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DEEVEYINAE, A NEW SUBFAMILY OF OSTRACODA (HALOCYPRIDIDAE) FROM A MARINE CAVE ON THE TURKS AND CAICOS ISLANDS

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Abstract.—Deeveyinae, a new subfamily of the Halocyprididae (Ostracoda, suborder Halocypridina) is proposed for *Deeveya spiralis,* a new genus and species of troglobitic ostracode from an anchialine cave in the Turks and Caicos Islands, West Indies. The new genus and species is described and illustrated.

Danielopol (1972) described the first troglobitic halocyprid ostracode from a marine cave in Cuba. Therefore, the discovery of a second halocyprid in an anachialine cave on the Turks and Caicos Islands, which are a southeast continuation of the outer line of the Bahama Islands, is of interest. Although the two caves are relatively close geographically, differences between the specimens from the two caves led to the proposing a new subfamily for the specimens from the Turks and Caicos Islands. Danielopol (1972) referred his species to the Thaumatocyprididae, whereas the present new species is referred to the Halocyprididae.

Family Halocyprididae

The Halocyprididae comprises five subfamilies, Conchoecinae, Halopyridinae, Archiconchoecinae, Euconchoecinae, and Deeveyinae, the new subfamily described herein.

Deeveyinae, new subfamily

Diagnosis.—First antenna with 8 segments. Sixth limb with distal dorsal process on 1st exopodial segment. Seventh limb with 3 bristles. Organ of Bellonci bifurcate.

Discussion.—The new subfamily is referred to the Halocyprididae rather than to the Thaumatocyprididae because the furca of *Deeveya spiralis* is of the halocyprid rather than the thaumatocyprid type. None of the other subfamilies of Halocyprididae have members having the combined characters listed in the diagnosis above.

Deeveya, new genus

Etymology.—The genus is named for Georgiana B. Deevey. Gender: Feminine.

Type-species.—*Deeveya spiralis,* new species.

Distribution.—The type-species from a marine cave in the Turks and Caicos Islands, depth 7 m.

Diagnosis.—Carapace without rostrum. First antenna with 8 segments: first segment without bristles; eighth segment bearing 4 bristles. Endopodite of second antenna with 3 segments: first segment without processus mammillaris but with 2 dorsal bristles; second segment with 3 long bristles; small third segment with 2

long bristles. Sixth limb with dorsal process bearing 4 bristles on first exopodial segment of type-species. Seventh limb with 3 bristles. Furca with 7 claws on each lamella, and 1 unpaired dorsal bristle; claws 5–7 bristle-like; all claws separated from lamella by suture. Organ of Bellonci short, bifurcate.

Comparisons.—The new genus differs from previously described members of the Halocyprididae in having no rostrum, eight segments on the first antenna, a dorsal bristle-bearing process on the first exopodial segment of the sixth limb, and three bristles on the seventh limb. *Deeveya* differs from known members of the Thaumatocyprididae in having all furcal claws separated from the lamellae by a suture, three bristles on the seventh limb, a bifurcate organ of Bellonci, and no bristles on the first segment of the first antenna. Some species of the halocyprid genera *Halocypris* and *Halocypria* have a minute rostrum.

Deeveya spiralis, new species
Figs. 1–12

Etymology.—From the Latin *spiralis* (=coil, twisted), in reference to the two twisted bristles of the mandibular basis.

Material.—Turks and Caicos Islands, Caicos Islands, Providenciales Island, The Hole, 30 Oct 1982, coll. Thomas M. Iliffe, specimens collected with suction bottle from 5 to 7 m depths using scuba. Holotype, USNM 193117, adult female; paratype, USNM 193118, adult female.

Distribution.—Known only from the anchialine habitats of The Hole, Providenciales Island, Turks and Caicos Islands.

