similar to that of adult female but without long hairs at base of claws and on lamella following claws.

*Bellonci Organ* (Figure 23e): Elongate, narrow proximally, with rounded tip.

*Eyes*: Medial eye with black pigment (Figure 23e). Lateral eye with black pigment and 7 or 8 ommatidia (Figure 22c, 23e). (Not all ommatidia shown in lateral eye of Figure 22c.)

*Genitalia* (Figure 22g): Elongate copulatory organ on each side of body terminating in long sclerotized hook just distal to sclerotized prong; proximal lobes with small bristles.

*Posterior of Body and Y-Sclerite* (Figure 22g): Similar to those of adult female.

*Gut Content*: Dark brown elliptical food ball in posterior part of gut of USNM 193375 with unrecognizable particles and some light brown transparent spheres of unknown origin.

DESCRIPTION OF INSTAR I (sex unknown) (Figure 24a–e).—Carapace with projecting caudal process (Figure 24a).

*Ornamentation* (Figure 24e): Surface smooth without processes. Long bristles scattered over valve surface and along margins. Small spines widely distributed. Surface coated by gelatinous film.

*Carapace Size*: USNM 193272A, length 0.55 mm, height 0.41 mm.

*First Antenna* (Figure 24b): 1st and 2nd joints bare. 3rd joint fused to 4th, with 2 fairly long bristles (1 ventral, 1 dorsal); 4th joint without bristles. Sensory bristle of long 5th joint without filaments. 6th joint minute, fused to 5th with small medial bristle near dorsal margin. 7th joint: a-bristle bare, b-bristle longer than a-bristle; c-bristle almost as long as sensory bristle, without filaments. 8th joint: d-, and e-bristles bare, shorter than c-bristle; f-, and g-bristles long, without filaments.

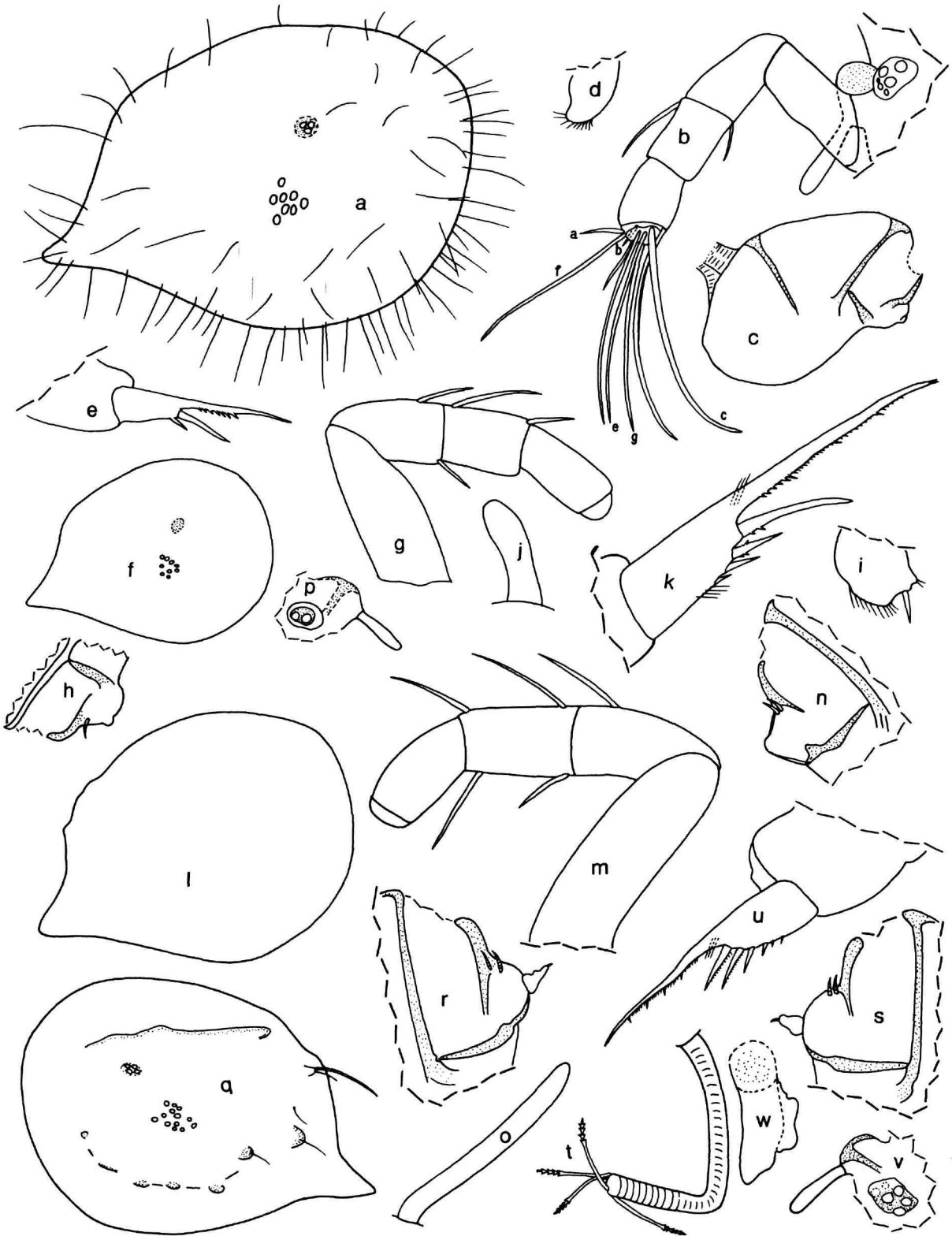
*Second Antenna* (Figure 24c): Protopodite bare. Endopodite bare, with single joint with small terminal protuberance. Exopodite similar to that of adult female, with 2 bristles on 9th joint.

*Mandible, Maxilla, Fifth Limb*: Well developed, but not examined in detail; similar type as that of adult female.

*Sixth Limb* (Figure 24d): Small, with marginal hairs but no bristles.

*Seventh Limb*: Absent.

*Furca* (Figure 24e): 1st claw fused to lamella, with stout proximal teeth on posterior margin; 2nd claw separated from



lamella by suture, with proximal teeth along posterior margin; 3rd claw a stout pointed process fused to lamella and with distal spines along anterior and posterior margins at tip; several minute teeth along lamella following claws; claw 1 of right lamella slightly anterior to claw 1 of left lamella.

*Bellonci Organ and Eyes* (Figure 24b): Well developed.

*Posterior of Body*: Similar to that of adult female.

*Y-Sclerite*: Present, but ventral branch may be absent.

DESCRIPTION OF FEMALE INSTAR II (Figure 24f-k).—Carapace similar in shape to that of instar I, but with better defined posterodorsal corner (Figure 24f).

*Ornamentation*: Surface smooth without protuberances. Bristles similar to those of instar I.

*Infold*: Posterior infold with 1 or 2 setose bristle dorsal to caudal process. Infold of caudal process with minute bristles along inner edge but none observed in middle part.

*Carapace Size*: USNM 193372B, length 0.65 mm, height 0.48 mm.

*First Antenna* (Figure 24g): 1st joint bare. 2nd joint with dorsal bristle. 3rd joint fused to 4th, with 2 bristles (1 ventral, 1 dorsal); 4th joint with 1 terminal dorsal bristle. Bristles of joints 5–8 of similar type as those of adult female; but filaments not observed at magnification observed (with  $\times 40$  objective and  $\times 15$  ocular, and without cover slip) but minute filaments could be present. (Bristles of joints 5–8 not shown on illustrated limb.)

*Second Antenna* (Figure 24h): Protopodite bare. Endopodite with single joint with ventral protuberance and either no bristles or 1 proximal anterior bristle. Exopodite similar to that of adult female, with 2 bristles on 9th joint.

*Mandible, Maxilla, Fifth Limb*: Not examined in detail but of similar type as that of adult female.

*Sixth Limb* (Figure 24i): With 1 anterior bristle.

*Seventh Limb* (Figure 24j): Short and without bristles.

*Furca* (Figure 24k): Claw 1 fused to lamella, claws 2–5 separated from lamella by suture. In general, furca similar to

that of adult female in having long medial hairs at base of claw 1, and long hairs on lamella following claws.

*Bellonci Organ, Posterior of Body, Y-Sclerite*: Similar to those of adult female.

*Eyes*: Medial eye with brown pigment forming horizontal zone near midheight. Lateral eye with brown pigment and 4 or 5 ommatidia.

*Remarks*: The small size of the protuberance on the endopodite of the 2nd antenna and the long hairs on the furcal lamella posterior to claws indicate that the specimen studied (USNM 193372B) is female.

DESCRIPTION OF FEMALE INSTAR III (Figure 24l-p).—Carapace similar in outline to that of instar II; USNM 193374B strongly calcified (Figure 24l).

*Ornamentation*: Surface with ribs and processes of similar type as those on adult female.

*Carapace Size*: USNM 193374B, length 0.91 mm, height 0.67 mm.

*First Antenna* (Figure 24m): 1st joint bare. 2nd joint with 1 dorsal bristle. 3rd joint fused to 4th; 3rd joint with 2 bristles (1 ventral, 1 dorsal); 4th joint with 2 bristles (1 ventral, 1 dorsal). Bristles of joints 5–8 not examined in detail (and not shown in illustrated limb), but of type similar to that of adult female.

*Second Antenna* (Figure 24n): Protopodite bare. Endopodite with 1 joint with terminal protuberance and 2 proximal anterior bristles. Exopodite similar to that of adult female.

*Mandible, Maxilla, Fifth and Sixth Limbs*: Not examined in detail but of similar type to those of adult female. Sixth limb with many bristles.

*Seventh Limb* (Figure 24o): Elongate without bristles.

*Furca*: Similar to that of adult female. Long hairs following claws of left lamella but not on right lamella.

*Bellonci Organ* (Figure 24p): Elongate with rounded tip.

*Eyes* (Figure 24p): Medial eye with black pigment. Lateral eye with black pigment and 2 ommatidia.

*Posterior of Body, Y-Sclerite*: Similar to those of adult female.

*Remarks*: The long hairs following the last claw on the left lamella of the furca suggests that USNM 193374B is a juvenile female. The endopodite of the 2nd antenna also suggests a female, but not with certainty.

DESCRIPTION OF MALE INSTAR IV (Figure 24q–w).—Carapace shape similar to that of female instar III (Figure 24q).

*Ornamentation* (Figure 24q): With ridges and protuberances of type in adult female; bristles and spines similar to those of adult female.

*Infold*: Infold of caudal process with 4 bristles near middle; posterior infold with 2 setose bristles dorsal to caudal process; anterior infold with 1 small bristle at inner edge ventral to valve midheight.

*Carapace Size*: USNM 193372C, length 0.98 mm, height 0.77 mm.

*First Antenna*: 1st joint bare. 2nd joint with 1 dorsal bristle.

FIGURE 24.—*Eusarsiella styx*, new species. USNM 193372A, paratype, instar I, length 0.55 mm: a, complete specimen showing location of right lateral eye (stippled) and central adductor muscle attachments, anterior to right; b, head region from left side showing left lateral eye, medial eye and Bellonci organ, and left 1st antenna; c, protopodite and endopodite of left 2nd antenna, medial view; d, left 6th limb, lateral view; e, right lamella of furca. USNM 193372B, paratype, instar II, length 0.65 mm: f, complete specimen from right side showing location of right lateral eye (stippled) and adductor muscle attachments, anterior to right; g, right 1st antenna, lateral view, bristles of joints 5–8 not shown; h, distal part of protopodite and endopodite of right 2nd antenna, medial view; i, right 6th limb, lateral view; j, 7th limb; k, right lamella of furca. USNM 193374B, paratype, female instar III, length 0.91 mm: l, outline of complete specimen from right side, anterior to right; m, left 1st antenna, lateral view, bristles of joints 5–8 not shown; n, distal part of protopodite and endopodite of right 2nd antenna, medial view; o, right 7th limb; p, left lateral eye, medial eye and Bellonci organ. USNM 193372C, paratype, male instar IV, length 0.98 mm: q, complete specimen from left side, anterior to left; r, s, proximal part of protopodites and endopodites of left and right 2nd antennae, medial view; t, 7th limb; u, left lamella of furca; v, left lateral eye, medial eye and Bellonci organ; w, left copulatory organ, anterior to left.

3rd and 4th joints fused; 3rd joint with 2 bristles (1 dorsal, 1 ventral); 4th joint with 3 bristles (1 dorsal, 2 ventral). Bristles of joints 6–8 not examined in detail but of type similar to that of adult female.

*Second Antenna* (Figure 24r,s): Protopodite bare. Endopodite 2 jointed: 1st joint with 2 proximal anterior bristles; 2nd joint tapering distally, with 1 small terminal bristle.

*Mandible, Maxilla, Fifth Limb, Sixth Limb*: Not examined in detail but of type similar to that of adult female.

*Seventh Limb* (Figure 24t): Elongate with 4 terminal bristles with 4 or 5 bells; bristles tapering distally (juvenile character).

*Furca* (Figure 24u): Similar to that of adult male. Differs from that of adult female in not having long hairs on lamella following last claw.

*Bellonci Organ* (Figure 24v): Elongate with rounded tip.

*Eyes* (Figure 24v): Medial eye with zone of black pigment at midheight and anteriorly. Lateral eye with area of black pigment with 4 ommatidia and anterior amber rim with 2 indistinct ommatidia.

*Genitalia* (Figure 24w): Seminal vesicle visible as ovoid amber mass; copulatory organ elongate, without sclerotized processes at tip.

*Posterior of Body, Y-Sclerite*: Similar to those of adult female.

*Gut Content*: The gut of most instars and adults dissected contained unrecognizable brown particles.

*Remarks*: The similarity of the endopodite of the 2nd antenna to that of the adult male identifies the specimen studied as a juvenile male. The presence of bristles on the 7th limb indicates it to be the A-1 instar, which is interpreted to be instar IV.

**COMPARISONS.**—The carapace of *E. styx* differs from that of *E. absens* in having a narrow projecting caudal process; the 1st antenna differs in having a ventral bristle on the 3rd joint. The male *E. styx* differs from the male of *E. absens* in having a well-developed 7th limb. The female *E. styx* differs from the female *E. cornuta* Poulsen (1965:105), in being larger, having more bristles on the infold of the caudal process, and in having a small terminal protuberance on the endopodite of the 2nd antenna. Only 4 species of *Eusarsiella* having a male with a well developed 7th limb bearing bristles have been described previously (Kornicker, 1986a, table 3).

**NUMBER OF GROWTH STAGES.**—Hiruta (1983:676) listed 6 species of the Sarsiellinae of which the number of instars has been determined. All have 4 juvenile stages, the same number determined herein for *E. styx*. The number of growth stages is known now for 4 species of *Eusarsiella*, 2 species of *Spinacopia*, and 1 species of *Junctichela*. Apparently, 4 juvenile growth stages is uniform within the Sarsiellinae. Appearance and development of limbs of *E. styx* is similar to those of other Sarsiellinae: Instar I is without bristles either on the 4th joint of the 1st antenna or on the 6th limb, and is without a 7th limb; instar II has 1 dorsal bristle on the 4th joint of the 1st antenna, 1 bristle on the 6th limb, and a short 7th

limb without bristles; instar III has 1 ventral and 1 dorsal bristle on the 4th joint of the 1st antenna, many bristles on the 6th limb, and a long bare 7th limb; instar IV has tapering bristles on the 7th limb.

**ONTOGENY AND SEXUAL DIMORPHISM.**—The carapaces of instars I and II are without ribs and processes, which appear first on instar III. The length of the adult male (1.10 mm) is less than that of the adult female (1.15–1.23 mm).

*First Antenna*: On instar I no bristles are present on joints 2 and 4, and no marginal filaments are present on either the sensory bristle of the 5th joint or the b-, c-, f-, and g-bristles of the 7th and 8th joints. On instar II a dorsal bristle is present on the 2nd joint and a dorsal bristle is present on the 4th joint; no filaments were observed on the sensory bristle of the 5th joint or on bristles of the 7th and 8th joints, but the bristles were not examined under sufficiently high magnification to be certain minute filaments are not present. On instar IV the 4th joint has 2 ventral bristles, the same number as on the adult (1 adult female had only 1 ventral bristle (Figure 20a)). The 5th joint and its sensory bristle of the adult male and female exhibit usual sexual dimorphism.

*Second Antenna*: Protopodite and exopodite of juveniles and adults similar except for dimensions. Endopodite: instar I (sex unknown) bare, with single joint with small terminal protuberance; female instar II similar to that of instar I except for having 1 proximal anterior bristle on 1 limb of examined specimen; female instar III similar to that of female instar II except for having 2 proximal anterior bristles; male instar IV 2-jointed, with 2 proximal anterior bristles on 1st joint and 1 small terminal bristle on tapering 2nd joint; adult female similar to that of female instar III; adult male similar to that of male instar IV except for having elongate 2nd joint with 2 or 3 small terminal bristles.

*Mandible*: Well developed on all instars, but mandibles of juvenile instars not examined in detail; they are of similar type to that of adult female. Mandible of adults dimorphic: male mandible differs from that of female in having a smaller coxale endite, a well-developed exopodite, and differences in bristles and claws of the exopodite.

*Maxilla and Fifth Limb*: Well developed on all juvenile instars (not examined in detail but of similar type to those of adult female). Maxillae and fifth limbs of adult male differ from limbs of adult female in being considerably reduced, as well as in number and type of bristles.

*Sixth Limb*: Instar I with marginal hairs but no bristles; instar II with 1 anterior bristle; instars III, IV, and adults well developed with many bristles.

*Seventh Limb*: Absent on instar I (sex unknown); short bare on instar II female; elongate bare on female instar III; elongate with 4 strongly tapering terminal bristles on male instar IV; limb of adult female elongate with 1 or 2 cylindrical proximal bristles, 6 cylindrical terminal bristles, and opposing terminal combs; limb of adult male with 4 cylindrical terminal bristles and without terminal combs.

*Furca*: Instar I with 1st claw fused to lamella, 2nd claw



separated from lamella by suture, and 3rd claw represented by stout, spinous, pointed process fused to lamella. Instars II-IV and adults similar in having 5 claws with only claw 1 fused to lamella.

**Eyes:** Lateral eye of adult female with 5 ommatidea and light brown pigment; lateral eye of adult male with 7 or 8 ommatidea and black pigment. Medial eye of adult male with black pigment, of adult female with small amount of brown pigment. Differences in pigmentation between eyes of the adult male and adult females could be due to the females being preserved for a longer period of time than the male.

#### Family RUTIDERMATIDAE Brady and Norman, 1896

**COMPOSITION.**—This family comprises 3 genera of which only 1, *Rutiderma*, has been reported from Bermuda (Kornicker, 1983:70).

#### *Rutiderma* Brady and Norman, 1896

**TYPE SPECIES.**—*Rutiderma compressa* Brady and Norman (1896:673).

Only 1 species has been reported from Bermuda, *R. sterreri* Kornicker (1981a:5), from open water. Two specimens of this species were collected in caves in this study.

#### *Rutiderma sterreri* Kornicker, 1981

FIGURES 25, 26

*Rutiderma sterreri* Kornicker, 1981a:5, figs. 3-5; 1983:70, figs. 41-43.—Maddocks and Kornicker, 1986:282, fig. 90 [part].

**HOLOTYPE.**—USNM 158115, ovigerous female on slide and in alcohol.

**TYPE LOCALITY.**—Station 630820, Harrington Sound, Bermuda.

**MATERIAL.**—Bermuda: *Cherry Pit Cave*, 22 Mar 1987: USNM 193399, 1 adult female in alcohol. *Cripplegate Cave*, 21 Oct 1981: USNM 193368, 1 adult male in alcohol. *Harrington Sound*, 1980-1981: USNM 193400, 3 adult males plus 4 adult females in alcohol.

**DISTRIBUTION.**—Bermuda: *Cherry Pit Cave*, 22 Mar 1987; *Cripplegate Cave*, 21 Oct 1981; *Harrington Sound* (open water), 1980-1981. Previously reported from *Hamilton Harbor*, *Spanish Point*, *Castle Harbor*, and *Harrington Sound* (Kornicker, 1981a:1, 2).

**SUPPLEMENTARY DESCRIPTION OF ADULT MALE**, USNM 193368 (Figure 26).—Carapace elongate with strong lateral ribs terminating posteriorly in connecting vertical rib with concavity at midheight and weaker ribs along dorsal and ventral margins (Figure 26a). Surface with small fossae (Figure 26a). Central adductor muscle attachments comprising about

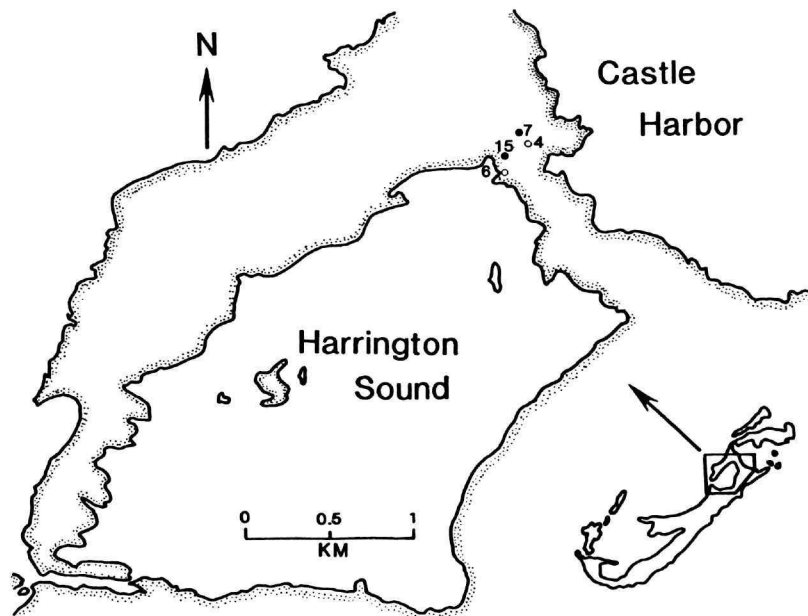


FIGURE 25.—Distribution of caves from which *Rutiderma sterreri* Kornicker (open circles) and *Parasterope muelleri* Skogsberg (solid circles) were collected (4 = *Cherry Pit Cave*; 6 = *Cripplegate Cave*; 7 = *Deep Blue Cave*; 15 = *Palm Cave*).

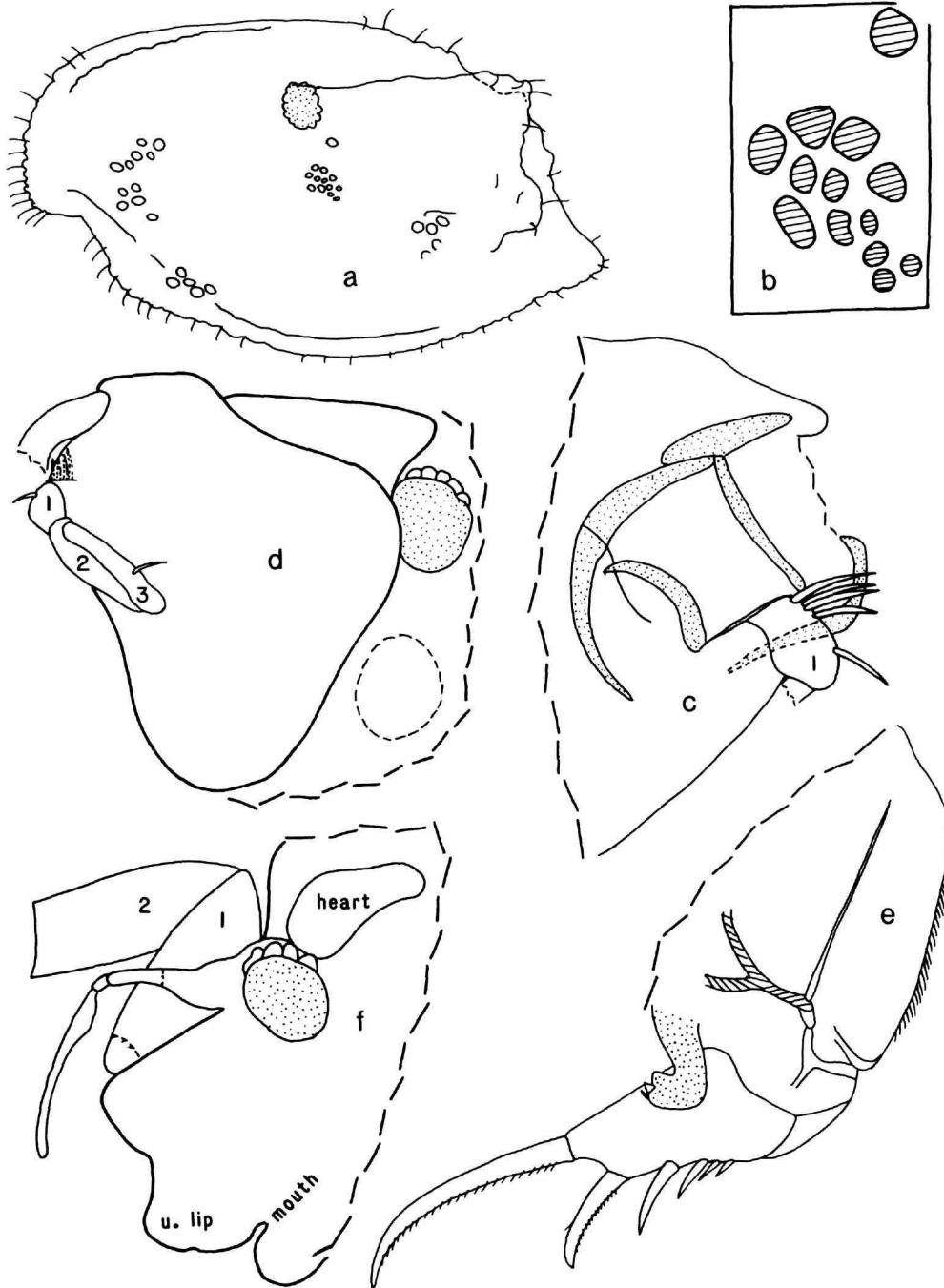


FIGURE 26.—*Ruiderma sterreri* Kornicker, USNM 193368, adult male, length 1.00 mm: *a*, complete specimen from left side showing location of left lateral eye (stippled) and central adductor muscle attachments (small cluster of circles beneath lateral eye), and few representative surface pits; *b*, detail from *a* of central adductor muscle attachments; *c*, protopodite and 1st endopodial joint of left 2nd antenna, sclerites stippled; *d*, anterior of body showing left lateral eye (stippled), protopodite, endopodite, and part of 1st exopodial joint of left 2nd antenna, and location of central adductor muscle attachments (dashed circle); *e*, posterior of body showing left lamella of furca, left copulatory organ, left Y-sclerite (lined) and other sclerites, and posterior hairs; *f*, anterior part of body showing location of heart, left lateral eye (stippled), medial eye, and Bellonci organ, joints 1 and 2 of right 1st antenna, broad anterior process ventral to 1st antenna, and upper lip (u.lip).

12 ovoid scars forming group and 1 additional scar dorsal to group (Figure 26b).

*Carapace Size:* Length 1.00 mm, height 0.58 mm.

*Second Antenna* (Figure 26c,d): Major sclerites of the protopodite viewed medially are stippled in illustration (only 1st joint of endopodite shown in illustration)(Figure 26c). Posterior margin of protopodite bears notch near upper end to accommodate lateral eye, and shallow indentation at midheight to accommodate lateral eye, and shallow indentation at midheight to accommodate central adductor muscles (similar morphology was noted by Kornicker (1985:24) on *R. hartmanni* Poulsen, 1965).

*Furca, Copulatory Organ, Posterior of Body with Sclerites:* Illustrated in Figure 26e.

*Bellonci Organ, Lateral Eye, Upper Lip, Anterior of Body, Heart:* Illustrated in Figure 26f.

### Superfamily CYLINDROLEBERIDOIDEA Müller, 1906

COMPOSITION.—The Cylindroleberidoidea comprise the family Cylindroleberididae Müller, 1906.

### Family CYLINDROLEBERIDIDAE Müller, 1906

COMPOSITION.—This family comprises 3 subfamilies of which only 1, the Cylindroleberidinae, is represented in collections from Bermuda.

### Subfamily CYLINDROLEBERIDINAE Müller, 1906

Two species in 2 genera in this subfamily have been reported previously from Bermuda (Kornicker, 1981a:2): *Parasterope muelleri* (Skogsberg, 1920:483) and *Bruuniella* species A (Kornicker, 1981a:12), but none have been reported previously from caves.

### *Parasterope* Kornicker, 1975

TYPE SPECIES.—*Asterope Mülleri* Skogsberg (1920:483); subsequent designation by Kornicker (1975:401).

Three specimens of *P. muelleri* were collected in Bermudan caves.

