Myodocopid Ostracoda from Exuma Sound, Bahamas, and from Marine Caves and Blue Holes in the Bahamas, Bermuda, and Mexico

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ABSTRACT

Kornicker, Louis S., and Thomas M. Iliffe. Myodocopid Ostracoda from Exuma Sound, Bahamas, and from Marine Caves and Blue Holes in the Bahamas, Bermuda, and Mexico. *Smithsonian Contributions to Zoology,* number 606, 98 pages, 56 figures, 6 maps, 5 tables, 2000.—Sixteen species in four families of myodocopine ostracodes were collected from a submarine escarpment on the SW edge of Exuma Sound at water depths of 62 m to142 m. Seven new species from this collection are described and illustrated: *Vargula exuma, Eurypylus eagari, E. hapax, Eusarsiella ryanae, Rutiderma schroederi, Diasterope procax,* and *Synasterope browni.*

Danielopolina kakuki, a new species of troglobitic (cave-limited) halocyprid ostracod in the family Thaumatocyprididae from Oven Rock Cave, Great Guana Cay, Great Bahama Bank, Bahamas, is described and illustrated. New records are presented for three troglobitic halocyprid ostracodes: *Spelaeoecia bermudensis* Angel and Iliffe, 1987 (from Church and Bitumen caves, Bermuda), *Spelaeoecia mayan* Kornicker and Iliffe, 1998 (from Cenote 27 Steps, Quintana Roo, Yucatan Peninsula, Mexico), and *Danielopolina mexicana* Kornicker and Iliffe, 1989 (from Cenote 27 Steps and Cenote Ponderosa in Quintana Roo, Yucatan Peninsula, Mexico). The collecting localities are described in detail, and a general discussion is included on marine caves and their biota.

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Contents

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Introduction

Within the last 15 to 20 years, the development of specialized cave diving techniques has opened the doors to a new and previously unsuspected biological realm in anchialine caves. Faunal surveys of anchialine caves in Bermuda (Sket and Iliffe, 1980; Iliffe et al., 1983; Iliffe, 1994; Kornicker and Iliffe, 1989b), the Yucatan Peninsula of Mexico (Kornicker and Iliffe, 1989a; Iliffe, 1993), the Canary Islands (Iliffe et al., 1984; Kornicker and Iliffe, 1995); the Galapagos Islands (Kornicker and Iliffe, 1989; Iliffe, 1991), the Balearic Islands (Jaume, 1995; Jaume and Boxshall, 1995, 1996a,b), the Cape Range Peninsula of Western Australia (Humphreys, 1993; Humphreys and Adams, 1991), and Croatia (Sket, 1986), among other locations, have resulted in the discovery of a diverse array of new marine taxa. These discoveries have included a new class of crustaceans (Yager, 1981), two new orders of Peracarida and Copepoda (Bowman et al., 1985; Fosshagen and Iliffe, 1985), and six new families or subfamilies of Isopoda, Ostracoda, Caridea, Harpacticoida, Cyclopoida, and Calanoida (Sket, 1979; Kornicker and Iliffe, 1985; Hart and Manning, 1986; Huys, 1988; Rocha and Iliffe, 1991; Suárez-Morales and Iliffe, 1996), in addition to more than 50 new genera (Sket, 1997).

It is of interest to note that crustaceans dominate the lists of fauna exclusively occurring in anchialine habitats, and some crustacean taxa are much better represented than others. For example, among the Ostracoda, halocyprids are far more important as anchialine troglobites than either myodocopids or polycopids that include mostly troglophilic species. Halocyprids include regressive and convergent characters (depigmentation, loss of eyes), expected adaptations (increase in tactile and chemical sensitivity, increase in metabolic economy, development of pedomorphic forms), certain trends in life cycles (such as K strategies, which include longer duration of phases of the life cycle, lack of reproductive cycles, tendency toward direct development), and development of certain reproductive strategies (low fecundity, increase in egg size, a decrease in number of eggs) (Camacho et al., 1992:181). These features, however, are not exclusively found in cave animals, as they also occur in species inhabiting other lightless, environmentally stable environments, such as the deep sea. Indeed, there are considerable faunal similarities between anchialine cave and deep-sea habitats.

A rich variety of troglobitic taxa, most notably polychaetes, remipedes, amphipods, ostracodes, isopods, mysids, thermobaenaceans, copepods, shrimp, and fishes inhabit extensive anchialine cave systems in the Bahama Islands (Juberthie and Iliffe, 1994). Among the ostracodes, 11 species of troglobitic halocyprids come from three genera: *Danielopolina, Spelaeoecia,* and *Deeveya* (Kornicker and Iliffe, 1985, 1989a, 1998; Kornicker et al., 1990; Kornicker and Palmer, 1987; Kornicker and Barr, 1997).

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The waters of anchialine caves in the Bahamas and elsewhere have marine salinities and experience tidal fluctuations, indicating a connection with the sea. These caves, however, have exceptionally transparent waters, little suspended particulate matter, and no typical open-water marine species, which suggests that connections to the sea are hydrologically remote. At first approximation, hydrologically detached anchialine caves on geographically remote islands would appear to be very isolated habitats. From the island biogeography viewpoint, they would seem to be islands (isolated caves) within islands. Despite the apparent hydrological and geographical isolation imposed by the anchialine cave habitat, these cave-limited ostracodes have a surprisingly wide and anomalous distribution. Species of *Danielopolina* inhabit caves in the Canary Islands, Bahamas, Cuba, Jamaica, Yucatan Peninsula (Mexico), Galapagos Islands, and Cape Range Peninsula (Western Australia), in addition to 3459 m deep waters in the South Atlantic. Species of *Spelaeoecia* are found in caves in the Bahamas, Bermuda, Cuba, and the Yucatan Peninsula, and species of *Deeveya* occur in caves in the Bahamas and the adjacent Turk and Caicos Islands.

The anomolous distribution, primitive nature, and troglomorphic adaptations (i.e., morphological adaptations to the lightless cave habitat, such as eye and pigment reduction of anchialine species exclusively limited to this habitat) of these taxon suggest a long history in an aquatic cave environment. During the last period of Pleistocene glaciation, however, sea level was depressed at least 100 m. As most known anchialine caves occur in relatively shallow waters, they would have been dry just 18,000 years ago. This conclusion is supported by the presence of large stalactites and stalagmites, which can only form in air by dripping waters. Thus, an alternate, deeper habitat must have provided a refuge for anchialine fauna for considerable periods of time.

In the Canary Islands, anchialine taxa, including specimens of *Danielopolina*, have been collected from brackish, inland ground water accessible through wells (Wilkens et al., 1986:225). This suggests that cave species may disperse, at least over short horizontal distances, through water-filled cracks and crevices within the bedrock, i.e., the crevicular environment. Similarly, vertical dispersal through the crevicular medium also may be possible. This could account for the colonization of previously dry caves as they became flooded by rising sea levels at the end of the Pleistocene.

In addition, it has been proposed that the anomalous distribution of anchialine taxa may be attributed to dispersal down submerged seamount or island slopes along the mid-ocean ridges through deep-sea crevicular habitats (Hart et al., 1985:291; Iliffe, 1990:95). The close taxonomic affinities of some anchialine species to deep sea taxa, such as is the case with *Danielopolina*, provide additional evidence for this theory. An alternate hypothesis suggests a shallow water origin for anchialine fauna from widely dispersed, open water ancestors (Stock, 1986; Danielopol, 1990); however, no deep water cave or crevicular (crevice-dwelling) species have ever been observed or collected.

One of the purposes of the present study was to document and compare faunistic characteristics of crevicular habitats (e.g., micro cave-like crevices or fissures) on the submerged, cliff-like escarpments with those of anchialine caves. To this end, submersible and deep scuba diving collections were made from ledges along the near vertical submarine escarpment bordering the 1800 m deep Exuma Sound (Figure 1). Although numerous smaller (0.5–2 m diameter) openings and vertical fissures were observed at 90 m to 100 m depths on the escarpment, it was not possible to get close enough in the submersible to sample these habitats. Thus, trap, grab, and suction samples were made from ledges within a few meters from the outer end of these openings.

No halocyprids previously identified from anchialine caves were collected from the escarpment. The collection contained 16 species of Myodocopina, which include three left in "open nomenclature" and two species that are described by Cohen et al. (in press) (Table 1; Appendix). Seven new species from the escarpment are described and illustrated herein.

New localities for halocyprids collected from anchialine caves in the Bahamas, Bermuda, and Mexico (Yucatan Peninsula) are also reported upon herein, and a new species of *Danielopolina* is described and illustrated from Oven Rock Cave, Great Guana Cay, Exuma Cays, Bahamas.

TERMINOLOGY.—Under the classification scheme of Barr and Holsinger (1985:314), cave-dwelling (cavernicolous)

TABLE 1.—Species collected from Exuma Sound in baited tube trap, plankton net, and grab and suction samplers. (X = one sample.)

Taxon	Tube trap	Plankton net	Grab sampler	Suction tube
CYPRIDINIDAE				
CYPRIDININAE				
Jimmorinia gamma	X			X
Jimmorinia gunnari	XXXX			
Skogsbergia lerneri	XX			
Vargula exuma		X		
Vargula sp. indet.		X		
SARSIELLIDAE				
SARSIELLINAE				
Eurypylus eagari		X		
Eurypylus hapax			X	
Eusarsiella costata		X		
Eusarsiella ryanae		XX		
Eusarsiella sp. indet.		XX		
RUTIDERMATIDAE				
Rutiderma schroederi		X		X
CYLINDROLEBERIDIDAE				
CYLINDROLEBERIDINAE				
Diasterope procax	XX		X	
Parasterope muelleri		X		
Synasterope browni	X			
ASTEROPTERONINAE				
Actinoseta chelisparsa		X		
Asteropella sp. indet.		X		

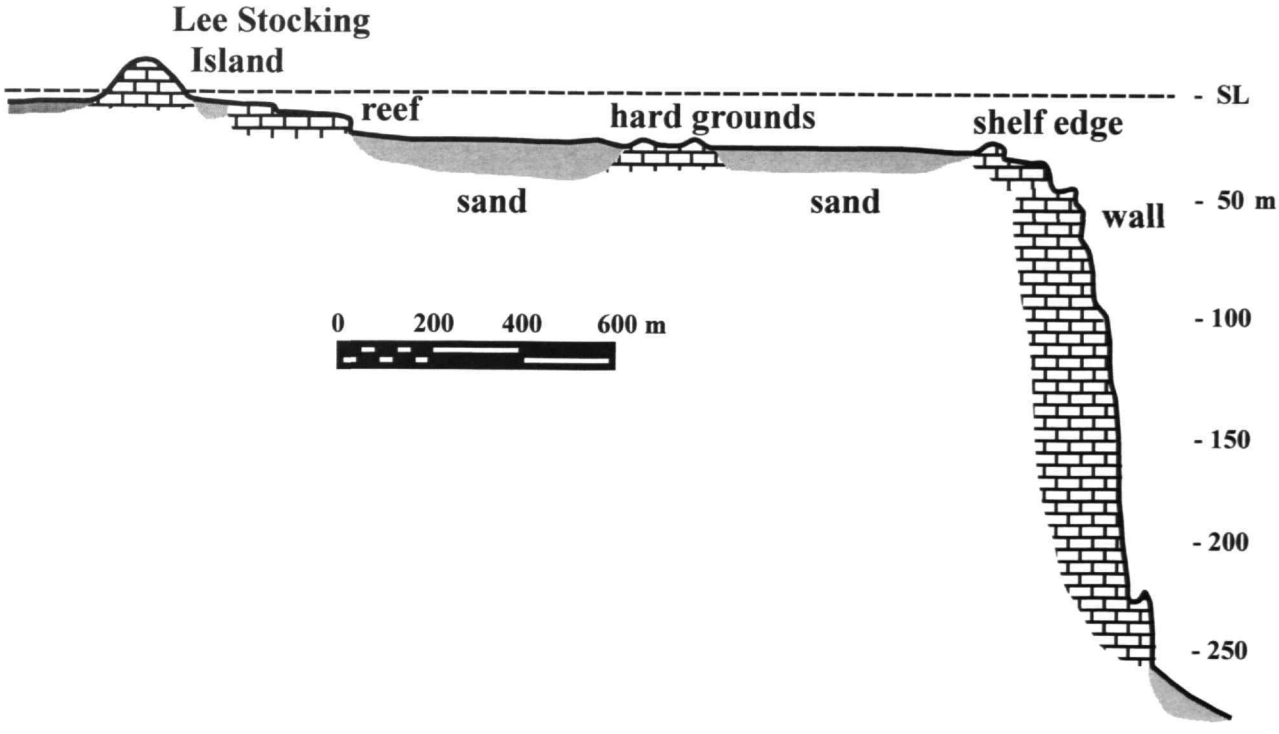

FIGURE 1.—Profile view (with exaggerated vertical scale) of the submarine escarpment off Lee Stocking Island (adapted from Kendall et al., 1990).

organisms can be ecologically summarized as follows. Troglobites are obligate cavernicoles, whereas troglophiles are facultative cavernicoles able to live inside or outside caves. Trogloxenes are regular cave inhabitants that return periodically to the surface for food. Accidentals are epigean species that involuntarily enter caves by falls, by flood waters, etc. Troglobites are typically found only in isolated and environmentally stable deep cave interiors, whereas troglophiles, trogloxenes, and accidentals generally occur in entrance-to-middle zones.

In practice, the decision as to which of the above four categories a particular ostracode species should be referred to is an interpretation subject to change, especially when indicated by pertinent additional data. No ostracodes have been reported to be trogloxenes. Unless it is known that an ostracode can or cannot complete its life cycle within a cave, it is not possible to designate with certainty a species as either troglophilic or accidental. If the area outside the cave has not been sampled, so that the possible presence of a cave species is unknown, the designation as a troglobite must depend on other factors, such as location of the species within the cave. Examples of ostracodes designated as either troglobites, troglophiles, or accidentals may be found in Kornicker and Iliffe (1989b:6).

Some myodocopid and podocopid ostracodes may border between troglophile and troglobite, but halocyprids like *Deeveya, Spelaeoecia,* and most *Danielopolina* spp. are almost certainly troglobites because they have been found exclusively in caves and, even then, only from the deep cave interior, where normal nontroglobitic species are absent. In addition, they are locally abundant in such habitats, and various stages of the life cycle are present.

Accidental cave species are infrequently observed; they are present in low numbers and are usually in poor physical condition. An example of an accidental species would be a frog that falls into a dry cave entrance; it usually stays around the illuminated parts of the entrance area, but it eventually starves to death. In underwater caves directly connected to the sea, emaciated open water surface fish that apparently became lost in the cave have been observed by the junior author; they soon starve and their bodies become food for cave animals.

Troglophiles can also live and carry out their life cycle in suitable habitats outside caves. Examples are sponges and hydroids present in cave entrances as well as under rocks and in cracks outside of caves.

The "dissolution caves" referred to in Juberthie and Iliffe, 1994:452) would include typical anchialine caves like Oven Rock (described in Kornicker and Iliffe (1998) and Hatchet Bay (described in Kornicker and Iliffe, 1989a:4, 19, fig. 4). Such caves have extensive horizontal development, abundant speleothems (stalactites and stalagmites), and marine waters with long residence times in the caves. The term "Blue Hole"

refers to the deep blue water in these sinkholes. "Inland blue holes" are circular, often deep, water-filled shafts that bell out beneath the surface into a wide underwater cavern. Few have solutional cave passages associated with them. "Oceanic blue holes" are openings to extensive, strongly tidal, submerged cave systems. Most of the caves associated with oceanic blue holes are fault caves with parallel walls and collapsed rock on the floor. Norman's Pond Cave, Norman's Pond Cay, is a fault cave, but it lacks strong tidal currents. Mystery Cave, Stocking Island, and Master Harbour Blue Hole, Great Exuma Island, are strongly tidal oceanic blue holes. A new section of Mystery Cave has recently been discovered that extends under Stocking Island to an area lacking in water currents and contains remipedes and possibly other anchialine troglobites (Brian Kakuk, in litt., 1997).

ABBREVIATIONS.—In the figures, Arabic numbers indicate limbs 1–7, as well as the individual joints of each limb (the location of the numeral indicating whether a limb or joint is indicated); the number 5 is also used to designate the sensory bristle of the 5th joint of the 1st antenna. Roman numerals indicate the endites. Arrows indicate the anterior. All measurements are in millimeters unless otherwise noted.

The following abbreviations are used in the illustrations and legends.

am	central adductor muscle attachments
ant	antenna
ap	anterior process
av	anterior view
bas	basale
Bo	Bellonci organ
br	brush-like organ
co	copulatory organ
cx	coxale
end	endopodite
epip	epipodite
esop	esophagus
ex	exopodite
fu	furca
gen	genitalia
gird	girdle
gl	gland
im	inner margin of infold
iv	inside view
le	lateral eye
lft	left
ll	lower lip
lp	lamellar prolongation of selvage
lv	lateral view
me	medial eye
mnd	mandible
mv	medial view
mx	maxilla
ov	outside view
precx	precoxale
pro	protopodite
pv	posterior view
rt	right
rv	right valve
ul	upper lip
up	unpaired bristle of furca

SAMPLING METHODS.—Ostracodes collected along the escarpment off Lee Stocking Island at 88–105 m water depth were obtained with plankton nets, baited traps, and grab and suction samplers placed on ledges (Table 1; Appendix). The plankton net was 30 cm in diameter and had a 93 μm mesh; a scuba diver fanned up the top layer of sediment and then strained this material through the plankton net.

The grab sampler used from the *Nekton Gamma* submersible consisted of a clam-shell type device with a mouth opening of about 30 cm. Surface samples on sandy substrates were obtained from depths of approximately 5 to 10 cm and were dumped into a wire collecting basket lined with a plastic bag; about 3 to 5 scoops of sediment were collected at each site.

The traps consisted of a clear plexiglass cylinder 18 cm long by 11 cm in diameter. A 15 cm diameter funnel placed at one end allowed entry of small animals into the trap. A 93 μm mesh plankton screen at the opposite end permitted water flow through the trap but retained the animals. A 1.5 m long PVC handle was attached to the trap with duct tape. Traps were baited with lobster legs or sandwich meat and placed on ledges with the robot arm of the manned submersible *Nekton Gamma;* one or two days later (in one sample, two years later), the traps were recovered by the submersible and taken to the 25 m water depth where a scuba diver placed the trap in a plastic bag before bringing it to the surface. The trap rested horizontally on the bottom so that one side of the funnel mouth was in contact with the substrate, providing a ramp that benthic animals potentially could use to enter the trap. Swimming animals could enter the trap directly through the funnel.

A sample from the submarine escarpment off Great Exuma Cay was collected with a suction sampler operated from the submersible *Clelia.* The suction sampler consisted of a tube to suck up sediments that was extended by a mechanical arm from the submersible. A water jet was used to create the suction. The suspended sediments were deposited in an external chamber for transport. The sample was obtained from sandy ledges in 90–100 m depth.

Cave samples were collected with a 93 μm mesh plankton net. One sample from Oven Rock Cave was collected with a suction bottle. Salinity, temperature, pH, and dissolved oxygen profiles within the water column at the submarine escarpment off George Town, Great Exuma Island, Bahamas, in Norman's Pond Cave, Norman's Pond Cay, Bahamas, in Church Cave, Hamilton Parish, Bermuda, and in Cenote Maya Blue, Tulum, Quintana Roo, Mexico, were obtained with a Hydrolab Recorder multiprobe logger. This device was carried by divers with the sensors held down in front of the diver's body so as to sample undisturbed water (Figures 2, 3).

SAMPLING RESULTS.—A plankton net drawn across the substrate captures specimens burrowed into the upper few centimeters of sediment as well as specimens that are either crawling on the substrate or swimming just above it. A grab sampler collects a similar array of specimens, and, in addition, might collect more deeply burrowed specimens, if the sampler should

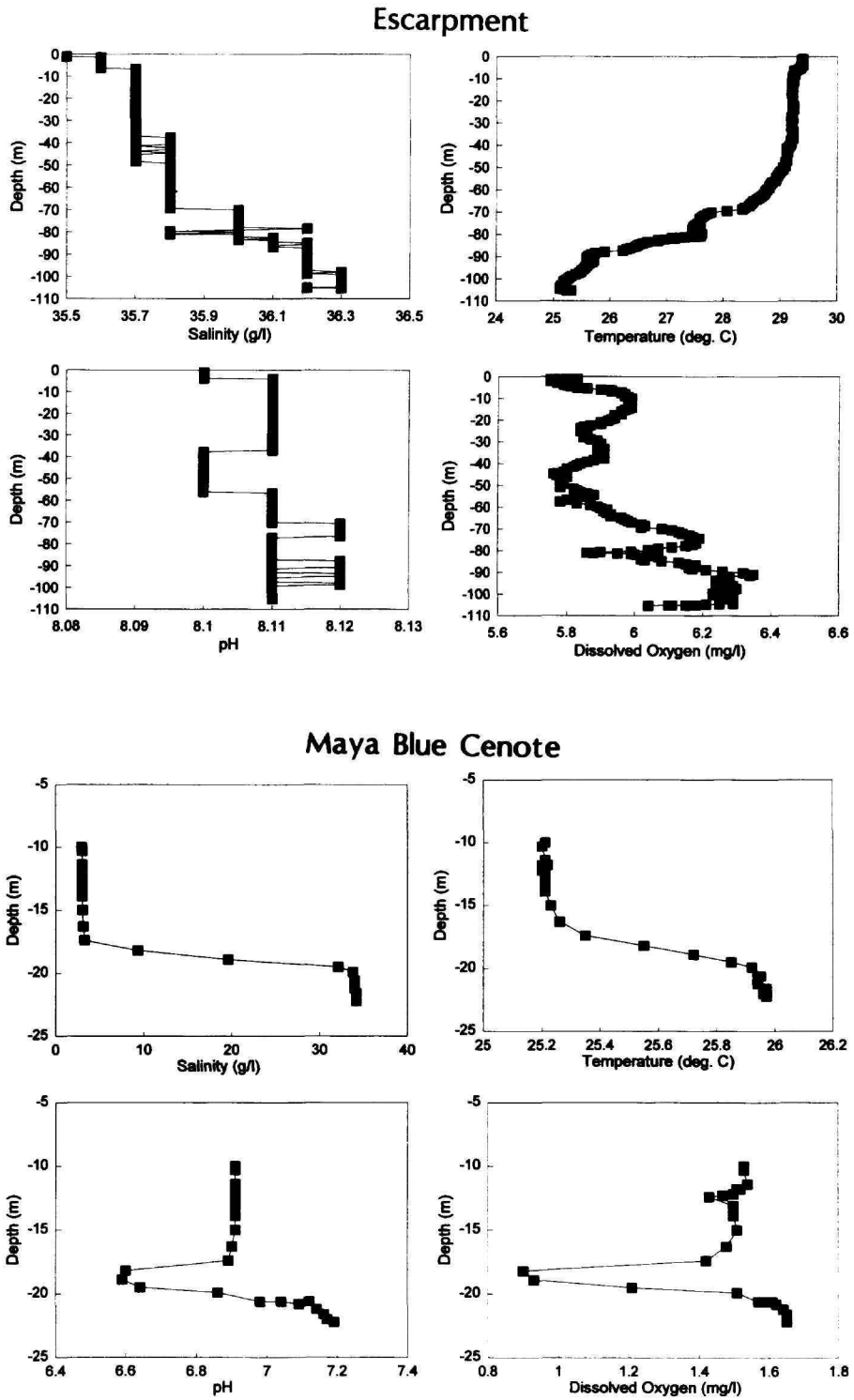

FIGURE 2.—Salinity, temperature, pH, and dissolved oxygen profiles within the water column of the submarine escarpment off George Town, Great Exuma Island, Bahamas, and Cenote Maya Blue, Tulum, Quintana Roo, Mexico.

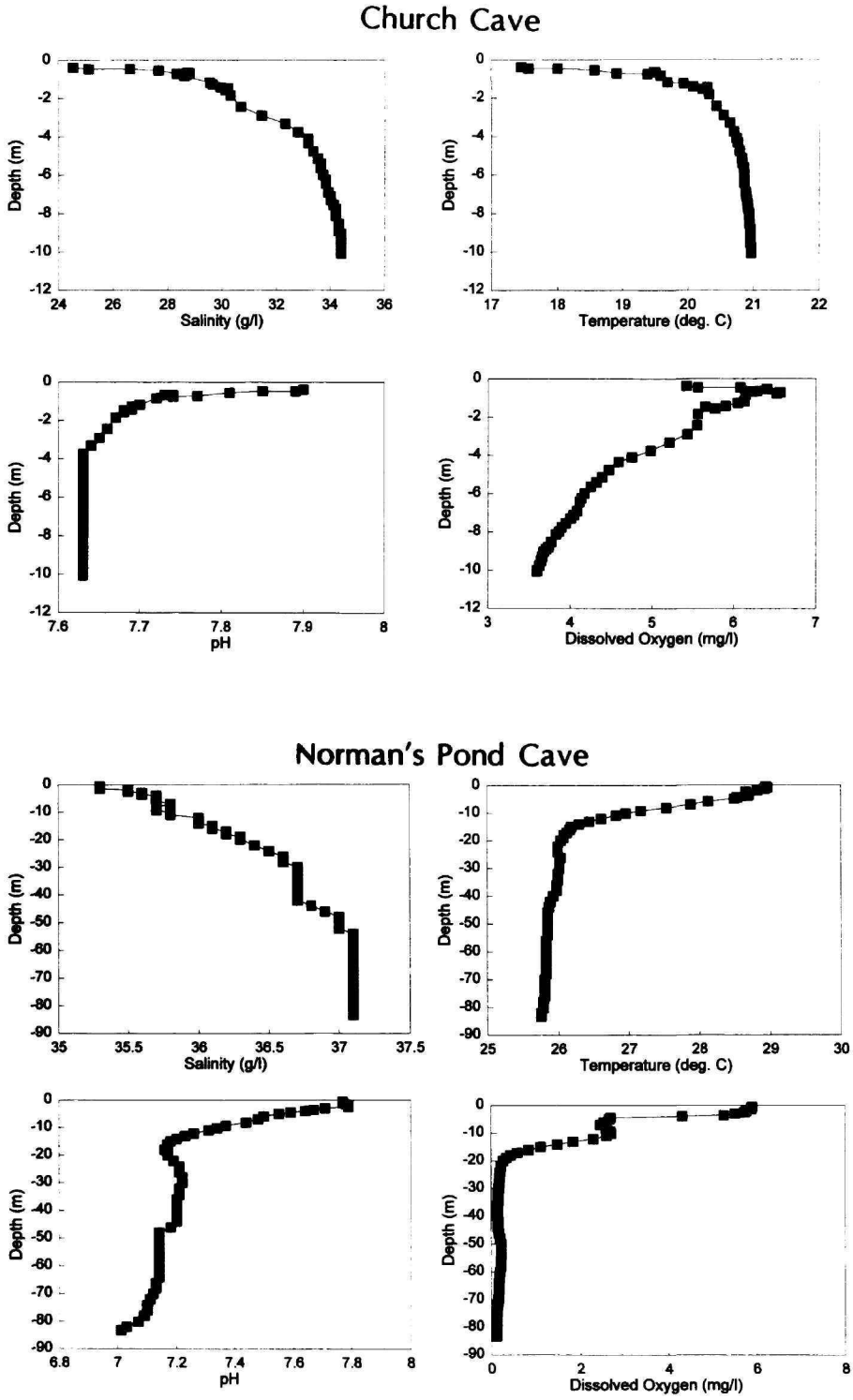

FIGURE 3.—Salinity, temperature, pH, and dissolved oxygen profiles within the water column of Church Cave, Hamilton Parish, Bermuda, and Norman's Pond Cave, Norman's Pond Cay, Exuma Cays, Bahamas.

penetrate more deeply into the sediment than the plankton net. A grab sample, however, generally obtains fewer specimens than a plankton net because it collects from a smaller area. A baited trap having the edge of the funnel mouth on the sediment collects only specimens that are able to swim or climb into the mouth of the trap and that are attracted to the bait. A baited trap with its mouth some distance above the sediment collects only specimens capable of swimming. The trap collects specimens that must exert themselves in order to be captured, whereas specimens are passively collected in a net or grab sampler. A suction tube generally collects specimens on or in the sediment.

Cohen (1983:242) placed traps baited with dead fish on coral reefs in the vicinity of Belize. Traps consisted of one-liter plastic jars. The jars had a funnel with a diameter of 10 cm in the open end. A tube having a diameter of 7 mm extended from the funnel almost to the bottom of the jar. One jar was placed on its side on the bottom, whereas two jars were attached in an upright position to a rod so that they were 45 cm and 70 cm above the substrate (Cohen, 1987:16, fig. 5B; in litt., 1996). The only ostracodes collected in the traps were specimens of *Skogsbergia lerneri* (Kornicker, 1958). *Skogsbergia lerneri* and many other species were collected in net samples drawn through the sediment (Cohen, 1989b:329), but many more specimens of *S. lerneri* were collected in traps than in sediment; it was concluded that most collecting methods (other than traps) have underestimated this species' abundance (Cohen, 1983:242).

In the present collection, the baited traps attracted five species, whereas 12 species were collected in the plankton net and grab sampler and three species were collected in a suction tube (Table 1). No members of either the Sarsiellidae or Rutidermatidae were collected in the traps even though they are capable swimmers. The members of both families are carnivores and, apparently, are not attracted to dead bait. Perhaps prey is located by its movement rather than odor. *Skogsbergia lerneri* was collected in two traps but not in either the plankton net or the grab sampler, which agrees with the finding of Cohen (1983:242) that the species may be more abundant in an area than is indicated by substrate samples. Cohen (1989b:330) estimated that, apparently, at night, *S. lerneri* may swim as far as 400 m to feed.

In addition to *S. lerneri, Synasterope browni,* new species, was collected only in the trap samples. If those species are capable of traveling some distance to feed, it is possible that they do not live precisely where they were collected. *Jimmorinia gamma* Cohen et al., in press, was collected both in a baited trap and in a suction tube; the latter capture indicates that the species lives at the collecting site.

CAVE ZONATION.—Three distinct stages are involved in cave colonization and adaptation: (1) the capacity to enter and survive in caves; (2) the capacity to reproduce, spread, and compete in caves; and (3) the capacity to evolve lineages of increasing troglomorphic and competitive species within caves (Christiansen, 1992:464). A considerable winnowing process goes on for organisms passing from one stage to the next.

These stages in cave colonization may occur in distinct ecological zones that typically are found in anchialine caves (Iliffe, 1986:5). The coastal or open-sea entrance zone has an environment intermediate between cave and open water. Owing to the proximity to the open sea and to strong tidal currents passing through this part of the cave, residence times are on the order of hours. This region contains a rich biota with especially large numbers of sponges, hydroids, bryozoans, and other encrusting organisms. Most of these species also can be found in shaded sites outside the cave. A middle zone shows a marked decrease in species abundance, but it begins to include animals not normally found outside caves. As the strength of tidal currents decreases, residence time increases from several days to a week. The far interior of anchialine caves has a lower diversity, but organisms inhabiting this part of the cave are almost exclusively troglobiants. No noticeable tidal currents are observed, and residence times may range from months to years. Local alteration of this zonation can result from cave collapse, producing surface openings and anchialine pools.

DISPOSITION OF SPECIMENS.—With the exception of most specimens of *Danielopolina mexicana,* specimens have been deposited in the National Museum of Natural History, Smithsonian Institution (S.I.), and have been assigned USNM catalog numbers. All except one specimen of *D. mexicana* have been sent to William F. Humphreys, Western Australia Museum, Perth, Australia, who plans to analyze their DNA.

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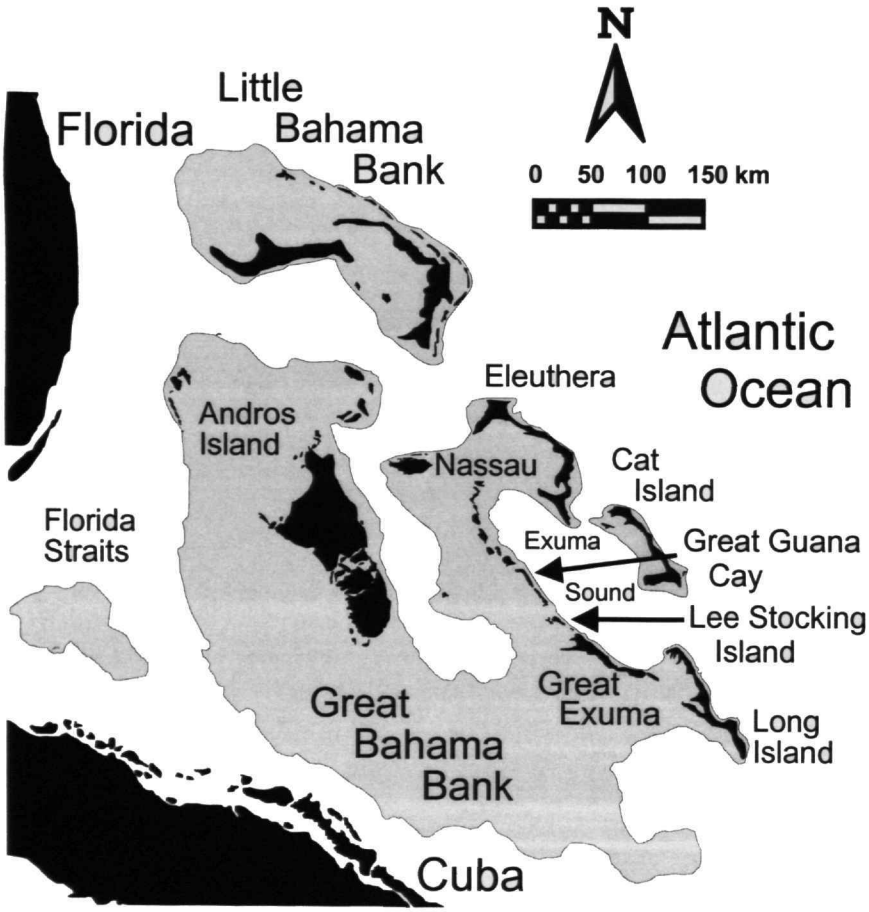
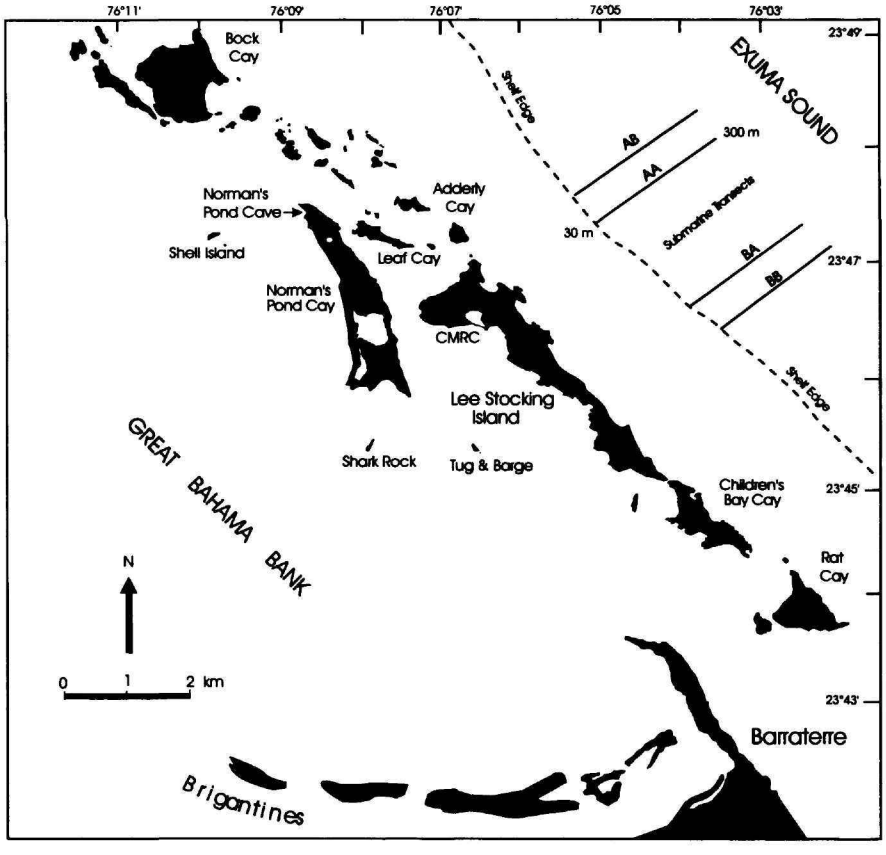
Description of Collection Localities

BAHAMAS.—Collections from the Bahamas were from a submarine escarpment in Exuma Sound, Great Bahama Bank; an anchialine cave on Great Guana Cay and another on Norman's Pond Cay, Exuma Cays, Great Bahama Bank; and from caves and blue holes in the Bahamas and Mexico.

Submarine Escarpment in Exuma Sound: The Great Bahama Bank is part of a series of large segmented fossil carbonate platforms that include parts of Florida, Cuba, Hispaniola, and Mexico's Yucatan Peninsula (Kendall et al., 1990: 10–13) (Map 1). Shallow waters covering the Great Bahama Bank have a surface area of more than 100,000 km^2. The islands, cays, and hard grounds consist of Pleistocene limestone covered by a thin veneer of Holocene carbonate reefs and sediments. Underlying these younger limestones is a continuous section of Tertiary and Cretaceous limestones and dolomites exceeding 11,000 m in thickness. Water depths on the broad, flat-floored interior of the platform are typically less than 10 m. The platform is dissected by several steep-sided submarine canyons, including Exuma Sound, which reach oceanic depths. The upper rim of the southwestern edge of Exuma Sound off Lee Stocking Island, Exuma Cays, is a steep escarpment (Figure 1). At the top of the escarpment, shallow submarine cliffs at 20 m or less have overhanging surfaces cut by still stands of sea level. Pronounced sea-level notches and ledges are especially evident on the nearly sheer rock face at 80 to 120 m depths. A talus slope begins at the base of the escarpment in about 250 m depths. This slope grades downward to a smooth, often gullied, rock surface with a thin sediment veneer. The slope angle of the escarpment is variable. Rock overhangs exist such that before ascending in some areas, it was necessary to move the submersible away from the escarpment in order to avoid rock outcrops.



MAP 1.—Great Bahama Bank showing the location of Lee Stocking Island, Great Guana Cay, and Exuma Sound. (Map based on Caribbean Marine Research Center, Research Opportunities and Proposal Guidelines for 1995, NOAA National Research Program (fig. 2).)



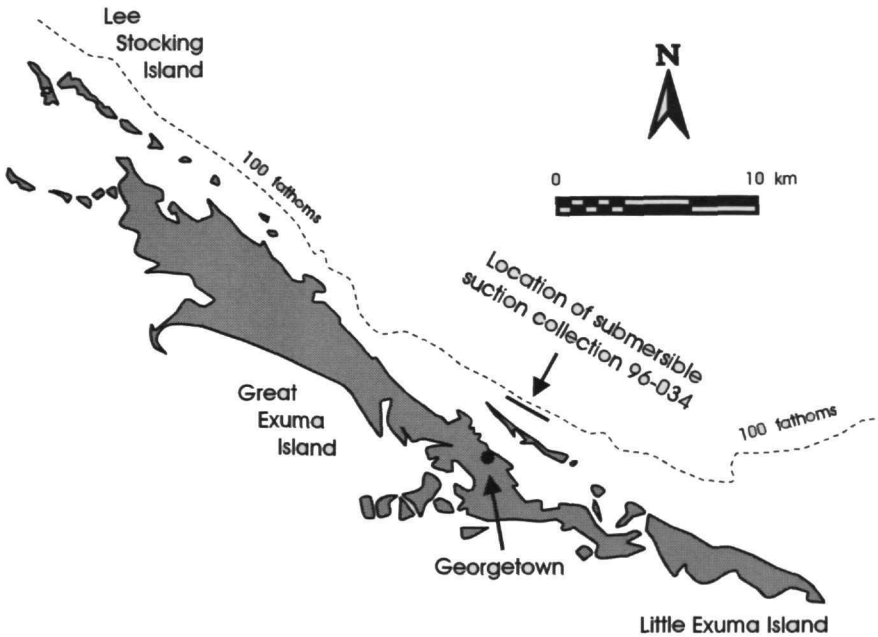
MAP 2.—Part of Great Bahama Bank showing the location off Lee Stocking Island of sampling transects AB, AA, BA, and BB along the submarine escarpment. "Shelf Edge" on the map indicates the location of the upper edge of the submarine escarpment.

The phrase "possible cave entrances," used in station descriptions in the Appendix, refers to numerous holes and undercut ledges on the escarpment. These are particularly common at 90–110 m depths, which was the approximate low point of Pleistocene sea level (according to data from drilled coral reefs off Barbados, sea level was at 131 m below present during the last glacial maximum (Fairbanks, 1989:639)). As the last Pleistocene low sea level stand was only about 18,000 years BP, the contribution of subsidence of the Bahamian Platform (about 1 cm per 1000 years (Sealey, 1994:46)) would not have been significant. These holes and ledges may represent wave-cut notches or even erosional sea caves. Many of these angle upwards so that it was not possible to determine from the submarine whether they continued or simply ended in a blind pocket. No water currents were noted, and no unusually profuse sponge growth (a typical sign of water movement in underwater caves) was observed in any of these. Perhaps these should more correctly be referred to as simply holes and undercut ledges on the escarpment until proven otherwise.

Along with ostracodes, the samples in total yielded small fish, copepods, cumaceans, tanaidaceans, amphipods, polychaetes, isopods, and nebaliaceans. At greater depths, less macrofauna was visible from the submersible, perhaps the result of the presence of more sediment and less exposed rock in deeper water where the slope is more gradual.

The samples were taken along transects AA, AB, BA, and BB, that began at the top of the escarpment (also referred to as the "Wall") in approximately 30 m depth and ended on a downward trending sand and rubble slope at 300 m (Map 2). The transect locations were used by the submersible pilots to navigate along the Wall and for a point of reference. Depth contours are not shown in Map 2, but they would be roughly parallel to the approximately 30 m deep shelf edge (top of the escarpment), which is shown in Map 2. Additional samples were collected on the escarpment off George Town, Great Bahama Bank (Map 3).

Oven Rock Cave, Great Guana Cay: The entrance to this cave is situated in a hillside about 1 km from the tip of the island (Map 4). The cave was described and four species of tro-



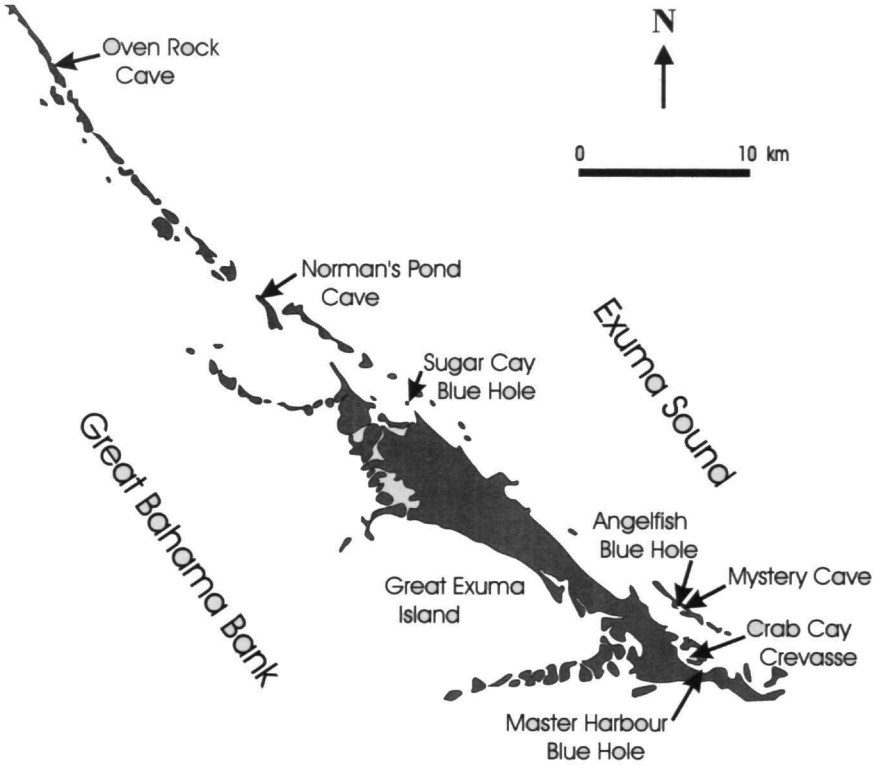
MAP 3.—Part of Great Bahama Bank showing the location of suction samples collected on the submarine escarpment off George Town, Great Exuma Island. (Map based on Defense Mapping Agency Hydrographic Chart 26300.)

globitic ostracodes were reported in the cave by Kornicker and Iliffe (1998): *Spelaeoecia capax* Kornicker, 1990; *S. styx* Kornicker, 1990; *Deeveya exleyi* Kornicker and Iliffe, 1998; and *Danielopolina* species A, Kornicker and Iliffe, 1998. *Danielopolina kakuki,* new species, is described herein. Also, additional specimens of *S. capax* are described herein from the cave.

Norman's Pond Cave, Norman's Pond Cay: The entrance is a 2 m wide by 8 m long sinkhole located near the northern end of Norman's Pond Cay (Maps 2, 4). The cave extends horizontally 210 m and reaches a depth of 86 m (Kornicker and Iliffe, 1998). Waters in the cave are fully marine. Two species of Ostracoda, *Spelaeoecia styx* and *Danielopolina exuma,* were reported in the cave by Kornicker and Iliffe (1998), and additional specimens of those species are reported herein. A specimen of *S. capax* also was collected in the cave.

Mystery Cave, Stocking Island: Mystery Cave is located on the southwest side of Stocking Island in an almost totally enclosed bay that faces Elizabeth Harbour (Map 4). The cave entrance is situated at 6 m depth in a vertical rock wall forming one edge of the island. The cave trends gradually downward, extending under the island, as a 5 m diameter fissure passage, somewhat similar in configuration to Norman's Pond Cave. Very strong reversing tidal currents sweep through this section of the cave, and all exposed rock surfaces are covered by sponges and other encrusting species. At depths exceeding 50 m, the passage becomes much narrower and partially filled with breakdown boulders. Recently, an upper-level passage has been discovered that leads to more hydrologically isolated sections of the cave where anchialine fauna, including remipedes, have been observed (Kakuk in litt., 1997). The isolated sections were not sampled herein. Ostracodes were collected by sweeping a plankton net across the walls and coarse sand bottom of the cave at 50 m water depth. None of the ostracodes are troglomorphs. Tanaidaceans, cumaceans, mysids, amphipods, and nebaliaceans—none apparently troglomorphic—also were collected. Salinity in the cave where the ostracodes were collected is fully marine.

Master Harbour Cave, Great Exuma Island: Master Harbour Cave is located in Master Harbour, about 4 km southeast of George Town on the northeast coast of Great Exuma Island (Map 4). The cave consists of an elongate fissure at 6–8 m depths in a submerged sinkhole. The fissure becomes roofed over at one end and continues as a narrow 1–3 m wide by up to 10 m high rift. Strong tidal currents move through the cave so that it can only be entered by divers at slack tide when the water flow changes direction. Like Mystery Cave, all exposed rock surfaces are covered with encrusting organisms. The cave has been explored horizontally for over 300 m, reaching water depths of 30 m. Ostracodes were collected with a plankton net used to scrape samples from the ceiling in 12–15 m water depths. None of the ostracodes are troglomorphs. Copepods, tanaidaceans, mysids, brachiopods, polychaetes, amphipods, shrimp, bryozoans and cumaceans—none apparently troglomorphic—also were collected. Salinity in the cave is fully marine.



MAP 4.—Part of Great Bahama Bank showing the location of Oven Rock Cave (Great Guana Cay), Norman's Pond Cave (Norman's Pond Cay), Sugar Cay Blue Hole (Sugar Cay), Mystery Cave (Stocking Island), and Master Harbour Blue Hole (Great Exuma Island). (Map based on Defense Mapping Agency Hydrographic Chart 26300.)

Sugar Cay Blue Hole, Sugar Cay: Sugar Cay Blue Hole is located about 50 m offshore from the small island of Sugar Cay, near Barraterre, Great Exuma Island (Map 4). The entrance is a submerged sinkhole about 10 m in diameter and 6 m deep from which extends a 60 cm high by 6 m wide passage floored with deep silt. The water flow in the entrance passage is very low due to its larger cross sectional profile, but it becomes very strong in the subsequent, smaller diameter passageways. Two small, phreatic passages located past the entrance section lie over, and are connected to, a very large and deep fracture type cave system. Entry into the main fracture is accomplished by squeezing through a tiny vertical crack at the end of the largest phreatic tube passage, 180 m from the entrance. Inside the main fracture cave, the tidal flow becomes almost undetectable, and breakdown rocks on the floor are covered with large, deep, silt mounds. This passage is more than 6 m wide and may reach depths in excess of 60 m. Due to the strong tidal flow in the upper, phreatic level section, visually observed animals are generally limited to sessile filter feeders, and the bottom of the passage is usually made up of large shell fragments. Specimens were collected in a very small phreatic tube, 70 m from the entrance, where a small alcove in the rock allowed accumulation of fine sediment away from the strong tidal flow. On 5 August 1995, specimens were collected (by Brian Kakuk) with a 93 μm mesh plankton net from the surface of a silt mound in 31 m depth. None of the ostracodes are troglomorphs.

Conch Sound Blue Hole, Andros Island: Conch Sound Blue Hole is located near the northeastern tip of Andros Island on the Great Bahamas Bank (Map 1). The cave was first dived by Dr. George Benjamin in the 1960s and was further explored by Rob Palmer in the 1980s (Palmer, 1986:271). At the far limits of present explorations, Brian Kakuk (pers. comm., 18 Apr 1996) discovered a large chamber with a passage that continues for more than 1300 m horizontal penetration. Maximum water depth in the cave is 30 m. The cave is fully marine and strongly tidal, with measured current velocities of up to 0.5 m/sec (Warner and Moore, 1984:31). It has a single entrance in shallow, 1–2 m deep, algal and seagrass flats close to shore. The large-entrance sinkhole drops to 10 m depth, whereupon the main passage (2 m high by 4–6 m wide) leads southwest, dropping rapidly to 20–25 m depth and then leveling out. A sessile invertebrate community consisting of hydroids, sponges, ahermatypic corals, anemones, and ascidians covers almost 100% of the rock surface in the main passage (Warner and Moore, 1984:32). Farther into the cave, the sessile community

becomes much less dense. Ostracod specimens were collected from a side passage approximately 700 m from the entrance at a depth of 22 m. The side passage has very little tidal flow and has been partially filled in with fine sediments (silt). Due to low flow conditions, this passage contains only a restricted sessile fauna consisting of a few serpulid worms. Wall rock is very fretted and brittle, with occasional remnants of eroded speleothem. A light dusting of red microbial mat typically covers all horizontal surfaces. This blue hole is equivalent to "Conch Sound #1" referred to in Warner and Moore (1984:30). Also collected in this sample were cumaceans, copepods, polychaetes, tanaidaceans, and isopods. Specimens were collected (by Brian Kakuk) on 6 June 1996 from the surface of a silt mound on the wall of the cave passage in 22 m depth using a 93 μm mesh plankton net. None of the ostracodes are troglomorhs.

Angelfish Blue Hole, Stocking Island: Ostracodes collected in the vicinity of this cave were mentioned by Kornicker and Iliffe (1998), but as the cave was not described in that paper, it is described herein (Map 4). Angelfish Blue Hole is located on the southwest side of Stocking Island in the northwest end of the same bay containing Mystery Cave. The cave entrance is a large submerged sinkhole at 10 m depth in the center section of the bay. The 2 m diameter cave passage leading off from the bottom of the entrance pit trends to the west at depths of 27 to 30 m for at least several hundred meters. Salinity in the cave is fully marine. Very strong tidal currents sweep through the cave. All rock surfaces are covered by encrusting sponges, hydroids, etc. Ostracodes were collected with a suction bottle from a ledge outside the cave entrance at 8 m depth and thus represent an open water, rather than a cave sample. Cumaceans, mysids, tanaidaceans, copepods, and a shrimp also were collected.

Crab Cay Crevasse, Crab Cay: Ostracodes collected in this cave were mentioned by Kornicker and Iliffe (1998), but as the cave was not described in that paper, it is described herein (Map 4). Crab Cay Crevasse is a submarine blue hole located in the central section of the bay between Great Exuma Island and Crab Cay. The entrance is a crescent-shaped collapse depression leading into a 5–10 m wide, boulder-floored passage at 40 m depth. Salinity in the cave is fully marine. Strong tidal currents are present, and abundant encrusting sponges, hydroids, etc. cover all rock surfaces. Ostracods in sample 95-010 were collected with a plankton net from a sand and shell hash on the bottom, about 100 m inside the cave at 35 m depth. Copepods, tanaids, and cumaceans also were collected in this sample. Sample 95-009 was collected with a suction bottle from algae covered rocks outside the cave entrance in 3 m depth and yielded copepods, mysids, cumaceans, and tanaidaceans, but no ostracods.

