

Ostracoda (Halocypridina,  
Cladocopina) from an Anchialine  
Lava Tube in Lanzarote,  
Canary Islands

LOUIS S. KORNICKER  
and  
THOMAS M. ILIFFE

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## ABSTRACT

Kornicker, Louis S., and Thomas M. Iliffe. Ostracoda (Halocypridina, Cladocopina) from an Anchialine Lava Tube on Lanzarote, Canary Islands. *Smithsonian Contributions to Zoology*, number 568, 32 pages, 16 figures, 1 table, 1995.—Two new species, *Danielopolina phalanx* (Halocypridina) and *Eupolycope pnyx* (Cladocopina) are described from a lava tube on Lanzarote, Canary Islands, and one specimen of Cladocopina is left in open nomenclature. A supplementary description is given of *Danielopolina wilkensi* (Hartmann, 1985) based on new material from the type locality (Lanzarote lava tube), including the first description of the adult male and juveniles. This is the first report of two different species of *Danielopolina* living in the same anchialine habitat. An emended description is given for the family Thaumatoocyprididae, and an emended diagnosis is given for the genus *Danielopolina*. Taxonomic keys are presented for living genera of Thaumatoocyprididae and for species of *Danielopolina*. The origin of anchialine populations, shell ornamentation of fossil and living Thaumatoocyprididae, and sexual dimorphism and ontogeny in species of *Danielopolina* are discussed.

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# Contents

	<i>Page</i>
Introduction . . . . .	1
Sampling . . . . .	1
Disposition of Specimens . . . . .	1
Abbreviations . . . . .	1
Acknowledgments . . . . .	2
World-wide Distribution of Cave Ostracoda . . . . .	2
Distribution of Ostracoda within the Atlantida Tunnel . . . . .	2
Origin of Stygofauna . . . . .	2
Fauna of the Atlantida Tunnel . . . . .	3
Description of the Atlantida Tunnel . . . . .	3
Order HALOCYPRIDA Dana, 1853 . . . . .	5
Suborder HALOCYPRIDINA Dana, 1853 . . . . .	5
Superfamily THAUMATOCYPRIDOIDEA Müller, 1906 . . . . .	5
Family THAUMATOCYPRIDIDAE Müller, 1906 . . . . .	5
Key to the Living Genera of Thaumatocyprididae . . . . .	6
<i>Danielopolina</i> Kornicker and Sohn, 1976 . . . . .	7
Key to the Species of <i>Danielopolina</i> . . . . .	7
<i>Danielopolina phalanx</i> , new species . . . . .	8
<i>Danielopolina wilkensi</i> Hartmann, 1985 . . . . .	16
Sexual Dimorphism . . . . .	24
Ontogeny . . . . .	24
Suborder CLADOCOPINA Sars, 1866 . . . . .	25
Superfamily POLYCOPOIDEA Sars, 1866 . . . . .	25
Family POLYCOPIDAE Sars, 1866 . . . . .	25
Subfamily POLYCOPINAE Sars, 1866 . . . . .	25
<i>Eupolycope</i> Chavtur, 1981 . . . . .	25
<i>Eupolycope pnyx</i> , new species . . . . .	25
Genus and Species Indeterminate . . . . .	28
Appendix: Station Data with Specimens Examined . . . . .	30
Literature Cited . . . . .	31



# Ostracoda (Halocypridina, Cladocopina) from an Anchialine Lava Tube on Lanzarote, Canary Islands

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## Introduction

The Atlantida Tunnel on Lanzarote in the Canary Islands is the world's largest known submarine lava tube (Figure 1). The tube was formed by an eruption of the volcano, Volcan la Carona approximately 3000–5000 years ago (Wilkens and Parzefall, 1974).

Two Myodocopa have been reported previously from the Atlantida Tunnel. The troglobitic thaumatocyprid (Halocyprida: Halocypridina: Thaumatoocypridoidea: Thaumatoocyprididae) *Danielopolina wilkensi* was described by Hartmann (1985:255), and the sarsiellid (Myodocopida: Myodocopina: Sarsiellidae) *Eusarsiella bedoyai* was described by Baltanás (1992:251). The latter species was collected only in sediment at a site where sea water directly enters, and is probably either troglophilic (living both inside and outside the cave) or an accidental inhabitant of the cave. Four species from the Atlantida Tunnel are identified herein: *Danielopolina wilkensi* Hartmann, 1985, *Danielopolina phalanx*, new species; *Eupolycope pnyx*, new species; and a Polycopinae left in open nomenclature.

**SAMPLING.**—Biological collections were primarily carried out with diver-towed plankton nets. The 30 cm diameter, 94  $\mu$ m mesh nets were typically pulled by a diver beginning at the base of the entrance pool in 9 m water depth to the point of farthest penetration into the cave and back. Thus, a dive of 300 m horizontal penetration into the cave would sample approxi-

mately 42 cubic meters of water ( $\pi \times (0.15)^2 \times 300 \times 2$ ). Most samples came from the proximal half of the cave. Quoted sampling depths relate to depths through which the nets were towed. Most dives were carried out at slack tide.

**DISPOSITION OF SPECIMENS.**—All specimens have been deposited in the National Museum of Natural History, Smithsonian Institution, and have been assigned USNM numbers.

**ABBREVIATIONS.**—In the figures, Arabic numerals indicate limbs 1–7, as well as individual joints of each limb (the location of the numeral indicating whether a limb or joint is indicated). Roman numerals I–III indicate the endites.

The following abbreviations are used in illustrations and legends.

am	central adductor muscle attachments
ant	antenna
Bo	Bellonci organ
bas	basale
cx	coxale
end	endopodite
esop	esophagous
ex	exopodite
fu	furca
im	inner margin of infold
lft	left
ll	lower lip
lv	lateral view
md	mandible
mv	medial view
mx	maxilla
precx	precoxale

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*Louis S. Kornicker, Department of Invertebrate Zoology, National Museum of Natural History, Smithsonian Institution, Washington, D.C. 20560. Thomas M. Iliffe, Department of Marine Biology, Texas A&M University at Galveston, P.O. Box 1675, Galveston, Texas 77553.*

prot      protopodite  
 rt        right  
 ul        upper lip

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#### World-wide Distribution of Cave Ostracoda

A new species of *Danielopolina* described herein brings to eight the known species of the genus: *D. carolynae* from 3459 m depth in the South Atlantic (Kornicker and Sohn (1976:97)) and seven troglobitic species from many anchialine habitats in the North Atlantic and eastern Pacific:

- Bahamas: *D. bahamensis* (Kornicker and Iliffe, 1989a:4).  
 Canary Islands: *D. wilkensi* (Hartmann, 1985:255); *D. phalanx*, new species.  
 Cuba: *D. orchidani* (Danielopol, 1972:1390, 1976:9; Kornicker and Sohn, 1976:94; Kornicker and Iliffe, 1989a:14).  
 Galapagos Islands: *D. styx* (Kornicker and Iliffe, 1989b:25).  
 Jamaica: *D. elizabethae* (Kornicker and Iliffe, 1992:12).  
 Yucatan, Mexico: *D. mexicana* (Kornicker and Iliffe, 1989a:15).

The Lanzarote lava tube is the only habitat having two species of *Danielopolina*, other habitats have only one. This suggests that at least one of the Lanzarote species evolved in a different locality.

The genus *Danielopolina* is more widely distributed than are the two known genera of troglobitic Halocyprididae in the subfamily Deeveyinae Kornicker and Iliffe, 1985:476:

*Spelaeoecia* Angel and Iliffe, 1987

- Bahamas: *S. sagax*, *S. capax*, *S. styx* (Kornicker et al., 1990).  
 Bermuda: *S. bermudensis* (Angel and Iliffe, 1987; Kornicker, 1989).

*Deeveya* Kornicker and Iliffe, 1985

- Bahamas: *D. styrax*, *D. hirpex*, *D. medix*, *D. jillae*, *D.*

*bransonii* (Kornicker and Palmer, 1987:610; Kornicker and Iliffe, 1989a:19; Kornicker et al., 1990:2).

Turks and Caicos Islands: *D. spiralis* (Kornicker and Iliffe, 1985:477).

A halocyprid in the subfamily Euconchoecinae, *Euconchoecia bifurcata pax*, has been described from Lake 2a Cave, Koror (Oreor) Island, Palau (Kornicker and Iliffe, 1989a:29). It is probably troglophilic.

The new species of *Eupolycope* Chavtur, 1981, brings to eight the known species of the genus; all previously known species were collected in the open sea of the northern hemisphere. Five species of four other genera of Cladocopa have been reported from anchialine caves in the North Atlantic:

- Bermuda: *Metapolycope duplex*, *Micropolycope eurax*, *Micropolycope styx*, *Polycopissa anax* (Kornicker and Iliffe, 1989c:6).  
 Canary Islands: *Eurypolycope pnyx*, new species, genus and species indeterminate (herein).  
 Jamaica: *Pontopolycope mylax* (Kornicker and Iliffe, 1992:17).

Six species of Myodocopina have been reported from caves, but probably only *Skogsbergia galapagensis* is troglobitic:

- Bermuda: *Eusarsiella styx*, *Pseudophilomedes kylix*, *Rutid-erma sterreri* (Kornicker and Iliffe, 1989c).  
 Canary Islands: *Eusarsiella bedoyai* (Baltanás, 1992:251).  
 Galapagos Islands: *Skogsbergia galapagensis* (Kornicker and Iliffe, 1989b).  
 Niue, central South Pacific: *Dantya ferox* (Kornicker and Iliffe, 1989d:901).

#### Distribution of Ostracoda within the Atlantida Tunnel

Because of the broad horizontal extent of the sampling in the Atlantida Tunnel, and to the strong tidal currents dispersing planktonic fauna, the precise distribution of ostracodes in the tunnel is difficult to determine. However, halocyprids and cladocopids were generally absent from the illuminated sections of the cave, although present in the dark upper levels near the Lago Escondido. Visual observations and limited collections from sections of the cave past the Montana de Arana at 700 m penetration suggest that faunal abundance varies inversely with distance from the island.

#### Origin of Stygofauna

The origin and age of stygofauna of Lanzarote were discussed by Wilkens, Parzefall, and Iliffe (1986:223–230), who concluded that the species that have both a deep sea origin and ampho-Atlantic distribution [the Thaumatoocyprididae has such a distribution] probably evolved independently from a widely dispersed ancestor, and that cave and deep-sea forms are



now apparently restricted to their respective biotopes (p. 229). Iliffe (1990:94) proposed that the Lanzarote lava tube may have been colonized through submarine crevices. The many competing hypotheses concerning origin of the fauna inhabiting anchialine habitats were recently summarized by Iliffe (1992:627). The distribution of Thaumatoctyprididae was used by Danielopol (1990:137) to test the "deep sea" versus "shallow water" hypothesis of the origin of the anchialine cave fauna, and he concluded that the data suggest the latter hypothesis prevails (Danielopol, 1990:141). The senior author favors the possibility that the Thaumatoctyprididae, which have fossil representatives in the Permian and Upper and Lower Jurassic of Europe, were initially widespread at shallow depths in the open sea, but at some later time were unable to compete successfully with other fauna living on the shelf, and thus were relegated to anchialine caves and crevices contiguous with those in which they are now found. Cladocopina are widely dispersed on the continental shelf, and those in anchialine habitats may have been recruited locally, but known species living in anchialine habitats have yet to be recorded living in the open sea. Anchialine habitats in fairly close geographical areas such as Cuba, Jamaica, the Bahamas, and the Yucatan Peninsula, have a different thaumatoctyprid species in each locality suggesting that the present distribution is not the result of current transport from one island to another.

#### *Fauna of the Atlantida Tunnel*

The troglotic fauna of the Atlantida Tunnel includes several primitive taxa with highly anomalous distribution. The most common biogeographic pattern for these species is an amphi-Atlantic distribution with congeners inhabiting caves or similar stygian habitats primarily on oceanic islands on opposite sides of the Atlantic (Iliffe et al., 1984; Wilkens et al., 1986). The remiped genus *Speleonectes* includes species in anchialine caves in the Bahamas and Yucatan Peninsula of Mexico as well as Lanzarote. In addition to the Atlantida Tunnel, the anthurid isopod *Curassanthura* inhabits anchialine caves in Bermuda and brackish groundwater in Curacao, whereas the mysid *Heteromysoides* also is found inside sponges in Cuban waters.

In addition, several species belong to groups primarily known from the deep sea. These include the galatheid crab *Munidopsis polymorpha*, the polynoid polychaete *Gesiella jameensis*, the pardaliscid amphipod *Spelaeonicippe buchi*, and three genera of misophroid copepods represented by *Expansophria dimorpha*, *Palpophria aestheta*, and *Dimisophria cavernicola* (Wilkens et al., 1986; Boxshall and Iliffe, 1987).

#### *Description of the Atlantida Tunnel*

The tunnel begins at the base of the volcano, Volcan la Carona, and extends 6 km down the mountain slope to the

coastline. In several places, the ceiling of the cave has collapsed. These openings, locally referred to as "Jameos," permit access to intact sections of the tube. About 1 km inland from the coast at Jameos de los Lagos, the cave reaches sea level and contains a series of tidal, salt water pools. A section of the cave near the coast, accessed through three collapse entrances, has been developed into a commercial tourist attraction, the Jameos del Agua. Here, a 50 m long by 10 m wide and 8 m deep lake is bounded by two breakdown mounds that form the Jameo Chico and Jameo Grande entrances to the cave.

A second, but smaller, lake lies on the seaward side of the last breakdown pile below the Jameo Chico. From this point, the Atlantida Tunnel, a submerged extension of the tube, continues seaward for 1415 m (Figure 1). The first 150 m of underwater passage averages about 5–8 m high and 6–10 m wide at water depths to 12 m. The "Sima" or pit at 150 m horizontal penetration connects the initial, shallower section of the tube with the gradually descending main level. Directly above the Sima is one of three connections to an upper level lying directly above the main lower level. Heading inland, the upper level emerges above sea level at the Lago Escondido or Hidden Lake that can only be reached by diving. This lake room extends inland as a dry passage terminating near a collapse sinkhole on the surface. In the opposite direction, the upper level bisects a major collapse chamber that connects the two levels and reaches just above sea level at the ceiling. Beyond this chamber, the upper level becomes lower and eventually pinches out. In the lower level, breakdown from the collapse chamber has created a narrow restriction that must be negotiated. At a point below the present coastline, both upper and lower levels take a sharp dogleg turn to the right. This may indicate that the lava flow forming the cave occurred at a time when the sea level was similar to present elevations causing the tube to be deflected upon reaching the sea.

Another upper level of the tube at 550 m horizontal penetration contains a partially lithified sand mound, the Montana Fossil. At one time, sand must have entered the cave from a hole in the ceiling that later became plugged. A lower tunnel at 700 m penetration ends in a sand plug. This sand originates from a still hydrologically active 20 cm diameter hole in the ceiling above a 10 m high mound of loose sand, the Montana de Arana. This is the only site in the cave where sea water directly enters. Sponges, hydroids, and other encrusting invertebrates are present around the hole, although absent in all other parts of the cave.

Beyond the Montana de Arana, the cave continues for another 700 m before ending. At its termination, the ceiling turns down to meet the floor and the tunnel pinches out in 57 m water depths. A second fossil sand mound is present at that point.

Tides in the entrance pool have a range of 1.5 m and occur about 1.5 hours after the corresponding tides in the open ocean.



FIGURE 1.—Map of Atlantida Tunnel, Lanzarote, Canary Islands, Spain.

Strong tidal currents are evident in the cave particularly at the base of the Sima and at the restriction. Salinity is nearly that of the open sea (37 ppt), whereas cave water temperatures remain nearly constant year round at 18°C. The water is exceptionally clean with nearly unlimited underwater visibility. Only artificial light is present at the entrance pool, but this is

extinguished within the first few tens of meters. The floor, walls, and ceiling of the cave consist primarily of bare rock, breakdown, or solidified lava flow. A white, carbonate submarine cement covers the upper surface of many of the exposed rocks in the cave. Other than at the sand mounds, little loose sediment is present.

## Order HALOCYPRIDA Dana, 1853

## Suborder HALOCYPRIDINA Dana, 1853

## Superfamily THAUMATOCYPRIDOIDEA Müller, 1906

## Family THAUMATOCYPRIDIDAE Müller, 1906

COMPOSITION.—This family includes two genera known only as Permian and Jurassic fossils, and three known from the Holocene (*Thaumatocypris* Müller, 1906, *Thaumatococoncha* Kornicker and Sohn, 1976, and *Danielopolina* Kornicker and Sohn, 1976).

DESCRIPTION (emended).—Since the description of the family by Kornicker and Sohn (1976:24) two additional species of *Thaumatococoncha* (Kornicker, 1985:1012; 1992:233) and six (including one herein) additional species of *Danielopolina* have been described (Hartmann, 1985:256; Kornicker and Iliffe, 1989a:4, 15; 1989b:25; 1992:12); also, the previously unknown adult male of *Thaumatocypris echinata* has been described by Rudjakov (1993:305).

*Carapace*: Length less than 2.5 mm, with straight or slightly concave anteroventral margin delimited by anterior and anteroventral processes, and with or without posterodorsal process on one or both valves. Shell surface: Ornamentation on the outer surface of valves of known Thaumatoocyprididae may be divided into 6 types (Table 1). Because shells of known thaumatocyprid fossils have reticulations formed by intersecting continuous ridges, it is possible to hypothesize the following "evolutionary" sequence based on ornamentation: (1) reticulate with walls of continuous ridges; (2) reticulate with walls of discontinuous ridges; (3) reticulate with papillate walls; (4) nonreticulate spinous; (5) nonreticulate smooth (some with reticulations along anteroventral margin); and (6) nonreticulate punctate. *Thaumatomma* and *Pokornyopsis* have Type 1; *Thaumatococoncha* has Types 5 and 6; *Thaumatocypris* has Type 4; and *Danielopolina* has Types 2–5.