Habitat.—The Turks and Caicos Islands are a southeast continuation of the outer line of the Bahama Islands. The basic geological and geomorphological setting is generally similar to that of the Bahamas. The Bahama Platform, including the Caicos Bank, is composed of a flat-lying shallow-water carbonate cap thicker than the surrounding ocean is deep (Dietz, Holden, and Sproll 1970). The thickness of this near homogeneous cap indicates that the depositional environment of the Platform—a shallow water situation—must have remained essentially the same since at least the early Cretaceous. A history of subsidence offset by upbuilding of coral-algal carbonates has maintained the plateau at sea level.

Providenciales Island is located on the northern edge of the Caicos Bank. The main topographical feature of the island is a line of rounded hills 20 to 40 m above sea level, running parallel to the coastline. These hills are formed from reef-derived eolian carbonates, probably of Pleistocene age.

The Hole is a sheer-walled cenote-like pit located near the crest of a line of hills at the western end of Providenciales, 1.1 km from the nearest open water, the south coast. It is about 15 m deep with a 15 m long by 10 m wide lake at the bottom, open to daylight. The bottom of the 6 to 8 m deep lake is completely choked with breakdown and surface debris such that no human-sized cave passages extending off from it were found. In addition to *Deeveya spiralis,* species observed or collected from the lake include a representative of a new genus of nebaliacean *Speonebalia cannoni* being described by Bowman, Yager, and Iliffe (1985), a new genus of amphipods being studied by John R. Holsinger, a crab identified as *Sesarma* (*H.*) *miersii* Rathbun by C. W. Hart, Jr., and an uncollected copepod. Other marine caves on Providenciales Island contain the shrimps *Barbouria cu-*

bensis and *Typhlatya garciai* (Buden and Felder 1977), the amphipod *Spelaeonicippe provo* (Stock and Vermeulen 1982), a new family of shrimps (Hart and Manning, in preparation), and a new species of stygiomysid (Bowman, Iliffe, and Yager 1984).

Although we did not measure salinity in the lake, we expect that, at least in the deeper waters from which the thaumatocyprids were collected, it is at or near open ocean levels (about 35 to 36‰). Salinities presumably measured from the surface waters of other caves on Providenciales were 18 and 19‰ (Buden and Felder 1977; Stock and Vermeulen 1982). Under similar conditions in Bermuda caves, a several meters-thick surface layer of 3 to 30‰ overlies full salinity waters (Sket and Iliffe 1980; Iliffe, Hart, and Manning 1983).

Discussion.—A number of taxa from primarily deep water groups have been recently discovered in shallow water marine caves. Several species inhabiting a sea water flooded lava tube cave in the Canary Islands show affinities to deep sea species (Iliffe *et al.* 1984). These include *Munidopsis polymorpha* from the primarily bathyal group of the Galatheidae, the amphipod *Spelaeonicippe buchi* belonging to the mainly abyssal family Pardaliscidae, and the polychaete *Gesiella jameensis* from the mostly deep water group Macellicephalinae. Similarly, from marine caves in the Caicos Islands, the amphipod *Spelaeonicippe provo,* a close relative of *S. buchi,* and a new polychaete being described by Pettibone and coworkers, also from the subfamily Macellicephalinae, may have a deep sea origin.

Among the ostracodes, a thaumatocyprid *Thaumatocypris orghidani* from caves in Cuba (Danielopol 1972, 1976), *Deeveya spiralis,* and new species having appendages similar to those of *D. spiralis* from Bermuda caves (Angel and Iliffe, in preparation) are most probably derived from stocks now inhabiting the deep sea.