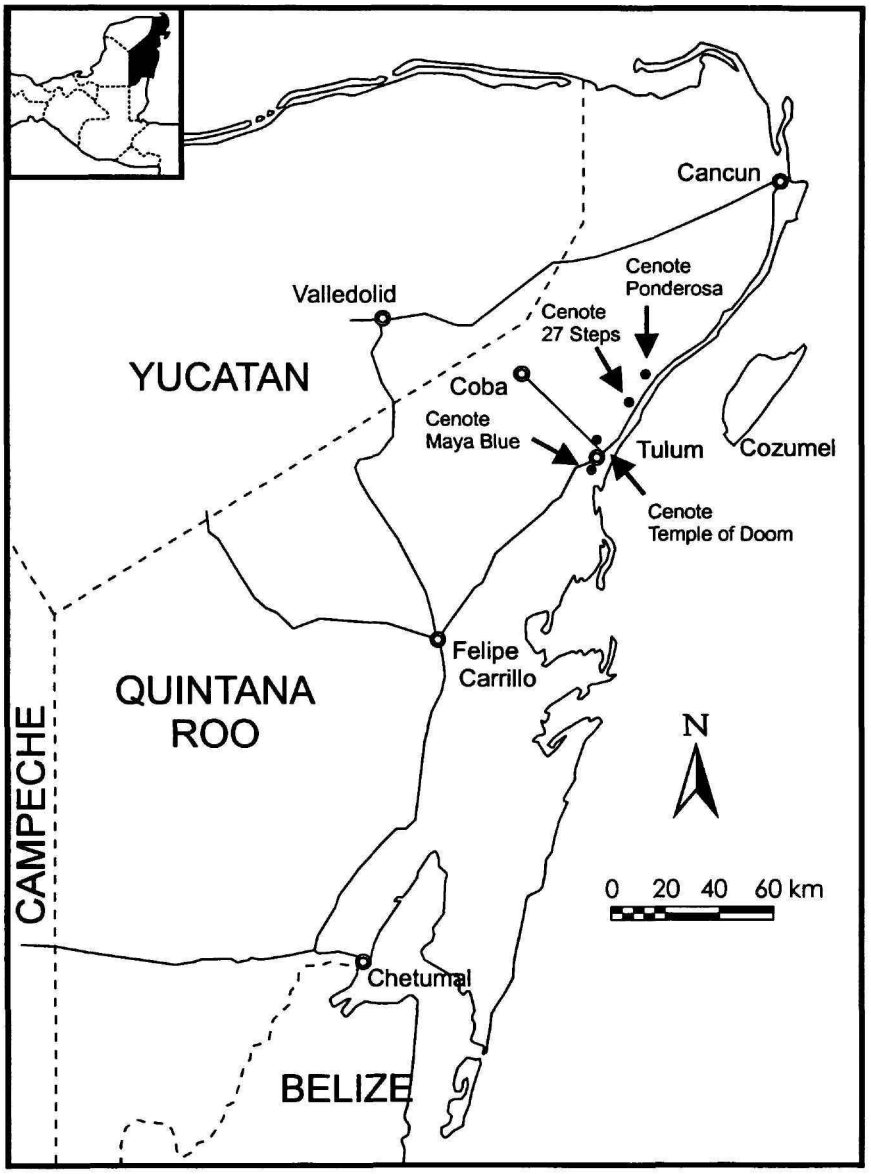
MEXICO.—Collections were made from two anchialine cenotes in the Yucatan Peninsula, which is a flat limestone plain with no surface streams or rivers. All drainage is subterranean through extensive networks of submerged cave systems. Kornicker and Iliffe (1989a:15; 1998) described *Danielopolina mexicana* and *Spelaeoecia mayan* from the Cenote Maya Blue, which is one of the two main entrances of the Systema Naranjal Cave System located about 5 km inland from the Caribbean coast near Tulum. They also reported *D. mexicana* from the Cenote Temple of Doom (also known as Cenote Esqueleto) near Tulum (Map 5). The two cenotes reported upon herein, Cenote Ponderosa and Cenote 27 Steps, are located along the eastern coast in the state of Quintana Roo, about 20 km northeast of both Tulum and Cenote Maya Blue (Map 5).

Cenote Ponderosa: This cenote is part of an 11.5 km long cave (Systema Ponderosa) located 4 km south of Puerto Aventuras and 1 km inland (west) of the main coastal highway. The main cenote is a 100 m long by 40 m wide collapse depression with a large lake covering most of the bottom. A spacious cavern, 18–24 m wide by 6 m high, extends 90 m back to the Cenote Corral. From the Cenote Corral, an underwater passage extends for more than 600 m to an air-filled cave chamber called the Chapel. The halocline in the cave is at 11.5 m. Specimens of *D. mexicana* were collected in the submerged passages between Cenote Corral and the Chapel.

Cenote 27 Steps: This cenote was named for the 27 cement steps that lead down the sinkhole slope to the edge of the pool. The steps were constructed within the last 10 years as part of an unsuccessful attempt to develop this cave for use by tourist divers. This cave is located about 1.5 km west of the main highway at Akumal along a dirt road that intersects a large powerline. The cave is about 200 m north and 30 m west of the powerline. The cenote consists of a 30 m long by 2 m wide and 8 m deep sinkhole with a pool extending along the undercut edges around three sides of the cenote. Three underwater passages extend from the pool. The left and center passages connect below the halocline in a series of large rooms that have walls that have been highly etched by solution. The far right passage off the main pool extends into a 12 m diameter air-filled dome room containing many tree roots. Total surveyed length of the cave is 760 m. The halocline in the cave is at 13 m depth. Specimens of *D. mexicana* and *S. mayan* were collected in the cave.

BERMUDA.—Collections were made from Church and Bitumen Caves, two anchialine caves located adjacent to one another on the grounds of Castle Harbour Hotel in Hamilton Parish (Map 6). Angel and Iliffe (1987:545) and Kornicker and Iliffe (1989b:46) reported *Spelaeoecia bermudensis* Angel and Iliffe, 1987, from nine other anchialine caves in Bermuda. The same species is reported herein from Church and Bitumen Caves. Of interest is that each of the two caves contained at least one adult male of *S. bermudenis*. Previously, an adult male was known from only Wonderland Cave, Bermuda (Kornicker, 1989:313).

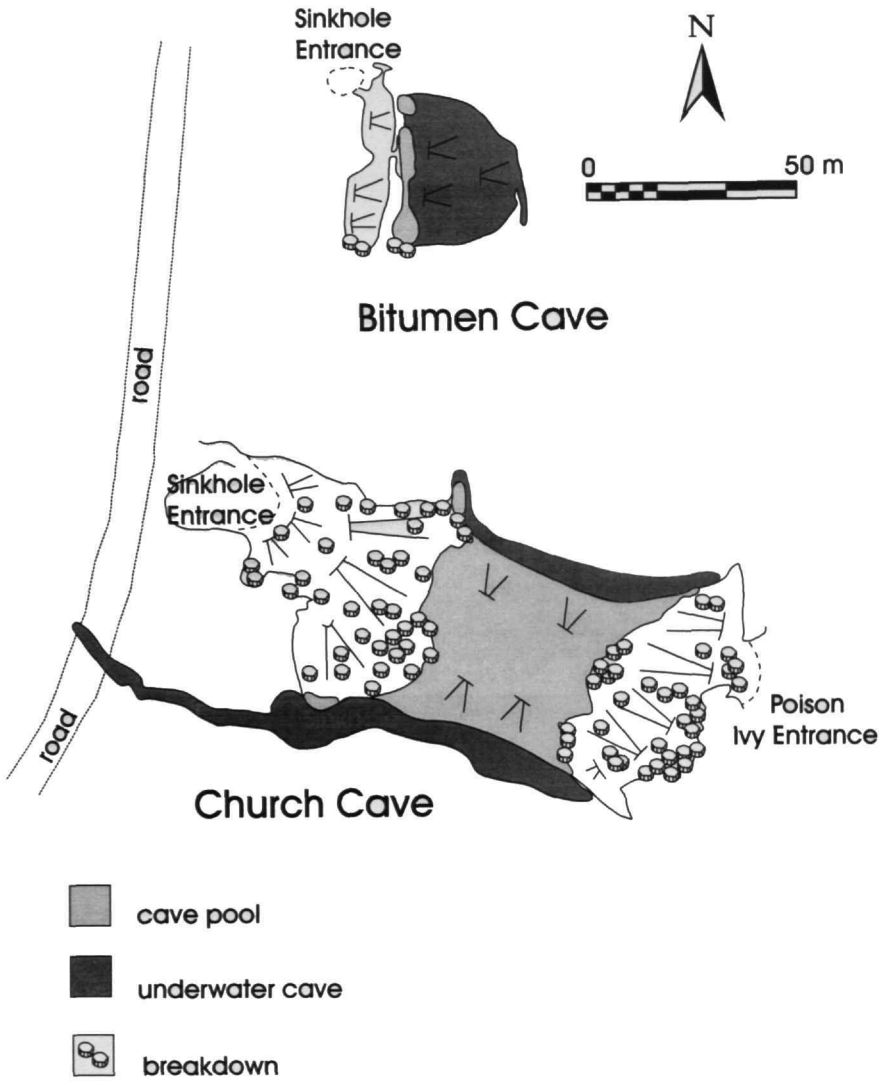
Church Cave: This cave contains the largest underground lake in Bermuda (Map 6). This breakdown-floored lake measures approximately 40 m by 35 m and covers an area of 1400 m^2. The lake contains tidal seawater reaching a maximum depth of 23 m. Considering that the cave entrance is 44 m above sea level, the total depth of this cave is thus 67 m, mak-



MAP 5.—Northeastern coast of Yucatan Peninsula, Mexico, showing the locations of Ponderosa, 27 Steps, Temple of Doom, and Maya Blue cenotes. (Map derived from Reddell (1977, fig. 11).)

ing it the deepest cave in Bermuda (Courbon et al., 1989:45). Tides in the lake are 40% that of the open ocean and occur 106 minutes later (Iliffe, unpublished data). The reduced amplitude and relatively long delay for the tides indicate a rather indirect connection with the sea and a corresponding long residence time for the cave waters. An underwater passage at depths from 7.5 to 14 m was surveyed extending away from the pool in a westwardly direction for 92 m. The main entrance to the cave consists of a 30 m diameter collapse sinkhole, with a breakdown slope leading down to the lake. On the far side of the lake, a steep breakdown slope ascends to a second entrance on the far side of the hill. The second entrance had at one time been used as a dump, and it contains a large amount of broken bottles, rusting metal, and other debris.

Bitumen Cave: This cave lies just north of Church Cave (Map 6). The entrance is located in an area of thick undergrowth bordered by the main hotel road on the west and a golf cart track on the south. The entrance consists of a collapse sinkhole floored with broken glass and other debris (Map 6). At the base of the sink is a small, very unstable opening to a



MAP 6.—Plan view of Bitumen and Church caves, two adjacent anchialine caves located on the grounds of Castle Harbor Hotel in Hamilton Parish, Bermuda. (Map derived from a 1974 map by A.N. Palmer, M.V. Palmer, J.M. Queen, and J.E. Mylroie that was later published in Mylroie et al. (1995:261, fig. 6).)

passage covered by glass and metal debris that descends into a large chamber with a sloping floor. This chamber contains hundreds of rusted and crumbling metal drums still containing residues of what appears to be bitumen. Although these barrels fill the bottom two-thirds of the chamber below the entrance, they have become wedged in such a way that only one was found in the pool at the lower level of the cave.[1]

At the south end of the main chamber, a vertical 7.5 m pit reaches a tidal salt water pool. This pool connects to an underwater room well decorated with speleothems. A deep rift follows the overall trend of the cave down to a depth of 25.5 m where a low unexplored passage heads in the direction of Church Cave. This depth is the deepest yet reached in any of Bermuda's underwater caves and is less than 5 m away from the limestone-basalt interface that averages 30 m below sea level. Based on the similar overall orientation of the breakdown

[1]Any further disturbances or collapse in the cave could dislodge the barrels and cause them to slide into the pool. The barrels presumably date from the early days, about 1930, of the Castle Harbour Hotel. Several areas of recent subsidence are evident in the parking lot next to the hotel cycle shop. As this site is situated directly above the 1.5 m wide by 30 m long main chamber, further collapse could result in the entire ceiling of the cave and anything sitting on top of it dropping into the void.

slopes in Church and Bitumen Caves and the observation that these caves end in breakdown, the two are most likely connected, at least hydrologically. On a rising tide, silt stirred up from the pool in Bitumen Cave was observed drifting in the direction of Church Cave.

Physical and Chemical Parameters of the Escarpment and Caves

Along with ecological zonation patterns, well-developed vertical zonation of chemical and physical parameters occur within the cave water column. These were less evident on the submarine escarpment.

Submarine Escarpment: According to Hydrolab profiles taken in September, 1996, with the submersible along the escarpment of Exuma Sound, physical and chemical parameters within the water column (Figure 2) varied as follows:

	Minimum	Maximum
Depth	0 m	105 m
Salinity	35.5 g/l	36.3 g/l
Temperature	25.2°C	29.4°C
pH	8.10	8.12
Dissolved Oxygen (percent saturation)	92	98
Redox potential (mV)	372	393

Caves: Well-developed vertical zonation of chemical and physical parameters occur within the cave water column (Figures 2, 3). Surface salinities of the three caves range from 2.9 g/l in Cenote Maya Blue (Figure 2) to 23.3 g/l in Church Cave (Figure 3) and 35.3 g/l in Norman's Pond Cave (Figure 3). Deeper waters in the three caves approach open ocean salinities. In Cenote Maya Blue, salinity increases from 3.3 to 33.8 g/l across an abrupt halocline situated between 17.4 and 19.9 m depth. Salinity gradually increases with depth in both Church and Norman's Pond caves, which lack significant haloclines. In Cenote Maya Blue and Church Cave, water temperature increases with increasing salinity in a conservative fashion. On the other hand, water temperature in Norman's Pond Cave varies inversely with salinity. Temperature profiles taken at various seasons of the year confirm these trends and suggest that perhaps deeper cave waters in Yucatan and Bermuda may be geothermally warmed.

A sharp drop in both dissolved oxygen and pH occurs at the halocline in Cenote Maya Blue, but levels recover in the underlying salt water. Minimum pH and dissolved oxygen values at the halocline reach 6.6 and 0.9 mg/l, respectively. As a result of density differences, particulate organic matter is likely to accumulate at the halocline. The microbial oxidation of this organic matter, with associated CO_2 output, could account for the oxygen depletion and hydrogen ion production. In both Norman's Pond and Church caves, pH first decreases with increasing depth and then stabilizes at values of 7.6 and 7.1, respectively. After a subsurface peak, dissolved oxygen levels in Norman's Pond Cave drop rapidly to 0.2 mg/l at 20 m depth and then stay uniformly very low to depths of at least 83 m.

Biogeographic Comparisons

It was somewhat unexpected that only four of the 13 species collected from the Exuma Sound escarpment had previously been recorded from the Bimini area by Kornicker (1958) (Table 2). In part, this is probably the result of different collecting techniques, but mostly it may be attributed to the Bimini samples having been collected from 1–20 m water depth and the Exuma Sound samples having been collected from depths of 62–142 m. It also seems likely that if more samples had been available from Exuma Sound, more of the Bimini species would have been collected because some Bimini species (*Harbansus paucichelatus* (Kornicker, 1958), *Pseudophilomedes ferulanus* (Kornicker, 1958), and *Amboleberis americana* (Müller, 1890)) have been collected in deeper water elsewhere in the Caribbean, the Atlantic shelf, and the Gulf of Mexico (Kornicker, 1986b, table 3).

TABLE 2.—Comparison of Myodocopa in the Bimini area and in Exuma Sound and the depths (in meters) at which they were collected. (– = no specimens collected.)

Taxa	Bimini	Exuma escarpment
CYPRIDINIDAE		
Jimmorinia gamma	–	105
Jimmorinia gunnari	–	88–105
Skogsbergia lerneri	shallow	96–105
Vargula exuma	–	62
PHILOMEDIDAE		
Harbansus paucichelatus	1–20	–
Pseudophilomedes ferulanus	6	–
Zeugophilomedes multichelata	shallow	–
SARSIELLIDAE		
Chelicopia arostrata	1–3	–
Eurypylus eagari	–	67
Eurypylus hapax	–	142
Eusarsiella capillaris	2–20	–
Eusarsiella "carinata"	1–20	–
Eusarsiella costata	2–20	62–67
Eusarsiella gigancantha	1–20	–
Eusarsiella punctata	1–5	–
Eusarsiella ryanae	–	67
Eusarsiella truncana	1–20	–
RUTIDERMATIDAE		
Rutiderma dinochelatum	1–20	–
Rutiderma schroederi	–	67
Alternochelata polychelata	1–5	–
CYLINDROLEBERIDIDAE		
CYLINDROLEBERIDINAE		
Diasterope procax	–	88–142
Parasterope extrachelata	shallow	–
Parasterope muelleri	shallow	67
Synasterope browni	–	96
Synasterope setisparsa	1–5	–
CYCLASTEROPINAE		
Amboleberis americana	3–10	–
ASTEROPTERONINAE		
Actinoseta chelisparsa	3–15	67
Asteropella monambon	3–20	–

TABLE 3.—Number of specimens of halocyprids collected in Oven Rock and Norman's Pond caves in different years. (* data from Kornicker and Iliffe (1998).)

Taxa	Oven Rock Cave				Norman's Pond Cave			
	1993*	1994*	1995	1996	1993*	1994*	1995*	1996
No. of samples with halocyprids	4	1	1	2	4	4	2	1
Spelaeoecia capax	15	2	41*	65	0	0	0	1
Spelaeoecia styx	10	2	7*	2	24	29	0	1
Deeveya exleyi	1	0	0	0	0	0	0	0
Danielopolina kakuki	0	0	1	0	0	0	0	0
Danielopolina exuma	0	0	0	1	6	28	1	0
Danielopolina species A	0	1	0	0	0	0	0	0

Three species (*Jimmorinia gamma, J. gunnari* Cohen et al., in press, and *Synasterope browni*) were collected in Exuma Sound mainly in baited traps, which had not been used in the Bimini area. *Jimmorinia gunnari* is widespread in the Caribbean where it has been collected in baited traps (Cohen et al., in press).

Other species reported from the Bahamas but not collected in Exuma Sound are *Rutiderma darbyi* Kornicker, 1983 (San Salvador and Andros Island; known depth range of this widespread species is intertidal to 168 m (Kornicker, 1983:11)), *R. cohenae* Kornicker, 1983 (San Salvador and Key West, Florida; subtidal to 4 m (Kornicker, 1983:11)), and *Eusarsiella athrix* Kornicker, 1986 (San Salvador; depth 2.4 m (Kornicker, 1986a:13)) (Table 2).

TEMPORAL EFFECT

The ostracodes collected in the Bahamas from Oven Rock Cave on Great Guana Cay, and Norman's Pond Cave on Norman's Pond Cay, have been described by Kornicker and Iliffe (1998) from collections made in 1993, 1994, and 1995. This paper provided the opportunity to compare the ostracodes in the caves over a span of several years (May 1993 to Aug 1996) (Table 3).

The populations of *S. capax* in samples collected from 1993 to 1996 (excluding sample from Sta 96-033) in Oven Rock Cave are compared in Table 4. Both juveniles and adults were in all years.

TABLE 4.—Comparison of the populations of *Spelaeoecia capax* in Oven Rock Cave in different years. (* data from Kornicker and Iliffe (1998); † does not include specimens from sta 96-033.)

Stage	1993*	1994*	1995*	1996†
No. of samples	4	1	1	1
Instar A–4 (Instar III?)	0	0	2	0
Instar A–3 (Instar IV?)	1	0	6	1
Instar A–2 (Instar V?)	1	1	4	3
Instar A–1 (Instar VI?)	3	0	5	5
Adult females	8	0	11	5
Adult males	1	1	13	5

Superorder MYODOCOPA Sars, 1866

Order MYODOCOPIDA Sars, 1866

Suborder MYODOCOPINA Sars, 1866

The Myodocopina contain five families; four are represented in the present collection.

Superfamily CYPRIDINOIDEA Baird, 1850

Family CYPRIDINIDAE Baird, 1850

Subfamily CYPRIDININAE Baird, 1850

Vargula Skogsberg, 1920

TYPE SPECIES.—*Cypridina norvegica* Baird, 1850.

COMPOSITION AND DISTRIBUTION.—This genus has numerous species and is cosmopolitan between 80°N and 74°S and at depths from 0–3431 m (Kornicker, 1994).

Vargula exuma, new species

FIGURES 4–10

ETYMOLOGY.—This species is named for its type locality.

HOLOTYPE.—USNM 194410, A–1 female (Instar V) on slide and in alcohol. (The appendages of the next instar are visible within appendages of the holotype.)

TYPE LOCALITY.—Sta 94-020, transect AB, Exuma Sound, Bahamas, depth 62 m.

PARATYPES.—None.

DISTRIBUTION.—Collected only at type locality, in baited trap.

AGE AND SEX OF HOLOTYPE.—The age of the holotype is based mainly on the number of bells on the bristles of the 7th limb. Most bristles of the A–1 instar have only one bell, whereas three are present on the bristles of the adult, which are visible within the bristles of the A–1 instar. A similar relationship was reported for the A–1 instar and adult of *Skogsbergia lerneri* by Cohen (1983, fig. 4). The sex of the holotype is interpreted to be female because suckers are not present on any of the 7th joint bristles of the 1st antennae, which are visible

inside the 1st antennae of the A–1 instar. The claws of the furca of the adult appear sclerotized, but the anterior protopodial tooth of the 5th limb is not. Many bristles on the appendages of the adult are poorly developed, suggesting that the specimen is in an early stage of ecdysis.

DESCRIPTION OF A–1 FEMALE (Instar V) (Figures 4–10).—Carapace oval in lateral view with small projecting caudal process (Figure 4*a*).

Ornamentation (Figure 4*c*): Surface with crescent-like scallops and scattered minute pores, some with small bristle. Ends of surface crescents projecting slightly past valve edge resulting in edge appearing denticulate.

Infold: Rostral infold with 16 or 17 divided bristles in row just posterior to anterior edge of rostrum, 5 or 6 divided bristles in row along list dorsal to ventral edge of rostrum, 2 bristles (1 long, 1 short) posterior to anterior row, 1 minute bristle posterior to inner end of incisur, and paired divided bristles (1 long, 1 short) on edge of inner end of incisur (Figure 4*d*). Anteroventral infold with 2 small divided bristles near inner end of incisur, 1 divided bristle closer to inner margin of infold, and 2 bristles (one indicated by socket in Figure 4*e*) anterior to anterior end of narrow scalloped list. Anteroventral list with row of 35 divided bristles (anterior bristles longer); 6 double bristles in row between anteroventral list and inner margin of infold (Figure 4*e*). List between infold at valve midlength and posteroventral infold, at place where infold broadens to form caudal process, with about 5 small widely separated bristles. List of caudal process with row of 8–13 minute bristles (Figure 5*a,b*). List of caudal process of right valve only with numerous pointed teeth along outer edge and about 9 minute processes near anterior end of spined part of list (Figure 5*b*). List of caudal process of left valve without row of pointed teeth present on right valve, but instead with a narrow shelf with undulating outer edge (Figure 5*a*). Left valve with minute indistinct truncate processes lateral and posterior to narrow shelf. Row of minute spines or processes just within outer edge of infold of caudal process (Figure 5*a,b*).

Selvage: Narrow lamellar prolongation with faint striations and smooth outer edge present along ventral and anterior margins; lamellar prolongation along ventral margin of incisur broad and striated (Figure 4*c*).

Carapace Size (length, height in mm): USNM 194410, 2.31, 1.50; height 65% of length; length to height ratio 1.54.

First Antenna: 1st joint bare. 2nd joint with ventral and dorsal spines and row of minute distal lateral spines (Figure 5*c*). 3rd joint short with 2 bristles (1 ventral, 1 dorsal). 4th joint with 2 bristles (1 ventral, 1 dorsal). Sensory bristle of 5th joint with 8 long proximal filaments, 2 shorter and slenderer distal filaments, and bifurcate tip (Figure 5*d*). 6th joint with short medial bristle near dorsal margin. 7th joint: a-bristle longer than bristle of 6th joint; b-bristle longer than a-bristle and with 3 short proximal filaments; c-bristle long with about 11 slender filaments (most with few spines) and bifurcate tip. 8th joint: d- and e-bristles long, bare, about twice length of b-bristle; f- and g-bristles long, each with about 10 slender filaments (most with few spines) and bifurcate tip; minute terminal thumb-like process present on joint adjacent to f-bristle (detail in Figure 5*e*).

Second Antenna: Protopodite with short distal medial bristle (Figure 6*a,b*). Endopodite 3-jointed (Figure 6*a,b*): 1st joint with 3 proximal bristles (1 long, 2 short) and 1 long distal bristle; 2nd joint elongate with short distal bristle; suture between 2nd and 3rd joints well developed; 3rd joint short with long terminal filament. Exopodite (Figure 6*c*): 1st joint with spines along concave dorsal margin; bristle of 2nd joint reaching 9th joint, with 1 or 2 small ventral spines followed by 6 stouter spines; bristles of joints 3–8 with natatory hairs, no spines; 9th joint with lateral spine about same length as basal spine of 8th joint and with 4 bristles (2 long and 1 medium with natatory hairs, 1 short (dorsal) bare); joints 2–8 with basal spines; joints 2–8 with small indistinct spines forming row along part of distal margin.

Mandible: Coxale endite terminating in 2 spines with small peg between them; small bristle present at base of endite (Figure 6*d*). Basale: ventral margin with 2 short a-bristles with bases on medial side, 1 short b-bristle close to a-bristles and with base on lateral side, 1 long and 1 short c-bristle near midlength, and 2 distal d-bristles, both some distance from c-bristles; dorsal margin with bristle just distal to midlength and 2 subterminal bristles (Figure 6*d*); medial surface spinous. Exopodite hirsute with pointed tip and 2 subterminal ventral bristles. 1st endopodial joint with 4 ventral bristles (2 short, 2 long). 2nd endopodial joint (Figure 6*d–f*): dorsal margin with 12–14 bristles (5 long, 4 or 5 short proximal, 3 or 4 medium distal; one of the short bristles with long marginal spines); ventral margin with 2 single distal bristles and subterminal pair of pointed bristles (medial unringed, lateral ringed); medial surface with rows of spines near dorsal margin. 3rd endopodial joint with 3 long pectinate claws and 4 bristles (ventral bristle spinous and slightly enlarged near base) (see detail in Figure 6*f*).

Maxilla (Figure 7*a–d*): Endite I with total of about 11 pectinate claws and spinous bristles; endite II with total of 5 pectinate claws and spinous bristles; endite III with about 5 bristles (1 proximal, 4 terminal). Precoxale and coxale with dorsal hairs. Coxale with spinous dorsal bristle. Basale with long ventral bristle and 1 short bristle near exopodite. Exopodite hirsute, with hirsute proximal bristle and 2 terminal bristles (middle bristle hirsute, other with short indistinct spines). 1st endopodial joint with rows of dorsal spines, 4 alpha-bristles (2 long spinous, 2 short bare or with short indistinct spines), and 3 beta-bristles (2 bare, 1 (outer bristle) with stout spines along inner margin); cutting tooth with 2 or 3 cusps (distal cusp with square tip); small rounded node present lateral to beta-bristles (Figure 7*d*). 2nd endopodial joint with 4 a-bristles (2nd from posterior with stout marginal spines), 2 stout pectinate b-bristles, 3 spinous or pectinate c-bristles, and 3 stout pectinate d-bristles.

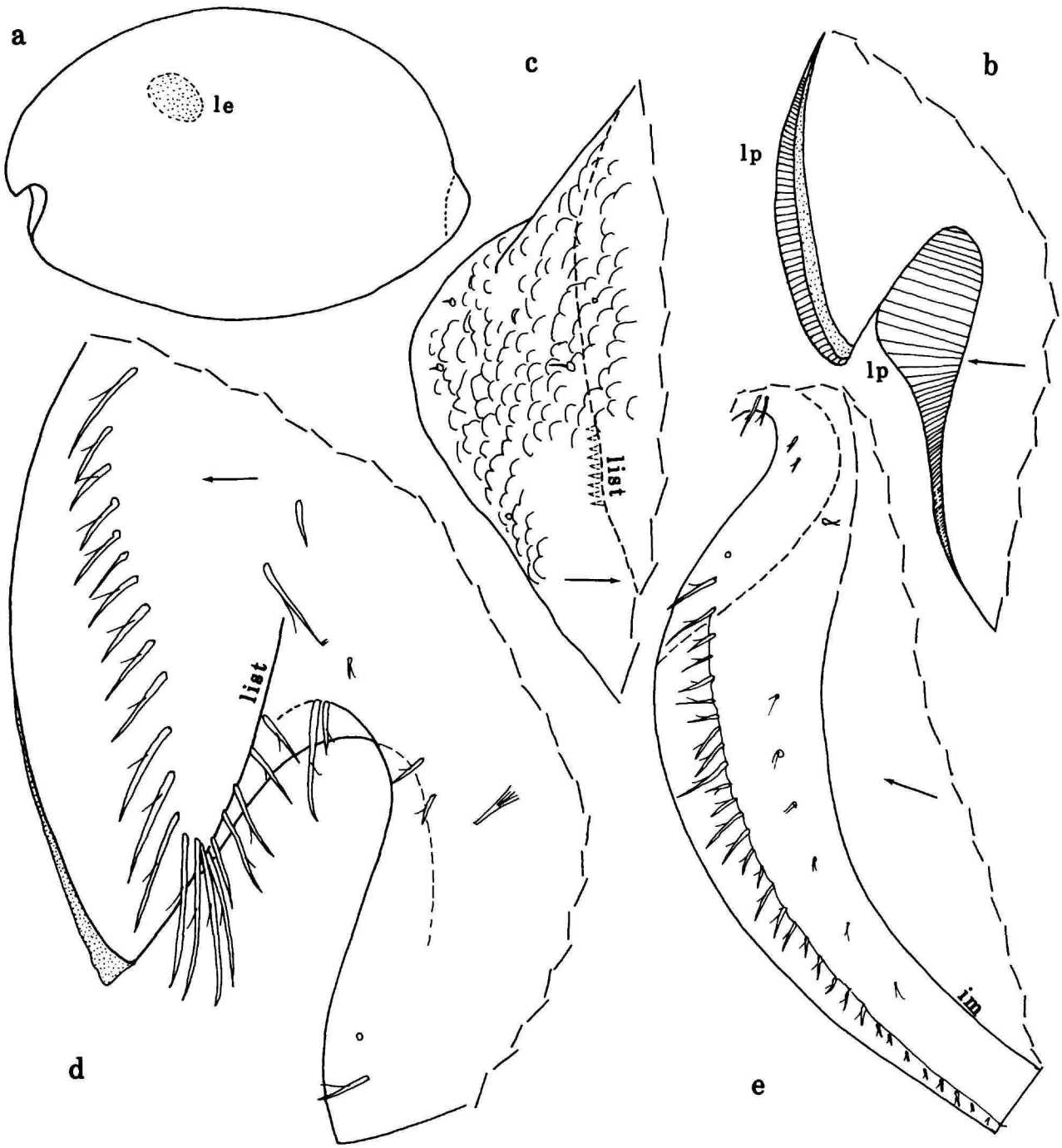


FIGURE 4.—*Vargula exuma*, new species, A–1 female, holotype, USNM 194410: *a*, complete specimen from left side, length 2.31 mm; *b*, anterior of right valve (no bristles shown), iv; *c*, caudal process, right valve, ov; *d*, rostrum and incisur, right valve, iv; *e*, anteroventral margin, right valve, iv.

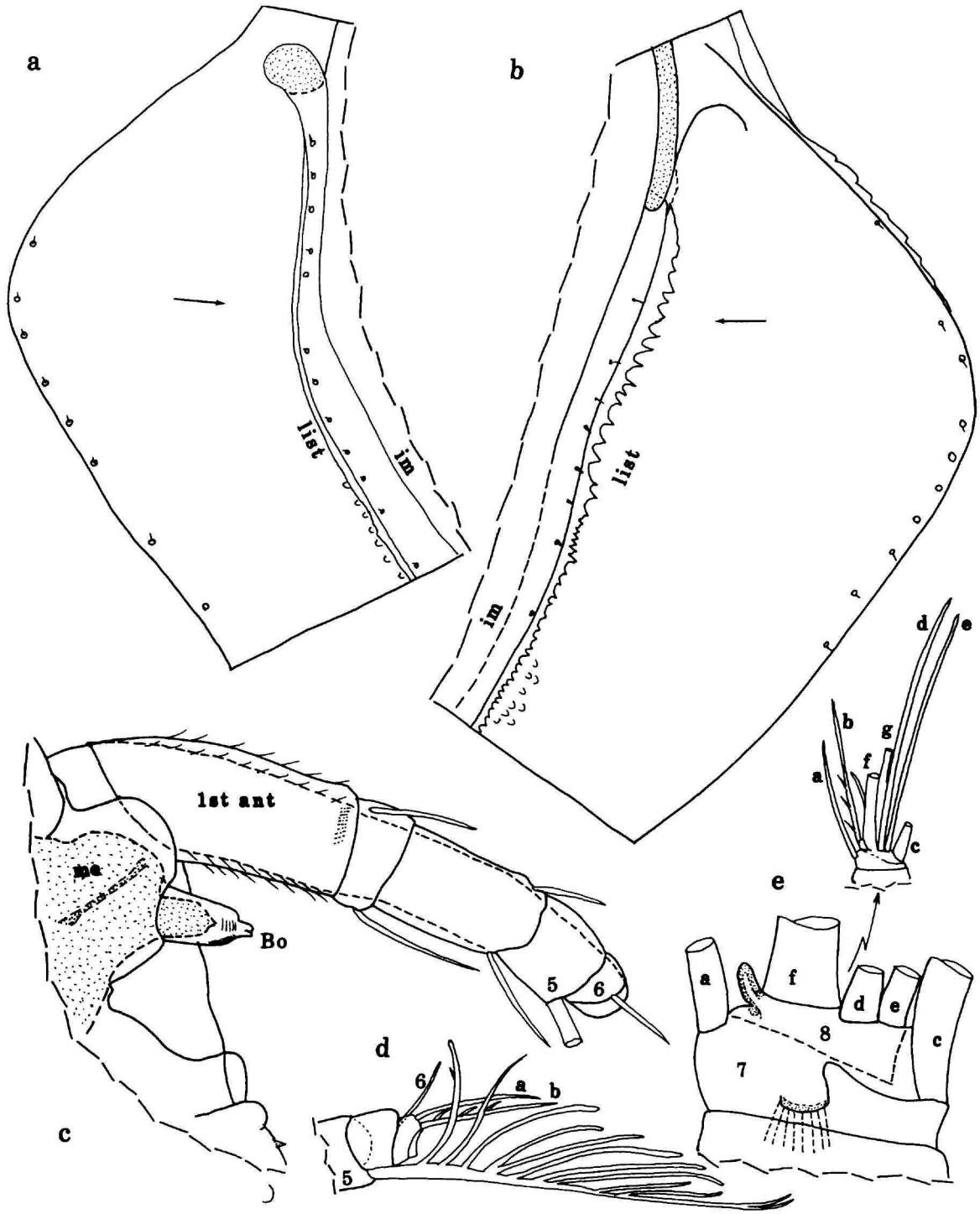


FIGURE 5.—*Vargula exuma*, new species, A–1 female, holotype, USNM 194410: *a,b*, caudal process of left and right valves, iv; *c*, anterior of body from right side (stippled areas within medial eye and Bellonci organ are the eye and organ of adult female); *d,e*, tip of right 1st antenna, lv.

FIGURE 6.—*Vargula exuma*, new species, A–1 female, holotype, USNM 194410: *a,b*, endopodite and part of protopodite of left and right 2nd antennae, mv; *c*, exopodite, right 2nd antenna, lv; *d–f*, left mandible, mv.

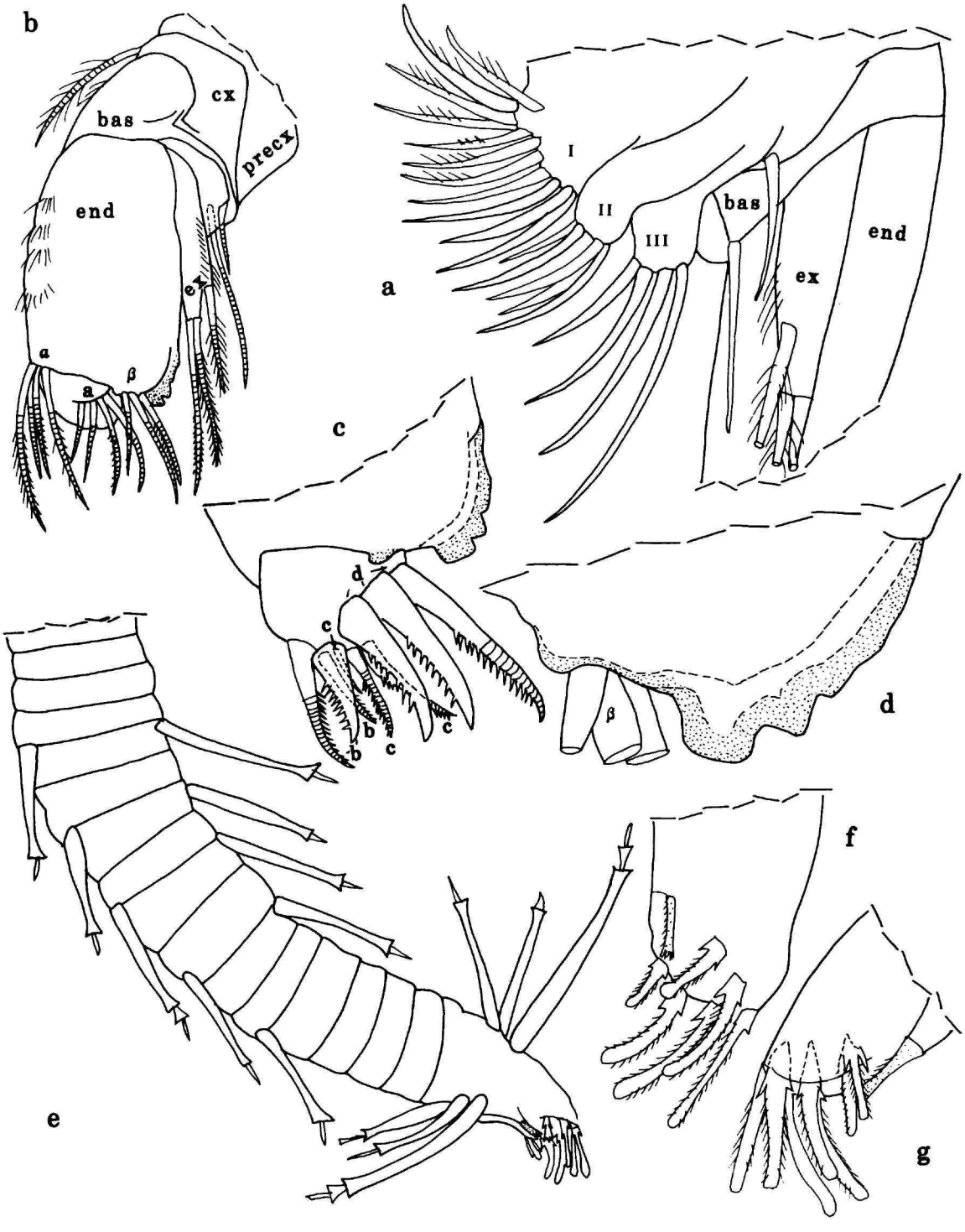


FIGURE 7.—*Vargula exuma*, new species, A–1 female, holotype, USNM 194410: *a*, part of right maxilla, lv; *b–d*, parts of left maxilla, lv; *e,f*, right 7th limb; *g*, tip of left 7th limb.

Fifth Limb (Figure 8): Epipodite with 49 spinous bristles. Endite I with 3 or 4 spinous bristles; endite II with total of 5 spinous bristles and pectinate claws; endite III with total of 7 spinous bristles and pectinate claws. Protopodite with long undulate anterior tooth; a cluster of 6–8 fairly stout spines present on proximal anterior side of protopodite (Figure 8*c,h,i*); a few rows of minute spines distal to cluster of stouter spines. 1st exopodial joint with 5 pectinate teeth and triangular proximal peg with drawn-out tip (Figure 8*g*); bristle with few long proximal spines present near peg; anterior side with 3 spinous bristles forming row and 1 spinous bristle close to protopodial tooth (innermost bristle also pectinate distally). 2nd exopodial joint with 4 unringed pectinate claw-like a-bristles (Figure 8*e*; only proximal a-bristle shown in Figure 8*f*), 3 b′-bristles, and 4 b″-bristles, all ringed and pectinate (Figure 8*f*); anterior and posterior sides of joint each with proximal bristle with long proximal hairs and short distal spines. Inner lobe of 3rd exopodial joint with 1 proximal bristle (with long proximal hairs and short distal spines), 1 long subterminal bristle, and 1 shorter terminal bristle; outer lobe with 2 terminal bristles (outer bristle with long proximal hairs and short distal spines, inner bristle with short spines). 4th and 5th exopodial joint separated by thin but fairly well-defined suture. 4th joint with 4 bristles (either bare or with short spines). 5th joint with 2 terminal bristles with short spines. Outer lobe of 3rd exopodial joint and joints 4 and 5 hirsute; 5th joint also with few small spines along inner edge (Figure 8*d*).

Sixth Limb (Figure 9*a*): 4 bare epipodial bristles. Endite I with 3 spinous bristles (2 short medial, 1 long terminal); endite II with 4 spinous bristles (2 short medial, 2 long terminal); endite III with 4 spinous bristles (1 medial, 3 terminal); endite IV narrower than endite III, with 3 spinous bristles (1 medial, 2 terminal). Most bristles of end joint of USNM 194410 fragmented during dissection. End joint of next instar, visible inside fragmented end joint, containing 5 or 6 spinous anterior bristles followed by small space and 3 stout bristles.

Seventh Limb (Figure 7*e–g*): Each limb with 15 or 16 strongly tapered bristles, 9 or 10 proximal (4 or 5 on each side), and 6 terminal (3 on each side). Proximal bristles with single bell, rarely with 3 bells; terminal bristles with 1 bell on 4 bristles and 2 bells on 2 longer bristles. Comb consisting of 4 or 5 long recurved teeth and 2 short teeth (1 on each side). Single long peg with terminal spines opposite comb. (On the limb having a comb with 5 long teeth, the middle tooth is longer than the 2 long teeth on one side but is shorter than the two long teeth on the other side.)

Furca (Figures 9*b,c,* 10*e*): Each lamella with 8 claws; claws 2 and 4 without suture at base, remaining claws separated from lamella by suture; claw 3 about same length as claw 4 but narrower. All claws with small teeth along posterior edge; claw 1 with distal medial teeth becoming larger distally; many claws with minute spines along anterior margin. Furca of next instar, visible inside present instar, bearing 9 claws on each lamella (Figure 10*e*).

Bellonci Organ (Figure 9*d*): Short, cylindrical with short nipple at tip.

Eyes: Medial eye smaller than lateral eye, bare, with narrow line of brown pigment (Figure 9*d*). Lateral eye large with brown pigment and 16 ommatidia (Figure 9*d*).

Upper Lip (Figure 9*e–h*): Anterior undivided part with 40 glandular processes in 3 rows (middle row with 16 processes, lateral rows each with 12 processes; each lateral row divided into 3 groups with 2 processes in anterior group, 3 in middle group, and row of 7 in posterior group (Figure 9*h*). Left tusk with 1 proximal and 3 terminal processes; right tusk with 3 proximal and 3 terminal processes; both tusks without hairs. Orientation of slit-like opening in each glandular process in left lateral row forms mirror image with slit-like opening in equivalent glandular process in right lateral row (Figure 9*h*). Orientation of slit-like openings in glandular processes in middle row without apparent uniformity (Figure 9*h*).

Anterior of Body (Figure 9*d,e*): Small rounded process ventral to attachment of 1st antennae; 3 minute spines just ventral to base of process.

Posterior of Body (Figure 9*c*): Smoothly rounded, bare.

Genitalia: Absent.

Y-*Sclerite* (Figure 9*c*): Typical for family.

DESCRIPTION OF ADULT FEMALE (Figure 10).—Description is based on appendages visible through appendages of Instar A–1 (Instar V).

Carapace Size: Skogsberg (1920:146) estimated the growth factor of *Vargula norvegica* to be 1.21. Using that growth factor on the length (2.31 mm) of the A–1 instar of *V. exuma* (USNM 194410), the length of the adult female should be about 2.80 mm.

First Antenna: Bristles indistinct but no suckers visible on them indicating specimen is not male.

Maxilla: With same number of exopodial and endopodial bristles as on A–1 instar.

Fifth Limb (Figure 10*a*): Endite bristles not counted. Protopodite with long undulate unsclerotized tooth. Only 4 pectinate teeth observed on 1st exopodial joint, one less than on A–1 instar (almost all known species of *Vargula* with 6 teeth (Kornicker, 1991, table 2), 2 teeth probably not yet extruded at time of collection); inner bristle row of 3 anterior bristles of 1st exopodial joint with much stouter marginal teeth than on A–1 instar. 2nd exopodial joint with same number of a- and b-bristles as on A–1 instar. Same number of bristles present on joints 3–5 as on A–1 instar; 5th exopodial joint well developed as on A–1 instar, but suture separating 4th and 5th joints not observed.

Seventh Limb: Short bristles having only 1 bell on A–1 instar, 3 bells on adult (3 bristles in proximal group examined) (Figure 10*d*). Comb with 2 short bristles on each side and 7 long bristles between them; middle long bristle shorter than bristle on either side of it (Figure 10*b,c*).

Furca (Figure 10*e*): With 9 claws on each lamella.

FIGURE 8.—*Vargula exuma*, new species, A–1 female, holotype, USNM 194410, parts of 5th limb (nabs): *a–d*, right limb, av; *e,f*, right limb, pv; *g*, left limb, pv; *h,i*, left limb, av.

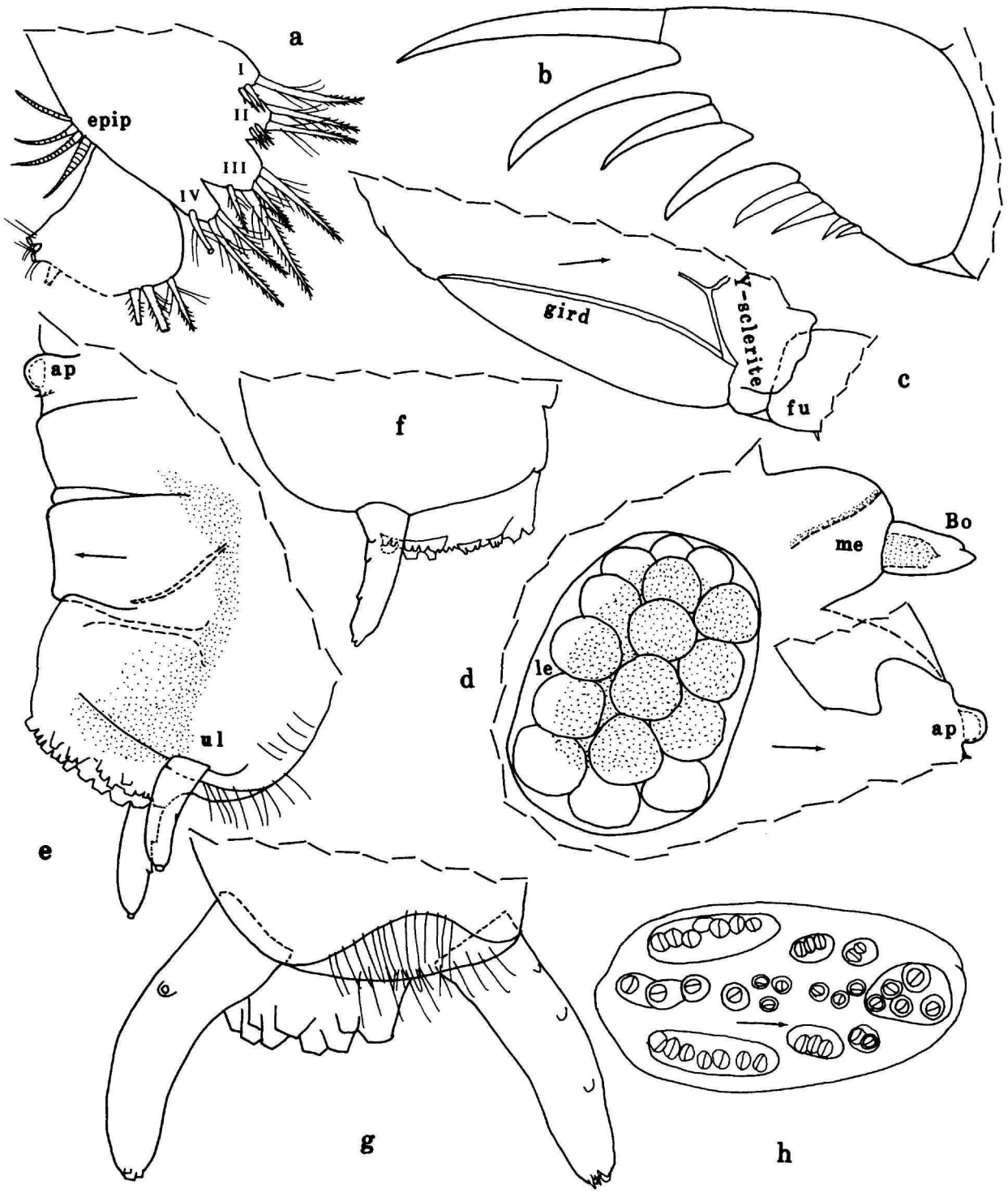


FIGURE 9.—*Vargula exuma*, new species, A–1 female, holotype, USNM 194410: *a*, left 6th limb, mv; *b*, left lamella of furca, lv; *c*, posterior of body from right side; *d*, portion of anterior of body from right side (stippled area within Bellonci organ is adult Bellonci organ); *e*, portion of anterior of body from left side; *f*, upper lip from right side; *g*, upper lip, pv (at slight angle); *h*, ventral surface of anterior part of upper lip as seen in dorsal view.

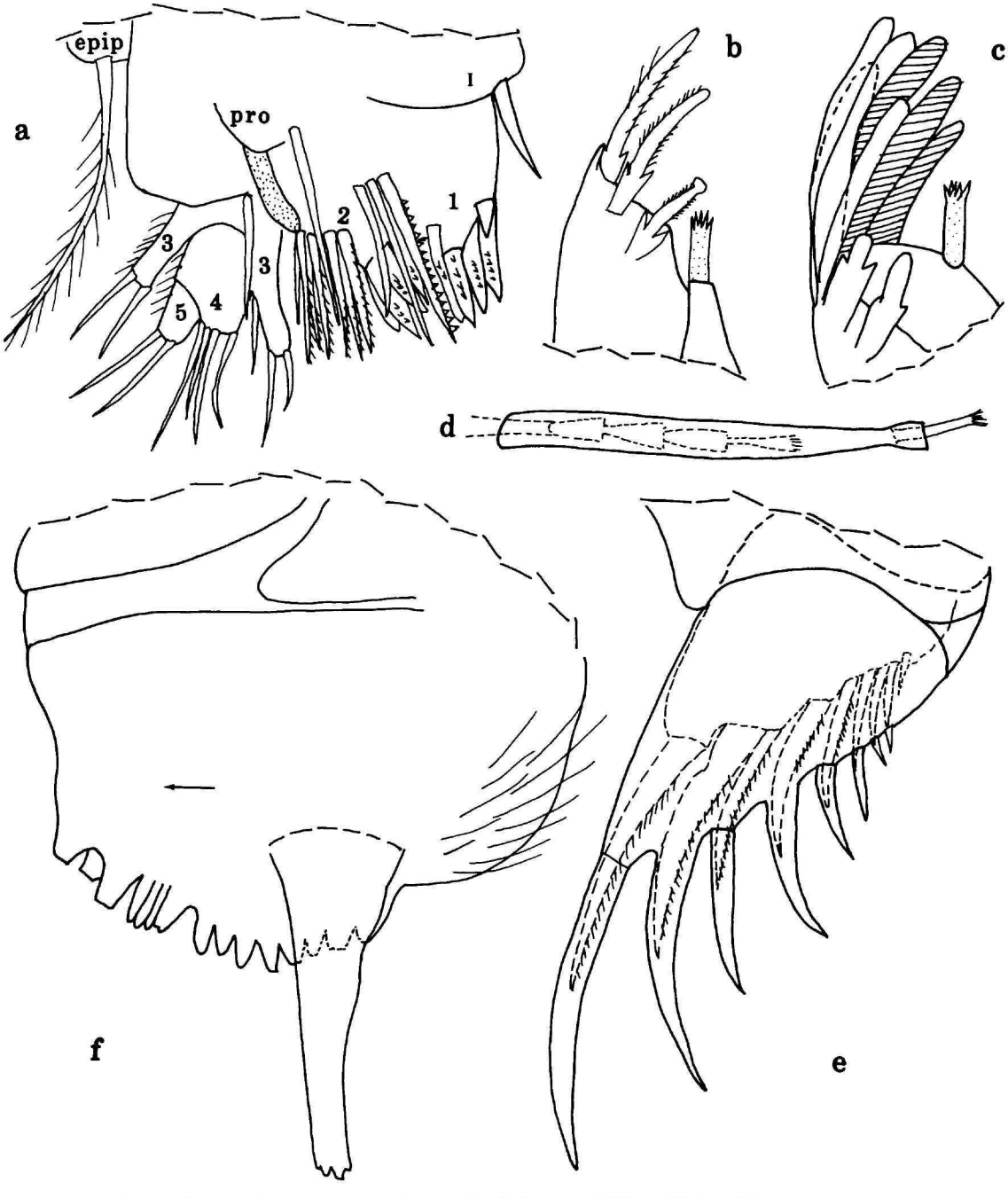


FIGURE 10.—*Vargula exuma*, new species, A–1 female, holotype, USNM 194410: *a*, right 5th limb of adult female viewed through 5th limb of A–1 female, av; *b*, tip of 7th limb of adult female viewed through 7th limb of A–1 female (only 3 of 7 teeth shown); *c*, tip of 7th limb opposite that shown in *b* (striated long teeth are those on far side of limb; middle tooth dashed); *d*, bristle of 7th limb showing dashed bristle of adult female; *e*, left lamella of furca showing dashed left lamella of adult female (not all teeth of claws shown); *f*, upper lip of adult female viewed through upper lip of A–1 female, from left side.

Bellonci Organ (Figure 9*d*, stippled part): Similar to that of A–1 instar.

Upper Lip (Figure 10*f*): Appearing incompletely developed but, in general, similar to that of A–1 instar.

COMPARISONS.—It is not known whether or not *V. exuma* is bioluminescent, but because so many Caribbean species of *Vargula*, in which this character is known, have bioluminescent displays (Cohen and Morin, 1990:383), it is likely that *V. exuma* is bioluminescent.

With the exception of having four rather than two alpha-bristles on the 1st endopodial joint of the maxilla, the appendages of *V. exuma* have the characters of the appendages of Group F females listed in the "Morphological Key to Adult Bioluminescent Species of *Vargula* from the San Blas Islands, Panama" presented by Cohen and Morin (1989:337). These are "MANDIBLE without terminal bulb-based bristle; FOURTH LIMB [maxilla] with 2 alpha-, 3 beta-, 4 a-, 3 b-, and 3 c-bristles; FIFTH LIMB with unfused fourth and fifth exopodial joints bearing 6 bristles; SEVENTH LIMB terminal comb with longest tooth lateral, ANTERIOR OF BODY with small pointed projections V [ventral] to rounded projection." The shell length to height ratio and the small caudal process of *V. exuma* also conforms with Group F species.

Known *Vargula* species of Group F from the Caribbean listed by Cohen and Morin (1990, table 1) include *V. graminicola* Cohen and Morin, 1986; *V. shulmanae* Cohen and Morin, 1986; *V. harveyi* King and Kornicker, 1965; and *V. parasitica* (Wilson, 1913).

The 7th limb of *V. exuma* differs from that of *V. harveyi* in that it lacks a terminal jaw opposite the comb. The maxilla of *V. exuma* differs from those of *V. graminicola, V. parasitica, V. harveyi,* and *V. shulmanae* in having four rather than two alpha-bristles. The 5th limb differs from *V. shulmanae* in having four rather than three bristles on the 4th exopodial joint.