*First Antenna*: Elongate with 8 joints; 1st and 2nd joints forming right-angle bend. 1st joint with 2 bristles (1 dorsal, 1 lateral), except lateral bristle lacking in female *Thaumatocypris echinata* [the presence of bristles on the 1st joint in species of Thaumatoocyprididae is unique among the Myodocopa]. 2nd joint with either no bristles, 1 dorsal bristle, or 2 bristles (1 ventral, 1 dorsal) in species of *Danielopolina*, and 2 bristles (1 ventral, 1 dorsal) in species of *Thaumatococoncha* and *Thaumatocypris*. 3rd joint without bristles and fused to 4th joint in females, and in some male *Danielopolina*, but separated from 4th joint in males (except for some *Danielopolina*). 4th joint: ventral margin of females without bristles, except for *Thaumatocypris echinata* which has 1; ventral margin of males with 2 bristles. 5th joint: *Thaumatococoncha* with 2 or 3 ventral bristles in female and 3 in male; *Thaumatocypris* with 3 ventral bristles in both male and female; *Danielopolina* with 1 or 2 ventral bristles in female and 3 in male. 6th joint without bristles

TABLE 1.—World distribution of fossil and living Thaumatoocyprididae arranged according to surface ornamentation.

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Type 1. Reticulate with walls of reticulations continuous.
<i>Pokornyopsis bettenstaedti</i> (Bartenstein, 1949), Lower Jurassic, Germany.
<i>Pokornyopsis feifeli</i> (Triebel, 1941), Upper Jurassic, Germany.
<i>Thaumatomma piscifrons</i> Kornicker and Sohn, 1976, Permian, Greece.
Type 2. Reticulate with walls of reticulations discontinuous.
<i>Danielopolina bahamensis</i> Kornicker and Iliffe, 1989a, cave, Bahama Islands.
<i>Danielopolina elizabethae</i> Kornicker and Iliffe, 1992, cave, Jamaica.
<i>Danielopolina wilkensi</i> Hartmann, 1985, lava tube, Canary Islands.
Type 3. Reticulate with walls of reticulations formed by papillae.
<i>Danielopolina carolynae</i> Kornicker and Sohn, 1976, 3459 m, South Atlantic.
<i>Danielopolina orghidani</i> (Danielopol, 1972), grotto, Cuba.
<i>Danielopolina styx</i> Kornicker and Iliffe, 1989b, cave, Galapagos Islands.
Type 4. Nonreticulate, spinous.
<i>Danielopolina mexicana</i> Kornicker and Iliffe, 1989a, cave, Yucatan Peninsula, Mexico.
<i>Thaumatocypris echinata</i> Müller, 1906, 1100–2000 m, pelagic, Indian Ocean.
Type 5. Nonreticulate, smooth.
<i>Danielopolina phalanx</i> , new species, lava tube, Canary Islands.
<i>Thaumatococoncha caraionae</i> Kornicker and Sohn, 1976, 2707 m, South Atlantic.
<i>Thaumatococoncha elongata</i> Kornicker and Sohn, 1976, 4124–4449 m, South Pacific.
<i>Thaumatococoncha hessleri</i> Kornicker and Sohn, 1976, 619–717 m, South Atlantic.
<i>Thaumatococoncha pix</i> Kornicker, 1992, 770–2900 m, off SE Australia and NE Tasmania.
<i>Thaumatococoncha polythrix</i> Kornicker and Sohn, 1976, 2095–2223 m, North Atlantic.
<i>Thaumatococoncha radiata</i> Kornicker and Sohn, 1976, 2440–4758 m, Antarctic, South Atlantic.
<i>Thaumatococoncha sandersi</i> Kornicker and Sohn, 1976, 3658–3752 m, Antarctic.
<i>Thaumatococoncha tuberculata</i> Kornicker and Sohn, 1976, 587–1493 m, South Atlantic.
<i>Thaumatococoncha</i> species A, Kornicker and Sohn, 1976, 3035 m, Weddell Sea.
<i>Thaumatococoncha</i> species, Kornicker, 1985, 4560 m, Cape Basin.
<i>Thaumatococoncha</i> species, Hartmann, 1986, 150 m, Antarctic.
Type 6. Nonreticulate, punctate.
<i>Thaumatococoncha punctata</i> Kornicker and Sohn, 1976, 3694 m, South Pacific.
<i>Thaumatococoncha porosa</i> Kornicker, 1985, 3716 m, Indian Ocean.

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except for filament-like ventral bristle on female *Thaumatocypris echinata* (Poulsen, 1969, fig. 1b). 7th joint: *Thaumatococoncha* with 1 dorsal and 2 ventral bristles; *Thaumatocypris* with 1 dorsal and 1 ventral bristle in female, and 1 dorsal and 2 ventral bristles in male; *Danielopolina* with none or 1 dorsal bristle and 2 ventral bristles. 8th joint: *Thaumatococoncha* and *Danielopolina* with 3 terminal bristles, *Thaumatocypris* with only 2.

*Second Antenna*: Protopodite with or without small areas of medial spines; three species of *Danielopolina* with bristle on

posteroventral corner [unique among the Myodocopa]. Endopodite: *Thaumatoconcha*: 1st joint with 3 bristles (1 ventral, 2 dorsal); 2nd joint with 5 bristles (1 lateral, 4 terminal); 3rd joint of female with 2 or 3 bristles, of male with sclerotized clasper. *Danielopolina*: 1st joint with no ventral and 2 dorsal bristles; 2nd joint of female with none or 1 lateral bristle and 3 terminal bristles, except for 4 terminal bristles on *D. carolynae*; 2nd joint of male with none or 1 lateral bristle and 4 terminal bristles; 3rd joint of female with 1 bristle, of male with sclerotized clasper (clasper with spines and 2 minute terminal bristles on some species). *Thaumatocypris*: 1st joint with 1 ventral and 2 dorsal bristles; 2nd joint with 1 short dorsal bristle and 4 long terminal filament-like bristles (unlike *Thaumatoconcha* and *Danielopolina*, the male *Thaumatocypris* is without a clasper). Exopodite with 8 or 9 joints with 1st joint divided into long proximal and short distal parts; 1st joint bare, except for *Danielopolina carolynae* which bears a long bristle; 9th joint with 2 bristles, except for *Thaumatoconcha radiata* which has 2 or 3.

**Mandible (endopodite):** 1st joint with 1 dorsal bristle, except for *Thaumatoconcha polythrix* which has 4–6, and *Danielopolina orghidani* which has none; 2nd joint with 3 or 4 ventral and 2 or 3 dorsal bristles. 3rd joint with 6 or 7 bristles including very long claw-like bristle.

**Maxilla (endopodite):** 1st joint: *Thaumatoconcha* with 5–7 anterior bristles and 2 or 3 posterior bristles; *Thaumatocypris* with 4 or 5 anterior bristles and 2 or 3 posterior bristles; *Danielopolina* with 3 or 4 anterior bristles and 2–4 posterior bristles. 2nd joint: *Thaumatoconcha* with 8 or 9 bristles; *Thaumatocypris* with 6 bristles; *Danielopolina* with 5–8 bristles.

**Fifth Limb (exopodite):** 1st joint with 1 dorsal bristle and 5–11 ventral bristles. 2nd joint: *Thaumatoconcha* with 2 or 3 midventral bristles and no ventral terminal bristle; *Thaumatocypris* with 2 midventral bristles and no ventral terminal bristle; *Danielopolina* with 2 midventral and none or 1 ventral terminal bristle. 3rd joint: *Thaumatoconcha* with 2 bristles; *Thaumatocypris* with 3 bristles; *Danielopolina* with 2 or 3 bristles.

**Sixth Limb:** Exopodite: 1st and 2nd joints fused: *Thaumatoconcha* with 3 or 4 bristles (2 or 3 midventral, 1 dorsal); *Thaumatocypris* with 3 bristles (2 midventral, 1 dorsal); *Danielopolina* with 2 or 3 midventral bristles (*Danielopolina carolynae* also with 1 terminal ventral bristle), and none or 1 dorsal bristle. 3rd joint: *Thaumatoconcha* with 2 bristles; *Thaumatocypris* with 3 bristles; *Danielopolina* with 2 bristles, except for of *D. bahamensis* which has only 1. Endopodite:

*Thaumatoconcha* with 3 plumose bristles; *Thaumatocypris* with 1 long bare bristle and 1 minute spine; *Danielopolina* with 2 bristles.

**Seventh Limb:** Elongate with 2 terminal bristles.

**Furca:** With anterior and ventral edges forming right-angle; claws on anterior margin articulated, those on ventral margin nonarticulated. *Thaumatoconcha* with 2 articulated anterior claws and 6 nonarticulated ventral claws; *Thaumatocypris* with 2 articulated anterior claws and 6 or 7 nonarticulated ventral claws; *Danielopolina* with 1–4 articulated anterior claws and 3–6 nonarticulated ventral claws (total number of claws 4–8).

**Bellonci Organ:** *Thaumatoconcha*: elongate with rounded tip. *Thaumatocypris*: *T. echinata* with short cone-like organ in female (Poulsen, 1969:12), but not discernible in male (Rudjakov, 1993:307). *Danielopolina*: elongate with rounded tip in some species (generally diaphanous), absent in others.

**Lips:** Distal edge of upper lip with 4 spine-like processes oriented posteriorly. Lower lip with lateral sclerotized triangular process oriented anteriorly on each side of mouth.

**Anterior of Body:** A sclerotized triangular process present on each side of body dorsal to upper lip.

**Posterior of Body:** Appearing wrinkled and segmented.

**Genitalia:** Female genitalia generally not discernible. Single male genitalia consisting of 2 parts present only on left side of body: a styliform posterior process with several terminal hairs, and a longer stouter anterior process with sclerotized tip. The anterior and posterior parts appear to move independently of each other so that their positions are reversed on some specimens; also, the limbs appear to be capable of turning 180 degrees so that the tip of the long sclerotized part points anteriorly on some specimens and posteriorly on others. *Thaumatoconcha*: the sclerotized tip of the anterior part varies considerably among species (see Kornicker and Sohn, 1976, fig. 18). Adjacent to the tip is a broad transparent lobe, except in *T. porosa*, in which the lobe is absent (Kornicker, 1985, fig. 3g,h). *Thaumatocypris*: the anterior part consists of a curved distal part with broadly rounded tip, and a pointed sclerotized process just proximal to it (Rudjakov, 1993, fig. 43f). *Danielopolina*: The anterior part consists of a bare pointed sclerotized tip without an adjacent transparent lobe and is similar to the copulatory organ of *Thaumatoconcha porosa*. The adult male is unknown for *D. carolynae*, the type species of the genus.

**Heart:** Probably always present but not clearly visible in many species.

#### Key to the Living Genera of Thaumatoocypridae

1. Each valve of carapace with long spine-like process (about  $\frac{1}{3}$  to  $\frac{1}{2}$  length of carapace) at anteroventral margin; eighth joint of 1st antenna with 2 bristles; endopodite of 6th limb with 1 long bristle and 1 small spine; 3rd joint of endopodite of male 2nd antenna without sclerotized clasper . . . . . *Thaumatocypris*
- Each valve of carapace with only short process (less than  $\frac{1}{4}$  length of carapace) at



- anteroventral margin; eighth joint of 1st antenna with 3 bristles; endopodite of 6th limb with 2 or 3 long bristles; 3rd joint of endopodite of a male 2nd antenna formed as sclerotized clasper . . . . . 2
- 2. Carapace smooth or punctate; 1st endopodial joint of 2nd antenna with 1 ventral bristle; endopodite of 6th limb with 3 long bristles . . . . . *Thaumatoconcha*  
Carapace smooth, reticulate, or spinous; 1st endopodial joint of 2nd antenna without ventral bristle; endopodite of 6th limb with 2 long bristles . . . . . *Danielopolina*

***Danielopolina* Kornicker and Sohn, 1976**

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

DIAGNOSIS (emended).—The original diagnosis of *Danielopolina* by Kornicker and Sohn (1976:93) was based on 2 species. An emended diagnosis by Kornicker and Iliffe (1989a:2) was based on 5 species. The genus now contains 8 species and the diagnosis requires further emendation.

*Carapace*: Length including anterior process but not extensions, less than 1 mm, except for *D. carolynae* (type species) which is 1.85 mm long. Outer surface of shell of *D. phalanx* smooth, other species with reticulations or spines.

*First Antenna*: 1st joint with 2 bristles (1 dorsal, 1 lateral); 7th joint with 2 or 3 bristles (2 ventral, 0 or 1 dorsal); 8th joint with 3 bristles.

*Second Antenna*: Protopodite with or without bristle on posteroventral corner. Endopodite 3-jointed (2nd and 3rd joints of female endopodite fused); 1st joint with no ventral bristles and 2 dorsal bristles; 2nd joint with 1 short lateral and 3 or 4 long filament-like terminal bristles. 3rd joint dorsal: female with 1 short bristle; male with sclerotized process.

*Sixth Limb*: Endopodite with 2 long bristles.

*Bellonci Organ*: Elongate, diaphanous, on some species, absent in others.

*Male Copulatory Organ*: Anterior part a narrow single sclerotized process with pointed tip and without adjacent lobe. (Male of type species *D. carolynae* unknown.)

CORRECTION.—(1) In *D. bahamensis* and *D. mexicana*, table 1 in Kornicker and Iliffe (1989a) indicates lateral bristles are lacking on the 2nd endopodial joint of the 2nd antenna; the illustrations of the limbs (Kornicker and Iliffe, 1989a, fig. 2e, and fig. 8b,c) correctly show 1 lateral bristle. (2) In *D. orghidani* the fused 1st and 2nd exopodial joints of the 6th limb bear 2 ventral bristles at midlength, not 1 ventral and 1 dorsal bristle as shown in the table (Note: the 1st and 2nd exopodial joints are used here in place of the 2nd and 3rd exopodial joints used in the table following terminology used for the genus *Spelaeoecia* by Kornicker et al. (1990:4)). (3) In the description of the 6th limb of *D. elizabethae* in Kornicker and Iliffe (1992:14) the exopodite and endopodite were unintentionally reversed; they are shown correctly in the illustration of the limb (1992, fig. 8j).

**Key to the Species of *Danielopolina***

- 1. Carapace smooth . . . . . *D. phalanx*, new species  
Carapace with surface spines . . . . . *D. mexicana*  
Carapace with surface reticulations . . . . . 2
- 2. Walls of reticulations formed of minute papillae . . . . . 3  
Walls of reticulations formed of continuous or discontinuous ridges . . . . . 5
- 3. Adult carapace longer than 1.5 mm . . . . . *D. carolynae*  
Adult carapace shorter than 1.0 mm . . . . . 4
- 4. Each valve with single posterodorsal process; each lamella of furca of adult with 2 articulated anterior claws and 3 short ventral nonarticulated claws . . . . .  
 . . . . . *D. orghidani*  
Each valve without posterodorsal process; each lamella of furca of adult with 1 articulated anterior claw and more than 3 ventral nonarticulated claws . . . . .  
 . . . . . *D. styx*
- 5. Each lamella of furca of adult with 1 articulated anterior claw . . . . .  
 . . . . . *D. elizabethae*  
Each lamella of furca of adult with more than 1 articulated anterior claw . . . . . 6
- 6. Each lamella of furca of adult with 3 short nonarticulated ventral claws . . . . .  
 . . . . . *D. bahamensis*  
Each lamella of furca of adult with 6 short nonarticulated ventral claws . . . . .  
 . . . . . *D. wilkensi*

*Danielopolina phalanx*, new species

FIGURES 2-7

ETYMOLOGY.—From the Greek *phalanx* (line, battle-array).

HOLOTYPE.—USNM 194126, undissected adult female in alcohol.

TYPE LOCALITY.—Sta 92-019, Atlantida Tunnel, Jameos del Agua lava tube, Lanzarote, Canary Islands; collected with plankton net from water in 9–21 m depth at 30–200 m penetration; salinity 37 ppt.

PARATYPES.—Sta 92-016: USNM 194125, adult female on slide and in alcohol. Sta 92-019: USNM 194127, 1 adult male on slide and in alcohol; USNM 194131, 1 undissected female in alcohol. Sta 92-030: USNM 194130, 1 undissected specimen in alcohol.

DISTRIBUTION.—Atlantida Tunnel, Jameos del Agua lava tube, Lanzarote, Canary Islands.

DESCRIPTION OF ADULT FEMALE (Figures 2-4).—Carapace subround in lateral view with straight dorsal margin in vicinity of hinge and slightly concave margin between anterior and anteroventral triangular processes (Figure 2c); ventral and posterior margins as well as anterior margin dorsal to anterior process evenly rounded. Short anterior and anteroventral processes with bases just lateral to valve edge; each process with cylindrical terminal process that easily breaks off and is absent from most specimens (terminal process on triangular anteroventral process shown in Figure 2c). Posterodorsal curvature of valves without processes.

*Ornamentation* (Figure 2a,c): Anterior surface between processes with 3 rows of minute papillae; anteroventral margin just within valve edge with 2 rows of minute papillae; parts of valve edge with indistinct minute triangular spines. (No reticulations were observed when shells were examined in original alcohol preservative prior to transferring to glycerine, which often renders reticulations invisible (Kornicker and Iliffe, 1992:12); or on the holotype which, after being immersed in glycerine, was stained with dilute silver nitrate and photographic developer.)