The stability and constancy of the shallow water environment on the Bahama Platform over prolonged geological periods has probably been a significant factor in sustaining relict populations of marine cavernicoles long after their open sea ancestors had become extinct. A large number of marine caves are now known from the Bahama Platform including the famous "Blue Holes," submerged circular sink holes of often spectacular dimensions (Warner and Moore 1984). These tidal, seawater-flooded caves have most probably existed on the Platform since the earliest stages of limestone deposition. A number of these Blue Holes have been explored to depths of 100 m or more and probably extend much deeper than that. A characteristic of the Bahama Platform is its steep-walled sides which rapidly drop off into oceanic depths. Strong tidal currents flowing into and out of those caves located near the edge of the Platform could draw deep water organisms or their larvae directly into caves. Subsurface water temperatures in those Bermuda marine caves remote from the sea have been found to remain seasonally constant at near the average year-round temperatures, thus indicating by extension that marine caves in general could have served as refugia for temperature-sensitive species during periods of Pleistocene glaciation (Iliffe, Hart, and Manning 1983). As a result of their age, geological and environmental stability, and proximity and tidal exchange with deep waters, marine caves of the Bahama Platform, including those caves in the Caicos Islands, are indeed highly suitable sites to serve as preserving centers for deep-water species.

Description of adult female (Figs. 1–12).—Carapace oval in lateral view except for linear dorsal margin and slightly concave anterior margin (Figs. 1, 4a). Car-

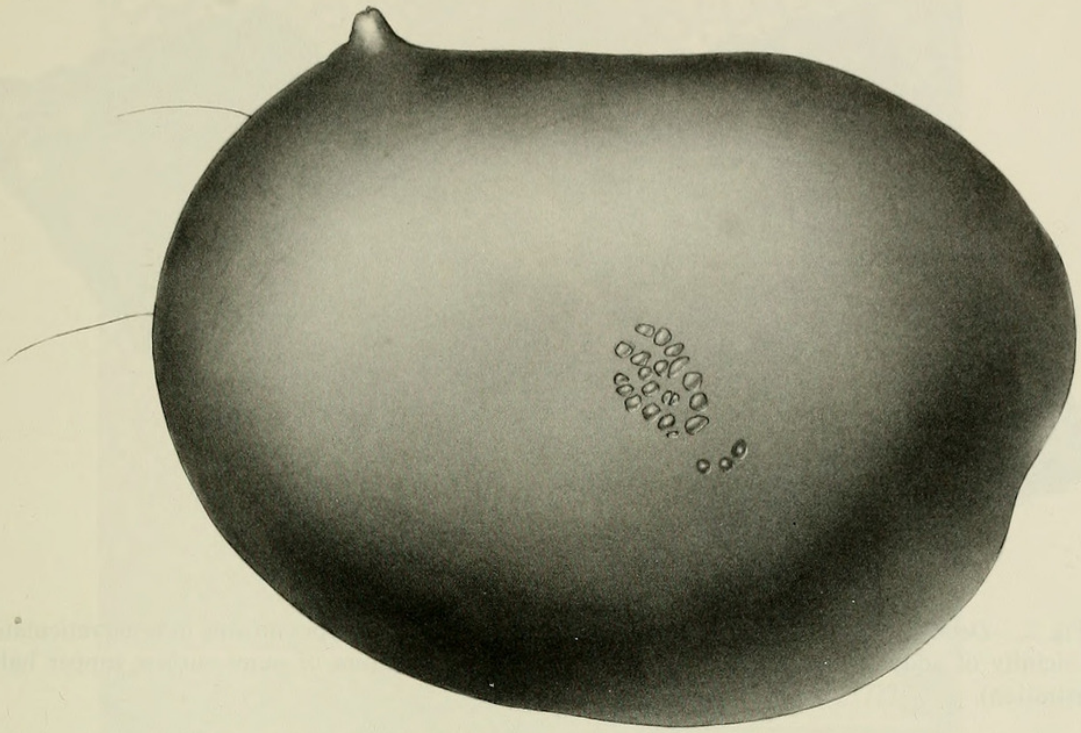

Fig. 1. *Deeveya spiralis,* lateral view of holotype, length 2.87 mm.

apace having greatest height just anterior to adductor muscles, greatest length just dorsal to adductor muscles, and greatest width near middle (Figs. 1, 4a–c). Right valve with small tubercle on dorsal margin near posterior end (Fig. 1).