A row of pointed teeth present along the posterior edge of the ridge of the caudal process of the right valve of *V. exuma* is lacking in both *V. tsujii* Kornicker and Baker, 1977, and *V. magna* Kornicker, 1984.

Vargula species indeterminate

FIGURES 11–13

MATERIAL.—Sta 94-020, USNM 194411, 1 Instar I.

DISTRIBUTION.—Sta 94-020, transect AB, Exuma Sound, depth 62 m, in baited trap.

DESCRIPTION OF INSTAR I (Figures 11–13).—Carapace with caudal process about ½ valve height (Figure 11*a–c*).

Carapace Size (length, height in mm): USNM 194411, 0.97, 0.58; height 60% of length; length to height ratio 1.67.

First Antenna: 1st, 2nd, and 4th joints without bristles. 3rd joint with 2 bristles (1 ventral, 1 dorsal). Sensory bristle of 5th joint long, without filaments. 6th joint with medial bristle about same length as 5th joint. 7th joint: a-bristle same length as bristle of 6th joint; b-bristle about twice length of a-bristle, bare; c-bristle longer than sensory bristle of 5th joint, bare. 8th joint: d- and e-bristles slightly shorter than sensory bristle of 5th joint, bare with blunt tips; f-bristle long, without filaments, and bent dorsally; g-bristle about same length as c-bristle, bare.

Second Antenna: Protopodite with small distal bristle. Endopodite 3-jointed with short bristle on 2nd joint and long terminal filament on 3rd joint (Figure 11*d*). Exopodite: bristle of 2nd joint reaching 7th joint, with 7–10 fairly stout ventral spines; bristle of 3rd joint with distal natatory hairs and with or without slender proximal ventral spines; bristles of joints 4–8 with natatory hairs; 9th joint with 2 bristles (1 short (dorsal) with small spines, 1 long with natatory hairs), and bifurcate lateral spine about ½ length of joint.

Mandible: Coxale endite spinous with 2 stout terminal spines without process between them. Basale: ventral margin with 1 short a-bristle (missing on right limb of USNM 194411 (Figure 11*f*), 1 long c-bristle, and 1 long d-bristle fairly close to c-bristle (bristles slightly farther apart on right limb of USNM 194411 than on left limb) (Figure 11*e,f*); dorsal margin with 1 long bristle distal to midlength and 2 long subterminal bristles. Exopodite hirsute distally, about same length as, or slightly shorter than, dorsal margin of 1st endopodial joint, with 2 subterminal bristles (distal bristle ⅓ to ½ length of proximal bristle). 1st endopodial joint with 2 unequal long ventral bristles. 2nd endopodial joint: ventral margin with stout subterminal finger (finger with narrow sclerotized (amber-colored) outer part and transparent inner flange) (Figure 11*e*); dorsal margin with 3 short and 3 long bristles proximal to midlength (2nd short bristle with long indistinct spines). 3rd endopodial joint with ventral bristle with bulge in proximal part and narrow ringed distal part, and with 3 claws (dorsal claw narrow bare with slightly bent tip; ventral lateral claw with broad base and 4 minute proximal ventral teeth (Figure 11*g*); ventral medial claw slightly shorter than ventral lateral claw, with small triangular projection on proximal ventral margin and 4 minute proximal ventral teeth (Figure 11*e*)).

Maxilla: Coxale with fringe of long dorsal hairs (Figure 13*b*). Endite I with 6 bristles; endite II with 3 or 4 bristles; endite III with 4 bristles (Figure 13*a*). Basale with long lateral ventral bristle near exopodite (Figure 13*c,e*). Exopodite well developed with 3 long bristles (proximal and middle bristles with long hairs) (Figure 13*f*). 1st endopodial joint with 1 alpha-bristle with slender hairs, 1 pectinate beta-bristle, triangular cutting tooth, and distal long hairs (Figure 13*d*). 2nd endopodial joint with 2 b-bristles, 2 c-bristles, and 2 d-bristles (Figure 13*d*).

Fifth Limb (Figure 12*a,b*): Epipodite with about 30 spinous bristles. Protopodal tooth absent. Endite I with 2 bristles (1 stout spinous, 1 minute spine-like and posterior); endite II with 3 bristles; endite III with 3 or 4 bristles. 1st exopodial joint: anterior side with long spinous bristle (this could be d-bristle of 2nd joint); main tooth single with 3 fused parts: proximal part with broad flange, 2nd part broad with 13 stout teeth, and 3rd

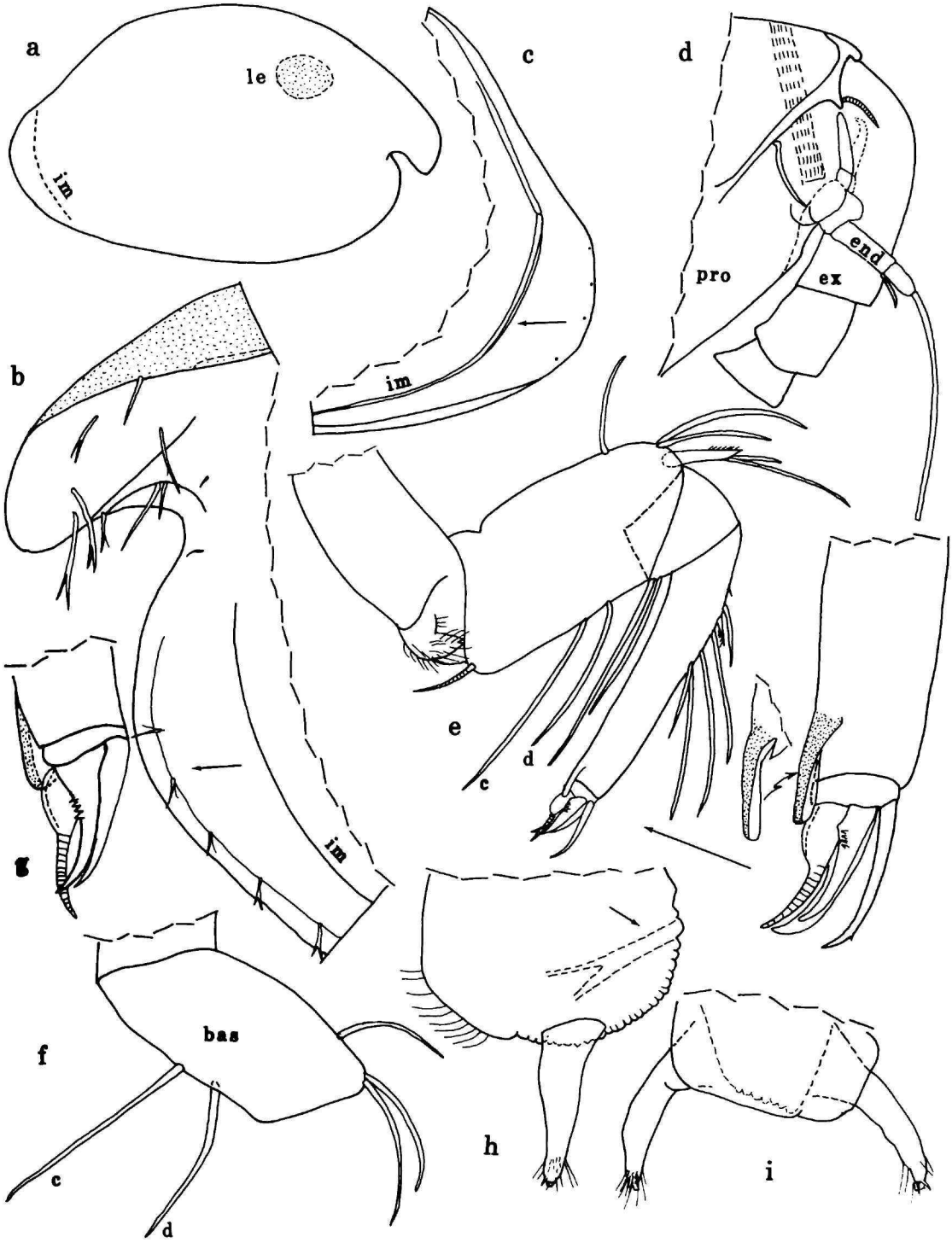


FIGURE 11.—*Vargula* species indeterminate, Instar I, USNM 194411: *a*, complete specimen from right side, length 0.97 mm; *b,c*, anterior and posterior views of right valve, iv; *d*, part of left 2nd antenna, iv; *e*, left mandible, mv; *f,g*, parts of right mandible, lv; *h,i*, views of upper lip from right side and from posterior.

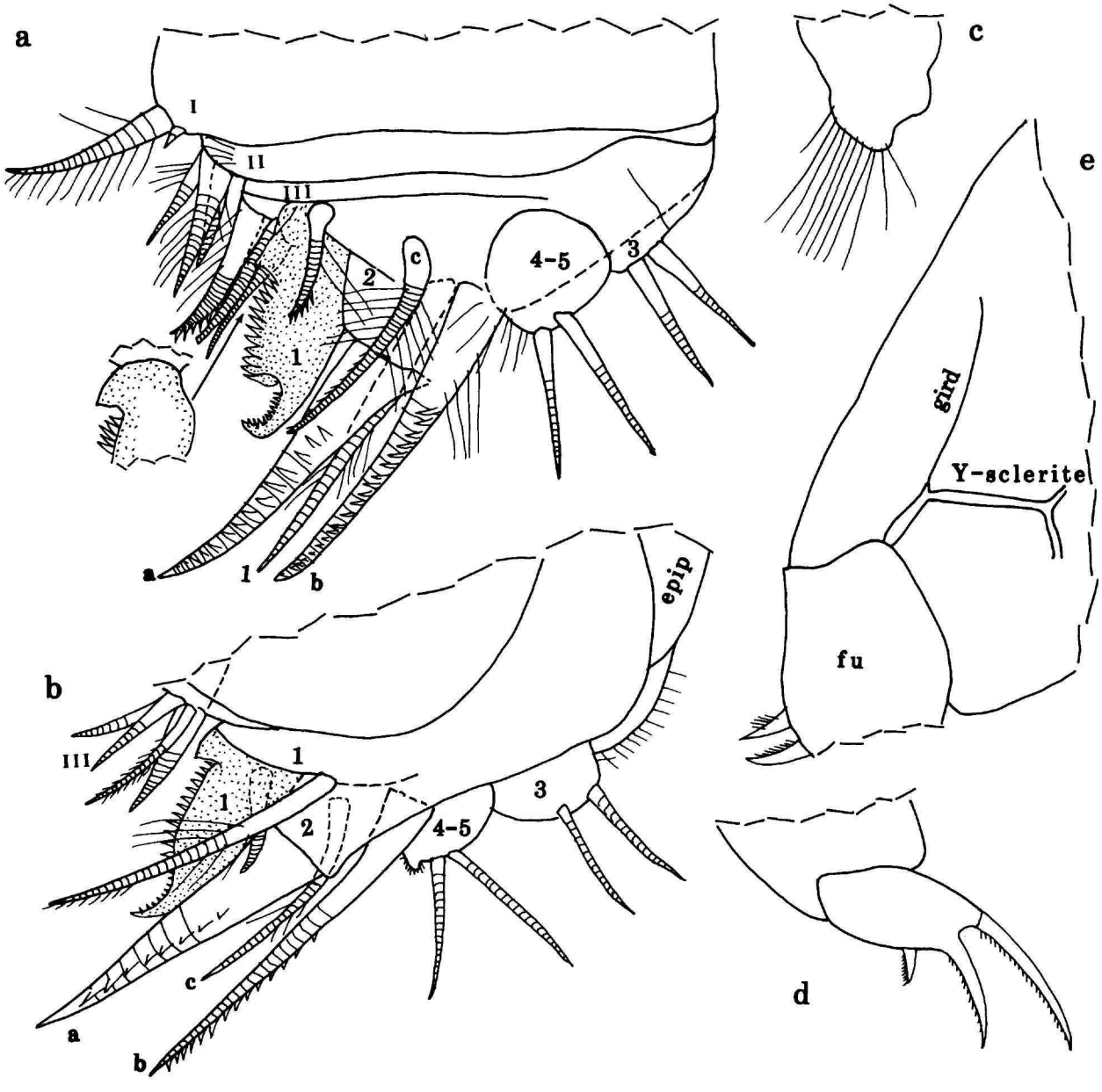


FIGURE 12.—*Vargula* species indeterminate, Instar I, USNM 194411: *a*, right 5th limb, pv; *b*, left 5th limb, av; *c*, 6th limb; *d*, right lamella of furca, lv; *e*, posterior of body from right side.

part short narrow with 8 minute teeth. 2nd exopodial joint with stout pectinate a- and b-bristles and stout posterior spinous c-bristle. 3rd exopodial joint: inner lobe absent and without bristle present in its place; outer lobe with 2 bristles of equal length. 4th and 5th exopodial joints fused, hirsute, with 2 terminal bristles and minute spinous node adjacent to bristles.

Sixth Limb (Figure 12*c*): Small with long hairs but no bristles.

Seventh Limb: Absent.

Furca (Figure 12*d*): Each lamella with 3 claws: claw 3

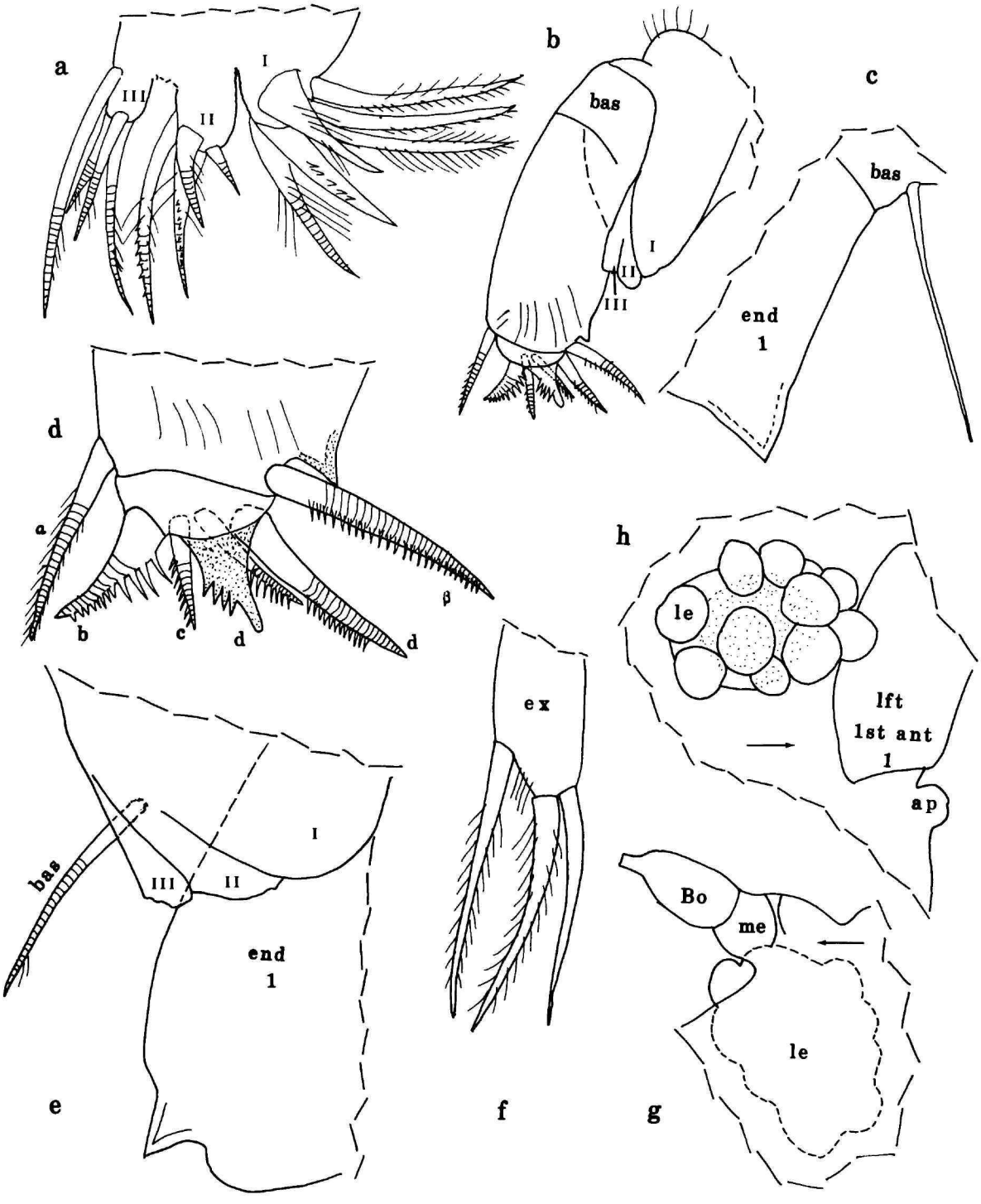


FIGURE 13.—*Vargula* species indeterminate, Instar I, USNM 194411: *a–d*, parts of right maxilla, mv; *e,f*, parts of left maxilla; *g*, portion of anterior of body from left side; *h*, portion of anterior of body from right side.

separated from lamella by sutures, claws 1 and 2 fused to lamella. Teeth along posterior edges of all claws.

Bellonci Organ (Figure 13*g*): Elliptical with protuberance at tip.

Eyes: Lateral eye large with brown pigment and about 10 ommatidia (Figure 13*h*). Medial eye smaller than lateral eye, unpigmented (Figure 13*g*).

Upper Lip (Figure 11*h,i*): Unpaired anterior part with many closely spaced small glandular processes. Paired tusks long tapered, with 2 terminal indistinct glandular processes and row of long medial hairs near tip.

Anterior of Body (Figure 13*h*): Anterior process rounded with small terminal indentation.

Posterior of Body (Figure 12*e*): Evenly rounded, bare.

Y-*Sclerite* (Figure 12*e*): Branching distally. Posterior end appears to be fused both to girdle and to sclerite leading to furca.

GENERIC IDENTIFICATION.—An elongate 3-jointed endopodite with a bristle on the 2nd joint of the 2nd antenna, the presence of two long tusks on the upper lips, the morphology of the endopodial bristles of the mandible (finger bristle on 2nd joint, bulbous bristle on 3rd joint), and the number and distribution of fused claws of the furca suggest that the 1st instar described herein (USNM 194411) is a species of either *Vargula* or *Kornickeria* Cohen and Morin, 1993:23. Both genera are numerous in the Caribbean (Cohen and Morin, 1986:1, 1989:297, 1990:381, 1993:23; Morin and Cohen, 1988:620). The c- and d-bristles of the mandibular basale are interpreted to be farther apart than is usual for species of *Kornickeria* (compare mandible in Figure 11 herein with those illustrated by Cohen and Morin (1993, fig. 10); therefore, it is tentatively concluded that the instar I described above is a species of *Vargula*. Without having more mature specimens in the collection, it is impossible to identify with certainty the species to which the instar belongs. In the "Comparisons" section below, some of the known species of *Vargula* in the vicinity are eliminated.

COMPARISONS.—The presence of a bristle with a bulbous base on the 2nd endopodial joint of the mandible of the instar described above indicates that it is not conspecific with the following species: *V. parasitica* (Wilson, 1913); *V. graminicola* Cohen and Morin, 1986; and *V. shulmanae* Cohen and Morin, 1986. The glandular processes of the unpaired anterior part of the upper lip appear to be more numerous and smaller than those of either *V. kuna* Morin and Cohen, 1988; and *V. mizonomma* Cohen and Morin, 1988. Also, the middle comb tooth of the 7th limbs of both the latter species is longer than the other teeth, which is not so on one of the limbs of instar I described above. This difference, however, requires verification by the study of mature specimens. Some additional species of *Vargula* could be shown to not be conspecific with the instar I described above, but many, including the six species described by Cohen and Morin (1989), probably could not.

Skogsbergia Kornicker, 1974

TYPE SPECIES.—*Skogsbergia minuta* Poulsen, 1962; subsequent designation by Kornicker (1974:3).

COMPOSITION AND DISTRIBUTION.—The genus includes 12 species; it is circumpolar between about 60°N and 38°S (Kornicker and Poore, 1996).

Skogsbergia lerneri (Kornicker, 1958)

FIGURE 14

Asterope elliptica Philippi.—Tressler, 1949:338 [in part, USNM 88860 only].
Cypridina squamosa.—Tressler, 1949:335, fig. 21 [in part; not *Cypridina squamosa* Müller].
Cypridina squamosa lerneri Kornicker, 1958:229, figs. 47:1a,b, 48a–d, 49a–e.
Skogsbergia lerneri (Kornicker).—Kornicker, 1974:4.—Cohen, 1983:235, figs. 2–10.

MATERIAL.—Exuma Sound: Sta 95-005, transect BB: USNM 194503, 4 specimens in alcohol. Sta 95-006, transect BB: USNM 194495, instar IV in alcohol.

DISTRIBUTION.—Widespread in the Bahamas, West Indies, Belize, Gulf of Mexico, and Atlantic continental shelf off Florida, at depths of 1–130 m (Kornicker, 1984:14). Collected herein in baited traps at 96 m and 105 m.

Carapace Size (length, height in mm): USNM 194495, 1.26, 0.81; height 64% of length; length to height ratio 1.56.

Superfamily SARSIELLOIDEA Brady and Norman, 1896

Family SARSIELLIDAE Brady and Norman, 1896

Subfamily SARSIELLINAE Brady and Norman, 1896

Eusarsiella Cohen and Kornicker, 1975

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

COMPOSITION AND DISTRIBUTION.—The genus is cosmopolitan between latitudes of about 63°N and 37°S. Its known depth range is intertidal to 1120 m (Kornicker, 1994:129). Kornicker (1986a) listed eight species of *Eusarsiella* from shallow water (mostly less than 7 m in depth) in the Bahamas. The present collection is from about 100 m.

Eusarsiella ryanae, new species

FIGURES 15–24, 25*a*

ETYMOLOGY.—Named in honor of Molly Ryan, Smithsonian Institution, who has illustrated the carapaces of many ostracodes in publications of the senior author.

HOLOTYPE.—USNM 194475, ovigerous female on slide and in alcohol.

TYPE LOCALITY.—Sta 94-018, transect BB, Exuma Sound, Bahamas, depth 67 m.

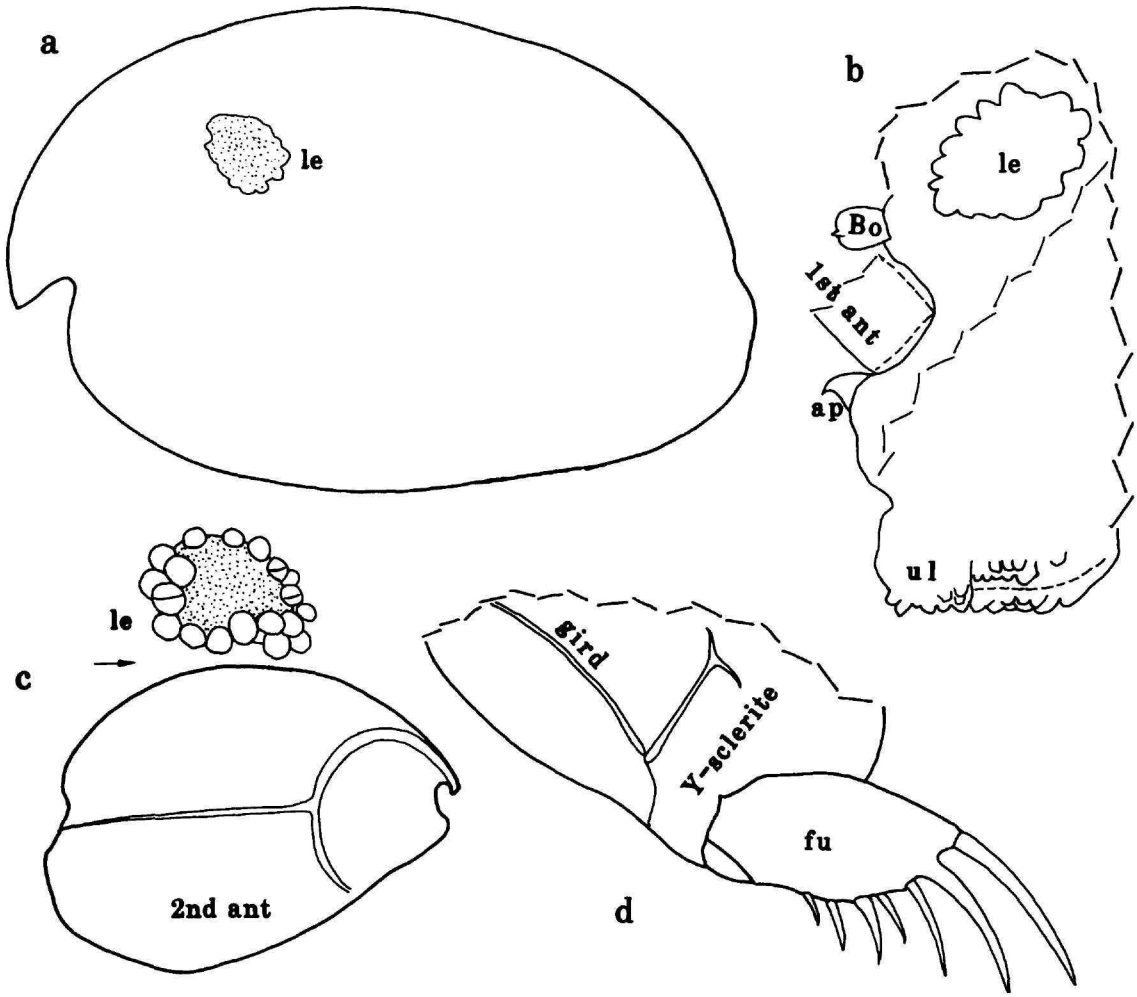


FIGURE 14.—*Skogsbergia lerneri* (Kornicker, 1958), Instar IV, USNM 194495: *a*, complete specimen from left side, length 1.26 mm; *b*, anterior of body from left side; *c*, right lateral eye and protopodite of right 2nd antenna in place on body (not under cover slip); *d*, posterior of body from right side.

PARATYPES.—Exuma Sound, off Lee Stocking Island: Sta 94-018, transect BB: USNM 194476, adult male on slide and in alcohol; USNM 194477, 4 undissected adult males in alcohol; USNM 194479, 1 Instar I on slide; USNM 194480, 3 Instar I in alcohol; USNM 194485, 194486, 194487, 194488, 4 Instar III males in alcohol. Sta 94-020, transect AB: USNM 194481, 1 Instar I on slide and in alcohol; USNM 194482, 1 Instar II ?female in alcohol; USNM 194483, 194484, 2 Instar III males in alcohol. Exuma Sound, off Great Exuma Island: Sta 96-034: USNM 194518, undissected juvenile in alcohol.

DISTRIBUTION.—Exuma Sound, depth range 62–100 m.

DESCRIPTION OF ADULT FEMALE (Figures 15–17, 25*a*).—Carapace oval in lateral view with long tapered backward-pointing caudal process and without incisur (Figures 15, 16*a,b*). Surface with 2 lateral horizontal ribs connected posteriorly by undulate vertical ridge with a spinous bulge at midheight and another at dorsal end. Posterodorsal corner of valve with backward-pointing spinous node.

Ornamentation (Figures 15, 16*a*): Surface with shallow round fossae rimmed by minute pointed spines; similar spines between fossae; bottoms of fossae bare. Surfaces of horizontal ribs, posterior vertical ridge, and free margin of valve with pointed spines longer than those around fossae. Long and short bristles with wide part near midlength present along valve margins; long bristles with broad basal part present along valve margins and sparsely distributed on lateral surface of valve. Tip of caudal process with 4 bristles (long slender bristle on each side of 2 short bristles). Outer edges of horizontal ribs and posterior connecting ridge with transparent gel-like substance filling space between bristles and along valve edge.

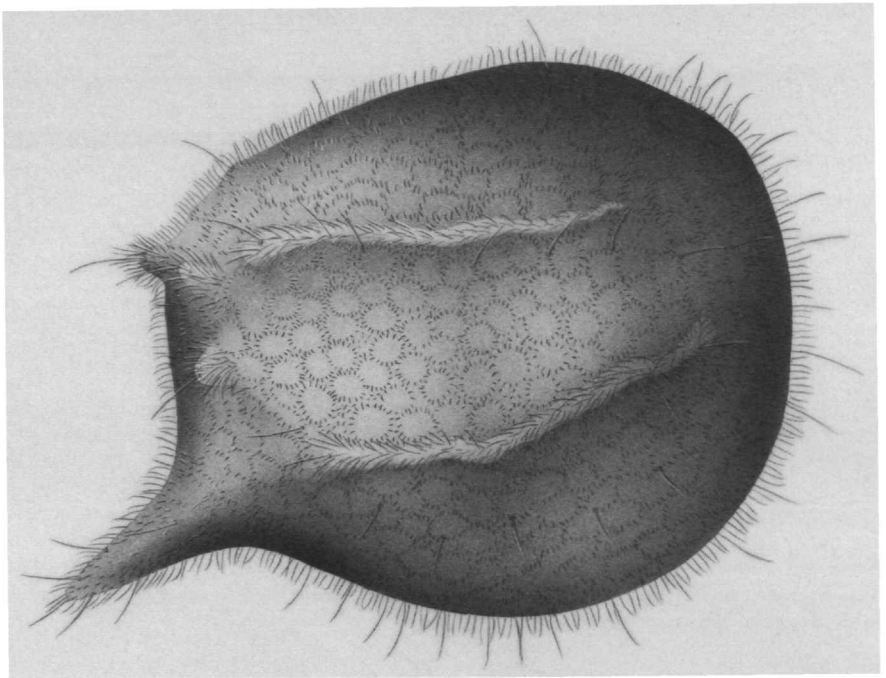


FIGURE 15.—*Eusarsiella ryanae*, new species, adult female, holotype, USMN 194475, carapace from right side, length 0.92 mm.

Infold: Anterior infold with small bristle near midheight. Infold of caudal process with vertical row of 8 or 9 setose bristles and few smaller undivided bristles near inner margin of infold (Figure 16*i*); posterior infold with 2 setal bristles below valve midheight.

Selvage: Lamellar prolongation extending well past tip of caudal process (Figure 16*a,b,i*). Lamellar prolongation broad along anterior and ventral valve margins and with smooth outer edge.

Central Adductor Muscle Attachments (Figure 16*c*): About 20 oval and elongate attachments.

Carapace Size (mm): USNM 194475, length with caudal process 0.92, length without caudal process 0.83, height 0.70.

First Antenna (Figure 16*a,e*): 1st joint bare. 2nd joint with bare dorsal bristle. 3rd and 4th joints fused; 3rd joint with 2 terminal bristles (1 ventral, 1 dorsal); 4th joint with 2 long terminal bristles (1 ventral, 1 dorsal). Sensory bristle of 5th joint with 2 short marginal filaments. 6th joint with short medial bristle. 7th joint: a-bristle short, spinous; b-bristle longer than a-bristle, bare; c-bristle about same length as sensory bristle of 5th joint, with 2 minute marginal filaments. 8th joint: d- and e-bristles about same length as sensory bristle of 5th joint, bare with blunt tips (d-bristle of illustrated left limb of USNM 194475 incompletely extruded (Figure 16*d*)); f-bristle with 1 or 2 minute marginal filaments; g-bristle with 2 small proximal filaments and 2 smaller marginal filaments near midlength.

Second Antenna: Protopodite bare (Figure 16*f*). Endopodite 1-jointed with 2 short ringed anterior bristles and terminal knob with short unringed bristle almost as long as proximal bristles (knob could be interpreted as being small 2nd joint) (Figure 16*f,g*). Exopodite: 1st joint with short medial spine on distal margin; bristles of joints 2–8 with slender ventral spines and distal natatory hairs; 9th joint with 2 bristles (1 small bare, other long with ventral spines and natatory hairs).

Mandible (Figure 17*a,b*): Coxale endite consisting of short stout spine; ventral margin of coxale with short hairs. Basale: ventral margin with 6 bristles (2 minute with bases lateral, others longer with bases medial); dorsal margin with minute spine-like terminal bristle. Exopodite absent. Endopodite: 1st joint with spines on medial surface, stout smooth ventral claw, and minute terminal dorsal spine. 2nd joint with minute dorsal spine-like bristle and stout smooth main claw. 3rd joint with 2 small bristles (1 ventral, 1 dorsal) and stout smooth terminal claw.

Maxilla: Endite I with about 6 bristles (Figure 17*e*); endite II with about 4 bristles; endite III with about 6 bristles. Basale with short bristle near exopodite (Figure 17*c*). Exopodite with 2 bristles. Endopodite: 1st joint with spinous alpha- and beta-bristles (Figure 17*c,d,f*); 2nd joint with 2 lateral a-bristles, 1 medial c-bristle, and 5 pectinate terminal bristles (Figure 17*c,d,f*); 4th terminal bristle from anterior end longer than others.

Fifth Limb (Figure 17*g*): Epipodite with 30 spinous bristles. Single endite with 1 short bristle. Exopodite: 1st joint with

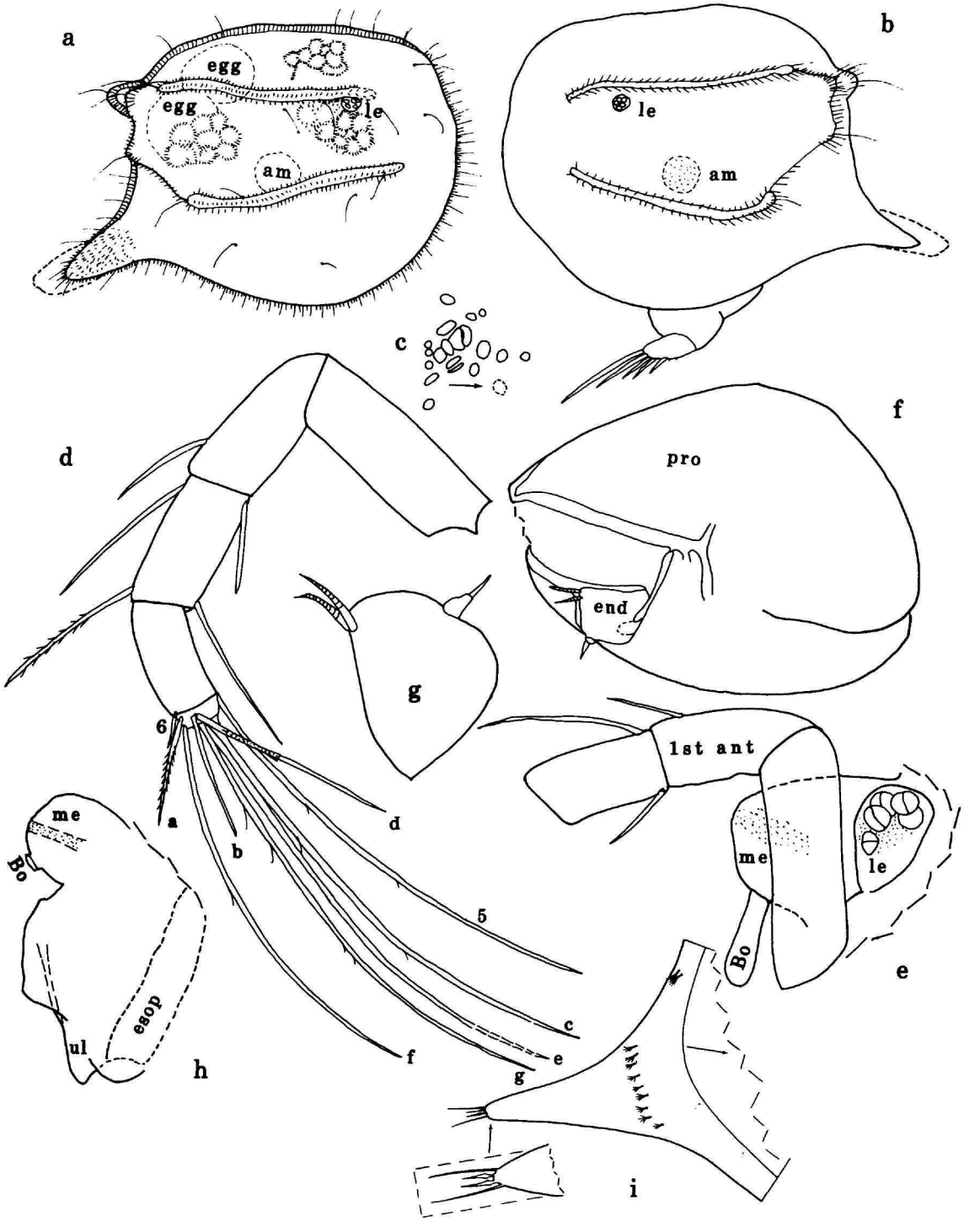


FIGURE 16.—*Eusarsiella ryanae*, new species, adult female, holotype, USNM 194475: *a,b*, complete specimen from right (2 eggs in marsupium dashed) and left sides, length 0.92 mm; *c*, central adductor muscle attachments on right valve (body removed), ov; *d*, left 1st antenna, lv; *e*, portion of anterior of body from left side; *f*, part of right 2nd antenna, mv; *g*, endopodite, left 2nd antenna, mv; *h*, portion of anterior of body from left side; *i*, posterior of right valve showing bristles of infold as seen through translucent shell, ov.


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FIGURE 17 (left).—*Eusarsiella ryanae*, new species, adult female, holotype, USNM 194475: *a*, view of right mandible protruding from carapace; *b*, right mandible, mv; *c*, left maxilla (endites I and II and 3 bristles of endite III not shown), lv; *d*, 2nd endopodial joint, right maxilla, mv; *e*, endites, left maxilla, mv; *f*, left maxilla (endites and exopodite not shown), mv; *g*, distal part of 5th limb; *h*, left 6th limb, lv; *i*, tip of 7th limb; *j*, right lamella and part of left lamella striated from right side; *k*, portion of posterior of body from left side.

2 spinous bristles; joints 2–5 fused, hirsute; 2nd joint with 3 bristles; fused 3rd to 5th joints with total of 6 bristles including 1 very short bristle.

Sixth Limb (Figure 17*h*): Single endite with 2 or 3 bristles; end joint with 11–13 bristles with short spines (spines not shown) separated by space from 2 posterior plumose bristles; posterior margin of limb hirsute.

Seventh Limb (Figure 17*i*): Each limb with 8 bristles (2 proximal, 1 on each side, and 6 terminal, 3 on each side); each bristle with 3–7 bells and no marginal spines. Terminus with opposing combs each with 5 or 7 curved teeth.

Furca (Figure 17*j*): Each lamella with 5 claws followed by few small spines; claw 1 continuous with lamella, others separated from lamella by suture; all claws with pointed tips and with teeth along posterior margins; 4 or 5 teeth on claw 1 much longer and stouter than others; slender medial spines or hairs present near base of claw 1; anterior edge of right lamella with few minute spines; right lamella anterior to left by width of base of claw 1.

Bellonci Organ (Figure 16*e*): 1-jointed, short, with broadly rounded tip.

Eyes: Lateral eye small, unpigmented, with 5 amber-colored divided ommatidia (Figure 16*e*); eye visible through shell (Figure 16*a,b*). Medial eye bare, larger than lateral eye, with small area of brown pigment (Figure 16*e,h*).

Posterior of Body: Evenly rounded, bare.

Upper Lip (Figure 16*h*): Helmet shaped, bare.

Genitalia (Figure 17*k*): Oval ring anterior to Y-sclerite.

Y-*Sclerite* (Figure 17*k*): With usual ventral branch.

Eggs (Figure 16*a*): USNM 194475 with 3 eggs in marsupium and smaller unextruded eggs. Length of 1 extruded egg 0.15 mm.

DESCRIPTION OF ADULT MALE (Figures 18–20).—Carapace more elongate than that of adult female and with incisur almost forming right angle (Figures 18, 19*a*). Surface with 2 lateral ribs similar to those of female except not connected posteriorly by undulating vertical rib. Curved vertical row of small spines connect anterior ends of horizontal ribs; 2 short parallel horizontal closely spaced rows of small spines connect the curved vertical row (at midpoint) with tip of rostrum.

Ornamentation: Surface with shallow round fossae rimmed by minute spines similar to those of adult female (Figures 18, 19*a*). Long bristles present similar to those of adult female. Transparent gel-like substance visible filling space between bristles on ribs and valve edges.

Infold: Anterior infold with small bristles near midheight well below rostrum. Infold of caudal process with 6 or 7 setose bristles forming row similar to that of adult female. Posterior infold with 2 setal bristles near midheight.

Selvage: Lamellar prolongation of selvage extending well past tip of caudal process. Broad anterior and ventral lamellar prolongation with smooth outer edge.

Central Adductor Muscle Attachments: Partly obscured, 13 shown in Figure 19*b*.

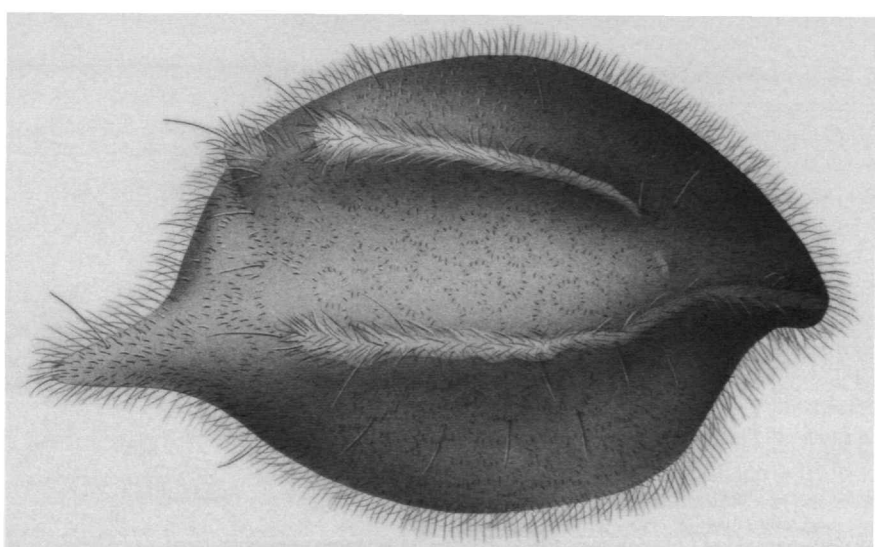

FIGURE 18.—*Eusarsiella ryanae*, new species, adult male, paratype, USNM 194476, carapace from right side, length 0.71 mm.

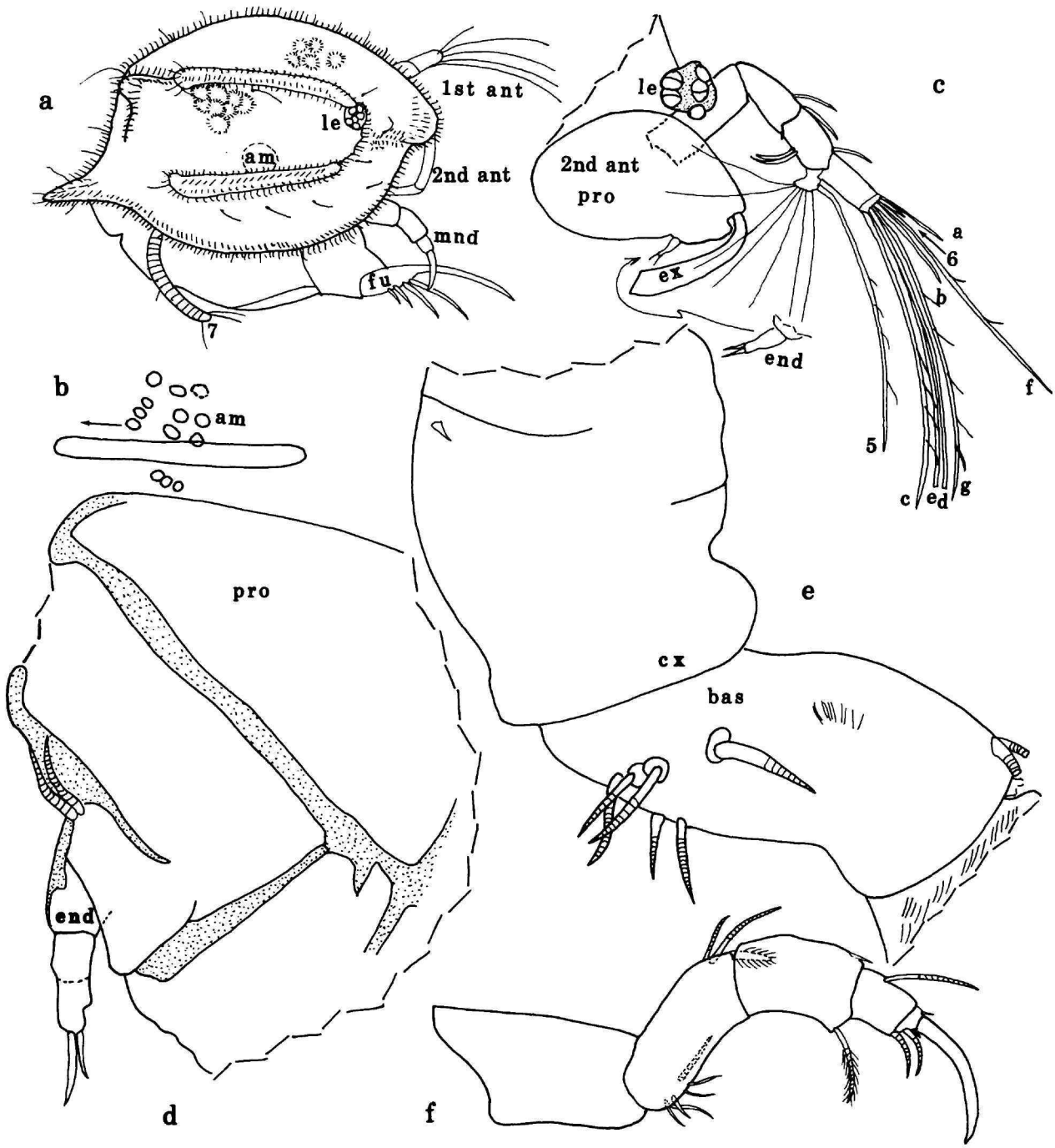

FIGURE 19.—*Eusarsiella ryanae*, new species, adult male, paratype, USNM 194476: *a*, complete specimen from right side, length 0.71 mm; *b*, central adductor muscle attachments of right valve and lower rib (from *a*); *c*, portion of anterior of body from right side; *d*, part of right 2nd antenna, mv; *e*, part of left mandible, mv; *f*, right mandible, lv.

Carapace Size (mm): USNM 194476, length with caudal process 0.85, length without caudal process 0.71, height 0.52. USNM 194477, 4 adult males (length with caudal process): length 0.80, height 0.50; length 0.77, height 0.47; length 0.83, height 0.52; length 0.79, height 0.50. Average length (including caudal process) 0.81 mm.

First Antenna (Figure 19*c*): 2nd joint with bare dorsal bristle. 3rd and 4th joints fused; 3rd joint with 2 bristles (1 dorsal, 1 ventral short); 4th joint with 3 bristles (1 dorsal, 2 ventral). 5th joint small and wedged ventrally between 4th and 6th joints; sensory bristle with hour-glass shaped base with numerous long thin terminal filaments and stem with 3 short filaments. 6th joint with short bare medial bristle. 7th joint: a-bristle bare, short, about ⅓ length of f-bristle; b-bristle longer than a-bristle, bare; c-bristle long, with 4 marginal filaments. 8th joint: d- and e-bristles slightly shorter than c-bristle, bare with blunt tips; f-bristle shorter than c-bristle, with 2 marginal filaments; g-bristle same length as c-bristle, with 5 marginal filaments.

Second Antenna: Protopodite bare (Figure 19*c,d*). Endopodite not reflexed, 2-jointed (Figure 19*d*): 1st joint with 2 anterior ringed proximal bristles; tip of 2nd joint with 2 short ringed bristles. Exopodite: 1st joint with minute curved medial spine on distal margin; bristles of joints 2–4 with slender ventral spines and natatory hairs; bristles of joints 5–8 with natatory hairs; 9th joint with 2 bristles (1 small bare dorsal, other long with natatory hairs).

Mandible (Figure 19*e,f*): Coxale endite consisting of short spine (Figure 19*e*). Basale: 6 bare bristles on or near ventral margin; 2 distal bare bristles on dorsal margin. Hirsute exopodite with base on lateral side of basale but then bends onto medial side of 1st endopodial joint. 1st endopodial joint with ringed ventral bristle (with long marginal hairs), small indistinct terminal bare dorsal bristle, and abundant medial hairs. 2nd endopodial joint with ringed bare terminal ventral bristle and long slender ringed bare dorsal bristle at midlength. 3rd endopodial joint with stout bare terminal claw, fairly long ringed bare ventral bristle, and 2 minute indistinct bare bristles (1 ventral, 1 dorsal).

Maxilla (Figure 20*a*): Reduced. Coxale with short dorsal bristle. Exopodite with 2 ringed bristles. Endites, basale, and endopodite with indistinct weakly developed bristles (not all shown in illustration).

Fifth Limb (Figure 20*b,d*): Reduced with weakly defined indistinct bristles (not all bristles shown in illustration).

Sixth Limb (Figure 20*c,d*): Single endite with bristles. End joint with about 11 bristles (differs from end joint of female in having more bristles hirsute to tip and in not having a space anterior to the 2 posterior bristles). Illustrated limb with endite folded over end joint, and not in natural position.

Seventh Limb (Figure 20*d,e*): Limb long with many well-defined segments. Terminal group with 3 or 4 bristles, 1 or 2 on each side, each with 5–7 distal bells and no marginal spines. Terminus convex and without combs.

Furca (Figure 20*d*): Similar to that of adult female except all claws with few stout teeth; those of claws 1 and 2 very large. Claw 1 with row of proximal long medial spines near base. All claws with spines along anterior margins; claws 5 and 6 also with few small proximal teeth on anterior margins (these visible under oil immersion lens (×100 objective, ×20 ocular)).

Bellonci Organ (Figure 20*f*): Similar to that of adult female.

Eyes: Lateral eye slightly larger than that of adult female and with 5 or 6 ommatidia (Figures 19*a,c*, 20*f*). Medial eye similar to that of adult female (Figure 20*f*).

Posterior of Body (Figure 20*d*): Evenly rounded bare.

Upper Lip: Similar to that of adult female.

Genitalia (Figure 20*d,g,h*): Lobate copulatory organ on each side of body anterior to furca; distal lobe with sclerotized curved tooth; all lobes with few short bristles.

Y-*Sclerite* (Figure 20*d*): Similar to that of adult female.

Gut Content: Without crustacean fragments observed in female gut.

DESCRIPTION OF INSTAR I (sex unknown) (Figures 21, 22).—Carapace with numerous pointed spines and scattered long bristles, some with broad part either near base or near midlength. Ribs absent (Figure 21*a*). Transparent gel-like substance filling space between spines visible along edge of valve, not elsewhere. Tip of caudal process with 4 slender bristles (2 bristles in middle with a flair at base and each mounted on minute cylindrical protuberance) (Figures 21*a–d*, 22*g*).

Infold: Caudal infold with 1 small double bristle near anteroventral corner; posterior with 1 setal bristle dorsal to caudal process (Figure 21*d*).

Selvage: With lamellar prolongation extending past tip of caudal process similar to that of adult female (Figure 21*d*).

Carapace Size (total length, height in mm): Sta 94-018: USNM 194479, 0.49, 0.35. USNM 194480, 3 specimens: 0.47, 0.34; 0.47, 0.36; 0.50, 0.33. Sta 94-020: USNM 194481: 0.45, 0.34. Average length 0.48 mm.

First Antenna (Figures 21*e,f*, 22*f*): 1st and 2nd joints bare. 3rd joint fused to 4th; 3rd joint with 2 bristles (1 ventral, 1 dorsal); 4th joint with few distal dorsal spines. Sensory bristle of long 5th joint without bristles. 6th joint minute, fused to 5th, with short medial bristle near dorsal margin. 7th joint: a-bristle bare, about twice length of bristle of 6th joint; b-bristle about same length as a-bristle, bare; c-bristle long, bare. 8th joint: d-, e-, and g-bristles long, bare; f-bristle shorter than g-bristle, bare.

Second Antenna (Figure 21*f,g*): Protopodite bare. Endopodite 1-jointed with minute terminal node with small bristle with spine at tip. Exopodite similar to that of adult female, 9th joint with 2 bristles.

Mandible (Figure 21*h*): Coxale endite comprising small spine. Basale: dorsal margin with minute subterminal bristle; ventral margin with 4 small bristles. Exopodite absent. 1st, 2nd, and 3rd endopodial joints each with stout terminal claw; 3rd joint with small ventral bristle at base of claw.