### *Parasterope muelleri* (Skogsberg, 1920)

FIGURE 27

*Asterope Mülleri* Skogsberg, 1920:483.

*Parasterope muelleri* (Skogsberg).—Kornicker, 1986b:20 [synonymy].—Maddocks and Kornicker, 1986:284, fig. 90 [part].

LECTOTYPE.—Adult female on slides in Swedish State Museum, Stockholm.

TYPE LOCALITY.—English Channel, off Salcombe, coast of England.

MATERIAL.—Bermuda: *Deep Blue Pool*, 23 Mar 1982:

USNM 193397, 1 early instar in alcohol. *Palm Cave*, 13 and 16 Mar 1982: USNM 193398A,B, 1 adult female and 1 adult male, respectively, both in alcohol.

DISTRIBUTION.—Deep Blue Pool, 23 Mar 1982. *Palm Cave*, 13 and 16 Mar 1982. Previously reported from Castle Harbor, Hamilton Harbor, Smith's Sound, and off St. George, Bermuda (Kornicker, 1981a:8). Species widespread in north Atlantic Ocean (Kornicker and Caraion, 1974:7).

DISCUSSION.—The body was removed from the shell of the single specimen collected in Deep Blue Cave and examined in a drop of glycerine. The absence of bristles on an elongate

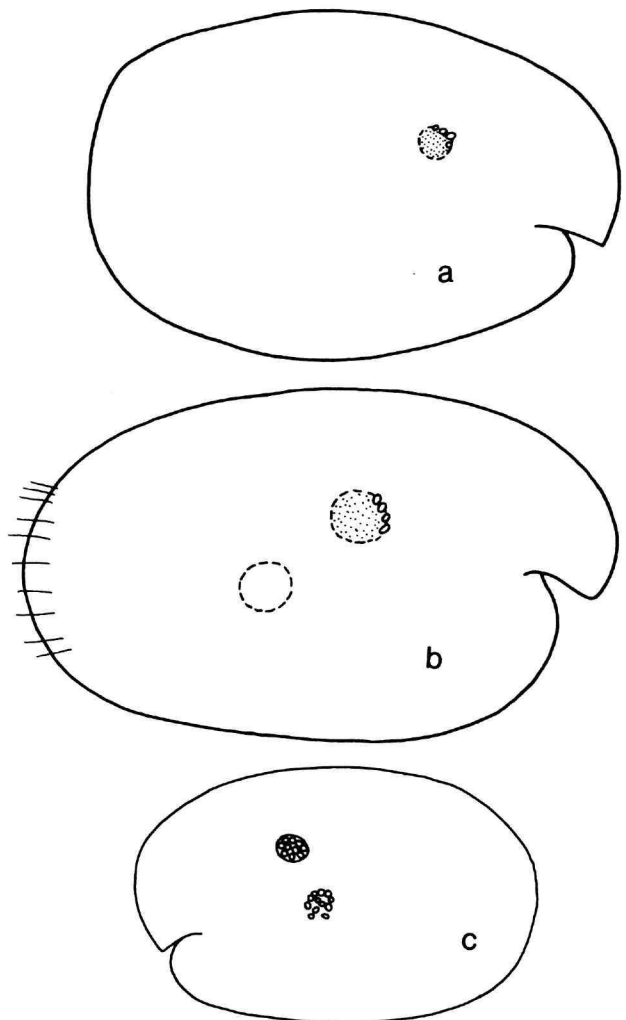


FIGURE 27.—*Parasterope muelleri* Skogsberg: a, USNM 193398A, adult female, length 1.07 mm, outline of complete carapace from right side showing location of right lateral eye, anterior to right; b, USNM 193398B, adult male, length 1.19 mm, outline of complete specimen from right side showing location of right lateral eye (stippled), location of central adductor muscle attachments (dashed circle) and hairs near posterior forming vertical row; c, USNM 193397, instar II or III, length 0.65 mm, outline of complete specimen from left side showing location of left lateral eye and central adductor muscle attachments.

7th limb and a 6th limb with 2 indistinct endite bristles and 2 bristles on the end joint (1 indistinct anteroventral bristle, and 1 ventral bristle at midlength) indicate that it is an early instar (instar II or III). An early instar cannot be referred to a genus or species with certainty, but I have referred it to *P. muelleri* because it resembles that species (Figure 27c). The presence of 2 endite bristles and an anteroventral bristle on the end joint of the 6th limb could not be determined with certainty on the undissected specimen.

**Carapace Sizes:** Of 3 specimens: USNM 193397, early instar (Figure 27c), length 0.69 mm, height 0.45 mm; USNM 193398A, adult female (Figure 27a), length 1.07 mm, height 0.71 mm; USNM 193398B, adult male (Figure 27b), length 1.19 mm, height 0.74 mm.

### Order HALOCYPRIDA Dana, 1853

COMPOSITION.—The Halocyprida comprise the suborders Halocypridina Dana, 1853, and Cladocopina Sars, 1866.

#### Suborder HALOCYPRIDINA Dana, 1853

COMPOSITION.—The Halocypridina comprise the superfamilies Thaumatoocypridoidea Müller, 1906, and Halocypridoidea Dana, 1853. The Thaumatoocypridoidea have been collected in anchialine caves of the Bahamas and the Yucatan Peninsula (Kornicker and Iliffe, in press), Canary Islands (Hartmann, 1985), Cuba (Danielopol, 1972) but not in Bermuda.

#### Superfamily HALOCYPRIDOIDEA Dana, 1853

Composition.—The superfamily comprises the family Halocyprididae Dana, 1853.

#### Family HALOCYPRIDIDAE Dana, 1853

COMPOSITION.—The family comprises the subfamilies Archiconchoecinae Poulsen, 1969, Euconchoecinae Poulsen, 1969, Halocypridinae Dana, 1853, Conchoecinae Claus, 1891, and Deeveyinae Kornicker and Iliffe, 1985. One species of Euconchoecinae has been reported from an anchialine cave in Palau (Kornicker and Iliffe, in press), but none were collected in Bermudan caves.

#### Subfamily DEEVEYINAE Kornicker and Iliffe, 1985

COMPOSITION.—The subfamily comprises the genera *Deeveya* Kornicker and Iliffe, 1985, and *Spelaeoecia* Angel and Iliffe, 1987. Two species of *Deeveya* have been collected from anchialine caves in the Bahamas (Kornicker and Palmer, 1987:610) and in the Turks and Caicos Islands (Kornicker and Iliffe, 1985:476) but not in Bermuda.

### *Spelaeoecia* Angel and Iliffe, 1987

TYPE SPECIES.—*Spelaeoecia bermudensis* Angel and Iliffe (1987:545).

COMPOSITION.—The genus is monotypic.

#### *Spelaeoecia bermudensis* Angel and Iliffe, 1987

FIGURES 28a, 29

*Spelaeoecia bermudensis* Angel and Iliffe, 1987:545, figs. 2–6.

HOLOTYPE.—USNM 228468, adult female on 5 slides.

TYPE LOCALITY.—Green Bay Cave, Bermuda.

MATERIAL.—Bermuda: *Green Bay Cave*, 29 Aug 1982, USNM 228468 (holotype), adult female on 5 slides; *Jane's Cave*: 27 Mar 1985: USNM 193404A, 1 A-1 male, left 2nd antenna on slide, remaining appendages and carapace in alcohol; USNM 193404B,C, 2 adult females in alcohol. 22 Jul 1985, USNM 193406, 1 juvenile in alcohol. 29 Jul 1986: USNM 193405A, 1 A-1 male in alcohol; USNM 193405B,C, 2 adult females in alcohol. *Roadside Cave*: 13 Mar 1985: USNM 193407, 1 A-3 instar in alcohol. 7 Aug 1985: USNM 193408, 1 specimen in alcohol.

DISTRIBUTION (Figure 28a).—Bermuda: *Jane's Cave* (new locality for species). *Christie's Cave*, *Crystal Cave*, *Fern Sink Cave*, *Green Bay Cave*, *Roadside Cave*, *Tucker's Town Cave*, *Walsingham Sink Cave*, *Wonderland Cave*.

SUPPLEMENTARY DESCRIPTION (Figure 29).—Surface of carapace with oblique lineations (Figure 29b,c) (indistinct on some specimens and not observed on others).

*Infold* (Figure 29a,m): Broad infold except along hinge, narrower just posterior to inner end of incisur; narrow list at about midwidth of infold extending from anterior near valve midheight to midlength or farther; a 2nd list forming sclerotized bar just posterior to posterior hinge juncture, then extending ventrally as narrow ridge intersecting posterior valve edge at midheight.

*Selvage* (Figure 29m): Narrow bare lamellar prolongation extending from point at ventral end of incisur to posterodorsal corner.

*Carapace Locking Structures* (Figure 29m): Each valve with 1 or 2 narrow sclerotized ridges between posterior juncture of hinge and posterodorsal corner of valve that may serve as locking structures when valves are closed.

*Central Adductor Muscle Attachments* (Figure 29f): Consisting of about 9 individual ovoid scars.

*Carapace Size*: Adult females: USNM 193404B, length 1.57 mm, height 0.85 mm; USNM 193404C, length 1.54 mm, height 0.86 mm. A-1 males: USNM 193404A, length 1.25 mm, height 0.62 mm; USNM 193405A, length 1.27 mm, height 0.67 mm.

*First Antenna*: Without bristle on 6th joint. 7th joint with a-, b-, and c-bristles. 8th joint with d-, e-, f-, and g-bristles. Limb of A-1 male (Figure 29n) similar to that of adult female (Figure 29g). Holotype differs from description of Angel and Iliffe

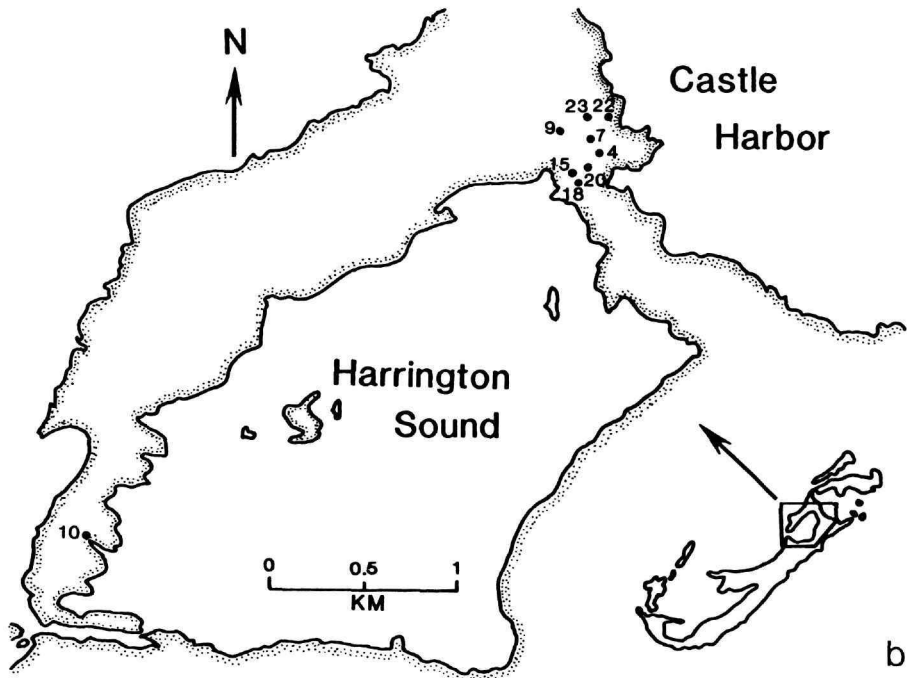
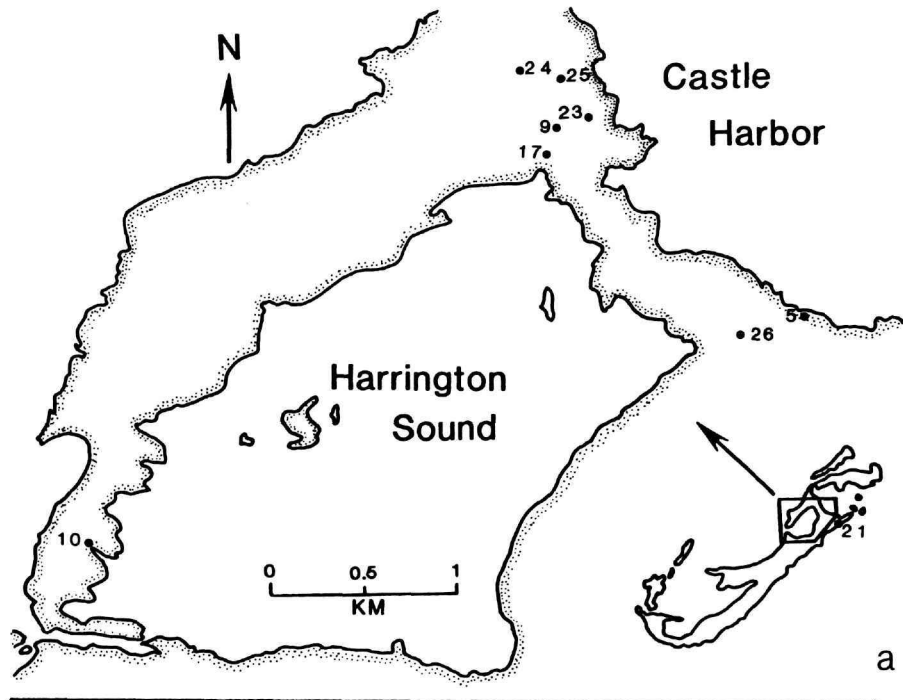


FIGURE 28.—Distribution of caves from which (a) *Spelaeoecia bermudensis* Angel and Iliffe and (b) *Metapolycope duplex*, new species, were collected (4 = Cherry Pit Cave; 5 = Christie's Cave; 7 = Deep Blue Cave; 9 = Fern Sink Cave; 10 = Green Bay Cave; 15 = Palm Cave; 17 = Roadside Cave; 18 = Sailor's Choice Cave; 20 = Straw Market Cave; 21 = Tucker's Town Cave; 22 = Walsingham Cave; 23 = Walsingham Sink Cave; 24 = Wonderland Cave; 25 = Crystal Cave; 26 = Jane's Cave).

(1987:546, fig. 3a) in having no bristle on 6th joint and 3 on 7th joint (1 dorsal, 2 ventral).

**Second Antenna:** Endopodite of adult female limb with minute medial bristle near base of j-bristle and minute lateral peg near f-bristle (Figure 29e). Endopodite of A-1 male with additional minute lateral c-bristle, and dorsal margin of 2nd joint convex (Figure 29p). Exopodite: 1st joint partly divided into long proximal and short distal segments, with long terminal bristle reaching well past 9th joint (Figure 29d,o); bristles of joints 1 and 2 with natatory hairs, and spines facing convex margin of exopodite; 9th joint of exopodite with 4 bristles (at least 3 with spines facing concave margin of exopodite). (Angel and Iliffe (1987: 546) describe the exopodite as having a short ventral bristle on the 1st joint, and that bristle is shown in their figure 3B. Although the legend of that illustration does not state that it is based on the holotype, each of the mounted 2nd antennae of the holotype does have the tip of an *endopodial* bristle in the same place as the "exopodial" bristle shown in their figure 3B, and that endopodial bristle was most likely misinterpreted by Angel and Iliffe to be an exopodial bristle.)

**Furca:** Each lamella of the furca of the A-1 male (Figure 29j,k,q) and adult female with claw 2 represented by stump and 7 additional claws with minute spines along posterior margins. The 'unpaired' bristle is bifid and bears marginal spines.

**Bellonci Organ:** In lateral view tapering distally and bifurcating at  $\frac{2}{3}$  length; tip of each branch broadly rounded (Figure 29g,i). Organ of USNM 193404A aberrant in being relatively short, not bifurcate, and having spine at tip (Figure 29n).

**Genitalia:** A-1 male (USNM 193405A) with long, broad, anterior process without terminal structures, and tapering rod-shaped organ with short pointed tip (Figure 29f). The anterior process either obscured or missing on one A-1 male (USNM 193404A), but rod-shaped organ well developed and with minute spine just proximal to pointed tip (Figure 29q,r). Adult female with small process bearing a terminal spine just anterior to base of left 7th limb in vicinity of receptaculum seminis, which was not visible (Figure 29h,i). (Müller (1894, pl. 1: fig. 9) illustrated the body of a female *Conchoecia magna* showing the location of the receptaculum seminis of that species at about the same location as the spined process of *S. bermudensis*.)

**Gut Content:** A-1 male, USNM 193404A, with large ovoid pellet emerging from anus: dark brown ventral part of pellet (that part extruded first) about  $\frac{1}{2}$  length and  $\frac{3}{4}$  width of dorsal

FIGURE 29.—*Spelaeocia bermudensis* Angel and Iliffe, USNM 228468, holotype, adult female, length 1.58 mm: a, left valve from outside showing 3 central adductor muscle attachment scars, inner margin of infold, list, and valve edge inside of rostrum (all shown as dashed lines); b,c, surface lineations on anteroventral and posterior parts of valve shown in a (arrow in b points toward anterior of valve); d, exopodite of left 2nd antenna, lateral view (only bristle of 1st joint shown); e, endopodite of left 2nd antenna, lateral view. f, USNM 193404B, adult female, length 1.57 mm, outside view of central adductor muscle attachment scars of left valve. USNM 193404C, adult female, length 1.54 mm: g, Bellonci organ and left 1st antenna (bristles of 6th-8th joints not shown); h, lateral view of left side of body as seen through shell showing spined process in vicinity of receptaculum seminis, epipodial appendage of 6th limb (bristles not shown), 7th limb, and apron anterior to furca. i, USNM 193409, adult female, length 1.44 mm, left side of body showing spined process, epipodial appendage of 6th limb (bristles not shown) and 7th limb. USNM 193405A, A-1 male, length 1.27 mm: j, posterior of body from left side showing copulatory organ, epipodial appendage of 6th limb (bristles not shown), 7th limb, apron, and left lamella of furca; k, right lamella of furca; l, Bellonci organ. USNM 193404A, A-1 male, length 1.25 mm: m, inside view of valves; n, Bellonci organ (aberrant) and left 2nd antenna, lateral view; o, exopodite of left 2nd antenna, medial view (only bristles of 1st and 2nd joints shown); p, endopodite of left 2nd antenna, medial view; q, posterior of body from left side showing rod-shaped copulatory organ, 5th and 6th limbs (not all bristles shown) and left lamella of furca; r, detail of copulatory organ shown in q.

part, and comprises minute unidentified particles; large dorsal part of pellet with pearly sheen in reflected light and comprises abundant, broken, hollow, transparent, colorless tubes of unknown origin.

**REMARKS.**—An adult male (USNM 193483) in a sample from Wonderland Cave collected by Jan H. Stock was encountered too late for including its description herein and will be described elsewhere (Kornicker, in press).

#### Suborder CLADOCOPINA Sars, 1866

**REMARKS.**—The long geological history of the Cladocopina was discussed recently by Neale (1983:612–626).

**COMPOSITION.**—The Cladocopina contains the superfamily Polycopoidea Sars, 1866.

#### Superfamily POLYCOPOIDEA Sars, 1866

**COMPOSITION.**—The Polycopoidea contains the Polycopidae Sars, 1866.

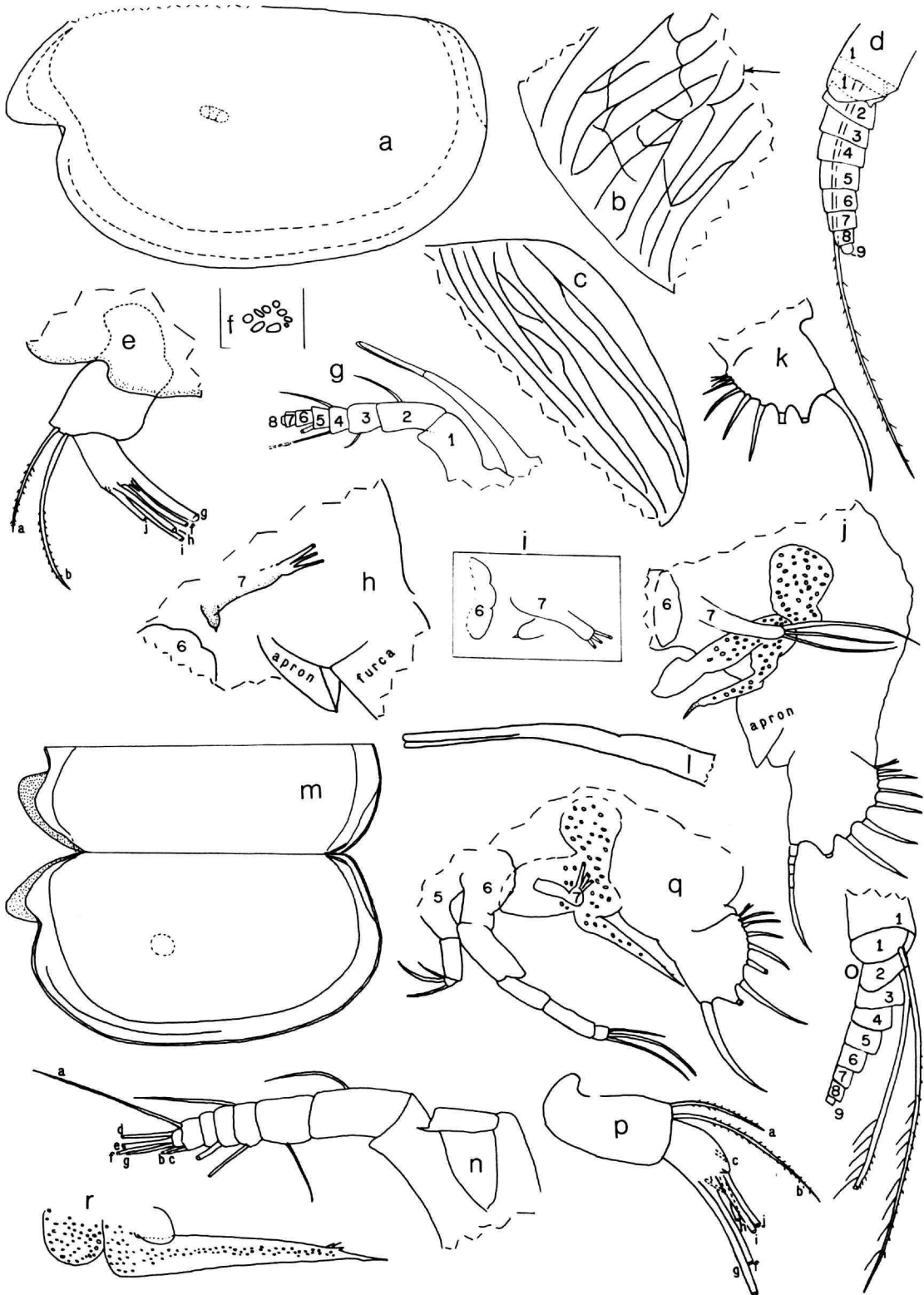
#### Family POLYCOPIIDAE Sars, 1866

**COMPOSITION.**—The Polycopidae comprise the Polycopinae Sars, 1866, and Polycoposinae Chavtur, 1983.

#### Key to the Subfamilies of Polycopidae

(from Chavtur, 1983:92, emended)

- 1st antenna with 5 or 6 segments delimited by sutures . . . . . POLYCOPOSINAE  
 1st antenna with 3 or 4 segments delimited by sutures . . . . . POLYCOPIINAE



### Subfamily POLYCOPSISINAE Chavtur, 1983

COMPOSITION.—The Polycopsisinae comprise the genera *Metapolycope* Kornicker and van Morkhoven, 1976, and *Polycopsis* Müller, 1894. Only *Metapolycope* is represented in Bermudan caves.

#### Key to the Genera of Polycopsisinae

(adapted from Chavtur, 1983:93)

- Central muscle scars comprising 9 or more individual scars; 1st antenna with 5 segments delimited by sutures . . . . . *Metapolycope*  
 Central muscle scars comprising 3 (always?) individual scars; 1st antenna with 6 segments delimited by sutures . . . . . *Polycopsis*

#### *Metapolycope* Kornicker and van Morkhoven, 1976

TYPE SPECIES.—*Metapolycope hartmanni* Kornicker and van Morkhoven, 1976.

COMPOSITION.—The genus comprises 5 species and 1 in open nomenclature: *M. hartmanni* Kornicker and van Morkhoven, 1976, *M. microthrix* Kornicker and van Morkhoven, 1976, *Metapolycope* species (Kornicker and van Morkhoven, 1976; known only from shell), *M. kornickeri* Chavtur, 1979, *M. echinata* Chavtur, 1981b, and *M. duplex* new species.

TERMINOLOGY OF FIRST ANTENNA.—The 1st antenna is interpreted herein to have 8 joints (Figure 30*b-d*), not 5 as given in the diagnosis of the genus by Kornicker and van Morkhoven (1976:2). The 2nd and 3rd joints are fused except in some adult males of *M. duplex*. The 3rd and 4th joints are fused except in *M. duplex*. The 7th and 8th joints are small and although each is fairly well defined on *M. duplex*, they could be interpreted to be a single joint (7th). With the present interpretation the 1st antenna of *Metapolycope* bears the same number of joints as the Myodocopina and, also, the genus *Deeveya* of the Halocypridina. Bristles with suckers (*Metapolycope*) or spatulate bristles (*Polycopsis*) of adult males are interpreted to be on the 6th joint.

#### *Metapolycope duplex*, new species

FIGURES 28*b*, 30–40

*Polycopse* spp.—Maddocks and Liffe, 1986:73 [part].

ETYMOLOGY.—From the Latin *duplex* in reference to the 2 anterior processes on the anterior margin of each lamella of the furca.

HOLOTYPE.—USNM 193320, 1 adult male.

TYPE LOCALITY.—Bermuda: Palm Cave, 13 and 16 Mar 1982.

MATERIAL.—*Cherry Pit Cave*: 23 Jun 1982: USNM 193326, 1 instar IV; USNM 193327, 1 instar VI female; USNM 193328, 1 adult male; USNM 193329A,B, 2 adult females; USNM 193329C, 1 instar V female; USNM 193330, 1 adult male, 2 adult females, 2 instar VI, 1 valve. 12 Jan 1984: USNM

193331, 1 instar VI male; USNM 193332, 1 adult female, 1 adult male, 2 instar VI, 3 valves. 22 Mar 1987: USNM 193435, 1 instar III; USNM 193403, 32 specimens. *Deep Blue Cave*: 20 Feb 1984: USNM 193340, 2 specimens (valves only). *Fern Sink Cave*: 25 Feb 1982: USNM 193337, 1 adult or late instar. *Green Bay Cave*: 18 Nov 1981: USNM 193343, 4 specimens (adults and late instars), 1 specimen (valves only). *Palm Cave*: 20 Jan 1982: USNM 193316, 1 instar I; USNM 193317, 1 instar V female; USNM 193318, 1 adult male; USNM 193319, 1 adult female; USNM 193325A, 1 instar VI female; USNM 193325B, 1 adult female; USNM 193325C, 4 adult females, 1 valve. 13 and 16 Mar 1982: USNM 193320, 1 adult male (holotype); USNM 193321, 1 instar V female; USNM 193322, 1 adult male; USNM 193323, 1 instar VI male; USNM 193324A, 1 adult female; USNM 193324B, 5 adult females; USNM 193379, 1 adult female, USNM 193378, 1 female, 5 juveniles. 9 Feb 1985: USNM 193314, 1 adult female; USNM 193315, 1 decalcified valve. *Sailor's Choice Cave*: 6 Jul 1982: USNM 193335, 4 specimens (adults and late instars). *Straw Market Cave*: 12 Jan 1984: USNM 193336, 1 adult. *Walsingham Cave*: 18 Feb 1982: USNM 193338, 7 specimens (adults and late instars); USNM 193339, 1 instar I. 14 Jun 1982: USNM 193333, 1 adult male, 3 single valves. 13 Jul 1984: USNM 193341, 1 instar IV; USNM 193342, 2 specimens (valves only). *Walsingham Sink Cave*: 13 Aug 1982: USNM 193334, 1 valve.

DISTRIBUTION (Figure 28*b*).—Bermuda: *Cherry Pit Cave*, 23 Jun 1982, 12 Jan 1984, 22 Mar 1987. *Deep Blue Cave*, 20 Feb 1984. *Fern Sink*, 25 Feb 1982. *Green Bay Cave*, 18 Nov 1981. *Palm Cave*, 20 Jan 1982, 9 Feb 1982, 13–16 Mar 1982. *Sailor's Choice Cave*, 6 Jul 1982. *Straw Market Cave*, 12 Jan 1984. *Walsingham Cave*, 18 Feb 1982, 14 Jun 1982, 13 Jul 1984. *Walsingham Sink Cave*, 13 Aug 1982, 13 Jul 1984.