Ornamentation (Figs. 1–6): Carapaces appearing reticulate in transmitted or reflected light (Figs. 4, 5), but reticulations mostly within translucent shell wall (Figs. 2, 3). Shell surface smooth except for minute bosses occurring mostly at intersections of walls forming reticulations (Figs. 5e, f, 6a–c, e), and for minute, round, shallow fossae occurring mostly in center of low domes within reticulations. Internal reticulations smaller and more numerous where muscles attach to shell (Fig. 2). Internal reticulations mostly with 4 sides but a few with 3 to 6 sides. (SEM micrographs show reticulations to be ubiquitous except in areas of muscle attachments where the shell appears smooth, except for shallow fossae and minute bosses (Figs. 6a–c). Reticulations appearing on surface in SEM micrographs probably occur during freeze-drying prior to taking micrographs when "skin" of shell contracts more at center of reticulations than at wall-forming reticulations. This interpretation is warranted because under the light microscope, reticulations are present in all areas of shell, not only in areas away from muscle attachments (Figs. 2, 3).)

Bristles (Figs. 1, 7a, b): 2–4 very long bristles present along posterior shell margin (Figs. 1, 7a); short bifurcate bristles along anterior and ventral shell margins (Fig. 7b); lateral surface of shell with very few slender short and medium length single bristles. Small bristle bearing long spines present at tip of dorsal tubercle of right valve.

Infold (Figs. 7a, b): Broad infold along anterior, ventral and posterior shell margins, narrowest opposite anterior concavity of margin, widest at anteroventral corner. Narrow list present near inner margin of infold, bearing narrow lameller

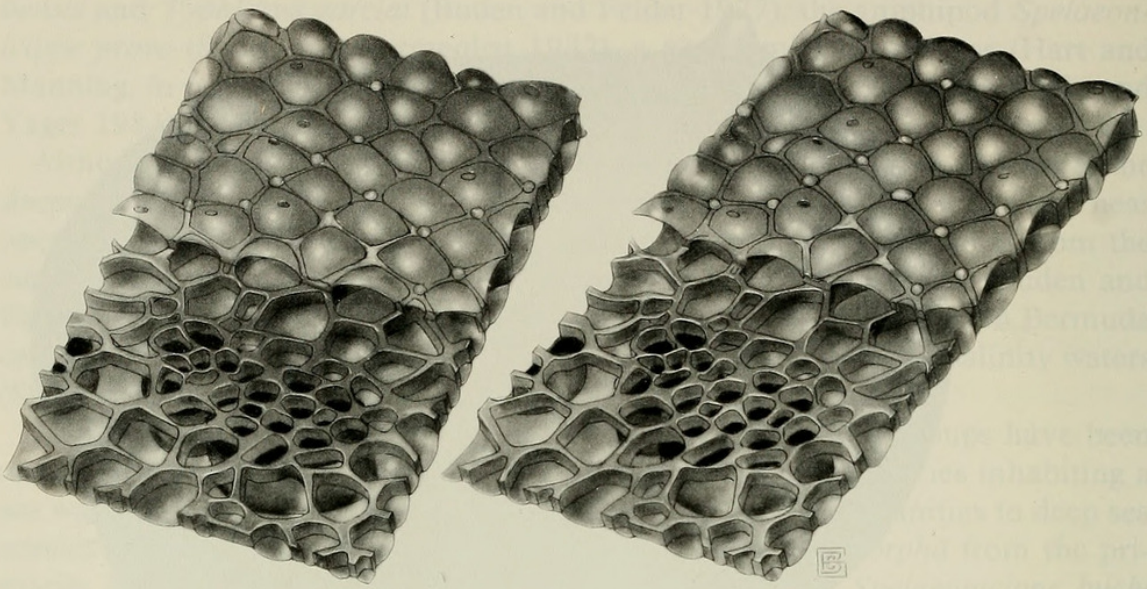

Fig. 2. *Deeveya spiralis,* stereoscopic pair of part of shell of holotype showing internal reticulations in vicinity of adductor muscles (ends black) and pillow structure of outer surface (upper half of illustration).

prolongation with smooth outer edge. Selvage along outer margin of infold with narrow lamellar prolongation with smooth outer edge.