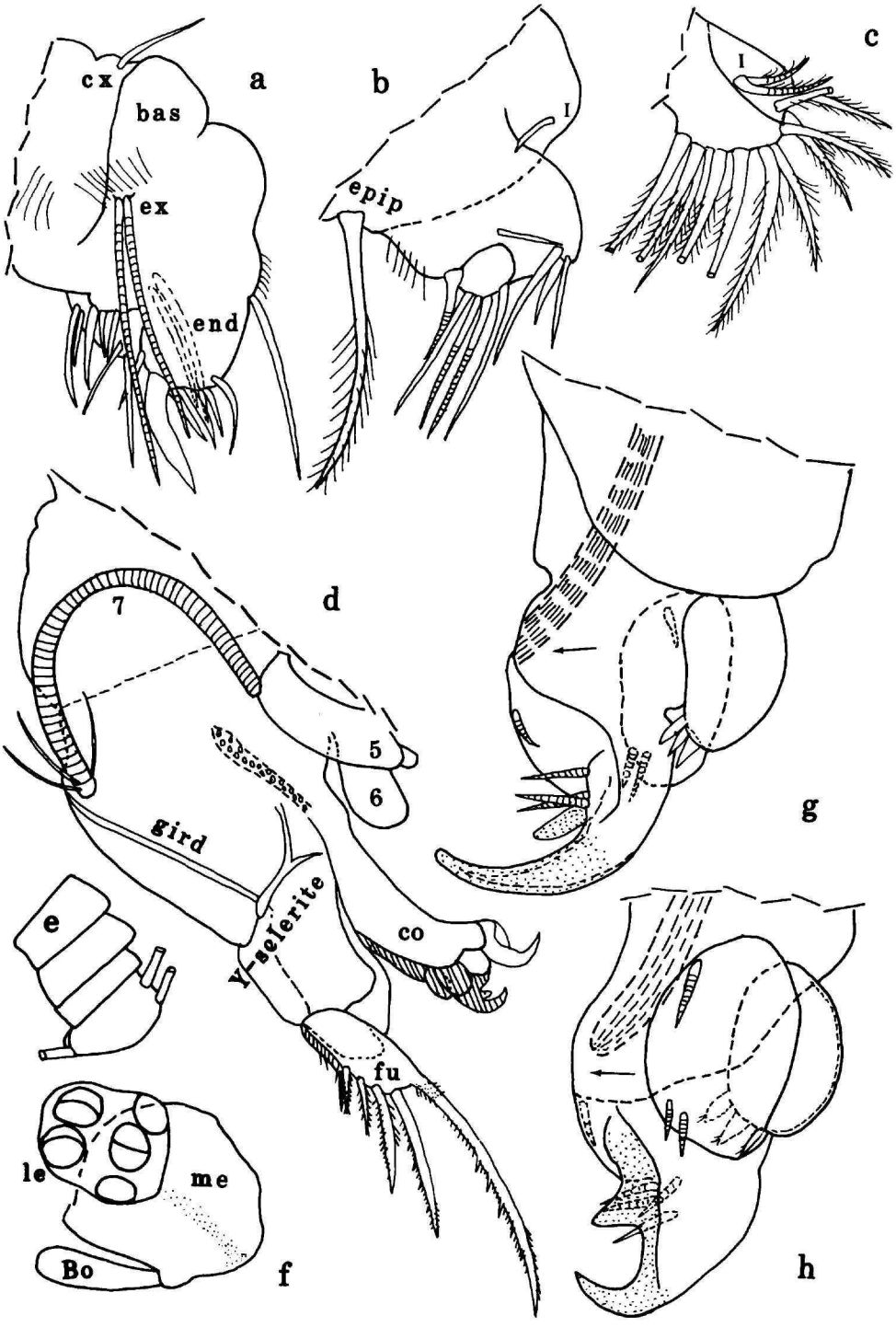

FIGURE 20.—*Eusarsiella ryanae*, new species, adult male, paratype, USNM 194476: *a*, right maxilla, lv; *b*, 5th limb (nabs); *c*, 6th limb (endite folded); *d*, posterior of body from right side; *e*, tip of right 7th limb (only proximal parts of bristles shown); *f*, portion of anterior of body from right side; *g,h*, lateral view of left copulatory organ, and medial view of right organ.

FIGURE 21.—*Eusarsiella ryanae*, new species, Instar I (sex unknown), paratype, USNM 194479: *a*, complete specimen from right side, length 0.49 mm; *b*, caudal process, right valve (not all spines shown), lv; *c,d*, caudal process, left valve (surface spines not shown), mv; *e*, right 1st antenna and right lateral eye, lv; *f*, portion of anterior of body from left side; *g*, part of left 2nd antenna, mv; *h*, left mandible (nabs), lv; *i,j*, endites I and II, right maxilla, lv; *k*, endites I–III, left maxilla, lv; *l*, right maxilla (nabs), lv; *m*, left maxilla and 5th and 6th limbs drawn in place on body; *n*, left 6th limb, lv; *o,p*, portions of anterior of body from left side.

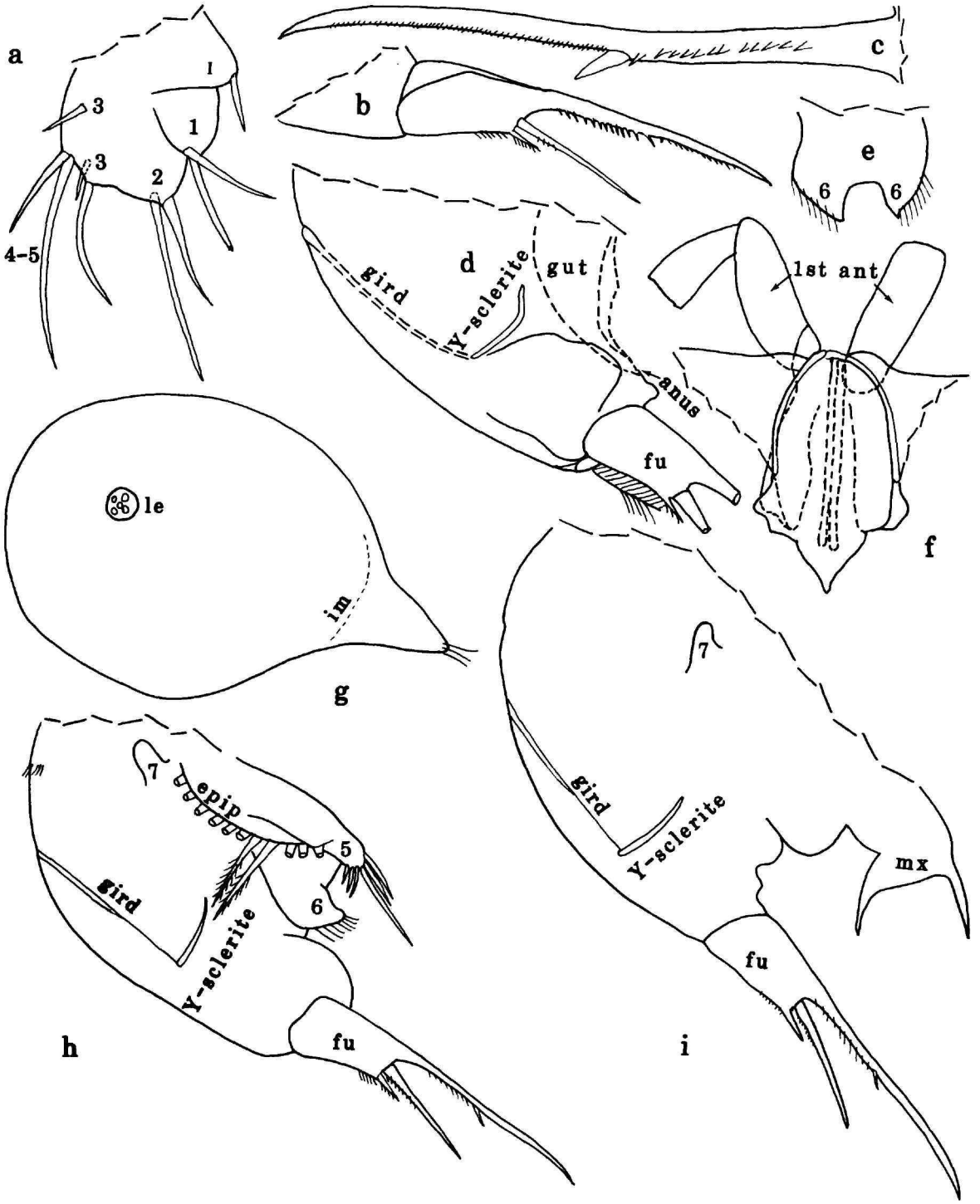

FIGURE 22.—*Eusarsiella ryanae*, new species, Instar I (sex unknown), paratypes. USNM 194479: *a*, 5th limb; *b*, claw 1 of right lamella of furca, lv; *c*, furcal claw 1; *d*, posterior of body from right side; *e*, right and left 6th limb; *f*, portion of anterior of body, pv. USNM 194481: *g*, complete specimen from left side, length 0.45 mm; *h,i*, portion of posterior of body from right side.

Maxilla (Figures 21*i–n*, 22*i*): Endites I–III each with 3 to 5 bristles (Figure 21*i–k*). Coxale with short dorsal bristle (Figure 21*l*). Basale with slender bristle near exopodite. Exopodite with 2 fairly long bristles. 1st endopodial joint with stout pectinate alpha- and beta-bristles. 2nd endopodial joint with 2 slender a-bristles and 3 stout pectinate end bristles.

Fifth Limb (Figure 22*a,h*): Single endite with small bristle. 1st and 2nd endopodial joints each with 2 bristles. Joints 3–5 fused with total of 5 bristles: 3rd joint with 3 bristles (2 inner, 1 outer); joints 4 and 5 with total of 2 bristles.

Sixth Limb (Figure 22*e,h*): Small with marginal hairs but no bristles.

Seventh Limb (Figure 22*h,i*): Minute, bare, thumb-like.

Furca (Figure 22*b–d,h,i*): 1st claw fused to lamella, with stout posterior tooth at midlength, smaller posterior teeth proximal, and slender minute closely spaced teeth distal; 2nd claw separated from lamella by suture, with proximal teeth along posterior margin; 3rd claw a stout pointed process fused to lamella and with spines along posterior margin; hairs along lamella following claws (hairs of left lamella longer); claw 1 of right lamella anterior to claw 1 of left lamella.

Bellonci Organ and Eyes (Figures 21*a,e,f,o*, 22*g*): Similar to those of adult female.

Anterior of Body (Figure 21*o,p*): Convex.

Posterior of Body (Figure 22*d*): Evenly rounded with few spines at posterodorsal corner dorsal to intersection of girdle and posterior margin.

Y-*Sclerite* (Figure 22*d,h,i*): Without clearly visible ventral branch.

Gut Content: With brown unrecognizable particles.

DESCRIPTION OF INSTAR II ?FEMALE (Figure 23).—Carapace similar in shape to carapace of Instar I (Figure 23*a*). Without ribs.

Ornamentation (Figure 23*a*): Spines and bristles of carapace similar to those of Instar I (not all spines or bristles shown in Figure 23*a*). Transparent gel-like substance visible

Infold: Infold of caudal process with 2 to 4 setose bristles forming row and 1 small double bristle in anteroventral corner near inner margin of infold (Figure 23*b*); 2 setal bristles just dorsal to caudal process; left valve of USNM 194482 with small bristle just dorsal to setal bristles.

Selvage: Similar to that of both Instar I and adult female.

Central Adductor Muscle Attachments (Figure 23*a*): Consisting of numerous ovoid attachments.

Carapace Size (total length, height in mm): USNM 194482, 0.57, 0.39.

First Antenna (Figure 23*c*): Differs from that of Instar I in having a short dorsal bristle on 2nd joint and a terminal dorsal bristle on 4th joint. Also, sensory bristle of 5th joint and some long bristles of 7th and 8th joints with few minute filaments.

Second Antenna (Figure 23*c*): Protopodite and exopodite similar to those of Instar I and adult female. Endopodite differs from that of Instar I in having a proximal anterior bristle.

Mandible: Similar to that of adult female but not examined in detail.

Maxilla: Similar to that of adult female but endite bristles not counted. 2nd endopodial joint differs from that of Instar I in having 5 instead of 3 end bristles.

Fifth Limb: Similar to that of adult female but not examined in detail.

Sixth Limb (Figure 23*e*): With single bristle.

Seventh Limb (Figure 23*d,e*): Bare, thumb-like, unsegmented, longer than 7th limb of Instar I.

Furca (Figure 23*d*): Similar to that of adult female. Differs from that of Instar I furca in having 5 instead of 3 claws, having suture at base of claw 3, and having 3 instead of 2 large teeth on posterior edge of claw 1. Hairs not observed on edges of lamellae following claws.

Bellonci Organ and Eyes (Figure 23*c*): Similar to those of both Instar I and adult female.

Posterior of Body (Figure 23*d*): Posterodorsal corner of body of USNM 194482 with triangular protuberance. (Protuberance probably resulting from inward bending of dorsal margin of body and not true posterodorsal process.) No spines observed on posterior of body.

Y-*Sclerite* (Figure 23*d,e*): Similar to that of adult female. Differs from that of Instar I in having ventral branch well developed.

Gut Content: USNM 194482 with several large seemingly complete crustaceans in posterior half of gut.

DESCRIPTION OF INSTAR III MALE (Figure 24).—Carapace similar in shape and ornamentation to that of Instar II (Figure 24*a,b,f,i*). No ribs present. Transparent gel-like substance visible covering spines along edge.

Infold (Figure 24*g*): Infold of caudal process with 5 setose bristles forming row; 2 setal bristles present just dorsal to caudal process. 1 double bristle present in anteroventral corner of caudal process.

Selvage: Similar to that of adult female.

Central Adductor Muscle Attachments (Figure 24*a,b,f,i*): Numerous ovoid attachments.

Carapace Size (total length, height in mm): USNM 194483, 0.68, 0.48; USNM 194484, 0.66, 0.46; USNM 194485, 0.66, 0.49; USNM 194486, 0.65, 0.48; USNM 194487, 0.67, 0.49; USNM 194488, 0.68, 0.48. Average total length 0.67 mm.

First Antenna (Figure 24*c*): Differs from Instar II in having a terminal ventral bristle on 4th joint.

Second Antenna (Figure 24*c*): Protopodite and exopodite similar to those of adult female. Endopodite 2-jointed: 1st joint with 2 proximal anterior bristles; 2nd joint triangular with 1 short terminal bristle.

Mandible, Maxilla, and Fifth Limb: Similar to those of adult female but not studied in detail.

Sixth Limb (Figure 24*e*): With single endite with bristle and end joint with many bristles.

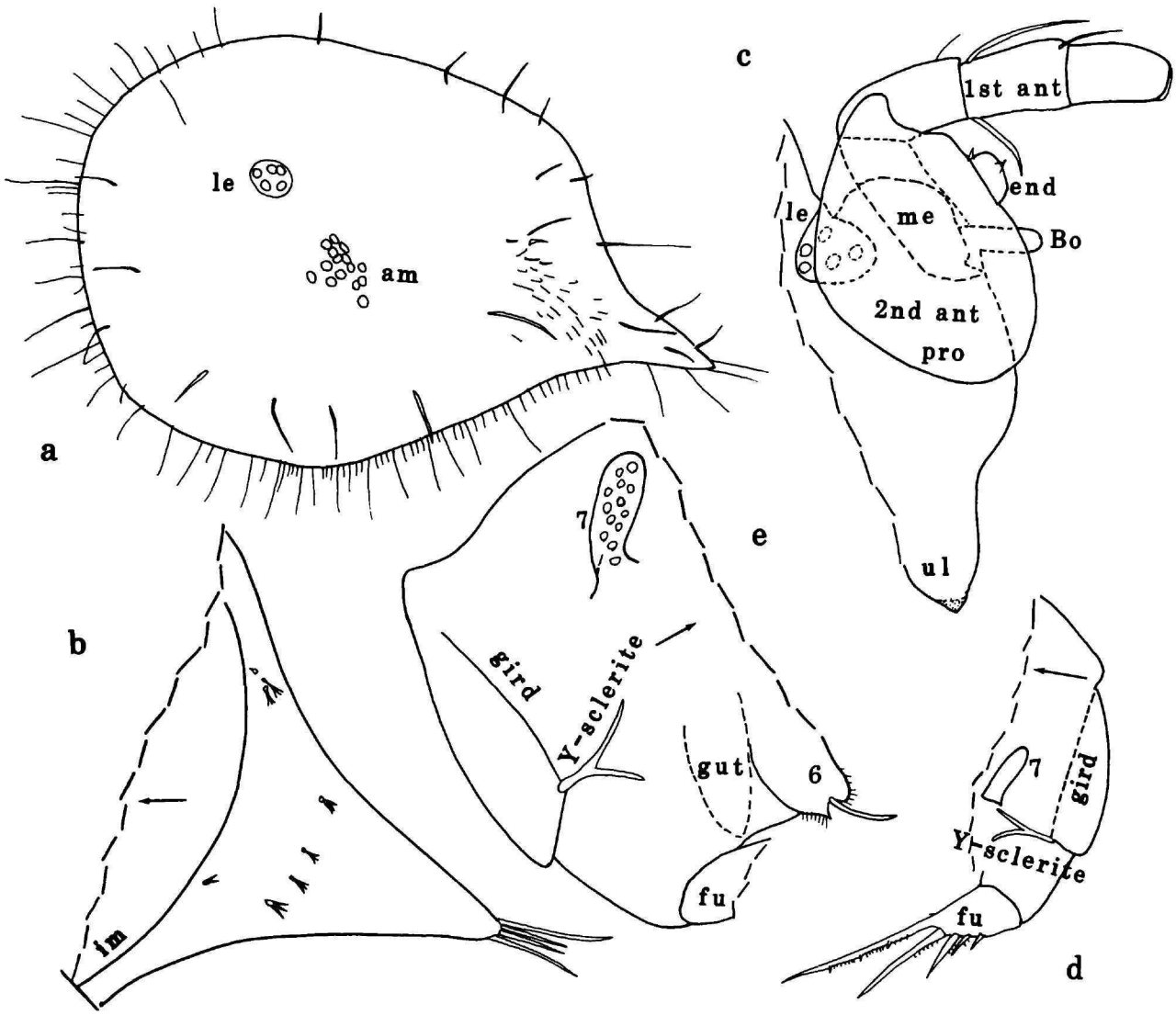

FIGURE 23.—*Eusarsiella ryanae*, new species, Instar II ?female, paratype, USNM 194482: *a*, complete specimen from left side (not all spines shown), length 0.57 mm; *b*, caudal process of right valve, iv; *c*, portion of anterior of body from right side; *d,e*, portion of posterior of body from left and right sides.

Seventh Limb (Figure 24*d,h,i*): Elongate, bare, without segments, longer than 7th limb of Instar II.

Furca (Figure 24*d*), *Bellonci Organ* (Figure 24*c*), *Eyes* (Figure 24*a–c,f,i*), *Posterior of Body* (Figure 24*d*), and Y-*Sclerite* (Figure 24*d,h,j*): Similar to those of adult female.

Gut Content: With almost complete skeletons of nematodes and crustacea and crustacean fragments. (A nematode (Figure 24*j*) was identified by Duane Hope (S.I.) as a free-living type, and was placed into the S.I. worm collection.)

REMARKS.—Three of the six instar III's were not dissected, but the undissected specimens all appeared to have a 2nd joint on the endopodite of the 2nd antenna when viewed through the shell, and therefore were interpreted to be males.

COMPARISONS.—The new species, *E. ryanae*, differs from *E.* "*carinata*" (Kornicker, 1986a) in lacking scalloped anterior and ventral carapace margins. The endopodite of the 2nd antenna of the female *E. ryanae* differs from that of *E. cornuta* Poulsen, 1965, in having a ventral node with a short bristle. The 7th limb of *E. ryanae* bears two proximal bristles on the 7th joint compared to four on *E. spicata* Poulsen, 1965. The carapace of *E. ryanae* differs from that of *E. capillaris* (Kornicker, 1958, 1986a) by not having nodes bearing finger-like

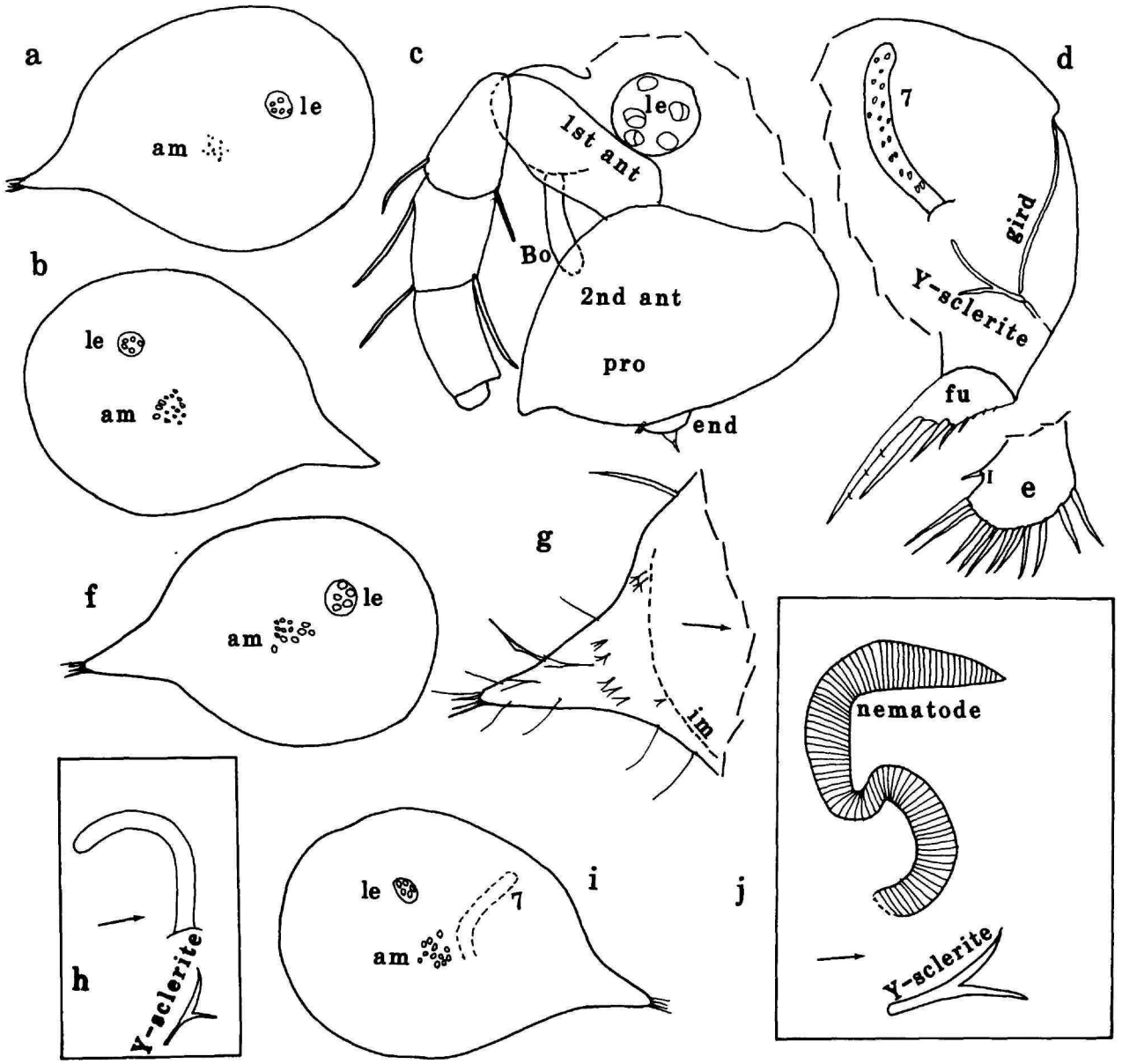

FIGURE 24.—*Eusarsiella ryanae*, new species, Instar III male, paratypes. USNM 194483: *a*, complete specimen from right side, length 0.68 mm; *b*, complete specimen from left side, length 0.68 mm; *c*, portion of anterior of body from left side; *d*, posterior of body from left side; *e*, left 6th limb, Iv. USNM 194484: *f*, complete specimen from right side, length 0.66 mm; *g*, posterior of left valve, iv. USNM 194485: *h*, right 7th limb and Y-sclerite (as seen through right valve). USNM 194487: *i*, complete specimen from left side, length 0.67 mm; *j*, nematode in gut and right Y-sclerite (as seen through right valve).

bristles. The carapace of *E. ryanae* differs from that of *E. paniculata* Kornicker, 1986a, and *E. donabbotti* (Cohen, 1989a) in lacking numerous spinous nodes. The Bellonci organ of *E. bedoyai* Baltanás, 1992, is much longer than that of *E. ryanae*. The carapace of *E. ryanae*, although smaller and with a narrower caudal process, outwardly strongly resembles that of *E. styx* Kornicker and Iliffe, 1989b; they differ in that the bristles of the infold of the caudal process of *ryanae* are setose and form a vertical row (Figure 25*a*), whereas those of *styx* are pointed and scattered (Figure 25*b*). Also, the adult female of

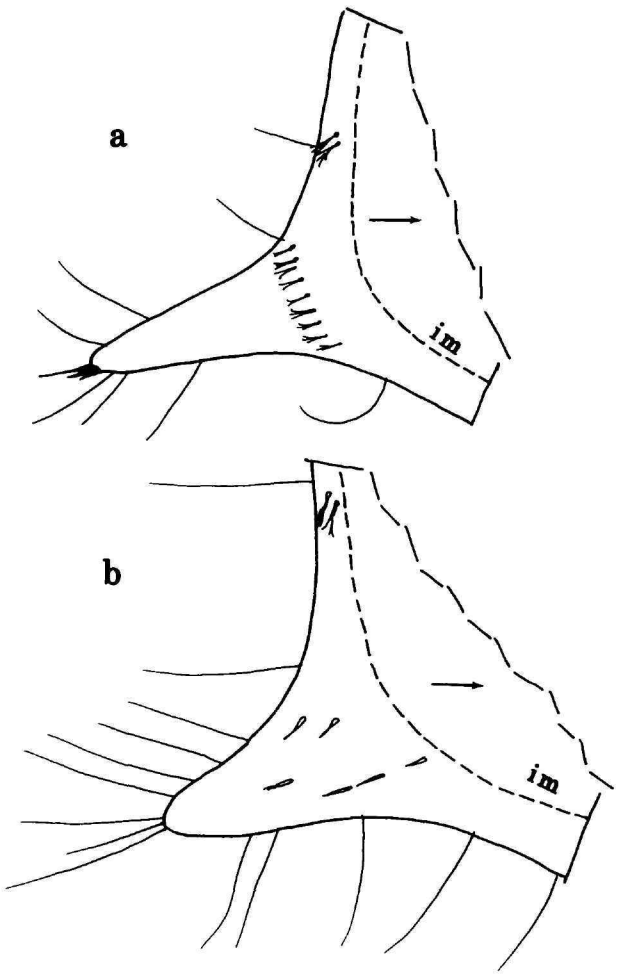

FIGURE 25.—Comparison of infold bristles of caudal processes of right valves of adult females of *Eusarsiella ryanae*, new species, and *Eusarsiella styx* Kornicker and Iliffe, 1989: *a*, *E. ryanae*, holotype, USNM 194475. *b*, *E. styx*, paratype, USNM 193383. Both illustrations drawn as seen through the right valve and at same magnification.

styx lacks a ventral bristle on the endopodite of the 2nd antenna. The orientation of the backward-pointing caudal process and its considerable length distinguishes *E. ryanae* from many previously described species of *Eusarsiella*.

The adult male of *E. ryanae* differs from the adult male of many species of *Eusarsiella* by having a well-developed 7th limb that bears bristles, and by not having a reflexed clasping-type endopodite on the 2nd antenna. Kornicker (1996, table 2) listed certain morphologic characters for adult males of 21 species of *Eusarsiella*. Only three species, *E. styx*, *E. chessi* Kornicker, 1991, and *E.* "*carinata*," have a 7th limb bearing bristles as well as a non-prehensile endopodite of the 2nd antenna. The male mandible of *E. chessi* differs from that of *E. ryanae* in having a claw on the 1st and 2nd endopodial joints. The endopodite of the 2nd antenna of the male *E. ryanae* differs from that of *E.* "*carinata*," but it is similar to that of *E. styx*, thus suggesting a close relationship between *E. styx* and *E. ryanae*.

ONTOGENY.—None of the specimens had within their appendages the appendages of the next stage.

Although no instar IV is in the collection, it does contain four instar I's (sex unknown), one instar II (?female), six instar III's (male), one ovigerous adult female, and five adult males. The calculated growth factors of total carapace length between successive instars are I–II, 1.19; II–III, 1.18. The adult male is about 12% shorter than the adult female. The ribs that are present on the adult carapace are absent in the first three instars.

The morphologic changes that took place in the appendages during the first three stages are, in general, similar to those described by Hiruta (1977) for *Sarsiella japonica* Hiruta, 1977. The changes for *E. ryanae* include the following. 1st antenna: no bristles on 2nd and 4th joints in instar I; a dorsal bristle is added to both the 2nd and 4th joints in instar II; and a ventral bristle is added to the 4th joint in instar III. Maxilla: 2nd endopodial joint with three end bristles in instar I and five in the following stages. 6th limb: without bristles in instar I, with one bristle in instar II, and with many bristles in the following stages. 7th limb: bare in instars I–III, but the limb is longer in each succeeding instar (instar IV not present but in other sarsiellids it has many bristles on limb). Furca: instar I with three claws and having 1st and 3rd claws fused to the lamella, and in following stages with five claws and having only claw 1 fused to the lamella.

Hiruta (1977:58) stated that the maxilla of the 1st instar of *Sarsiella japonica* differed from that of *Spinacopia sandersi* Kornicker, 1969, in having on the 2nd endopodial joint three rather than five terminal bristles and no c-bristle. Hiruta understandably, but incorrectly, interpreted Kornicker's 1969:23 description of the mandible, maxilla, and 5th limbs of instar I of *S. sandersi*, which stated, "well developed, but not examined in detail; similar type as that of adult female" as meaning that the number of bristles on the 2nd endopodial joint of the maxillae of instar I and adult were the same. The number of bristles on the 1st instar maxilla in my study was one of the details not examined. The presence of only three end bristles and the lack of a c-bristle on the 2nd endopodial joint of the maxilla of instar I are probably constant in the Sarsiellidae, but the 1st instar of more species should be studied to confirm this.

Unlike the 2nd antennae of members of the Cypridinidae, on which the number of bristles of the 9th exopodial joint increases during ontogeny (Kornicker, 1992, fig. 5), the 9th joint of *E. ryanae* has two bristles on the juveniles as well as on the adults. The number of ommatidia in the lateral eye of *E. ryanae* remains at five in both juveniles and adults, except some adult males have either five or six.

The carapaces of juveniles as well as the adults of *E. ryanae* have a gel-like coating covering the short bristles on the valve margins.

Eusarsiella costata (Kornicker, 1958)

FIGURE 26

Sarsiella costata Kornicker, 1958:251, figs. 47:4A,B, 80A–E, 81A–E, 88B,C,G.
Eusarsiella costata.—Poulsen, 1965:83.—Kornicker, 1986a: 61, figs. 31–35.

HOLOTYPE.—USNM 122912, dry specimen, length 1.02 mm, (Kornicker, 1958:252, number 156-2).

TYPE LOCALITY.—Bimini Islands, Bahamas.

MATERIAL.—Exuma Sound: Sta 94-018, transect AA: USNM 194489, adult male in alcohol.

DISTRIBUTION.—Bahamas: Bimini Islands, San Salvador Island, the Wall off Lee Stocking Island, Exuma Cays (depth 67 m). Known depth range 1–100 m.

SUPPLEMENTARY DESCRIPTION OF ADULT MALE (Figure 26).—*Carapace Size* (length, height in mm): USNM 194489, 0.91, 0.68.

Eusarsiella species indeterminate

MATERIAL.—Exuma Sound: Sta 94-018, transect AA: USNM 194491, 3 juveniles; USNM 194492, 3 juveniles. Sta 94-020, transect AB: USNM 194490, 1 instar IV; USNM 194493, 1 juvenile. All specimens in alcohol. (The material includes two species with lateral outlines similar to that of *E. costata,* but one species is without ribs, and the other has 2 poorly defined ribs (1 dorsal, 1 at midheight).)

DISTRIBUTION.—Exuma Sound at depths of 62–67 m.

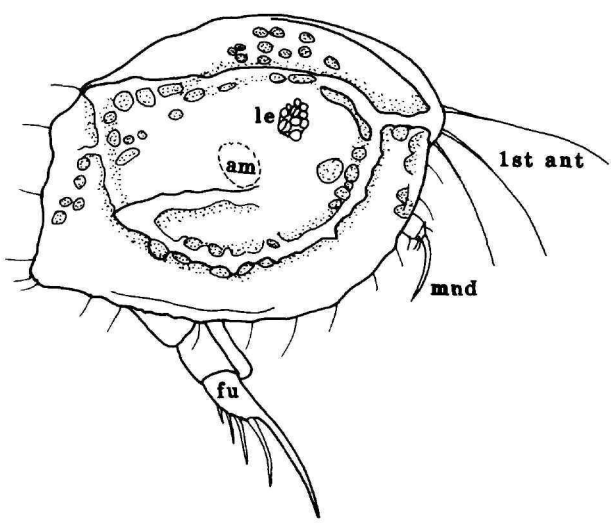

FIGURE 26.—*Eusarsiella costata* (Kornicker, 1958), adult male, USNM 194489, complete specimen from right side, length of carapace 0.91 mm.

Eurypylus Brady, 1869

Eurypylus Brady, 1869:141.—Kornicker and McKenzie, 1976:348.—Kornicker, 1986a:33.

TYPE SPECIES.—*Eurypylus petrosus* Brady, 1869, monotypy.

COMPOSITION AND DISTRIBUTION.—Including the two new species described herein, the genus contains 10 species (Kornicker, 1996). Members of the genus have been reported on the continental shelf off Georgia; a mangrove area in the vicinity of Tanzania, east Africa; the Cape Verde Islands off west Africa; shallow water in the vicinity of Singapore; in the vicinity of Mayotte and Glorioso Islands, Indian Ocean; shallow waters off Australia; and the Wall off Lee Stocking Island, Exuma Cays, Bahamas (Kornicker, 1996). The previous known depth range was shallow water to a depth of about 30 m (Kornicker, 1986a:33, 1996:57); the maximum known depth is increased to 142 m herein.

Eurypylus hapax, new species

FIGURES 27–29

ETYMOLOGY.—From the Greek *hapax* (once only).

HOLOTYPE.—USNM 194494, Instar IV female on slide and in alcohol.

TYPE LOCALITY.—Sta 95-002, transect BA, Exuma Sound, Bahamas, depth 142 m.

PARATYPES.—None.

DISTRIBUTION.—Collected only at type locality.

DESCRIPTION OF INSTAR IV FEMALE (Figures 27–29).—Carapace oval in lateral view with slightly projecting rostrum and short broad caudal process with straight posterior edge (Figure 27*a–c*).

Ornamentation: Surface without either lateral ribs, short spines, or gel-like coating. Posterior edge of caudal process with 7 bristles with bases either on lateral side or along edge (Figure 27*a,c,e*). Bristles, some with wide proximal part, present along valve edge and scattered on outer surface; all bristles with pointed tips (Figure 27*a–e*). Outer surface with minute triangular processes (on USNM 194494 processes restricted to edges of valves and best visible on posterior edge of caudal process (Figure 27*e*)).

Infold: Anterior infold with small bristle dorsal to incisur (Figure 27*d*). Caudal process with scattered small pointed bristles (Figure 27*e*). Two setal bristles on infold just dorsal to caudal process.

Selvage: Broad lamellar prolongation with smooth outer edge present along free margins and extending past posterior end of caudal process.

Central Adductor Muscle Attachments: Consisting of numerous small oval attachments (Figure 27*f*).

Carapace Size (total length, height in mm): USNM 194494, 0.87, 0.70.

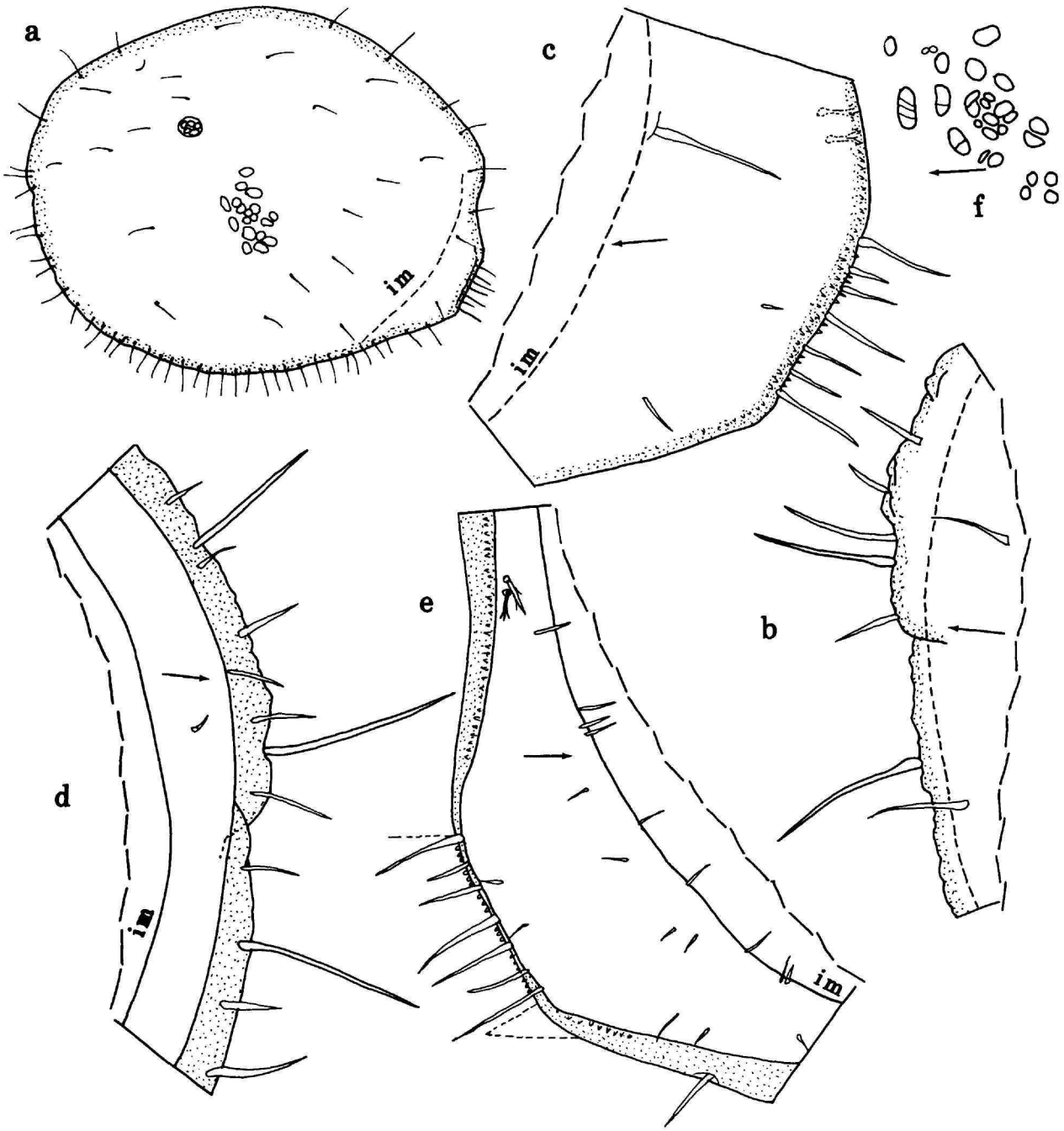

FIGURE 27.—*Eurypylus hapax*, new species, Instar IV female, holotype, USNM 194494: *a*, complete specimen from left side, length 0.87 mm; *b,c*, anterior and posterior of left valve, ov; *d,e*, anterior and posterior of left valve, iv; *f*, central adductor muscle attachments on left valve, ov.

First Antenna (Figure 28*a,b*): 1st joint bare. 2nd joint with dorsal bristle with indistinct spines. 3rd and 4th joints fused; 3rd joint with 1 dorsal bristle and no ventral bristle; 4th joint with ventral spines and 3 bristles (1 dorsal, 2 ventral). 5th joint with long ventral bristle with minute distal marginal spine or filament and terminal spine. 6th joint minute, fused to 5th joint,

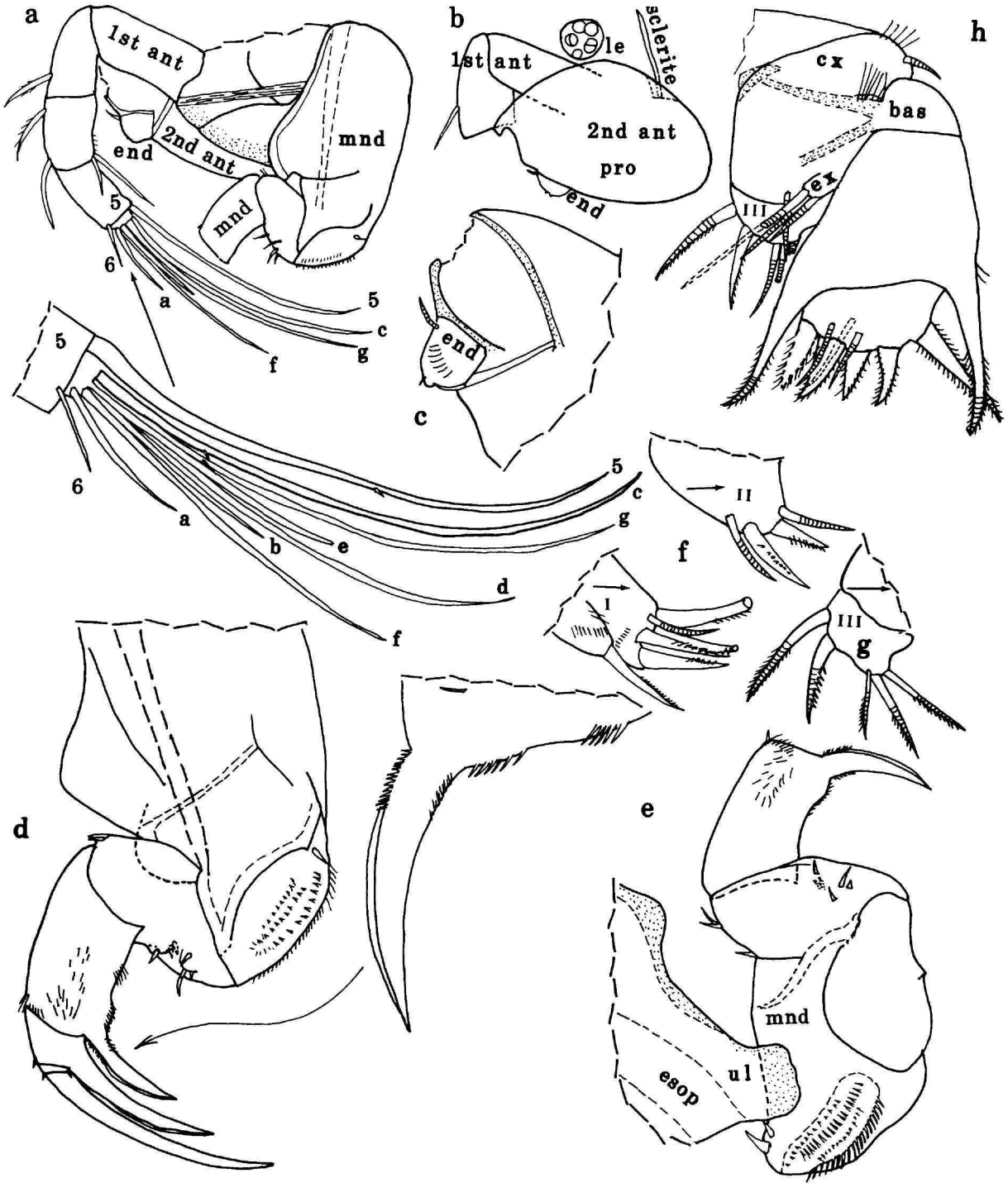

FIGURE 28.—*Eurypylus hapax*, new species, Instar IV female, holotype, USNM 194494: *a*, portion of anterior of body from left side; *b*, portion of anterior of body from left side; *c*, part of right 2nd antenna, mv; *d*, right mandible, mv; *e*, upper lip and part of left mandible, both in place on body and drawn from right side; *f*, endites I and II, left maxilla, mv; *g*, endite III, right maxilla, lv; *h*, part of right maxilla, lv.

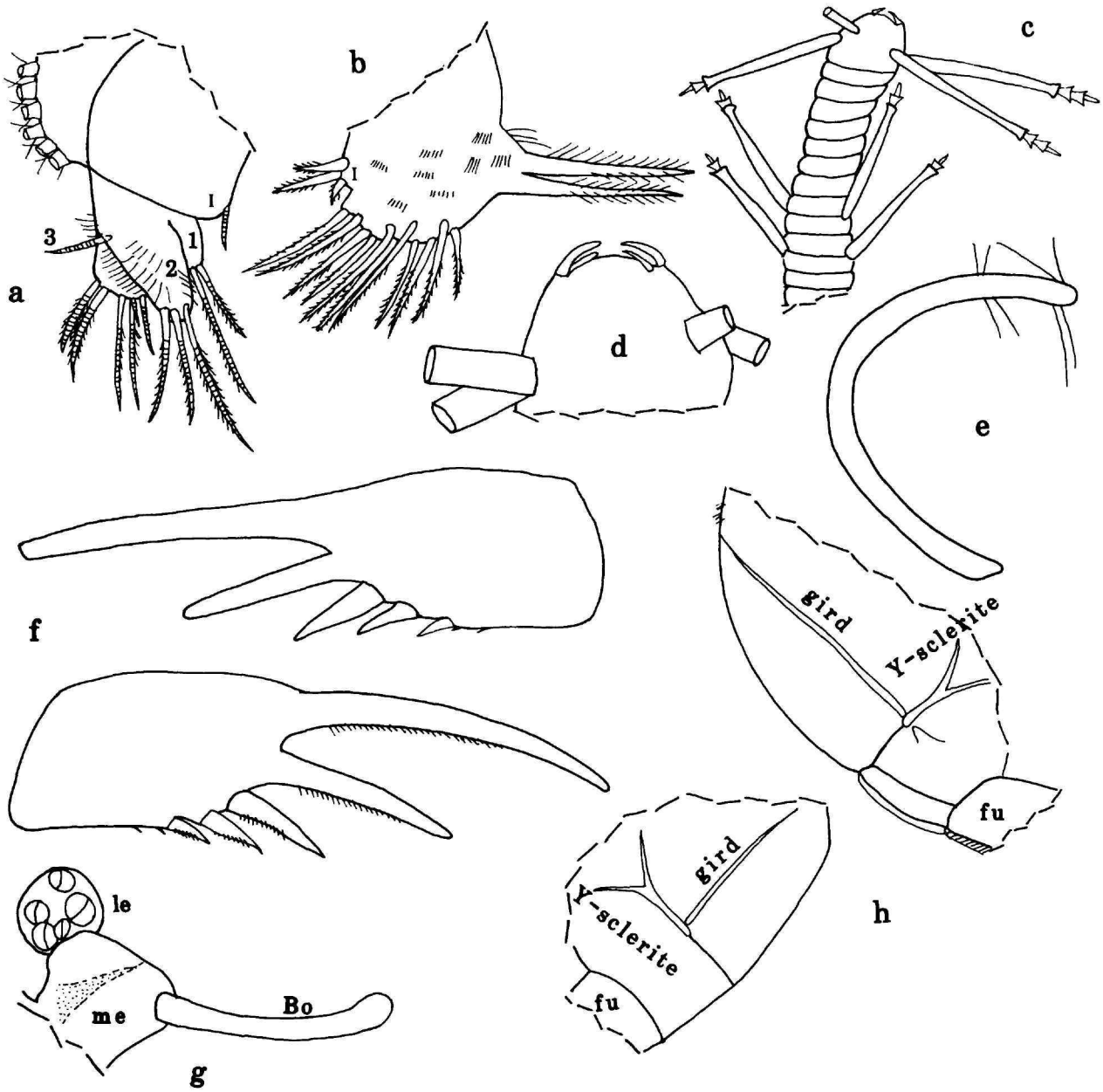

FIGURE 29.—*Eurypylus hapax*, new species, Instar IV female, holotype, USNM 194494: *a*, right 5th limb, lv; *b*, 6th limb; *c,d*, left 7th limb; *e*, right 7th limb viewed through right valve; *f*, left and right lamellae of furca (marginal teeth of claws not shown on left lamella), lv; *g*, left lateral eye, medial eye, and Bellonci organ in place on body (stippling in medial eye represents brown pigment); *h*, views of portions of posterior of body from right and left sides.

with short medial bristle. 7th and 8th joints fused. 7th joint: a-bristle about twice length of bristle of 6th joint; b-bristle medial and longer than a-bristle; c-bristle about same length as bristle of 5th joint, with small proximal filament and terminal spine. 8th joint: d-bristle about same length as bristle of 5th joint, bare with blunt tip; e-bristle about ¾ length of d-bristle, bare with blunt tip; f-bristle shorter than c-bristle, with minute terminal spine; g-bristle about same length as bristle of 5th joint, with minute indistinct proximal filament and terminal spine.

Second Antenna (Figure 28*a–c*): Protopodite bare. Endopodite 1-jointed, with medial spines, proximal ringed anterior bristle, and minute spine or bristle adjacent to slight terminal protuberance (Figure 28*c*). Exopodite: 1st joint with

small terminal medial bristle with blunt tip; bristles of joints 1–8 long with slender ventral spines and distal natatory hairs; 9th joint with 2 bristles (dorsal short with few minute spines, ventral long with slender ventral spines and distal natatory hairs).

Mandible (Figure 28*a,d,e*): Coxale endite consisting of 1 or 2 short stout spines in proximal ventral corner; ventral margin of coxale with hairs, and surface near ventral margin with slender spines. Basale: ventral margin with 4 small medial and 2 small lateral bristles; dorsal margin with 3 small bristles (1 distal to midlength, 2 subterminal). Exopodite absent. 1st endopodial joint with medial, ventral, and dorsal spines, and stout ventral terminal claw with proximal ventral and dorsal spines. 2nd endopodial joint with stout ventral claw and small dorsal bristle. 3rd endopodial joint with stout terminal claw and 2 minute bristles (1 ventral, 1 dorsal).

Maxilla: Endite I with 2 lobes with medial spines, proximal lobe with 1 unringed terminal bristle, distal lobe with 5 bristles (1 ringed, 4 claw-like) (Figure 28*f*); endite II with 4 bristles (Figure 28*f*); endite III with 5 bristles (Figure 28*g,h*). Coxale with short ringed dorsal bristle and long dorsal hairs (Figure 28*h*). Basale with bristle near exopodite (Figure 28*h*). Exopodite with 3 bristles (1 long, 2 short). 1st endopodial joint with few distal spines on anterior margin and pectinate alpha- and beta-bristles. 2nd endopodial joint with 2 a-bristles, 1 c-bristle, and 5 pectinate end bristles (middle bristle shortest, anterior longest).

Fifth Limb (Figure 29*a*): Single endite with short bristle. 1st exopodial joint with 2 spinous bristles; 2nd exopodial joint with 3 spinous terminal bristles; joints 3–5 fused with total of 7 bristles. Exopodial joints 2–5 hirsute.

Sixth Limb (Figure 29*b*): Single endite with 3 short bristles. End joint with 11 spinous anterior bristles followed by short space and 2 stout hirsute bristles.

Seventh Limb (Figure 29*c–e*): Limb with 8 tapered bristles, 4 in proximal and 4 in terminal group, each with 2 or 3 bells. Terminus with opposing combs, each comb with about 3 minute teeth.

Furca (Figure 29*f*): Each lamella with 5 claws decreasing in length along lamella; claws 1 and 2 nonarticulated, claws 3–5 articulated. All claws with teeth along posterior margin; few teeth on claws 1–3 slightly stouter than others; teeth of claw 5 indistinct. Few spines on lamellae following claws. Right lamella anterior to left by width of base of claw 1.

Bellonci Organ (Figure 29*g*): Elongate, broadening near rounded tip.

Eyes: Medial eye bare with line of brown pigment near midheight (Figure 29*g*). Lateral eye smaller than medial eye, with 5 divided amber-colored ommatidia (Figures 27*a*, 28*b*, 29*g*).

Upper Lip (Figure 28*e*): Projecting anteriorly, bare.

Posterior of Body (Figure 29*h*): With few indistinct spines at posterodorsal corner dorsal to posterior end of girdle.

Genitalia: None observed.

Y-*Sclerite* (Figure 29*h*): With ventral branch typical for family.

REMARKS CONCERNING 7TH LIMB.—The holotype, USNM 194494, is an instar IV female and the 7th limb has some juvenile characters. It is likely that the 7th limb of the adult female will have cylindrical rather than tapered bristles, 2 proximal anterior bristles rather than only 1, 6 rather than 4 terminal bristles, and more strongly developed opposing terminal combs.

COMPARISONS.—The absence of secondary claws on the furca of *E. hapax* places the species in the *E. rousei* group of Kornicker (1996, table 3). The only known species in that group having five furcal claws on each lamella is *E. concentricostatus* (Hartmann, 1974). The carapace of *E. hapax* is without the concentric rib present on *E. concentricostatus*.

CORRECTION.—Kornicker (1996, table 3) incorrectly listed *E. concentricus* instead of *E. concentricostatus*.

Eurypylus eagari, new species

FIGURES 30–32

ETYMOLOGY.—Named for Dr. Stephan Eagar, ostracodologist.

HOLOTYPE.—USNM 194478, ovigerous female on slide and in alcohol.

TYPE LOCALITY.—Sta 94-018, transect AA, Exuma Sound, Bahamas, depth 67 m.

PARATYPES.—None.

DISTRIBUTION.—Collected only at type locality.

DESCRIPTION OF ADULT FEMALE (Figures 30–32).—Carapace oval in lateral view with projecting caudal process, and lateral projection at valve midheight extending posteriorly just past valve edge (Figure 30). Location of incisur indicated by indentation in lateral surface of anterior margin of valve at about midheight, but no indentation present in valve edge.

Ornamentation (Figure 30): Surface with lateral ribs both dorsal and ventral to valve midheight; a peripheral rib located well in from valve edge and with small riblets extending from rib to valve edge. Surface with numerous oval fossae with minute papillae on bottom. Bristles, some with broad base, numerous along valve edge and sparse on lateral surface. Ventral and anterior margins scalloped. Valves without gel-like coating.

Infold: Small bristle near inner margin of anterior infold just ventral to incisure. Infold of caudal process with 9–11 small bristles and with few smaller bristles along inner edge of infold (Figure 32*i*). Two setal bristles present dorsal to caudal process at about ¼ valve height measured from caudal process.

Selvage: Wide lamellar prolongation along anterodorsal, anterior, anteroventral, and ventral edges of valves; lamellar prolongation extending well past tip of caudal process; outer edge of anteroventral lamellar prolongation with fringe of closely spaced coarse spines; fringe along anterior and anterodorsal lamellar prolongation with slenderer spines; edge of ventral and posterior lamellar prolongation without spines. (Poulsen (1965:48) stated that the outer edge of the selvage of

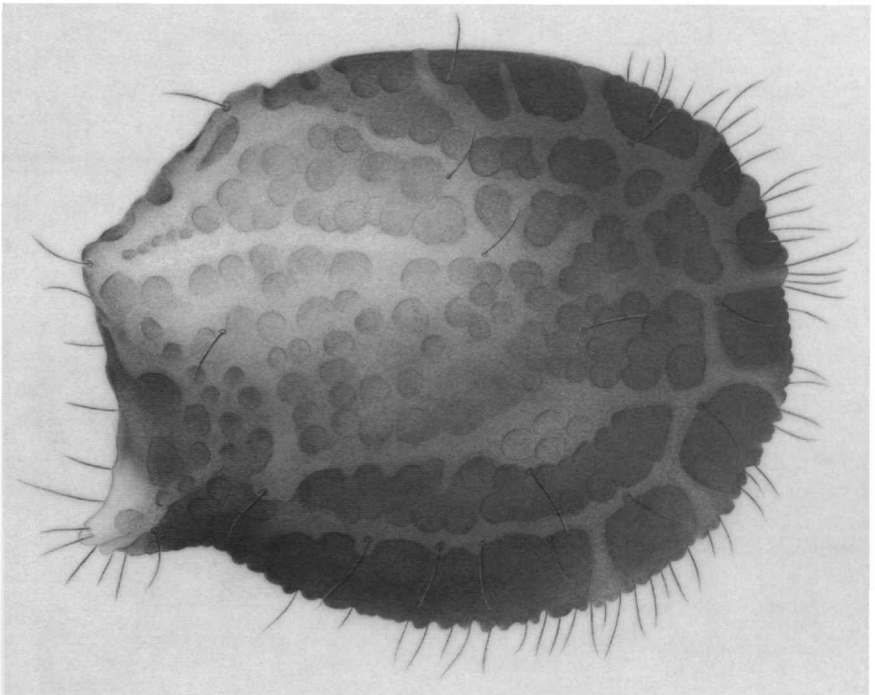

FIGURE 30.—*Eurypylus eagari*, new species, adult female, holotype, USNM 194478: complete specimen from right side, length 0.64 mm.

the Sarsiellidae is without a fringe of hairs that is characteristic of the Philomedinae and Rutidermatidae. Thus, the fringe of hairs along the outer edge of part of the lamellar prolongation of *E. eagari* is unusual, and has not previously been reported on other Sarsiellinae, but has been reported on species of *Dantyinae* by Kornicker and Cohen (1978:497).)