DESCRIPTION OF ADULT FEMALE (Figures 30, 31).—Carapace oval in lateral view (Figure 30*a*). Shell translucent, edges and most carapaces light amber color.

Ornamentation (Figure 30*a*): Surface smooth. Anterovenral margin serrate with 16–17 triangular processes (processes near middle broader).

Central Adductor Muscle Attachments (Figure 30*a*): Com-



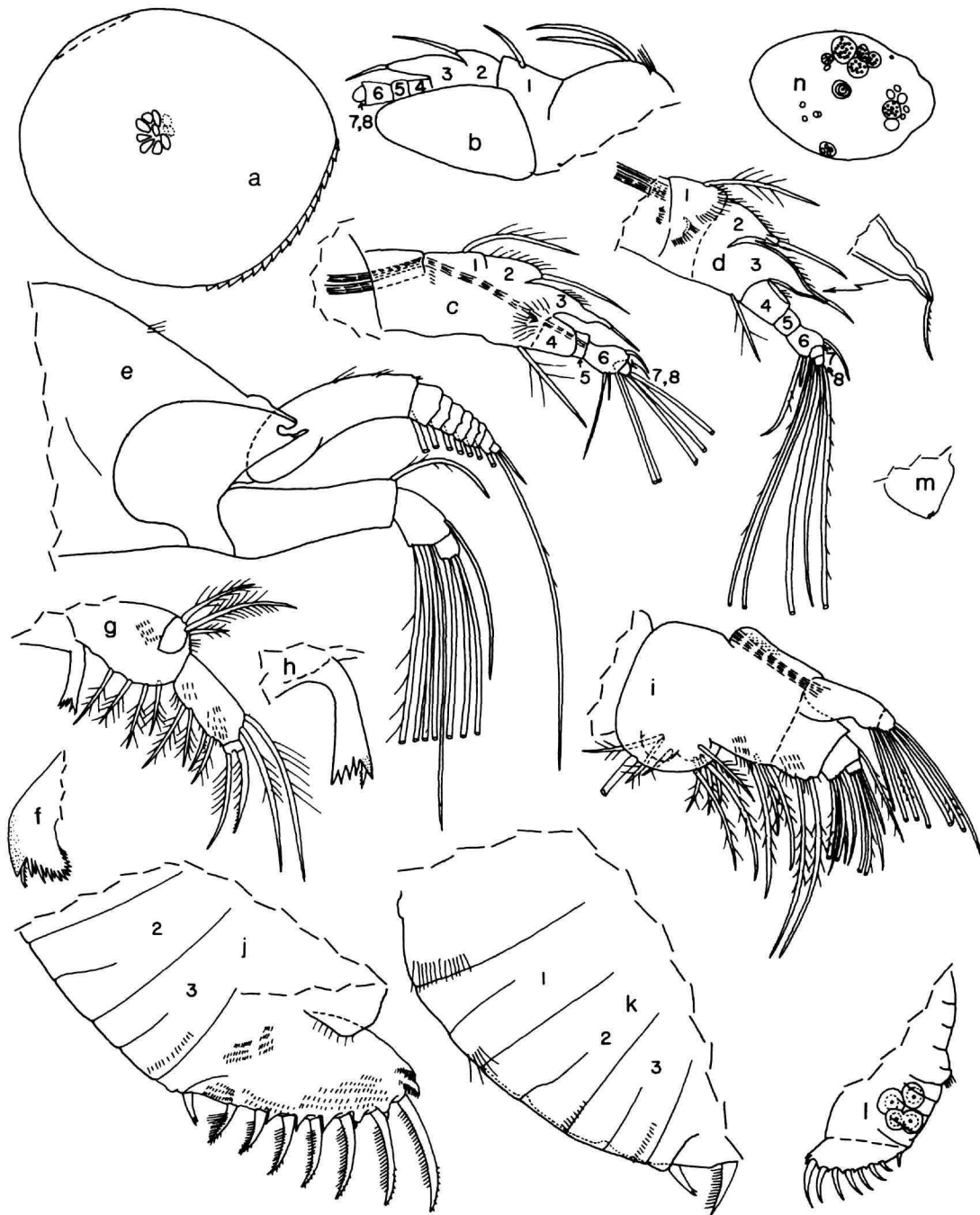


FIGURE 30.—*Metapolycope duplex*, new species, USNM 193314, paratype, adult female, length 0.54 mm: *a*, lateral view of complete specimen, anterior to right; *b*, lateral view of left 1st antenna and prodopodite of left 2nd antenna (not all bristles shown); *c*, left 1st antenna, medial view; *d*, right 1st antenna, lateral view; *e*, left 2nd antenna, medial view. Mandible: *f*, coxale endite of left limb, lateral view; *g, h*, right limb and detail of coxale endite, lateral view. *i*, maxilla; *j*, right lamella of furca and posterior of body; *k*, posterior of body from right side with unpaired process and 7th claw of right furcal lamella at lower edge; *l*, posterior of body from left side showing right lamella of furca, unpaired process, and 4 unextruded eggs; *m*, upper lip, anterior to right; *n*, food pellet in gut (drawn with  $\times 100$  oil immersion objective).

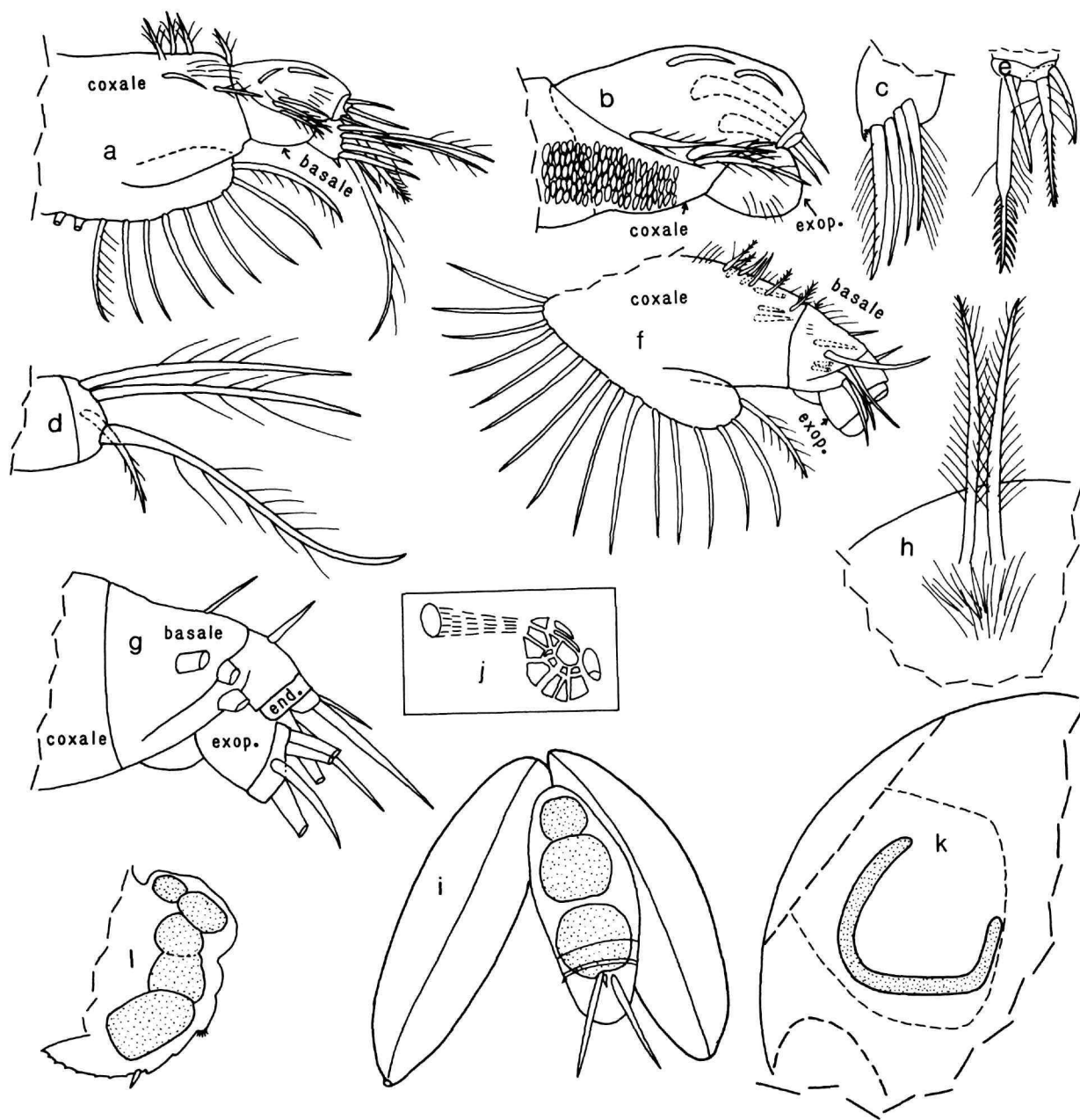


FIGURE 31.—*Metapolycope duplex*, new species. USNM 193314, paratype, adult female, length 0.54 mm: *a–e*, left 5th limb, medial views: *a*, complete limb except for proximal epipodial bristles; *b*, limb showing internal lenticular-shaped cells (not all bristles shown); *c*, medial bristles of exopodite; *d*, terminal bristles of exopodite; *e*, endopodite; *f, g*, lateral view of complete right 5th limb and detail from *f* (not all bristles shown); *h*, dorsal view of head region showing Bellonci organ (2 bristles). USNM 193330, paratype, adult female: *i*, posteroventral view of complete specimen with valves open showing 3 unextruded eggs (stippled) (diameter of smallest egg 0.07 mm, of largest egg 0.14 mm), unpaired process, and 2 furcal claws at lower edge (parts of other visible limbs not shown). USNM 193319, paratype, adult female, length 0.53 mm: *j*, lateral view of right valve showing central adductor muscles as seen through shell, anterior to right; *k*, nematode (stippled) with body of animal as seen through right valve, anterior of valve to right (dashed line represents location of hinge line). USNM 193324A, paratype, adult female, length 0.45 mm: *l*, posterior of body showing 5 unextruded eggs (stippled), unpaired process of furca at lower right.

prising central ovoid scar, 7 radial wedge-shaped scars forming half of a rosette with convex edge of rosette oriented posteroventrally, 1 ovoid scar anterior to central scar, 2 narrow scars dorsal to central scar, and 5 small scars between wedge-shaped scars and central scar. An additional ovoid scar present posterior to central adductor muscle cluster and separated from cluster by distance about equal to maximum dimension of cluster. (Attachments not always clearly visible through valve so that variability of scar in illustrations presented herein may be the result of poor visibility. Also, changes may occur during preservation causing separations in individual muscles making a single muscle appear to be 2 muscles; the 5 small scars indicated at the inner end of the wedge-shaped scars could be the result of division of the wedge-shaped muscles in the alcohol preservative and not actual divisions of the scars in the shell; the muscle of USNM 193319 (Figure 31j) probably best represents the central adductor muscle attachments because it was clearly visible on that specimen.)

**Carapace Size:** USNM 193314, length 0.54 mm, height 0.48 mm; USNM 193319, length 0.53 mm, height 0.45 mm; USNM 193324A,B, 2 specimens, both with same dimensions, length 0.54 mm, height 0.47 mm; USNM 193325B, length 0.49 mm, height 0.44 mm.

**First Antenna** (Figure 30b-d): 1st joint spinous, with long dorsal bristle with long proximal spines; except near dorsal margin, suture separating 1st and 2nd joints weakly developed or absent. 2nd and 3rd joints fused; each joint spinous, and with dorsal process with terminal bristle (tip of process of 3rd joint extended and with narrow neck at base of extension); 3rd joint with subterminal ventral bristle, and with well-developed suture separating it from 4th joint on lateral side only (suture on medial side either poorly developed or absent). 4th joint with spines along dorsal margin, and well-developed suture separating it from 5th joint. 5th joint short, bare. 6th joint with 3 bristles (1 dorsal, 2 ventral (longer of ventral bristles lateral)); dorsal margin of joint sinuate. 7th joint short, partly embedded in 6th joint, with 2 long terminal ventral bristles (both ringed proximally and with widely separated marginal spines on ringed part; ventral of the 2 bristles shorter, but both longer than stem). 8th joint short with 3 bristles (2 about twice length of stem, 1 about same length as stem, all ringed proximally and with widely separated marginal spines on ringed part).

**Second Antenna** (Figure 30b,e): Protopodite with spines forming dorsal row at midlength. Exopodite with 9 joints: 1st joint arcuate with spines forming rows along convex margin; joints 1-8 each with long bristle ringed along proximal  $\frac{3}{4}$  (ringed part bearing natatory hairs appearing more numerous on bristles of joints 1-4); 9th joint with 2 bristles (1 short, bare, other shorter than bristles of joints 1-8 and with few short proximal hairs). Endopodite 3-jointed: 1st joint elongate with 1 terminal dorsal bristle having few marginal hairs; 2nd joint short with 1 short terminal dorsal bristle, and 5 terminal ventral bristles with rings along proximal half (1 bristle about length of endopodite, others about twice the length; marginal hairs

observed on ringed part of 2 long bristles); 3rd joint short with 3 long bristles having rings along proximal  $\frac{3}{4}$  (dorsal bristle shorter than others; proximal marginal hairs observed on 1 of the longer bristles).

**Mandible** (Figure 30f-h): Coxale endite with stout anterior tooth followed by short spinous bristle, 2 slender teeth with smaller tooth between them, then 5 or 6 smaller slender teeth and about 7 minute distal posterior teeth. Basale with 4 spinous bristles on or near ventral margin, 1 distal spinous dorsal bristle, distal dorsal spines, and few small lateral spines near middle. Exopodite well developed with 2 spinous distal bristles. Endopodite 2-jointed: 1st joint with 3 or 4 bristles on or near ventral margin, 1 long dorsal at midlength (Figure 30g; USNM 193314 without bristle), 2 longer distal dorsal bristles (with long proximal spines), and long spines medially and along ventral margin; end joint with 2 long bristles (ventral of these with long proximal marginal spines, dorsal bristle stouter, somewhat claw-like, with long proximal and shorter distal spines).

**Maxilla** (Figure 30i): Precoxale and coxale well defined: precoxale endite of specimen studied fragmented; coxale with 1 distal hirsute lateral bristle near ventral margin, 3 long spinous bristles on ventral margin (1 proximal, 2 distal), and 2 endites, each with 3 spinous bristles. Basale: ventral margin with 2 spinous distal bristles; dorsal margin with proximal hump with internal muscle extending into exopodite; medial surface with long hairs near ventral margin and short indistinct proximal hairs near dorsal margin. Exopodite weakly divided into short proximal and longer distal parts, with 8 terminal bristles (3 with marginal hairs). Endopodite 3-jointed: 1st joint with 2 long, spinous, distal, ventral bristles, and long medial spines near ventral margin; 2nd joint with 4 terminal ventral bristles (2 long, 2 short; ventral long bristle with long marginal spines), and 1 spinous dorsal bristle; small 3rd joint with 4 bristles (2 with long marginal spines).

**Fifth Limb** (Figure 31a-g): Epipodite with 16 hirsute bristles; and with minute spines along proximal  $\frac{3}{4}$  of edge. Coxale hirsute with about 9 short spinous bristles on or near dorsal margin. Basale with distal suture not reaching outer margin, and with about 9 bristles. Endopodite short, possibly 2-jointed, with indistinct hairs and 4 bristles: longest and next-to-longest bristles with long slender marginal spines on broad proximal part and shorter stouter spines on distal narrower part (Figure 31e). Exopodite with 4 hirsute bristles forming medial proximal row (Figure 31c), and 4 spinous terminal bristles (1 short, 3 long) (Figure 31d). Lenticular-shaped cells (sporozoans?) present within coxale and basale near medial surface of USNM 193314 (Figure 31b).

**Furca** (Figures 30j-l, 31i): Each lamella with 7 claws decreasing in length proximally; each claw with long spine-like teeth along posterior margin and indistinct distal hair-like spines along anterior margin; posterior teeth longer on proximal 2 claws, especially on last claw. Small process with triangular terminal tooth present between all claws except proximal 2; each process closer to proximal claw. Apex of

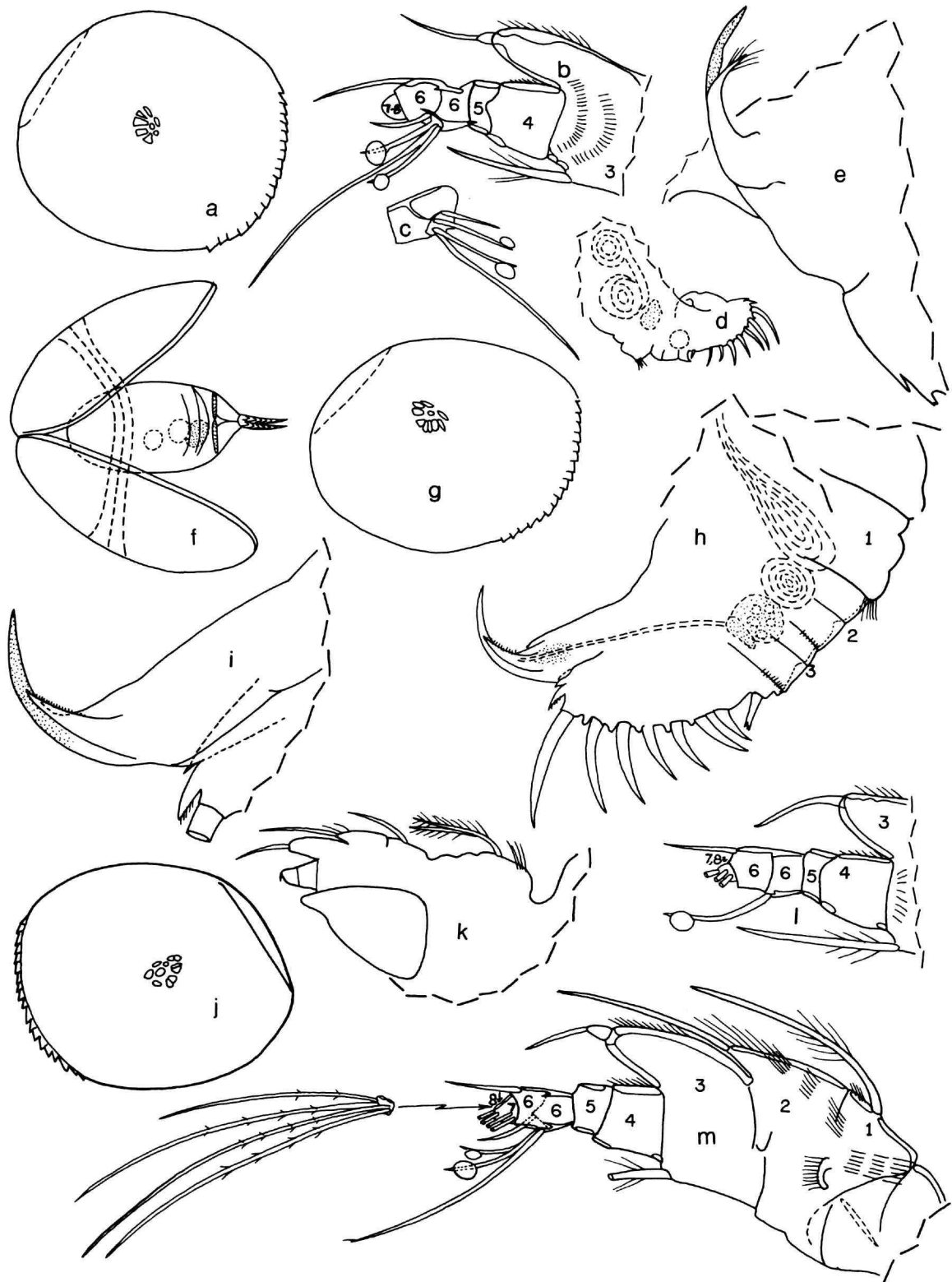


FIGURE 32(left).—*Metapolycope duplex*, new species. USNM 193320, holotype, adult male, length 0.47 mm: *a*, lateral view of complete specimen, anterior to right; *b*, joints 3–8 of right 1st antenna, medial view (bristles of fused joints 7 and 8 not shown); *c*, joint 6 of left 1st antenna showing ventral bristles, medial view; *d*, posterior of body from right side showing unpaired furcal process, right lamella of furca, copulatory organ, and internal genitalia; *e*, genital organ from left side, part of furca at bottom edge. USNM 193328, paratype, adult male, length 0.50 mm: *f*, ventral view of complete specimen with valves open, showing internal genitalia, 2 furcal claws, and location of central adductor muscles, additional visible parts of appendages not shown. USNM 193322, paratype, adult male, length 0.46 mm: *g*, lateral view of complete specimen from right side (valves slightly open), anterior to right; *h*, posterior of body from left side showing genital organ and internal genitalia, and left lamella of furca; *i*, detail from *h*. USNM 193318, paratype, adult male, length 0.49 mm: *j*, inside view of right valve, anterior to left (infold not shown); *k*, left view of body showing Bellonci organ, left 1st antenna (not all bristles shown) and protopodite of left 2nd antenna; *l*, joints 3–8 of right 1st antenna, only 1 of 2 bristles of 8th joint shown (limb aberrant in having only 1 ventral bristle on 6th joint); *m*, left 1st antenna, lateral view.

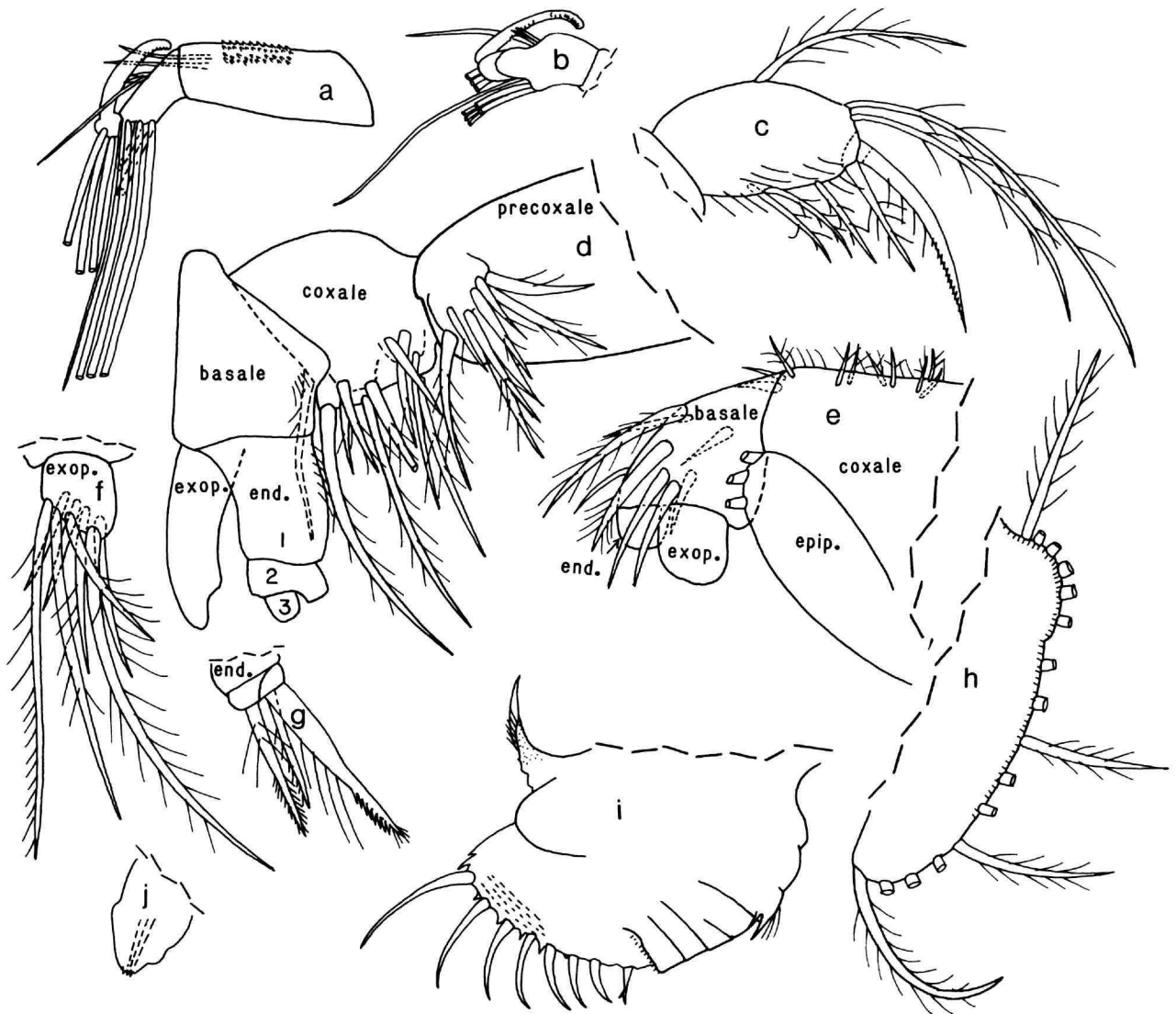


FIGURE 33.—*Metapolycope duplex*, new species, USNM 193318, paratype, adult male, length 0.49 mm: *a*, endopodite of right 2nd antenna, medial view; *b*, tip of endopodite of left 2nd antenna, lateral view; *c*, endopodite of left mandible, medial view; *d*, maxilla and bristles of basale (exopodite and endopodite not shown). Left 5th limb, lateral views: *e*, complete limb showing only bristles of coxale, basale, and stumps of 3 bristles of epipodite (epip.); *f*, exopodite (exop.); *g*, endopodite (end.); *h*, epipodite, distal end at bottom. *i*, posterior of body from left side showing copulatory organ, left furcal lamella, and unpaired furcal process; *j*, upper lip, lateral view.

each lamella with 2 processes (distal process longer) bearing ventral spines. Single unpaired process on body proximal to proximal claw (process with digitate tip and about  $\frac{3}{4}$  length of proximal claw). Outer surface of lamellae proximal to claws with small broad spines (spines smaller posterior to proximal claw); inner surface with short slender spines. Right lamella not anterior to left.

*Bellonci Organ* (Figures 30b, 31h): Comprising 2 plumose bristles. Cluster of long hairs on surface of head posterior to bristles.

*Upper Lip* (Figure 30m): Helmet-shaped with glandular openings in anteroventral corner.

*Posterior of Body* (Figure 30j–l): With 3 main segments; proximal segment with long hairs forming short distal row, segments 2 and 3 with shorter less distinct hairs forming distal row; 2nd and 3rd segment each divided by secondary suture at midheight; in lateral view sclerotized edge of posterior margin forming broad boss at midheight of segments 2 and 3 (dotted line in Figure 30k); posterodorsal margin proximal to segment 1 with short spines forming row.

*Eggs*: Location of eggs is shown in Figure 31i,l.

*Gut Content* (Figure 30n): Gut of USNM 193314 with light amber food ball with darker amber and brown ovoid particles (with internal structures) that may be of plant origin.

*Parasites* (Figure 31k): USNM 193319 with nematode within dorsal part of body. USNM 193314 with cells within 5th limb that may be internal sporezoans (Figure 31b).

DESCRIPTION OF ADULT MALE (Figures 32, 33).—Carapace similar to that of adult female except smaller (Figure 32a,f,g,j).

*Ornamentation* (Figure 32a,g,j): Surface smooth. Anteroventral margin serrate with 18–22 triangular processes (USNM 193322 with 18 on right valve and 22 on left).

*Central Adductor Muscle Attachments* (Figure 32a,g,j): Similar to those of adult female.

*Carapace Size*: USNM 193318, length 0.49 mm, height 0.40 mm; USNM 193320, holotype, length 0.47 mm, height 0.45 mm; USNM 193322, length 0.46 mm, height 0.42 mm; USNM 193328, length 0.50 mm, height 0.42 mm.

*First Antenna* (Figure 32b,c,k–m): 1st joint spinous with long dorsal bristle; 1st and 2nd joints fused except near dorsal margin. 2nd and 3rd joints separated by suture on some limbs but not on others (illustrated left limb of USNM 193318 with 2nd and 3rd joints separated by suture (Figure 32m), but joints of right limb fused); each joint spinous and with dorsal process with terminal bristle. 3rd joint with subterminal ventral bristle; suture separating 3rd and 4th joints well developed only on lateral side; dorsal process of 3rd joint differing from that of female in having small joint at tip proximal to bristle (this joint fused to process on female). 4th joint with dorsal spines; sutures separating 4th and 5th joints well developed on both sides. 5th joint short bare. 6th joint with 1 short dorsal bristle and 4 ventral bristles: 1 long lateral, 1 short medial bare, 2 short medial with subterminal sucker (suckers transparent and difficult to see except under oil immersion objective, and even then indistinct); joint with transverse medial suture near

midlength in vicinity of the 4 bristles; dorsal margin of joint sinuate. 7th joint small with 2 long proximal bristles near ventral margin. 8th joint minute with 2 terminal bristles (1 long and 1 about  $\frac{2}{3}$  length of longer bristle). Bristles of 7th and 8th joints ringed proximally and with widely separated short spines on ringed part. Right limb of USNM 193318 aberrant (Figure 32l) in having only 1 ventral bristle on 6th joint and only 1 bristle on 8th joint.