Glands: No glandular openings observed on infold. Glandular opening on tip of dorsal tubercle of right valve anterior to minute seta.

Muscle attachments (Figs. 1–4a, d): Adductor muscles consisting of about 20 ovoid muscles attaching in elliptical area oriented obliquely just anterior to valve midlength; 3 muscle attachments forming row just anterior and ventral to central adductor muscle attachments (3 muscles may also be adductor muscles); few additional muscles attaching to valves closer to dorsal margin. Internal shell reticulations smaller and more numerous at points of muscle attachments than elsewhere (possible means of strengthening shell at points of muscle attachments).

Shell microstructure (Fig. 6f): When calcium carbonate of shell is dissolved by lactic acid, abundant fibers are visible in areas within walls of polygons. Some fibers are visible within broken edge of shell shown in Fig. 6f.

Shell size: Holotype, length 2.87 mm, height including tubercle 2.08 mm; paratype, length 2.67 mm, height including tubercle 2.05 mm.

First antenna (Fig. 8a): Elongate with 8 segments. First segment with distal lateral spines becoming longer near ventral margin; distal end of lateral side of first segment overlapping proximal part of second segment, especially in vicinity of ventral margin. Second segment with dorsal midbristle bearing short marginal spines; distal end of second segment overlapping proximal end of third segment, especially near ventral margin; distal half of second segment bearing abundant short spines (spines not shown on illustrated limbs). Third segment elongate, with spinous ventral bristle distal to middle, short proximal spines along dorsal margin, and longer spines on medial surface more or less restricted to distal ventral quarter. Fourth segment short, with slender dorsal bristle bearing short, faint, marginal spines. Fifth segment shorter than fourth, with long, ventral, terminal, filament-