Carapace Size (length, height in mm): USNM 194478, 0.64, 0.52.

First Antenna (Figure 31*c,d*): 1st joint bare. 2nd joint with dorsal spines and dorsal bristle with indistinct spines. 3rd and 4th joints fused; 3rd joint with 2 bristles (1 dorsal, 1 ventral (ventral bristle missing on right limb of USNM 194478; the bristle shown dashed on illustrated right limb (Figure 31*c*) is based on length of bristle of left limb)); 4th joint with 3 bristles (1 dorsal, 2 ventral). 5th joint with long ventral bristle with minute spine at midlength and 1 terminal spine. 6th joint minute, fused to 5th joint, with small terminal medial bristle. 7th and 8th joints fused. 7th joint: a-bristle short; b-bristle about ½ length of a-bristle; c-bristle long. 8th joint: d- and e-bristles equilength, slightly shorter than bristle of 5th limb, bare with blunt tips; f-bristle claw-like in proximal half with curved and oblique cross-sutures, and bristle-like in distal half with closely spaced rings (proximal end of distal half narrower than distal end of proximal half); g-bristle similar to f-bristle, but slightly longer.

Second Antenna (Figure 31*c,e*): Protopodite bare. Endopodite 2 jointed: 1st joint with 1 or 2 proximal ringed anterior bristles; 2nd joint with terminal bristle (with slender drawn-out tip) slightly longer than bristles of 1st joint (endopodite could be interpreted to be 1-jointed if terminal protuberance considered part of 1st joint). Exopodite: 1st joint with small recurved terminal medial bristle with blunt tip; bristles of joints 2 and 3 with slender proximal ventral spines and distal natatory hairs; bristles of joints 4–8 with natatory hairs, no spines; 9th joint with 2 bristles (dorsal short bare, ventral long with few proximal hair-like ventral spines and natatory hairs).

Mandible (Figure 31*f–h*): Coxale endite consisting of medial spine in proximal ventral corner; ventral margin of coxale with hairs; medial surface near ventral margin with few indistinct small spines. Basale: ventral margin with 4 small medial and 2 small lateral bristles; dorsal margin with 2 small

FIGURE 31 (right).—*Eurypylus eagari*, new species, adult female, holotype, USNM 194478: *a*, complete specimen from right side, length 0.64 mm; *b*, adductor muscle attachments on right valve (not all shown), ov; *c*, portion of anterior of body from right side; *d*, tip of left 1st antenna (8th joint not shown), mv; *e*, part of right 2nd antenna, mv; *f*, right mandible, lv; *g,h*, proximal part and endopodite of right mandible, mv; *i*, furca (only part of left lamella shown, striated); *j*, right lateral eye, medial eye, and Bellonci organ; *k*, left lateral eye; *l*, portion of posterior of body from right side; *m*, genital organ.

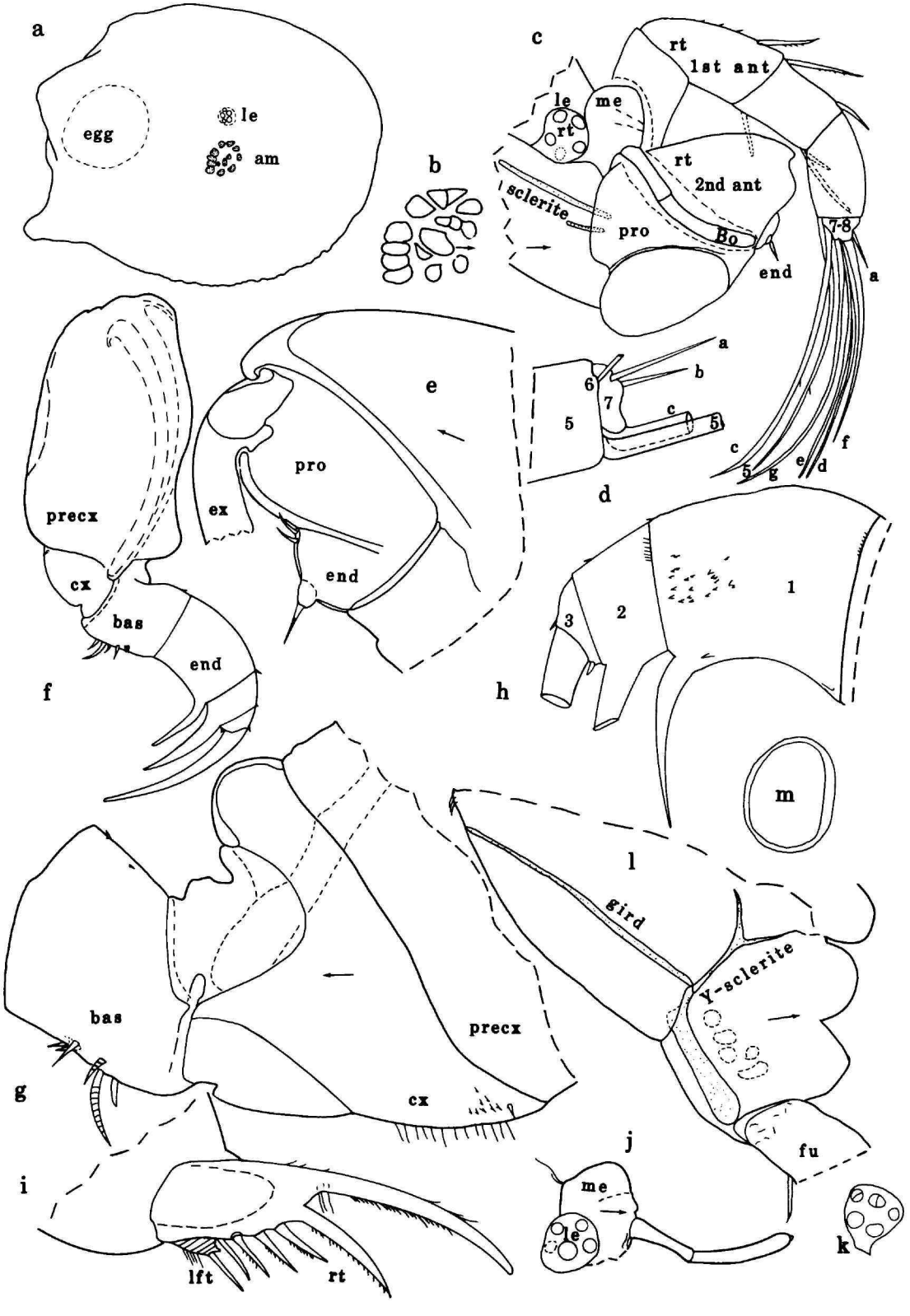
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FIGURE 32 (left).—*Eurypylus eagari*, new species, adult female, holotype, USNM 194478: *a*, left maxilla, lv; *b*, endites I–III, right maxilla, mv; *c*, portion of posterior of body from left side; *d*, 5th limb (only bristle of endite I shown); *e*, distal 5th limb (folded on slide); *f*, right 6th limb, lv; *g*, left 7th limb; *h*, posterior of body, av; *i*, posteroventral infold of left valve, iv.

indistinct bristles (1 near midlength, 1 subterminal). Exopodite absent. 1st endopodial joint with medial spines, a row of slender medial spines along distal edge near dorsal margin, a few indistinct terminal spines on dorsal margin, and stout bare ventral claw. 2nd endopodial joint with small dorsal bristle and stout bare ventral claw. 3rd endopodial joint with stout terminal claw and 2 minute bristles (1 ventral, 1 dorsal).

Maxilla (Figure 32*a,b*): Precoxale and coxale with long hairs. Coxale with bare dorsal bristle. Endite I with 6 bristles (2 claw-like pectinate); endite II with 4 bristles; endite III with 5 bristles (2 proximal, 3 terminal). Transparent thumb-like flap projects from basale (or from near base of endites). Basale with bristle near exopodite. Exopodite with 3 bristles (1 long, 2 short). 1st endopodial joint with pectinate alpha- and beta-bristles. 2nd endopodial joint with 2 a-bristles, 1 c-bristle, and 5 pectinate end bristles (middle bristle shortest, anterior bristle ringed).

Fifth Limb: Epipodite with about 22 bristles. Single endite with 1 small bristle (Figure 32*d*). 1st exopodial joint with 2 bristles (Figure 32*e*); 2nd exopodial joint with 3 terminal bristles; 3rd exopodial joint with 1 bristle on outer lobe; fused 4th and 5th joints with 2 terminal bristles; exopodite with long hairs. (A small bristle illustrated by dashes on folded limb shown in Figure 32*e* could be either the endite bristle or a bristle on an exopodial joint.)

Sixth Limb (Figure 32*f*): Single endite with 1 terminal bristle and 1 or 2 shorter medial bristles. End joint with 9 or 10 bristles with short spines and 2 broader plumose posterior bristles; medial surface and posterior margin of end joint with long hairs.

Seventh Limb (Figure 32*c,g*): Limb with 8 cylindrical bristles: 2 in proximal group (1 on each side) each with 2 bells; 6 in terminal group (3 on each side) with either 1–4, or 2–4 bells; clappers of terminal bells unusually long. Terminus with opposing combs, each with 2 or 3 minute teeth.

Furca (Figures 31*i,l*, 32*c,h*): Each lamella with 6 claws: claws 1 and 2 primary and nonarticulated; claws 3–6 secondary and articulated. Claws 1–5, and possibly 6, with teeth along posterior margin; a few teeth on claws 1 and 2 stouter than others. Long slender medial spines near base of claw 1; slender spines present along margins of lamellae following claws. Right lamella anterior to left by width of base of claw 1.

Bellonci Organ (Figure 31*j*): Elongate with suture proximal to midlength and rounded tip with minute node.

Eyes: Medial eye bare unpigmented (Figure 31*j*). Lateral eye unpigmented, smaller than medial eye, with 5 amber-colored divided ommatidia (Figure 31*j,k*).

Upper Lip: Indistinct, projecting anteriorly, bare.

Posterior of Body (Figures 31*l*, 32*c,h*): With few spines dorsal to dorsal end of girdle.

Genitalia (Figures 31*m*, 32*c*): Rimmed oval on each side anterior to furca.

Y-*Sclerite* (Figure 31*l*): With ventral branch typical for family.

Eggs: USNM 194478 with 2 oval eggs in marsupium (1 shown in Figure 31*a*). Maximum lengths of each egg (mm): 0.15, 0.17.

COMPARISONS.—The presence of secondary claws following the primary claws on the furca places *E. eagari* in the *Eurypylus petrosus* group of Kornicker (1996, table 3). The only species in that group having a total of six claws is *E. darwinensis* Kornicker, 1996. The caudal process of the female *E. eagari* projects farther posteriorly than that of *E. darwinensis*, and the endopodite of the female 2nd antenna of *E. darwinensis* is without a terminal bristle. *Eurypylus eagari* is the only species of the sarsiellinae reported to have spines along the outer edge of the lamellar prolongation of the selvage.

Family RUTIDERMATIDAE Brady and Norman, 1896

This family contains two subfamilies: Rutidermatidinae Brady and Norman, 1896, and Metaschismatinae Kornicker, 1994.

Subfamily RUTIDERMATIDINAE Brady and Norman, 1896

Rutiderma Brady and Norman, 1896

TYPE SPECIES.—*Rutiderma compressa* Brady and Norman, 1896.

COMPOSITION AND DISTRIBUTION.—This genus is cosmopolitan between the latitudes of 45°N and 53°S, at depths from intertidal to 317 m (questionably to 1834 m), and contains about 31 species (Cohen and Kornicker, 1987; Kornicker, 1992, 1996).

Rutiderma schroederi, new species

FIGURES 33–38

ETYMOLOGY.—Named for Jack Schroeder, artist, who inked the camera lucida drawings of appendages for this and many other papers by the senior author.

HOLOTYPE.—USNM 194472, adult female on slide and in alcohol.

TYPE LOCALITY.—Sta 94-018, transect AA, Exuma Sound, Bahamas, depth 67 m.

PARATYPES.—Sta 94-018, USNM 194473, instar III, in alcohol. Sta 96-034, USNM 194517, undissected late instar in alcohol (length 1.16 mm, height 0.75 mm).

DISTRIBUTION.—Collected at Sta 94-018, off Lee Stocking Island, depth 67 m, and Sta 96-034, off Great Exuma Island, depth 90–100 m.

DESCRIPTION OF ADULT FEMALE (Figures 33–37).—Carapace oval in lateral view with prominent rostrum and caudal process (Figure 33*a*).

Ornamentation: Horizontal ribs present above and below central adductor muscle attachments form alar process on each valve that extend past posterior edge of valve (Figure 33*a,c*); both valves with small triangular process at anterodorsal corner (Figure 33*a,c*); surface of valves with abundant large fossa, each fossae lies within 5- or 6-sided polygon (polygons formed by indistinct intersecting thin sutures and not raised walls) (Figure 33*a,b*); tip of rostrum and anteroventral corner of valves extend well past valve edge (Figure 34*a,b,e*); long bristles, some with broad base, along anterior and ventral margins and scattered over valve surface. USNM 194472 with internal marginal pore canals along free margin (Figure 34*c*).

Infold: Rostral infold with 17 bristles forming row parallel to valve edge, and with 2 paired bristles near inner end of incisur (Figure 34*a*); small bristles near inner margin of infold posterior to incisur (Figure 34*a,e*); anteroventral infold with about 11 short bristles and 6 or 7 parallel ridges (Figure 34*e*); infold of caudal process with list just within inner margin of infold at angle of 20° to 30° with ventral edge of valve (Figure 34*d,f*); list with 6 to 11 short bristles; infold of caudal process with 5 or 6 small scattered bristles between list and valve edge.

Selvage: Wide lamellar prolongation with marginal fringe present along free margins; prolongation divided at inner end of incisur (Figure 34*e*) and probably also at tip of caudal process.

Central Adductor Muscle Attachments (Figure 33*e*): Consisting of about 11 individual oval scars.

Carapace Size (length, height in mm): USNM 194472, 1.73, 1.4, height 66% of length.

First Antenna (Figure 35*a*): 1st joint bare. 2nd joint with spinous dorsal bristle near midlength. 3rd and 4th joints fused; 3rd joint short with 3 bristles (1 ventral, 2 dorsal); 4th joint with 3 spinous terminal bristles (2 ventral, 1 dorsal). 5th joint with row of minute lateral spines near base of sensory bristle; sensory bristle with small proximal filament and bifurcate tip. 6th joint minute, fused to 5th joint, with spinous medial bristle. 7th joint: a-bristle longer than bristle of 6th joint; b-bristle longer than a-bristle; c-bristle twice length of b-bristle. 8th joint: d- and e-bristles almost as long as c-bristle, bare with blunt tips (bristles not shown in Figure 35*a*); f-bristle almost as long as c-bristle, with 2 proximal filaments and bifurcate tip; g-bristle longer than c-bristle with 2 proximal filaments and bifurcate tip. (The 2nd joint of each limb of USNM 194472 is unusual in not having a lateral bristle; however, the 2nd joint of instar III, USNM 194473, described below, does have a long lateral bristle indicating that the missing lateral bristle on the adult is either an aberrancy or was broken off during the dissection.)

Second Antenna: Protopodite bare (Figure 35*b,c*). Endopodite a single joint with 1 anterior and 4 posterior bristles (Figure 35*b,c*). Exopodite: 1st joint with small terminal medial bristle; bristle of 2nd joint reaching well past 9th joint, with small triangular ventral spines and hooked tip; bristles of joints 3–5 short, with triangular and rounded ventral spines; bristles of joints 6 to 8 long with natatory hairs, no spines; 9th joint with 5 bristles (3 long, 1 medium, 1 short dorsal) with natatory hairs.

Mandible (Figure 35*d,e*): Coxale endite bifurcate (endite broken off right limb) (spines not observed on endite but present on endite of instar III described herein). Basale: dorsal margin with 3 distal bristles; ventral margin with 4 bristles in proximal corner (2 unringed pectinate, 2 ringed) and 3 or 4 distal bristles with bases medial (Figure 35*e*) (2 proximal bristles broken off in right limb (Figure 35*d*)). 1st endopodial joint with 3 slender ventral bristles; medial surface with abundant spines. 2nd endopodial joint: dorsal margin with 5 proximal bristles (including 2 small bristles with bases medial); ventral margin with small a-bristle (a 2nd a-bristle may have been broken off left limb during dissection; both a-bristles broken off right limb; an instar III, USNM 194473, described below has 2 a-bristles), small terminally ringed b-bristle on sclerotized base, and stout terminal claw-like c-bristle with ventral spines, proximal peg, and tapered tip (tip broken off c-bristle of one limb of adult USNM 194472 (Figure 35*e*) but appears intact on other limb (Figure 35*d*); however, tip of the c-bristle on instar III, USNM 194473, more drawn-out than that of adult female, suggesting tip might have broken off both limbs of adult) with minute spines along distal inner margin, and 2 small d-bristles; medial side with abundant spines. 3rd endopodial joint with 3 slender medial a-bristles, long terminal b-bristle with minutely serrate ventral margin, and long terminal stout claw-like c-bristle with minutely serrate ventral margin and broadly rounded tip.

Maxilla (Figure 36*a–d*): Precoxal and coxale with fringe of hairs (not shown); coxale with dorsal bristle. 3 endites each with 2 or 3 pectinate claw-like bristles in addition to a few slender bristles; endite III also with slender proximal bristle. Basale with 2 bristles (1 medial, 1 dorsal (dorsal bristle missing on right limb)). Exopodite with 3 bristles (2 long, 1 short). 1st endopodial joint with dorsal spines, 1 spinous alpha-bristle, and 2 spinous beta-bristles (beta-bristles missing on left limb). 2nd endopodial joint with 2 stout pectinate claws and 5 slender spinous or pectinate ringed bristles.

Fifth Limb (Figures 36*f*, 37*a–e*): Endite I with 1–3 bristles; endite II with 5 bristles; endite III with 5 or 6 bristles (Figure 37*a,c*). 1st exopodial joint (Figure 37*d,e*): with 2 anterior bristles at midwidth; inner edge of anterior side with 2 small cusps; minute spine-like bristle proximal to proximal cusp (arrow in Figure 37*e*); main tooth composed of 4 prongs along inner edge; all but proximal prong with 1 to 4 cusps; small bristle adjacent to base of proximal prong. 2nd exopodial joint a large flat tooth with 3 smooth prongs along inner edge (Figure 37*b,c*); posterior side with spines, 2 adjacent distal bristles, 1 long proximal bristle near inner edge of tooth (not observed on left limb), and 1 minute ringed bristle near outer proximal corner (Figure 37*b*). 3rd exopodial joint with 3 bristles on inner lobe and 2 bare bristles on outer lobe. 4th and 5th exopodial

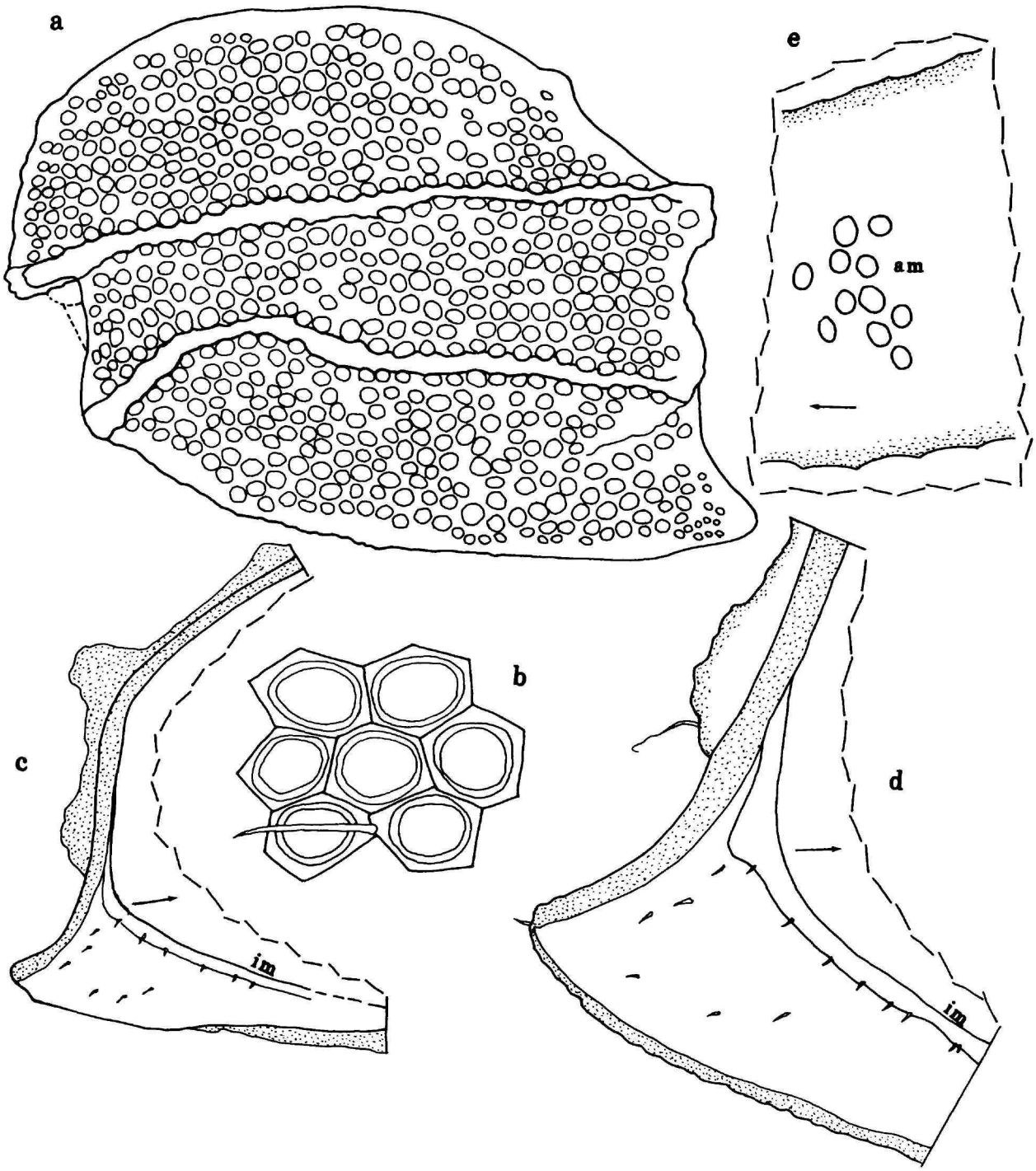

FIGURE 33.—*Rutiderma schroederi*, new species, adult female, holotype, USNM 194472: *a*, complete specimen from left side, length 1.73 mm; *b*, detail showing a bristle, fossae, and reticulations on valve surface; *c,d*, posterior of left valve, iv; *e*, central adductor muscle attachments on left valve, ov.

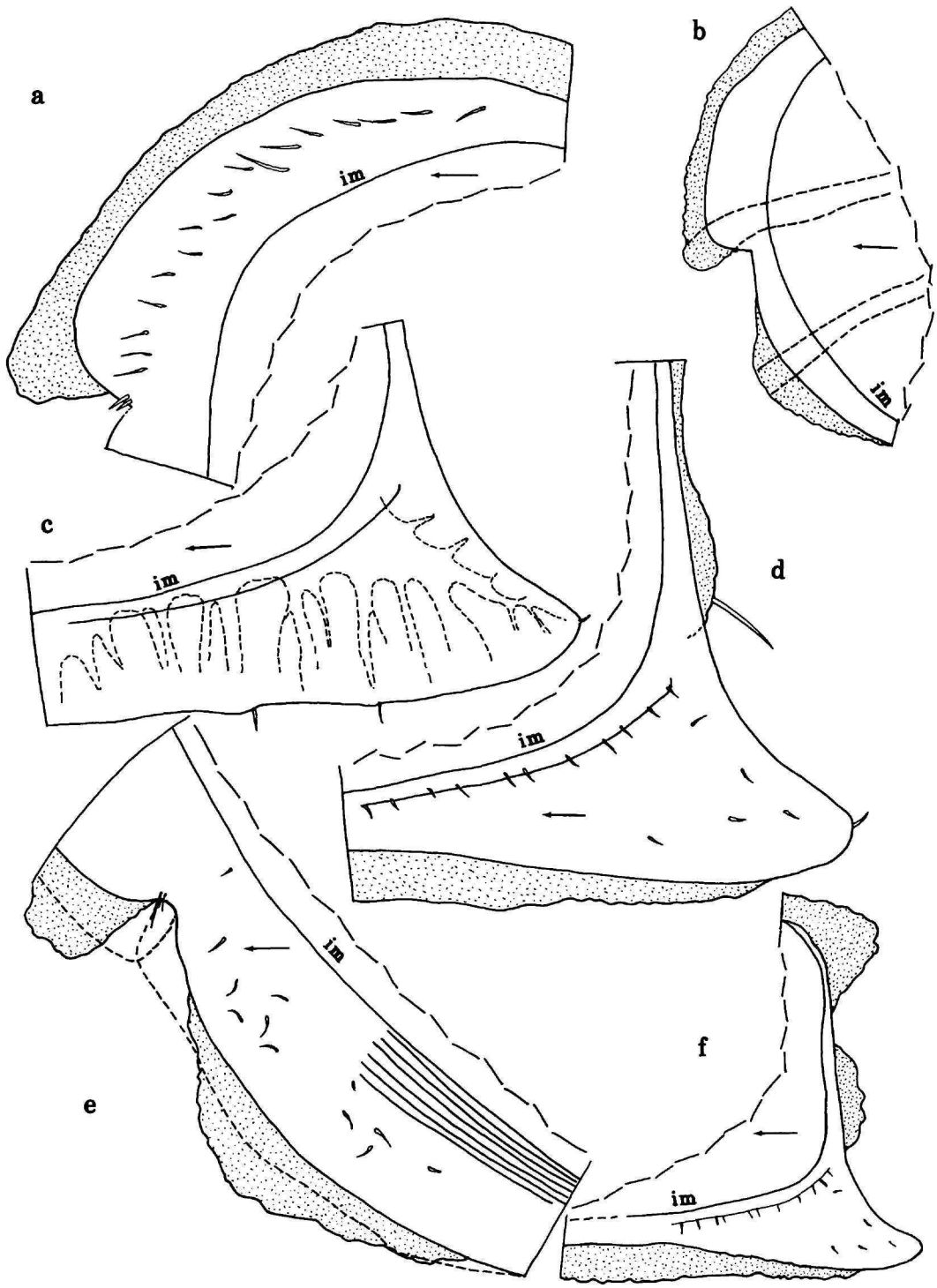

FIGURE 34.—*Rutiderma schroederi*, new species, adult female, holotype, USNM 194472: *a–f*, inside views of parts of right valve. Dashes in *e* represent pore canals.

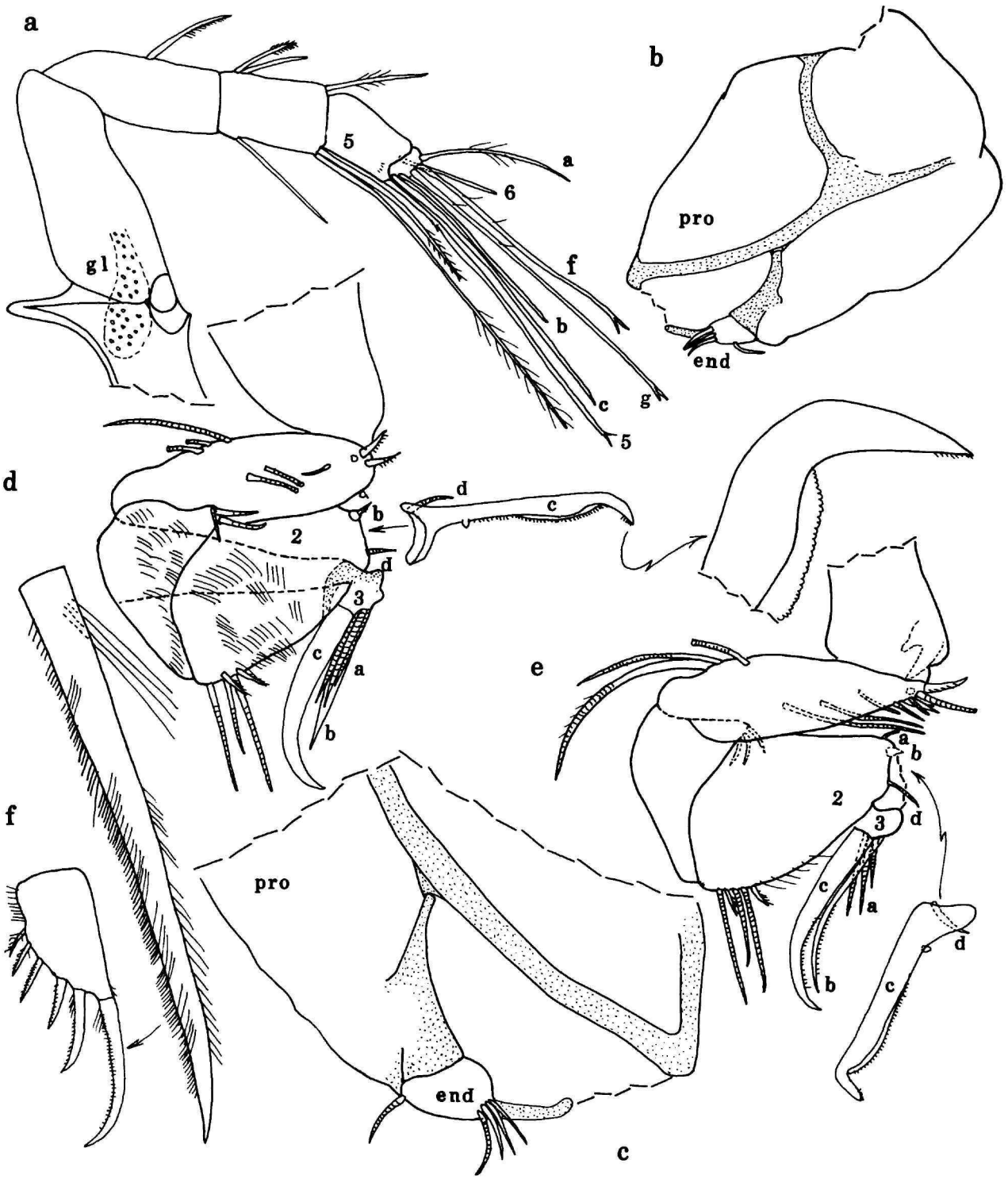

FIGURE 35.—*Rutiderma schroederi*, new species, adult female, holotype, USNM 194472: *a*, right 1st antenna, lv; *b,c*, parts of right and left 2nd antennae, mv; *d*, right mandible, mv; *e*, left mandible, lv; *f*, right lamella of furca, lv.

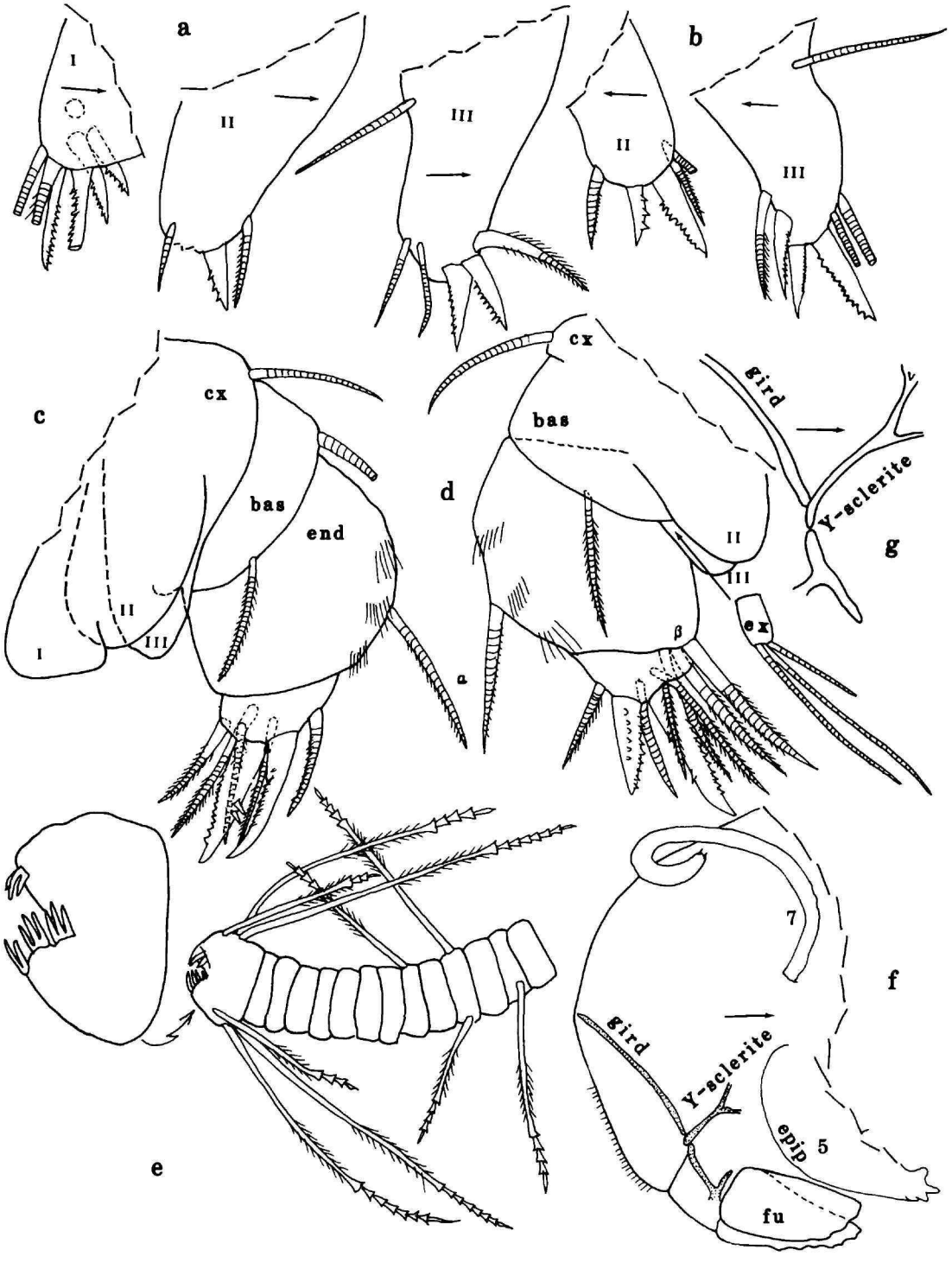

FIGURE 36.—*Rutiderma schroederi*, new species, adult female, holotype, USNM 194472: *a*, endites I–III, left maxilla, mv; *b*, endites II and III, right maxilla, mv; *c*, left maxilla (nabs), mv; *d*, right maxilla (nabs), mv; *e*, 7th limb; *f*, posterior of body from right side (nabs); *g*, right Y-sclerite.

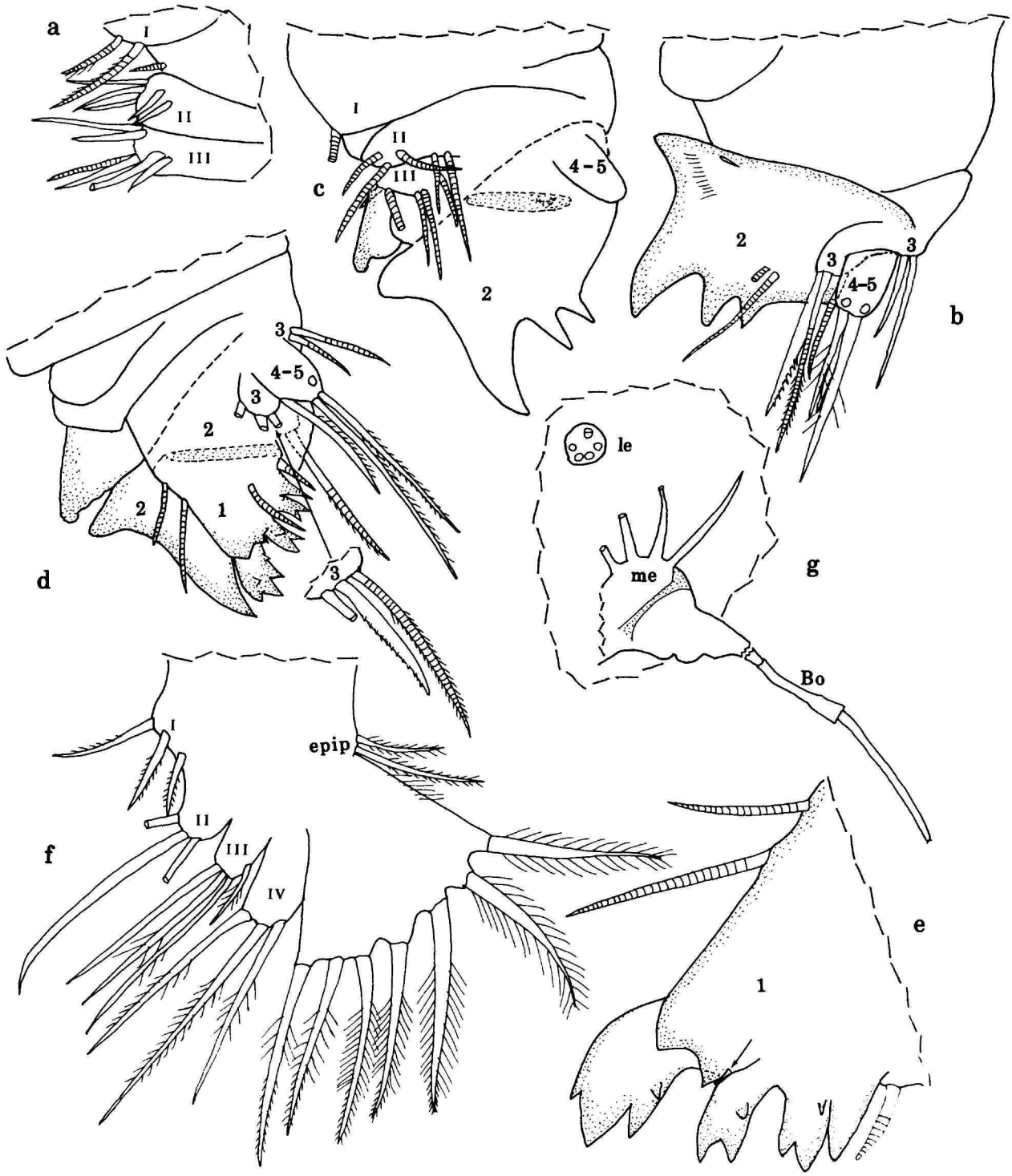

FIGURE 37.—*Rutiderma schroederi*, new species, adult female, holotype, USNM 194472: *a*, endites, left 5th limb (as seen through 1st and 2nd exopodial joints), pv; *b*, part of left 5th limb (1st exopodial joint not shown), pv; *c*, part of right 5th limb (1st and 3rd exopodial joints not shown), av; *d,e*, right 5th limb, av; *f*, 6th limb; *g*, portion of anterior of body from right side.

joints fused, with total of 4 bristles (1 or 2 bristles missing on both limbs).

Sixth Limb (Figure 37*f*): With 2 spinous epipodial bristles. Endites I, II, and IV each with 3 bristles; endite III with 4 bristles. End joint with 3 anterior bristles (with long proximal and short distal spines) on slight projection followed by 1 bristle with long proximal hairs and short distal spines, then 2 bristles plumose to tip.

Seventh Limb (Figure 36*e,f*): Each limb with 10 bristles (with small distal marginal spines), 4 proximal (2 on each side, each with 4 bells) and 6 terminal (3 on each side, each with 3–7 bells). Terminus with comb of 5 alate teeth opposite comb with 2 alate teeth.

Furca (Figures 35*f*, 36*f*): Each lamella with 4 primary claws followed by 2 secondary claws; primary claws with row of long medial spines near base; claw 1 with anterior spines and medial and lateral rows of slender spine-like teeth along posterior margin, teeth about same length except for few slightly longer than others; teeth along proximal half of claw slightly stouter than distal teeth (Figure 35*f*). Claws 2–4 with slender spine-like teeth along posterior margins. Secondary claws 5 and 6 spinous and with stout proximal anterior and posterior spines. Each lamella posterior to claws with long spines; right lamella anterior to left by width of base of claw 1.

Bellonci Organ (Figure 37*g*): Long with broad proximal part and rounded tip bearing 2 minute spines.

Eyes (Figure 37*g*): Medial eye elongate with area of brown pigment and slender dorsal filaments. Lateral eye small, unpigmented, with about 5 minute ommatidia (eye not visible through adult shell, but visible through shell of instar III, USNM 194473).

Upper Lip: Simple, rounded.

Genitalia: Small indistinct oval on each side anterior to furca.

Anterior of Body: Not observed.

Posterior of Body (Figure 36*f*): Part at midheight hirsute.

Y-*Sclerite* (Figure 36*f,g*): Branching distally; dorsal branch with bifurcate tip.

Eggs: USNM 194472 with small unextruded eggs.

Gut Content: USNM 194472 with many crustacean fragments.

DESCRIPTION OF INSTAR III (Figure 38).—Carapace similar in shape to that of adult female except less elongate (Figure 38*a*).

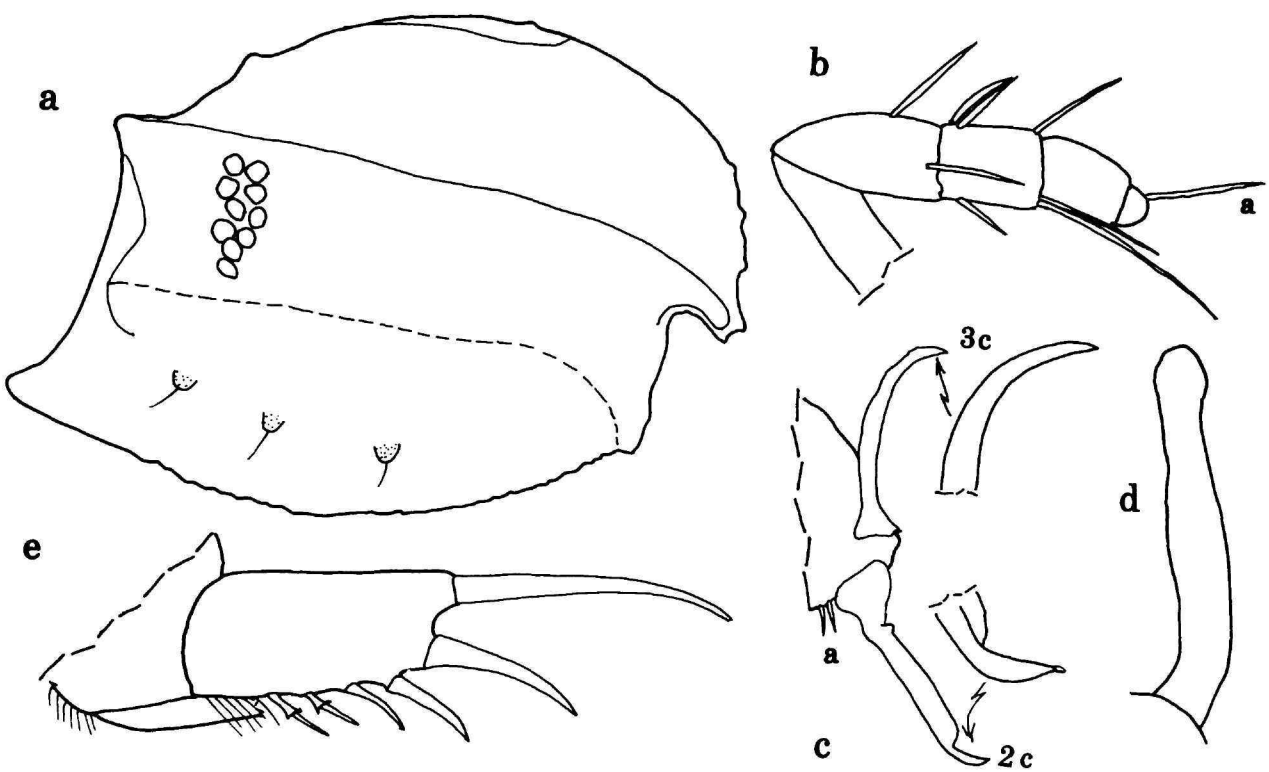

FIGURE 38.—*Rutiderma schroederi*, new species, Instar III, paratype, USNM 199473: *a*, complete specimen from right side (only few representative fossae shown), length 1.09 mm; *b*, right 1st antenna (nabs), lv; *c*, part of right mandible as seen through right valve (nabs), lv; *d*, right 7th limb, lv; *e*, right lamella of furca, lv.

Ornamentation: Similar to that of adult female except with 3 low nodes, each bearing bristles, present between lower horizontal ridge and ventral margin of valve.

Carapace Size (length, height in mm): USNM 194473, 1.09, 0.78, height 71.5% of length.

First Antenna: Illustrated in Figure 38*b* (bristles of 5th, 6th, and 8th joints not shown, and only a-bristle of 7th joint shown).

Fifth Limb (Figure 38*c*): Not examined in detail, but c-bristle of 2nd exopodial joint with slightly drawn-out tip.

Seventh Limb (Figure 38*d*): Elongate without bristles or terminal comb.

Furca (Figure 38*e*): Similar to that of adult female.

Bellonci Organ: Similar to that of adult female.

Eyes: Lateral eye similar to that of adult female, but visible through shell. Medial eye also similar to that of adult female, with brown pigment and 4 dorsal filaments.

Gut Content: Crustacean fragments.

COMPARISONS.—The carapace of *R. schroederi* outwardly resembles that of *R. darbyi* Kornicker, 1983:36. The infold of the caudal process of the left valve of *R. schroederi* is without the pleated ruffle present on *R. darbyi* (the ruffle is easily visible through the outside of the left valve). The carapace of *R. schroederi* also outwardly resembles *R. gyre* Kornicker, 1983:54, but the infold of the caudal process of *R. schroederi* is without the vertical crescent list present on *R. gyre*. The endopodites of the 2nd antennae of *R. darbyi* and *R. gyre* are without the ringed posterior bristle present on *R. schroederi*.

The carapace of *R. schroederi* also outwardly resembles that of *R. cohenae* Kornicker, 1983:62, which was collected near San Salvador, Bahamas, and Key West, Florida, from subtidal to 4 m depth (Kornicker, 1983:62). The morphology of the infolds of the caudal processes of the two species are also similar. The rostral infold of *R. schroederi* bears 17 bristles compared to 7 or 8 for *R. cohenae*. The length of the carapace of the unique female of *R. schroederi* is 1.73 mm, compared to a range of 1.24–1.29 mm for two females of *R. cohenae* (Kornicker, 1983:63). A major difference between the two species occurs in the mandible: the c-bristle of the 2nd exopodial joint of *R. cohenae* has a prolonged finger-like tip that is absent on *R. schroederi*. Slides of three type-specimens of *R. cohenae* (USNM 158213, juvenile female; USNM 158359, ovigerous female; and USNM 158414, ovigerous female) were reexamined during the present study, and all six limbs have the long finger-like tip on the c-bristle. The two specimens of *R. schroederi* examined do not have the long finger-like tip, but the tip of one limb of the holotype is obviously broken. The endopodites of the 2nd antennae of *R. schroederi* and *R. cohenae* both share the unusual character of having a fairly long posterior bristle; the bristle is ringed in *R. schroederi* and unringed in *R. cohenae*, but more specimens should be examined to determine whether this character might be variable.

Superfamily CYLINDROLEBERIDOIDEA Müller, 1906

Family CYLINDROLEBERIDIDAE Müller, 1906

Subfamily CYLINDROLEBERIDINAE Müller, 1906

Diasterope Kornicker, 1975

TYPE SPECIES.—*Diasterope pilosa* Poulsen, 1965; subsequent designation by Kornicker (1975:388).

COMPOSITION AND DISTRIBUTION.—Species of this genus are widespread at depths from 11–400 m (Kornicker, 1986:84). Two species, *D. tenuiseta* Poulsen, 1965, and *D. canina* Poulsen, 1965, have been previously reported from the Virgin Islands, West Indies, to near the present study area. Both species are known only from juvenile males. The new species described herein from the Bahamas, *D. procax*, is known from an adult female as well as from juveniles.

REMARKS.—The genera *Diasterope* and *Parasterope* differ mainly on the presence or absence, respectively, of a short proximal bristle on the sensory bristle of the 1st antenna of the adult female. The juvenile male of some species of *Parasterope* has a short proximal bristle on the sensory bristle that is lacking on the adult female; therefore, it is possible that when adult females are known for the two species described by Poulsen from the Virgin Islands, they may have to be referred to *Parasterope*.

Diasterope procax, new species

FIGURES 39–44, 52*h*

ETYMOLOGY.—From the Latin *procax* (bold, forward, impudent).

HOLOTYPE.—USNM 194460, adult female on slide and in alcohol.

TYPE LOCALITY.—Sta 95-006, transect BB, Exuma Sound, Bahamas, depth 88 m.

PARATYPES.—Exuma Sound, off Lee Stocking Island: Sta 93-005, transect BB: USNM 194316, A–2 male on slide and in alcohol. Sta 95-002, transect BA: USNM 194461, A–4 instar in alcohol; USNM 194462, A–4 instar in alcohol; USNM 194463, A–1 male in alcohol. Sta 95-006, transect BB: USNM 194468, A–4 instar in alcohol; USNM 194467, A–3 male in alcohol; USNM 194466, A–3 female in alcohol; USNM 194464, A–2 male in alcohol; USNM 194465, A–2 male in alcohol.

DISTRIBUTION.—Exuma Sound at depths from 88–142 m, collected with baited trap and grab sampler.

DESCRIPTION OF ADULT FEMALE (Figures 39, 40, 43*a,h*).—Carapace elongate with convex dorsal margin, fairly straight ventral margin, evenly rounded anterior margin, and posterodorsal corner of posterior margin more oblique than posteroventral corner (Figures 39*a*, 43*a*). Tip of ventral edge of rostrum projecting ventrally past inner straight part of ventral edge (Figure 39*c*).

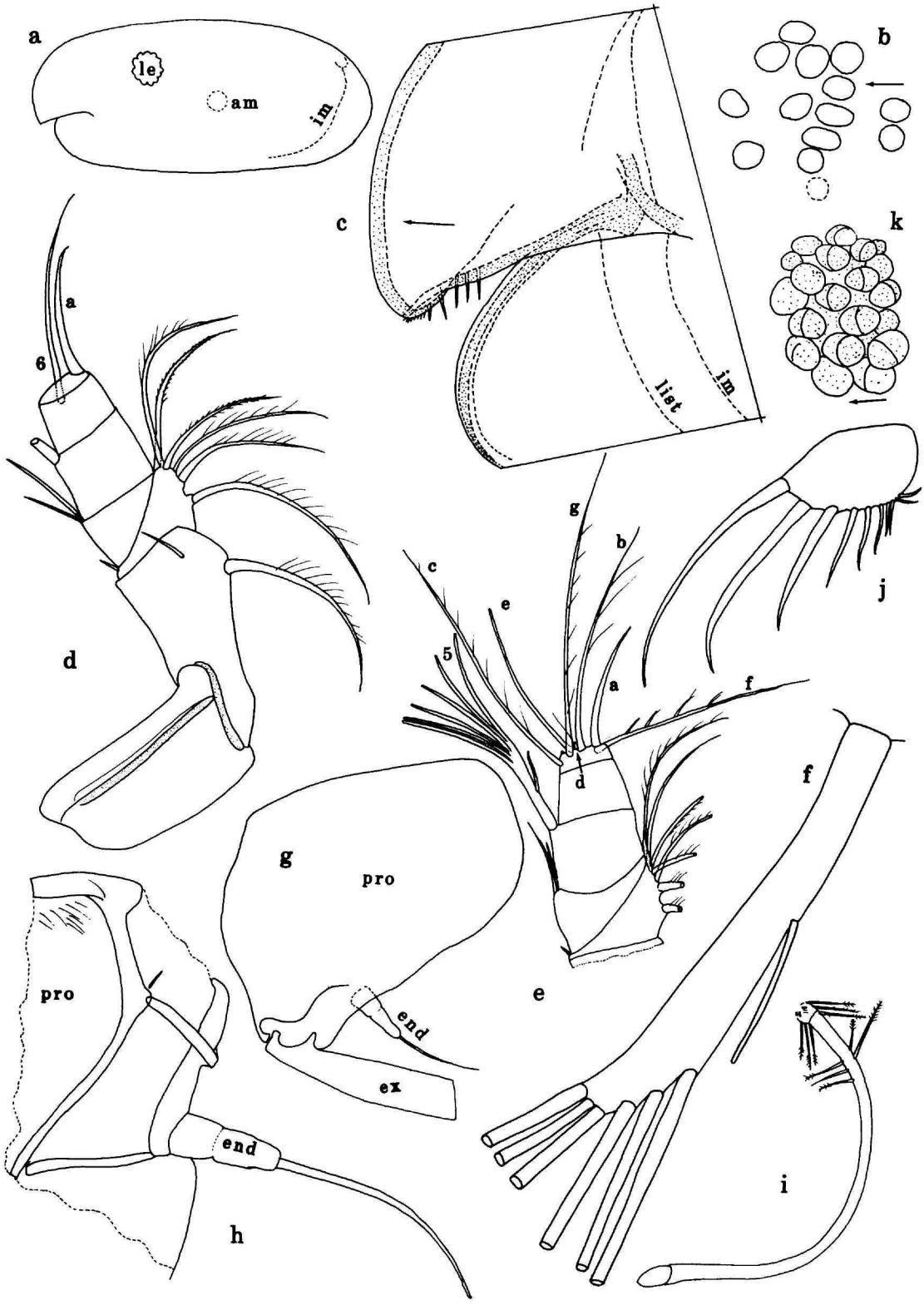
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FIGURE 39 (left).—*Diasterope procax*, new species, adult female, holotype, USNM 194460: *a*, complete specimen from left side, length 2.01 mm; *b*, central adductor muscle attachments on right valve, iv; *c*, anterior of left valve, ov; *d*, left 1st antenna (not all bristles of 7th and 8th joints shown), lv; *e*, distal right 1st antenna, mv; *f*, part of sensory bristle, 5th joint, right 1st antenna, lv; *g*, part of left 2nd antenna, lv; *h*, part of left 2nd antenna, mv; *i*, right 7th limb, lv; *j*, left furcal lamella, lv; *k*, right lateral eye, lv.