*Second Antenna* (Figures 32k, 33a,b): Protopodite and exopodite similar to those of female. Endopodite 3-jointed: 1st joint with short spines along dorsal margin and 2 distal bristles; 2nd joint with 3 dorsal bristles (1 long, and 2 short, diaphanous), and total of 6 ventral and terminal bristles with proximal rings (one of these with few long proximal spines, others bare or with few short proximal spines); 3rd joint with sclerotized hook-shaped clasping organ (with rounded tip and minute distal ridges on concave edge) and 3 bristles (ringed proximally and with few widely spaced marginal spines on ringed part).

*Mandible* (Figure 33c): Similar to that of adult female.

*Maxilla* (Figure 33d): Precoxale and coxale well defined. Endite of precoxale with 9 spinous bristles. Coxale with 1 hirsute, lateral, terminal bristle near ventral margin, 3 long spinous bristles on ventral margin (1 proximal, 2 distal) and 2 endites, each with 3 spinous bristles. Basale with surface spines and 2 or 3 terminal ventral spinous bristles. Exopodite undivided, with 8 terminal bristles. Endopodite similar to that of adult female.

*Fifth Limb* (Figure 33e–h): Epipodite with 16 spinous bristles (proximal 6 bristles more closely spaced than distal bristles and on convex projection (Figure 33h); edge of epipodite along posterior  $\frac{3}{4}$  with minute spines). Coxale hirsute with 10 short spinous bristles on or near dorsal margin (Figure 33e). Basale with about 8 bristles (Figure 33e). Endopodite short with 3 bristles (longest and shortest with long slender spines on broad proximal part and shorter stouter spines on distal narrower part) (Figure 33g). Exopodite with 4 hirsute medial bristles forming proximal row and 4 spinous terminal bristles (1 short, 3 long) (Figure 33f). Right limb of USNM 193322 aberrant in having an endopodite with only 2 bristles and an exopodite without medial bristles forming proximal row (not illustrated). (No lenticular-shaped cells present within coxale as in coxale of female USNM 193314: Figure 31b.) *Furca* (Figures 32d–f,h,i; 33i), *Bellonci Organ* (Figure 32k), *Upper Lip* (Figure 33j), *Posterior of Body* (Figure 32d,h,i): Similar to that of adult female.

*Genitalia* (Figures 32d,e,h,i; 33i): Consisting of sclerotized hook-like process tapering to pointed tip; left side of process near base with indistinct lateral process with short spines on USNM 193322 (Figure 32h,i) and longer spines on USNM 193320 (Figures 32e). Mobility of process indicated by its different positions shown in illustrations.

DESCRIPTION OF INSTAR I (sex unknown) (Figure 34).—Carapace more evenly rounded than that of adult (Figure 34a).

*Ornamentation* (Figure 34a): Surface smooth. Anteroventral

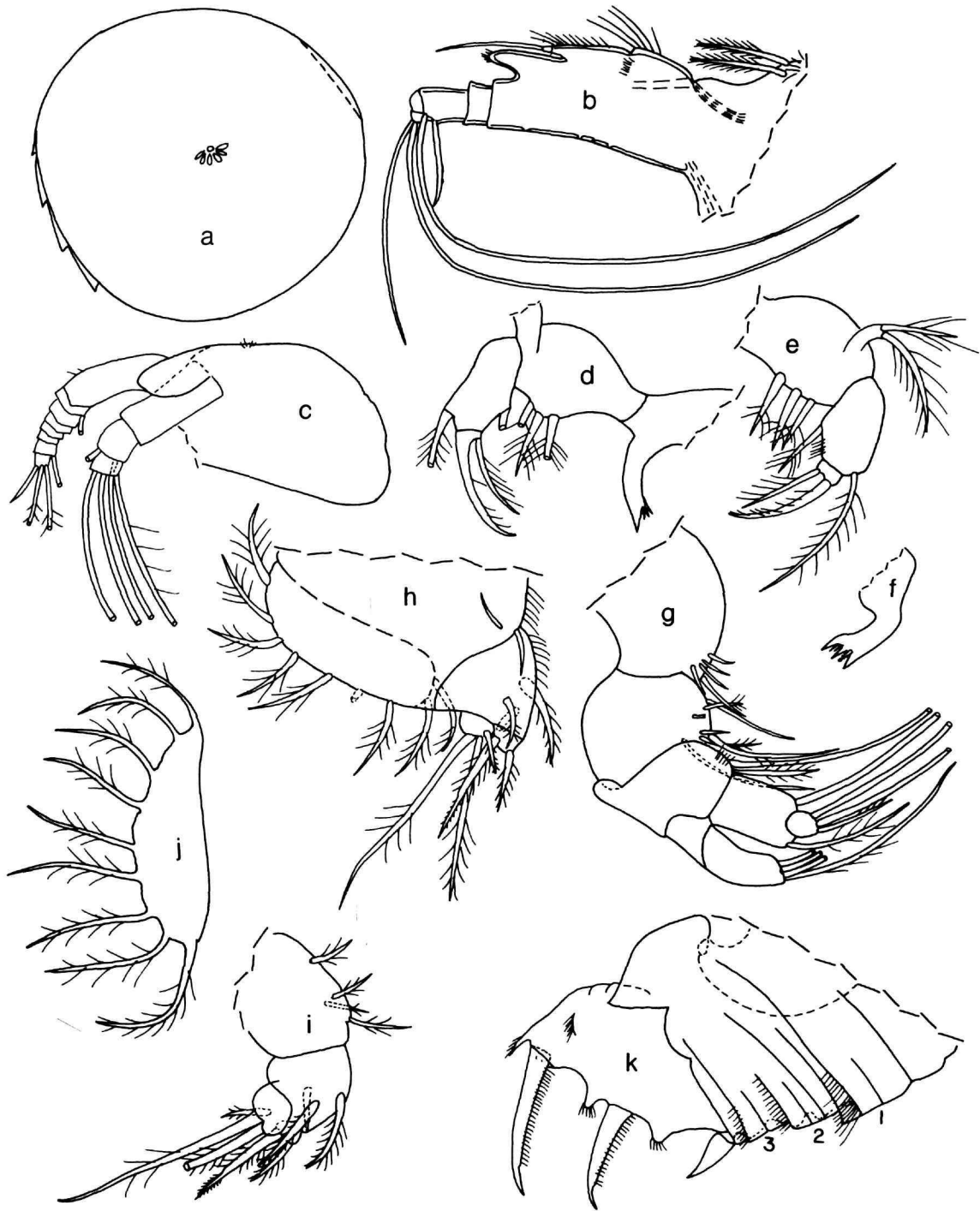


FIGURE 34.—*Metapolycope duplex*, new species, USNM 193316, paratype, instar I, length 0.25 mm: a, complete specimen from left size, anterior to left; b, Bellonci organ and left 1st antenna, lateral view; c, left 2nd antenna, lateral view; d, left mandible, lateral view (only proximal part of exopodite shown); e, f, right mandible and its coxale, lateral views; g, right maxilla, medial view; h, left 5th limb, medial view; i, j, right 5th limb and epipodite (distal end at bottom), lateral view; k, posterior of body from left showing left lamella of furca and unpaired furcal process.

tral margin serrate with 4 triangular processes.

**Central Adductor Muscle Attachments** (Figure 34a): Comprising central ovoid scar and 6 additional scars forming rosette with convex outline oriented posteroventrally.

**Carapace Size:** USNM 193316, length and height 0.25 mm; USNM 193339, length 0.27 mm, height 0.24 mm.

**First Antenna** (Figure 34b): Joints 1–4 fused except at sclerotized ventral and dorsal edges. 1st joint with long dorsal hairs and shorter hairs forming distal lateral row near dorsal margin. 2nd joint with dorsal process with marginal spines and terminal bristle. 3rd joint with dorsal process bearing terminal spines. 5th joint short, bare, with well-developed sutures separating it from 4th and 6th joints. 6th joint with 1 ventral bristle. 7th and 8th joints fairly well defined; 7th joint with long ventral bristle with few widely separated marginal spines; 8th joint with 2 bristles with widely separated marginal spines (longer bristle about same length as bristle of 7th joint, shorter bristle about  $\frac{1}{3}$  length of longer bristle).

**Second Antenna** (Figure 34c): Protopodite similar to that of adult female. Exopodite: similar to that of adult female except for absence of bristle on 1st joint and fusing of 8th and 9th joints; sparse slender marginal spines on bristles of joints 7 and 8. Endopodite 3-jointed: 1st joint elongate, bare; 2nd joint short, with 1 short terminal dorsal bristle, and 1 long terminal ventral bristle; 3rd joint short with 3 long terminal bristles.

**Mandible** (Figure 34d-f): Coxale endite similar to that of adult female (Figure 34f). Basale with 3 spinous ventral bristles and no dorsal bristle. Exopodite well developed, with 2 spinous terminal bristles. Endopodite 2-jointed: 1st joint with 1 spinous ventral bristle and 1 long, spinous, distal, dorsal bristle; end joint with 2 long spinous bristles (dorsal bristle somewhat claw-like).

**Maxilla** (Figure 34g): Precoxale and coxale well defined; precoxale endite with 5 spinous bristles (1 long, 4 short); coxale with 1 long, terminal, lateral bristle near ventral margin, 2 long ventral bristles (1 proximal, 1 distal), and 2 endites, each with 2 short spinous bristles. Basale with 2 terminal ventral bristles; dorsal margin with proximal hump. Exopodite with weak diagonal proximal suture and 4 terminal bristles. Endopodite 3-jointed, but 1st and 2nd joints fused; 1st joint bare; 2nd joint with 2 bristles (1 ventral, 1 dorsal); 3rd joint with 3 terminal bristles.

**Fifth Limb** (Figure 34h-j): Epipodite with 9 hirsute bristles; edge without minute spines. Coxale with 3 or 4 small spinous bristles on or near dorsal margin. Basale with 3 spinous bristles. Endopodite short with 2 spinous terminal bristles. Exopodite with 3 spinous bristles.

**Furca** (Figure 34k): Each lamella with 2 stout claws with spine-like teeth along posterior margin; Small process with terminal spines between claws and following claw 2; anterior of each lamella with distal process bearing spines. Single unpaired process on body following claws. Outer surface of lamellae with minute spines forming row proximal to claw 1.

**Bellonci Organ** (Figure 34b): Comprising 2 plumose

bristles. Long hairs forming cluster on surface posterior to base of bristles.

**Upper Lip:** Helmet-shape.

**Posterior of Body** (Figure 34k): With 3 main segments with stepped posterior edge; segment 1 with short secondary suture followed by long secondary suture bearing long hairs, then shorter suture at stepped margin; segment 2 with 1 long secondary suture followed by short secondary suture, then short suture (with fairly long hairs) at stepped margin; segment 3 with short secondary suture followed by long suture (with fairly long marginal hairs) at stepped margin.

**DESCRIPTION OF INSTAR III** (sex unknown)(Figure 35).—Carapace similar in shape to that of adult female (Figure 35a).

**Ornamentation** (Figure 35a): Surface smooth. Anteroventral margin serrate with 12 triangular processes.

**Central Adductor Muscle Attachments:** Similar to those of adult female.

**Carapace Size:** USNM 193435, length 0.35 mm, height 0.32 mm.

**First Antenna** (Figure 35b): Differs from instar I in having 2 ventral bristles on 6th joint; long bristle of 7th joint with few widely separated marginal spines; shorter bristle of 8th joint about  $\frac{3}{4}$  length of longer bare bristle, with few widely separated marginal spines.

**Second Antenna** (Figure 35b): Protopodite without spines. Exopodite differs from that of instar I in having bristle on 1st joint (bristle reaching just past 9th joint) and in having

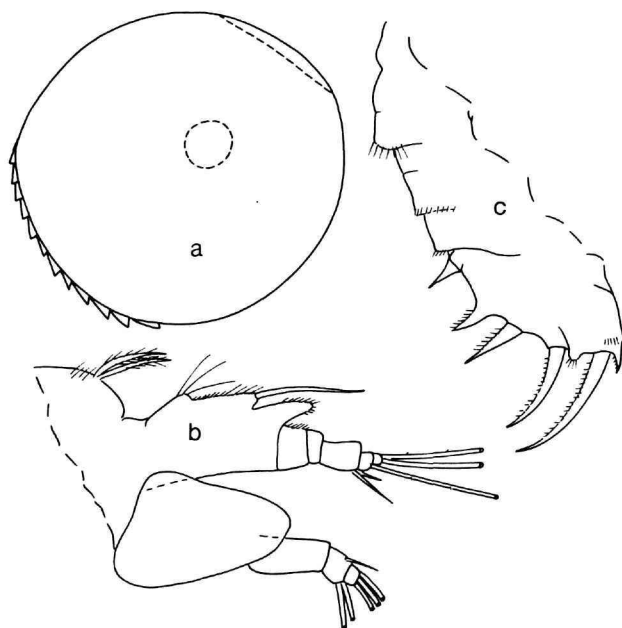


FIGURE 35.—*Metapolycope duplex*, new species, USNM 193435, paratype, instar III, length 0.35 mm: a, complete specimen from left side, anterior to left; b, anterior of body showing Bellonci organ, right 1st antenna, and protopodite and endopodite of right 2nd antenna; c, posterior of body showing right lamella of furca, unpaired furcal process, and posterior segmentation.



well-defined small 9th joint; bristles of 7th and 8th joints and longer bristle of 9th joint with few widely separated slender ventral spines on proximal half; indistinct long natatory hairs observed only on bristles of joints 3 and 4. Endopodite differs from that of instar I in having 2 long ventral bristles on 2nd joint in addition to short dorsal bristle.

**Mandible:** Coxale endite similar to that of adult female. Basale differs from that of adult female in having only 3 ventral bristles. Exopodite similar to that of adult female. Endopodite differs from that of adult female in having 1st joint with 1 ventral bristle (at joint midlength) and 1 dorsal bristle (distal).

**Maxilla:** Precoxale and coxale well defined; precoxale with 5 spinous bristles; coxale with 8 or 9 bristles. Basale with 1 or 2 terminal ventral bristle; dorsal margin with proximal hump. Exopodite undivided, with 4 terminal bristles. Endopodite 3-jointed, but suture between 1st and 2nd joints weak: 1st joint with 1 long terminal ventral bristle with long marginal spines; 2nd joint with 2 terminal bristles (1 ventral, 1 dorsal); end joint with 3 bristles.

**Fifth Limb:** Epipodite with 11 hirsute bristles; edge with indistinct spines. Coxale with 7 short bristles near dorsal margin. Basale with 3 spinous bristles. Endopodite with 3 spinous bristles. Exopodite with 3 spinous bristles.

**Furca (Figure 35c):** Each lamella with 4 claws with spine-like teeth along posterior margins (spines of claw 4 broader but shorter than those on claws 1-3; relative length and breadth of spines not accurately shown in illustration); claw 4 without basal suture; small spinous process between claws 1 and 2; anterior of each lamella with distal process bearing spines; single unpaired process on body following claws.

**Bellonci Organ (Figure 35b), Upper Lip, Posterior of Body (Figure 35c):** Similar to those of adult female.

**DESCRIPTION OF INSTAR IV (sex unknown) (Figure 36).**—Carapace similar in shape to that of adult female (Figure 36a,b).

**Ornamentation (Figure 36a,b):** Surface smooth. Anteroventral margin serrate with 13 or 14 triangular processes.

**Central Adductor Muscle Attachments (Figure 36a):** Similar type to those of adult female.

**Carapace Size:** USNM 193326, length 0.39 mm, height 0.33 mm; USNM 193341, length 0.39 mm, height 0.34 mm.

**First Antenna (Figure 36c,d):** Differs from that of adult female in having shorter ventral bristle on 3rd joint (tip of bristle reaching midlength of 5th joint), shorter dorsal bristle on 6th joint (tip reaching distal end of 7th joint), only 1 long ventral bristle on 7th joint, and only 2 long bristles on 8th joint. 5th joint with few short spines forming distal lateral row near ventral margin.

**Second Antenna (Figure 36c,d):** Protopodite and exopodite similar to those of adult female. Endopodite: 1st joint bare; 2nd joint with short dorsal bristle and 3 long, terminal, ventral and medial bristles; 3rd joint with 3 long terminal bristles.

**Mandible (Figure 36c):** Coxale endite similar to that of adult female. Basale with 4 spinous bristles (1 dorsal, 3 ventral). Exopodite similar to that of adult female. Endopodite:

1st joint with 3 bristles on or near ventral margin and 1 distal, long, spinous, dorsal bristle; 2nd joint with 2 bristles similar to those of adult female.

**Maxilla (Figure 36c):** Precoxale with 7 spinous bristles (6 short, 1 long). Coxale: ventral margin with 2 or 3 long ventral bristles (1 proximal, 1 or 2 distal); lateral side with 0 or 1 distal bristle; proximal and distal endites each with 3 short spinous bristles. Basale with 2 spinous bristles on or near ventral margin and proximal dorsal hump as on adult female. Exopodite elongate, unsegmented, with 6 long terminal bristles. Endopodite: 1st joint with 1 long spinous ventral bristle; 2nd joint with 2 terminal, spinous, ventral bristles and 1 spinous dorsal bristle; 3rd joint with 4 terminal bristles.

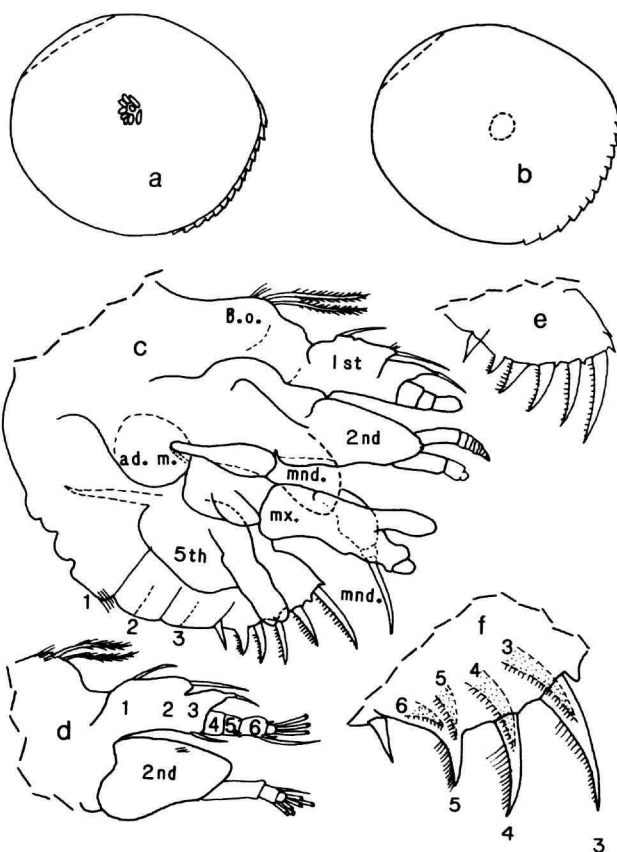


FIGURE 36.—*Metapolycope duplex*, new species, USNM 193341, paratype, instar IV, length 0.39 mm: a, complete specimen from right side showing central adductor muscle attachment scars, anterior to right. USNM 193326, paratype, instar IV, length 0.39 mm: b, separated right valve from outside, anterior to right, dashed circle represents central adductor muscle attachment area; c, body of animal viewed from right side (not all bristles and joints shown, and not under cover slip) showing Bellonci organ (B.O.), central adductor muscle scars (ad.m.), mandible (mnd.), and maxilla (mx.); d, anterior of body showing Bellonci organ, right 1st antenna, and protopodite and endopodite of right 2nd antenna; e, right lamella of furca and unpaired furcal process; f, claws 3-5 of right lamella of furca showing internally claws 3-6 of right lamella of next instar.

**Fifth Limb** (Figure 36c): Epipodite with 13 hirsute bristles. Coxale hirsute with 9 short spinous bristles on or near dorsal margin. Basale hirsute, with 6 bristles. Endopodite with 4 bristles (longest with long slender spines on broad proximal part and shorter stouter spines on narrower distal part). Exopodite with 5 bristles.

**Furca** (Figure 36c,e,f): Each lamella with 5 claws bearing posterior spine-like teeth; claw 5 fused to lamella; small process between claws 1 and 2 and 2 and 3, none between claws 3 and 4, and 4 and 5; each process closer to following claw. Anterior of each lamella with 2 distal spinous processes (proximal process very small). Single unpaired process on body following last claw. Outer surface of lamella proximal to claws 2-4 with minute spines.

**Bellonci Organ** (Figure 36c,d), **Upper Lip**, **Posterior of Body** (Figure 36c): Similar to those of adult female.

**Ecdysis**: USNM 193326 with appendages of instar V visible within. 6 claws present on each lamella of the furca of instar V. As illustrated in Figure 36f the 6th claw is added posteriorly.

**DESCRIPTION OF INSTAR V FEMALE** (Figure 37a-j).—Carapace similar in shape to that of adult female (Figure 37a,d).

**Ornamentation**: Surface smooth. Anteroventral margin serrate with 15 or 16 triangular processes (Figures 37a,d).

**Central Adductor Muscle Attachments** (Figure 37a,d): Similar type to those of adult female.

**Carapace Size**: USNM 193317, length 0.44 mm, height 0.39 mm; USNM 193321, length 0.42 mm, height 0.35 mm; USNM 193329C, length 0.42 mm, height 0.37 mm.

**First Antenna** (Figure 37b): Similar to that of adult female.

**Second Antenna** (Figure 37b): Protopodite and exopodite similar to those of adult female. Endopodite 3-jointed: dorsal bristle of 1st joint short (length about half to full width of joint); endopodite otherwise similar to that of adult female.

**Mandible** (Figure 37b): Coxale endite and basale similar to those of adult female. Endopodite: 1st joint with 2 or 3 spinous ventral bristles and 1 long, spinous, distal, dorsal bristle; 2nd joint similar to that of adult female.

**Maxilla** (Figure 37b): Precoxale and coxale well defined; precoxale endite with 7 or 8 bristles; coxale with 1 long, hirsute, terminal, lateral bristle near ventral margin, 3 long spinous ventral bristles (1 proximal, 2 terminal), and 2 endites (proximal endite with 2 short spinous bristles, distal endite with 3). Basale with surface spines and 2 distal ventral bristles. Exopodite with 7 terminal bristles. Endopodite: 1st joint with 2 spinous ventral bristles; 2nd joint with 1 spinous dorsal bristle and 3 ventral bristles (1 short, 2 long); 3rd joint with 4 bristles (2 with long marginal spines).

**Fifth Limb** (Figure 37b): Epipodite with 15 spinous bristles; proximal margin of epipodite with minute spines. Coxale with 10 short spinous bristles on or near dorsal margin. Basale with about 9 bristles. Endopodite short, with 4 or 5 bristles (longest with long slender spines on broad proximal part and shorter stout spines on distal narrower part; next-to-longest bristle with long slender spines on broad

proximal part). Exopodite with 3 hirsute bristles forming medial proximal row, and 4 spinous terminal bristles. Lenticular-shaped cells present within coxale and basale of adult female absent.

**Furca** (Figure 37b,c,f): Differs from that of adult female in having only 6 claws, a weakly developed suture at base of 5th claw, no suture at base of 6th claw, and a process between only claws 1 and 2, 2 and 3, and 3 and 4, none between claws 4 and 5 and 5 and 6.

**Bellonci Organ** (Figure 37b,g,h): Similar to that of female. Illustrated organ of USNM 193317 aberrant in having only 1 bristle.

**Upper Lip** (Figure 37i,j): Similar to that of adult female.

**Posterior of Body** (Figure 37b,c): USNM 193321: 3 main segments similar to those of adult female; secondary sutures not developed; thickening of sclerotized posterior margin to form boss at midheight as on adult female absent. USNM 193317: Similar to that of adult female except for segment 1 being much broader and having well-developed secondary suture; also posterior edge of segments stepped.

**Epizoa**: USNM 193317 with disk-like protistan with spines along 1 edge attached to head near base of Bellonci organ (Figure 37h).

**DESCRIPTION OF INSTAR V MALE** (Figures 37k-m).—Carapace similar in shape to that of adult male (Figure 37k).

**Ornamentation**: Surface smooth. Anteroventral margin serrate with 17 triangular processes (Figure 37k).

**Central Adductor Muscle Attachments** (Figure 37k): Similar type to those of adult.

**Carapace Size**: USNM 193331, length 0.43 mm, height 0.37 mm.

**First Antenna** (Figure 37l): Joints 1-5 similar to those of instar VI male. 6th joint with 1 short dorsal bristle and 3 ventral bristles (shorter 2 very slightly broader in proximal unringed part than in normal uniformly tapering bristles). 7th joint with 2 long ventral bristles. 8th joint with 3 long bristles.

**Second Antenna**: Protopodite and exopodite similar to those of adult male. Endopodite: 1st joint bare; 2nd and 3rd joints similar to those of adult female.

**Mandible**: Coxale endite and basale similar to that of adult male. Endopodite: 1st joint with 3 spinous ventral bristles and 1 long, spinous, distal, dorsal bristle; 2nd joint similar to that of adult male.

**Maxilla**: Precoxale and coxale well defined; precoxale endite with 6 bristles; coxale with 1 long, hirsute, terminal, lateral bristle near ventral margin, 3 long spinous ventral bristles (1 proximal, 2 terminal), and 2 endites, each with 3 short spinous bristles. Basale with surface spines and 2 distal ventral bristles. Exopodite with 8 terminal bristles. Endopodite: 1st joint with 2 spinous ventral bristles; 2nd joint with 1 spinous dorsal bristle and 3 ventral bristles (1 short slender, 2 long stout); 3rd joint with 4 bristles.

**Fifth Limb**: Epipodite fragmented. Coxale with about 9 short spinous bristles on or near dorsal margin. Basale with about 9 bristles. Endopodite short, with 4 bristles (longest with

long slender spines on broad proximal part and shorter stout spines on distal narrower part; next-to-longest with long slender spines on broad proximal part). Exopodite with 3 hirsute bristles forming medial row and 3 spinous terminal bristles.

*Furca* (Figure 37*m*): Each lamella with 6 claws, a weakly developed suture at base of 5th claw, and no suture at base of 6th claw; a process between claws 1 and 2, 2 and 3, and 3 and 4; no process between either claws 4 and 5 or 5 and 6; unpaired process following claws.