*Central Adductor Muscle Attachments* (Figure 2d,e): Comprising about 8 attachments arranged more-or-less radially, but could be considered to be 2 opposing rows each with 4 attachments.

*Carapace Size*: USNM 194125, length including anterior triangular process 0.93 mm, height 0.68 mm. USNM 194126, length including anterior triangular process 0.95 mm, length excluding anterior triangular process 0.93 mm, height 0.67 mm.

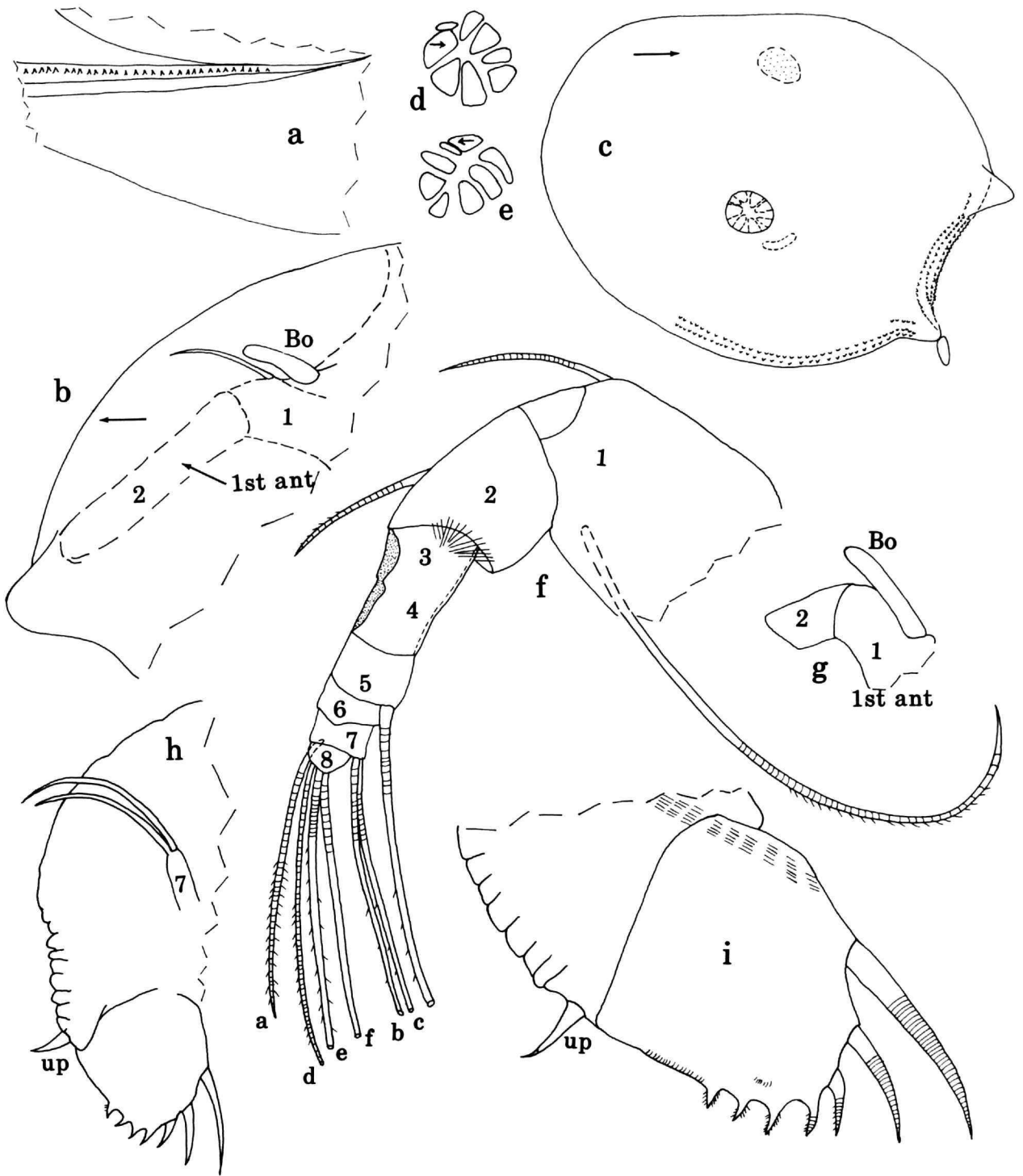
*First Antenna* (Figure 2b,f): 1st joint with 2 bristles (1 long ventral with base on lateral side and ringed distally, 1 shorter dorsal). 2nd joint with distal medial spines and 1 dorsal bristle at midlength. 3rd and 4th joints fused, but place of fusion indicated by small indentation in dorsal margin near midlength. 5th joint with long filament-like terminal ventral bristle with minute widely spaced spines. 6th joint bare. 7th joint with 3

terminal bristles (unusually long ringed dorsal a-bristle with short marginal spines, 2 long filament-like ventral b- and c-bristles with widely spaced minute spines); a short peg may be present between b-bristle and 8th joint but not clearly resolved. 8th joint with 3 terminal bristles (slender dorsal d-bristle with short marginal spines, 1 long filament-like lateral e-bristle with widely separated marginal spines, and 1 long filament-like medial f-bristle narrower and shorter than e-bristle). Filament-like bristles weakly ringed proximally.

*Second Antenna*: Protopodite with fairly long bristle on posterior edge and long hairs in vicinity of proximal ventral corner (Figure 3a). Endopodite 3-jointed (Figure 3b): 1st joint with 2 ringed a- and b-bristles; 2nd joint with short ringed dorsal bristle with base on lateral side and 3 long filament-like terminal bristles near ventral margin; 3rd joint small, fused to 2nd, with short terminal bristle. Exopodite 9-jointed (Figure 3c): 1st joint divided into long proximal and short distal parts (see Kornicker and Sohn, 1976:25); bristles of joints 2–8 with natatory hairs (some also with minute ventral spines); 9th joint with 2 bristles with minute ventral spines, longer bristle also with natatory hairs.

*Mandible*: Coxale endite with proximal and distal sets of teeth separated by a space (Figure 4a,b); proximal set comprising 4 cusps plus 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 just distal to triangular tooth; distal set of teeth consisting of 2 flat teeth, each having 5 or 6 cusps; 1 slender spinous bristle with base proximal to distal set of teeth. Basale (Figure 4c,d): tooth of endite with 5 triangular cusps (all bare, or anterior 4 may have few very weakly developed teeth); posterior edge of endite spinous, with 2 short ringed distal 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 short ringed distal bristle; medial side of endite with row of 3 pores or processes, long spines near anterior and posterior edges and near midlength, and 2 rows of shorter distal spines; medial side of basale near dorsal margin with 2 ringed bristles (ventral of these slightly broader at base and shorter), and with long spines near bristles;

FIGURE 2.—*Danielopolina phalanx*, new species, USNM 194126, holotype, adult female: a, dorsal view of anterior of carapace showing row of triangular spines along edge of left valve (carapace length including triangular anterior process 0.95 mm); b, Bellonci organ and 1st and 2nd joints of 1st antenna (dashed) as seen through left valve, anterior to left. USNM 194125 paratype, adult female: c, complete specimen from right side showing central adductor muscle attachments, crescent-shaped spot anteroventral to muscle attachments, and brown organ (stippled) within body as seen through right valve (carapace length including triangular anterior process 0.93 mm); d,e, right and left central adductor muscle attachments, respectively, ov; f, right 1st antenna, mv; g, Bellonci organ and 1st and 2nd joints of 1st antenna (bristles not shown) from left side; h, posterior of body from right side, showing 7th limb and right furcal lamella; i, right furcal lamella and unpaired process.



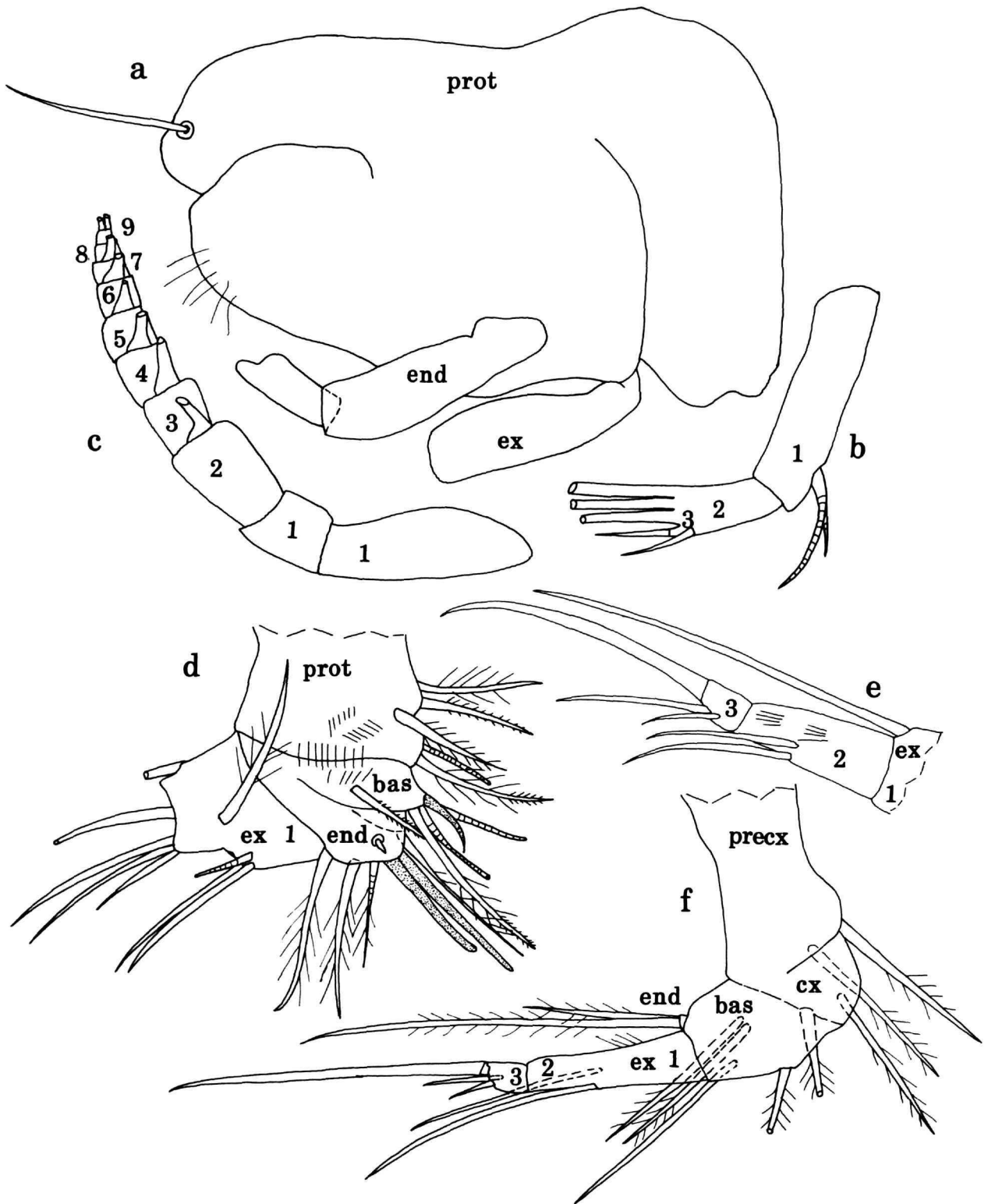


FIGURE 3.—*Danielopolina phalanx*, new species, USNM 194125, paratype, adult female: *a*, left 2nd antenna showing protopodite, 1st joint of exopodite, and endopodite (without bristles), mv; *b*, endopodite of left 2nd antenna, mv; *c*, exopodite of left 2nd antenna, mv; *d,e*, left 5th limb, mv; *f*, right 6th limb, lv.



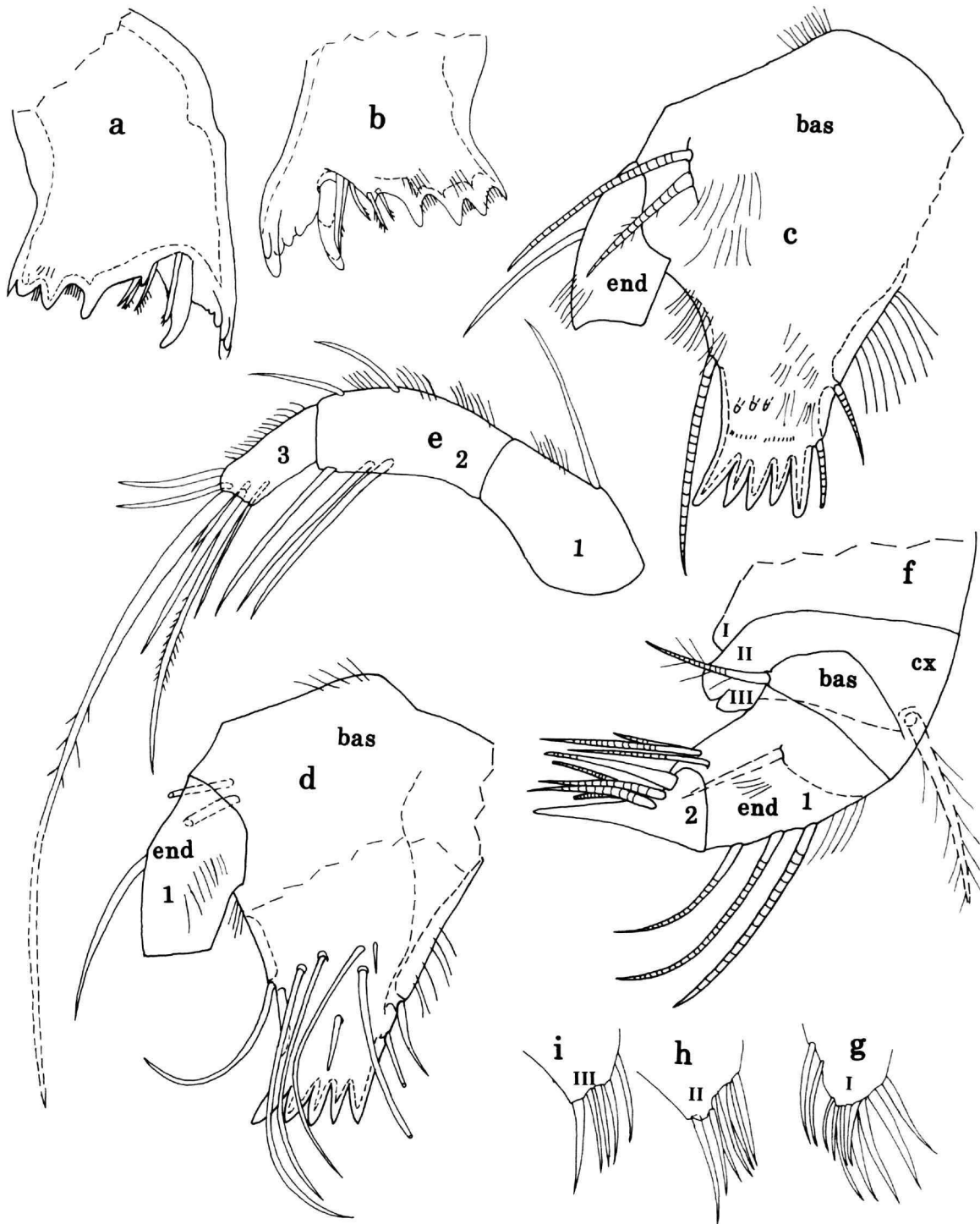


FIGURE 4.—*Danielopolina phalanx*, new species, USNM 194125, paratype, adult female: *a, b*, coxale endites of right and left mandibles, respectively, lv; *c*, basale and 1st endopodial joint of right mandible, mv; *d*, basale and 1st endopodial joint of left mandible, lv; *e*, endopodite of left mandible, lv; *f*, right maxilla, lv; *g-i*, endites I, II, and III, respectively, of right maxilla, lv.

dorsal margin of basale with cluster of spines at apex. Endopodite 3-jointed (Figure 4c–e): 1st joint with medial and lateral spines, and dorsal bristle at midlength; 2nd joint spinous, with 1 ringed terminal ventral bristle, 2 ringed medial bristles near ventral margin, and 2 ringed dorsal bristles (proximal of these tubular); 3rd joint with dorsal and medial spines and 7 bristles (4 with bases medial, 3 with bases terminal (long middle bristle and ventral bristle claw-like)). (Rings not shown on all bristles.)

**Maxilla:** Endite I with 11 bristles (4 tubular) (Figure 4g); endite II with 6 bristles (some tubular) (Figure 4h); endite III with 5 bristles (2 tubular (Figure 4i) (tubular bristles not differentiated)). Coxale with long stout plumose dorsal bristle (Figure 4f). Basale with 2 long bristles (1 proximal ventral near base of endite III with widely separated long marginal hairs; 1 medial at joint midwidth) (Figure 4f). Endopodite (Figure 4f): 1st joint with proximal anterior spines, lateral spines at midlength, 3 long ringed distal anterior bristles, and 3 distal bristles (2 with bases lateral, 1 with base medial) near posterior margin; 2nd joint with 1 anterior stout straight nonarticulated terminal bare claw, 3 bristles with bases lateral (2 ringed (anterior bare; posterior with few minute indistinct spines) close to bare claw, and 1 stout proximal bare claw-like with distal rings), and 2 ringed bare tubular bristles with bases medial.