Infold: Rostral infold with about 125 long and short bristles. Anteroventral infold with about 115 long and short bristles. Ventral infold with about 28 bristles forming row ending posteriorly at point where list becomes broad. List beginning at inner margin of infold near posterior end of incisur, extending along ventral margin, and continuing on posterior infold where it broadens; list approaching valve edge at midlength. Broad posterior list with 25 broad transparent flap-like bristles and 43 slender bristles (1–3 bristles between each pair of flap-like bristles); 4 tubular processes forming row along midwith of posterior infold; about 15 long and 17 short bristles forming row between posterior list and posterior edge of valve (long bristles ventral to valve midheight). Tip of rostrum of each valve with minute indistinct hairs along inside edge (Figure 39*c*).

Selvage: Short broad fringed lamellar prolongation along inner part of ventral edge of incisur. Posterodorsal curvature of right valve with short segment of fringed lamellar prolongation.

Central Adductor Muscle Attachments (Figure 39*a,b*): Consisting of about 14 oval attachments.

Carapace Size (length, height in mm): USNM 194460, 2.01, 0.89, height 44% of length.

First Antenna (Figure 39*d–f*): 1st and 2nd joints spinous (not shown) and with long spinous dorsal bristle and shorter distolateral bristle. Combined 3rd and 4th joints shorter than wide, separated by curved suture. 3rd joint with short ventral bristle; left limb of USNM 194460 with 5 dorsal bristles (3 single with long spines, followed by 2 paired bristles (lateral with long spines, medial with short spines)), right limb with 6 dorsal bristles (2 single bristles with long spines, 2 paired bristles (lateral with long spines, medial with short spines), followed by 2 paired bristles (lateral with long spines, medial with short spines)). 4th joint with 2 terminal ventral bristles and 1 terminal dorsal bristle with short spines. Sensory bristle of 5th joint with short slender proximal filament and 6 long terminal filaments (Figure 39*e,f*). Medial bristle of 6th joint long. 7th joint (Figure 39*e*): a-bristle claw-like, concave dorsally, bare; b-bristle with 3 long marginal filaments; c-bristle long with 7 short marginal filaments. 8th joint: d-bristle represented by minute peg; e-bristle reaching tip of sensory bristle of 5th joint, bare with blunt tip; f-bristle oriented dorsally, with 4 short proximal filaments; g-bristle long with 6 or 7 short marginal filaments. Filaments of sensory bristle of 5th joint and filaments of bristles of 7th and 8th joints, and also tips of b-, c-, f-, and g-bristles of 7th and 8th joints each with minute terminal papilla.

Second Antenna: Protopodite with numerous medial spines mostly on distal dorsal half (Figure 39*g,h*), and small distomedial bristle (Figure 39*h*). Endopodite with 3 joints indicated by indistinct suture between 1st and 2nd joints and thinning of sclerotized outer layer between 2nd and 3rd joints (Figures 39*g,h*, 43*h*); 3rd joint with long terminal filament. Exopodite: bristle of 2nd joint reaching just past 9th joint, with dense row of slender ventral spines, and dorsal margin either bare or with few slender spines; bristles of joints 3–6 with small ventral spines and natatory hairs; bristles of joints 7 and 8 with natatory hairs, no spines; 9th joint with 4 bristles (2 long with natatory hairs, 2 small bare); joints 3–8 with basal spines increasing in length on distal joints (spine of 8th joint about ⅔ length of 9th joint); 9th joint with either single spine or double lateral spines, about same length as spine of 8th joint; joints 2–8 with row of small spines along distal edges.

Mandible (Figure 40*a–c*): Coxale endite: small bristle near base of ventral branch; ventral branch with spines forming 4 oblique rows, and with long slender tip; ventral margin of dorsal branch with proximal spines, 3 pairs of low pointed teeth followed by about 8 minute uneven teeth, short main spine, and without terminal spinous bristle; marginal spines present between main spine and tip; dorsal margin serrate distally and with slender bristle set well back from tip. Basale endite with 4 spinous end bristles (2 long, 2 about ¾ length of long bristles), small glandular peg, 2 dwarf bristles (1 about ½ length of other), and 3 triaenid bristles with 5–7 pairs of spines proximal to terminal pair. Ventral margin bare with narrow U-shaped process set well back from valve edge; dorsal margin with backward-pointing bristle (with indistinct spines at midlength), and with 2 terminal bristles (lateral short, medial long); basale without spines. Exopodite about 62% length of dorsal margin of 1st endopodial joint (Figure 40*c*), hirsute distally, and with 2 short terminal bristles. 1st endopodial joint with 3 long ventral bristles (2 with long and short spines, 1 with short spines). 2nd endopodial joint: ventral margin with 3 long terminal bristles with short marginal spines; dorsal margin with a- to g-bristles (c-bristle slightly stouter than b- and d-bristles; d-bristle about same width as b-bristle, both stouter than a-bristle); 1 short spinous bristle proximal to a-bristle, and 1 short spinous (cleaning-type bristle) between a- and b-bristles; medial side with few rows of indistinct short spines, an oblique row of 2 or 3 spinous cleaning bristles between b- and c-bristles, and an oblique row of 4 or 5 spinous cleaning bristles between c- and d-bristles. 3rd endopodial joint with 5 spinous bristles and stout straight claw with ventral spines.

Maxilla (Figure 40*d*): Epipodite triangular, hirsute. Endite I with 4 bristles (3 long, 1 short); endite II with 3 long bristles. Basale: dorsal margin with 2 short bristles with bases on medial side (1 proximal near base of epipodite, 1 distal); ventral margin with 1 backward-pointing proximal bristle, 1 minute distal bristle with base on lateral side, and 1 long spinous terminal bristle; lateral side with short proximal bristle near midheight; medial surface and dorsal margin spinous. 1st

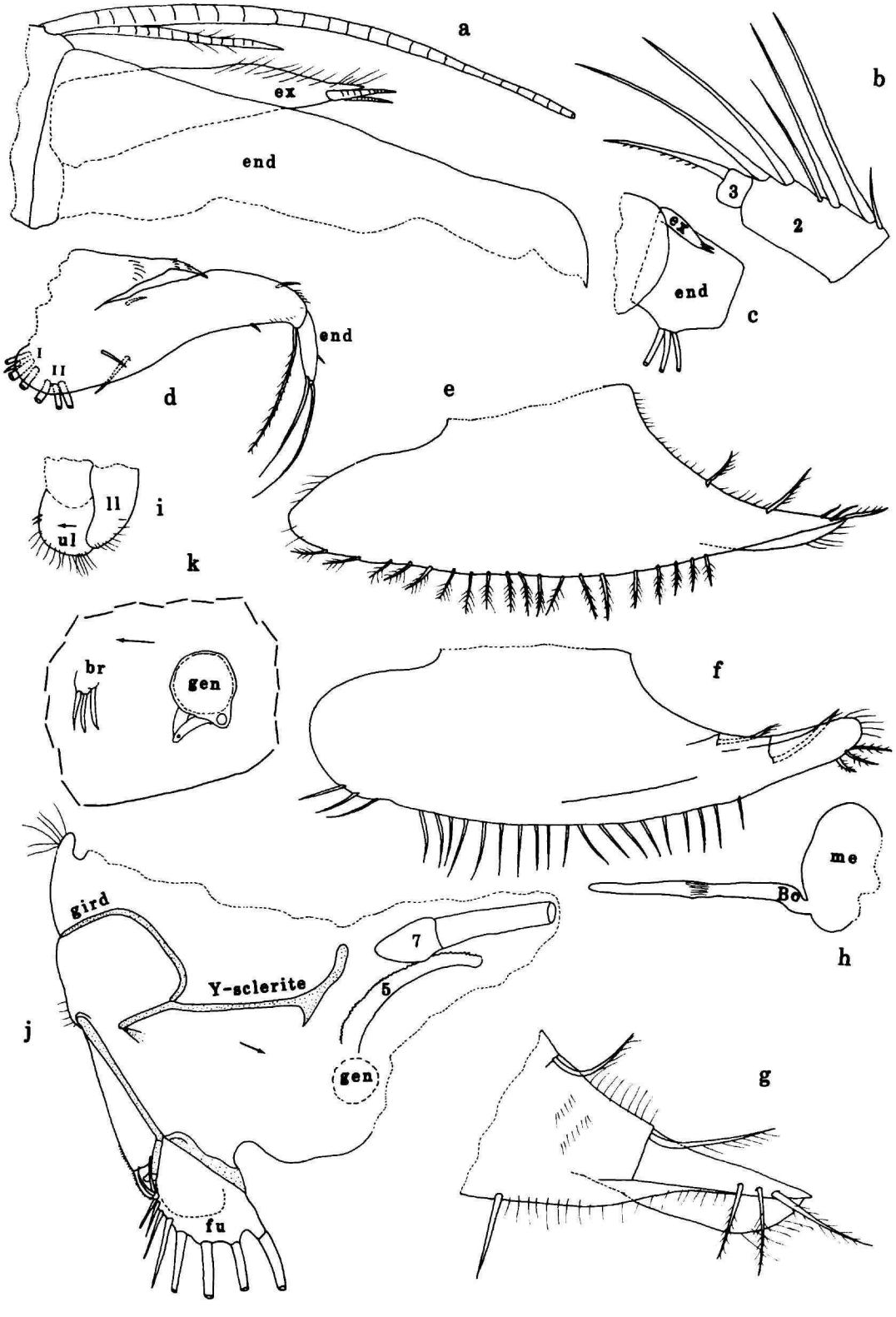
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FIGURE 40 (left).—*Diasterope procax*, new species, adult female, holotype, USNM 194460: parts of left mandible: *a*, exopodite and part of basale and 1st endopodial joint, mv; *b*, 1st and 2nd endopodial joints (nabs), lv; *c*, exopodite and parts of basale and 1st endopodial joints, lv; *d*, right maxilla, lv; *e*, left 6th limb, mv; *f*, right 6th limb, lv; *g*, anterior tip of left 6th limb, mv; *h*, medial eye and Bellonci organ; *i*, lips from left side; *j*, posterior of body from right side; *k*, left genitalia and brush-like organ.

endopodial joint with short bare alpha-bristle and long bare beta-bristle; 2nd joint with long terminal bare bristle reaching past beta-bristle.

Fifth Limb: Ventral margin of comb with 36–39 spinous bristles. Comb otherwise similar to that of A–2 male described below.

Sixth Limb (Figure 40*e–g*): Ventral margin of skirt with 19–22 bristles, otherwise similar to that of A–2 male described below.

Seventh Limb (Figure 39*i*): Limb very long. Proximal group with 5 cylindrical bristles (3 on 1 side, 2 on other), each with 3–5 bells. Distal group with 6 cylindrical bristles, 3 on each side (4 on terminus, 2 on segment proximal to terminus), each with 3–6 bells. Terminus with opposing combs, each with 11 or 12 spinous teeth.

Furca (Figure 39*j*): Each lamella with 10 claws; 4 posterior claws bristle-like but without rings (2 bent backwards); claws 1–6 with teeth along posterior edge, some longer than others; claws 1–5 with distal anterior spines; claws 9 and 10 also with distal anterior spines; right lamella anterior to left by width of base of claw 1. Lamellae following claws with small spines.

Bellonci Organ (Figure 40*h*): Elongate with broadly rounded tip.

Eyes: Medial eye bare, without pigment (Figure 40*h*). Lateral eye larger than medial eye, with 20 divided ommatidia and brown pigment (Figures 39*a,k*, 41*a*).

Lips (Figure 40*i*): Similar to that of A–2 male described below.

Genitalia (Figure 40*j,k*): Oval (with sclerotized tube along ventral edge) on each side of body anterior to furca.

Brush-like Organ (Figure 40*k*): Several indistinct minute bristles on each side of body anterior to genitalia.

Posterior of Body (Figure 40*j*): With small spinous dorsal process, and with few long hairs near midheight.

Gills: Well developed.

Y-*Sclerite* (Figures 40*j*, 52*h*): Without ventral branch.

DESCRIPTION OF A–1 MALE (Figure 43*b,i,j*).—Carapace shape similar to that of adult female (Figure 43*b*).

Carapace Size (length, height in mm): USNM 194463, 1.95, 0.90, height 46% of length.

First Antenna: Bristles similar in number and location to those of adult female. f-bristle of 8th joint with about 20 short proximal filaments. Bristles on joints similar in number to those of adult female.

Second Antenna: Endopodite 3-jointed, larger than that of A–2 male, with 2 short bristles on 2nd joint and 1 long proximal bristle on 3rd joint; tip of 3rd joint tapers to point (Figure 43*i,j*). Exopodite with 4 bristles on 9th joint. Protopodite and exopodite similar to those of adult female.

Mandible: Similar to that of adult female. 2nd endopodial joint with 2 rows of cleaning bristles between b- and c-bristles (2 in proximal row, 6 in distal row).

Maxilla and 5th Limb: Not examined in detail but appearing to be similar to the same limbs on the adult female.

Sixth Limb: End joint with 19 ventral bristles.

Seventh Limb: Bristles cylindrical and same number as those of adult female. Each bristle with 3–5 bells.

Furca: Each lamella with 10 claws, similar to those of adult female.

Bellonci Organ: Similar to that of adult female.

Eyes: Medial eye similar to that of adult female. Lateral eye with 20 ommatidia and brown pigment.

Genitalia: A small lobe anterior to furca may be part of copulatory limb, but not identified as such with certainty.

DESCRIPTION OF A–2 MALE (Figures 41, 42, 43*c,k*).— Carapace elongate with evenly rounded anterior and posterior margins, convex dorsal margin, and slightly convex ventral margin (Figures 41*a*, 43*c*); incisur slit-like and just ventral to valve midheight. Surface of valves with minute scattered pores.

Infold: Rostral infold with about 50 bristles (Figure 41*b*). Anteroventral infold with about 57 short and long bristles (Figure 41*b*). Ventral infold with about 18 bristles forming row ending posteriorly at point where list becomes broad. List beginning at inner margin of infold near posterior end of incisur, extending along ventral margin, and continuing on posterior infold where it broadens; list approaching ventral edge of valve at midlength. Broad posterior list with 20–22 broad transparent flap-like bristles and 25–29 slender bristles (1 or 2 bristles between each pair of flap-like bristles) (Figure 41*c*); 4 tubular processes forming row along midwith of posterior infold; about 20 bristles forming row between posterior list and posterior edge of valve. Tip of rostrum of each valve with minute indistinct hairs along inside edge (possibly part of selvage) (detail in Figure 41*b*).

Selvage: Short broad fringed lamellar prolongation along inner part of ventral edge of incisur.

Carapace Size (length, height in mm): USNM 194316, 1.58, 0.80, height 50% of length; USNM 194464, 1.67, 0.76, height 46% of length; USNM 194465, 1.56, 0.73, height 47% of length.

First Antenna (Figure 41*d,e*): 1st joint with medial and lateral spines and hairs. 2nd joint with medial, lateral, ventral, and dorsal spines, 1 spinous dorsal bristle, and 1 shorter spinous distolateral bristle. 3rd and 4th joints partly fused; 3rd joint with minute medial spines in ventral half, small ventral bristle, and 6 dorsal bristles (2 single with long spines, 2 paired bristles with long spines, followed by 2 paired bristles (lateral with long spines, medial with short spines)); 4th joint with few ven-

FIGURE 41.—*Diasterope procax*, new species, Instar A–2 male, paratype, USNM 194316: *a*, complete specimen from left side, length 1.58 mm; *b*, anterior of left valve, iv; *c*, posterior of right valve, iv; *d*, right 1st antenna, lv; *e*, part of left 1st antenna, mv; *f*, part of right 2nd antenna, mv; *g*, comb of left 5th limb, mv; *h*, right 6th limb, mv; *i*, medial eye and Bellonci organ from right side; *j*, portion of posterior of body from right side.

tral spines, 2 terminal ventral bristles, and 1 terminal dorsal bristle. Sensory bristle of 5th joint with small proximal filament and 6 long terminal filaments. Medial bristle of 6th joint long. 7th joint: a-bristle claw-like, concave dorsally, bare; b-bristle with 3 long marginal filaments; c-bristle long, but broken, with 7 short filaments on remaining part. 8th joint: d-bristle represented by minute peg; e-bristle reaching tip of sensory bristle of 5th joint, bare with blunt tip; f-bristle oriented dorsally, with 10 short proximal filaments and terminal papilla; g-bristle long with 7 marginal filaments and terminal papilla.

Second Antenna: Protopodite with numerous medial spines mostly in distal dorsal half, and small distomedial bristle (Figure 41*f*). Endopodite 3-jointed (Figures 41*f*, 43*k*); 2nd joint with distal ventral bristle; 3rd joint with long filament at midlength and minute diaphanous terminal process. Exopodite: bristle of 2nd joint reaching 9th joint, with dense row of slender ventral spines and shorter dorsal spines; bristles of joints 3–7 with slender ventral spines and natatory hairs; bristle of joint 8 with natatory hairs, no spines observed; 9th joint with 4 bristles (2 long with natatory hairs, 2 short with short indistinct spines); joints 3–8 with basal spines increasing in length on distal joints (spine of 8th joint ¾ length of 9th joint); 9th joint with lateral spine about same length as basal spine of 8th joint; joints 2–8 with row of small spines along distal edges.

Mandible: Coxale endite (Figure 42*a–c*): small bristle near base of ventral branch; ventral branch with spines forming 4 oblique rows, and long slender tip with minute subterminal spine; ventral margin of dorsal branch with proximal spines, 3 pairs of low pointed teeth followed by 6–10 single minute uneven teeth, short main spine, and small terminal spine; marginal spines present between main spine and tip; dorsal margin serrate distally and with slender bristle set well back from tip. Basale endite with 4 (3 long, 1 short) spinous end bristles, small glandular peg, 2 dwarf bristles, and 3 triaenid bristles with 4 or 5 pairs of spines proximal to terminal pair. Ventral margin bare with U-shaped boss set well back from ventral edge; dorsal margin with backward-pointing bristle (with indistinct spines) at midlength, and 2 terminal bristles (lateral short, medial long); lateral and medial sides without spines. Exopodite about ¾ length of dorsal margin of 1st endopodial joint, hirsute distally, with 2 short terminal bristles. 1st endopodial joint with 3 long ventral bristles (2 with long and short spines, 1 with short spines). 2nd endopodial joint: ventral margin with 3 spinous terminal bristles; dorsal margin with a- to g-bristles (c-bristle stouter than b- and d-bristles; d-bristle about same width as b-bristle), 1 short bristle proximal to a-bristle, and 1 short spinous bristle (cleaning-type bristle) between a- and b-bristles; medial side with few rows of indistinct spines, 2 spinous cleaning bristles between b- and c-bristles, and 4 or 5 spinous cleaning bristles forming oblique row between c- and d-bristles (Figure 42*b*). 3rd endopodial joint with stout straight claw with ventral teeth, and 5 spinous bristles (Figure 42*c*).

Maxilla (Figure 42*d*): Epipodite triangular, hirsute. Endite I with 4 bristles (3 long, 1 short); endite II with 3 long bristles. Basale: dorsal margin with 2 short bristles with bases on medial side (1 proximal near base of epipodite, 1 distal); ventral margin with 1 backward-pointing proximal bristle, 1 minute distal bristle with base on lateral side, and 1 long spinous terminal bristle; lateral side with 1 short proximal bristle near midheight; medial surface and dorsal margin spinous. 1st endopodial joint with short alpha-bristle and long bare beta-bristle, 2nd joint with long terminal bristle (with indistinct spines) reaching past beta-bristle.

Fifth Limb (Figure 41*g*): Comb: lateral side with stout spinous exopodial bristle reaching past end of comb, 1 short slender bristle ventral to base of stout bristle, 2 pairs of bristles closer to ventral margin, and 1 bristle just proximal to proximal pair with base almost on ventral margin, and 1 proximal and 2 distal bristles with bases close to ventral margin. Ventral margin with 34 spinous bristles (4 anterior bristles longer than others; shorter bristles of ventral margin comprising row of alternating long and short bristles, all with short proximal spines and longer spines at tip; anterodorsal corner of comb with few long hairs.

Sixth Limb (Figure 41*h*): Small indistinct medial bristle near proximal anterior corner. Anterior margin with slender spinous bristle at upper endite and longer and stouter spinous bristle at lower endite. Skirt: anterior end with 3 hirsute ventral bristles and no bristles on lateral flap; ventral margin at midlength with 14–17 bristles (either with long proximal and short distal spines or only long spines) followed by short space and 2 short bristles with long spines; posterior end of skirt broadly rounded; limb hirsute.

Seventh Limb (Figure 42*e*): Proximal group with 5 tapered bristles (3 on one side, 2 on other), each with 2–4 bells. Distal group with 6 tapered bristles, 3 on each side (4 on terminus, 2 on segment proximal to terminus), each with 2–4 bells. Terminus with opposing combs each with 9 or 10 spinous teeth.

Furca (Figure 42*f*): Each lamella with 9 claws; 2 or 3 posterior claws bristle-like but unringed (1 or 2 bent backwards); claws 1–6 with teeth along posterior edge, some longer than others; claws 1 and 2 with distal anterior spines; right lamella anterior to left by width of claw 1. Lamellae following claws with small spines.

Bellonci Organ (Figure 41*i*): Elongate with broadly rounded tip.

Eyes: Medial eye without pigment, bare (Figure 41*i*). Lateral eye missing from USNM 194316 (probably broken off), but well developed with 16 ommatidia and brown pigment on USNM 194465.

Lips (Figure 42*g*): Upper lip comprising hirsute lobe on each side of saddle, with 2 minute anterior spines on each lobe. Lower lip comprising hirsute flap on each side of mouth.

Genitalia: None observed.

Posterior of Body (Figure 41*j*): With small spinous dorsal process, and with long marginal hairs near midheight.

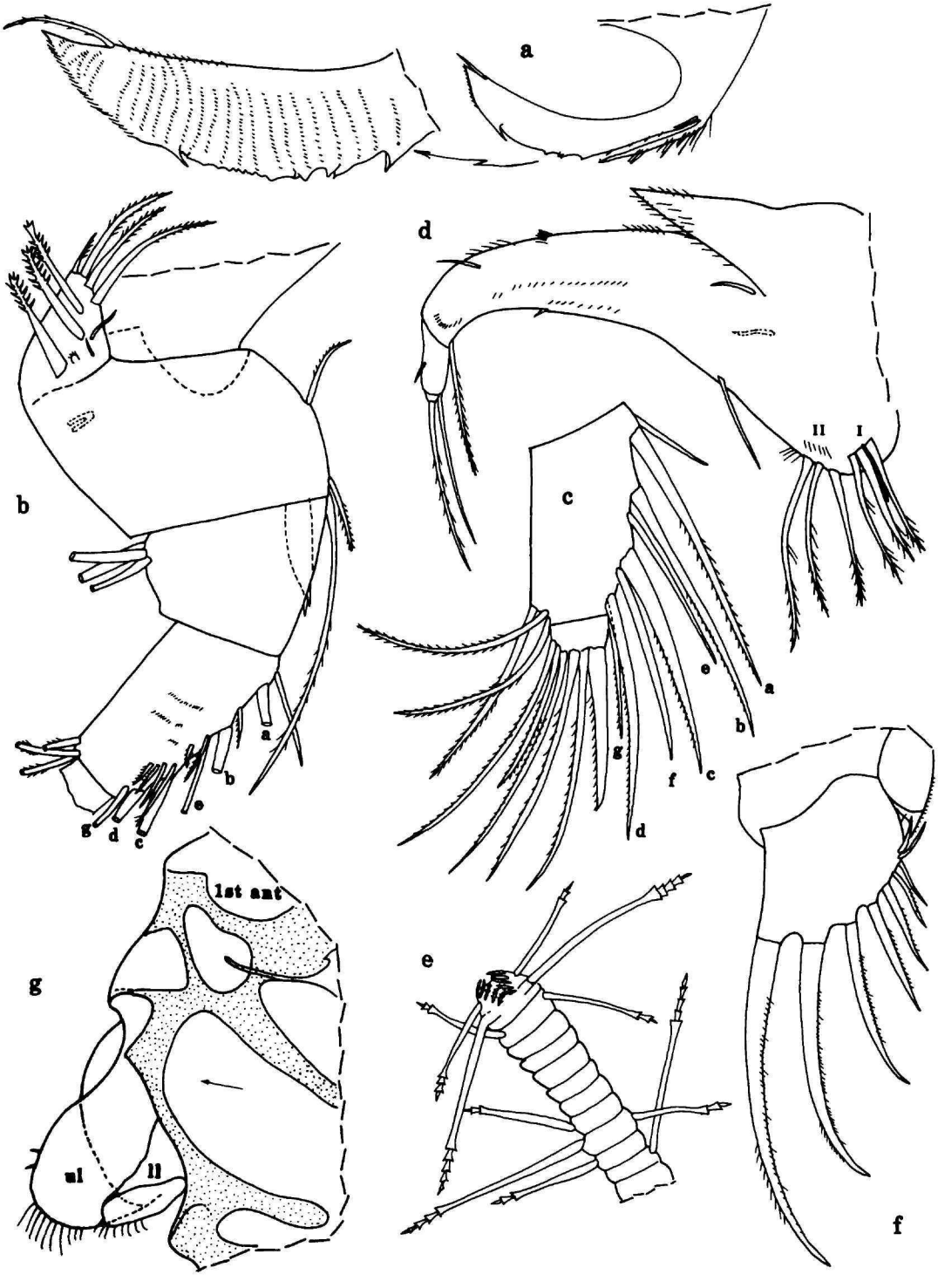

FIGURE 42.—*Diasterope procax*, new species, Instar A–2 male, paratype, USNM 194316: *a*, coxale endite, left mandible, mv; *b*, left mandible (nabs), mv; *c*, distal right mandible, lv; *d*, right maxilla, mv; *e*, 7th limb; *f*, left lamella of furca, lv; *g*, portion of anterior of body from left side (mandible removed).

Y-*Sclerite:* Typically unbranched (only proximal part shown in Figure 41*h*).

Gills: Well developed.

DESCRIPTION OF A–3 FEMALE (Figure 43*e,l*).—Carapace similar in shape to that of adult female (Figure 43*e*).

Carapace Size (length, height in mm): USNM 194466, 1.36, 0.63, height 46% of length.

First Antenna: 3rd joint with 6 dorsal bristles. Sensory bristle of 5th joint of right limb, but not left limb of USNM 194466, with small proximal filament. 8th joint: f-bristle with 4 proximal filaments.

Second Antenna: Endopodite similar to that of adult female. Exopodite: 9th joint with 3 bristles.

Mandible: 2nd endopodial joint with e-bristle, and short bristle proximal to a-bristle (Figure 43*l*).

Maxilla and 5th Limb: Not examined in detail but, in general, similar to adult female.

Sixth Limb: Skirt with 15 ventral bristles.

Seventh Limb: With same number of bristles as on adult female; each bristle with 2–3 bells.

Furca: Each lamella with 8 claws.

Bellonci Organ: Similar to that of adult female.

Eyes: Medial eye similar to that of adult female. Lateral eye with 18 ommatidia and brown pigment.

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

Posterior of Body: With short spinous thumb-like process similar to that of adult female.

DESCRIPTION OF A–3 MALE (Figure 43*d,m*).—Carapace similar in shape to that of A–2 male (Figure 43*d*).

Carapace Size (length, height in mm): USNM 194467, length 1.36, height 0.64, height 47% of length.

First Antenna: Differs from that of adult female in not having short proximal filament on sensory bristle of 5th joint. 8th joint: f-bristle with 7 short filaments.

Second Antenna: Endopodite weakly 3-jointed with short distal bristle on 2nd joint and long subterminal filament on 3rd joint (Figure 43*m*). Exopodite: 9th joint with 3 bristles.

Mandible: 2nd exopodial joint with e-bristle.

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

Sixth Limb: Similar to that of adult female except with only 14 ventral bristles on skirt. Anterior tip of skirt with 3 bristles.

Seventh Limb: With same number of bristles as on adult female; each bristle with 1–3 bells; bristles slightly tapered.

Furca: Each limb with 8 claws.

Bellonci Organ: Similar to that of adult female.

Eyes: Medial eye similar to that of adult female. Lateral eye large with 15 ommatidia and brown pigment.

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

Gills: Each side with 7 well-developed gills.

Posterior of Body: With short spinous thumb-like process similar to that of adult female.

DESCRIPTION OF A–4 INSTAR (sex unknown) (Figure 43*f,g,n,o*).—Carapace similar in shape to that of adult female (Figure 43*f,g*).

Carapace Size (length, height in mm): USNM 194461, 1.03, 0.49, height 48% of length; USNM 194462, 1.02, 0.50, height 49% of length; USNM 194468, 1.10, 0.52, height 47% of length.

First Antenna: Dorsal margin of 3rd joint with 4 or 5 bristles; sensory bristle of 5th joint with 6 terminal filaments but without short proximal filament; limb otherwise similar to those of adult female, but filaments of bristles of joints 7 and 8 not counted, except f-bristle with 3 or 4 proximal filaments.

Second Antenna: Endopodite similar to that of adult female (Figure 43*n,o*). Exopodite: 9th joint with 3 bristles.

Mandible: 2nd endopodial joint without e-bristle, without dorsal bristle proximal to a-bristle, and with fewer cleaning bristles than on adult.

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

Sixth Limb: Similar to that of adult female except with fewer ventral bristles (7–12) on skirt.

Seventh Limb: Proximal group with either 5 bristles (3 on one side, 2 on other) or 6 bristles (3 on each side). Distal group with 4 bristles, 2 on each side. All bristles with 1 or 2 bells and bristles tapered (juvenile character).

Furca: With 7 claws on each lamella.

Bellonci Organ: Similar to that of adult female.

Eyes: Medial eye similar to that of adult female. Lateral eye with about 14 ommatidia and brown pigment.

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

Gills: Each side with 7 well-developed slender gills reaching past posterior of body.

Posterior of Body: With short spinous thumb-like process similar to that of adult female.

COMPARISONS.—This species differs from *D. canina* in not having a terminal claw-like dorsal bristle on the basale of the mandible, and from *D. tenuiseta* in having one of the terminal bristles on the dorsal margin of the basale being much shorter than the other, in having 1 dorsal midbristle on the mandibular basale, and in having 2 instead of 4 dorsal bristles on the basale of the maxilla. *Diasterope procax* differs from *D. pilosa* in the maxilla having 2 instead of 3 dorsal bristles on the basale and in not having a short bristle just distal to endite II. *Diasterope procax* differs from *D. bisetosa* Poulsen, 1965, in not having 2 finger-like anterior processes on the upper lip. *Disaterope procax* differs from *D. grisea* (Brady, 1898), and *D. schmitti* Kornicker, 1975, in having 1 instead of 3 or 5 dorsal midbristles on the mandibular basale.

ONTOGENY.—*Recognition of Stages:* It is helpful in identifying stages to examine specimens in which ecdysis has proceeded to where the appendages of the next stage are visible within the appendages of the present stage. Unfortunately, no specimens were at this stage in the 10 specimens of *D. procax* in the present collection.

The adult male of the Cylindroleberidinae is easily recognized by its 3-jointed reflexed endopodite of the 2nd antenna, and by a brush-like sensory bristle on the 5th joint of the 1st

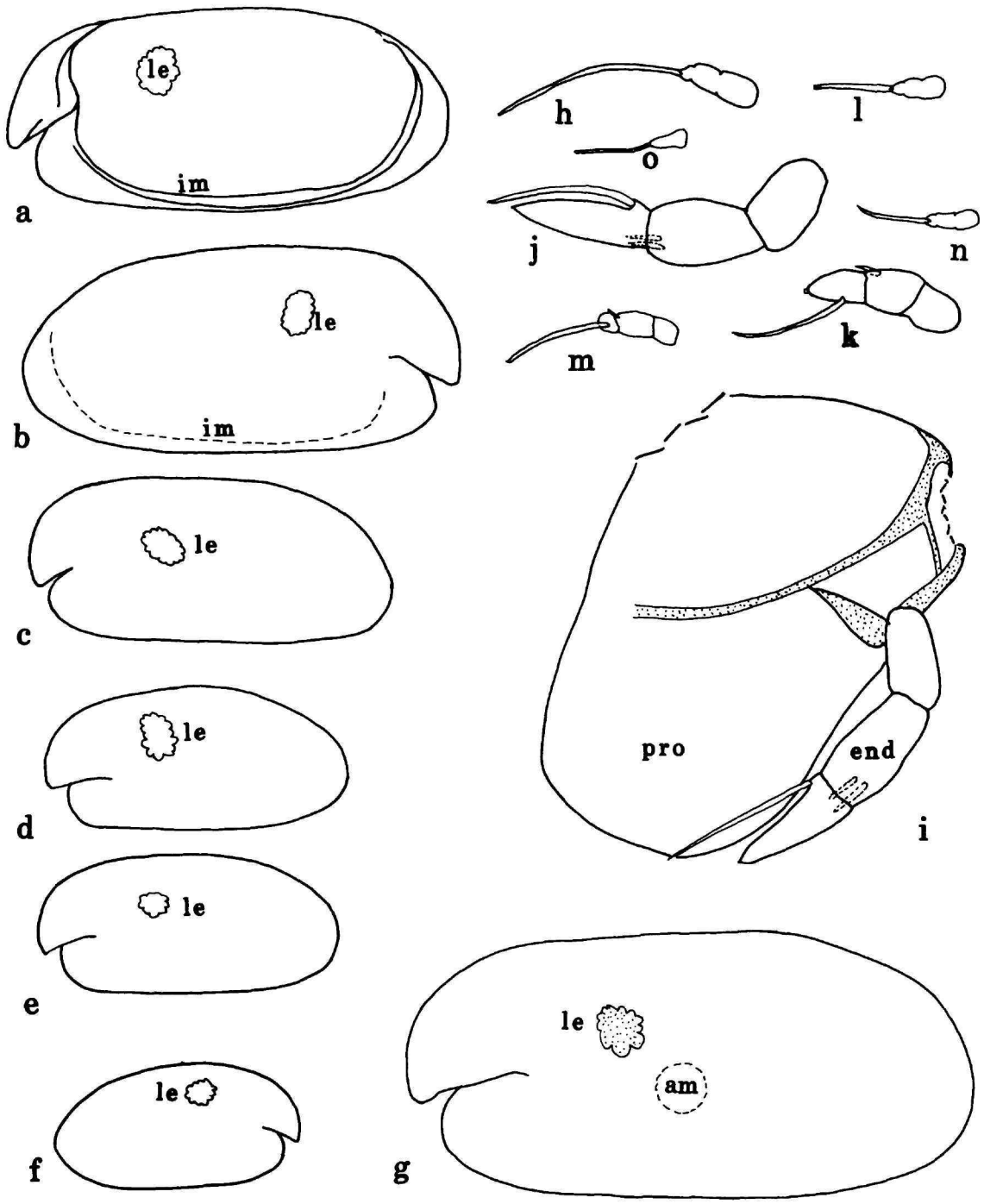

FIGURE 43.—*Diasterope procax*, new species: *a–g*, carapaces (Figures *a–f* drawn at same magnification): *a*, adult female, holotype, USNM 194460, right valve, length 2.01 mm, iv; *b*, Instar A–1 male, paratype, USNM 194463, complete specimen from right side, length 1.95 mm; *c*, Instar A–2 male, paratype, USNM 194464, complete specimen from left side, length 1.67 mm; *d*, Instar A–3 male, paratype, USNM 194467, complete specimen from left side, length 1.36 mm; *e*, Instar A–3 female, paratype, USNM 194466, complete specimen from left side, length 1.36 mm; *f,g*, Instar A–4 (sex unknown), USNM 194468, complete specimen from right and left sides at different magnifications, length 1.10 mm. *h–o*, endopodites of 2nd antennae (drawn at same magnification): *h*, adult female, holotype, USNM 194460, right limb, mv; *i*, Instar A–1 male, paratype, USNM 194463, left limb, mv; *j*, Instar A–1 male, paratype, USNM 194463, right limb, mv; *k*, Instar A–2 male, paratype, USNM 194316, right limb, mv; *l*, Instar A–3 female, paratype, USNM 194466, left limb, lv; *m*, Instar A–3 male, paratype, USNM 194467, left limb, lv; *n*, Instar A–4 (sex unknown), paratype, USNM 194468, right limb, lv; *o*, Instar A–4 (sex unknown), paratype, USNM 194461, one limb.

antenna. No adult males of *D. procax* were in the present collection.

Adult females are most easily recognized if the marsupium of the carapace contains eggs. No ovigerous females were in the present collection.

One adult female in the collection (USNM 194460) was identified by having genitalia and also by a brush-like organ anterior to the genitalia.

An A–1 and an A–2 male were identified as male by the large size of the endopodite of the 2nd antenna and by having a characteristic long proximal filament on an elongate 3rd joint. The growth stage of the A–1 male was identified by having a carapace almost as large as the adult female, which is a common relationship among species of the Cylindroleberidinae. The growth stage of the A–2 male was identified by comparing the development of the endopodite of its 2nd antenna with that of the A–1 male, which has a larger endopodite with a longer 3rd joint.

The endopodite of the 2nd antenna of the A–3 male differs from that of the female in being slightly larger and in having the long filament of the 3rd joint in a subterminal rather than a terminal location. The f-bristle of the 8th joint of the 1st antenna of the A–3 male of *D. procax* differs from that of the A–3 female in having 7 rather than 4 short proximal filaments.

Recognition of the growth stage of the A–3 female cannot be determined with certainty because the appendages are fairly similar to those of later female instars. In the present collection, the stage of the A–3 female was estimated by comparing it with the A–3 male: (1) both have the same number of claws on the furca; (2) both have the same maximum number of bells on the bristles of the 7th limb; and (3) both have a carapace of similar length. Also, if a growth factor of 1.23 is assumed, the A–3 female, USNM 194466, should produce an adult female of approximately the size of the adult female USNM 194460. (No A–2 females were in the collection.)

It is difficult to identify the sex of A–4 instars with certainty, so the sexes of the three A–4 instars in the present collection were left unidentified. The endopodite of the 2nd antenna of USNM 194468 appears slightly larger and more strongly developed than those of the other two A–4 instars, which suggests that it is a male and that the other two are females.

If the sex of the A–4 instars were known with certainty, the degree of development of the endopodite of the 2nd antenna could be used to separate the A–4 instars from the male A–3 instar. Without knowing the sex of the A–4 instars and, also, the variability of the appendages at either stage, it is difficult to separate the A–3 and A–4 instars with certainty. The A–4 instar stage is estimated by comparing it with the A–3 instar: (1) the carapaces of the A–4 instars are smaller and (2) there are fewer appendage bristles, as well as fewer filaments or bells on the bristles, on the A–4 instars (Table 5).

TABLE 5.—Selected morphological changes during ontogeny of *Diasterope procax*. (d = dorsal; no. = number; v = ventral; – = absent; + = present.)

Feature	Instars					Adult
	A–4	A–3	A–3	A–2	A–1	
No. of specimens	3	1	1	3	1	1
Sex	?	F	M	M	M	F
Carapace length (mm)*	1.06	1.36	1.36	1.60	1.95	2.01
First Antenna						
3rd joint, d bristle	4–5	6	6	6	6	6
4th joint, v/d bristles	2/1	2/1	2/1	2/1	2/1	2/1
5th joint, sensory bristle						
short proximal filament	0	0–1	0	1	1	1
8th joint, f-bristle						
proximal filaments	3–4	4	7	10	20	4
Second Antenna						
Exopodite						
9th joint bristles	3	3	3	4	4	4
Mandible						
2nd endopodite joint						
e-bristle	–	+	+	+	+	+
Sixth Limb						
v bristles	7–12	15	14	16–19	19	19–22
Seventh Limb						
distal bristles	4–6	6	6	6	6	6
proximal bristles	5–6	5	5	5	5	5
no. of bells on bristle	1–2	2–3	1–3	2–4	3–5	3–6
Furca, claws	7	8	8	9	10	10
Lateral eye						
no. of ommatidia†	13–14	18	15	16	20	20

* Lengths of specimens averaged.

† Approximate.

Although the number of specimens are too few for statistical analysis, it is interesting to note that two A–4 instars have 6 proximal bristles on both 7th limbs, and one A–4 instar has 5 on one limb and 6 on other, compared to a total of 5n nine later instars and adults. The number of bristles on the 7th limb was not determined on a tenth later instar in the collection, USNM 194465 (A–1 male). A decrease in the number of proximal bristles on the 7th limb in later developmental stages has not been previously reported.

Determination of the Number of Instars: The collection of *D. procax* on hand is interpreted to contain the last three instars and the adult female (Figure 44). Because of the absence of younger stages, it is not possible to be certain of the total number of instars in the species. Both Kornicker (1969:3) and Hiruta (1983:673), however, presented a key to early myodocopid instars in which instar III is without bristles on the 7th limb, whereas later instars have bristles on the 7th limb. If this were to follow in *D. procax,* the A–4 instar would be at least instar IV, because the 7th limb bears bristles. If that is so, *D. procax* would have at least seven instars.

An alternative interpretation is that instar III of *D. procax* differs from most other myodocopids in having bristles on the 7th limb. With that interpretation, *D. procax* would have six instars. Final determination must await the collection of the earlier instars.

Two previously studied species of the Cylindroleberidinae (*Bathyleberis yamadai* Hiruta, 1979, and *Synasterope calyx* Kornicker, 1981) have only five instars. The number of instars of *D. procax* is more similar to some members of the Cyclasteropinae (Cyclasteropini and Cycloleberidini), which have six instars (Hiruta, 1983:675).

Synasterope Kornicker, 1975

TYPE SPECIES.—*Synasterope implumis* Poulsen, 1965; subsequent designation by Kornicker (1975:440).

COMPOSITION AND DISTRIBUTION.—Species of the genus are widespread between latitudes of about 47.5°N and 73°S and depths from 1–445 m (Kornicker, 1992:194). Only one species of *Synasterope* (*S. setisparsa* Kornicker, 1958) has been reported previously from the Bahamas. Three species of *Synasterope* (*S. implumis* Poulsen, 1965; *S. longiseta* Poulsen, 1965; and *S. serrata* Poulsen, 1965) have been reported from the Virgin Islands, West Indies. Four additional species (one left in open nomenclature) have been reported from the continental shelves and bays of North America (Atlantic Ocean and Gulf of Mexico) (Kornicker, 1986b). An additional species, collected at the Belize Barrier Reef near Carrie Bow Cay, was listed by Cohen (1989b) as *Synasterope* new species A.

Synasterope browni, new species

FIGURES 45–47, 52*g*

ETYMOLOGY.—The species is named in honor of Roland Brown, Smithsonian Institution, who has been of considerable assistance in facilitating research in the Department of Invertebrate Zoology.

HOLOTYPE.—USNM 194469, adult female on slide and in alcohol.

TYPE LOCALITY.—Sta 95-005, transect BB, Exuma Sound, Bahamas, depth 96 m.

PARATYPES.—None.

DISTRIBUTION.—Collected only at type locality, in baited trap.

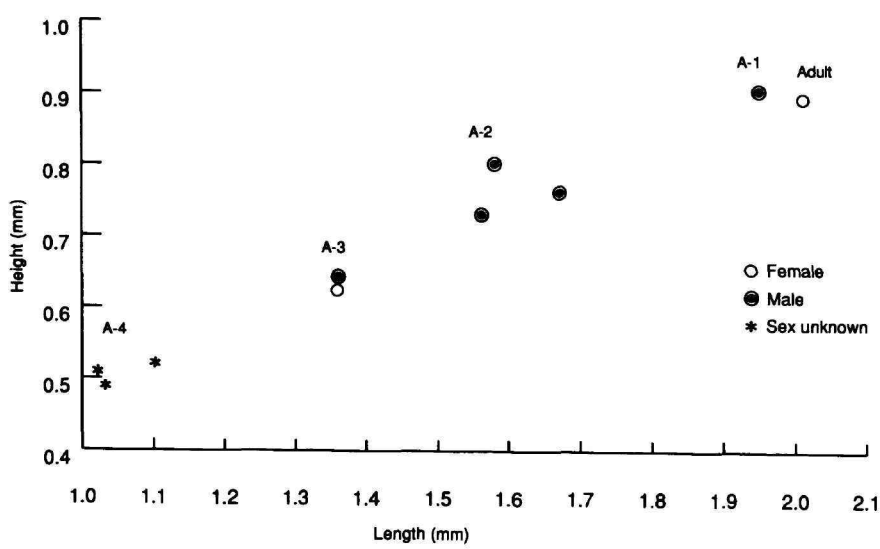

FIGURE 44.—Graph of carapace length to carapace height for specimens of *Diasterope prolixa* in the collection.

DESCRIPTION OF ADULT FEMALE (Figures 45–47).—Carapace oval with evenly rounded anterior and posterior margins; dorsal margin more convex than ventral margin (Figure 45*a*).

Infold: Obscure on slides, but appearing to have relatively few bristles on infold of rostrum (Figure 45*d*). Approximate number of flap-like bristles and small bristles on broad posteroventral list shown in Figure 45*e*. No processes observed between broad posteroventral list and valve edge. Each valve with 2 large ?glands containing closely spaced light amber-colored globules present in space between inner surfaces of anteroventral infold and outer shell (Figure 45*b,c*).

Selvage: Posterodorsal curvature of right valve with short segment of fringed lamellar prolongation (Figure 45*e*).

Central Adductor Muscle Attachments (Figure 45*a,f*): Comprising about 8 ovoid attachments.

Carapace Size (length, height in mm): USNM 194469, 0.80, 0.50, height 63% of length.

First Antenna (Figure 45*g,h*): 1st joint with long lateral spines. 2nd joint with row of short lateral spines near distal margin, spinous dorsal bristle, and without lateral bristle. 3rd and 4th joints combined shorter than wide; 3rd joint with small ventral bristle and 6 dorsal bristles (2 single bristles with long spines, 2 paired bristles (lateral with short spines, medial with long spines), and 2 paired bristles with short spines); 4th joint with 1 terminal ventral bristle and 1 terminal dorsal bristle with short spines; suture separating 4th and 5th joints convex. Sensory bristle of 5th joint with 6 terminal filaments. Medial bristle of 6th joint long with short spines. 7th joint: a-bristle claw-like, concave dorsally, with proximal dorsal spines; b-bristle with 3 long dorsal filaments; c-bristle long with 4 or 5 filaments. 8th joint: d-bristle represented by minute peg; e-bristle reaching tip of sensory bristle of 5th joint, bare with blunt tip; f-bristle oriented dorsally, with 3 marginal filaments; g-bristle long with 4 marginal filaments. Filaments of sensory bristle of 5th joint and filaments of 7th and 8th joints each with minute terminal papilla.

Second Antenna (Figure 45*i,j*): Protopodite with small distomedial bristle, and with few rows of medial spines in distodorsal corner. Endopodite 3-jointed with long terminal filament. Exopodite: bristle of 2nd joint reaching 8th joint, with slender ventral spines; bristles of joints 3–8 with slender ventral spines and natatory hairs; 9th joint small, with 2 bristles (1 about ½ length of bristle of 8th joint and with natatory hairs, 1 short with small spines); joints 2 and 3 with small spines along distal medial margin; lateral side of exopodite obscured, but some joints with minute spines along distal margins (spines not shown), basal spines not observed (obscured), but not large if present.

Mandible (Figure 46*a,b*): Coxale endite broken off both limbs of USNM 194469. Basale endite with 3 spinous end bristles, glandular peg, 2 dwarf bristles (one ¾ length of other), and 2 triaenid bristles (one close to base) with 3 pairs of spines proximal to terminal pair (terminal pair well developed, about ⅓ length of bristle). Basale: ventral margin with U-shaped boss near midlength; dorsal margin with 2 subequal terminal bristles with short spines. Exopodite about ½ length of dorsal margin of 1st endopodial joint, with rounded hirsute tip and 2 short subterminal bristles (exopodite of right limb of USNM 194469 larger than that of left limb (compare Figures 46*a* and 46*b*). 1st endopodial joint with 3 long ventral bristles (2 with long spines, 1 with short spines). 2nd endopodial joint: ventral margin with 3 terminal bristles with short marginal spines; dorsal margin with a-, b-, c-, d-, f-, and g-bristles (c-bristle with slightly stouter base than b- and d-bristles), and with 1 short bristle proximal to a-bristle; medial surface of joint with 4 cleaning bristles in row between b- and c-bristles but closer to c-bristle. 3rd endopodial joint with slightly curved claw with ventral and dorsal spines, and with 5 spinous bristles.

Maxilla (Figure 46*c,d*): Epipodite triangular, short, hirsute at tip. Endite I with 4 bristles (3 long, 1 short); endite II with 3 long bristles. Basale: medial surface with 1 short proximal bristle near ventral margin, and 2 short bristles (proximal near midwidth, distal closer to dorsal margin); lateral surface with 1 short proximal bristle near midwidth; ventral margin with long stout spinous terminal bristle; medial surface and dorsal margin spinous. 1st endopodial joint with short bare alpha-bristle and long bare beta-bristle; 2nd joint with long terminal bare bristle reaching past tip of beta-bristle.

Fifth Limb (Figure 46*e*): Comb (right limb USNM 194469): lateral side with stout spinous exopodial bristle reaching past end of comb, 1 short slender bifurcate bristle ventral to base of stout bristle (tip of both branches broken off on illustrated limb), 1 pair of bristles and 1 single bristle closer to ventral margin, 1 single bristle proximal to paired bristles and almost on ventral margin, and 1 proximal and 2 distal bristles almost on ventral margin; anterodorsal tip of comb with long hairs.

Sixth Limb (Figure 47*a*): Small indistinct medial bristle near proximal anterior corner. Anterior margin with slender bristle at upper endite and longer spinous bristle at lower endite. Skirt: anterior end with 3 spinous ventral bristles; lateral flap with slender hirsute anterior bristle; ventral margin posterior to midlength with 9 spinous bristles; posterior edge of skirt slightly concave.

Seventh Limb (Figure 47*b*): Proximal group with 5 or 6 bristles (2 or 3 on each side), each with 2–4 bells; distal group with 6 bristles (3 on each side), each with 2–4 bells. Terminus with opposing combs, each with 8 spinous teeth.

Furca (Figures 46*f*, 47*c*): Each lamella with 9 claws; posterior 4 claws bristle-like but not ringed (2 bent backward); claws 1–5 with teeth along posterior edge (not shown), some longer than others; claw 1 with distal anterior spines; right lamella anterior to left by width of base of claw 1.

Bellonci Organ (Figure 46*g*): Elongate, broad near midlength, with rounded tip.

Eyes: Medial eye without pigment, bare (Figures 46*g*, 47*d*). Lateral eye well developed with brown pigment and 15 ommatidia (Figure 45*a,j,k*).

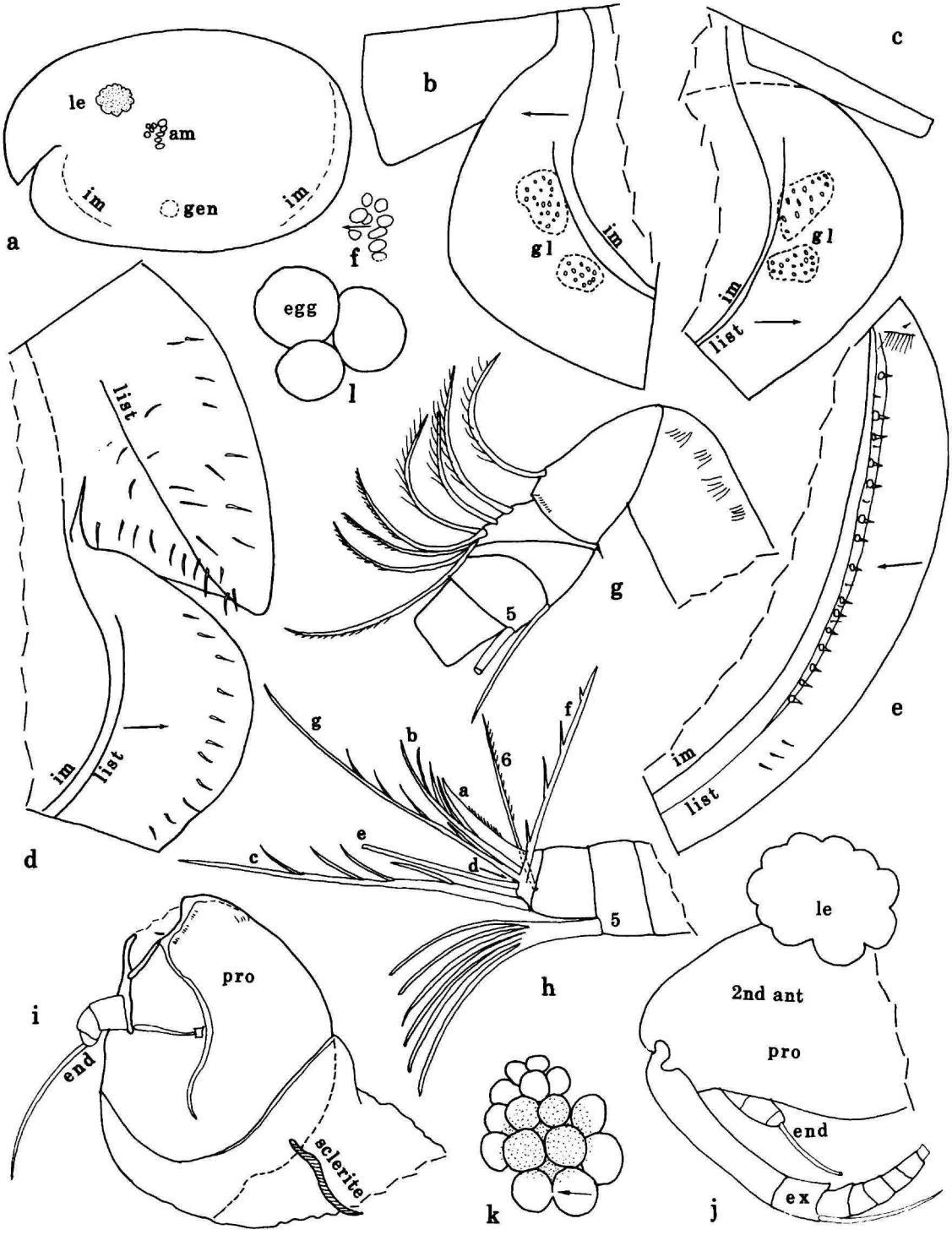

FIGURE 45.—*Synasterope browni*, new species, adult female, holotype, USNM 194469: *a*, complete specimen from left side, length 0.80 mm; *b,c*, anterior of right and left valves (bristles not shown), iv; *d*, anterior of left valve, iv; *e*, posterior of right valve, iv; *f*, central adductor muscle attachments on left valve, ov; *g,h*, parts of left 1st antenna, lv; *i*, part of right 2nd antenna, mv; *j*, left lateral eye and part of left 2nd antenna, lv; *k*, left lateral eye, lv; *l*, 3 eggs in marsupium.