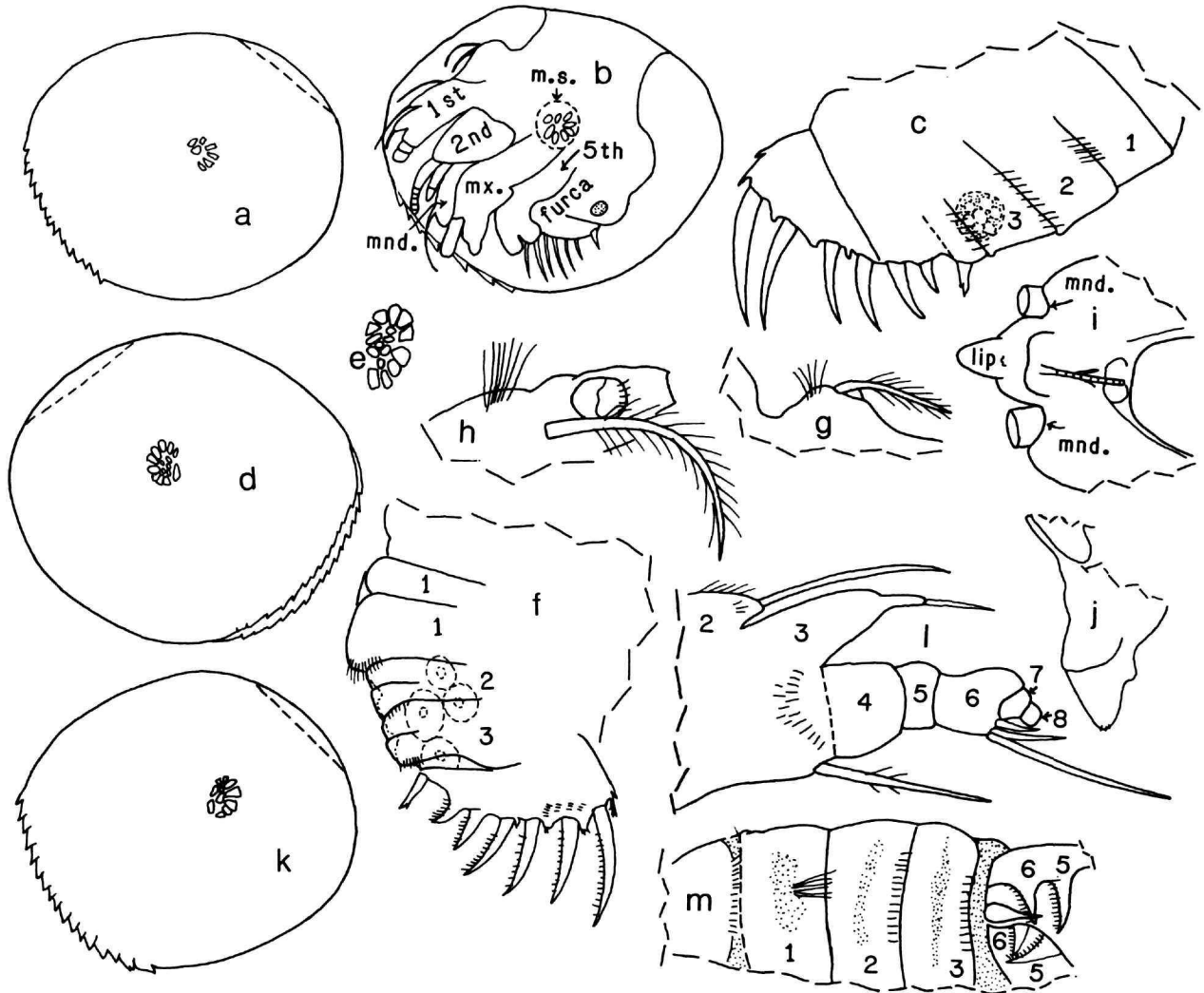


FIGURE 37.—*Metapolycope duplex*, new species, USNM 193321, paratype, instar V female, length 0.42 mm: a, complete specimen from left side, anterior to left; b, body of specimen within right valve (not all bristles or joints of appendages shown) showing mandible (mnd.), central adductor muscle scars (m.s.), and maxilla (mx.); c, posterior of body showing left lamella of furca and unpaired bristle. USNM 193317, paratype, instar V female, length 0.44 mm: d, complete specimen from right side, anterior to right (outer serrate anteroventral margin represents edge of left valve); e, outside view of muscle attachments of left valve, anterior to left; f, posterior of body from right side showing posterior segmentation, right lamella of furca, unpaired furcal process, and 4 unidentified internal disks; g, right side of dorsal part of body bearing single bristle of Bellonci organ (1 bristle instead of usual 2 comprising Bellonci organ probably aberrant); h, detail from g showing attached oval ?protistan; i, dorsal view of anterior of body with 1st and 2nd antennae removed showing outline of upper lip (mnd. = mandible); j, anterior side of body from right side showing upper lip, anterior to left. USNM 193331, paratype, instar V male, length 0.43 mm: k, complete specimen from left side, anterior to left; l, joints 2-8 of left 1st antenna, medial view (dorsal bristle of 6th joint and bristles of joints 7 and 8 not shown); m, dorsal view of posterior of body flattened under cover slip (unpaired furcal process, claws 5 and 6 of right lamella (top) and left lamella (bottom) are on right end of illustration; sclerotized areas indicated by stippling).

*Bellonci Organ, Upper Lip, Posterior of Body* (Figure 37m): Similar to those of adult male.

*Genitalia*: None observed.

DESCRIPTION OF INSTAR VI FEMALE (Figure 38a-c).—Carapace similar to that of adult female (Figure 38a).

*Ornamentation* (Figure 38a): Surface smooth. Anterovenral margin serrate with 18 triangular processes.

*Central Adductor Muscle Attachments* (Figure 38a): Similar to those of adult female.

*Carapace Size*: USNM 193325A, length 0.48 mm, height 0.40 mm; USNM 193327, length 0.46 mm, height 0.40 mm.

*First Antenna*: Similar to that of adult female (with same number of bristles).

*Second Antenna*: Protopodite and exopodite similar to that of adult female. Endopodite: 1st joint elongate, with no or 1 dorsal bristle; 2nd and 3rd joints similar to those of adult female.

*Mandible*: Similar to that of adult female.

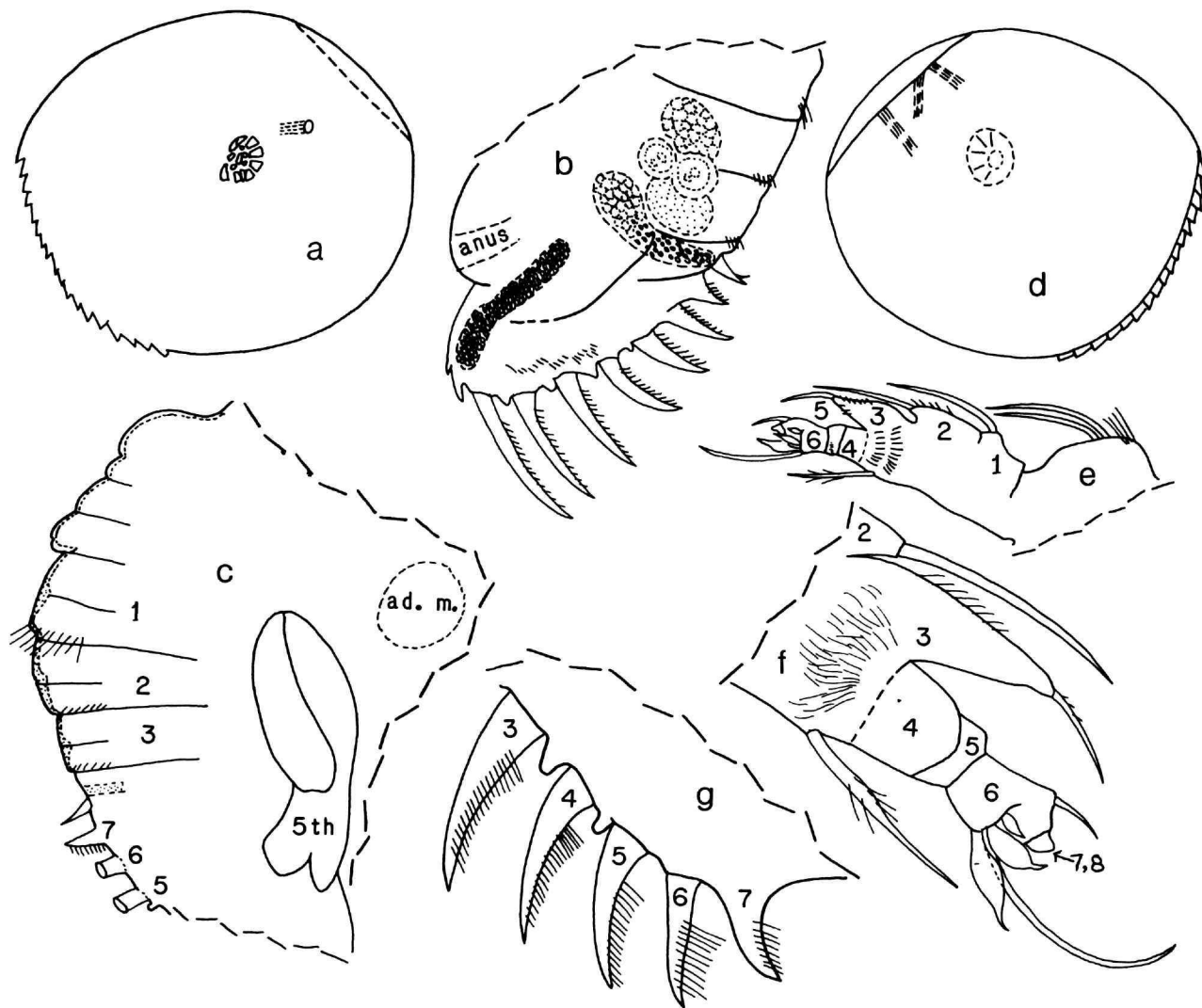


FIGURE 38.—*Metapolycope duplex*, new species, USNM 193325A, paratype, instar VI female, length 0.48 mm: a, complete specimen from left side, anterior to left; b, posterior of body from left side showing unpaired furcal process, left lamella of furca, location of anus, and unidentified internal organs. USNM 193327, paratype, instar VI female, length 0.46 mm: c, posterior of body from right side showing posterior segmentation (stippling indicates sclerotized margin, which thickens at midheight of segments), unpaired furcal process, claws 5–7 of right lamella of furca, locations of central adductor muscles (ad.m.), and right 5th limb. USNM 193323, paratype, instar VI male, length 0.45 mm: d, left valve from inside showing location of central adductor muscle attachments, and posterodorsal muscles extending from shell, anterior to right (narrow infold not shown); e, Bellonci organ (marginal hairs not shown) and right 1st antenna, medial view (bristles of joints 7 and 8 not shown); f, detail from e showing joints 2–8 of 1st antenna (bristles of joints 7 and 8 not shown); g, lateral view of claws 3–7 of left lamella of furca, anterior to left.

**Maxilla:** Precoxale endite with 8 spinous bristles. Basale with 3 distal, spinous, ventral bristles. Endopodite: 1st joint with 2 or 3 spinous ventral bristles. Coxale, 2nd and 3rd endopodial joints, and exopodite similar to those of adult female.

**Fifth Limb** (Figure 38c): Epipodite with 15 or 16 hirsute bristles; entire edge with minute indistinct spines. Coxale of USNM 193325A with 3 bristles (aberrant) on left limb and 11 on right. Basale with 8 bristles. Exopodite with 4 hirsute bristles forming medial row, and 5 terminal bristles (2 short, 3 long). Endopodite similar to that of adult female.

**Furca** (Figure 38b,c): Similar to that of adult female except for not having a small process between claws 5 and 6 in addition to none between claws 6 and 7.

**Bellonci Organ, Upper Lip:** Similar to those of adult female.

**Posterior of Body** (Figure 38c): Having 3 main segments similar to those of adult female. USNM 193327 having dorsal to 1st segment 2 short sutures suggesting additional segments, but these are without thickening of sclerotized edge at midheight as on main segments.

DESCRIPTION OF INSTAR VI MALE (Figure 38d–g).—Carapace similar in shape to that of adult male (Figure 38d).

**Ornamentation** (Figure 38d): Surface smooth. Anteroventral margin serrate with 17 triangular processes.

**Central Adductor Muscle Attachments** (Figure 38d): Similar type to those of adult male.

**Carapace Size:** USNM 193323, length 0.45 mm, height 0.41 mm.

**First Antenna** (Figure 38e,f): Joints 1–4 similar to those of adult male except for tip of dorsal process of 3rd joint without separate joint. Small 5th joint with few indistinct, minute, medial spines along distal edge. 6th joint with 1 short dorsal bristle and 4 ventral bristles: 1 long slender lateral, 3 short medial, all spatulate with bristle-like tip (inner spatulate bristle minute). 7th with 2 long bristles. 8th joint with 3 long bristles (adult male with only 2 bristles on 8th joint).

**Second Antenna:** Protopodite and exopodite similar to those of adult male. Endopodite 3-jointed: 1st joint elongate with 2 short dorsal bristles (1 with length about equal to width of joint, 1 (lateral) about half width of joint); 2nd joint short with 1 long, slender, dorsal bristle and 6 long ventral and terminal bristles; 3rd joint short with 3 long terminal bristles.

**Mandible:** Similar to that of adult male. Basale with 4 bristles on or near ventral margin.

**Maxilla:** Precoxale and coxale well defined. Endite of precoxale with 8 bristles. Coxale with 1 distal lateral bristle, 2 long distal bristles on ventral margin, and 2 endites (proximal endite with 4 bristles; distal endite with 3 bristles). Basale with 3 distal, spinous, ventral bristles. Exopodite undivided with 8 terminal bristles. Endopodite similar to that of adult male.

**Fifth Limb:** Epipodite with 16 hirsute bristles. Coxale with 10 short spinous bristles on or near dorsal margin. Basale with 8 bristles. Endopodite short, with 4 bristles similar to those of adult male. Exopodite with 3 hirsute bristles forming medial

proximal row and 4 spinous terminal bristles.

**Furca** (Figure 38g): Each lamella with 7 claws as on adult furca. Differs in absence of process between claws 5 and 6 as well as between claws 6 and 7. 7th claw without suture at base. Anterior of each lamella with 2 spinous distal processes as on adult. Single unpaired process following last claw.

**Bellonci Organ** (Figure 38e), **Upper Lip, Posterior of Body:** Similar to those of adult male.

**Genitalia:** None observed on USNM 193323 when dissected specimen was examined without cover slip with X20 objective; when specimen was placed under cover slip the genital area was obscured).

COMPARISONS.—The furca of *M. duplex* differs from those of previously described species of the genus in having 2 distal anterior processes instead of 1. The 1st antenna differs in having a well-defined lateral suture separating the 3rd and 4th joints. The mandible differs in having 2 instead of 3 dorsal bristles on the 1st endopodial joint. The carapace is smaller than in previously described species.

REPRODUCTION.—The unpaired male genitalia (including internal organs and external penis) are located on the left side of the body (Figure 32f,h). The copulatory appendage, which includes the penis, comprises an elongate sclerotized branch and a diaphanous hirsute shorter branch (Figure 32h,i). The point of termination of an internal tube (presumably through which sperm is passed) could not be ascertained (Figure 32h). No copulatory organ was observed in the instar VI male. The adult female bears 1–5 eggs forming a single row within the posterior part of the body with egg centers at about body centerline (Figure 31i). Eggs increase in size distally within the body (Figure 31i), but in USNM 193330, which has 3 eggs, the distal 2 eggs are of similar size. Apparently, in *M. duplex*, eggs are formed within the ovary either individually or in pairs with a maximum of about 5 eggs being in the ovary at one time. Because eggs deposited first are considerably larger than those deposited last, some time must elapse between their initial deposition. Probably, the instar I (metanauplius) leaves the ovary either individually or in pairs, and then some time must elapse to allow the remaining unextruded eggs to develop before their extrusion. No eggs observed in females in the collection had visibly developed into embryos. The method of egg production of *M. duplex* differs from that of *Polycope orbicularis* Sars, 1866, according to a female illustrated by Sars (1922, pl. 14), which contains at least 11 eggs of similar size.

ONTOGENY AND SEXUAL DIMORPHISM.—All 5 appendages are present on instar I, including the 5th limb which bears many bristles. The collection comprises both male and female instars V, VI, and adults, and 3 instars (I, III, IV) whose sex could not be determined; instar II is absent from the collection. The rate of addition of bristles to appendages in each succeeding instar is shown in Tables 14–18. The adult male is generally smaller than the adult female, but no difference in size between sexes was observed for earlier instars (Figure 39).

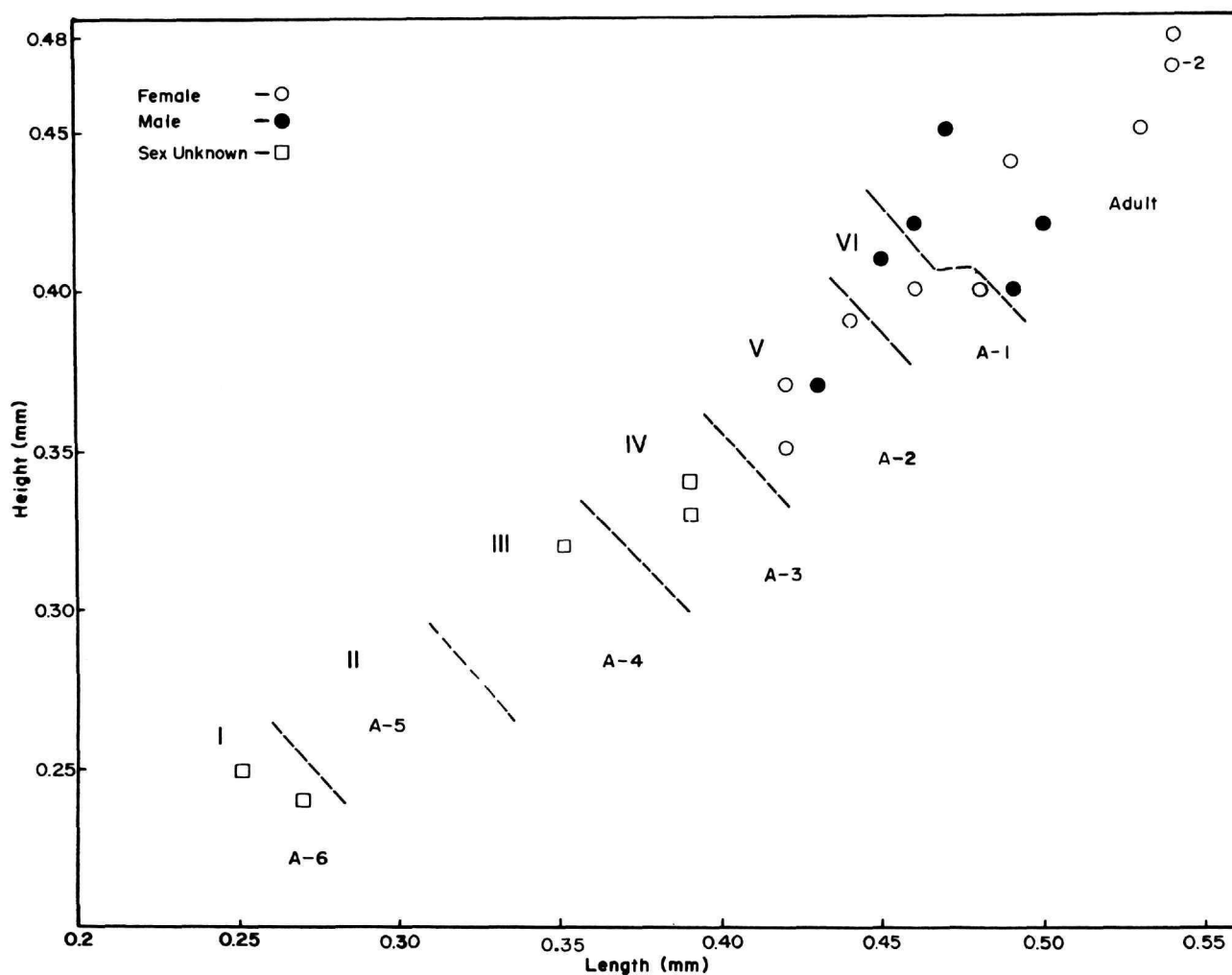


FIGURE 39.—*Metapolycope duplex*, new species, carapace length/height graph (-2 = 2 specimens).

**First Antenna** (Table 14): The sex may be determined on instar V by the number of ventral bristles on the 6th joint: 3 on the male and only 2 on the female (2 of the bristles of the male are very slightly broader in the proximal half than in normal uniformly tapering bristles). On the 6th joint of instar VI the male has 4 ventral bristles (3 of which are spatulate and have slender bristle-like tips (Figure 40a)) and the female has 2. The adult male also has 4 ventral bristles on the 6th joint (2 on the female) but 2 of them have a subterminal sucker (Figure 40b). The adult male antenna differs from both those of the adult female and male instar VI in having only 2 instead of 3 bristles on the 8th joint.

**Second Antenna** (Table 15): The exopodite of instar I differs from later instars in the collection in not having a bristle on the 1st joint. The protopodite and exopodite differ only in size for instars III to adult, and are similar in both sexes. The endopodite of the male instar VI differs from that of the female

instar VI in having 2 instead of either 0 or 1 bristle on the 1st joint, and 6 instead of 5 ventral bristles on the 2nd joint. The endopodite of the adult male differs from that of the adult female in having 9 instead of 6 bristles on the 2nd joint and in having a sclerotized hook-like clasping organ on the 3rd joint (Figure 33a,b).

**Mandible** (Table 16), **Maxilla** (Table 17), **Fifth Limb** (Table 18), **Bellonci Organ**, **Upper Lip**, **Posterior of Body**: No sexual dimorphism. The number of bristles on the mandible, maxilla, and 5th limb increases in later instars.

**Furca** (Table 19): No sexual dimorphism. The number of stout furcal claws on each lamella increases from 2 on instar I to 7 on instar VI and the adult, with 1 stout claw added on each succeeding instar (instar II is not represented in the collection but probably bears 3 stout claws and a triangular process (node) between claws 1 and 2). The adult differs from instar VI in having an additional triangular process (between

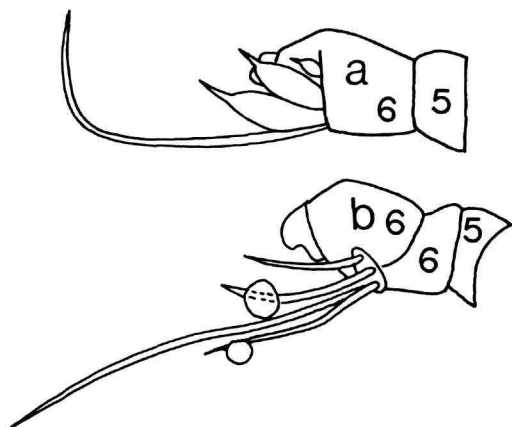


FIGURE 40.—*Metapolycope duplex*, new species, ontogenetic development of sensory bristles on 6th joint of 1st antennae of males: a, USNM 193323, paratype, instar VI male; b, USNM 193320, holotype, adult male.

TABLE 14.—Ontogenetic development of number of bristles of first antenna of *Metapolycope duplex*, new species (v = ventral; d = dorsal; nd = no data).

Growth stage & sex	1st joint	2nd joint	3rd joint (v/d)	6th joint (v/d)	7th joint	8th joint
I (sex?)	0	1	0/0	1/0	1	2
II			no data for this stage			
III (sex?)	0	1	0/0	2/0	1	2
IV (sex?)	1	1	1/1	2/1	1	2
V female	1	1	1/1	2/1	2	3
male	1	1	1/1	3/1	2	3
VI female	1	1	1/1	2/1	2	3
male	1	1	1/1	4/1	2	3
VII (adult)						
female	1	1	1/1	2/1	2	3
male	1	1	1/1	4/1	2	2

TABLE 15.—Ontogenetic development of number of bristles of endopodite of second antenna of *Metapolycope duplex*, new species (v = ventral; d = dorsal).

Growth stage & sex	1st joint	2nd joint (v/d)	3rd joint
I (sex?)	0	1/1	3
II	no data for this stage		
III (sex?)	0	2/1	3
IV (sex?)	0	3/1	3
V female	1	5/1	3
male	0	5/1	3
VI female	0-1	5/1	3
male	2	6/1	3
VII (adult)			
female	1	5/1	3
male	2	6/3	3+hook

TABLE 16.—Ontogenetic development of number of bristles of mandible of *Metapolycope duplex*, new species (v = ventral; d = dorsal).

Growth stage	Basale (v/d)	Endopodite joints		Exopodite
		1st (v/d)	2nd	
I	3/0	1/1	2	2
II	no data for this stage			
III	3/1	1/1	2	2
IV	3/1	3/1	2	2
V	4/1	2-3/1	2	2
VI	4/1	3-4/3	2	2
VII (adult)	4/1	3-4/3	2	2

TABLE 17.—Ontogenetic development of number of bristles of maxilla of *Metapolycope duplex*, new species (v = ventral; d = dorsal).

Growth stage	Precoxale	Coxale	Basale	Endopodial joints			Exopodite
				1st	2nd (v/d)	3rd	
I	5	7	2	0	1/1	3	4
II	no data for this stage						
III	5	8-9	1-2	1	1/1	3	4
IV	7	8-10	2	1	2/1	4	6
V	6-8	9-10	2	2	3/1	4	7-8
VI	8	10	3	2-3	4/1	4	8
VII (adult)	9	10	2-3	2	4/1	4	8

TABLE 18.—Ontogenetic development of number of bristles of fifth limb of *Metapolycope duplex*, new species.

Growth stage	Epipodite	Coxale	Basale	Endopodite	Exopodite
I	9	3-4	3	2	3
II	no data for this stage				
III	11	7	3	3	3
IV	13	9	6	4	5
V	15	9-10	9	4-5	6-7
VI	15-16	10-11	8	4	7-9
VII (adult)	16	9-10	8-9	3-4	8

claws 5 and 6). In the sequence between instars III and the adult a triangular process is added between claws on each succeeding instar.

**Male Copulatory Organ:** This was not observed on the instar VI male. On the adult male it comprises 2 branches, one of which is diaphanous and hirsute (Figure 32*t*).

**RECOGNITION OF THE FIRST INSTAR OF CLADOCOPINA.**—No Cladocopa have been reported with eggs or embryos within the shell. Therefore, it is likely that the eggs are deposited directly on the substrate. However, the time of retention within the shell may be so short that the chance of collecting a specimen with eggs or embryos inside the shell may be minimal. Within the Myodocopa (Myodocopina, Halocypridina, Cladocopina) additional claws are added to the furca with each succeeding molt. In the present collection of *M. duplex* the youngest specimens have 2 claws on the furca. Hartmann (1955:246, 1968:536) also reported a juvenile Cladocopa with only 2 claws. Müller (1894:185) and Skogsberg (1920:95) observed that the first free-living stage of cypridinids have 2 stout claws followed by weak spine-like claws. Claus (1893:286) and Skogsberg (1920:95) observed the same for the first stage of halocyprids. If it also holds for cladocopids, juvenile cladocopids with fewer than 2 furcal claws do not exist, and the first instar has at least 2 furcal claws. Therefore, it seems reasonable to accept that specimens with only 2 claws are first instars. Therefore, the A-6 cladocopid discussed by Hartmann (1968:536) as well as the A-6 specimens of *M. duplex* are assumed herein to be first instars (instar I). The numbers of furcal claws reported on first instars of some Myodocopida are listed in Table 20.

**NUMBER OF GROWTH STAGES** (Figure 39).—It is assumed herein that the youngest stage of *M. duplex* in the collection, which bears 2 claws on the furca, is instar I. It is believed that instar II, which would be expected to have 3 furcal claws is missing from the collection. Instars III, IV, V, VI, and the adult are in the collection, and have 4, 5, 6, 7, and 7, claws, respectively. Thus, it is concluded that *M. duplex* has a total of 7 instars of which 6 are juvenile stages. Only the A-1 and adult stages are known for *M. hartmanni*, and their furcae have 6 and 7 claws, respectively. If instar I of that species has 2 claws and a claw is added at each stage, then *M. hartmanni*

would have only 6 growth stages of which 5 would be juvenile stages.

The number of furcal claws of adult cladocopids ranges from 4 to 7 (Hartmann, 1955:208). *Polycope japonica* Hiruta, 1983, has on each lamella of the furca 4 stout claws followed by 2 spines [small claws] (Hiruta, 1983:8). If instar I of cladocopids has 2 claws on the furca, and an additional claw is added at each succeeding growth stage from instar I to instar VI, and an additional claw may, or may not, be added in the adult, then the number of growth stages could vary from about 3 to 7. Data on juvenile stages is known from only a few species, all having 7 furcal claws on the adult (Hartmann, 1955:245, 1968:536; Kornicker and van Morkhoven, 1976:16; and herein), and it seems safe to conclude that species with 7 furcal claws have either 6 or 7 growth stages (based on assumption that instar I has 2 claws and a claw is added at growth stages II to V). Following the description of the new species *Polycopissa anax* (herein), it is estimated that that species, which has 6 furcal claws plus a bristle on each lamella of the adult, has a total of 6 growth stages. Conclusions or estimates concerning the number of growth stages for species with fewer than 6 furcal claws in the adult must await additional studies of juveniles of those species.

**SHELL SIZE AND WATER DEPTH.**—The length of *M. duplex* is less than other known species of the genus collected at greater depths in the open sea, possibly indicating that *M. duplex* is restricted to caves (Table 21), but additional comparisons of other ostracode species with their relatives in the open sea are needed before generalizations are acceptable.

#### Subfamily POLYCOPIINAE Sars, 1866

**COMPOSITION.**—The Polycopinae comprise 14 living genera. Two genera were collected in Bermudan caves: *Micropolycope* Chavtur, 1979, and *Polycopissa* Chavtur, 1979.

TABLE 19.—Ontogenetic development of furca of *Metapolycope duplex*, new species ("Length" refers to the carapace; X = furca claw; x = node; nd = no data).

Growth stage & sex	Length (mm)	Order of claws and nodes <sup>1</sup>
I (sex?)	0.25-0.27	X x X x
II (nd)	(nd)	X x X X (predicted)
III (sex?)	0.35	X x X X X
IV (sex?)	0.39	X x X x X X X
V female	0.42-0.44	X x X x X x X X X
IV male	0.43	X x X x X x X X X
VI female	0.46-0.48	X x X x X x X x X X X
VI male	0.45	X x X x X x X x X X X
VII (adult)		
female	0.49-0.54	X x X x X x X x X x X X
male	0.46-0.50	X x X x X x X x X x X X

<sup>1</sup>Beginning with distalmost claw on each lamella.



TABLE 20.—Patterns of furcal claws on the first instars of species of *Myodocopa* for which this character is known.