**Fifth Limb** (Figure 3d,e): Epipodite with 3 groups of plumose bristles, each group with 4 bristles. Protopodite with 5 bristles (1 tubular). Basale with 6 bristles (1 short claw-like, 2 long plumose, 1 slender medial proximal, 2 slender ventral tubular). Endopodite with 6 bristles (1 small medial tooth-like, 2 long sclerotized ventral claw-like, 2 long plumose ringed ventral, 1 ventral tubular). Exopodite 3-jointed: 1st joint with 9 bristles (6 ventral (3 at midlength, 3 terminal), 2 lateral at joint midheight (1 at midlength, 1 terminal), and 1 very long dorsal terminal); 2nd joint with 2 ventral bristles at midlength; 3rd joint with 3 bristles (middle bristle about 53% and smallest bristle about 28% of longest bristle).

**Sixth Limb** (Figure 3f): Epipodite with 3 groups of plumose bristles (2 dorsal groups each with 4 bristles, ventral group with 5). Precoxale with 2 plumose bristles. Coxale with 2 plumose bristles. Basale with 4 bristles (1 bare, 3 plumose). Small endopodite with 2 bristles (shorter bristle plumose; longer bristle more than 2 times length of other and plumose proximally). Exopodite: 1st and 2nd joints fused, with medial hairs, and 2 long bare ventral bristles at midlength; 3rd joint with 3 bare bristles (2 short bristles 18%–26% of longest bristle).

**Seventh Limb** (Figure 2h): Elongate with 2 terminal bristles.

**Furca** (Figure 2h,i): Each lamella with 7 claws. Claws 1–3 anterior, articulated, and weakly ringed; claw 4 on anteroventral corner, nonarticulated, and weakly ringed; claws 5–7 ventral, nonarticulated, and unringed. All claws with minute teeth along posterior edges, some also with smaller teeth along

anterior edges. Each lamella with lateral and medial rows of minute spines (only few shown). Stout unpaired process on posterior of body just proximal to lamellae.

**Bellonci Organ** (Figure 2b,g): Elongate, well developed, and visible through translucent valves.

**Lips:** Typical for genus.

**Anterior of Body:** With small triangular process on each side dorsal to upper lip.

**Posterior of Body** (Figure 2h,i): Appearing segmented.

**Genitalia:** Not observed.

**DESCRIPTION OF ADULT MALE** (Figures 5–7).—Shape, ornamentation, and central adductor muscle attachments similar to those of adult female (Figure 5a,b).

**Carapace Size:** USNM 194127, separated right valve, length with anterior process 0.86 mm, length without anterior process 0.83 mm, height 0.57 mm.

**First Antenna** (Figure 6a,b): 1st joint with 2 bristles (1 long ventral with base on lateral side and ringed distally, 1 shorter dorsal). 2nd joint with distal medial spines and 1 dorsal bristle near midlength. 3rd and 4th joints fused, but place of fusion indicated by small indentation in dorsal margin and by 3rd joint being wider; 4th joint with 2 long ventral filament-like bristles. 5th joint with 3 filament-like bristles (ventral of these slightly broader and with closely spaced distal spines (short triangular spines followed by longer slender curved hair-like spines (detail in Figure 6a))). Joints 6–8 similar to those of adult female.

**Second Antenna:** Protopodite similar to that of adult female (Figure 5c). Exopodite similar to that of adult female except left limb of USNM 194127 with only 8 joints. Endopodite 3-jointed (Figure 5c,d): 1st joint with 2 ringed a- and b-bristles; 2nd joint with short ringed dorsal bristle with base on lateral side and row of 4 long filament-like terminal bristles near ventral margin; 3rd joint small, fused to 2nd joint, with elongate terminal process with 2 minute indistinct unringed bristles at sclerotized tip (row of minute spines may be present on tip but not resolved with certainty).

**Mandible** (Figure 6c): Similar to that of adult female except basale endite with only 2 pores in medial row, 2nd endopodial joint shorter, and ventral claw-like bristle of 3rd endopodial joint with slightly stouter marginal spines at midlength.

**Maxilla:** Similar to that of adult female but endite bristles not counted.

**Fifth Limb** (Figure 7a): Epipodite with 3 groups of bristles (dorsal group with 5 bristles, 2 ventral groups with 4). Limb otherwise similar to that of adult female.

**Sixth Limb** (Figure 7b): Limb similar to that of adult female.

**Seventh Limb:** Right limb of USNM 194127 with 2 bristles (Figure 6d); left limb aberrant in having 3 bristles (Figure 6e).

**Furca** (Figure 6d,f): Similar to that of adult female except claw 4 articulated, and left lamella of USNM 194127 with

additional ventral claw; total number of claws 7 or 8. Stout unpaired process on posterior of body just proximal to lamellae.

*Bellonci Organ* (Figure 6b): Similar to that of adult female.

*Lips*: Typical for genus.

*Anterior and Posterior of Body*: Similar to those of adult female.

*Genitalia* (Figures 6d,g, 7c): Anterior part with long curved process tapering to narrow tip (tip broken off in Figure 7c). Styloform process not observed with certainty (obscured).

**COMPARISONS.**—The carapace of *D. phalanx* differs from that of *D. wilkensi* Hartmann, 1985, in not having a posterodorsal process on each valve and in being larger, as well as in not having a reticulate surface. The furca of *D. phalanx* has 3 or 4 articulated anterior claws compared to 2 for *D. wilkensi*. The carapace of *D. mexicana* Kornicker and Iliffe, 1989a, differs from that of *D. phalanx* in having a posterodorsal process on each valve. *Danielopolina phalanx* is the only known species in the genus having more than 2 anterior articulated furcal claws (3 on adult female, 4 on adult male).

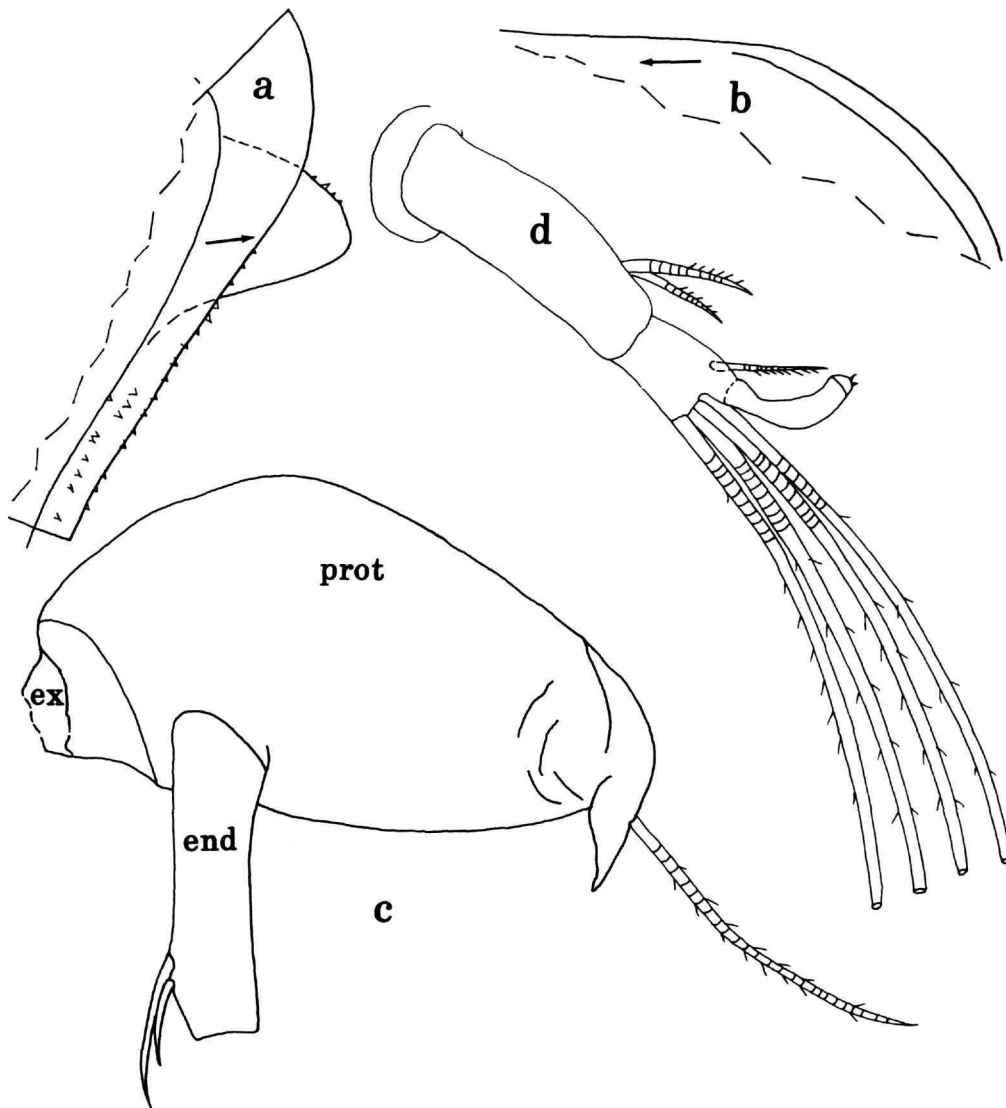


FIGURE 5.—*Danielopolina phalanx*, new species, USNM 194127, paratype, adult male: a, part of anterior of left valve showing spines and upper anterior process (carapace length including triangular anterior process 0.86 mm), iv; b, posterodorsal corner of left valve, ov; c, right 2nd antenna showing protopodite, base of exopodite, and 1st endopodial joint, mv; d, endopodite of left 2nd antenna, mv.

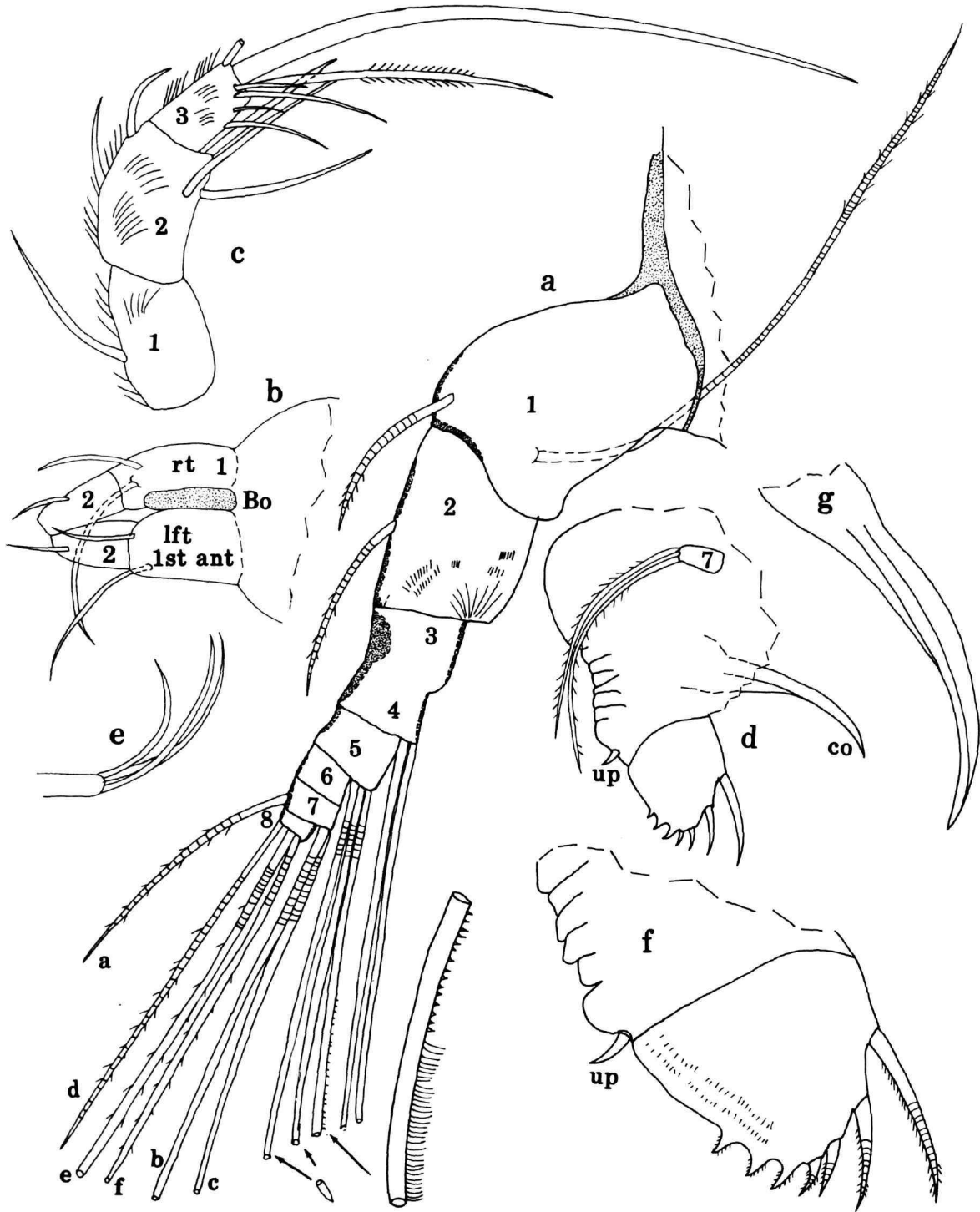


FIGURE 6.—*Danielopolina phalanx*, new species, USNM 194127, paratype, adult male: *a*, right 1st antenna, mv; *b*, dorsal view of anterior of body showing Bellonci organ (stippled) and 1st and 2nd joints of 1st antennae; *c*, endopodite of left mandible, mv; *d*, posterior of body from right side showing 7th limb, right lamella of furca, and copulatory organ; *e*, left 7th limb; *f*, right lamella of furca and unpaired process; *g*, copulatory organ.



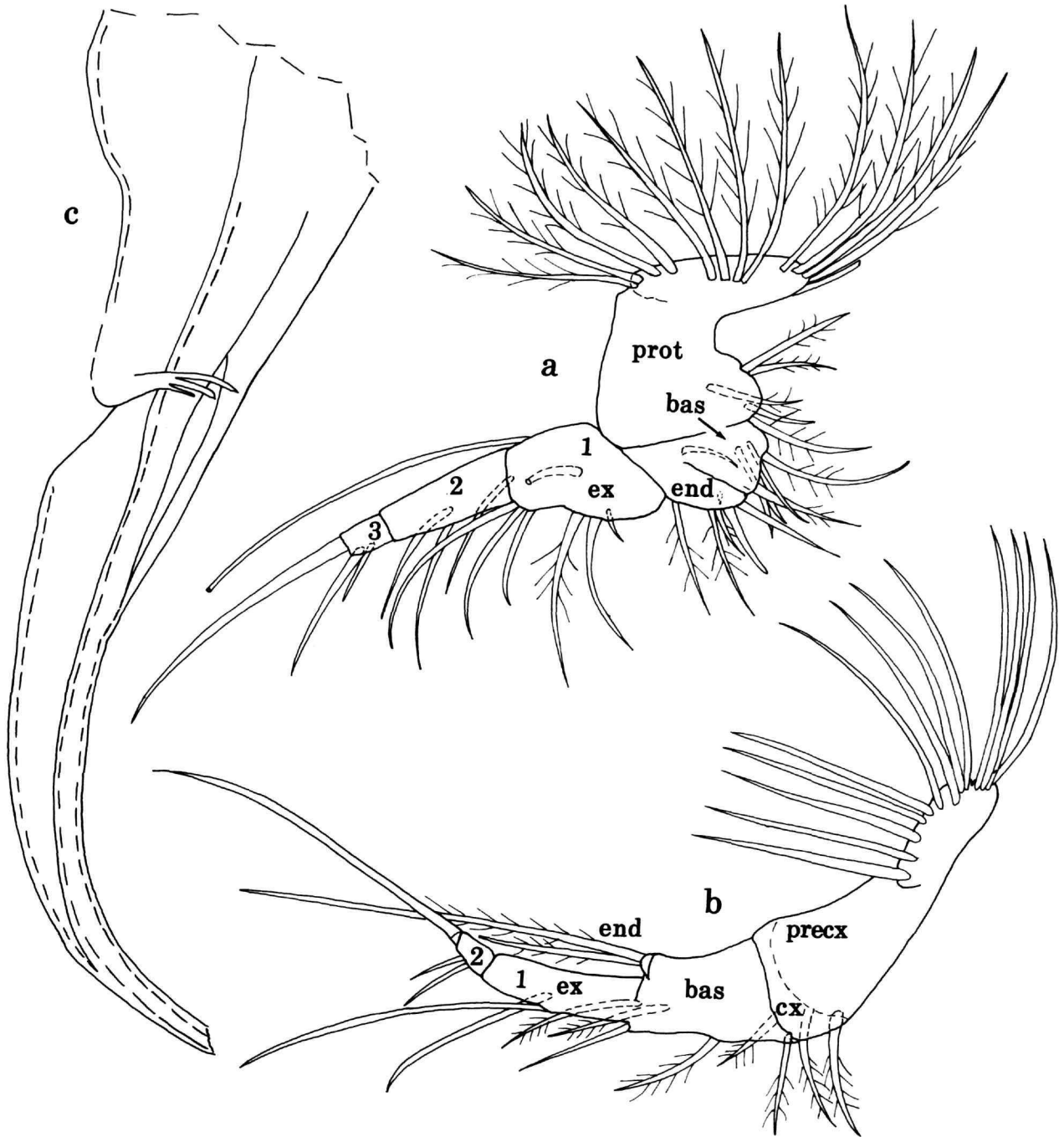


FIGURE 7.—*Danielopolina phalanx*, new species, USNM 194127, paratype, adult male: a, right 5th limb, lv; b, right 6th limb, lv; c, copulatory organ, anterior to left.