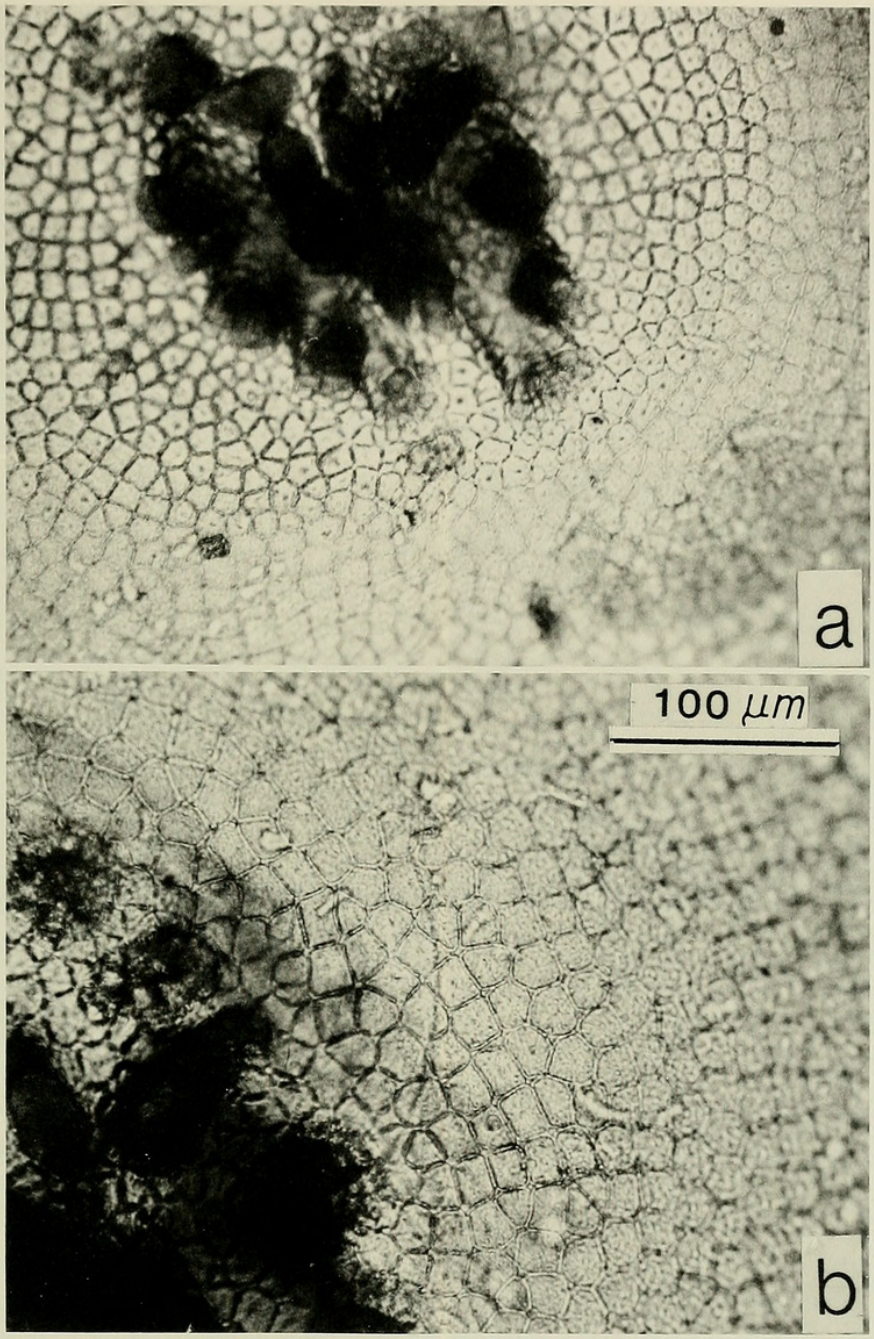

Fig. 3. *Deeveya spiralis,* a, Photograph using transmitted light and phase contrast of right valve of holotype showing internal reticulations in vicinity of adductor muscles (dark areas); b, Detail from a. Photographs by Dr. Robert P. Higgins.

like bristle bearing widely spaced short marginal spines and minute terminal spine. Sixth segment shorter than fifth, bare. Seventh segment about same length as fourth segment, with 1 short, distal, lateral, spinous bristle near dorsal margin, and 2 long, spinous (spines widely spaced) bristles on terminal ventral pedestal (both bristles longer than bristle of fifth segment; medial bristle about ¾ length of lateral bristle and filament-like). Eighth segment with long principal bristle (about 2 times length of stem) and 3 filament-like bristles about ½ length of principal bristle, all bristles with widely spaced marginal spines.