Species	Claws	Source
<b>Myodocopina</b>		
<b>CYPRIDINIDAE</b>		
<i>Doloria pectinata</i>	2 stout + 4 weak	Skogsberg, 1920:14, fig. 37
<i>Gigantocypris agassizi</i>	2 stout + 6 slender	Poulsen, 1962:45
<i>Gigantocypris muelleri</i>	2 stout + 5 or 6 flat, thin	Poulsen, 1962:72
<i>Gigantocypris danae</i>	2 stout + 5 juvenile type	Poulsen, 1962:99
<i>Macrocypridina castanea</i>	2 stout claws + 3 flat spines	Poulsen, 1962:130
<i>Skogsbergia lernerii</i>	5	Cohen, 1983, fig. 9a
<i>Vargula hilgendorfii</i>	4 or 5	Hiruta, 1980:149
<b>PHILOMEDIDAE</b>		
<i>Euphilomedes nipponica</i>	2 + 1 claw-like process	Hiruta, 1980:157
<i>Philomedes brenda</i>	2 stout + 2 weak	Skogsberg, 1920, fig. 69:21
<i>Pseudophilomedes kyllix</i>	2 stout + 3 processes	Herein
<b>SARSIELLIDAE</b>		
<i>Eusarsiella japonica</i>	2 + 3 protuberances	Hiruta, 1977:54
<i>Eusarsiella misakiensis</i>	3	Hiruta, 1978:274
<i>Eusarsiella styx</i>	3	Herein
<i>Spinacopia sandersi</i>	2 + prong	Kornicker, 1969a:29
<b>CYLINDROLEBERIDIDAE</b>		
<i>Ambroleberis americana</i>	4	Kornicker, 1981b:179
<i>Asteropella monambon</i>	2 stout + 3 small	Kornicker, 1981b:229
<i>Asteropteron fuscum</i>	3	Hiruta, 1979a:23
<i>Bathyleberis yamadai</i>	4 or 5 + hairy process	Hiruta, 1979b:111,
<i>Cycloleberis christei</i>	3	Kornicker, 1981b:89
<i>Lewroleberis sharpei</i>	3 or 4	Kornicker, 1981b:111
<i>Parasterope muelleri</i>	4 + bristle	Poulsen, 1965:377
<i>Pteromeniscus intesi</i> <sup>1</sup>	3 or 4	Kornicker and Caraion, 1974:65, fig. 34m; Kornicker, 1981b:334
<i>Tetraleberis species 1</i>	4	Kornicker, 1981b:166
<b>Halocypridina</b>		
<b>HALOCYPRIDIDAE</b>		
<i>Euconchoecia bifurcata pax</i>	2 + process	Kornicker and Iliffe, in press
<b>THAUMATOCYPRIDIDAE</b>		
<i>Thaumatoconcha radiata</i>	2 + small process	Kornicker and Sohn, 1976, fig. 34b
<b>Cladocopina</b>		
<b>POLYCOPIIDAE</b>		
<i>Metapolycope duplex</i>	2 + 2 processes	Herein
<i>Polycopissa anax</i>	2 + 2 processes	Herein
<i>Polycope</i> sp.	2 + 1 process	Hartmann, 1955:246

<sup>1</sup>Kornicker and Caraion (1974:59) listed this specimen as "instar II?". Because of the absence of filaments on the sensory bristle of the 5th joint and on the b- and c-bristles of the 7th joint, and e-, f-, and g-bristles of the 8th joints, it is interpreted herein as instar I.

TABLE 21.—Female carapace lengths (mm) of known species of *Metapolycope* and depths of water (m) where collected.

Species	Carapace length	Locality	Water depth	Source
<i>M. duplex</i>	0.49–0.54	Bermuda caves	shallow	Herein
<i>M. kornickeri</i>	0.75–0.80	Bering Sea	60	Chavtur, 1979
<i>M. hartmanni</i>	1.00–1.07	South Atlantic	587–1007	Kornicker and van Morkhoven, 1976
<i>M. microthrix</i>	0.86–0.95	South Atlantic	1964–2191	Kornicker and van Morkhoven, 1976
<i>M. echinata</i>	0.75–0.78	Kuril-Kamchatka Trench	5240	Chavtur, 1981b

REMARKS.—In the classification of Polycopinae proposed by Chavtur (1981a, 1983), which is used herein, the morphology of the exopodite of the mandible is critical. On an exopodite interpreted to have 2 joints the 2nd joint is

probably a modified bristle, and a decision as to whether an exopodite is 2-jointed with 1 bristle, or 1-jointed with 2 bristles, can be subjective. The choice plays a major role in deciding to which genus a species is referred.

#### Key to the Genera of Polycopinae

(adapted from Chavtur, 1981a:60, 1983:95)

1. Dorsal margin of 2nd joint of 1st antenna with large process . . . *Parapolycopissa*  
Dorsal margin of 2nd joint of 1st antenna without large process . . . . . 2
2. Exopodite of maxilla shorter than basale; furcal claws short and broad; copulatory organ flagellate . . . . . *Parapolycope*  
Exopodite of maxilla longer than basale; furcal claws slender; copulatory organ not flagellate . . . . . 3
3. Exopodite of mandible with 2 joints with or without bristles . . . . . 4  
Exopodite of mandible represented by bristle, or by 1 joint with 1–3 bristles . 11
4. Distal joint of mandibular exopodite reduced in form of tubercle . *Hexapolycope*  
Distal joint of mandibular exopodite well developed, tip either narrow or funnel-shaped . . . . . 5
5. Carapace with rostrum; endopodite of male 2nd antenna with dorsal process . . . . . *Pontopolycope*  
Carapace without rostrum (anterodorsal tooth may be in place of rostrum); endopodite of male 2nd antenna with or without dorsal process . . . . . 6
6. Bellonci organ represented by 2 bristles . . . . . 7  
Bellonci organ represented by 1 bristle (which may be divided distally into 2 bristles with common base) . . . . . 9
7. Carapace length less than 0.4 mm; basale of mandible with 3 ventral bristles, distal joint of exopodite stout and conical . . . . . *Micropolycope*  
Carapace length more than 0.4 mm; basale of mandible with 4 ventral and 1 distolateral bristles, distal joint of exopodite not stout and conical . . . . . 8
8. Exopodite of mandible without bristle; endopodite of male 2nd antenna with hook-shaped process . . . . . *Archypolycope*  
Exopodite of mandible with 1 bristle; endopodite of male 2nd antenna without hook-shaped process . . . . . *Polycope*
9. Bellonci organ not distally divided . . . . . *Eupolycope*  
Bellonci organ distally divided . . . . . 10
10. Bellonci organ divided at midlength; endopodite of male 2nd antenna with hook-shaped process and dorsal process . . . . . *Polycopetta*  
Bellonci organ divided near its base, endopodite of male 2nd antenna without hook-shaped process and dorsal process . . . . . *Pseudopolycope*

11. Exopodite of mandible without single joint but represented by 1 bristle . . . . . *Polycopiella*  
 Exopodite of mandible with single joint with 1–3 bristles . . . . . 12
12. Exopodite of mandible with 1 bristle . . . . . *Orthopolycope*  
 Exopodite of mandible with 2 or 3 bristles . . . . . 13
13. Exopodite of mandible with 2 bristles . . . . . *Polycopissa*  
 Exopodite of mandible with 3 bristles . . . . . *Polycopinna*

### *Micropolycope* Chavtur, 1979

TYPE SPECIES.—*Polycope angulata* Chavtur, 1977, by monotypy.

COMPOSITION.—The genus comprises 8 species plus 1 in open nomenclature: *M. angulata* (Chavtur, 1977), *M. paramushiri* (Chavtur, 1977), *M. crassidentata* (Chavtur, 1977), *M. triangularis* Chavtur, 1983, *M. multidentata* Chavtur, 1983, *M. aliena* Chavtur, 1984, *Micropolycope* sp. (Chavtur, 1983), *M. eurax*, new species, and *M. styx*, new species. Chavtur (1981a:56) stated that probably *Polycope obtusa* Hartmann (1954a:96), and *P. duplidentata* Hartmann (1959:204), should be referred to *Micropolycope*; we have no opinion on *P. obtusa*, and concur on *P. duplidentata*, but are taking no taxonomic action herein.

TERMINOLOGY OF APPENDAGES.—The 1st antennae of species of *Micropolycope* have only 2 sutures forming 3 segments (1st and 3rd segments short, middle segment very long). In the description of *M. eurax* the middle segment is interpreted to be homologous to segments 2–5 of *Metapolycope duplex*, and the end segment of *M. eurax* is interpreted to be homologous to segments 6–8 of *M. duplex*. In the maxillae of *Polycope setigera* Skogsberg (1920, fig. 153:6) and *M. duplex* (herein), a muscle extends from the exopodite to the proximal dorsal corner of the basale. That muscle is used to locate the proximal end of the basale of *M. eurax* (herein); however, in order to conform with the interpretation of Chavtur (1981a:56), the proximal end of the basale is assumed to be closer to the exopodite in the key to the Polycopinae presented herein. Thus, the exopodite of *Micropolycope* is longer than the basale when using the key. The coxale endite may be located on the proximal half of the medial side of the basale of *M. eurax*, but this could not be determined with certainty. Chavtur (1981a:57) interpreted what is described herein as a stout hirsute bristle on the mandibular exopodite to be a conical 2nd joint. This bristle is referred to as the 2nd joint in the key to the genera of Polycopinae presented herein, in order for the key to be more easily related to the work of Chavtur.

### *Micropolycope eurax*, new species

FIGURES 41–43

*Polycope* spp.—Maddocks and Iliffe, 1986:73 [part].

ETYMOLOGY.—From the Greek *eurax* (on one side, sideways).

HOLOTYPE.—USNM 193349, 1 adult female, complete specimen in alcohol.

TYPE LOCALITY.—Bermuda: Deep Blue Cave, entrance pool, 23 Mar 1982.

MATERIAL.—*Deep Blue Cave* (entrance pool), 23 Mar 1982: USNM 193349, 1 adult female (holotype), complete specimen in alcohol; USNM 193347, 1 dissected adult female on slide with cover slip; USNM 193350, adult dissected female on slide with cover slip; USNM 193348, 1 adult female with left shell and left 1st antenna removed, mounted on 2 slides with cover slips. *Sailor's Choice Cave*, 6 Jul 1982: USNM 193358, 1 adult female in alcohol + 1 late instar in alcohol (length 0.14 mm, height 0.12 mm).

DISTRIBUTION (Figure 41).—Bermuda: Deep Blue Cave (entrance pool), 23 Mar 1982. *Sailor's Choice Cave*, 6 Jul 1982.

DESCRIPTION OF ADULT FEMALE (Figures 42, 43).—Shell translucent, colorless. Carapace oval in lateral view (Figure 42a, 43a), but slight angle formed at posteroventral end of straight hinge-line, and very slight indentation along anterior margin (Figure 43c).

Ornamentation: Surface smooth without visible ornamentation. (Although shell margins are smooth a serrate lamellar prolongation of the selvage along the anteroventral margin could be misinterpreted to be part of the shell proper).

Selvage (Figure 43a–c): Each valve with broad lamellar prolongation along margins except in vicinity of hinge; prolongation fringed and distinctly segmented along anteroventral margin, fringed only along posteroventral and posterior margins.

Central Adductor Muscle Attachments (Figure 42a): Comprising 6 or 7 small scars forming oval.

Carapace Size: USNM 193347, 193348, 193349, 193350: length 0.19 mm, height 0.18 mm; USNM 193358, length 0.18 mm, height 0.16 mm.

First Antenna (Figures 42b,f, 43d–f): 1st joint separated from 2nd by oblique suture on medial side only; joint bare or with few terminal spines on dorsal margin. Joints 2–5 fused: inferred 2nd joint with dorsal spines and terminal dorsal bristle on distinct projection; inferred 3rd joint with dorsal and medial spines; inferred 4th joint bare; inferred 5th joint separated from 4th by indentation of dorsal margin, with several ventral hairs. Joints 6–8 fused, separated from 5th joint by distinct suture, with 5 terminal bristles.

Second Antenna (Figures 42b, 43d,g): Protopodite bare. Exopodite with 8 joints: joints 1–7 each with long bristle; joint 8 with 2 bristles (1 small, 1 shorter than bristles of other joints).

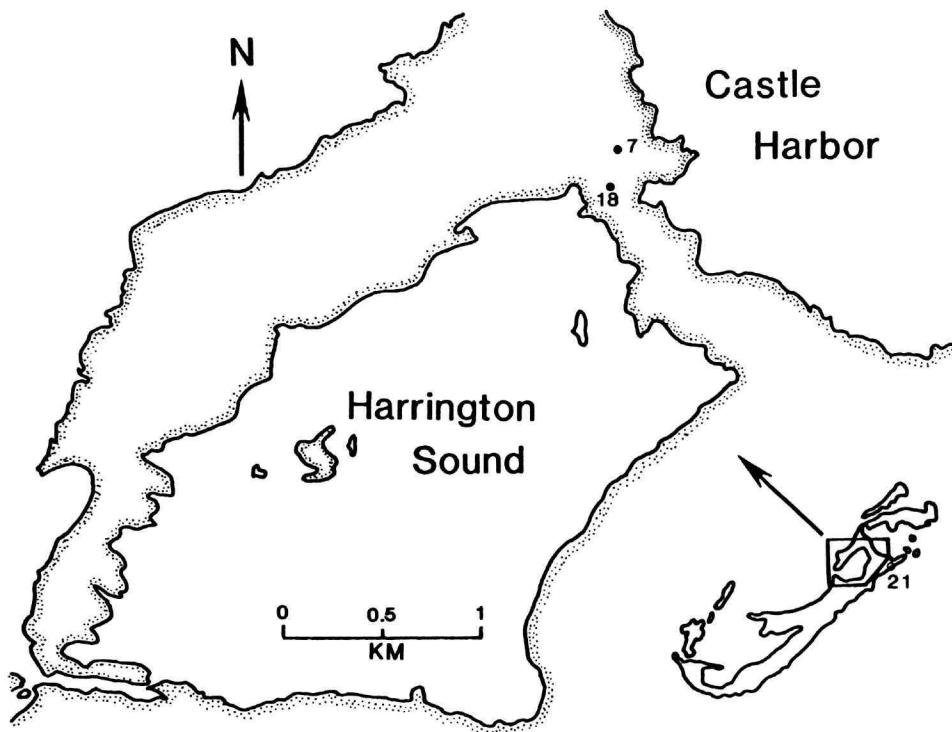


FIGURE 41.—Distribution of caves from which *Micropolycope eurax*, new species (solid circle), and *M. styx*, new species (open circle), were collected (7 = Deep Blue Cave; 18 = Sailor's Choice Cave; 21 = Tucker's Town Cave).

Endopodite 3-jointed: 1st joint elongate, bare; 2nd joint with small dorsal bristle and 5 long ventral bristles; small 3rd joint with 4 bristles (1 shorter than others). (Exopodite could be interpreted as having 9 joints, with 8th joint having bristle shorter than that on joints 1–7, and 9th joint with only 1 small bristle.)

**Mandible** (Figures 42b, 43h): Coxale endite well developed, tip obscure. Basale with 3 hirsute ventral bristles. Exopodite pear-shaped with 2 terminal bristles (1 stout, 1 slender). Endopodite: 1st joint with 2 long distal dorsal bristles and 2 shorter hirsute ventral bristles; end joint with 2 spinous bristles (dorsal somewhat claw-like, with angular bends).

**Maxilla** (Figures 42c, 43d,i): Precoxale and coxale endites obscure on whole mount and bristles broken off on dissected specimens (some bristles missing on illustrated limbs). Muscles extending from proximal dorsal hump of basale to exopodite (Figures 42c, 43i). Basale: proximal margin indicated by base of muscle attaching to dorsal hump and extending into exopodite; distal margin indicated by slight indentation on ventral margin coinciding with location of a stout bristle (this bristle broken off on all dissected specimens but observed on 1 limb of whole mount); a suture present proximal to exopodite on only medial side of limb. Endopodite:

1st and 2nd joints fused: 1st joint with distal ventral bristle; 2nd joint with 2 terminal ventral bristles (stouter of these with 4 or 5 long proximal dorsal hairs, about 6 stout, distal, widely spaced, ventral spines, and numerous, slender, distal, dorsal spines), and 1 slender dorsal bristle; end joint with 3 long bristles. Exopodite with distal dorsal hairs and 6 long terminal bristles.

**Fifth Limb** (Figures 42d, 43d): Epipodite with about 8 bristles (bristles very indistinct). Basale hirsute distally but no bristles observed. Exopodite with 4 terminal bristles. Endopodite with 1 stout bristle with marginal hairs.

**Furca** (Figures 42e,g, 43d): Each lamella with anterior terminal process bearing marginal spines and 7 claws with slender teeth along posterior margins; triangular process between all claws except claws 6 and 7. Unpaired process following lamellae.

**Bellonci Organ** (Figures 42b, 43d): 2 stout hirsute bristles.

**Posterior of Body** (Figures 42e,g, 43d): Weakly segmented; proximal segment with long spines forming row.

**Eggs**: Holotype and paratypes with small closely packed globules forming poorly defined eggs in posterior of body.

**COMPARISONS**.—The appendages of *M. eurax* resemble closely those of *M. angulata*, but the shell of that species has surface sculpture not observed on *M. eurax*. The central

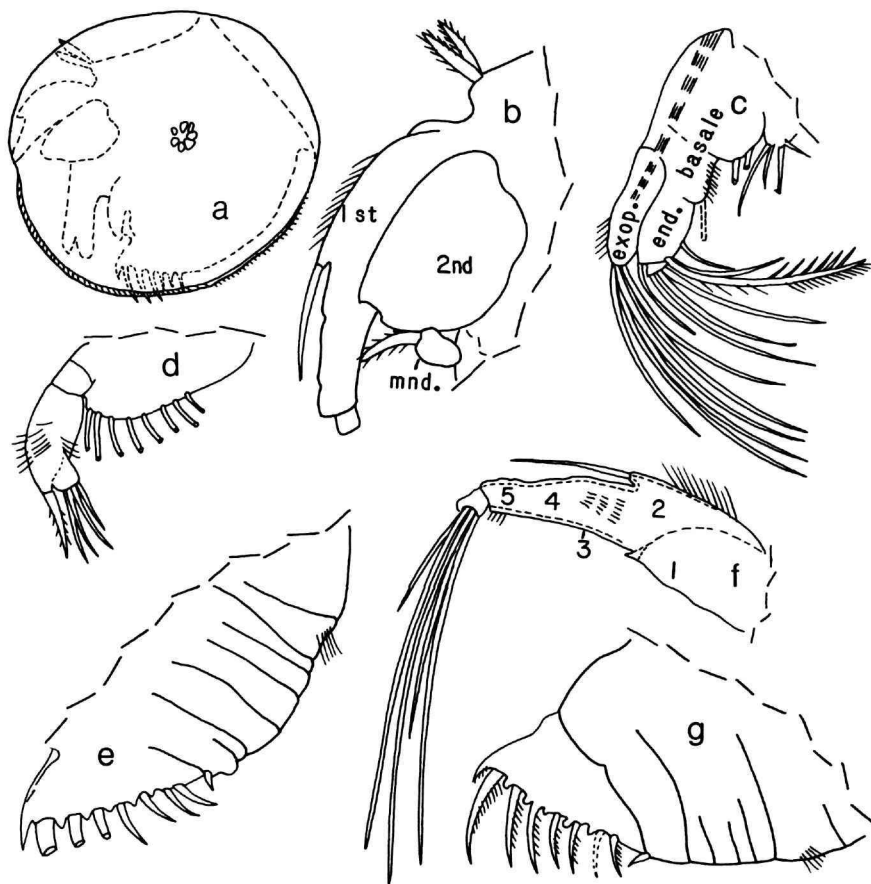


FIGURE 42.—*Micropolycope eurax*, new species. USNM 193349, holotype, adult female, length 0.19 mm: *a*, complete specimen from left side showing central adductor muscle attachments and outline of appendages within shell. USNM 193348, paratype, adult female, length 0.19 mm: *b*, anterior of body showing 2 bristles of Bellonci organ, left 1st antenna (only bristle of 2nd joint shown), protopodite of left 2nd antenna, and exopodite of left mandible (mnd.); *c*, left maxilla, lateral view (exop. = exopodite, end. = endopodite); *d*, left 5th limb, lateral view; *e*, posterior of body showing left furcal lamella, unpaired furcal process, and posterior segmentation. USNM 193350, paratype, adult female, length 0.19 mm: *f*, right 1st antenna, medial view; *g*, posterior of body showing left lamella of furca, unpaired furcal process, and posterior segmentation.

adductor muscle attachment scars of *M. eurax* comprise 6 or 7 discrete scars in an oval arrangement; whereas, those of *M. angulata* comprise 3 closely located patches. The basale of the 5th limb of *M. angulata* bears 3 bristles not observed on *M. eurax*.

#### *Micropolycope styx*, new species

FIGURES 41, 44

*Polycope* spp.—Maddocks and Iliffe, 1986:73 [part].

ETYMOLOGY.—From the Latin and Greek *Styx* (river in the nether world).

HOLOTYPE.—USNM 193359, 1 adult female on slide.

TYPE LOCALITY.—Bermuda: Tucker's Town Cave, 16–18 m, 16 Mar 1984.

MATERIAL.—Tucker's Town Cave, 16 Mar 1984: USNM 193359, 1 adult female on slide (holotype).

DISTRIBUTION (Figure 41).—Bermuda: collected only in Tucker's Town Cave (type locality), 16 Mar 1984.

DESCRIPTION OF ADULT FEMALE (Figure 44).—Carapace globose with slight but distinct anteroventral concavity (Figure 44a–c).

Ornamentation (Figure 44d–f): Surface with indistinct reticulations (Figure 44d,f), and minute, sparsely distributed, indistinct spines; edge of valve viewed under high magnification ( $\times 100$  objective,  $\times 15$  ocular) minutely crenulate (Figure 44f).

Selvage (Figure 44e): Each valve with broad lamellar prolongation along margins except in vicinity of hinge; prolongation along anteroventral and ventral valve margins with indistinct fringe; inner surface of anterior, anteroventral,

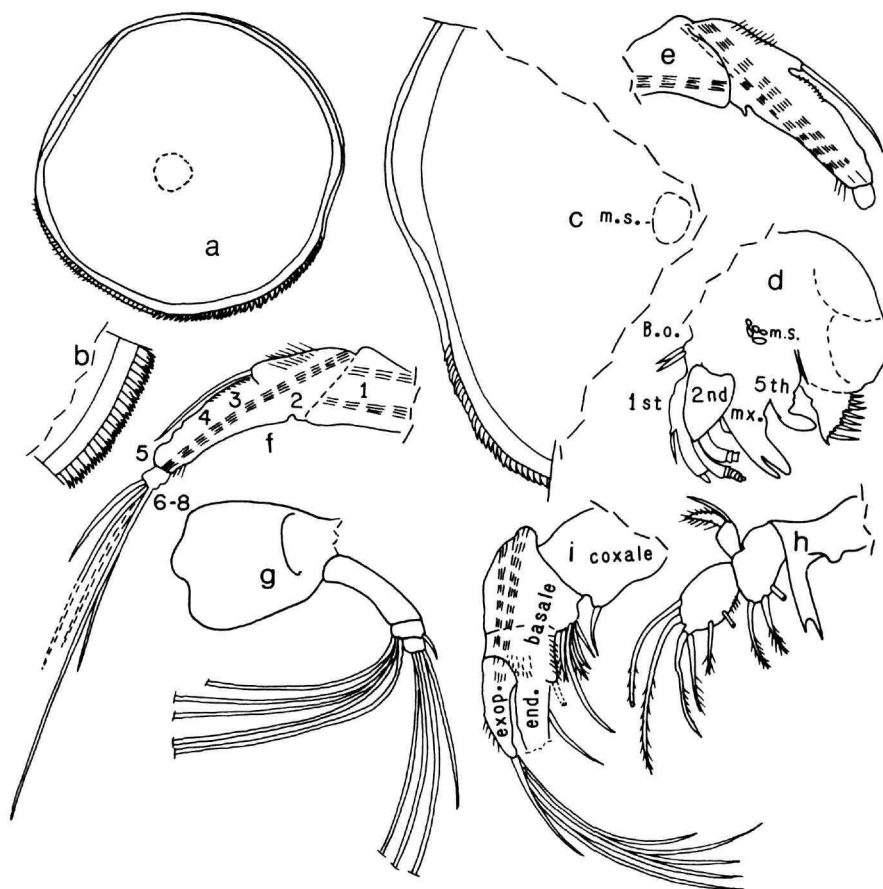


FIGURE 43.—*Micropolycope eurax*, new species, USNM 193347, paratype, adult female, length 0.19 mm: *a*, inside view of left valve under cover slip (dashed circle represents location of central adductor muscle attachments); *b*, detail of anteroventral selvage, from *a*; *c*, inside view of anterior of right valve under cover slip (dashed circle represents location of central adductor muscle attachments); *d*, outline of body showing Bellonci organ (B.O.), maxilla (mx.), and location of appendages and central adductor muscles (m.s.); *e*, right 1st antenna, lateral view, internal muscles (dashed lines) (only bristle of 2nd joint shown); *f*, left 1st antenna showing joints 1-8, lateral view, internal muscles (dashed lines); *g*, right 2nd antenna, lateral view (exopodite not shown); *h*, right mandible, medial view; *i*, maxilla (exop. = exopodite; end. = endopodite).

and ventral prolongation with triangular spikes (could not determine whether these are folds in selvage or part of valve edge).

**Central Adductor Muscle Attachments** (Figure 44a): Unclear, possible 4 minute scars forming oval.

**Carapace Size:** Holotype, length 0.103 mm, height 0.098 mm.

**First Antenna** (Figure 44g): 1st joint separated from 2nd by oblique suture, with few indistinct distal dorsal spines. Joints 2-5 fused: inferred 2nd joint with short, terminal, dorsal bristle; inferred 3rd joint with indistinct dorsal spines; inferred 4th and 5th joints bare. Joints 6-8 fused, with 5 terminal bristles.

**Second Antenna** (Figure 44h,i): Protopodite bare. Exopodite with 8 joints: joints 1-8 each with long bristle; joint 8

with 2 bristles. Endopodite 3-jointed: 1st joint elongate, bare; 2nd joint triangular, projecting ventrally, bristles obscure (at least 3 apparent); 3rd joint small, bristles obscure (at least 3 apparent).

**Mandible** (Figure 44j): Coxale endite, basale, and exopodite obscure. Endopodite: 1st joint with 2 distal dorsal bristles and 1 (possibly 2) ventral bristles; end joint with 2 bristles (dorsal bristle somewhat claw-like).

**Maxilla** (Figure 44k): Obscure, not all bristles shown on illustrated limb.

**Fifth Limb:** Obscure.

**Furca** (Figure 44l): Each lamella with small anterior terminal process and 7 claws; small triangular process between all claws except claws 6 and 7. Unpaired process following lamellae.