*Danielopolina wilkensi* Hartmann, 1985

FIGURES 8-13

*Danielopolina wilkensi* Hartmann, 1985:255, figs. 1-8.

**HOLOTYPE.**—K 32644, female, Zoological Museum Hamburg.

**MATERIAL.**—Sta 92-016: 194141A, undissected adult male in alcohol; USNM 194141B, undissected Instar II (A-5?) juvenile in alcohol; USNM 194141C, 4 undissected adult females in alcohol; USNM 194141D, 2 undissected Instar I (A-6?) juveniles in alcohol. Sta 92-017: USNM 194133, undissected Instar II (A-5?) juvenile in alcohol. Sta 92-018: USNM 194137, undissected Instar I (A-6?) juvenile in alcohol. Sta 92-019: USNM 194129, adult female on slide and in alcohol; USNM 194134A, undissected Instar III (A-4?) juvenile in alcohol; USNM 194134B, undissected Instar I (A-6?) juvenile in alcohol; USNM 194134C, undissected Instar I (A-6?) juvenile in alcohol; USNM 194135A, undissected Instar II (A-5?) juvenile in alcohol; USNM 194135B, 6 undissected adult females in alcohol. Sta 92-020: USNM 194128, adult male on slide and in alcohol; USNM 194138, 2 undissected adult females in alcohol. Sta 92-021: USNM 194152, undissected Instar I (A-6?) juvenile in alcohol. Sta 92-025: USNM 194132A, undissected adult male in alcohol; USNM 194132B, undissected adult female in alcohol; USNM 194132C, undissected adult female in alcohol. Sta 92-028: USNM 194140A, undissected Instar I (A-6?) juvenile in alcohol; USNM 194140B, undissected adult female in alcohol. Sta 92-030: USNM 194136A, undissected Instar VI (A-1?) juvenile male in alcohol; USNM 194136B, undissected Instar I (A-6?) juvenile in alcohol; USNM 194136C, 2 undissected adult females (shells torn) in alcohol; USNM 194139A, 1 partly dissected adult male in alcohol; USNM 194139B, 1 undissected adult female in alcohol.

**DISTRIBUTION.**—Atlantide Tunnel, Jameos del Agua lava tube, Lanzarote, Canary Islands.

**REMARKS.**—The original description of the species was based on adult females (Hartmann, 1985:256). Descriptions of the adult male and some juveniles, as well as a supplementary description of the female, are presented herein.

All valves of specimens have a triangular anterior, anteroventral, and posterodorsal process (Figures 8, 12a, 13a,d,g). On some specimens each process bears a fragile extension with lateral points having an outward orientation (Figure 13a,g). Each extension bears an outer layer bearing the points and an inner cylindrical core. On many specimens the outer layer breaks away leaving the cylindrical core (Figures 8, 13d). On most specimens, especially the adults, the cylindrical core also breaks away leaving the basic triangular process, which is an integral part of the shell and always remains. Walls of reticulations on the outer surface of the shell consist of both continuous and discontinuous ridges. These are fragile and easily break away leaving a smooth surface. In the present

collection when the specimens were initially preserved in alcohol, the reticulations were easily visible; but once they were transferred to glycerine for study in a depression slide, the reticulations became invisible. This loss of reticulations occurred in most, but not all, specimens. A similar effect of glycerine mountant on the reticulations of the shells of *D. elizabethae* Kornicker and Iliffe, 1992, was reported by Kornicker and Iliffe (1992:12).

The guts of most specimens (including juveniles and adult males and females) contained minute amber or brown-colored organic particles; the gut content of 2 females in the sample from Sta 92-030 consisted of unidentified colorless narrow flat strips with parallel sides. No recognizable fragments of animals are identifiable within the guts. This species apparently feeds upon detritus.

**DESCRIPTION OF ADULT MALE** (Figures 8-11).—Carapace similar to that of adult female described herein.

**Central Adductor Muscle Attachments** (Figure 8): Comprising about 8 radial attachments. Crescent-shaped spot near anteroventral corner of muscle attachments.

**Carapace Size:** USNM 194128 (shell torn), length including triangular anterior process about 0.48 mm, height about 0.40 mm. USNM 194132A, length including triangular anterior process 0.57 mm, length excluding anterior process 0.53, height 0.45 mm. USNM 194139A, length including triangular anterior process 0.58 mm, length excluding anterior process 0.53 mm, height 0.45 mm.

**First Antenna** (Figure 9a,b): 1st joint with 2 bristles (1 long ventral inserted on lateral side, 1 shorter dorsal). 2nd joint with distal medial spines and 1 dorsal bristle near midlength. 3rd and 4th joints fused, but place of fusion indicated by small indentation in dorsal margin, wider sclerotized dorsal margin of 3rd joint, and by 3rd joint being wider; both joints with ventral spines; 4th joint with 2 long ventral filament-like bristles with distal widely separated minute marginal spines. 5th joint with 3 filament-like bristles (ventral of these slightly broader and with 5 distal widely separated hook-like spines (Figure 9b); remaining 2 bristles with distal widely separated minute marginal spines). 6th joint bare. 7th joint with 3 terminal bristles (short bare ringed dorsal a-bristle and 2 ventral filament-like b- and c-bristles). 8th joint with 3 terminal bristles (slender dorsal d-bristle with few short marginal spines, 1 long filament-like e-bristle with widely separated minute marginal spines, and f-bristle similar to e-bristle but narrower). Filament-like bristles weakly ringed proximally (rings not shown) and tapering to pointed tip with terminal papilla (Figure 9b).

**Second Antenna:** Protopodite with few long hairs in vicinity of proximal ventral corner, but without bristle on posterior edge as on *D. phalanx*. Endopodite 3-jointed (Figure 9c): 1st joint with 2 ringed a- and b-bristles; 2nd joint with short ringed dorsal bristle with base on lateral side and row of 4 long filament-like terminal bristles (with tapering tips, each with minute terminal papilla) near ventral margin; 3rd joint small, fused to 2nd, with elongate terminal process with 2

minute unringed bristles at tip; minute indistinct spines may be present along edge of tip but not resolved with certainty. Exopodite 8-jointed: 1st joint subdivided into a long proximal and a short distal part; bristles of joints 2–7 with natatory hairs (some also with minute ventral spines); 8th joint with 2 bristles with minute spines, longer of these also with natatory hairs.

**Mandible:** Coxale endite (Figure 9d) and basale (Figure 9e) similar to those of adult male *D. phalanx*. Endopodite similar to that of adult male *D. phalanx*, except 3rd joint differs in having 3 instead of 4 medial bristles and slenderer marginal spines on the terminal ventral bristle (Figure 9f).

**Maxilla** (Figure 10a,b): Endite I with 10 bristles (4 tubular) (Figure 10b); endite II with 8 bristles (4 tubular); endite III with 5 bristles (1 tubular). Coxale with long plumose dorsal bristle. Basale with 2 long bristles (1 ventral near base of endite III, 1 medial at joint midwidth). Endopodite: 1st joint with proximal anterior spines, distal medial spines, 3 long ringed anterior bristles, and 2 or 3 (exact number obscured) distal bristles near posterior margin; 2nd joint with stout nonarticulated claw and 4 bristles (2 tubular).

**Fifth Limb** (Figure 11a): In general, similar to that of *D. phalanx*.

**Sixth Limb** (Figure 11b,c): Epipodite with 3 groups of plumose bristles (2 dorsal groups each with 4 bristles, ventral group with 5). Precoxale with 1–3 plumose bristles. Coxale

with 2 plumose bristles. Basale with 2 or 3 bristles (1 bare, 1 or 2 plumose). Small endopodite with 2 unequal long bristles (shorter bristle plumose; longer bristle either bare or with long indistinct hairs). Exopodite: 1st and 2nd joints fused, with 2 long bare ventral bristles at midlength; 3rd joint with 2 bare bristles (short bristle broken on both limbs of USNM 194128, but length estimated to be about 30% of long bristles).

**Seventh Limb** (Figure 10c): Elongate with 2 spinous terminal bristles.

**Furca** (Figure 10d): Each lamella with 8 claws followed by low triangular process. Claws 1 and 2 anterior, articulated, and weakly ringed; claws 3–8 and low triangular process ventral, nonarticulated, and unringed; all claws with small teeth along posterior edges; claws 1 and 2 with few anterior subterminal minute teeth, and claws 3–8 with many anterior minute teeth. Each lamella with medial and lateral rows of minute spines. Stout unpaired process with few minute marginal spines present on posterior of body just proximal to lamellae. (The low triangular process following the ventral claws is not claw-like, and therefore is not included in claw count.)

**Bellonci Organ:** Absent.

**Lips** (Figure 10e,f): Typical for genus.

**Anterior of Body** (Figure 10e): With small sclerotized triangular process on each side dorsal to upper lip.

**Posterior of Body:** Appearing segmented.

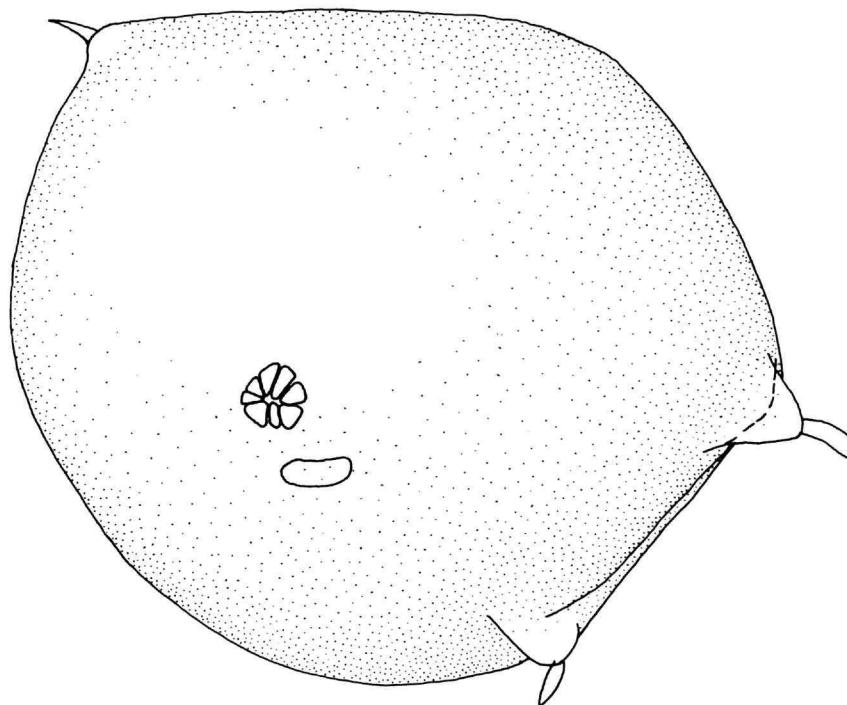


FIGURE 8.—*Danielopolina wilkensi* Hartmann, USNM 194132A, adult male, carapace of complete specimen from right side (reticulations not shown), length including triangular anterior process 0.57 mm.

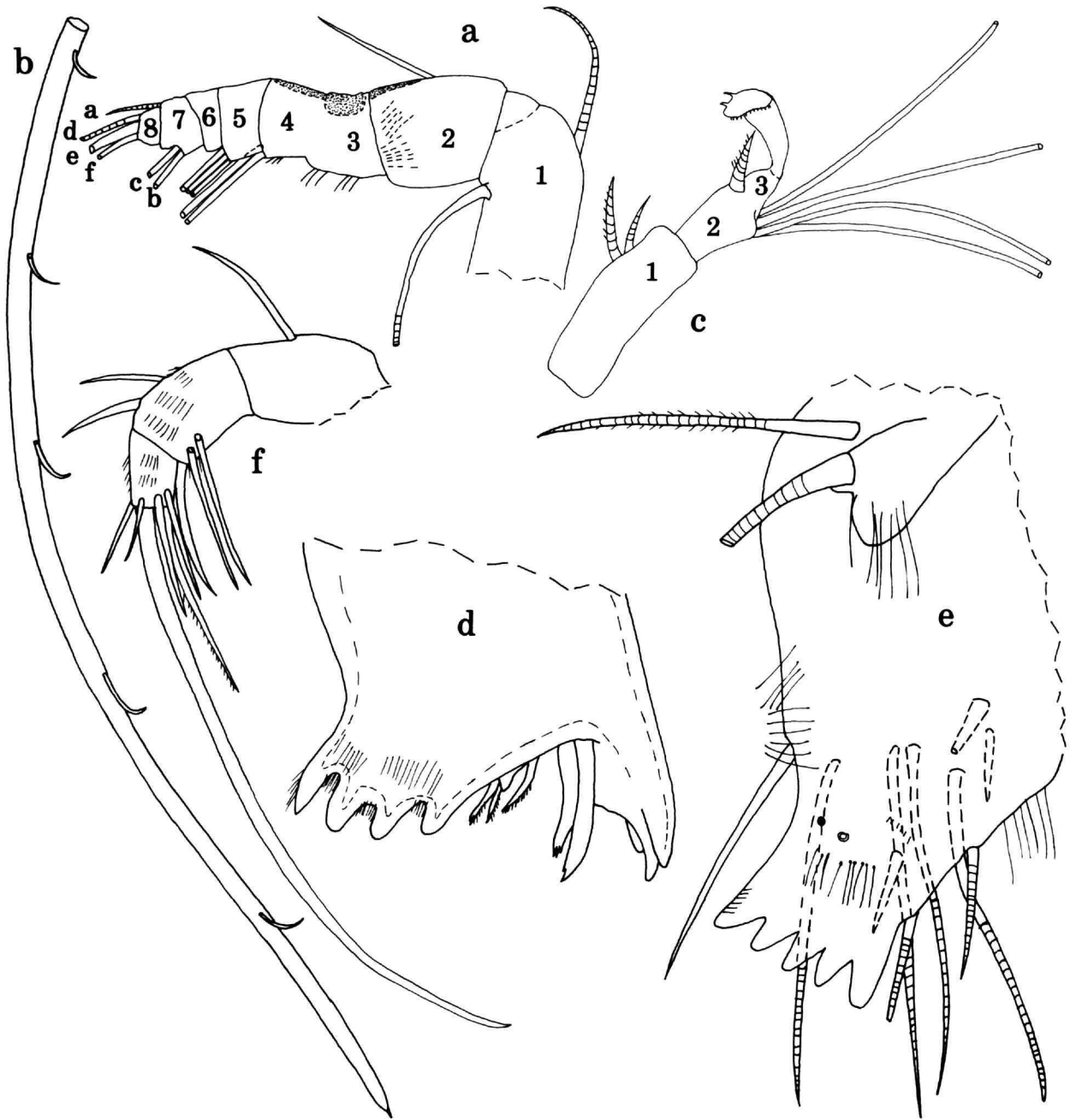


FIGURE 9.—*Danielopolina wilkensi* Hartmann, USNM 194128, adult male: a, left 1st antenna, lv; b, tip of ventral bristle of 1st joint of 1st antenna in a; c, endopodite of right 2nd antenna, lv; d, coxale of left mandible, mv; e, f, basale and endopodite of right mandible, respectively, mv.

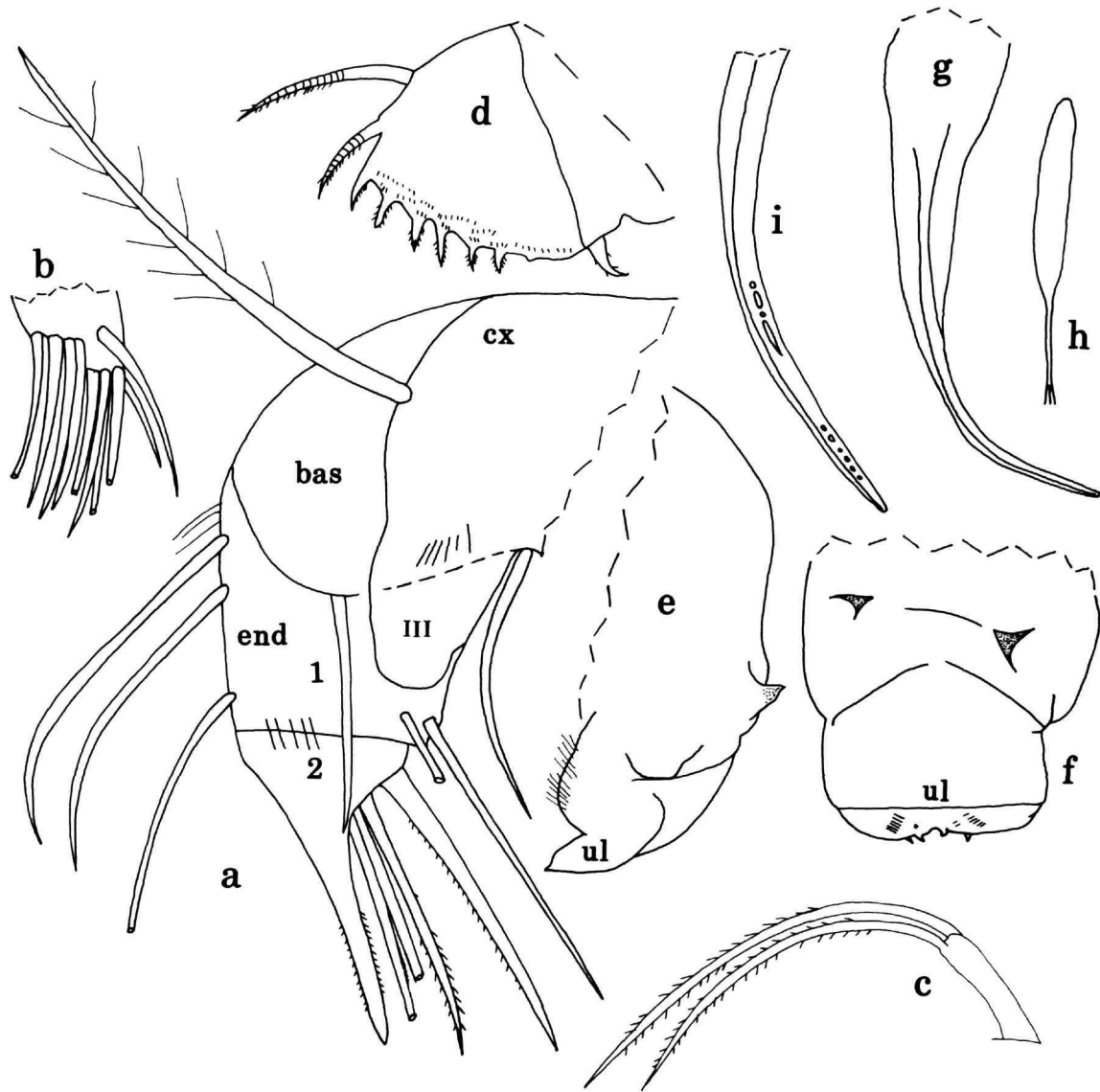


FIGURE 10.—*Danielopolina wilkensi* Hartmann, USNM 194128, adult male: *a*, right maxilla (endite bristles not shown), mv; *b*, endite I of right maxilla, mv; *c*, left 7th limb, lv; *d*, left furcal lamella and unpaired process; *e*, anterior of body from right side, anterior to right (triangular process stippled); *f*, anterior of body from front showing triangular processes (stippled) and upper lip; *g*, anterior part of copulatory organ; *h*, posterior styliform part of copulatory organ; *i*, detail of tip in *g*.