FIGURE 46.—*Synasterope browni*, new species, adult female, holotype, USNM 194469: *a*, left mandible, mv; *b*, exopodite of right mandible and dorsal edge of 1st endopodial joint, mv; *c*, right maxilla (limb torn apart during dissection as shown), mv; *d*, part of left maxilla (nabs), mv; *e*, comb of right 5th limb, lv; *f*, right lamella of furca, lv; *g*, medial eye and Bellonci organ from left side.

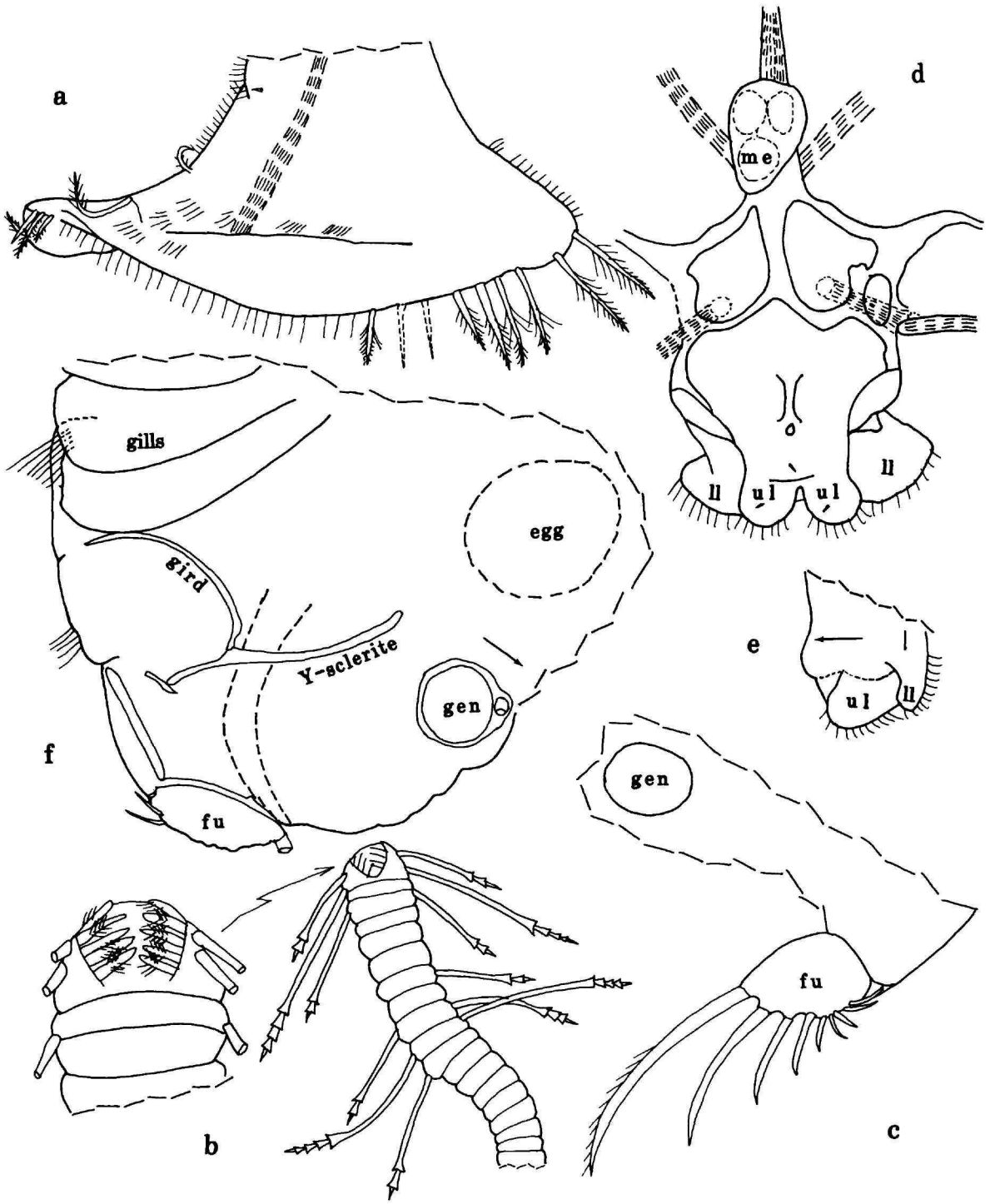

FIGURE 47.—*Synasterope browni*, new species, adult female, holotype, USNM 194469: *a*, right 6th limb, mv; *b*, 7th limb; *c*, portion of posterior of body from left side showing left genitalia and left lamella of furca; *d*, anterior view of body (Bellonci organ broken off medial eye and not shown); *e*, lips; *f*, posterior of body from right side (not all furcal claws shown).

Lips (Figure 47*d,e*): Upper lip comprising 2 hirsute lobes on each side of saddle; minute anterior spine on each lobe; saddle not visible in lateral view (Figure 47*e*) but observed in anterior view (Figure 47*d*). Lower lip a hirsute flap on each side of mouth.

Genitalia (Figures 45*a*, 47*c,f*): Oval with sclerotized peripheral rim, present on each side anterior to furca.

Brush-like Organ: Not observed, but could have been torn off during dissection.

Posterior of Body (Figure 47*f*): Posterodorsal corner spinous and forming right angle; posterior margin with few long hairs at midheight.

Gills: Seven on each side reaching just past posterior of body (2 shown in Figure 47*f*).

Y-*Sclerite* (Figures 47*f*, 52*g*): Without ventral branch.

Eggs: USNM 194469 with small unextruded eggs (3 shown in Figure 45*l*; 1 shown in Figure 47*f*); diameter of 3 eggs 0.07 mm, 0.10 mm, 0.10 mm.

COMPARISONS.—The new species, *S. browni*, differs from *S. setisparsa* (Kornicker, 1958), the only other species of the genus reported in the Bahamas, in having many more ventral and posteroventral bristles on the 6th limb (nine compared to at most two or three for *S. setisparsa*), and also in having a much shorter bristle at the anterior tip of the 6th limb. *Synastrope browni* differs from *S. cushmani* Kornicker, 1974, *S. williamsae* Kornicker, 1986, and *S. psitticina* (Darby, 1965) in having well-developed lateral eyes. The 1st antenna of *S. browni* differs from that of *S. serrata* Poulsen, 1965, in lacking a lateral bristle on the 1st joint. The 6th limb of *S. browni* differs from that of *S. longiseta* Poulsen, 1965, in not having two long bristles at the anterior tip of the skirt and also differs by having many more bristles along the ventral and posteroventral edge (nine compared to four or five for *S. longiseta*). The stem proximal to the terminal filaments of the sensory bristle of the 5th joint of the 1st antenna is much longer in *S. longiseta* and *S. implumis* Poulsen, 1965, than it is in *S. browni*.

Parasterope Kornicker, 1975

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

COMPOSITION AND DISTRIBUTION.—Members of the genus are widespread between latitudes of about 55°N to 65°S with a depth range from intertidal to 4303 m (Kornicker and Caraion, 1974:7). Two species of *Parasterope*, *P. muelleri* (Skogsberg, 1920) and *P. extrachelata* Kornicker, 1958, have been reported previously from the Bahamas. Four additional species of the genus have been reported from the eastern Atlantic: *P. longungues* Poulsen, 1965, from about 900 m off St. Croix, U.S. Virgin Islands; *P. pollex* Kornicker in Bowman and Kornicker, 1967, which is widespread along the North American coast of the Atlantic and Gulf of Mexico; *P. zeta* Kornicker, 1986b, on the continental shelf of Texas; and *P. hulingsi* Baker, 1978, on the continental shelf off North Carolina and Georgia (Kornicker, 1986b).

Parasterope muelleri (Skogsberg, 1920)

FIGURES 48–51, 52*a–f*

Asterope Mülleri Skogsberg, 1920:483.

Parasterope muelleri (Skogsberg).—Kornicker, 1986b:20 [synonymy].—Maddocks and Kornicker, 1986:284, fig. 90 [in part].—Kornicker and Iliffe, 1989b:45, fig. 27.

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

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

MATERIAL.—Exuma Sound: Sta 94-018, transect AA: USNM 194470, adult female on slide and in alcohol. Bermuda: USNM 158293, adult female on slide and in alcohol. Biscayne Bay, Florida: USNM 152854, 152855, 2 adult females each on slide and in alcohol. Mauritania: Sta X070, USNM 143977, adult female on 2 slides and in alcohol.

DISTRIBUTION.—Exuma Sound at depth of 67 m; also, widespread in North Atlantic Ocean (Kornicker and Iliffe, 1989b:45).

DISCUSSION.—This species was originally described from the English Channel (Skogsberg, 1920:483). It was subsequently reported in the western Atlantic extending from Bermuda to the West Indies (Kornicker, 1986b:20), and in the eastern Atlantic off Mauritania (Kornicker and Caraion, 1974:8). Because this wide distribution is unusual in benthic myodocopids, an adult female from the Wall was studied in considerable detail to determine whether a character might have been overlooked that could be used to separate the eastern and western Atlantic specimens. The Wall specimen is described below. The 5th joint of the 1st antenna and the Y-sclerite of specimens from four localities are compared in the Figures.

The 1st antenna of the Wall female differs from that of the holotype described and illustrated by Skogsberg (1920:484, fig. 89.4) in having a distal row of minute spines just within the dorsal margin of the 5th joint (Figure 48*e,f*). Could Skogsberg have overlooked such spines in the holotype? The lectotype was not reexamined herein, but a female specimen in the Smithsonian collection (USNM 143977) that had been collected in the eastern Atlantic off Mauritania (depth 170–175 m) and identified as *Parasterope muelleri* by Kornicker and Caraion (1974:8) was examined; this specimen is not from the type locality, but it is at least from the same side of the Atlantic.

The 1st antenna of the Mauritanian female bears a row of lateral distal spines near the dorsal margin (Figure 52*d*). These had been overlooked by Kornicker and Caraion (1974:16), who reported no spines on the 5th joint. Unlike the spines on the Bahamian female, this row of spines is slightly curved ventrally at its distal end.

Kornicker (1986b:8) reported *P. muelleri* from eastern Florida and the Florida Keys, but did not mention spines on the 5th joint of the 1st antenna. The 1st antennae of two Florida females (USNM 152855) from Biscayne Bay, which had been identified by Kornicker in 1975 as *P. muelleri*, were reexamined. Both limbs of the specimens have distal spines along the

dorsal margin of the 5th joint (Figure 52*b,c*). These differ from both the Bahamian and Mauritanian females in projecting past the dorsal edge of the joint and in being more strongly developed; the spines on the Florida specimens are visible using an ×40 objective, whereas the spines on the Bahamian and Mauritanian specimens are clearly visible only at a higher magnification (objective: ×100, oil immersion). The row of spines of the Florida specimens also differs from the Mauritanian specimen in not curving ventrally at its distal end.

Kornicker (1981:9, fig. 7c) reported that the 5th joint of the 1st antenna of an adult female of *P. muelleri* from Bermuda has short spines forming a row along the distal dorsal margin. A 1st antenna from one of the Bermudian specimens in that collection (USNM 158293) was reexamined. The row of spines project past the dorsal edge of the joint but are only clearly visible using an oil immersion objective (×100) (Figure 52*a*). The row of spines differs from that of the Mauritanian female in not bending ventrally at its distal end. The spines are less strongly developed than those of the female from Florida, and they project farther past the dorsal edge of the 5th joint then they do in the female from the Bahamas.

An insufficient number of specimens were studied at the four localities to determine the variability at each locality in either distribution or the degree of development of the spines on the 5th joint of the female 1st antenna. If future examination of additional specimens also reveals small differences in the distribution and development of the spines of specimens from these different localities, it would suggest that populations of *P. muelleri* differ in the East and West Atlantic, and that they also differ within the eastern Atlantic in Bermuda, the Bahamas, and Biscayne Bay, Florida. Because spines are present on all specimens examined herein from various localities, it is hypothesized that the spines were overlooked in the original description of the species by Skogsberg (1920:483).

No differences were observed in the morphology of the carapace and appendages of the specimens from the four localities studied to warrant the proposal of a new species.

The Y-sclerites of the females from the four localities studied are similar (Figure 52*e–h*).

DESCRIPTION OF ADULT FEMALE FROM THE WALL (Figures 48–51, 52*g*).—Carapace tumid in lateral view with dorsal margin more convex than ventral margin; incisur ventral to midheight (Figure 48*a*).

Infold (Figure 48*b,c*): Rostrum and anterodorsal infold with 42 bristles; list of rostrum restricted to tip. Anteroventral infold with about 30 small bristles; about 10 bristles present along ventral infold to point opposite lowermost hyaline flap-like bristle on posterior list. List beginning near inner margin of anterior infold, extending along ventral infold, and continuing on postero-ventral and posterior infold where it broadens; broad postero-ventral and posterior list with 18 or 19 hyaline flap-like transparent bristles and about 12 minute bristles, generally only 1 minute bristle between adjacent flap-like bristles, and no more than 2; 8 long bristles along posteroventral infold between broad list and valve edge, all confined to ventral half of posterior infold. No processes on posterior infold between list and valve edge.

Central Adductor Muscle Attachments (Figure 48*a,d*): Consisting of about 12 ovoid attachments.

Vestment (Figure 48*b*): Cluster of few indistinct hairs on vestment just proximal to anterodorsal infold.

Carapace Size (length, height in mm): USNM 194470, 1.05, 0.70, height 67% of length.

First Antenna (Figure 48*e,f*): 1st joint with few distal lateral and medial spines. 2nd joint with ventral and dorsal spines, 1 spinous dorsal bristle, and 1 shorter lateral bristle with few indistinct spines. 3rd joint with 6 dorsal bristles (2 single with long spines, 1 single bristle with long spines and base slightly lateral, 1 single bristle with long spines, and 2 paired bristles (medial with short spines, lateral with long spines)) and 1 minute ventral bristle. 4th joint with 1 long dorsal bristle with short spines and 2 terminal ventral bristles (longest with short spines). 5th joint with distal row of minute pointed spines along dorsal margin (base of spines on lateral side of joint) (spines seen best using oil immersion objective, and better developed on some limbs than on others); sensory bristle long slender and with 6 terminal filaments. 6th joint with long spinous medial bristle. 7th joint: a-claw with indistinct dorsal spines; b-bristle with 4 marginal filaments; c-bristle longer than sensory bristle of 5th joint, with 5 marginal filaments. 8th joint: d-bristle represented by indistinct minute peg; e-bristle long bare with blunt tip; f-bristle bent dorsally, with 3 marginal filaments and bifurcate tip; g-bristle similar to c-bristle of 7th joint but with 4 marginal filaments.

Second Antenna (Figure 49*a–c*): Protopodite with small distal medial bristle and rows of indistinct distomedial spines (medial bristle missing on right limb of USNM 194470). Endopodite distinctly 3-jointed with long terminal filament. Exopodite: 1st joint with few distal dorsal spines, but without minute medial terminal bristle; bristle of 2nd joint reaching 9th joint, with abundant slender ventral spines; bristles of joints 3–6 with slender ventral spines and natatory hairs; bristles of joints 7 and 8 with natatory hairs, no spines; 9th joint with 3 bristles with natatory hairs (1 short dorsal, 1 long ventral, 1 medium at joint midwidth); basal spines obscured but observed on joints 5–8; spine of 8th joint about ⅓ length of 9th joint; lateral spine of 9th joint about ¾ length of 9th joint; joints 2–8 with row of minute spines along distal edges.

Mandible (Figure 49*d–f*): Coxale endite with slender medial bristle at base of ventral branch; ventral branch with 4 rows of spines and prolonged tip with 2 minute teeth; ventral margin of dorsal branch with 3 small paired nodes, very small main spine, and slender drawn-out tip; dorsal margin of dorsal branch without distal bristle but with minute spines at location of base of missing bristle (bristle missing from both limbs of USNM 197470, but whether this is normal for the species, or whether they are broken off this specimen is not known). Basale with 4 end-type bristles (only 1 shown in Figure 49*e*) and 3 triaenid bristles with 4 or 5 pairs of marginal spines in addition to small terminal pair, 1 fairly long dwarf bristle, and

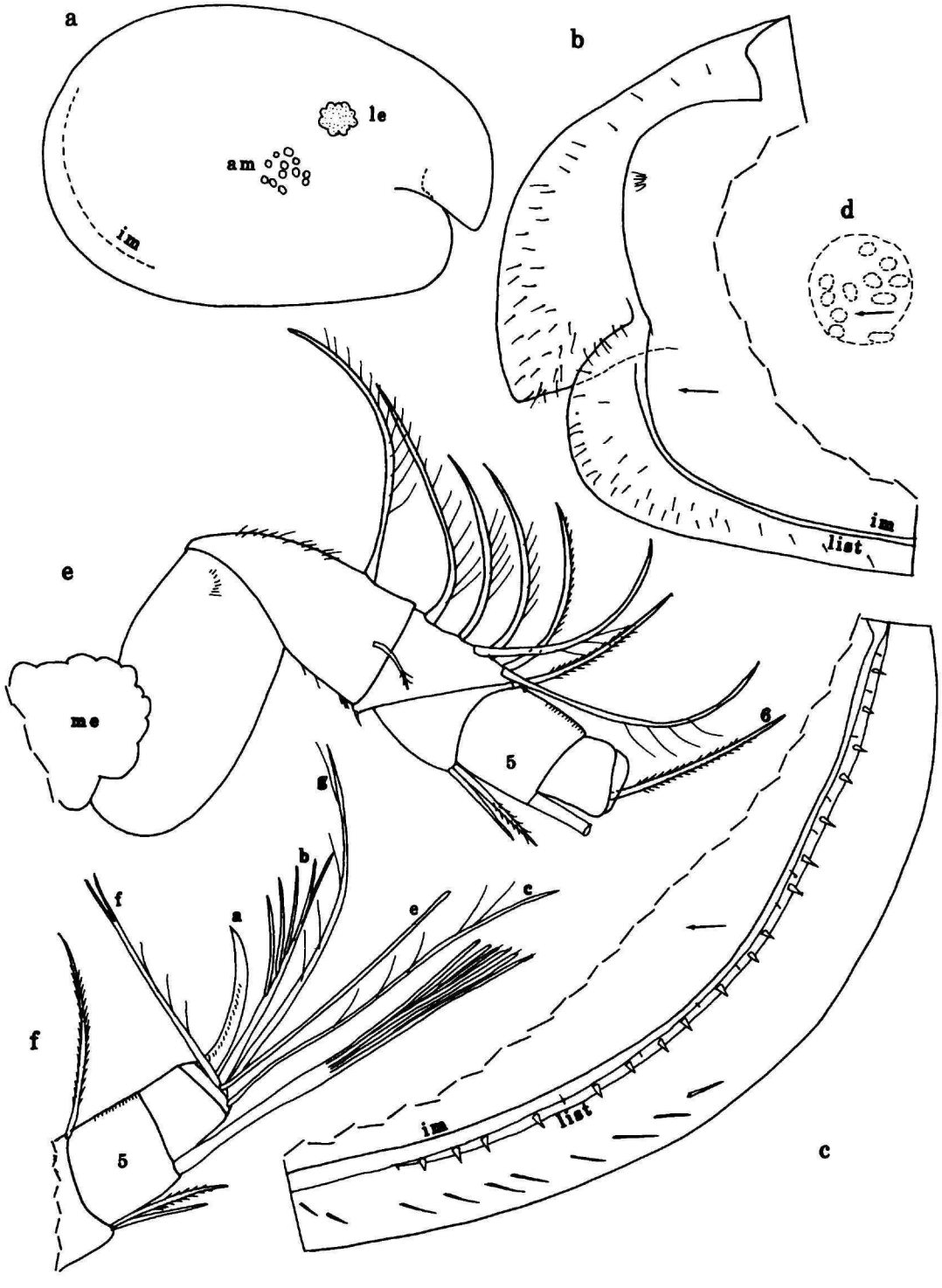

FIGURE 48.—*Parasterope muelleri* (Skogsberg, 1920), adult female, USNM 194470: *a*, complete specimen from right side, length 1.05 mm; *b,c*, anterior and posterior of right valve, iv; *d*, adductor muscle attachments on right valve, iv; *e,f*, parts of right 1st antenna, lv.

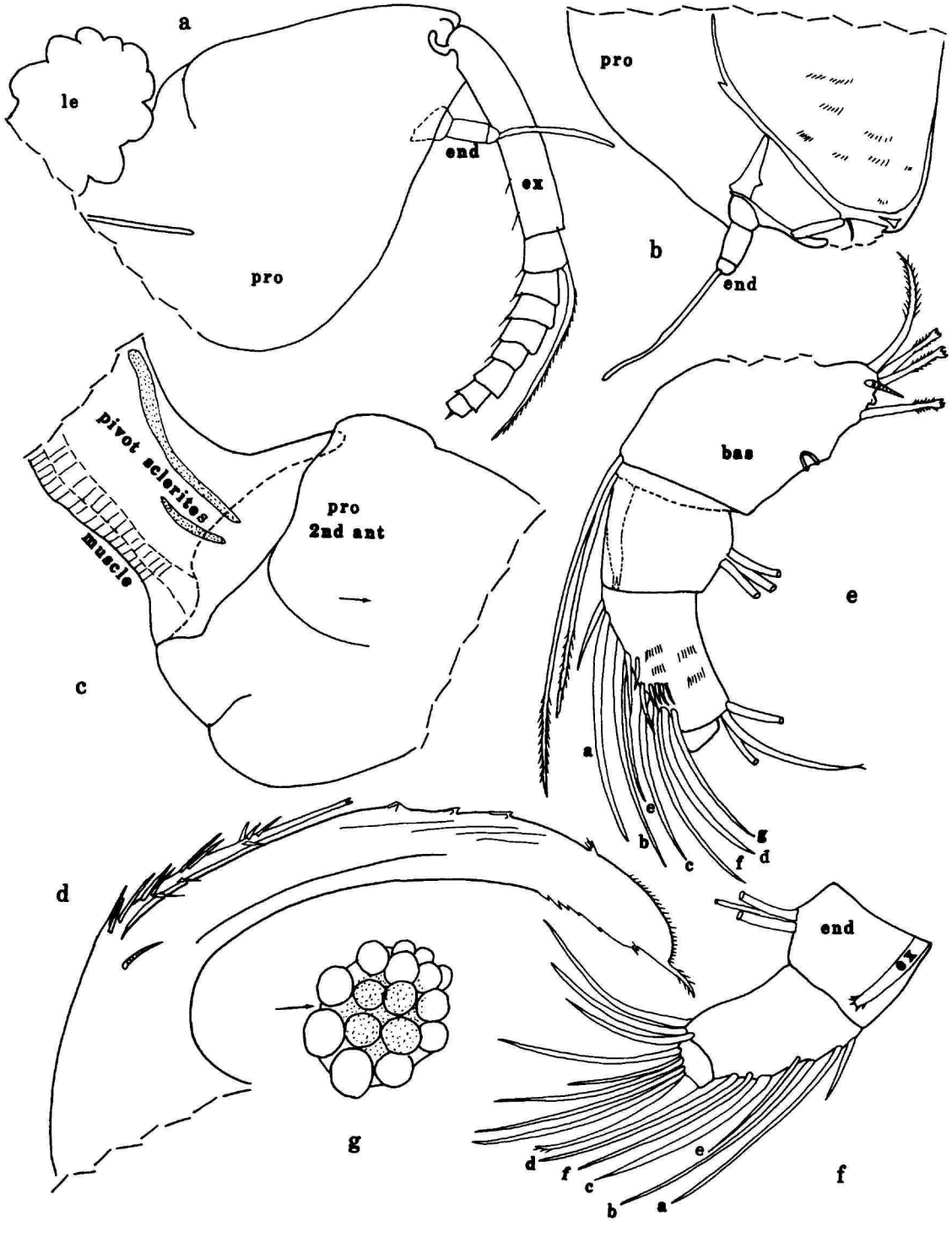

FIGURE 49.—*Parasterope muelleri* (Skogsberg, 1920), adult female, USNM 194470: *a*, right lateral eye and right 2nd antenna (nabs), lv; *b*, part of left 2nd antenna, mv; *c*, sclerites attached to protopodite of left 2nd antenna, mv; *d*, coxale endite, left mandible, mv; *e*, part of right mandible, mv; *f*, part of right mandible, lv; *g*, right lateral eye, lv.

glandular peg; ventral margin with U-shaped boss near base of endite; dorsal margin with 2 long bristles with short spines. Exopodite about same length as dorsal margin of 1st endopodial joint, with 2 small subterminal bristles and hirsute tip. 1st endopodial joint with 3 ventral bristles (2 long with long spines, 1 shorter with short spines). 2nd endopodial joint: dorsal margin with 1 short proximal bristle, long a-, b-, c-, d-bristles, and short cleaning-type bristle between b- and c-bristles; base of c-bristle very slightly stouter than bases of b- and d-bristles; lateral surface with long e- and g-bristles; medial surface with 1 small cleaning bristle and oblique row of 5 cleaning bristles between b- and c-bristles, 1 long g-bristle close to base of d-bristle, and rows of spines; ventral margin with 3 bristles with short spines. 3rd endopodial joint with slightly curved claw with few minute dorsal teeth near tip, and with 5 slender bristles.

Maxilla (Figure 50*a,b*): Endite I with 4 bristles (3 long spinous, 1 short); endite II with 3 long spinous bristles. Epipodite with drawn-out hirsute tip reaching to about midlength of dorsal margin of basale. Basale: medial surface near dorsal margin with bristles (1 proximal, 1 distal); lateral surface with 1 proximal bristle near base of epipodite; ventral margin with 1 proximal backward-oriented bristle and 1 long spinous terminal bristle; dorsal margin with indistinct hairs. 1st endopodial joint with short distal alpha-bristle and long bare beta-bristle about ⅔ length of long bare terminal bristle of small 2nd endopodial joint.

Fifth Limb (Figure 50*c*): Comb with spinous exopodial bristle, 1 slender bristle just ventral to base of exopodial bristle (this area somewhat obscured on both limbs of USNM 194470 and the possibility that 2 bristles are present cannot be ruled out), and 5 bristles at midlength of comb and almost on ventral margin.

Sixth Limb (Figure 50*d*): Medial side with minute bristle in proximal anterior corner and a bristle at each endite; bristle of lower endite longer and set back slightly from anterior margin. Skirt: anterior tip with 2 bristles (longer bristle anterior and spinous, other bristle bare); ventral margin with 12 or 13 spinous bristles in posterior ⅔ (bristles at posteroventral corner longer); lateral anterior flap with hairs but no bristles.

Seventh Limb: 6 bristles in proximal group, 3 on each side, same number and distribution in distal group, each bristle with 2–4 bells; terminus consisting of opposing combs, each with 8 spinous teeth.

Furca (Figure 50*e*): Each lamella with nine claws; 2 posterior claws bent backward, bristle-like, ringed, bare; claws 1–6 with teeth along posterior edges, some slightly longer than others; claws 1 and 2 with distal anterior spines.

Bellonci Organ (Figure 50*f*): Elongate, broadening near midlength, with rounded tip.

Eyes: Lateral eye well developed with 16 ommatidia and brown pigment (Figures 48*a,e,* 49*a,g*). Medial eye about same size as lateral eye, unpigmented (Figure 50*f*) (whether or not medial eye bears hairs not determined).

Upper Lip (Figure 50*g*): Consisting of 2 hirsute lobes, each with indistinct minute anterior spine, one on each side of saddle bearing minute indistinct anterior spine. Lower lips consisting of hirsute lateral flap on each side of mouth.

Genitalia (Figures 50*h,* 51*a,e*): Small oval ring on each side of body anterior to furca.

Brush-like Organ (Figure 50*h*): 4 minute bristles on each side of body near genitalia.

Posterior of Body (Figure 51*a,b,c*): Posterodorsal margin with 3 low lobes; ventral of these with long spines; 3 spinous crescents on each side proximal to margin; long hairs along middle of posterior margin.

Y-*Sclerite* (Figures 51*a,f,* 52*g*): Without ventral branch; anterior attached to upward curving sclerite.

Gills (Figure 51*a,d*): 7 on each side with small terminal lobe on ventral edge.

Eggs (Figure 51*d*): USNM 197470 with small round unextruded eggs; diameter of 1 egg 0.16 mm.

Genus and Species Indeterminate

MATERIAL.—Exuma Sound: Sta 94-020, transect AB, 1 partly dissected juvenile plus 3 early instars, all in alcohol. Sta 95-004, transect BB, 1 early instar in alcohol. Sta 95-005, transect BB, 2 early instars in alcohol.

DISCUSSION.—The specimens are early instars and were not identified further.

Subfamily ASTEROPTERONINAE Kornicker, 1981

Actinoseta Kornicker, 1958

TYPE SPECIES.—*Actinoseta chelisparsa* Kornicker, 1958.

COMPOSITION AND DISTRIBUTION.—The type species has previously been reported from the Bahamas, Florida, West Indies, and from off Venezuela (Kornicker, 1981). Another species, *A. hummelincki* Kornicker, 1981, has been reported from the Florida Keys, West Indies, and off Argentina (Kornicker, 1981). Two additional species have been described in this genus: *A. jonesi* Kornicker, 1981, from off Argentina, and *A. nodosa* Kornicker, 1981, from the Indian Ocean.

Actinoseta chelisparsa Kornicker, 1958

Actinoseta chelisparsa Kornicker, 1958:244, figs. 43a–l, 46:10a,b, 69a–f, 70a–i, 89h,j,p,q; 1981:192, figs. 9o, 11e, 12c, 16d, 17e, 72–77, pls. 52–58.

HOLOTYPE.—Ovigerous female (lost).

TYPE LOCALITY.—Bimini, Bahamas.

MATERIAL.—Exuma Sound: Sta 94-018, transect AA, USNM 194471, 2 specimens in alcohol.

DISTRIBUTION.—Wall off Lee Stocking Island, Exuma Cays, Sta 94-018, depth 67 m.

REMARKS.—The two specimens in the collection were not dissected.

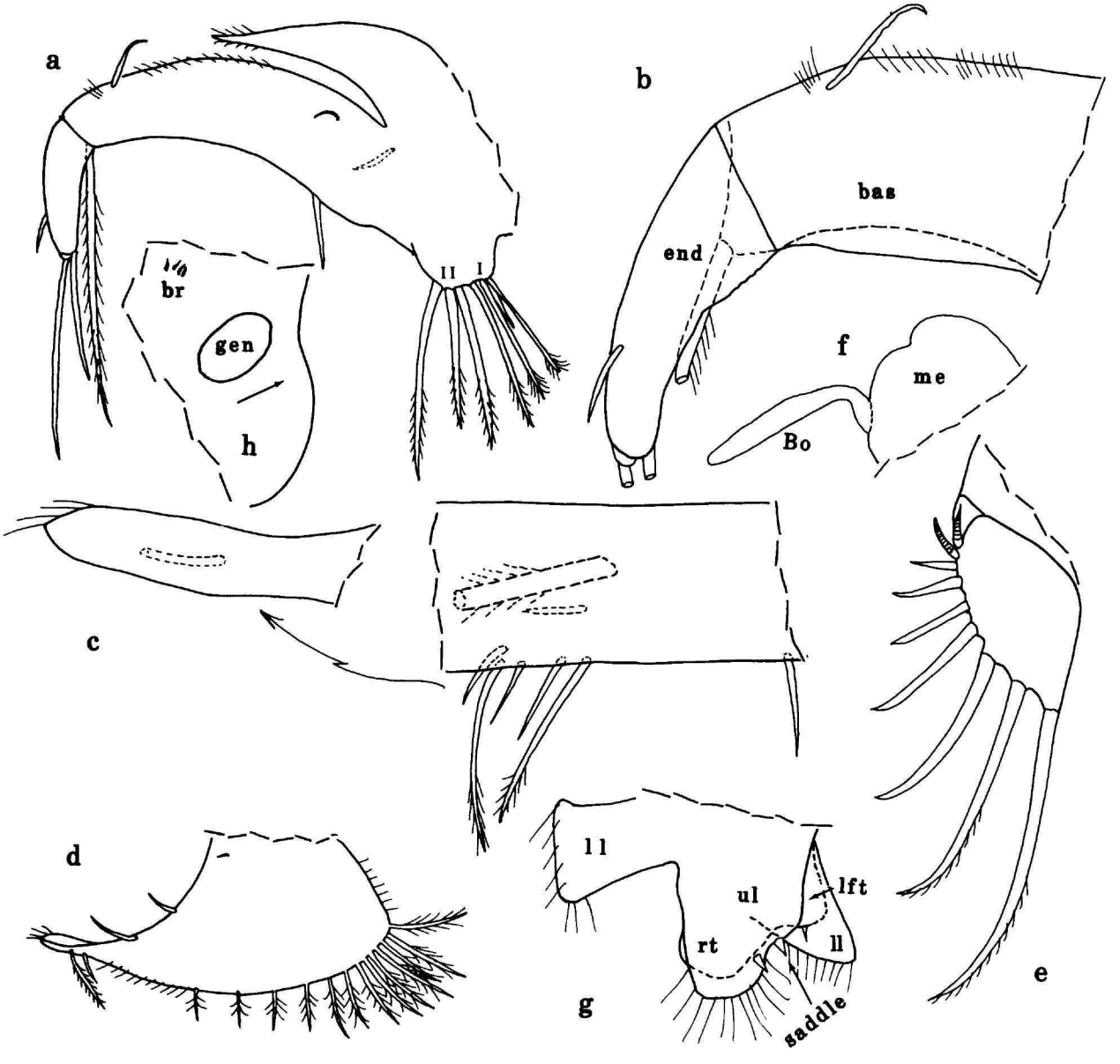

FIGURE 50.—*Parasterope muelleri* (Skogsberg, 1920), adult female, USNM 194470: *a,b,* parts of right maxilla, mv; *c,* comb of right 5th limb (nabs), mv; *d,* right 6th limb, mv; *e,* right lamella of furca, lv; *f,* medial eye and Bellonci organ from left side; *g,* upper and lower lips (distorted); *h,* genitalia and brush-like organ on right side of body.

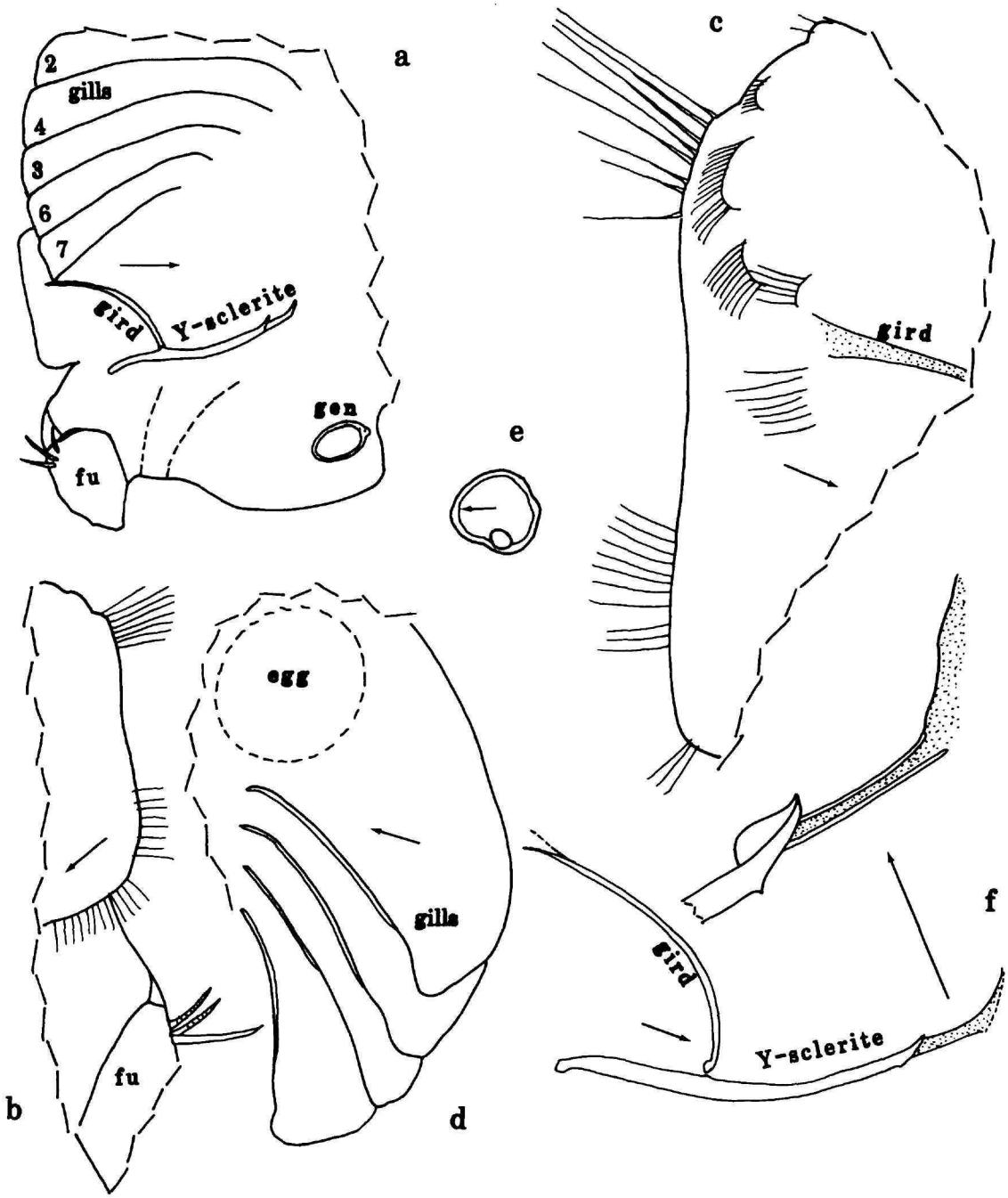

FIGURE 51.—*Parasterope muelleri* (Skogsberg, 1920), adult female, USNM 194470: *a*, posterior of body from right side (not all furcal claws shown); *b*, posterior of body from left side (gills and spinous crescents not shown); *c*, posterior of body from right side (gills not shown); *d*, posterior of body from left side showing 4 gills and 1 egg); *e*, genitalia on left side of body; *f*, right Y-sclerite and girdle of posterior of body from right side.

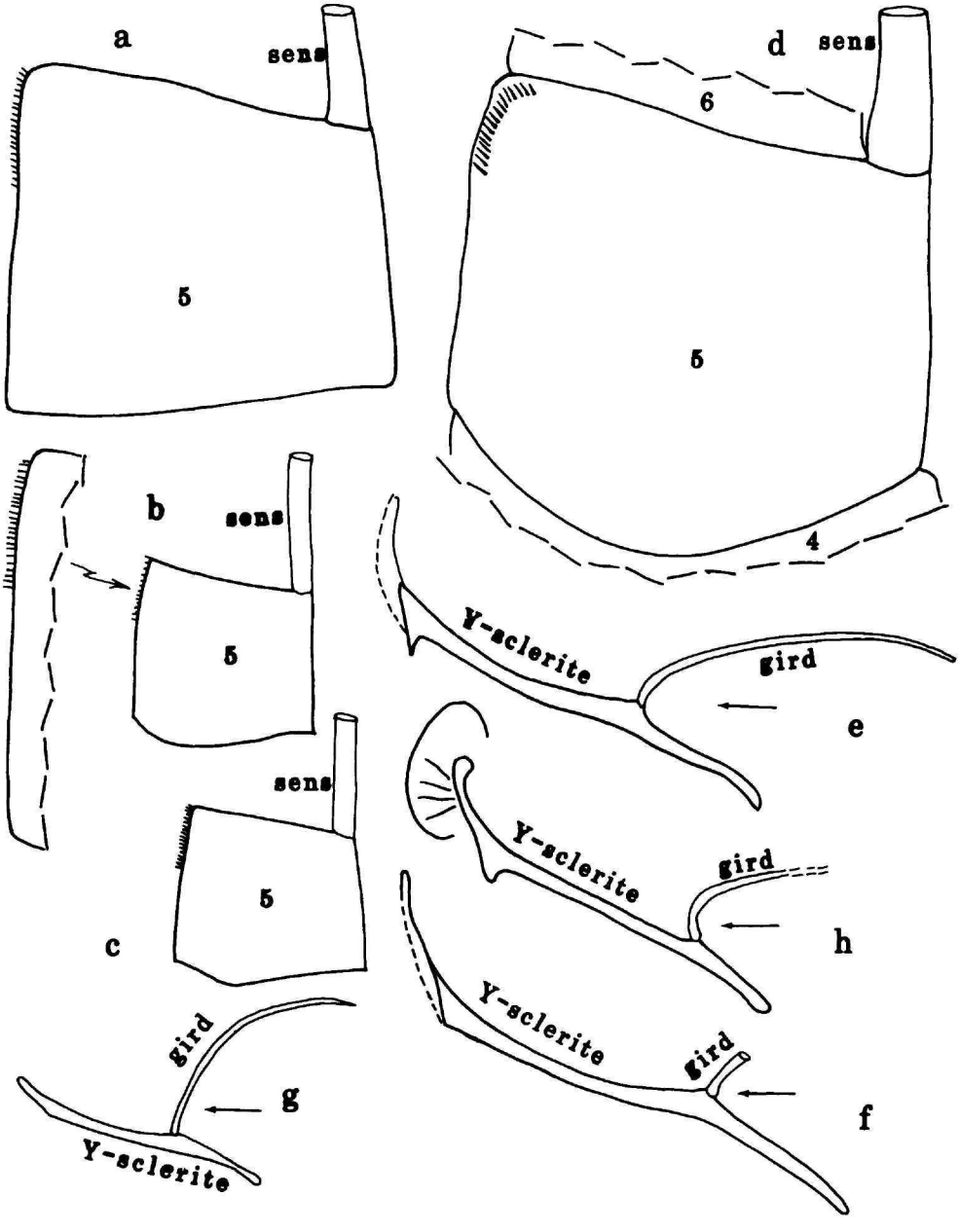

FIGURE 52.—*Parasterope muelleri* (Skogsberg, 1920), adult females: *a–d*, 5th joints of 1st antennae: *a*, right limb, lv, Bermuda, USNM 158293; *b*, right limb, mv; *c*, left limb, lv, Florida, USNM 152855; *d*, right limb, lv, Mauritania, USNM 143977. *e–h*, left Y-sclerites and girdles of adult females: *e*, Bermuda, *P. muelleri*, USNM 158293; *f*, Mauritania, *P. muelleri*, USNM 143997; *g*, Bahamas, *Synasterope browni*, holotype, USNM 194469; *h*, Bahamas, *Diasterope procax*, holotype, USNM 194460.

Asteropella Kornicker, 1975

TYPE SPECIES.—*Asteropella mortenseni* Poulsen, 1965; subsequent designation by Kornicker (1975:557).

COMPOSITION AND DISTRIBUTION—This genus contains 12 named species from the Atlantic and Pacific oceans in the vicinity of North and South America between latitudes of about 37°30′N and 41°48′S from depths of intertidal to 57 m (Kornicker, 1981, 1986b).

Asteropella species indeterminate

MATERIAL.—USNM 194474, undissected juvenile, length 0.75 mm, height 0.55 mm.

DISTRIBUTION.—Sta 94-018, Wall off Lee Stocking Island, Exuma Cays, Bahamas, depth 67 m.

Order HALOCYPRIDA Dana, 1853

Suborder HALOCYPRIDINA Dana, 1853

The Halocypridina contains the superfamilies Halocypridoidea Dana, 1853, and Thaumatocypridoidea Müller, 1906. Both are represented in the present collection.

Superfamily HALOCYPRIDOIDEA Dana, 1853

Family HALOCYPRIDIDAE Dana, 1853

Subfamily DEEVEYINAE Kornicker and Iliffe, 1985

Spelaeoecia Angel and Iliffe, 1987

TYPE SPECIES.—*Spelaeoecia bermudensis* Angel and Iliffe, 1987.

COMPOSITION AND DISTRIBUTION.—The genus contains eight species from anchialine caves in Bermuda, Bahamas, Jamaica, Cuba, and Mexico (Kornicker and Yager, 1996; Kornicker and Iliffe, 1998).

Spelaeoecia bermudensis Angel and Iliffe, 1987

Spelaeoecia bermudensis Angel and Iliffe, 1987:545, figs. 2–6.—Kornicker and Iliffe, 1989b:46, fig. 29.—Kornicker, 1989:313, figs. 1–5.

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

TYPE LOCALITY.—Green Bay Cave, Bermuda.

MATERIAL.—Bermuda: Church Cave, sta 95-050: USNM 194500, 25 specimens including an adult male. Bitumen Cave, sta 95-010: USNM 194501, 8 specimens.

DISTRIBUTION.—Anchialine caves in Bermuda.

Spelaeoecia capax Kornicker in Kornicker et al., 1990

Spelaeoecia capax Kornicker in Kornicker et al., 1990:23, fig. 14.—Kornicker and Iliffe, 1998:10, figs. 3a, 4–16.

HOLOTYPE.—USNM 193449, empty carapace in alcohol (sex and age unknown).

TYPE LOCALITY.—Alfonso Dean Blue Hole, Long Island, Great Bahama Bank.

MATERIAL.—Exuma Cays: Oven Rock Cave, Great Guana Cay, Sta 96-033: USNM 194526, adult male; USNM 194528, 3 specimens; USNM 194529, 1 A–4 instar, 9 adult males, 9 adult females, 24 specimens. Sta 96-050 (all specimens undissected and in alcohol): USNM 194520, 1 A–3 instar (sex unknown); USNM 194521, 5 adult males; USNM 194522, 5 adult females; USNM 194523, 3 A–1 instars (sex unknown); USNM 194524, 2 A–1 instars (sex unknown); USNM 194525, 3 A–2 instars (sex unknown). Norman's Pond Cave, Norman's Pond Cay, Sta 96-032: USNM 194527, 1 adult female.

DISTRIBUTION.—Great Bahama Bank: Alphonso Dean Blue Hole, Long Island (type locality), at depth of 13 m, salinity about 20 ppt. Oven Rock Cave, Great Guana Cay, Exuma Cays, at depths of 0–20 m, salinity 35–36 ppt. Norman's Pond Cave, Norman's Pond Cay, Exuma Cays, at depths of 0–50 m.

SUPPLEMENTARY DESCRIPTION OF ADULT FEMALE FROM OVEN ROCK CAVE.—Surface of all carapaces with distinct striations.

Carapace Size (length, height in mm): USNM 194522, 5 specimens: A, 3.03, 1.42; B, 3.05, 1.45; C, 2.87, 1.40; D, 2.71, ~1.16; E, 2.73, 1.22.

SUPPLEMENTARY DESCRIPTION OF ADULT MALE FROM OVEN ROCK CAVE.—Surface of all carapaces with distinct striations.

Carapace Size (length, height in mm): USNM 194521, 5 specimens: A (length only), 2.74; B, 2.78, 1.30; C, ~2.66, ~1.21; D, 2.82, 1.23; E, ~2.90, ~1.11.

SUPPLEMENTARY DESCRIPTION OF A–1 INSTAR (Instar VI?, sex unknown) FROM OVEN ROCK CAVE.—Surface of all carapaces with distinct striations.

Carapace Size (length, height in mm): USNM 194523, 3 specimens: A, 2.08, 0.94; B, 2.21, 1.02; C, 2.20, 1.13. USNM 194524, 2 specimens: 1.97, 0.81; 2.05, 0.85.

SUPPLEMENTARY DESCRIPTION OF A–2 INSTAR (Instar V?, sex unknown) FROM OVEN ROCK CAVE.—Surface of all specimens with distinct striations.

Carapace Size (length, height in mm): USNM 194525, 3 specimens: A, 1.52, 0.69; B (length only), 1.48; C (length only), 1.50.

SUPPLEMENTARY DESCRIPTION OF A–3 INSTAR (Instar IV?, sex unknown) FROM OVEN ROCK CAVE.—Surface of specimen with distinct striations.

Carapace Size (length, height in mm): USNM 194520, 1.13, 0.50.

Spelaeoecia styx Kornicker in Kornicker et al., 1990

Spelaeoecia styx Kornicker in Kornicker et al., 1990:6, figs. 2–8.—Kornicker and Iliffe, 1998:26, figs. 17–29.

HOLOTYPE.—USNM 194270, undissected adult male in alcohol.

TYPE LOCALITY.—El Dorado Cave, South Andros Island, Great Bahama Bank.

MATERIAL.—Exuma Cays: Norman's Pond Cave, Norman's Pond Cay: Sta 96-032: USNM 194530, 1 specimen in alcohol. Oven Rock Cave, Great Guana Cay, sta 96-033: USNM 194531, 1 adult female without carapace, 1 adult male, both in alcohol.

DISTRIBUTION.—Great Bahama Bank: Eldorado Cave, South Andros Island; Norman's Pond Cave, Norman's Pond Cay, Exuma Cays; Oven Rock Cave, Great Guana Cay, Exuma Cays.

SUPPLEMENTARY DESCRIPTION OF ADULT MALE FROM NORMAN'S POND CAVE.—Valves decalcified and without visible surface ornamentation.

Carapace Size (length, height in mm): USNM 194531, 0.91, 0.54.

Spelaeoecia mayan Kornicker and Iliffe, 1998

Spelaeoecia mayan Kornicker and Iliffe, 1998:43, figs. 30–36.

HOLOTYPE.—USNM 194322, undissected adult male in alcohol.

TYPE LOCALITY.—Cenote Maya Blue, Tulum, Quintana Roo, Mexico.

MATERIAL.—Cenote 27 Steps, Sta 96-001: USNM 194533, 4 specimens.

DISTRIBUTION.—Quintana Roo, Mexico: Cenote Maya Blue (type locality) and Cenote 27 Steps.

Superfamily THAUMATOCYPRIDOIDEA Müller, 1906

Family THAUMATOCYPRIDIDAE Müller, 1906

This family includes two fossil genera known only from the Permian and Mesozoic, and three known from the Holocene (*Thaumatocypris* Müller, 1906; *Thaumatoconcha* Kornicker and Sohn, 1976; and *Danielopolina* Kornicker and Sohn, 1976).

Danielopolina Kornicker and Sohn, 1976

TYPE SPECIES.—*Danielopolina carolynae* Kornicker and Sohn, 1976.

COMPOSITION AND DISTRIBUTION.—Including the new species described herein, the genus contains 10 species (see Kornicker and Iliffe, 1998, for key to nine species) from anchialine habitats in the Bahamas, Canary Islands, Cuba, Galapagos Islands, Jamaica, Mexico (Yucatan Peninsula), and Australia, and in the South Atlantic (3459 m depth).

Danielopolina mexicana Kornicker and Iliffe, 1989

Danielopolina mexicana Kornicker and Iliffe, 1989a:15, figs. 1, 7, 8; 1998:62, figs. 43–48.

HOLOTYPE.—USNM 193312, adult female on slide and in alcohol.

TYPE LOCALITY.—Cenote Maya Blue, Tulum, Quintana Roo, Mexico.

MATERIAL.—Cenote Ponderosa: Sta 95-020: 3 specimens in alcohol; Sta 96-002, 2 specimens in alcohol. Cenote 27 Steps: Sta 95-021: 3 specimens in alcohol; Sta 96-001: 1 specimen in alcohol. All above specimens returned to Iliffe for DNA analysis. Cenote 27 Steps: Sta 96-011: USNM 194501, 1 specimen in alcohol.

DISTRIBUTION.—Quintana Roo Province, Yucatan Peninsula, Mexico: Cenote Maya Blue, Cenote Ponderosa, Cenote 27 Steps.

Danielopolina exuma Kornicker and Iliffe, 1998

Danielopolina exuma Kornicker and Iliffe, 1998:70, figs. 50–60.

HOLOTYPE.—USNM 194305, undissected adult female in alcohol.

TYPE LOCALITY.—Norman's Pond Cave, Norman's Pond Cay, Exuma Cays, Great Bahama Bank.

MATERIAL.—Exuma Cays: Oven Rock Cave, Great Guana Cay, Sta 96-033: USNM 194532, undissected adult male in alcohol.

DISTRIBUTION.—Norman's Pond Cave, Norman's Pond Cay, and Oven Rock Cave, Great Guana Cay, Exuma Cays, Bahamas.

SUPPLEMENTARY DESCRIPTION OF ADULT MALE.—*Carapace Size* (length, height in mm): ~0.46 (including small anterior process), ~0.42.

Danielopolina kakuki, new species

FIGURES 53–56

ETYMOLOGY.—This species is named in honor of Brian Kakuk, an exceptional cave diver, and Diving Officer at the Caribbean Marine Research Center, who carried out exploration and biological collections from Oven Rock and other caves in the Bahamas.

HOLOTYPE.—USNM 194534, 1 juvenile male on slide and in alcohol.

TYPE LOCALITY.—Sta 95-012, Oven Rock Cave, Great Guana Cay, Exuma Cays, Bahamas.

PARATYPES.—None.

DISTRIBUTION.—Collected only at type locality.