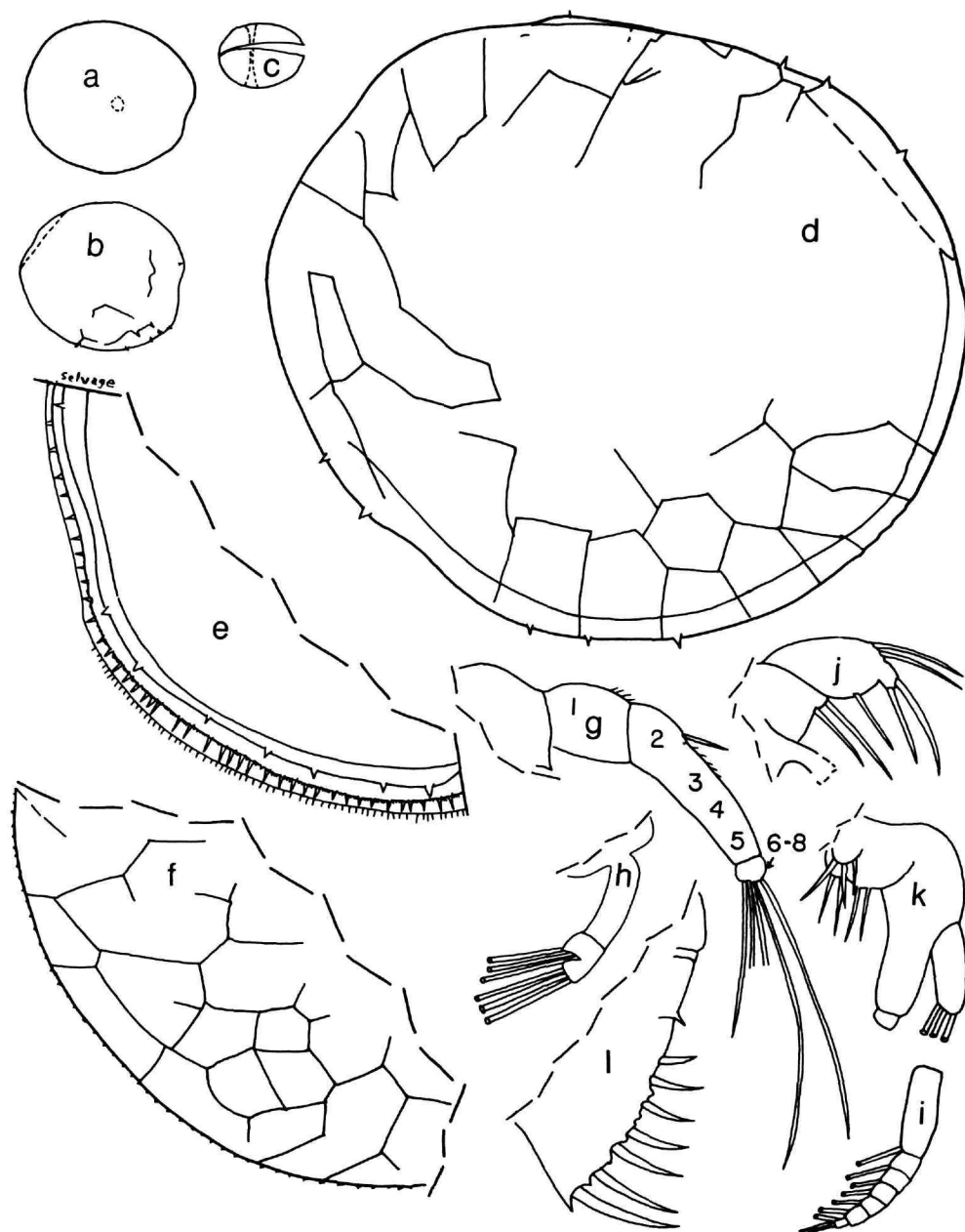


FIGURE 44.—*Micropolycope styx*, new species, USNM 193359, holotype, adult female, length 0.103 mm: *a*, complete specimen from right side showing location of central adductor muscle attachments (dashed circle); *b*, same as *a* showing dashed hinge line and few spines and reticulations on shell surface; *c*, ventral view of complete specimen showing location of central adductor muscles (dashed), anterior of specimen to right; *d*, inside view of right valve under glass showing thin surface reticulations as seen through shell; *e*, inside view of anterior and anteroventral part of right valve under cover slip showing inner edge of selvage, inner row of surface spines as seen through shell, middle row of spines on finely crenulate valve edge (spines indistinct and may actually be folds in lamellar prolongation of selvage), and fringe along outer edge of lamellar prolongation of selvage (outer edge of shell finely crenulate); *f*, inside view of posteroventral corner of left valve showing thin surface reticulations as seen through shell and crenulations along valve edge; *g*, 1st antenna; *h*, endopodite of 2nd antenna; *i*, exopodite of 2nd antenna; *j*, mandible; *k*, 5th limb (not all bristles shown); *l*, posterior of body showing left lamella of furca and unpaired furcal process.

*Bellonci Organ*: Not seen.

*Posterior of Body*: Weakly segmented.

REMARKS.—Only 1 specimen of this species is in the collection. Because of its small size, the valves were separated and mounted with the inside upward on a slide. One of the 1st and 2nd antennae, one mandible and the Bellonci organ were lost; remaining appendages are inside the valves, and could not be seen as clearly as they would have been if mounted individually. The generic assignment is tenuous, but the species can be reassigned if necessary, when the Bellonci organ and undescribed appendages become known. It has been referred to *Micropolycope* herein because of its small size and the morphology of the 1st antenna. The presence of 7 claws on the furcal lamella indicates that the specimen is an adult. No eggs were present, but the absence of male characters indicates that the specimen is a female.

COMPARISONS.—*Micropolycope styx* is smaller than previously described living Polycopidae. In addition to its small size, *M. styx* differs from other species reported from Bermudan Caves herein in having reticulations on the surface of the carapace.

### *Polycopissa* Chavtur, 1979

TYPE SPECIES.—*Polycopissa japonica* Chavtur (1979:97), by monotypy.

COMPOSITION.—The genus comprises 2 species: *P. japonica* Chavtur, 1979, and *Polycopissa anax*, new species. Chavtur (1981a:57) stated that possibly *Polycope limbata* Hartmann (1954a:87), *P. levis* Hartmann (1954b:176), and *P. sievingli* Hartmann (1958:229), also belong here; we concur but take no taxonomic action here.

EMENDED DIAGNOSIS.—Carapace with 2 or more small anterior teeth, and 3–8 central adductor muscle attachment scars. 1st antenna with 3 or 4 joints separated by sutures; 1st and 2nd joints with dorsal spines or hairs; penultimate joint of adult male with 2 spatulate bristles (always?). Endopodite of male 2nd antenna with sclerotized elongate lateral process on 1st joint and short sclerotized dorsal process on 2nd joint (always?). Mandible with 3 or 4 ventral bristles on basale; exopodite with single joint bearing 2 terminal spinous bristles, anterior bristle longer and better defined. Maxilla with exopodite reaching past distal end of basale. Furca with 6 or 7 slender claws (each lamella of *P. anax* with single bristle following last (6th) claw); 1–3 unpaired bristles on body just proximal to furca; triangular process between adjacent claws. Bellonci organ comprising 2 hirsute bristles. Male copulatory appendage without flagellum.

### *Polycopissa anax*, new species

FIGURES 45–49

*Polycope* spp.—Maddocks and Iliffe, 1986:73 [part].

ETYMOLOGY.—From the Greek *anax* (lord, master, king).

HOLOTYPE.—USNM 193366, 1 adult male in vial (not illustrated).

TYPE LOCALITY.—Bermuda: Roadside Cave, 0–1.5 m, 27 Aug 1982.

MATERIAL.—*Bee Pit Cave*, 23 Jan 1984: USNM 193352, 1 adult male on slide. *Christie's Cave*, 24 Nov 1982: USNM 193364A, 1 instar V female in vial; USNM 193364B, 2 adult females in vial; USNM 193364C, 1 instar V female on slide. *Fern Sink Cave*, 24 Jul 1984: USNM 193365A, 1 adult female on slide; USNM 193365B, 1 adult male in vial; USNM 193365C, 2 adult females in vial. *Roadside Cave*, 27 Aug 1982: USNM 193361, 19 specimens in vial; USNM 193366, 1 adult male in vial (holotype); 12 Nov 1982: USNM 193351, 1 adult male on slide; USNM 193354, 1 adult male on slide; USNM 193355A,B, 2 instar I on slides; USNM 193356A,B, 2 instar III on slides; USNM 193357, 1 instar II on slide; USNM 193360A, 1 early instar on slide (length 0.18 mm, height 0.12 mm); USNM 193360B, 3 early instars in vial. *Tucker's Town Cave*, 8 Sep 1982: USNM 193362A, 1 instar V female on slide, USNM 193362B, 6 specimens in vial (2 adult males, 2 adult females, 1 instar I, 1 instar II); USNM 163362C, 1 adult male in vial; 16 Mar 1984: USNM 193363, 3 females and 2 males in vial. *Walsingham Sink Cave*, 13 Aug 1982: USNM 193353, 1 adult female on slide.

DISTRIBUTION (Figure 45).—Bermuda: Bee Pit Cave: 23 Jan 1984; Christie's Cave: 24 Nov 1982; Fern Sink Cave: 24 Jul 1984; Roadside Cave: 27 Aug 1982 (type locality), 12 Nov 1982; Tucker's Town Cave: 8 Sep 1982, 16 Mar 1984; Walsingham Sink Cave: 13 Aug 1982.

DIAGNOSIS.—Carapace with 7 or 8 small wedge-shaped central adductor muscle attachments forming oval. 1st antenna with 3 sutures forming 4 distinct segments without dorsal processes; penultimate joint of adult male with 2 spatulate bristles. Male endopodite of 2nd antenna: 1st joint with lateral elongate sclerotized process with recurved tip; 2nd joint with short sclerotized dorsal process. Mandible: basale with 3 ventral bristles; exopodite with 2 terminal bristles (posterior bristle indistinct). Maxilla with exopodite longer than basale. Furca: each lamella with 6 claws followed by slender bristle; 2 or 3 unpaired bristles following lamellae; a triangular process between adjacent claws; each claw with narrow transparent vellum along posterior edge. Bellonci organ comprising 2 short stout hirsute bristles.

DESCRIPTION OF ADULT MALE (Figures 46–48f).—Elongate, smoothly rounded, shell translucent, colorless; anteroventral margin slightly less rounded and with 2 minute triangular processes (Figures 46, 48a; processes not shown in Figure 46a).

*Ornamentation*: Surface smooth without visible ornamentation at low magnification but in anteroventral quarter of valves faint ridges and punctae visible in transmitted light with × 50 objective (Figure 48a). Anteroventral margin with 2 minute triangular processes (Figure 46d,f). About 7 long hairs present along anterodorsal margin, extremely sparse elsewhere (Figure 48a). Glands composed of closely packed globules,



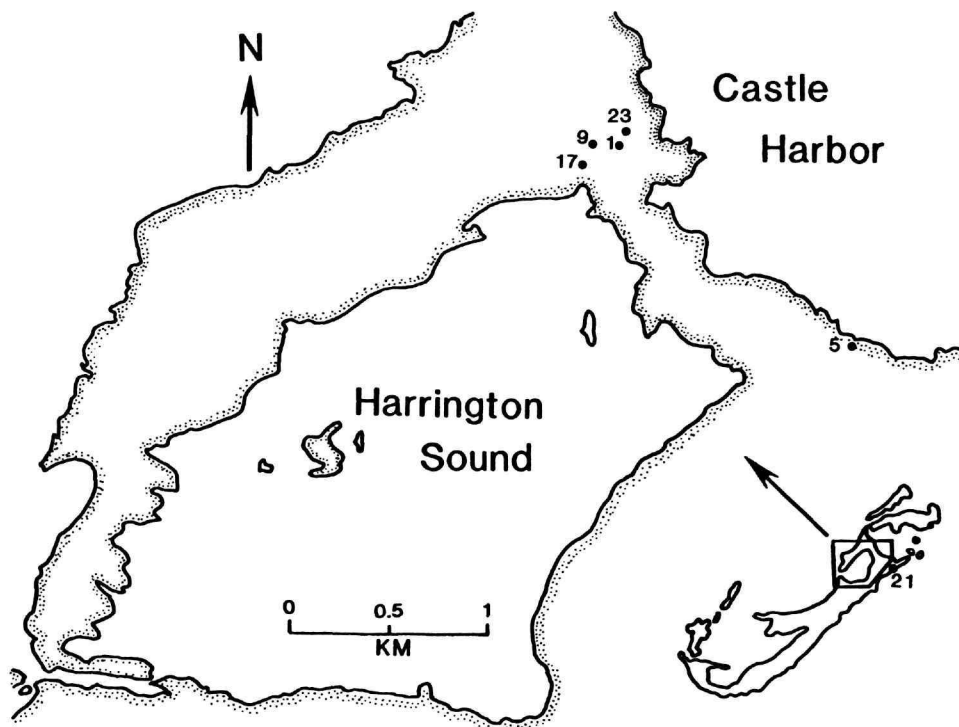


FIGURE 45.—Distribution of caves from which *Polycopissa anax*, new species, was collected (1 = Bee Pit Cave; 5 = Christie's Cave; 9 = Fern Sink Cave; 17 = Roadside Cave; 21 = Tucker's Town Cave; 23 = Walsingham Sink Cave).

appearing slightly yellow in preserved valves when viewed with transmitted light, forming discrete patches between vestment and shell, and more abundant along margins than near valve middle (Figure 46b–d). External pores present just within valve margins (Figure 46b–d, 48a) leading to glands through tube having bulbous section near pore; similar pores sparsely distributed over external surface of valves (Figure 48a); the marginal pore just ventral to ventral of the 2 triangular processes on anteroventral margin of valves of USNM 193351 with extruded substance emanating from it (Figure 46a,d–f), extruded substance not present on valves of USNM 193351 (Figure 46a).

**Infold** (Figure 46b–f): Infold broader along anterior margin (Figure 46b,e); right valve with well-defined list extending from midheight of anterior margin to midheight of posterior margin (Figure 46c,d); list of left valve less extensive and defined (Figure 46f).

**Selvage** (Figure 46c,d): Broad lamellar prolongation along anterior, ventral, and posteroventral margins, with slender marginal hairs along anteroventral, ventral, and posteroventral margins, but longest along anteroventral margin (Figure 46d); margin of prolongation smooth dorsal to lower of the 2 anteroventral triangular processes (Figure 46d); edge of prolongation appearing slightly sclerotized between the 2 anteroventral triangular processes.

**Vestment:** Spines present on anterior, posterior, and dorsal areas (Figure 46c).

**Central Adductor Muscle Attachments** (Figures 46a, 47a): Comprising 7 or 8 wedge-shaped scars forming oval. Muscle consisting of 3 compact strands where passing through body and then subdividing into 7 or 8 strands just before shell.

**Carapace Size:** USNM 193351, 193354, length 0.25 mm, height 0.21 mm; USNM 193352, length 0.25 mm, height 0.20 mm; USNM 193366 (holotype), length 0.26 mm, height 0.20 mm; USNM 193362B, 2 specimens, length 0.25 mm, height 0.20 mm, length 0.26 mm, height 0.21 mm; USNM 193365B, 0.25 mm, height 0.21 mm.

**First Antenna** (Figures 47a–c, 48b): 1st joint with dorsal spines and well-defined distal suture. Joints 2–5 fused: inferred 2nd joint with short dorsal spines and terminal dorsal bristle on distinct projection; joints 3–5 with short dorsal spines, medial spines distal to midlength (3rd joint?) and short ventral bristle on inferred 5th joint. 6th joint elongate (62 percent length of joints 2–5), with well-defined proximal and distal sutures, 1 short dorsal bristle, and 4 medial bristles near ventral margin (2 middle bristles with spatulate tips (Figures 47b, 48b)). Joints 7 and 8 fused with 5 bristles (2 long, 1 medium, 2 short; long and medium bristles with indistinct rings proximally).

**Second Antenna** (Figure 47a,d,e): Protopodite triangular,

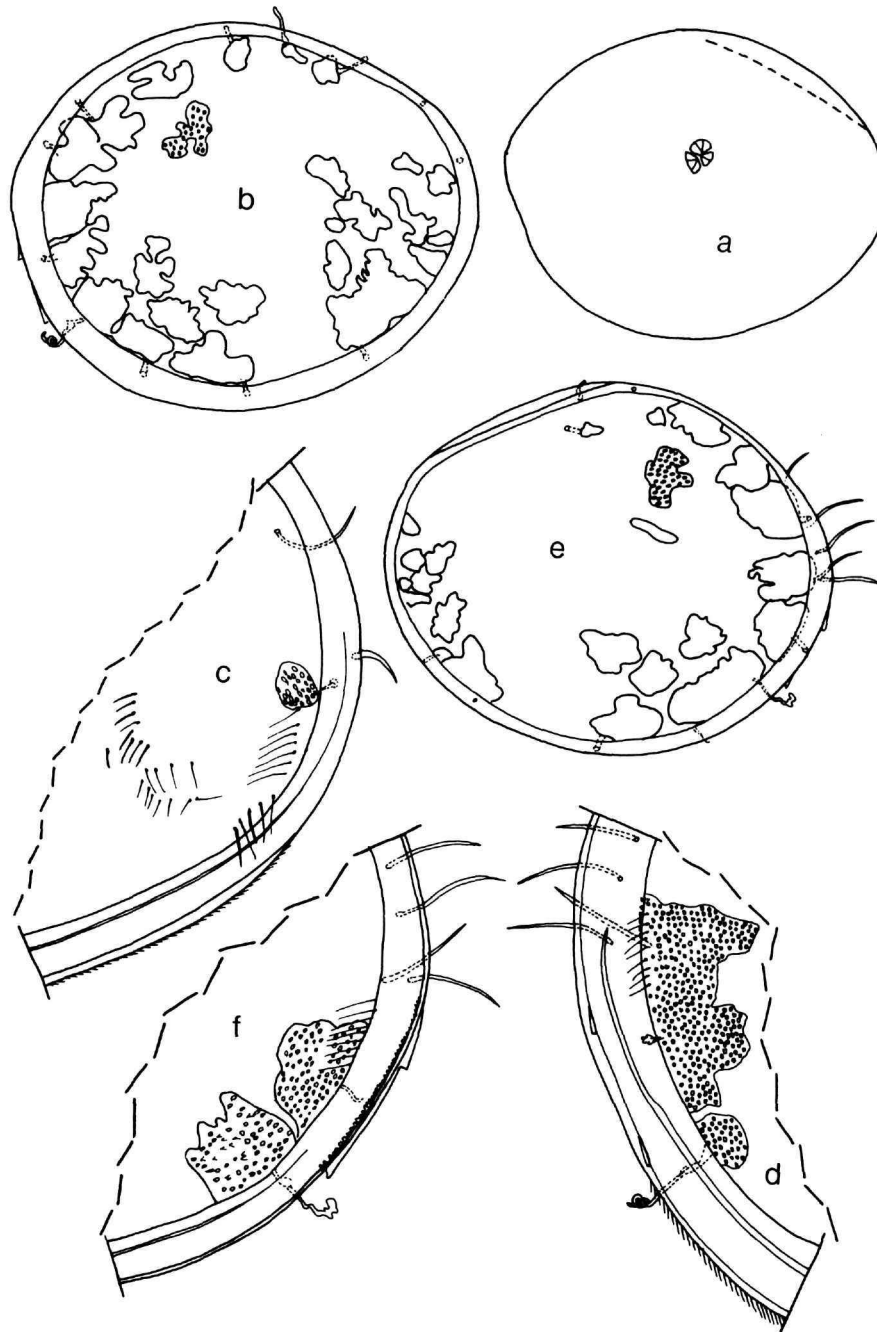


FIGURE 46.—*Polycopissa anax*, new species, USNM 193351, paratype, adult male, length 0.25 mm: *a*, complete specimen from left side showing central adductor muscle attachments and dashed hinge line, anterior to left (2 minute triangular anteroventral processes not shown); *b*, inside view of right valve (anterior to left) showing inner margin of selvage, glandular masses between vestment and shell (cells within glands shown in only 1 gland), pore canals (dashed lines) (note extrusion emanating from anteroventral pore). *c*, inside view of posterior of right valve showing inner margin of infold, narrow list on infold, 1 glandular mass between vestment and shell, a pore canal leading from mass to outer surface of shell, 2 long hairs on outer surface of valve, and spines on inner surface of vestment; *d*, detail of anterior of right valve shown in *b* showing inner margin of infold and narrow list, glandular mass and pore canals, and long hairs on valve surface; *e*, inside view of left valve, anterior to right; *f*, detail from *e* showing anteroventral margin.

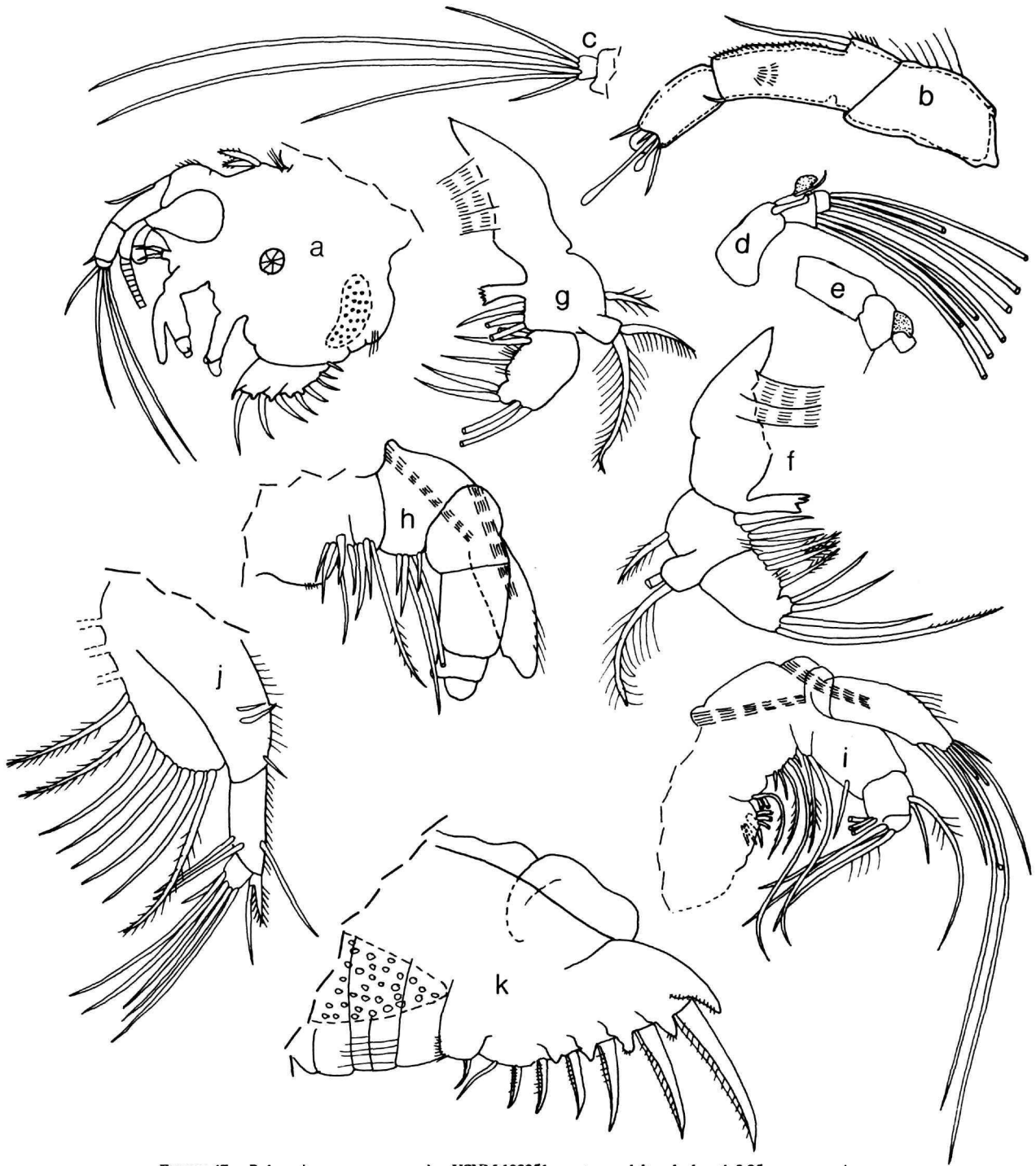


FIGURE 47.—*Polycopissa anax*, new species, USNM 193351, paratype, adult male, length 0.25 mm: a, specimen without valves showing location of appendages; b, right 1st antenna, medial view (bristles of joints 7 and 8 not shown, dashed line indicates inner edge of sclerotized exoskeleton); c, fused 7th and 8th joints of right 1st antenna, medial view; d, endopodite of right 2nd antenna, lateral view; e, joints 1-3 of endopodite of left 2nd antenna, medial view (bristles not shown); f, left mandible, lateral view; g, right mandible, lateral view; h, left maxilla, medial view, only endite bristles of precoxale and coxale shown; i, right maxilla, lateral view; j, left 5th limb, medial view; k, posterior of body showing right lamella of furca, 2 unpaired furcal bristles, posterior segmentation, and outline of compact copulatory process on left side of body.

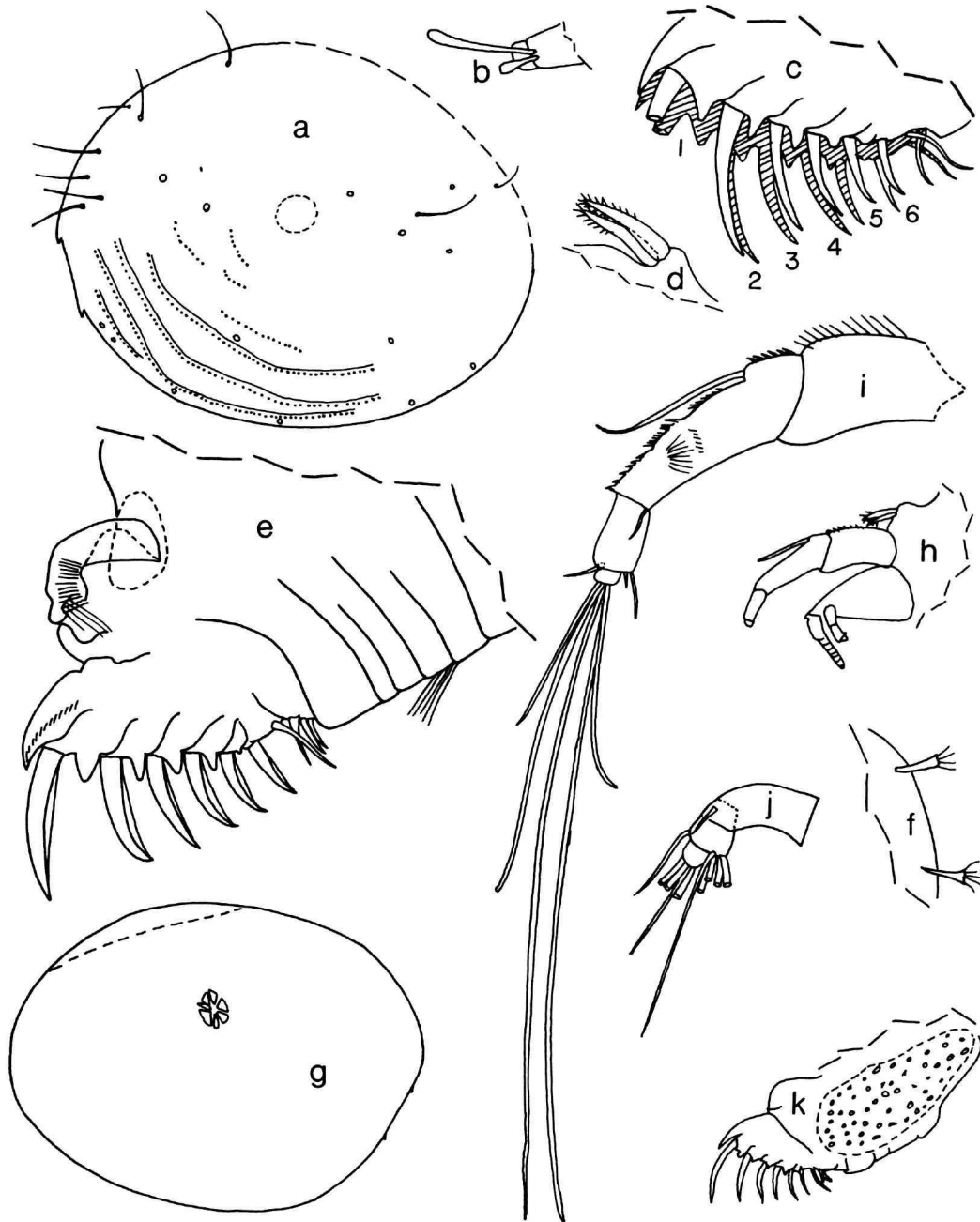


FIGURE 48.—*Polycopissa anax*, new species. USNM 193352, paratype, adult male, length 0.25 mm: *a*, complete specimen from left side showing hairs, faint ridges and punctae on outer surface, location of central adductor muscle attachments (dashed circle), anterior of valve to left; *b*, spatulate bristles of 6th joint of right 1st antenna, medial view; *c*, furcal lamellae from left side (right lamella lined), claws 1-6, slender posterior bristle, and 2 unpaired furcal bristles; *d*, Bellonci organ. *e*, USNM 193354, paratype, adult male, length 0.25 mm, posterior of body showing left lamella of furca, 3 unpaired furcal bristles, copulatory organ, and posterior segmentation. *f*, USNM 193365B, paratype, adult male, length 0.25 mm, posterodorsal corner of left valve showing attached protistans. USNM 193353, paratype, adult female, length 0.26 mm: *g*, complete specimen from right side (because valves slightly open, view of right side slightly oblique; dashed line indicates hinge line); *h*, Bellonci organ, left 1st antenna (only bristle of 2nd joint shown), and left 2nd antenna (no bristles shown); *i*, right 1st antenna, lateral view; *j*, endopodite of left 2nd antenna, lateral view; *k*, posterior of body showing left lamella of furca and 2 unpaired furcal bristles (dashed line with circles indicates unidentified internal organs).

with few hairs near midlength of dorsal margin. Exopodite with 9 joints: joints 1–8 with long bristle with natatory hairs; joint 9 with 3 bristles (1 medium, 2 short). Endopodite 3-jointed: 1st joint with terminal, lateral, club-like sclerotized process with recurved tip; 2nd joint with 1 indistinct short ventral bristle, a short sclerotized dorsal process, and 5 terminal bristles (3 long, 2 medium); 3rd joint with 4 terminal bristles (3 long, 1 medium).