**Genitalia:** Anterior part with long curved process tapering to narrow tube-like tip (Figure 10*g,i*). Posterior styliform part with several indistinct hairs at tip (Figure 10*h*). (Anterior part of USNM 194128 with row of minute spheres and few elongate particles within canal near its tip (Figure 10*i*)).

**SUPPLEMENTARY DESCRIPTION OF ADULT FEMALE** (Figure 12).—Carapace similar to that illustrated by Hartmann (1985,

fig. 1*a*), except some specimens with additional projections from anterior, anteroventral, and posterodorsal processes (Figure 12*a*).

**Ornamentation** (Figure 12*a*): With reticulate structure (walls forming reticulations continuous on some specimens, discontinuous on others, and some specimens with both types).

**Central Adductor Muscle Attachments** (Figure



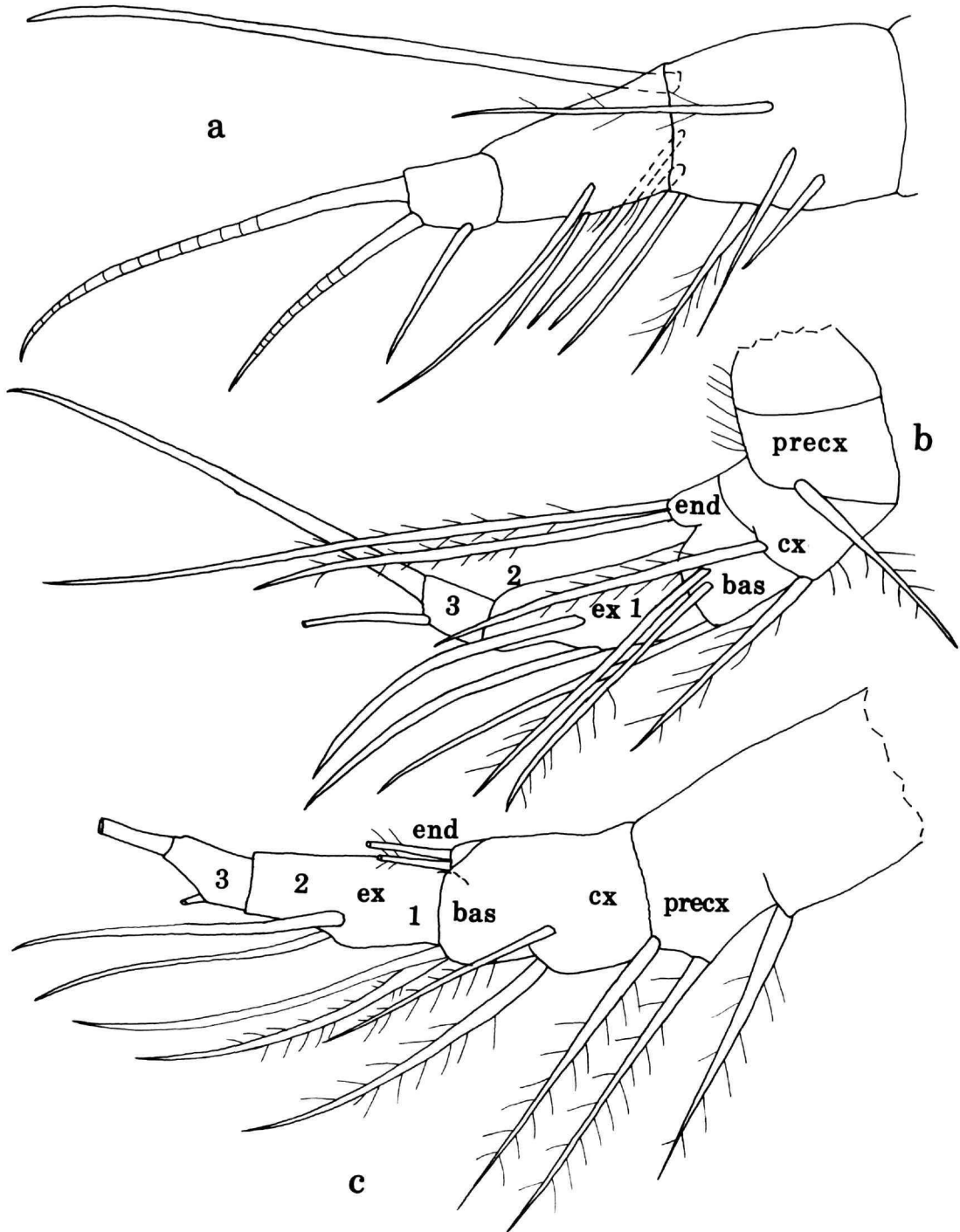


FIGURE 11.—*Danielopolina wilkensi* Hartmann, USNM 194128, adult male: a, exopodite of 5th limb; b, left 6th limb, mv; c, right 6th limb, lv.

12a,b): With about 8 individual attachments arranged in 2 rows. Crescent-shaped spot near anteroventral corner of muscle attachments.

*Carapace Size:* USNM 194129, length including anterior triangular process 0.63 mm, length excluding process 0.59 mm, height 0.49 mm. USNM 194132B, length including triangular anterior process 0.60 mm, length excluding anterior process 0.55 mm, height 0.49 mm. USNM 194132C, length including triangular anterior process 0.63 mm, length excluding anterior process 0.59 mm, height 0.50 mm.

*First Antenna* (Figure 12c): 1st joint with 2 bristles (1 long ventral with base on lateral side, 1 shorter dorsal). 2nd joint with distal medial spines, and 1 dorsal bristle near midlength. 3rd and 4th joints fused, but place of fusion indicated by indentation in dorsal margin, and wider sclerotized dorsal margin of 3rd joint; 3rd joint with ventral spines; 4th joint bare. 5th joint with long ventral filament-like bristle. 6th joint bare. 7th joint with 3 terminal bristles (short bare ringed dorsal a-bristle and 2 ventral filament-like b- and c-bristles). 8th joint with 3 terminal bristles (slender dorsal ringed d-bristle with few marginal spines, 1 long filament-like e-bristle with widely separated minute marginal spines, and f-bristle similar to e-bristle but longer, narrower, and marginal spines not observed). Filament-like bristles weakly ringed proximally (rings not shown) and tapering to pointed tip with terminal papilla (not shown).

*Second Antenna:* Protopodite (Figure 12d) and exopodite similar to those of adult male. Endopodite 3-jointed (Figure 12d): 1st joint with 2 ringed a- and b-bristles; 2nd joint with short ringed dorsal bristle with base on lateral side and 3 long filament-like terminal bristles (each with widely separated minute marginal spines and a tapered tip with minute terminal papilla) near ventral margin; 3rd joint small with short ringed terminal bristle. (Note: the endopodite differs from that of the specimen illustrated by Hartmann (1985, fig. 3a) in having 2 bristles on the 1st joint, and a 3rd joint with 1 bristle.)

*Mandible:* Coxale (Figure 12e-h), basale, and endopodite (Figure 12i) similar to those of adult male. (Note: the basale differs from that of the specimen illustrated by Hartmann (1985, fig. 4) in having more bristles, and the endopodite differs in having a suture between the 1st and 2nd joints and more bristles on the 2nd and 3rd joints.)

*Maxilla:* Similar to that of adult male. (Note: the maxilla differs from that of the specimen illustrated by Hartmann (1985, fig. 5) in having more endite bristles, and in lacking a small process on the anterodorsal corner of the basale.)

*Fifth Limb:* In general, similar to that of adult male. (Note: the 5th limb differs from that of the specimen illustrated by Hartmann (1985, fig. 6) in that the 2nd endopodial joint has only 2 bristles, both at midlength, and the 3rd endopodial joint has 3 bristles.)

*Sixth Limb, Seventh Limb, Furca* (Figure 12j), *Bellonci*

*Organ, and Anterior and Posterior of Body:* Similar to those of adult male.

*Genitalia:* Not observed.

DESCRIPTION OF JUVENILE INSTAR I (A-6?) (sex unknown) (Figure 13a-c).—Carapace similar to that of adult female (Figure 13a).

*Carapace Size:* USNM 194134B, length including anterior process 0.32 mm, length excluding anterior process 0.31 mm, height 0.25 mm. USNM 194136B, length including anterior process 0.29 mm, length excluding anterior process 0.26 mm, height 0.24 mm. USNM 194137, length with anterior process 0.33 mm, length without anterior process 0.31 mm, height 0.26 mm. USNM 194152, length including anterior process 0.30 mm, length excluding anterior process 0.29 mm, height 0.26 mm. USNM 194140A, length including anterior process 0.31 mm, length excluding anterior process 0.30 mm, height 0.25 mm.

*First Antenna:* 1st and 2nd joints bare. 3rd and 4th joints fused, without bristles. 5th joint with small terminal ventral bristle. 6th joint bare. 7th joint with small dorsal a-bristle, and 1 long filament-like ventral b- or c-bristle. 8th joint with short dorsal d-bristle and long filament-like e- or f-bristle.

*Second Antenna:* Endopodite 3-jointed: 1st joint without bristles; 2nd joint with 1 small dorsal a-bristle and 1 long filament-like ventral b- or c-bristle; 3rd joint small, fused to 2nd joint, with 1 small terminal bristle. Exopodite: 1st joint not divided into proximal and distal parts; eighth joint with 1 long terminal bristle.

*Mandible:* Endopodite: 1st joint without bristles; 2nd joint with 1 distal dorsal bristle; 3rd joint with 3 terminal bristles and 1 distal ventral bristle.

*Fifth Limb* (Figure 13b): Well developed; 3rd endopodial joint with 1 bristle.

*Sixth and Seventh Limbs:* Absent.

*Furca* (Figure 13c): Each lamella with 1 articulated anterior claw, 1 short nonarticulated claw on anteroventral corner, followed by 1 small nonarticulated ventral claw. Unpaired process on posterior of body following lamellae.

DESCRIPTION OF JUVENILE INSTAR II (A-5?) (sex unknown) (Figure 13d-f).—Carapace similar to that of adult female (Figure 13d).

*Carapace Size:* USNM 194133, length including triangular anterior process 0.34 mm, length excluding anterior process 0.31 mm, height 0.27 mm. USNM 194141B, length including triangular anterior process 0.34 mm, length excluding anterior process 0.32 mm, height 0.26 mm. USNM 194135A, length including triangular anterior process 0.31 mm, length excluding anterior process 0.27 mm, height 0.27 mm.

*Fifth Limb* (Figure 13e): Well developed; 3rd endopodial joint with 2 bristles.

*Sixth Limb* (Figure 13e): Small thumb-like process without bristles.

*Seventh Limb:* Absent.

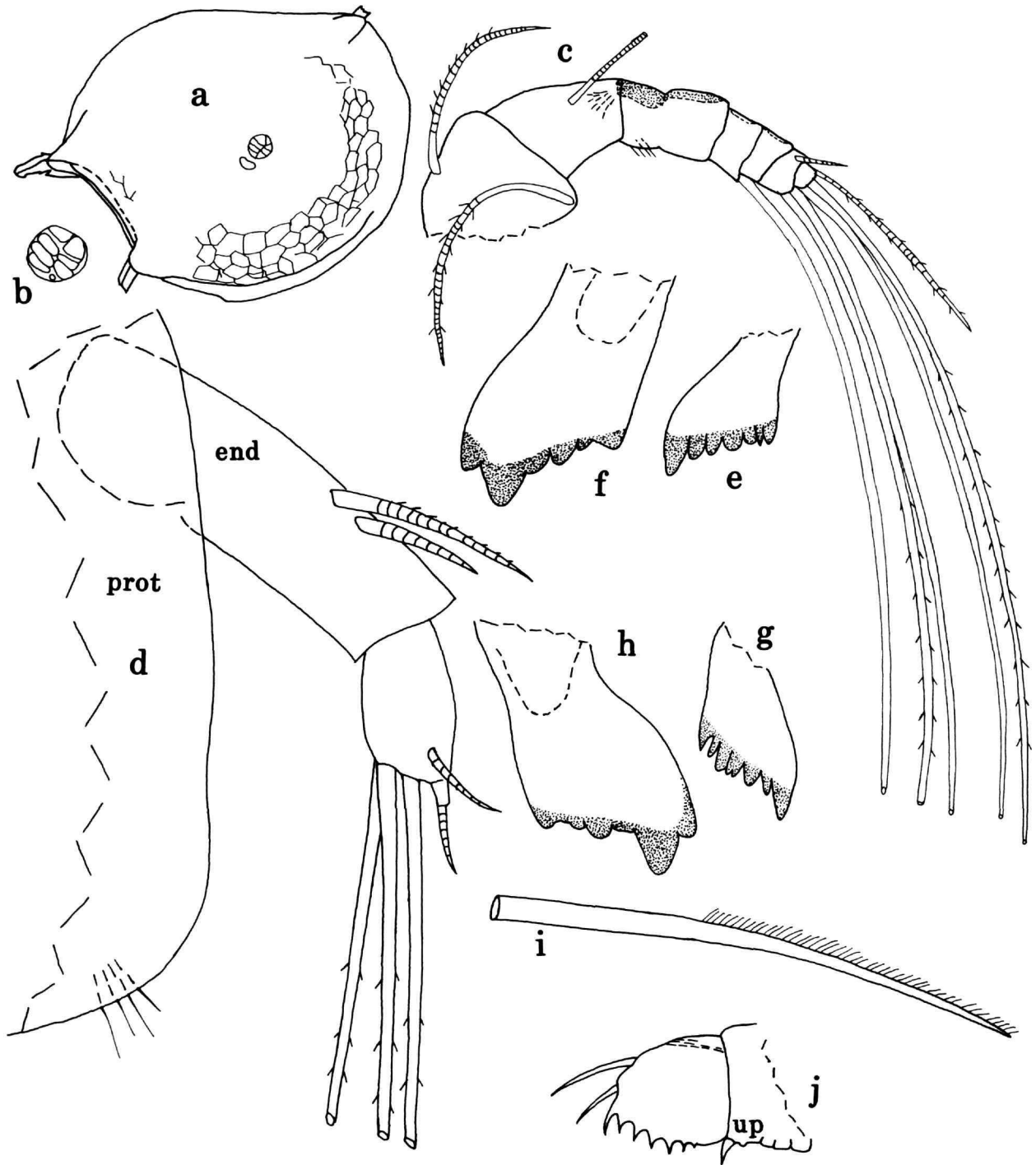


FIGURE 12.—*Danielopolina wilkensi* Hartmann, USNM 194129, adult female: *a*, complete specimen from left side (length including anterior triangular process 0.63 mm); *b*, detail of central adductor muscle attachments shown in *a*; *c*, right 1st antenna, lv; *d*, part of protopodite and endopodite of right 2nd antenna, lv; *e, f*, proximal and distal sets of teeth, respectively, of coxale endite of mandible; *g, h*, same for opposite mandible to that in *e, f*; *i*, ventral bristle of 3rd endopodial joint of left mandible, mv; *j*, left furcal lamella and unpaired process.