DESCRIPTION (Figures 53–56).—Carapace slightly elongate with fairly straight dorsal margin in vicinity of hinge and also straight margin between anterior and anteroventral processes (Figures 53, 54*a*). Ventral and posterior margins evenly

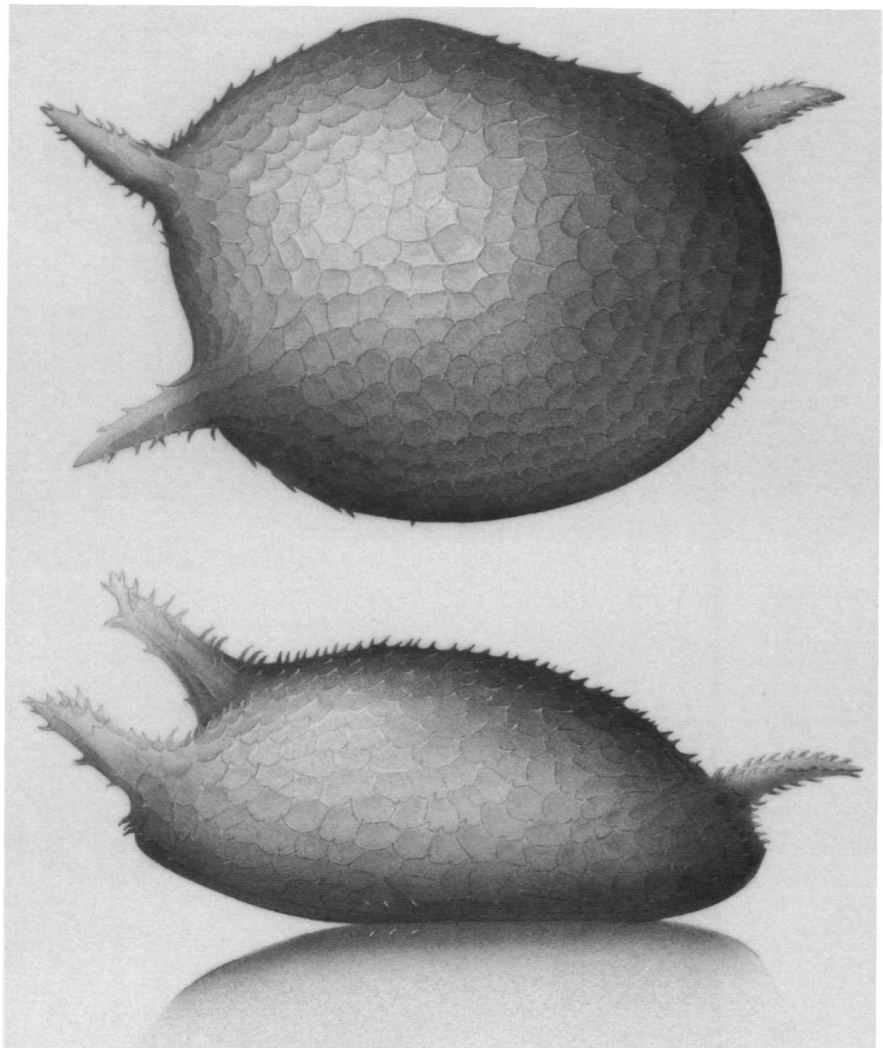

FIGURE 53.—*Danielopolina kakuki*, new species, juvenile male, holotype, USNM 194534, length (including processes) 0.63 mm, lateral and dorsal views.

rounded; valves at greatest width at about midlength and midheight, in vicinity of adductor muscle attachments. Fairly long anterior, anteroventral, and posterodorsal processes with bases just lateral to valve edge, and in similar location on each valve.

Ornamentation (Figures 53, 54*a*): Surface reticulate with small spine at intersections of walls forming reticulations. Spines also present on 3 processes. Walls of reticulations generally broader in vicinity of intersections then tapering to point midway between intersections so that walls appear as 3-pointed star with spine at center. Reticulations mostly hexagonal but few with 4 or 5 sides. Right valve with few long bristles along dorsal and posterodorsal margins (Figure 54*a*); both valves with divided bristle on anteroventral margin just ventral to anteroventral process (Figure 54*a*).

Muscle Attachments: Adductor muscle attachments central in location (Figure 54*a*); subround with greatest diameter trending towards posterior end of hinge; consisting of several obscure segments. Oval auxiliary muscle scar located anteroventral to adductor muscle attachments (Figure 54*a*; not shown in Figure 53).

Carapace Size: USNM 194534, length including anterodorsal and posterodorsal processes 0.63 mm; length excluding processes 0.56 mm; height including anteroventral process 0.49 mm; height excluding anteroventral process 0.435 mm.

First Antenna (Figure 54*b*): 1st joint with 2 ringed bristles (1 lateral, 1 dorsal). 2nd joint with distal medial spines and 1 ringed dorsal bristle. 3rd and 4th joints fused, but place of fusion indicated by thinning in sclerotized dorsal margin and

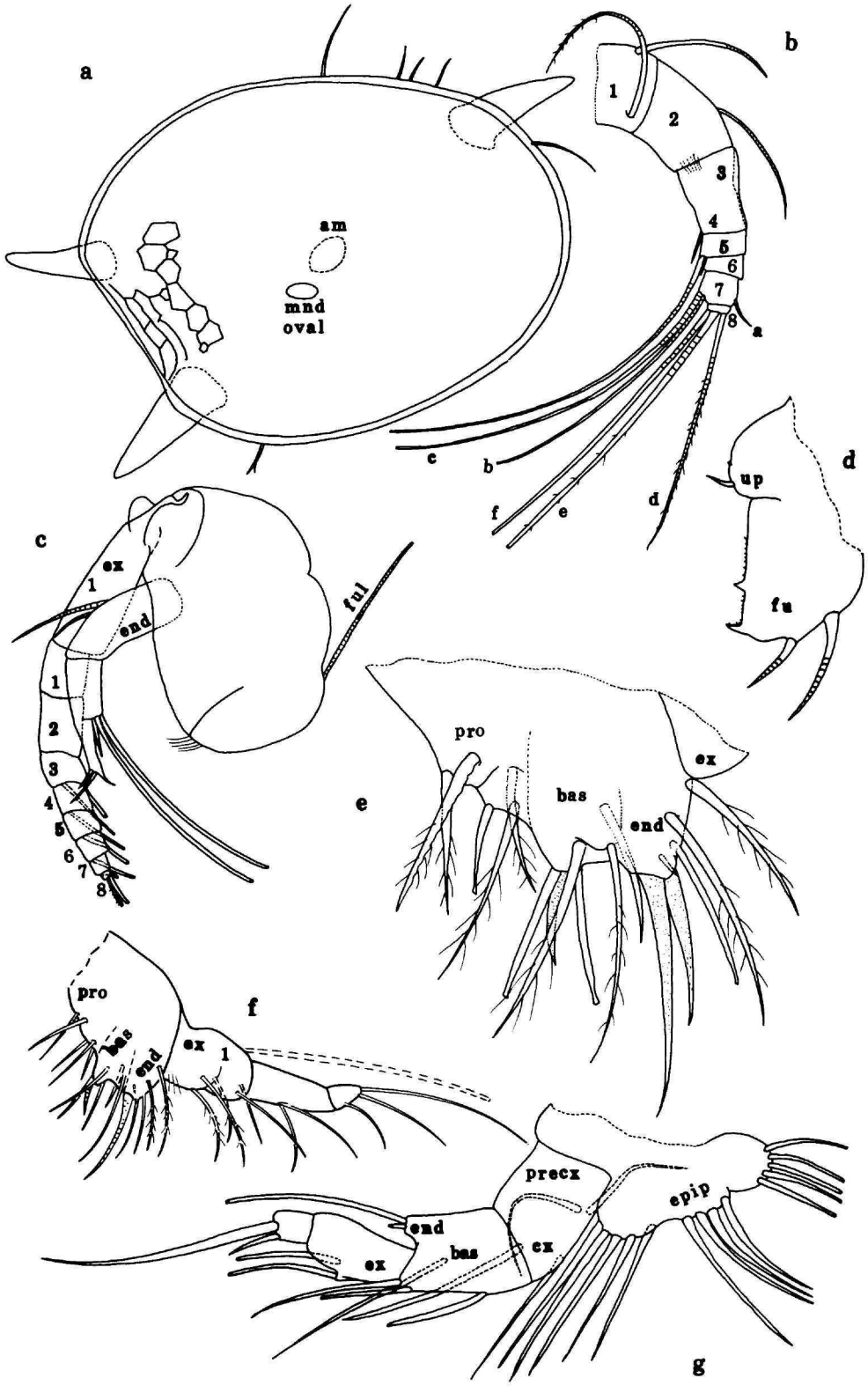
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FIGURE 54 (left).—*Danielopolina kakuki*, new species, juvenile male, holotype, USNM 194534: *a*, inside view of right valve showing representative reticulations as seen through shell; *b*, right 1st antenna, lv; *c*, left 2nd antenna, lv; *d*, right furcal lamella and unpaired bristle on endopodite of right 2nd antenna, mv; *e*, proximal left 5th limb, lv; *f*, left 5th limb, lv; *g*, right 6th limb, lv.

slight decrease in joint width shown by minute step near midlength of ventral margin; 4th joint with short unringed filament-like ventral terminal bristle (bristle broad except for narrow tip). 5th joint with 2 filament-like bristles (1 long (tip missing on illustrated limb), 1 small indistinct). 6th joint bare. 7th joint with 3 bristles (1 short ringed a-bristle, 2 long filament-like b- and c-bristles). 8th joint with 3 terminal bristles (slender dorsal ringed spinous d-bristle, 1 long filament-like e-bristle with widely separated marginal spines, and 1 long filament-like medial f-bristle narrower than e-bristle (tips of e- and f-bristles missing on illustrated limb). Filament-like bristles weakly ringed proximally.

Second Antenna: Protopodite with few long hairs at proximal ventral corner (Figure 54*c*). Endopodite 3-jointed (Figures 54*c*, 55): 1st joint with 2 ringed a- and b-bristles; 2nd joint with short ringed dorsal bristle with base near midwidth of lateral side and 3 filament-like ventral bristles (2 long, 1 short); 3rd joint of left limb long slender with 3 bristles or processes at tip (ventral process with 2 or 3 minute terminal papillae; dorsal process short unringed; middle process longer than others and somewhat bristle-like, but at most weakly ringed) (Figures 54*c*, 55*b*); 3rd joint of right limb with terminal processes broken off; stem shorter than on left limb (Figure 55*a*). Exopodite 8-jointed (Figure 54*c*): 1st joint divided into long proximal and short distal parts; bristles of joints 2–7 long, with natatory hairs; 8th joint with 2 bristles (1 long with natatory hairs, 1 shorter and narrower with small marginal spines); joints 3–7 with indistinct minute spines along distal dorsal margins; only proximal parts shown of long bristles; natatory hairs not shown on long exopodial bristles.

Mandible: Coxale endite with proximal and distal sets of teeth separated by a space (Figure 56*a,b*); proximal set comprising 4 cusps plus a triangular tooth close to distal set of teeth; surface between cusps and medial and lateral surfaces just proximal to cusps with slender spines; 2 spinous bristles with bases just proximal and another bristle with base just distal to triangular tooth; distal set of teeth consisting of 2 flat teeth, each having 3–5 cusps; 1 slender bristle with base proximal to distal set of teeth. Basale (Figure 56*a,c*): tooth of endite with 5 triangular cusps (anterior 4 with indistinct minute marginal teeth); posterior edge of endite spinous, with 2 short ringed bristles (distal of these tubular); anterior margin of endite with 1 long ringed bristle near midlength; lateral side of endite with 5 ringed bristles (4 long, 1 short) near midlength and 1 distal bristle ringed except near tip; medial side of basale

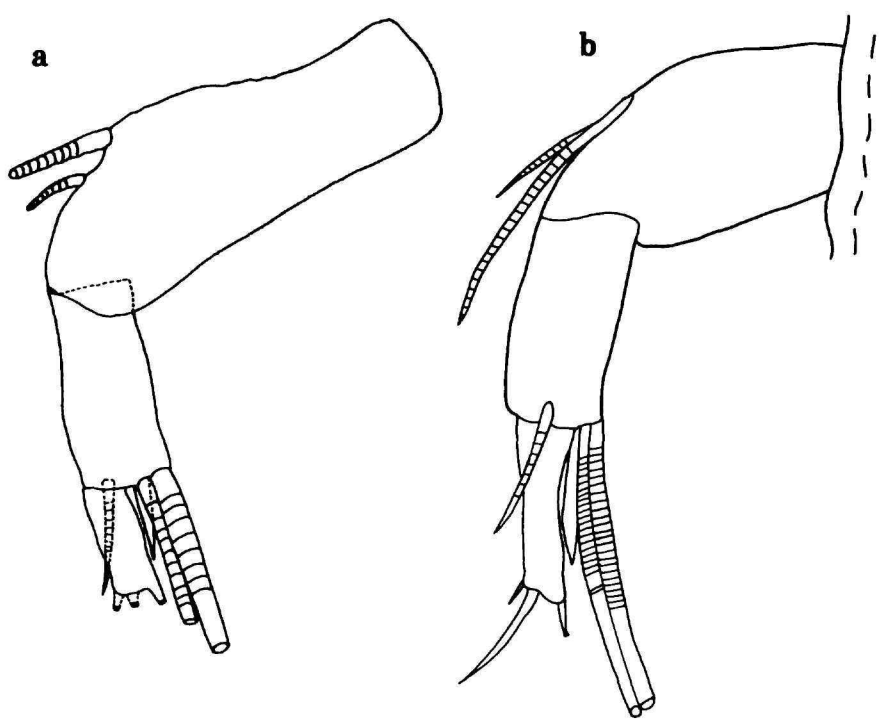

FIGURE 55.—*Danielopolina kakuki*, new species, juvenile male, holotype, USNM 194534: *a*, endopodite, right 2nd antenna, mv; *b*, endopodite, left 2nd antenna, lv.


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II
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FIGURE 56 (left).—*Danielopolina kakuki*, new species, juvenile male, holotype, USNM 194534: *a*, left mandible, lv; *b*, distal coxale, left mandible, lv; *c*, distal basale, left mandible, lv; *d*, distal 3rd endopodial joint, left mandible, lv; *e,f*, parts of maxilla (limb B); *g,h*, parts of maxilla (limb A); *i*, portion of posterior of body from right side showing 7th limb and oval containing round brown cells (stippled); *j*, left lower lip from left side; *k*, posterior of body from right side showing limbs in place on body (nabs).

near dorsal margin with 2 stout ringed bristles; dorsal margin of basale with cluster of spines at apex. Endopodite 3-jointed: 1st joint with lateral spines and dorsal bristle near midlength; 2nd joint spinous with 1 ringed terminal ventral bristle, and 2 ringed dorsal bristles; 3rd joint with dorsal and medial spines and 6 bristles (middle lateral bristle long claw-like) (Figure 56*a,d*). Rings not shown on all bristles.

Maxilla (Figure 56*e–h,k*): Endites I to III each with 5 to 8 obscured bristles. Coxale without usual dorsal bristle (probably broken off). Basale with 2 bristles (1 ventral with widely separated long marginal hairs, 1 medial at midwidth). Endopodite: 1st joint with long proximal anterior spines, lateral spines at midlength, 3 long ringed distal anterior bristles, and 3 distal bristles near posterior margin; 2nd joint with 1 anterior stout straight nonarticulated terminal bare claw, 3 slender ringed bristles with bases lateral, and 1 stout proximal claw-like bristle with distal rings and indistinct short marginal spines.

Fifth Limb (Figures 54*e,f*, 56*k*): Protopodite with 5 bristles (1 tubular). Basale with 6 bristles (1 short claw-like, 2 long plumose, 2 ventral tubular, 1 slender medial proximal). Endopodite with 6 bristles (1 small medial tooth-like, 2 long sclerotized ventral claw-like, 1 ventral tubular, and 2 long plumose). Exopodite 3-jointed: 1st joint with 6 bristles; 2nd joint with 2 ventral bristles at midlength; 3rd joint with 3 bristles (middle bristle about 58% and smallest bristle about 34% of longest bristle). Epipodite obscured.

Sixth Limb (Figures 54*g*, 56*k*): Epipodite with 3 groups of plumose bristles (dorsal and ventral group each with 5 bristles, middle group with 4). Precoxale and coxale each with 2 bristles. Basale with 4 bristles. Small endopodite with 2 bristles. Exopodite: joints 1 and 2 fused, with 2 ventral bristles at midlength; 3rd joint with 1 long bristle and 1 small obscured bristle. With appendages in place, tip of 6th limb extends posteriorly slightly past tip of 5th limb.

Seventh Limb: A 7th limb with 2 bristles was observed prior to dissection of specimen (Figure 56*i,k*), but the limb was not found after specimen was dissected. Whether the limb was lost during the dissection, or was mistakenly observed on the whole specimen prior to dissection, is not known with certainty.

Furca (Figure 54*d*): Each lamella with 4 claws. Claws 1 and 2 anterior, articulated, and weakly ringed, claw 3 on anteroventral corner, nonarticulated, slight recurved, unringed; claw 4 separated by space from claw 3, nonarticulated, not recurved, triangular, unringed; claws 3 and 4 with minute teeth along posterior edges. Each lamella with medial rows of minute spines, some extending ventrally past edge of lamellae. Stout unpaired process on posterior of body just proximal to lamellae.

Bellonci Organ: Not observed on specimen but could have been obscured.

Lips: Lower lip sclerotized and triangular (Figure 56*j*). Upper lip with small sclerotized triangular process on each side of anterior of body dorsal to upper lip.

Copulatory Organ: Not observed.

Ganglion (Figure 56*i*): Oval on each side containing round brown cells (stippled) present posterior to 2nd antenna.

DISCUSSION.—This unique specimen bears an elongate 3rd joint on the endopodite of the 2nd antenna; this indicates that the specimen is a male. Because of the absence of a copulatory organ, the specimen is interpreted to be a late instar rather than an adult. Because known A–1 males in the Thaumatocyprididae usually have a fairly well-developed copulatory organ (Kornicker and Sohn, 1976, table 4), the specimen may be younger than A–1, but it certainly is not younger than A–2 because of the well-developed 3rd joint of the endopodite of the 2nd antenna.

COMPARISONS.—The new species, *D. kakuki*, differs from *D. exuma* Kornicker and Iliffe, 1998, in having an a-bristle on the 7th joint of the 1st antenna. Also, the reticulations on the carapace of *D. kakuki* have continuous walls, whereas the walls of reticulations of *D. exuma* are formed by rows of papillae. *Danielopolina exuma* is reported from Oven Rock Cave for the first time herein.

The carapace of *D. kakuki* resembles that of *D. mexicana* Kornicker and Iliffe, 1989a, in having numerous spines, but the surface of *D. kakuki* is more strongly reticulated. Each lamella of the furca of the specimen of *D. kakuki* in the present collection, which is probably an A–2 male, bears only two unarticulated ventral claws, whereas each lamella of the furca of the A–2 instar of *D. mexicana* probably bears four unarticulated ventral claws (extrapolated from Kornicker and Iliffe, 1998).

A specimen interpreted to be an instar II and left in open nomenclature as *Danielopolina* species A, has been reported previously from Oven Rock Cave (Kornicker and Iliffe, 1998). The carapace of that specimen is without the numerous spines present on the carapace of *D. kakuki* and each valve is without a posterodorsal process. The 1st antenna of that specimen has an a-bristle on the 7th joint similar to that on the 1st antenna of *D. kakuki*. The carapace differences between *D. kakuki* and *D.* species A do not permit them to be synonymized at this time.

Oven Rock Cave is the second cave reported to have more than one species of *Danielopolina* (Kornicker and Iliffe, 1995).

Appendix

Station Data with Specimens Collected

(in chronological order)

Submarine Escarpment

All stations were from the escarpment off Lee Stocking Island, Exuma Cays, Bahamas, with the exception of Sta 96-034, which was collected in a suction sample off Great Exuma Island by the submersible *Clelia*. For these stations, the tube trap samples and grab samples were made from the submersible *Nekton Gamma,* plankton net samples were collected by scuba divers, and a suction sample was made from the submersible *Clelia.* Two listed species of *Jimmorinia* are deliberate nomen nuda (being described by Cohen et al., in press), which are included herein to present all myodocopids collected on the escarpment. Open-ocean salinities of 34.9 g/l–36.2 g/l are assumed to be present at all stations on the escarpment, based on profiles obtained in September 1996.

Sta 93-005, 7 May 1993, Transect BB Buoy; collected with tube trap baited with sandwich meat and left for 48 hours on a sandy ledge near possible cave entrance at 88 m depth. In addition to ostracodes, the sample contained copepods and nebaliaceans.

Diasterope procax: USNM 194316, A–2 male.

Jimmorinia gunnari: USNM 194317, Instar I; USNM 194318, adult female; USNM 194319, Instar III; USNM 194320, Instar V.

Sta 94-018, 19 May 1994, Transect AA Buoy; collected with plankton net from sandy sediments on ledges at 67 m depth of the upper slope. In addition to ostracodes, the sample contained copepods, cumaceans, tanaidaceans, and polychaetes.

Actinoseta chelisparsa: USNM 194471, 2 specimens.

Asteropella sp. indet.: USNM 194474, 1 juvenile.

Eurypylus eagari: USNM 194478, ovigerous female.

Eusarsiella costata: USNM 194489, adult male.

Eusarsiella ryanae: USNM 194475, ovigerous female; USNM 194476, adult male; USNM 194477, 4 adult males; USNM 194479, Instar I; USNM 194480, 3 Instar I; USNM 194485, 194486, 194487, 194488, 4 Instar III males.

Eusarsiella sp. indet.: USNM 194491, 3 juveniles; USNM 194492, 3 juveniles.

Parasterope muelleri: USNM 194470, adult female.

Rutiderma schroederi: USNM 194472, adult female; USNM 194473, Instar III.

Sta 94-020, 22 May 1994, Transect AB Buoy; collected with plankton net from sandy sediments on ledges at 62 m depth of upper slope. In addition to ostracodes, the sample contained copepods and cumaceans.

Eusarsiella ryanae: USNM 194481, Instar I; USNM 194482, Instar II ?female; USNM 194483, 194484, 2 Instar III males.

Eusarsiella sp. indet.: USNM 194490, Instar IV; USNM 194493, 1 juvenile.

Vargula exuma: USNM 194410, Instar V female.

Vargula sp. indet.: USNM 194411, Instar I.

Cylindroleberidinae: 4 juveniles.

Sta 95-001, 12 May 1995, Transect AA Buoy, collected with grab sampler from sandy slope at 240 m depth. This was from the deepest depth sampled and was from a site where a few boulders projecting from the sand had probably fallen from the rocky escarpment above. The sample contained amphipods, copepods, tanaidaceans, and polychaetes.

Myodocopid ostracodes: none.

Sta 95-002, 12 May 1995, Transect BA Buoy; collected with grab sampler from sandy sediment on ledge beneath rock outcropping at 142 m depth. In addition to ostracodes, the sample contained amphipods, copepods, cumaceans, isopods, nebaliaceans, and tanaidaceans.

Diasterope procax: USNM 194461, A–4 instar; USNM 194462, A–4 Instar; USNM 194463, A–1 male.

Eurypylus hapax: USNM 194494, Instar IV female.

Sta 95-004, 15 May 1995, Transect BB Buoy; collected with tube trap baited with lobster legs and set on a sandy ledge near possible cave entrance at 99 m depth for 24 hours. In addition to ostracodes, the sample contained amphipods, copepods, and fish.

Jimmorinia gunnari: USNM 277656, adult female; USNM 277655, 277657–277660, 5 adult males.

Cylindroleberidinae: 1 juvenile.

Sta 95-005, 15 May 1995, Transect BB Buoy; collected with tube trap baited with lobster legs and set on bare rock ledge near possible cave entrance at 96 m depth for 24 hours. In addition to ostracodes, the sample contained amphipods, copepods, and polychaetes.

Jimmorinia gunnari: USNM 194502, 2 specimens.

Skogsbergia lerneri: USNM 194503, 4 specimens.

Synasterope browni: USNM 194469, adult female.

Cylindroleberidinae: 2 juveniles.

Sta 95-006, 14 May 1995, Transect BB Buoy; collected with tube trap baited with lobster legs and set on a sandy ledge

near possible cave entrance at 105 m depth for 24 hours. In addition to ostracodes, the sample contained amphipods, copepods, isopods, and nebaliaceans.

Diasterope procax: USNM 194460, adult female; USNM 194464, A–2 male; USNM 194465, A–2 male; USNM 194466, A–3 female; USNM 194467, A–3 male; USNM 194468, A–4 instar.

Jimmorinia gamma: USNM 194497, adult female.

Jimmorinia gunnari: USNM 194496, adult female; USNM 194498, 2 juveniles; USNM 194504, 8 specimens.

Skogsbergia lerneri: USNM 194495, Instar IV.

Sta 95-007, 15 May 1995, within 50 m of Transect BB; collected with tube trap baited with sandwich meat and set on ledge at 93 m depth on 7 May 1993. Due to inclement weather it could not be recovered in two days as planned. The next opportunity to collect this trap did not occur until 15 May 1995. At that time, the trap appeared undisturbed, but it was partially encrusted with sponges. All bait had long disappeared from this trap; therefore, it was functioning primarily as a protective habitat and not as a feeding attractant. If ostracodes were initially present, attracted by the original bait, they had since been eaten or had decomposed and had not bred in the trap. The trap contained amphipods, copepods, isopods, tanaidaceans, and fish (2 blennies).

Myodocopid ostracodes: none.

Sta 96-034, 14 Sep 1996, submarine escarpment off George Town, Great Exuma Island, Exuma Cays, Bahamas (about 50 km southeast of the other stations); collected with a suction sampler from sandy ledges at 90–100 m depth.

Eusarsiella ryanae: USNM 194518, 1 juvenile.

Jimmorinia gunnari: USNM 194519, 1 specimen (length 1.04 mm, height 0.73 mm).

Rutiderma schroederi: USNM 194517, 1 late instar.

Anchialine Caves

Sta 95-012, 22 May 1995, Oven Rock Cave, Great Guana Cay, Exuma Cays, Bahamas; salinity 35 ppt; collected with 93 μm mesh plankton net and suction bottle from water column at 1–22 m depths. Kornicker and Iliffe (1998) reported 41 specimens of *Spelaeoecia capax* and 7 specimens of *S. styx* from this sample.

Danielopolina kakuki: USNM 194534, 1 juvenile male.

Sta 95-020, 25 Jul 1995, Cenote Ponderosa, Puerta Aventuras, Quintana Roo, Mexico; salinity 35 ppt; collected with 93 μm mesh plankton net in the passage to the Chapel at 10–16 m depths, which was at or below halocline.

Danielopolina mexicana: 3 specimens.

Sta 95-021, 27 Jul 1995, Cenote 27 Steps, Akumal, Quintana Roo, Mexico; salinity 35 ppt; collected with 93 μm mesh plankton net from water column at 15–25 m depths.

Danielopolina mexicana: 3 specimens.

Sta 95-050, 15 Dec 1995, Church Cave, Bermuda; salinity 35 ppt; collected with 93 μm mesh plankton net from water column at 1–20 m depths.

Spelaeoecia bermudensis: USNM 194500, 25 specimens (including adult male).

Sta 95-051, 16 Dec 1995, Bitumen Cave, Bermuda; salinity 35 ppt; collected with 93 μm mesh plankton net from water column at 1–25 m depths.

Spelaeoecia bermudensis: USNM 194501, 8 specimens.

Sta 96-001, 11 Jan 1996, Cenote 27 Steps, Akumal, Quintana Roo, Mexico; salinity 35 ppt; collected with 93 μm plankton net from water column at 15–25 m depths.

Danielopolina mexicana: 1 specimen.

Spelaeoecia mayan: USNM 194533, 4 specimens.

Sta 96-002, 2 Jan 1996, Cenote Ponderosa, Puerto Aventuras, Quintana Roo, Mexico; salinity 35 ppt; collected with 93 μm mesh plankton net from water column at 10–16 m depths, which was at or below halocline.

Danielopolina mexicana: 2 specimens.

Sta 96-011, 17 Mar 1996, Cenote 27 Steps, Akumal, Quintana Roo, Mexico; collected with 93 μm mesh plankton net from water column at 15–24 m depths, with halocline at 12 m depth. (Salinity on 1 Jan 1996 was 35 ppt.)

Danielopolina mexicana: USNM 194501, 1 specimen.

Sta 96-032, 10 Sep 1996, Norman's Pond Cave, Norman's Pond Cay, Exuma Cays, Bahamas, collected with 93 μm mesh plankton net and vials from water column at 15–20 m and 50 m depths.

Spelaeoecia capax: USNM 194527, 1 adult female.

Spelaeoecia styx: USNM 194530, 1 specimen.

Sta 96-033, 13 Sep 1996, Oven Rock Cave, Great Guana Cay, Exuma Cays, Bahamas, collected with 93 μm mesh plankton net from water column at 0–18 m depths.

Danielopolina exuma: USNM 194532, 1 adult male.

Spelaeoecia capax: USNM 194526, 194528, 194529: 47 specimens.

Spelaeoecia styx: USNM 194531, 1 adult male, 1 adult female.

Sta 96-050, 18 Aug 1996, Oven Rock Cave, Great Guana Cay, Exuma Cays, Bahamas, collected with suction bottle from water column at 0–18 m depths.

Spelaeoecia capax: USNM 194520–194525: 19 specimens.

Tidal Blue Holes

The tidal Blue Holes have strong tidal currents. Typical open-water species can be swept for considerable distances into these caves and likewise, troglobitic species, if present, could be washed out. No troglobitic ostracodes were collected in these caves. The species in blue holes may be described in a later paper.

Sta 95-091, 5 Aug 1995, Sugar Cay Blue Hole, Sugar Cay, Exuma Cays, Bahamas; collected with 93 μm mesh plankton net from surface of silt mound on wall of cave passage at 31 m depth.

Harbansus sp.: 3 specimens.

Sarsiellinae: 10 specimens.

Sta 96-030, 9 Sep 1996, Mystery Cave, Stocking Island, Exuma Cays, Bahamas; collected with 93 μm mesh plankton net from sandy bottom and walls at 50 m depth.

Cylindroleberidinae: 3 specimens.

Sta 96-031, 9 Sep 1996, Master Harbour Cave, Great Exuma Island, Exuma Cays, Bahamas; collected with 93 μm mesh plankton net from ceiling at 12–15 m depths.

Cypridininae: 2 specimens.

Cylindroleberidinae: 1 specimen.

Sta 96-040, 6 Apr 1996, Conch Sound Blue Hole, Andros Island, Bahamas; collected with 93 μm mesh plankton net from surface of silt mound at 22 m depth.

Harbansus sp.: 11 specimens.

Sarsiellinae: 1 specimen.

Literature Cited

Angel, M.V., and T.M. Iliffe

1987. *Spelaeocia bermudensis* New Genus, New Species, a Halocyprid Ostracod from Marine Caves in Bermuda. *Journal of Crustacean Biology,* 7(3):541–553, figures 1–7, tables 1–3.

Baird, W.

1850. *The Natural History of the British Entomostraca.* 364 pages, 36 plates. London. [Printed for the Ray Society.]

Baker, J.H.

1978. Two New Species of *Parasterope* (Myodocopina, Ostracoda) from Southern California. *Crustaceana,* 35(2):139–141, figures 1–4.

Baltanás, A.

1992. *Eusarsiella bedoyai* (Myodocopida, Sarsiellidae), a New Ostracode Species from a Marine Lava Cave in the Canary Islands. *Bijdragen tot de Dierkunde,* 61(4):251–255, figures 1–6.

Barr, T.C., Jr., and J.R. Holsinger

1985. Speciation in Cave Faunas. *Annual Review of Ecology and Systematics,* 16:313–337, figure 1.

Bowman, T.E., and L.S. Kornicker

1967. Two New Crustaceans: The Parasitic Copepod *Sphaeronellopsis monothrix* (Choniostomatidae) and Its Myodocopid Ostracod Host *Parasterope pollex* (Cylindroleberidae) from the Southern New England Coast. *Proceedings of the United States National Museum,* 123(3613): 29 pages, 7 figures, 1 plate.

Bowman, T.E., S.P. Garner, R.R. Hessler, T.M. Iliffe, and H.L. Sanders

1985. Mictacea, a New Order of Crustacea Peracarida. *Journal of Crustacean Biology,* 5:74–78, figure 1.

Brady, G.S.

1869. Entomostracés. *In* A.G.L. de Folin and L. Périer, *Les Fonds de la Mer,* 1(supplement):138–141.

1898. On New or Imperfectly Known Species of Ostracoda, Chiefly from New Zealand. *Transactions of the Zoological Society of London,* 14(part B):429–452, plates 43–47.

Brady, G.S., and A.M. Norman

1896. A Monograph of the Marine and Freshwater Ostracoda of the North Atlantic and of Northwestern Europe. *Scientific Transactions of the Royal Dublin Society,* series 2, 5:621–784.

Camacho, A.I., E. Bello, J.M. Becerra, and N. Vaticon

1992. A Natural History of the Subterranean Environment and Its Associated Fauna. *In* Ana Isabel Camacho, editor, *The Natural History of Biospeleology,* pages 171–197, 7 figures, 4 diagrams. Madrid: Museo Nacional de Ciencias Naturales.

Christiansen, K.

1992. Biological Processes in Space and Time: Cave Life in the Light of Modern Evolutionary Theory. *In* Ana Isabel Camacho, editor, *The Natural History of Biospeleology,* pages 453–478, table 1. Madrid: Museo Nacional de Ciencias Naturales.

Cohen, A.C.

1983. Rearing and Postembryonic Development of the Myodocopid Ostracode *Skogsbergia lerneri* from Coral Reefs of Belize and the Bahamas. *Journal of Crustacean Biology,* 3(2):235–256, figures 1–10, tables 1–5.

1987. Myodocopid Ostracodes on the Coral Barrier Reef at Carrie Bow Cay, Belize: Systematics, Juvenile Stages, Life History, and Distribution 1978–1981. Two volumes, xvi + 655 pages, 128 figures, 26 tables. Doctoral dissertation, George Washington University, Graduate School of Arts and Sciences, Washington, D.C.

1989a. *Eusarsiella donabbotti,* New Ostracode Species (Sarsiellidae) from the Belize Barrier Reef. *Bulletin of Marine Science,* 45(2):304–315.

1989b. Comparison of Myodocopid Ostracodes in Two Zones of the Belize Barrier Reef Near Carrie Bow Cay with Changes in Distribution 1978–1981. *Bulletin of Marine Science,* 45(2):316–337.

Cohen, A.C., and L.S. Kornicker

1975. Taxonomic Indexes to Ostracoda (Suborder Myodocopina) in Skogsberg (1920) and Poulsen (1962, 1965). *Smithsonian Contributions to Zoology,* 204: 29 pages.

1987. Catalog of the Rutidermatidae (Crustacea: Ostracoda). *Smithsonian Contributions to Zoology,* 449: 11 pages.

Cohen, A.C., L.S. Kornicker, and T.M. Iliffe

In press. *Jimmorinia,* a New Genus of Myodocopid Ostracoda (Cypridinidae) with Two New Species from the Bahamas, Jamaica, Honduras, and San Blas Islands, Panama. *Smithsonian Contributions to Zoology,* 605.

Cohen, A.C., and J.G. Morin

1986. Three New Luminescent Ostracodes of the Genus *Vargula* from the San Blas Region of Panama. *Contributions in Science, Natural History Museum of Los Angeles County,* 373: 23 pages, 8 figures.

1989. Six New Luminescent Ostracodes of the Genus *Vargula* (Myodocopida, Cypridinidae) from the San Blas Region of Panama. *Journal of Crustacean Biology,* 9(2):297–340, 14 figures, 1 table.

1990. Morphological Relationships of Bioluminescent Caribbean Species of *Vargula* (Myodocopa). *In* R. Whatley and C. Maybury, editors, *Ostracoda and Global Events,* pages 381–400. New York: Chapman and Hall.

1993. The Cypridinid Copulatory Limb and a New Genus *Kornickeria* (Ostracoda: Myodocopida) with Four New Species of Bioluminescent Ostracods from the Caribbean. *Zoological Journal of the Linnean Society,* 108:23–84, figures 1–24.

Courbon, P., C. Chabert, P. Bosted, and K. Lindsley

1989. *Atlas of the Great Caves of the World.* 369 pages. St. Louis, Missouri: Cave Books.

Dana, J.D.

1853. Tribe III: Cyproidea = Ostracoda. *In* Crustacea. In *United States Exploring Expedition during the Years 1838, 1839, 1840, 1841, 1842, under the Command of Charles Wilkes, U.S.N., with Atlas of 96 plates,* 13(2):1277–1304, plates 90, 91. Philadelphia: C. Sherman.

Danielopol, D.L.

1990. The Origin of the Anchialine Cave Fauna—the "Deep Sea" Versus the "Shallow Water" Hypothesis Tested Against the Empirical Evidence of the Thaumatocyprididae (Ostracoda). *Bijdragen tot de Dierkunde,* 60(3/4):137–143, figure 1.

Darby, D.G.

1965. Ecology and Taxonomy of Ostracoda in the Vicinity of Sapelo Island, Georgia. *In* R.V. Kesling, editor, *Four Reports of Ostracod Investigations,* 2:1–77, 11 figures, 33 plates. Ann Arbor, Michigan: University of Michigan.

Fairbanks, R.G.

1989. A 17,000-Year Glacio-Eustatic Sea Level Record: Influence of Glacial Melting Rates on the Younger Dryas Event and Deep-Ocean Circulation. *Nature,* 342 (7 December 1989):637–642, figures 1–6.

Fosshagen, A., and T.M. Iliffe

1985. Two New Genera of Calanoida and a New Order of Copepoda, Platycopioida, from Marine Caves on Bermuda. *Sarsia,* 70:345–358.

Hart, C.W., Jr., and R.B. Manning

1986. Two New Shrimps (Procarididae and Agostocarididae, New Family) from Marine Caves of the Western North Atlantic. *Journal of Crustacean Biology,* 6(3):408–416, figures 1–47.

Hart, C.W., Jr., R.B. Manning, and T.M. Iliffe
1985. The Fauna of Atlantic Marine Caves: Evidence of Dispersal by Sea Floor Spreading while Maintaining Ties to Deep Waters. *Proceedings of the Biological Society of Washington,* 98:288–292.

Hartmann, G.
1974. Zur Kenntnis des Eulitorals der afrikanischen Westküste zwischen Angola und Kap der Guten Hoffnung und der afrikanischen Ostküste von Südafrika und Moçambique unter besonderer Berücksichtigung der Polychaeten und Ostracoden, 3: Die Ostracoden des Untersuchungsgebiets. *Mitteilungen aus dem Hamburgischen Zoologischen Museum und Institut,* 69:229–520, plates 1–151.

Hiruta, Shinlchi
1977. A New Species of the Genus *Sarsiella* Norman from Hokkaido, with Reference to the Larval Stages (Ostracoda: Myodocopina). *Journal of the Faculty of Science, Hokkaido University,* series 6 (Zoology), 21(1):44–60, figures 1–12, plate 1.
1979. A New Species of *Bathyleberis* Kornicker from Hokkaido, with Reference to the Larval Stages (Ostracoda: Myodocopina). *Journal of the Faculty of Science, Hokkaido University,* 22(1):99–121.
1983. Post-Embryonic Development of Myodocopid Ostracoda. *In* Rosalie F. Maddocks, editor, *Applications of Ostracoda,* pages 667–677. University Park, Houston: Department of Geosciences, University of Houston.

Humphreys, W.F.
1993. Stygofauna in Semi-Arid Tropical Western Australia: A Tethyan Connection? *Mémoires de Biospéologie,* 20:111–116.

Humphreys, W.F., and M. Adams
1991. The Subterranean Aquatic Fauna of the North West Cape Peninsula, Western Australia. *Records of the Western Australia Museum,* 15:383–411.

Huys, R.
1988. Rotundiclipeidae, a New Family (Copepoda: Harpacticoida) from an Anchihaline Cave on Tenerife, Canary Islands. *Stygologia,* 4(1):42–63, figures 1–11, table 1.

Iliffe, T.M.
1986. The Zonation Model for the Evolution of Aquatic Faunas in Anchialine Waters. *Stygologia,* 2:2–9, table 1.
1990. Crevicular Dispersal of Marine Cave Faunas. *Mémoires de Biospéologie,* 17:93–96.
1991. Anchialine Cave Fauna of the Galapagos Islands. *In* Matthew J. James, editor, *Galápagos Marine Invertebrates,* 209–231, table 1, figures 1–8. New York: Plenum Press.
1993. Fauna Troglobia acuática de la península de Yucatán. *In* Sergio I. Salazar-Vallejo and Norma Emilia González, editors, *Biodiversidad marina y costera de México,* 865 pages. Quintana Roo, Mexico: Comisión Nacional para el Conocimiento y Aprovechamiento de la Biodiversidad, Centro de Investigaciones de Quintana Roo.
1994. Bermuda. *In* V. Decu and C. Juberthie, editors, *Encyclopaeida Biospeologica,* 1:417–424, figures 1–4, tables 1–2. Paris: Society of Biospeleology.

Iliffe, T.M., C.W. Hart, Jr., and R.B. Manning
1983. Biogeography and the Caves of Bermuda. *Nature,* 302:141–142, figure 1.

Iliffe, T.M., H. Wilkens, J. Parzefall, and D. Williams
1984. Marine Lava Cave Fauna: Composition, Biogeography, and Origins. *Science,* 255:309–311.

Jaume, D.
1995. Presence of Troglobitized Janiridae (Isopoda: Asellota: Janiroidea) in Anchihaline Caves of the Balearic Islands (Mediterranean); Description of *Trogloianiropsis lloberai* n. gen., n. sp. *Contributions to Zoology,* 65(3):177–187, figures 1–44.

Jaume, D., and G.A. Boxshall
1995. *Stygocyclopia balearica,* a New Genus and Species of Calanoid Copepod (Pseudocylopiidae) from Anchihaline Caves in the Balearic Islands (Mediterranean). *Sarsia,* 80:213–322, figures 1–6.
1996a. A New Genus and Two New Species of Cave-Dwelling Misophrioid Copepods from the Balearic Islands (Mediterranean). *Journal of Natural History,* 30:989–1006, figures 1–7.
1996b. Two New Genera of Cyclopinid Copepods (Crustacea) from Anchihaline Caves on Western Mediterranean and Eastern Atlantic Islands. *Zoological Journal of the Linnean Society,* 117:283–304, figures 1–9.

Juberthie, C., and T.M. Iliffe
1994. Bahama Islands. *In* V. Decu and C. Juberthie, editors, *Encyclopaeida Biospeologica,* 1:447–458, figures 1–8, table 1. Paris: Society of Biospeleology.

Kendall, C.G. St. C., R.F. Dill, and E.A. Shinn, editors
1990. *Guidebook to the Marine Geology and Tropical Environments of Lee Stocking Island, the Southern Exumas, Bahamas.* 74 pages, plates 1–10. San Diego, California: KenDill Publishers.

King, C.E., and L.S. Kornicker
1970. Ostracoda in Texas Bays and Lagoons: An Ecologic Study. *Smithsonian Contributions to Zoology,* 24: 92 pages, 15 figures, 21 plates, 19 tables.

Kornicker, L.S.
1958. Ecology and Taxonomy of Recent Marine Ostracodes in the Bimini Area, Great Bahama Bank. *Publications of the Institute of Marine Science* (The University of Texas), 5:194–300, 89 figures, 1 map, 4 tables.
1969. Morphology, Ontogeny, and Intraspecific Variation of *Spinacopia,* a New Genus of Myodocopid Ostracod (Sarsiellidae). *Smithsonian Contributions to Zoology,* 8: 50 pages, 26 figures, 6 plates, 7 tables.
1974. Revision of the Cypridinacea of the Gulf of Naples (Ostracoda). *Smithsonian Contributions to Zoology,* 178: 64 pages, 26 figures, 2 tables.
1975. Antarctic Ostracoda (Myodocopina), Parts 1 and 2. *Smithsonian Contributions to Zoology,* 163: 720 pages, 432 figures, 9 plates, 21 tables.
1981. Revision, Distribution, Ecology, and Ontogeny of the Ostracode Subfamily Cyclasteropinae (Myodocopina: Cylindroleberididae). *Smithsonian Contributions to Zoology,* 319: 548 pages, 174 figures, 185 plates, 23 tables.
1983. Rutidermatidae of the Continental Shelf of Southeastern North America and the Gulf of Mexico (Ostracoda: Myodocopina). *Smithsonian Contributions to Zoology,* 371: 89 pages, 51 figures, 3 plates, 1 table.
1984. Cypridinidae of the Continental Shelves of Southeastern North America, the Northern Gulf of Mexico, and the West Indies (Ostracoda: Myodocopina). *Smithsonian Contributions to Zoology,* 401: 37 pages, 17 figures, 2 maps, 1 table.
1986a. Sarsiellidae of the Western Atlantic and Northern Gulf of Mexico, and Revision of the Sarsiellinae (Ostracoda: Myodocopina). *Smithsonian Contributions to Zoology,* 415: 217 pages, 113 figures, 34 plates, 7 tables.
1986b. Cylindroleberididae of the Western North Atlantic and the Northern Gulf of Mexico, and Zoogeography of the Myodocopina (Ostracoda). *Smithsonian Contributions to Zoology,* 425: 139 pages, 63 figures, 6 tables.
1989. The Adult Male of the Troglobitic Ostracode *Spelaeocia bermudensis* Angel and Iliffe, 1989, from an Anchialine Cave in Bermuda (Crustacea: Ostracoda: Halocypridoidea). *Proceedings of the Biological Society of Washington,* 102(2):313–323, figures 1–5.
1991. Myodocopid Ostracoda of Enewetak and Bikini Atolls. *Smithsonian Contributions to Zoology,* 505: 140 pages, 71 figures.
1992. Myodocopid Ostracoda of the Benthédi Expedition, 1977, to the NE Mozambique Channel, Indian Ocean. *Smithsonian Contributions to Zoology,* 531: 243 pages, 109 figures, 4 tables.
1994. Ostracoda (Myodocopina) of the SE Australian Continental Slope, Part 1. *Smithsonian Contributions to Zoology,* 553: 200 pages, 111 figures, 4 tables.

1996. Ostracoda (Myodocopina) from Shallow Waters of the Northern Territories and Queensland, Australia. *Smithsonian Contributions to Zoology,* 578: 97 pages, 64 figures, 4 tables.

Kornicker, L.S., and J.H. Baker

1977. *Vargula tsujii,* a New Species of Luminescent Ostracoda from Lower and Southern California (Myodocopa: Cypridininae). *Proceedings of the Biological Society of Washington,* 90(2):218–231, figures 1–6.

Kornicker, L.S., and D.J. Barr

1997. Anchialine Ostracoda (Halocyprididae) from San Salvador, Bahamas. *Smithsonian Contributions to Zoology,* 588: 20 pages, 11 figures, 3 tables.

Kornicker, L.S., and F.E. Caraion

1974. West African Myodocopid Ostracoda (Cylindroleberididae). *Smithsonian Contributions to Zoology,* 179: 78 pages, 43 figures, 1 table.

Kornicker, L.S., and A.C. Cohen

1978. Dantyinae, a New Subfamily of Ostracoda (Myodocopina: Sarsiellidae). *Proceedings of the Biological Society of Washington,* 91(2):490–508, figures 1–5, plates 1–7.

Kornicker, L.S., and T.M. Iliffe

1985. Deeveyinae, a New Subfamily of Ostracoda (Halocyprididae) from a Marine Cave on the Turks and Caicos Islands. *Proceedings of the Biological Society of Washington,* 98(2):476–493, figures 1–13.

1989a. New Ostracoda (Halocyprida: Thaumatocyprididae and Halocyprididae) from Anchialine Caves in the Bahamas, Palau, and Mexico. *Smithsonian Contributions to Zoology,* 470: 47 pages, 22 figures, 8 tables.

1989b. Ostracoda (Myodocopina, Cladocopina, Halocypridina) Mainly from Anchialine Caves in Bermuda. *Smithsonian Contributions to Zoology,* 475: 88 pages, 49 figures, 22 tables.

1989c. Troglobitic Ostracoda (Myodocopa: Cypridinidae, Thaumatocyprididae) from Anchialine Pools on Santa Cruz Island, Galapagos Islands. *Smithsonian Contributions to Zoology,* 483: 38 pages, 17 figures, 15 tables.

1995. Ostracoda (Halocypridina, Cladocopina) from an Anchialine Lava Tube in Lanzarote, Canary Islands. *Smithsonian Contributions to Zoology,* 568: 32 pages, 16 figures, 1 table.

1998. Myodocopid Ostracoda (Halocypridina, Cladocopina) from Anchialine Caves in the Bahamas, Canary Islands, and Mexico. *Smithsonian Contributions to Zoology,* 599: 93 pages, 64 figures, 2 maps, 9 tables.

Kornicker, L.S., and K.G. McKenzie

1976. Redescription of *Eurypylus petrosus* Brady, 1869, and a Key to the Genera of Sarsiellidae (Myodocopina: Ostracoda). *Proceedings of the Biological Society of Washington,* 89(27):347–352, 1 figure.

1996. The Adult Male of the Myodocopid Ostracode *Philomedes cubitum* Kornicker, 1975, from the Strait of Magellan (Crustacea: Ostracoda: Myodocopina). *Proceedings of the Biological Society of Washington,* 109(3):517–525, figures 1–7.

Kornicker, L.S., and R.J. Palmer

1987. *Deeveya bransoni,* a New Species of Troglobitic Halocyprid Ostracode from Anchialine Caves on South Andros Island, Bahamas (Crustacea: Ostracoda). *Proceedings of the Biological Society of Washington,* 100(3):610–623.

Kornicker, L.S., and G.C.B. Poore

1996. Ostracoda (Myodocopina) of the SE Australian Continental Slope, Part 3. *Smithsonian Contributions to Zoology,* 573: 186 pages, 102 figures, 17 tables.

Kornicker, L.S., and I.G. Sohn

1976. Phylogeny, Ontogeny, and Morphology of Living and Fossil Thaumatocypridacea (Myodocopa: Ostracoda). *Smithsonian Contributions to Zoology,* 219: 124 pages, 93 figures.

Kornicker, L.S., and J. Yager

1996. The Troglobitic Halocyprid Ostracoda of Anchialine Caves in Cuba. *Smithsonian Contributions to Zoology,* 580: 16 pages, 9 figures.

Kornicker, L.S., J. Yager, and D. Williams

1990. Ostracoda (Halocyprididae) from Anchialine Caves in the Bahamas. *Smithsonian Contributions to Zoology,* 495: 51 pages, 30 figures, 4 tables.

Maddocks, R.F., and L.S. Kornicker

1986. Class Ostracoda (Mussel Shrimps). *In* W. Sterrer, editor, *Marine Fauna and Flora of Bermuda,* pages 280–288. New York: John Wiley and Sons.

Morin, J.G., and A.C. Cohen

1988. Two New Luminescent Ostracodes of the Genus *Vargula* (Myodocopida: Cypridinidae) from the San Blas Region of Panama. *Journal of Crustacean Biology,* 8(4):620–638, figures 1–7, table 1.

Müller, G.W.

1906. Ostracoda. In *Wissenschaftliche Ergnebnisse der Deutsche Tiefsee-Expedition...1898–1899,* 8(2): 154 pages, 31 plates.

Mylroie, J.E., J.L. Carew, and H.L. Vacher

1995. Karst Development in the Bahamas and Bermuda. *In* H.A. Curran and B. White, editors, Terrestrial and Shallow Marine Geology of the Bahamas and Bermuda. *Geological Society of America, Special Paper,* 300:251–167, figures 1–9.

Palmer, R.

1986. Life in a Sunless Sea. *Sea Frontiers,* 32(4):269–277, photographs 2–9, map 1.

Poulsen, E.M.

1962. Ostracoda—Myodocopa, 1: Cypridiniformes—Cypridinidae. *Dana Report,* 57:1–414, 181 figures. Copenhagen: Carlsberg Foundation.

1965. Ostracoda—Myodocopa, 2: Cypridiniformes—Rutidermatidae, Sarsiellidae and Asteropidae. *Dana Report,* 65:1–484, 156 figures. Copenhagen: Carlsberg Foundation.

Reddell, J.R.

1977. A Preliminary Survey of the Caves of the Yucatan Peninsula. *In* J.R. Reddell, editor, *Studies of the Caves and Cave Fauna of the Yucatan Peninsula,* pages 215–296. Association for Mexican Cave Studies, bulletin 6. Austin, Texas: Speleo Press.

Rocha, C.E.F. da, and T.M. Iliffe

1991. Speleoithonidae, a New Family of Copepoda Cyclopoida, from Anchialine Caves on the Bahama Islands. *Sarsia,* 76:167–176, figures 1–28.

Sars, G.O.

1866 ("1865"). Oversigt af Norges marine Ostracoder. *Forhandlinger i Videnskabs-Selskabet I Christiania,* 8:1–130. [Preprint, 1865.]

Scott, A.

1905. Report on the Ostracoda Collected by Professor Herdmann at Ceylon in 1902. *Supplementary Reports, Ceylon Pearl Fisheries,* 22:365–384, figures 1, 2. London.

Sealey, N.E.

1994. *Bahamian Landscapes: An Introduction to the Geography of the Bahamas.* Second edition, 128 pages, 142 figures. Nassau, Bahamas: Media Publishing.

Sket, B.

1979. *Atlantasellus cavernicolus,* n. gen. n. sp. (Isopoda Asellota, Atlantasellidae n. fam.) from Bermuda. *Biološki Vĕstnik* (Ljubljana), 27(2):175–183.

1986. Ecology of the Mixohaline Hypogean Fauna along the Yugoslav Coasts. *Stygologia,* 2(4):317–338.

1997. The Anchihaline Habitats, a Dispersed "Center" of Biotic Diversity. *In* Ira D. Sasowsky, Daniel W. Fong, and Elizabeth L. White, editors, *Conservation and Protection of the Biota of Karst,* 125 pages. Charles Town, West Virginia: Karst Waters Institute, Special Publication 3.

Sket, B., and T.M. Iliffe
1980. Cave Fauna of Bermuda. *Internationale Revue der Gesamten Hydrobiologie,* 65:871–882, figure 1, tables 1–3.

Skogsberg, T.
1920. Studies on Marine Ostracods, I: Cypridinids, Halocyprids, and Polycopids. *Zoologiska Bidrag från Uppsala,* supplement 1:1–784.

Stock, J.H.
1986. Deep Sea Origin of Cave Faunas, an Unlikely Supposition. *Stygologia,* 2:105–111.

Suárez-Morales, E., and T.M. Iliffe
1996. New Superfamily of Calanoida (Copepoda) from an Anchialine Cave in the Bahamas. *Journal of Crustacean Biology,* 16(4): 754–762, figures 1–4, table 1.

Tressler, W.L.
1949. Marine Ostracoda from Tortugas, Florida. *Journal of the Washington Academy of Sciences,* 39(10):335–343, 25 figures.

Warner, G.F., and C.A.M. Moore
1984. Ecological Studies in the Marine Blue Holes of Andros Island, Bahamas. *Cave Science,* 11(1):30–44, figures 1, 2, plates 1–9, tables 1–8.

Wilkens, H., J. Parzefall, and T.M. Iliffe
1986. Origin and Age of the Marine Stygofauna of Lanzarote, Canary Islands. *Mitteilungen aus dem Hamburgischen Zoologischen Museum und Institut,* 83:223–230, figures 1–3.

Wilson, C.W., Jr.
1913. Crustacean Parasites of West Indian Fishes and Land Crabs, with Descriptions of New Genera and Species. *Proceedings of the United States National Museum,* 44(1950):189–277, plates 18–53.

Yager, J.
1981. Remipedia, a New Class of Crustacea from a Marine Cave in the Bahamas. *Journal of Crustacean Biology,* 1(3):328–333.

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