**Mandible** (Figure 47a,f,g): Coxale endite well developed, tip obscure. Basale with 3 ventral bristles and 1 dorsal bristle at midlength. Exopodite broadening distally, with 2 terminal bristles (anterior bristle long with long marginal hairs; posterior bristle indistinct, about half length of anterior bristle, with extremely thin marginal hairs difficult to resolve with light microscope). Endopodite: 1st joint with 2 long distal dorsal bristles, and 3 shorter hirsute ventral bristles; end joint with 2 bristles.

**Maxilla** (Figure 47a,h,i): Precoxale endite with proximal ventral papillae, 4 or 5 slender bristles and 1 short, stout, claw-like bristle. Coxale with dorsal proximal hump forming attachment for internal muscle extending to basale just proximal to base of exopodite; with 2 endites (proximal endite with 3 bristles; distal endite with 5 bristles). Basale: proximal margin indicated by base of muscle attaching to proximal end of convex dorsal margin and extending into exopodite; distal margin indicated by slight indentations in dorsal margin at base of exopodite and ventral margin at base of endopodite; sutures separating basale from coxale and 1st endopodial joint clearly visible only on medial side; ventral margin with 2 bristles (1 very long). Endopodite: 1st and 2nd joint separated by well-defined suture; 1st joint with 1 distal ventral bristle; 2nd joint with 2 dorsal bristles (longer bristle with few long proximal hairs), and 3 long ventral bristles (marginal hairs not observed); end joint with 3 long stout bristles (dorsal of these with long proximal hairs). Exopodite slightly shorter than endopodite, with distal dorsal hairs and 8 terminal bristles.

**Fifth Limb** (Figure 47a,j): Epipodite with 11 bristles (proximal 3 bristles missing on illustrated limb). Coxale with 2 short, distal, medial bristles, and 1 short, terminal, anterior bristle. Basale with 2 distal posterior bristles, 1 distal anterior bristle, and hirsute anterior margin. Short exopodite with 6 terminal bristles. Endopodite with single small joint with 2 bristles (anterior bristle broad, short, hirsute; posterior bristle slender, about twice length of anterior bristle).

**Furca** (Figures 47a,k, 48e): Each lamella with anterior terminal process and 6 claws (with slender teeth and narrow velum along posterior margins) followed by 1 slender bare bristle; a triangular process present between adjacent claws (process between claws 5 and 6 very small). 2 or 3 slender, bare, unpaired, closely spaced bristles proximal to lamellae. Posterior edges of anterior terminal process and triangular processes between claws with well-defined S-shaped line extending proximally into lamellae (line extending from small process between claws 5 and 6 almost straight); medial surface of lamellae with short spines forming rows.

**Bellonci Organ** (Figures 47a, 48d): 2 stout hirsute bristles.

**Posterior of Body** (Figures 47a,k, 48e): With 3 well-defined segments; proximal segment with long spines forming row; distal segments with small spines.

**Copulatory Organ** (Figures 47k, 48e): On left side of furca, compact.

**Epizoa**: USNM 193365B with 2 funnel-shaped protostans on posterodorsal margin of left valve (Figure 48f) and 1 on right.

**DESCRIPTION OF ADULT FEMALE** (Figure 48g–k).—Carapace, ornamentation, and central adductor muscle attachments similar to those of adult male (Figure 48g).

**Carapace Size**: USNM 193353, length 0.26 mm, height 0.21 mm; USNM 193362B, 2 specimens, length 0.28 mm, height 0.22 mm; length 0.27 mm, height 0.23 mm; USNM 193363, 3 specimens, length 0.25 mm, height 0.22 mm, length 0.26 mm, height 0.22 mm, length 0.28 mm, height 0.23 mm; USNM 193365C, length 0.29 mm, height 0.25 mm.

**First Antenna** (Figure 48h,i): Joints 1–5 similar to those of adult male. 6th joint shorter than that of male (length 43 percent length of joints 2–5), with 1 short dorsal bristle and 2 medial bristles near ventral margin (inner bristle very small, no spatulate bristles). Bristles of joints 7 and 8 similar to those of adult male.

**Second Antenna** (Figure 48h,j): Protopodite and exopodite similar to those of adult male. Endopodite 3-jointed: 1st joint elongate with 1 short lateral bristle; 2nd joint broadening distally, with 1 slender dorsal bristle and 5 terminal ventral bristles (3 medial, 2 lateral (1 slender, 1 stout)); small 3rd joint with 4 bristles.

**Mandible**: Similar to that of adult male.

**Maxilla**: Exopodite with 9 bristles. Limb otherwise similar to that of adult female.

**Fifth Limb**: Basale with 3 distal posterior bristles. Limb otherwise similar to that of adult male.

**Bellonci Organ** (Figure 48h), **Furca and Posterior of Body** (Figure 48k): Similar to that of adult male.

**DESCRIPTION OF INSTAR I** (Figure 49a–e).—Carapace similar in shape to that of adult, uncalcified.

**Central Adductor Muscle Attachments**: Indistinct but comprising about 5 wedge-shaped scars forming oval.

**Carapace Size**: USNM 193355A,B, 2 specimens, length 0.15 mm, height 0.12 mm; length 0.15 mm, height 0.90 mm; USNM 193362B, length 0.14 mm, height 0.12 mm.

**First Antenna** (Figure 49a,c): Similar to adult in having sutures between joints 1 and 2, 5 and 6, and 6 and 7; joints 2–5 and 7 and 8 fused. Joint 1 with dorsal spines; joint 2 with long dorsal bristle reaching 6th joint; joints 2–5 with dorsal spines and medial spines distal to midlength; joint 6 with 1 short ventral bristle; fused joints 7 and 8 with 3 bristles (2 long stout, 1 medium slender).

**Second Antenna** (Figure 49a,d): Protopodite similar to that of adult. Exopodite with 8 joints: joints 1–7 with long bristle with natatory hairs; 8th joint with 2 bristles (1 medium, 1 small). Endopodite 3-jointed: 1st joint bare; fused 2nd and 3rd



FIGURE 49.—*Polycopissa anax*, new species, USNM 193355B, paratype, instar I, length 0.15 mm: a, body showing locations of some appendages (Bellonci organ and furca not shown, mx = maxilla, mnd. = mandible); b, tip of left 5th limb (indistinct). USNM 193355A, paratype, instar I, length 0.15 mm: c, left 1st antenna, lateral view; d, endopodite of left 2nd antenna, lateral view; e, left lamella of furca and 2 unpaired furcal bristles. f, USNM 193357, paratype, instar II, length 0.17 mm, body showing location of appendages (all bristles and joints not shown). USNM 193356A, paratype, instar III, length 0.17 mm: g, right 1st antenna, lateral view; h, posterior of body showing left lamella of furca, 2 unpaired furcal bristles, and posterior segmentation; i, Bellonci organ. j, USNM 193364C, paratype, instar V, length 0.23 mm, posterior of body showing right lamella of furca, 3 unpaired furcal bristles, and posterior segmentation.

joints with 1 short dorsal bristle (on 2nd joint) and 6 distal bristles.

*Mandible and Maxilla* (Figure 49a): Well developed.

*Fifth Limb* (Figure 49a,b): Developed, exopodite and endopodite with bristles, but epipodial bristles not observed (possibly not resolved).

*Furca* (Figure 49e): Each lamella with anterior terminal process and 2 claws; a triangular process between claws 1 and 2 and following claw 2. 2 slender unpaired bristles following lamellae; without S-shaped line extending proximally into lamella from posterior edges of anterior terminal process and triangular processes.

*Bellonci Organ, Posterior of Body*: Similar to those of adult.

DESCRIPTION OF INSTAR II (Figure 49f).—Carapace similar to that of adult male.

*Carapace Size*: USNM 193357, length 0.17 mm, height 0.15 mm; USNM 193362B, length 0.16 mm, height 0.14 mm.

*First Antenna* (Figure 49f): Similar to that of instar I.

*Second Antenna* (Figure 49f): Protopodite similar to that of instar I. Exopodite with 8 joints: joints 1–7 with stout natatory bristle; joint 8 with 2 bristles (1 short, 1 medium). Endopodite similar to that of instar I.

*Maxilla* (Figure 49f): Well developed.

*Fifth Limb* (Figure 49f): Well developed; epipodite with at least 5 bristles.

*Furca* (Figure 49f): Each lamella with anterior terminal process and 3 claws; a triangular process between claws 1 and 2, and following claw 3; none between claws 2 and 3; without S-shaped line extending proximally into lamella from posterior edges of anterior terminal process and triangular processes; without medial spines forming rows on lamellae; 2 unpaired bristles following lamellae.

*Bellonci Organ and Posterior of Body* (Figure 49f): Similar to those of instar I.

DESCRIPTION OF INSTAR III (Figure 49g–i).—Carapace similar to that of adult, uncalcified.

*Carapace Size*: USNM 193356A,B, length 0.17 mm, height 0.12 mm, length 0.20 mm, height 0.17 mm.

*First Antenna* (Figure 49g): Similar to that of instar I.

*Second Antenna*: Protopodite similar to that of instar I. Exopodite with 9 joints; joints 1–8 with 1 long bristle; 9th joint minute, with 2 bristles (1 medium, 1 short). Endopodite: 1st joint bare; 2nd and 3rd joints fused; with 1 short dorsal bristle (on 2nd joint) and 7 terminal bristles.

*Mandible, Maxilla, Fifth Limb*: Well developed.

*Furca* (Figure 49h): Each lamella with anterior terminal process and 4 claws; a triangular process between claws 1 and 2, and 2 and 3, and following claw 4; none between claws 3 and 4; without S-shaped line extending proximally into lamellae from posterior edges of anterior terminal process and triangular processes; without medial spines forming rows on lamellae; 2 unpaired bristles following lamellae.

*Bellonci Organ* (Figure 49i), *Posterior of Body* (Figure 49h): Similar to those of adult.

DESCRIPTION OF INSTAR V FEMALE (Figure 49j).—Carapace similar to that of adult.

*Carapace Size*: USNM 193362A, 1 specimen, length 0.23 mm, height 0.19 mm; USNM 193364C, 1 specimen, length 0.23 mm, height 0.19 mm; USNM 193364A, length 0.25 mm, height 0.20 mm.

*First and Second Antennae*: Similar to those of adult female.

*Mandible, Maxilla, Fifth Limb*: Not examined in detail but similar to those of adult female.

*Furca* (Figure 49j): Differs from that of adult male and female in not having a small process between claws 5 and 6, in having small process in place of bristle following claw 6, and in not having S-shaped line extending proximally into lamella from posterior edges of anterior terminal process and triangular process; lamellae without medial spines forming rows; 3 unpaired, closely spaced bristles following lamellae.

*Bellonci Organ, Posterior of Body* (Figure 49j): Similar to those of adult.

FOOD.—The guts of many specimens contain unidentifiable brown particles.

ONTOGENY AND SEXUAL DIMORPHISM.—It is estimated that the youngest instar in the collection is Instar I, because of having only 2 furcal claws (see "Recognition of the First Instar of Cladocopina," p. 66, herein). An additional furcal claw is added in Instar II (total 3), and another in instar III (total 4). Instar IV is absent from the collection but it is predicted to have 5 claws (Table 22). Instar V has 6 claws, the same number as the adult. Juveniles have a triangular process following the last claw; in the adult the process is replaced by a bristle. A very low triangular process between claws 5 and 6 of the adult furca is absent on Instar V (A-1 instar). An S-shaped well-defined line on the adult furca extending proximally into the lamellae from the posterior edges of the anterior terminal triangular process (present on all instars) and the triangular processes between claws is absent on juveniles. The species has a total of 6 instars of which 5 are juveniles. This is 1 less than the number of instars of *Metapolycope duplex* described herein.

TABLE 22.—Ontogenetic development of furca of *Polycopissa anax*, new species ("Length" refers to carapace; X = furcal claw; x = node; B = bristle; nd = no data).

Growth stage & sex	Length (mm)	Order of claws, nodes, and bristles <sup>1</sup>
I (sex?)	0.14–0.15	X x X x
II (sex?)	0.16–0.19	X x X X x
III (sex ?)	0.17–0.20	X x X x X X x
IV (nd)	nd	X x X x X x X X x (predicted)
V female	0.23–0.25	X x X x X x X x X X x
VI (adult) female	0.25–0.29	X x X x X x X x X x X B
male	0.25–0.26	X x X x X x X x X x X B

<sup>1</sup>Beginning with distalmost claw on each lamella.

Instar I has all five appendages; exopodial and endopodial bristles are present on the 5th limb (epipodial bristles were not seen on the epipodite, but these thin bristles are difficult to resolve even on later instars so they could be present).

The 1st antenna of the adult female has 2 medial bristles near the ventral margin of the 6th joint, whereas that of the adult male has 4 of which the middle 2 have spatulate tips (probably used for grasping female). Instars V (A-1) in the collection have 2 simple bristles on the 6th joint similar to those of the adult female, and because of this they were interpreted to be females. A-1 males of *Metapolycope hartmanni* (Kornicker and van Morkhoven, 1976, fig. 14a) and of *M. duplex*, herein, have modified medial bristles on the 6th joint of the 1st antenna.

The endopodite of the 2nd antenna of the adult male has a sclerotized club-like process with recurved tip on the 1st joint,

and a short sclerotized dorsal process on the 2nd joint, both absent on the adult female. The adult male has a bulky copulatory organ proximally of the left lamella of the furca.

COMPARISONS.—Chavtur (1981a:57) recognized with certainty only 1 species in the genus *Polycopissa*: *P. japonica* Chavtur (1979:97), known only from the female. The carapace of *P. japonica* bears only 3 central adductor muscle attachments compared to 7 or 8 on *P. anax*. On the 1st antenna of *P. japonica* the combined length of the joints following the 2nd suture is much smaller relative to the length of the 2nd joint than it is on *P. anax*. The basale of the mandible bears 4 ventral bristles on *P. japonica* and only 3 on *P. anax*. Each lamella of the furca bears 7 claws on *P. japonica* and 6 claws plus 1 bristle on *P. anax*. Spatulate bristles on the penultimate joint of the male 1st antenna have not previously been reported in the Polycopidae.



# Appendix

## Station Data with Specimens Collected

(Includes occurrences of *Spelaeoecia bermudensis* reported in Angel and Iliffe (1987, table 2); caves listed in alphabetical order)

Bee Pit Cave, Hamilton Parish, 23 Jan 1984, fine-mesh dip net from underwater soil slope in 0–1 m water; no currents evident (isolated pool).

*Polycopissa anax*: 1 adult male, USNM 193352.

Cathedral Cave, Hamilton Parish. All stations with no currents evident (isolated pool).

15 Feb 1984, fine-mesh hand net from bottom rocks and silt in 0–4 m.

*Pseudophilomedes kylix*: 1 adult male, USNM 193386; 1 instar III male, USNM 193393; 1 instar IV male, USNM 193394.

2 Oct 1984, 6–8 m. Collected by Jan H. Stock.

*Pseudophilomedes kylix*: 1 adult female, USNM 193395 (holotype).

Cherry Pit Cave, Hamilton Parish.

23 Jun 1982, fine-mesh hand net from bottom rocks and gravel at 5 m; moderate currents.

*Metapolycope duplex*: 1 instar IV, USNM 193326; 1 instar VI female, USNM 193327; 1 adult male, USNM 193328; 2 adult females, USNM 193329A,B; 1 instar V female, USNM 193329C; 1 adult male, 2 adult females, 2 instar VI, 1 valve, USNM 193330.

*Pseudophilomedes kylix*: 1 adult male, USNM 193155; 1 adult female, USNM 193154; 1 adult male, USNM 193385.

*Eusarsiella styx*: 1 ovigerous female, USNM 193367; 1 ovigerous female, USNM 193369 (holotype); 1 adult female, USNM 193370; 5 adult females, USNM 193371; 46 juveniles, USNM 193377.

12 Jan 1984, fine-mesh hand net from bottom silt and gravel at 3–12 m; weak to moderate currents.

*Metapolycope duplex*: 1 instar VI male, USNM 193331; 1 adult male, 1 adult female, 2 instar VI, 3 valves, USNM 193332.

*Eusarsiella styx*: 4 adult females and 14 juveniles, USNM 193382.

22 Mar 1987, fine-mesh hand and plankton nets from bottom silts and gravel at 3–10 m; weak to moderate current.

*Metapolycope duplex*: 32 specimens including 2 empty carapaces, USNM 193403; 1 instar III, USNM 193435.

*Pseudophilomedes kylix*: 1 adult female, USNM 193384; 1

instar I, USNM 193391; 1 instar III female, USNM 193396; 1 instar IV male, USNM 193392.

*Eusarsiella styx*: 70 adult females and juveniles, USNM 193374A; 1 instar III female, USNM 193374B; 1 adult male, USNM 193375.

*Rutiderma sterreri*: 1 adult female, USNM 193399.

Christie's Cave, St. George's Parish. All stations with no currents evident (isolated pool).

1 Sep 1982, dip net at 0–1.5 m.

*Spelaeoecia bermudensis*: 1 A-3 instar (data from Angel and Iliffe (1987, table 2).

24 Nov 1982, fine-mesh hand net from bottom rocks and silt in 2–8 m water.

*Polycopissa anax*: 1 instar V female, USNM 193364A; 2 adult females, USNM 193364B; 1 instar V female, USNM 193364C.

*Spelaeoecia bermudensis*: ? specimens (data from Angel and Iliffe (1987, table 2); original notes of Iliffe show 40 specimens collected).

Cripplegate Cave, Hamilton Parish, 21 Oct 1981, 30 cm diameter plankton net in tidal currents flowing out of coastal cave entrance.

*Rutiderma sterreri*: 1 adult male, USNM 193368.

Crystal Cave, Hamilton Parish. All stations with no current evident (isolated pool).

30 Mar 1982, suction bottle from water column in main pool at depth of 15–20 m.

*Spelaeoecia bermudensis*: 1 adult, 1 A-1 instar, suction bottle at 15–20 m (data from Angel and Iliffe, 1987, table 2).

16 Oct 1982, hand-towed plankton net through main pool at depth of 2–4 m.

*Spelaeoecia bermudensis*: 1 A-1 instar (data from Angel and Iliffe, 1987, table 2).

Deep Blue Cave, Hamilton Parish. All stations with weak current.

23 Mar 1982, specimens sorted from algae growing in open entrance pool at 1–2 m depth.

*Micropolycope eurax*: 1 adult female, USNM 193349 (holotype); 2 adult dissected females, USNM 193347 and 193350; 1 adult female, USNM 193348.

- Parasterope muelleri*: 1 early instar, USNM 193397.  
20 Feb 1984, fine-mesh dip net from water column and soil slope at 0–1 m in open pool.  
*Metapolycope duplex*: 2 specimens (valves only), USNM 193340.  
*Eusarsiella styx*: 1 adult female and 4 juveniles, USNM 193383.
- Fern Sink Cave, Hamilton Parish. All stations with no currents visible (isolated pool).  
25 Feb 1982, fine-mesh net from fine bottom silt past base of underwater entrance slope at 18 m.  
*Metapolycope duplex*: 1 adult or late instar, USNM 193337.  
24 Jul 1984, fine-mesh hand net from surface of ceiling and water column in 18 m water.  
*Polycopissa anax*: 1 adult female, USNM 193365A; 1 adult male, USNM 193365B; 2 adult females, USNM 193365C.  
24 Jul 1984, short handled net from water column and surface of silty sediment at base of entrance slope at depth of 18 m.  
*Spelaeoecia bermudensis*, 1 adult (data from Angel and Iliffe, 1987, table 2).
- Green Bay Cave, Hamilton Parish.  
18 Nov 1981, fine-mesh hand net from fine bottom silt in Green Bay Passage just past the 'Rat Trap' at 14 m; moderate currents.  
*Metapolycope duplex*: 4 specimens (adults and late instars), 1 specimen (valves only), USNM 193343.  
*Pseudophilomedes kyllix*: 1 instar I, USNM 193389.  
29 Aug 1982, suction bottle from water column in Dungeon area past Air Room in Green Bay Passage at depth of 16–17 m; no currents evident (isolated pool).  
*Spelaeoecia bermudensis*: 10 adults, 3 A-1 instars (data from Angel and Iliffe, 1987, table 2).  
12 Jul 1984, by hand in vials from water column in Dungeon Area past Air Room in Green Bay Passage with SCUBA at depth of 18 m; no currents evident (isolated pool).  
*Spelaeoecia bermudensis*: 2 A-1 instars (data from Angel and Iliffe, 1987, table 2).
- Jane's Cave, Hamilton Parish. All stations with no current evident (isolated pool).  
27 Mar 1985, short-handed net from water column and rocky floor in pool at back northwest corner of cave at depth of 8–12 m. (Numerous ostracodes observed in water column throughout pool).  
*Spelaeoecia bermudensis*: 3 specimens, USNM 193404A,B,C.  
22 Jul 1985 (same collecting data as 27 Mar 1985).  
*Spelaeoecia bermudensis*: 1 juvenile, USNM 193406.  
29 Jul 1986, short-handed net from water column and peat-like sediments in pool at back northwest corner of cave at depth of 3–12 m.  
*Spelaeoecia bermudensis*: 1 A-1 male, USNM 193405A; 2 adult females, USNM 193405B,C.
- Myrtle Bank Cave, Hamilton Parish, 7 Feb 1982, fine-mesh hand net from bottom silt in the "Pumpkin Passage" between the Palm and Myrtle Bank entrances at depth of 21 m; moderate currents. [This station is same as Palm Cave, 9 Feb 1985, but station reached by entering Myrtle Bank rather than Palm Cave.]  
*Pseudophilomedes kyllix*: 1 instar III female, USNM 193387.  
Palm Cave, Hamilton Parish.  
20 Jan 1982, fine-mesh hand net from bottom silt near base of entrance slope at 9 m; weak currents.  
*Metapolycope duplex*: 1 instar I, USNM 193316; 1 instar V female, USNM 193317; 1 adult male, USNM 193318; 1 adult female with parasitic nematode within body dorsal to adductor muscles, USNM 193319; 1 instar VI female, USNM 193325A; 1 adult female, USNM 193325B, 4 adult females, 1 valve, USNM 193325C.  
13 and 16 Mar 1982, fine-mesh net from bottom silt in underwater Palm Cave Room at 16 m; moderate currents.  
*Metapolycope duplex*: 1 adult male, USNM 193320 (holotype); 1 instar V female, USNM 193321; 1 adult male, USNM 193322; 1 instar VI male, USNM 193323; 1 adult female, USNM 193324A; 5 adult females, USNM 193324B; 1 adult female, USNM 193379; 1 female, 5 juveniles, USNM 193378.  
*Eusarsiella styx*: 1 ovigerous female and 5 juveniles, USNM 193378.  
*Parasterope muelleri*: 1 adult male and 1 adult female, USNM 193398A,B.  
9 Feb 1985, short-handed net from rock walls in the 'Pumpkin Passage' between the Palm and Myrtle Bank entrances at depth of 21 m; moderate currents.  
*Metapolycope duplex*: 1 adult female, USNM 193314; 1 decalcified valve, USNM 193315.
- Red Bay Cave, Hamilton Parish, 23 Oct 1986, collected from hydroids and other organisms growing on guideline in 9–14 m first 150 m of cave from entrance (guideline had been in place for about 2 years); strong currents.  
*Eusarsiella styx*: 1 adult female, USNM 193373.
- Roadside Cave, Hamilton Parish. All station with no current evident (isolated pool).  
27 Aug 1982, fine-mesh dip net from water column and bare rock walls in 0–1.5 m water.  
*Polycopissa anax*: 19 specimens, USNM 193361; 1 adult male, USNM 193366 (holotype).  
12 Nov 1982, fine-mesh net from bottom rocks at 4–8 m water.  
*Polycopissa anax*: 1 adult male, USNM 193351; 1 adult male, USNM 193354; 2 instar I, USNM 193355A,B; 2 instar III, USNM 193356A,B; 1 instar II, USNM 193357; 1 early instar, USNM 193360A; 3 early instars, USNM 193360B.  
12 Nov 1982, suction bottle at 4–8 m.  
*Spelaeoecia bermudensis*: 2 adults, 9 A-1 instars, 1 A-2 instar (data from Angel and Iliffe, 1987, table 2).  
28 Aug 1984, dip net at 3–8 m.  
*Spelaeoecia bermudensis*: 2 A-1 instars, 1 A-3 instar (data

- from Angel and Iliffe, 1987, table 2).
- 27 Sep 1984, plankton net at 2–8 m.  
*Spelaeoecia bermudensis*: 1 adult, 5 A-1 instars, 1 A-4 instar (data from Angel and Iliffe, 1987, table 2).
- 13 Mar 1985, short-handled net from water column and rocky substrate at depth of 7 m.  
*Spelaeoecia bermudensis*: 1 A-3 instar, USNM 193407.
- 7 Aug 1985, short-handled net from water column and rocky substrate at depth of 18–20 m.  
*Spelaeoecia bermudensis*: 1 specimen, USNM 193408.
- Sailor's Choice Cave, Hamilton Parish, 6 Jul 1982, fine-mesh dip net (*M. eurax* from undercut sloping walls of entrance pool at 0–1 m; *M. duplex* from bottom rocks at 3–5 m; weak currents.)  
*Metapolycope duplex*: 4 specimens (adults and late instars), USNM 193335.  
*Micropolycope eurax*: 1 adult female plus 1 late instar, USNM 193358.
- Straw Market Cave, Hamilton Parish, 12 Jan 1984, fine-mesh hand net from gravelly sediment where currents come out of breakdown in 10–12 m water depths; weak currents.  
*Metapolycope duplex*: 1 adult, USNM 193336.  
*Eusarsiella styx*: 3 juveniles, USNM 193381.
- Tucker's Town Cave, St. George's Parish. All stations with no current evident (isolated pool).
- 8 Sep 1982, fine-mesh hand dip net from the sparsely algal-covered rear wall of entrance slope in 0–2 m depth.  
*Polycopissa anax*: 1 instar V female, USNM 193362A; 6 specimens (2 adult males, 2 adult females, 1 instar I, 1 instar II), USNM 193362B; 1 adult male, USNM 193362C.
- 4 Dec 1982, suction bottle from base of entrance slope and main chamber at depth of 18–20 m.  
*Spelaeoecia bermudensis*: 4 adults, 2 A-1 instars, 1 A-1 instar (data from Angel and Iliffe, 1987, table 2).
- 16 Mar 1984, fine-mesh net from sand and rotting wooden planks at base of the entrance slope in 16–18 m water.  
*Micropolycope styx*: 1 adult female, USNM 193359 (holotype).  
*Polycopissa anax*: 3 females and 2 males, USNM 193363.
- Walsingham Cave, Hamilton Parish. All stations with moderate currents.
- 18 Feb 1982, collected with suction bottle and fine-mesh hand net from bottom silt and walls of rear part of main entrance pool at 6–8 m.  
*Metapolycope duplex*: 7 specimens (adults and late instars), USNM 193338, 1 instar I, USNM 193339.  
*Pseudophilomedes kyllix*: 1 instar IV male, USNM 193388.  
*Eusarsiella styx*: 1 instar I female, 1 instar II, 1 male instar IV, USNM 193372A,B,C.
- 14 Jun 1982, fine-mesh hand net from rear part of entrance pool, at 5 m depth.  
*Metapolycope duplex*: 1 adult male, 3 single valves, USNM 193333.  
*Eusarsiella styx*: 15 females and juveniles, USNM 193376.
- 13 Jul 1984, fine-mesh hand net from surface of silty sediments in main entrance room at water depth of 6 m.  
*Metapolycope duplex*: 1 instar IV, USNM 193341; 2 specimens (valves only), USNM 193342.  
*Eusarsiella styx*: 1 juvenile, USNM 193380.
- 22 Oct 1986, short-handled net from under ledges near 'Round Room' at depth of 3–5 m.  
*Pseudophilomedes kyllix*: 1 adult male, USNM 193390.
- Walsingham Sink Cave, Hamilton Parish. All stations with no current evident (isolated pool).
- 7 Feb 1982, pumping water from 5 m depth through plankton net.  
*Spelaeoecia bermudensis*: 1 A-1 instar (data from Angel and Iliffe, 1987, table 2).
- 13 Aug 1982, fine-mesh dip net from water column, walls and ledges at 0–1.5 m.  
*Metapolycope duplex*: 1 valve, USNM 193334.  
*Polycopissa anax*: 1 adult female, USNM 193353.
- Wonderland Cave. All stations with no current evident (isolated pool).
- 19 May 1982, suction bottle in water column of main pool at depth of 10–15 m.  
*Spelaeoecia bermudensis*: 2 adults (carapaces only) (data from Angel and Iliffe, 1987, table 2).
- 20 Oct 1982, collected with plastic bottle trap baited with fish and left for 1 week in main pool at depth of 3 m.  
*Spelaeoecia bermudensis*: 1 adult (data from Angel and Iliffe, 1987, table 2).

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