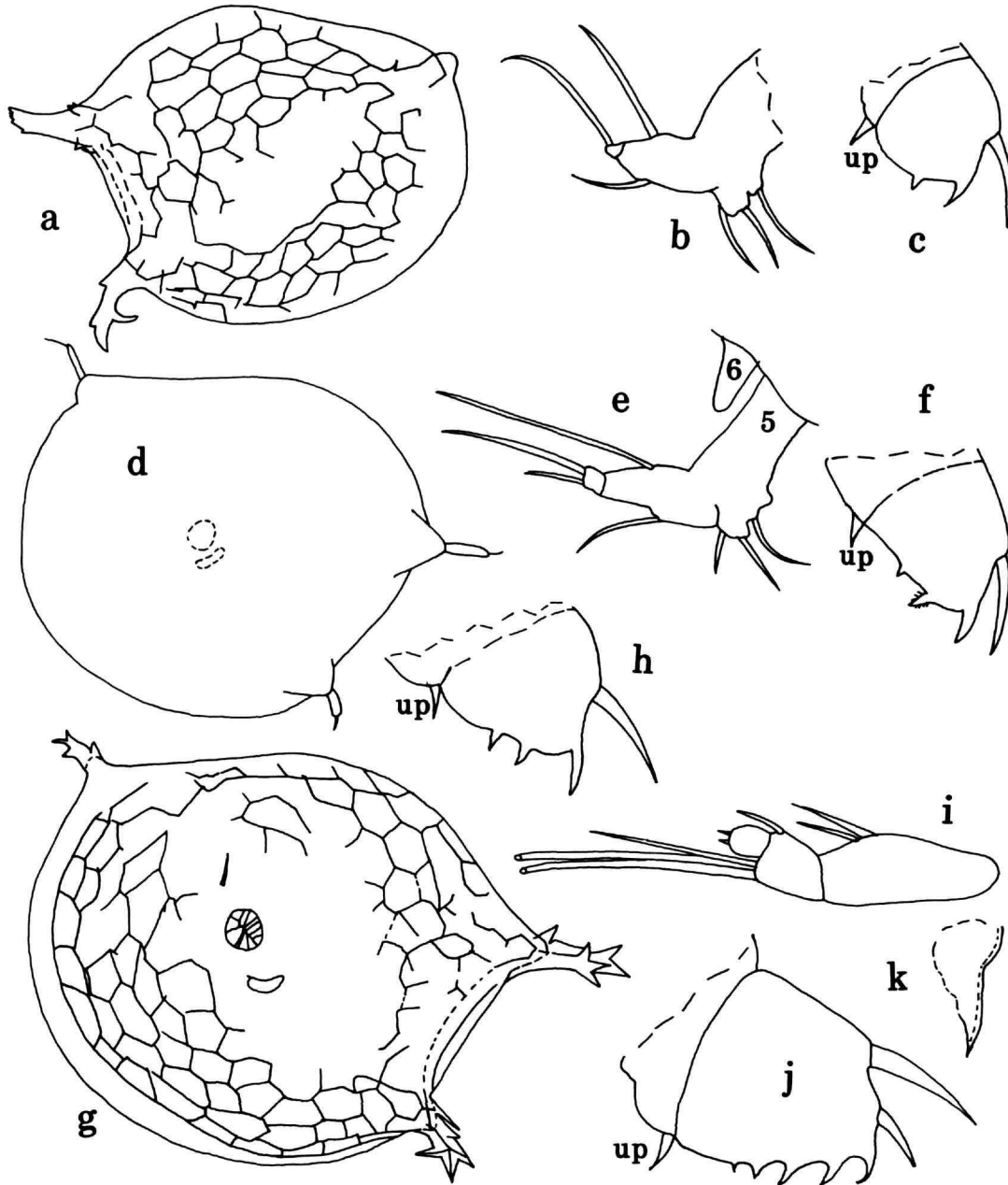


FIGURE 13.—*Danielopolina wilkensi* Hartmann, USNM 194134B, Instar I, sex unknown: *a*, complete specimen from left side, (length including anterior process 0.32 mm); *b*, 5th limb; *c*, right furcal lamella and unpaired process. USNM 194133, Instar II, sex unknown: *d*, complete specimen from right side (length including anterior triangular process 0.34 mm); *e*, 5th and 6th limbs; *f*, right furcal lamella and unpaired process. USNM 194134A, Instar III, sex unknown: *g*, complete specimen from right side (length including anterior triangular process 0.41 mm); *h*, right lamella of furca and unpaired process. USNM 194136A, Instar VI, male: *i*, endopodite of right 2nd antenna, mv; *j*, right furcal lamella and unpaired process; *k*, copulatory organ from left side, anterior to left.

*Furca* (Figure 13f): Each lamella with 1 articulated anterior claw, 1 shorter nonarticulated claw on anteroventral corner, 1 nonarticulated ventral claw (with anterior and posterior teeth) followed by small nonarticulated claw. Unpaired process on posterior margin of body following lamellae.

DESCRIPTION OF JUVENILE INSTAR III (A-4?) (sex unknown) (Figure 13g,h).—Carapace similar to that of adult female (Figure 13g).

*Carapace Size*: USNM 194134A, length including triangular anterior process 0.41 mm, length excluding anterior process 0.38 mm, height 0.34 mm.

*Fifth Limb*: Well developed; 3rd endopodial joint with 2 bristles.

*Sixth Limb*: Present with bristles.

*Seventh Limb*: Absent.

*Furca* (Figure 13h): Each lamella with 1 articulated anterior claw, 1 shorter claw on anteroventral corner (articulation obscured), followed by 2 nonarticulated ventral claws. Unpaired process on posterior margin of body following lamellae.

DESCRIPTION OF JUVENILE INSTAR VI (A-1?) Male (Figure 13i-k).—Carapace torn, dimensions unknown (USNM 194136A).

*First Antenna*: 1st and 2nd joints similar to those of adult male. 3rd and 4th joints fused; 4th joint with 1 short ventral bristle. 5th joint with long filament-like ventral bristle. 6th joint bare. 7th joint with 1 short dorsal a-bristle and 2 long filament-like ventral b- and c-bristles. 8th joint with pointed dorsal d-bristle about same length as combined length of joints 2-8, and long filament-like e- and f-bristles.

*Second Antenna*: Endopodite (Figure 13i): 1st joint with 2 dorsal bristles; 2nd joint with 1 short dorsal bristle, and 3 filaments (2 long, 1 (dorsal) short); 3rd joint thumb-like with 2 minute terminal bristles. Protodopite and exopodite similar to those of adult male.

*Mandible*: Coxale and basale not examined in detail but appearing similar to that of adult male. Endopodite similar to that of adult male.

*Fifth, Sixth, and Seventh Limbs*: In general, similar to those of adult male. 3rd endopodial joint of 5th limb with 3 bristles.

*Furca* (Figure 13j): Each lamella with 2 long articulated anterior claws, 4 well developed nonarticulated short ventral claws, followed by smaller pointed nonarticulated claw.

*Copulatory Organ* (Figure 13k): Vestigial.

#### Sexual Dimorphism

Sexual dimorphism in *Danielopolina bahamensis* has been discussed by Kornicker and Iliffe (1989a:12). The adult male is now known in *D. wilkensi*, *D. elizabethae* (adult female unknown), *D. bahamensis*, and *D. phalanx*. In those species in which both sexes are known the adult male is slightly smaller than the adult female.

*First Antenna*: Unlike adult males of other species, the 3rd

and 4th joints of *D. wilkensi* and *D. phalanx* are not separated by a distinct suture. As in other species the adult males of *D. wilkensi* and *D. phalanx* bear 2 long filament-like ventral bristles on the 4th joint that are absent in the female, and the 5th joint bears 3 long filament-like ventral bristles compared to only 1 in the female. One of the ventral bristles on the male bears distal curved hairs (the distribution and number of hairs differ among species).

*Second Antenna*: Endopodite: The 2nd joints of *D. wilkensi*, *D. bahamensis*, and *D. phalanx* bear 4 long filament-like bristles near the ventral margin in the male, and only 3 bristles in the female (the adult male of *D. elizabethae* also has 4 bristles); the 3rd joints of all known males form a sclerotized clasper.

#### Ontogeny

The shells of *D. wilkensi* are sufficiently transparent to observe the furca and some appendages without removing the body, and observations concerning ontogeny are based mainly on undissected specimens. The furcae of all specimens in the collection have 3, 4, 7, or 8 claws on each lamella, indicating that not all instars are present. Kornicker and Sohn (1976, table 4) concluded that in *Thaumatococha radiata* Kornicker and Sohn, 1976, bristles first appear on the 6th limb in the 3rd instar. One specimen of *D. wilkensi* having only 4 furcal claws has a 6th limb with bristles, and it is interpreted to be the 3rd instar. Several specimens, also with 4 furcal claws, have a thumb-like bare 6th limb and are interpreted to be the 2nd instar. The thumb-like bare 6th limb was not observed in all specimens, but it was noted that those with it also have only 1 bristle on the end joint of the 5th limb, whereas the specimen having bristles on the 6th limb has 2 bristles on the end joint of the 5th limb, so this character was used to separate 2nd and 3rd instars. Carapace size of the 2nd and 3rd instars overlap. Specimens without a 6th limb and having only 3 furcal claws were identified as 1st instars. All specimens with 3 or 4 furcal claws are without a 7th limb. No specimens in the collection have either 5 (4th instar) or 6 (5th instar) furcal claws. One juvenile male in the collection has 7 furcal claws on each lamella (the 7th claw is smaller than others and could be considered to be an anlage); it has 3 bristles on the end joint of the 5th limb, and a fully developed 7th limb; this specimen is interpreted to be the 6th instar; it has a small poorly developed copulatory organ (Figure 13k), and the 6th instar is interpreted to be the A-1 stage. Adults of both sexes have 8 furcal claws. According to the above interpretation, *D. wilkensi* has 7 growth stages. Seven growth stages have been estimated for *T. radiata* by Kornicker and Sohn (1976, table 15). Five growth stages have been estimated for *D. bahamensis* Kornicker and Iliffe (1989a:14). *Danielopolina orghidani* (Danielopol, 1972) may have only 4 growth stages (Correction: Kornicker and Iliffe (1989a:14) incorrectly estimated the species to have 5 growth stages). Thus, unlike known species of *Thaumatococha*,



which have 7 growth stages, the number of stages in species of *Danielopolina* is quite variable (4–7); however, no collection of *Danielopolina* has contained all growth stages, so conclusions concerning the number of stages must be considered estimates.

The stages of *D. wilkensi* are described above but main points are summarized here. The 1st instar has 1 bristle on the terminal joint of the 5th limb, is without 6th and 7th limbs, and the furca bears 3 claws on each lamella. The 2nd instar has 2 bristles on the terminal joint of the 5th limb, a small bare thumb-like 6th limb, no 7th limb, and the furca bears 4 claws on each lamella. The 3rd instar has 2 bristles on the end joint of the 5th limb, many bristles on the 6th limb, no 7th limb, and the furca bears 4 claws on each lamella. 4th and 5th instars are absent from the collection, but presumably have well-developed 5th, 6th, and 7th limbs, and each lamella of the furcae bears 5 and 6 claws, respectively. The 6th instar has well-developed 5th (end joint with 3 bristles), 6th, and 7th limbs, and each lamella of the furca bears 6 well-developed claws followed by a smaller claw (anlage); also, the male bears a small poorly developed copulatory organ. The adult has fully developed limbs, and each lamella of the furca bears 8 claws followed by a small triangular process.

#### Suborder CLADOCOPINA Sars, 1866

#### Superfamily POLYCOPOIDEA Sars, 1866

#### Family POLYCOPIDAE Sars, 1866

#### Subfamily POLYCOPINAE Sars, 1866

COMPOSITION AND DISTRIBUTION.—The Polycopinae include 14 genera of which two (*Micropolycope* Chavtur, 1981, and *Polycopissa* Chavtur, 1981) have representatives in Bermudian Caves (Kornicker and Iliffe, 1989c), and one (*Pontopolycope* Chavtur, 1981) is represented in a Jamaican Cave (Kornicker and Iliffe, 1992). *Eupolycope* Chavtur, 1981, previously known only from open seas, is recorded in a lava tube in the Canary Islands herein. A second species of Polycopinae represented by a single specimen collected in the lava tube is left in open nomenclature as “genus and species indeterminate.” One species of *Metapolycope* Kornicker and van Morkhoven, 1976, which is in the subfamily Polycopissinae Chavtur, 1983, is known from Bermudian Caves (Kornicker and Iliffe, 1989c:50).

#### *Eupolycope* Chavtur, 1981

TYPE SPECIES.—*Polycope putjatini* Chavtur, 1977.

COMPOSITION.—Including the new species described herein, the genus *Eupolycope* contains eight species. All previously known species were collected in the open marine environment of the northern hemisphere (Chavtur, 1983:109).

#### *Eupolycope pnyx*, new species

FIGURES 14, 15

ETYMOLOGY.—From the Greek *pnyx* (place for public assembly in Athens).

HOLOTYPE.—USNM 194149, undissected adult female in alcohol.

TYPE LOCALITY.—Sta 92-020, Atlantida Tunnel, Jameos del Agua lava tube, Lanzarote, Canary Islands; collected with plankton net from water in 9–24 m depths at 10–300 m penetration.

PARATYPES.—Sta 92-016: USNM 194148A, 194148B, 194148C, 3 undissected adult females in alcohol; USNM 194148D, 3 undissected specimens in alcohol. Sta 92-017: USNM 194150, holomount adult female on slide. Sta 92-019: USNM 194142, dissected adult female on slide; USNM 194144, dissected adult female on slide; USNM 194146, dissected adult female on slide. Sta 92-021: USNM 194143, holomount adult female on slide; USNM 194151A, dissected specimen on slide (shape of carapace similar to that of adult female (length 0.20 mm, height 0.15 mm), with small copulatory organ and appendages similar to those of adult female, including endopodite of 2nd antenna); USNM 194151B, 2 adult females in alcohol.

DISTRIBUTION.—Atlantida Tunnel, Jameos del Agua lava tube, Lanzarote, Canary Islands.

DESCRIPTION OF ADULT FEMALE (Figures 14, 15).—Carapace elongate with anterior concavity and serrate anteroventral margin (Figure 14a,b). Several long bristles present along dorsal margin. (Specimens in their original alcohol had on the anterior of the shell several lines parallel to the anteroventral margin; these disappeared when the specimens were immersed in glycerine.)

*Carapace Size*: USNM 194142, length 0.22 mm, height 0.17 mm; USNM 194143, length 0.20 mm, height 0.14 mm; USNM 194146, length 0.23 mm, height 0.17 mm; USNM 194148A, length 0.21 mm, height 0.16 mm; USNM 194148B, length 0.22 mm, height 0.16 mm; USNM 194148C, length 0.21 mm, height 0.16 mm; USNM 194149, length 0.22 mm, height 0.14 mm; USNM 194150, length 0.18 mm, height 0.16 mm.

*First Antenna* (Figures 14f,g, 15a): 1st joint fused to 2nd but boundary indicated by slight indentations in dorsal and ventral margins and by oblique lateral row of long spines (Figure 15a), dorsal margin of 1st joint with few distal spines. Joints 2–5 fused; inferred 2nd joint with terminal dorsal bristle and proximal ventral bulge; inferred 3rd joint with few distal ventral spines; inferred 4th bare; inferred 5th joint with few indistinct distal ventral spines. 6th joint separated by suture from 5th joint and fused 7th and 8th joints, with 1 short dorsal bristle. 7th and 8th joints with total of 4 long filament-like bristles (with proximal rings), but distribution could be interpreted to be 2 bristles on each joint.

*Second Antenna*: Protopodite with few medial long dorsal hairs at midlength (Figure 14f,g). Exopodite with 9 joints (Figure 14c); a long ringed bristle on each of joints 1–8 (hairs on bristles, if present, not resolved); 9th joint with 2 bristles (1

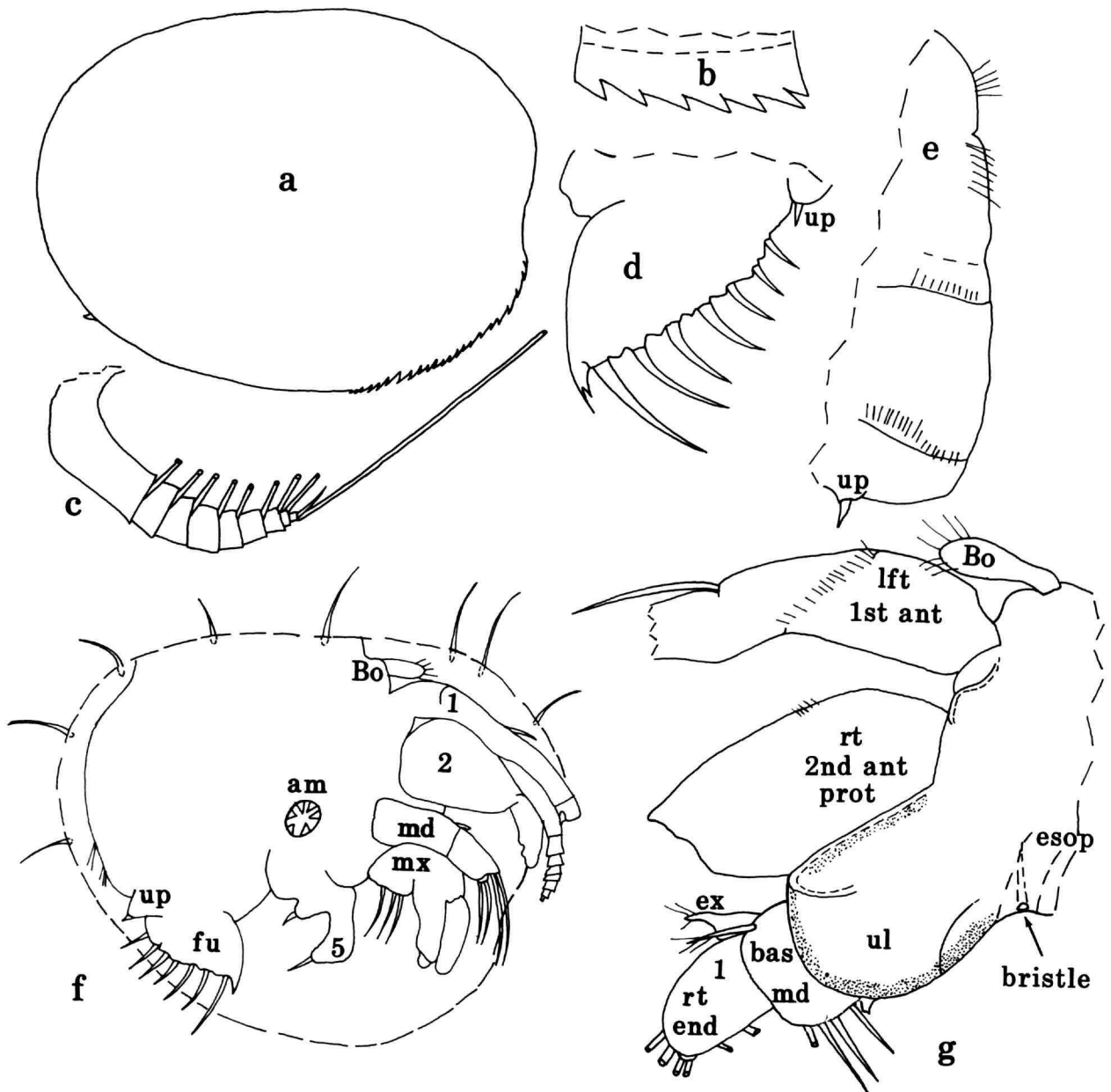


FIGURE 14.—*Eupolycope pnyx*, new species, USNM 194142, paratype, adult female: *a*, complete specimen from right side, length 0.22 mm; *b*, serrations along anteroventral edge of left valve, ov; *c*, exopodite of 2nd antenna (only small bristle of 9th joint completely shown; natatory hairs not shown); *d*, left lamella of furca and unpaired process, lv; *e*, posterior of body from left side showing unpaired process and spines. USNM 194143, paratype, adult female: *f*, complete specimen from right side, outline of carapace dashed, length 0.20 mm. USNM 194146, paratype, adult female (carapace length 0.23 mm); *g*, anterior of body from left side showing Bellonci organ, parts of 1st and 2nd antennae, mandible, upper lip (stippled), and a bristle (dashed) extending into esophagus (dashed).

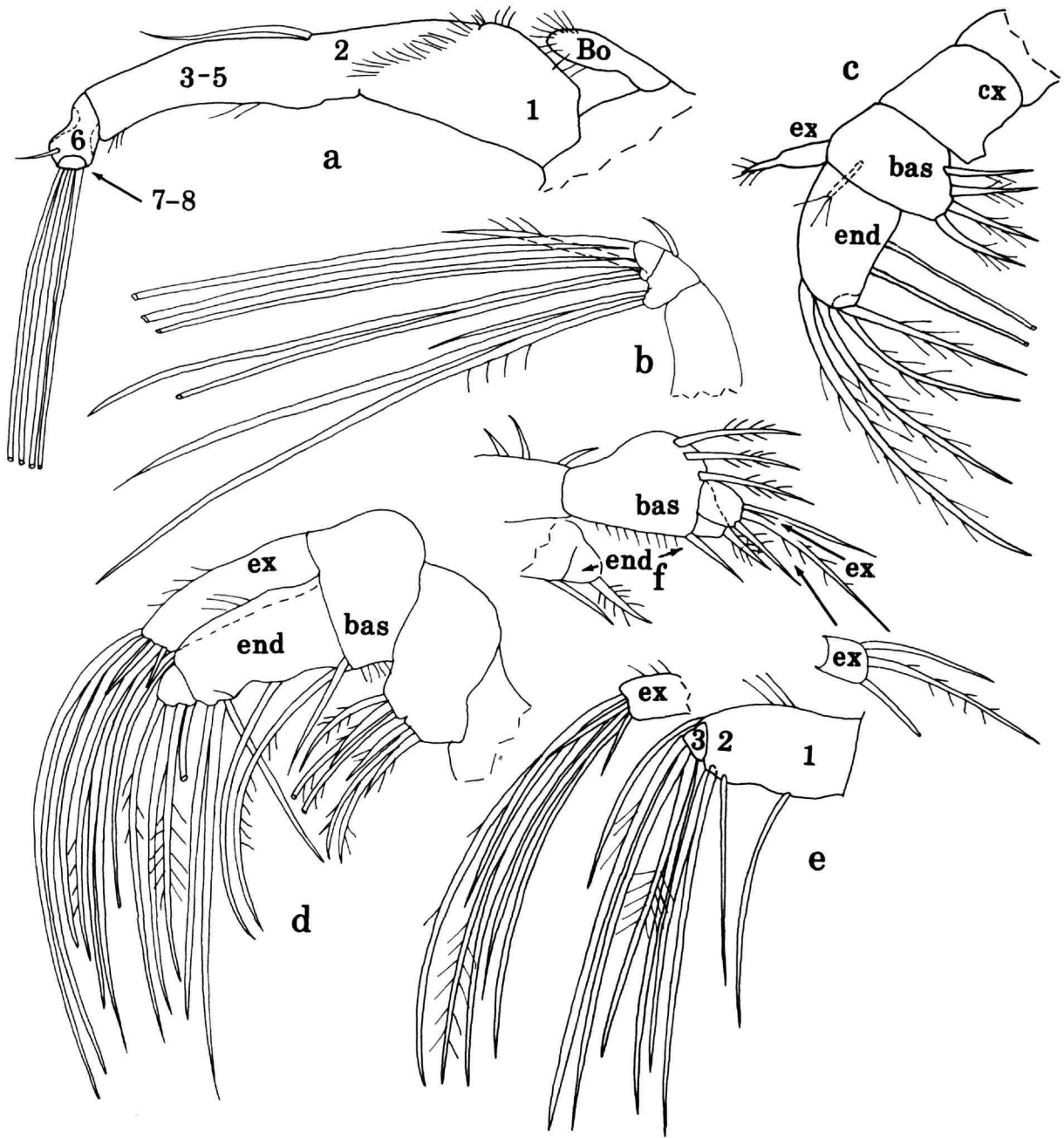


FIGURE 15.—*Eupolycope pnyx*, new species, USNM 194146, paratype, adult female: *a*, left 1st antenna, lv; *b*, endopodite of left 2nd antenna, lv; *c*, left mandible, lv; *d*, right maxilla, mv; *e*, right maxilla showing endopodite and tip of exopodite in place, mv; *f*, right 5th limb, lv.

short, 1 long but shorter than bristles of joints 1–8). Endopodite (Figure 15b): 1st joint bare. 2nd joint with 1 short dorsal bristle and 3 ventral bristles (1 short, 2 long filament-like (1 bare, 1 with few long hairs)). 3rd joint with 6 bristles (1 short with long hairs, 5 long filament-like).

**Mandible** (Figures 14f,g, 15c): Coxale endite with fairly smooth distal edge. Basale with 4 spinous ventral bristles, and 1 distal stout spinous medial bristle near dorsal margin. Exopodite diaphanous, difficult to resolve, with stout proximal 1st joint and narrow 2nd joint with terminal hairs; joints fused but indistinct suture observed on USNM 194146 (not shown). Endopodite: 1st joint with 2 distal long spinous dorsal bristles and 2 long ventral bristles; 2nd joint small with 2 long spinous bristles.

**Maxilla** (Figures 14f, 15d,e): Precoxale fragmented. Coxale with bare convex dorsal margin, and ventral margin with 2 endites each with 4 spinous bristles (2 short medial, 2 long lateral). Basale separated from coxale, endopodite, and exopodite by well-defined sutures: dorsal margin with proximal hump (internal muscles extend from hump into exopodite and endopodite); ventral margin with indistinct hairs, and 2 terminal bristles (1 short, 1 long). Endopodite: 1st and 2nd joints fused; inferred 1st joint long, with 1 long ventral bristle near midlength; inferred 2nd joint short with 3 ventral bristles (longest with broad area near base) and 1 dorsal bristle; 3rd joint well defined, with 4 terminal bristles (medial ventral of these with few stout spines near midlength). Exopodite: with indistinct distal dorsal spines and 8 terminal bristles (6 long (3 narrowing near midlength), 2 short).

**Fifth Limb** (Figures 14f, 15f): Epipodite with 10–12 diaphanous bristles. Coxale with 3 dorsal bristles. Basale spinous, with 4 bristles (3 dorsal and 1 terminal ventral). Endopodite 1-jointed with short stout spinous terminal bristle. Exopodite with 3 terminal bristles (middle bristle longer and spinous).

**Furca** (Figures 14d,f): Each lamella generally with 7 claws but some with only 6 on left lamella; each claw with indistinct sheath or spines along posterior edge; anterior corner of lamella with slender process overhanging short triangular protuberance; short protuberance on lamella following each claw. Single short unpaired pointed process following lamellae.

**Bellonci Organ** (Figures 14f,g, 15a): Single club-like process with terminal spines (organ usually visible through shell).

**Upper Lip** (Figure 14g (stippled)): Large single process in lateral view.

**Posterior of Body** (Figure 14e): Spinous.

**Genitalia**: None observed.

**COMPARISONS**.—Chavtur (1983:110) referred seven species to *Eupolycope*: *E. difficilis* (Klie, 1936:517), *E. putjatina* (Chavtur, 1977:154), *E. pseudoputjatina* (Chavtur, 1977:156), *E. kurilensis* (Chavtur, 1977:152), *E. pellucida* Chavtur, 1979:96, *E. orientalis* (Chavtur, 1983:111), and *E. parma* Chavtur, 1983:113. The 1st endopodial joints of the mandibles of all seven species bear 2 or 3 proximal ventral bristles, which are absent on *E. pnyx*. The central adductor muscle attachments of *E. pnyx* consist of 6 small radially arranged muscles. Previously described species of the genus have 3 central adductor muscle attachments (not known for *E. difficilis*). Previously described species of the genus have an anterior bristle on the exopodite of the mandible, which apparently is lacking on the diaphanous exopodite of *E. pnyx*.

### Genus and Species Indeterminate

FIGURE 16

The morphology of the 1st antenna indicates that it belongs in the subfamily Polycopinae, but the mandible and Bellonci organ are obscured on the mounted specimen so that it could not be identified further. Two easily visible characters that distinguish the species from *Eupolycope pnyx* are given below.

**MATERIAL**.—Single adult female.

**DISTRIBUTION**.—Sta 92-016.

**DESCRIPTION OF ADULT FEMALE** (Figure 16).—Carapace oval in lateral view with about 8 small truncated processes along anteroventral edge (Figure 16a), and more widely separated indistinct pointed processes along ventral edge.

**Carapace Size**: Length 0.19 mm, height 0.14 mm.

**First Antenna** (Figure 16b): 1st joint with indistinct suture separating it from 2nd joint and with proximal ventral node. Joints 2–5 fused; inferred 2nd joint with dorsal terminal bristle. 6th joint bare. 7th and 8th joints with total of 5 long bristles.

**COMPARISONS**.—This species is easily separated from *Eupolycope pnyx* in having truncated processes along the anteroventral edge of the carapace rather than serrations; also, the 7th and 8th joints of the 1st antenna bear a total of 5 long bristles (Figure 16b) compared to 4 on *E. pnyx* (Figure 15a).

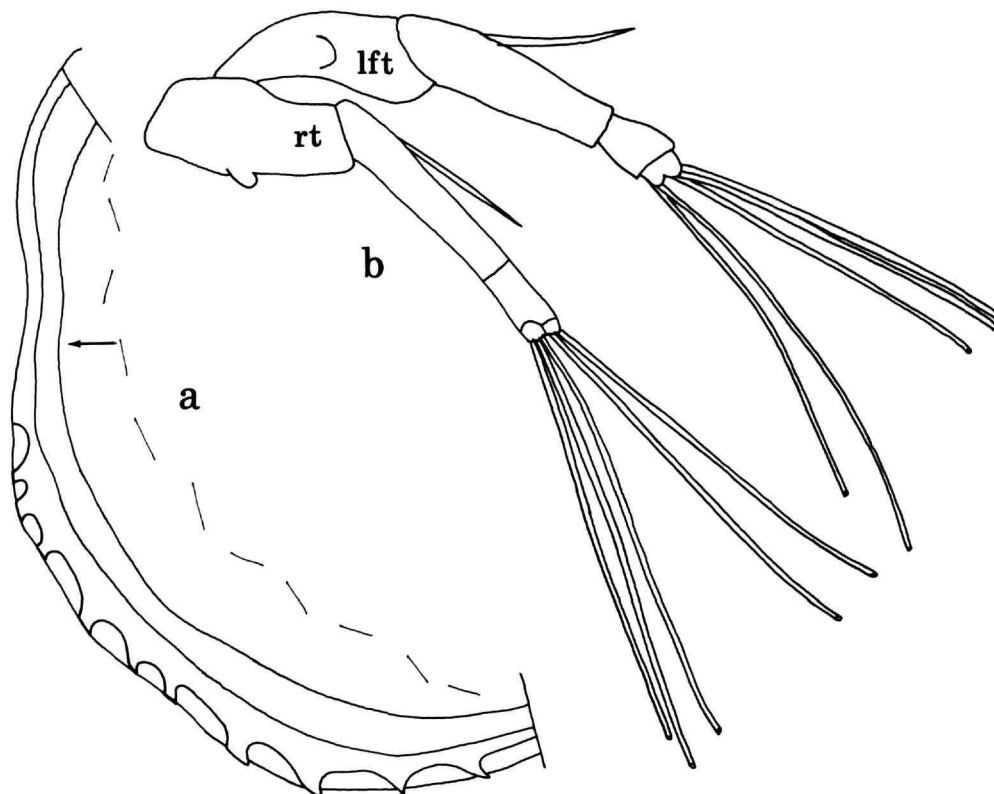


FIGURE 16.—Polycopinae, genus and species indeterminate, adult female, from sta 92-016: *a*, anterior and anteroventral margin of right valve, anterior to left (complete carapace length 0.19 mm), iv; *b*, 1st antennae.



## Appendix

### Station Data with Specimens Examined

(Except for sta 92-028 from Jameos de los Lagos, a more inland tidal lake in the same lava tube, samples are from Atlantida Tunnel, Jameos del Agua lava tube, Lanzarote. All samples were collected in water having a salinity of 37‰.)

- Sta 92-016, 16 Jul 1992; collected with plankton net from water in 9–24 m depths at 10–350 m penetration.  
*Danielopolina phalanx*: 1 adult female, USNM 194125.  
*Danielopolina wilkensi*: 1 adult male, USNM 194141A; 1 Instar II (A–5?) juvenile, USNM 194141B; 4 adult females, USNM 194141C; 2 Instar I (A–6?) juveniles, USNM 194141D.  
*Eupolycope pnyx*: 1 adult female, USNM 194148A; 1 adult female, USNM 194148B; 1 adult female, USNM 194148C; 3 specimens, USNM 194148D.  
Polycopinae, genus and species indet.: 1 adult female.
- Sta 92-017, 16 Jul 1992; collected with plankton net from bottom silt in 23 m depth at 300 m penetration.  
*Danielopolina wilkensi*: 1 Instar II (A–5?) juvenile, USNM 194133.  
*Eupolycope pnyx*: 1 adult female, USNM 194150.
- Sta 92-018, 19 Jul 1992; collected with baited traps in 24 m depth at 150 and 200 m penetration.  
*Danielopolina wilkensi*: 1 Instar I (A–6?) juvenile, USNM 194137.
- Sta 92-019, 20 Jul 1992; collected with plankton net from water in 9–21 m depths at 30–300 m penetration.  
*Danielopolina phalanx*: 1 adult female, USNM 194126 (holotype); 1 adult male, USNM 194127; 1 adult female, USNM 194131.  
*Danielopolina wilkensi*: 1 adult female, USNM 194129; 1 Instar III (A–4?) juvenile, USNM 194134A; 1 Instar I (A–6?) juvenile, USNM 194134B; 1 Instar I (A–6?) juvenile, USNM 194134C; 1 Instar II (A–5?) juvenile, USNM 194135A; 6 adult females, USNM 194135B.  
*Eupolycope pnyx*: 1 adult female, USNM 194142; 1 adult female, USNM 194144; 1 adult female, USNM 194146.
- Sta 92-020, 22 Jul 1992; collected with plankton net from water in 9–24 m depths at 10–300 m penetration.  
*Danielopolina wilkensi*: 1 adult male, USNM 194128; 2 adult females, USNM 194138.  
*Eupolycope pnyx*: 1 adult female, USNM 194149 (holotype).
- Sta 92-021, 22 Jul 1992; collected with plankton net from water in 0–9 m depths in upper level.  
*Danielopolina wilkensi*: 1 Instar I (A–6?) juvenile, USNM 194152.  
*Eupolycope pnyx*: 1 adult female, USNM 194143; 1 specimen (sex uncertain), USNM 194151A; 2 adult females, USNM 194151B.
- Sta 92-025, 25 Jul 1992; collected with plankton net from water in 5–10 m depths in upper level.  
*Danielopolina wilkensi*: 1 adult male, USNM 194132A; 1 adult female, USNM 194132B; 1 adult female, USNM 194132C.
- Sta 92-028, 28 Jul 1992; Jameos de los Lagos, collected with plankton net from water in 0–50 m depths.  
*Danielopolina wilkensi*: 1 Instar I (A–6?) juvenile, USNM 194140A; 1 adult female, USNM 194140B.
- Sta 92-030, 1 Aug 1992; collected with plankton net from water in 10–25 m depths at 10–450 m penetration.  
*Danielopolina phalanx*: 1 specimen (sex not determined), USNM 194130.  
*Danielopolina wilkensi*: 1 Instar I (A–1?) male, USNM 194136A; 1 Instar I (A–6?) juvenile, USNM 194136B; 2 adult females, USNM 194136C; 1 adult male, 194139A; 1 adult female, USNM 194139B.

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