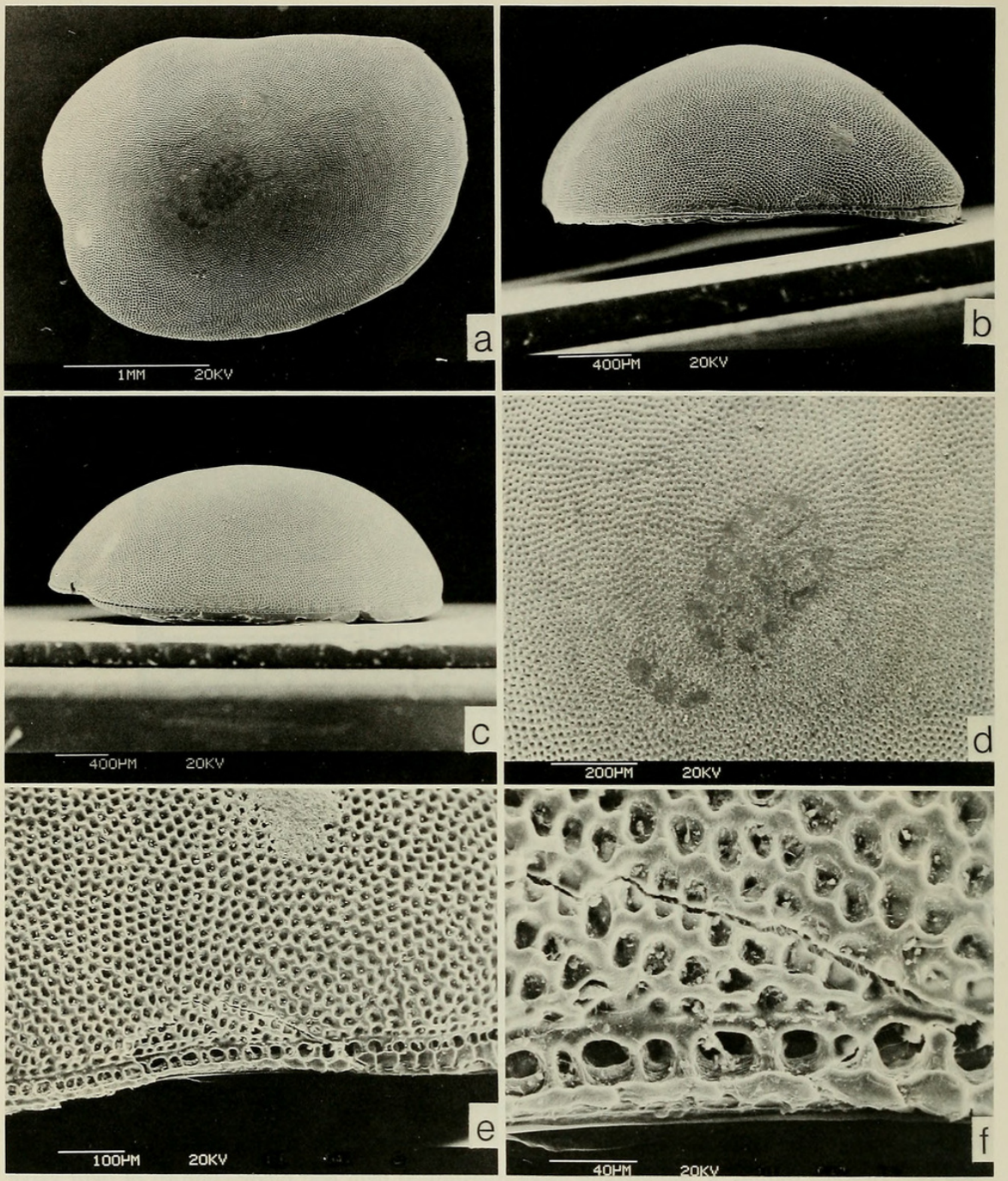

Fig. 4. *Deeveya spiralis,* SEM micrographs of left valve of holotype: a, Lateral view; b, Anterior view; c, Ventral view; d, Central area showing places where adductor muscles attach; e, Anterior view in vicinity of anteroventral concavity, from b; f, Detail from e.

Second antenna (Fig. 9a): Protopodite with long lateral spines forming 2 groups (1 proximal, 1 distal), and minute medial spines along dorsal margin. Endopodite 3-segmented: First segment with 2 spinous bristles on distal dorsal protuberance; second segment with 4 bristles (1 short, dorsal, spinous bristle and 3 long filament-like bristles with short widely spaced marginal spines), and short spine-like lateral bristle near dorsal margin of terminal ventral pedestal. Third segment with 2 long terminal bristles bearing widely spaced marginal spines (1 of the bristles filament-

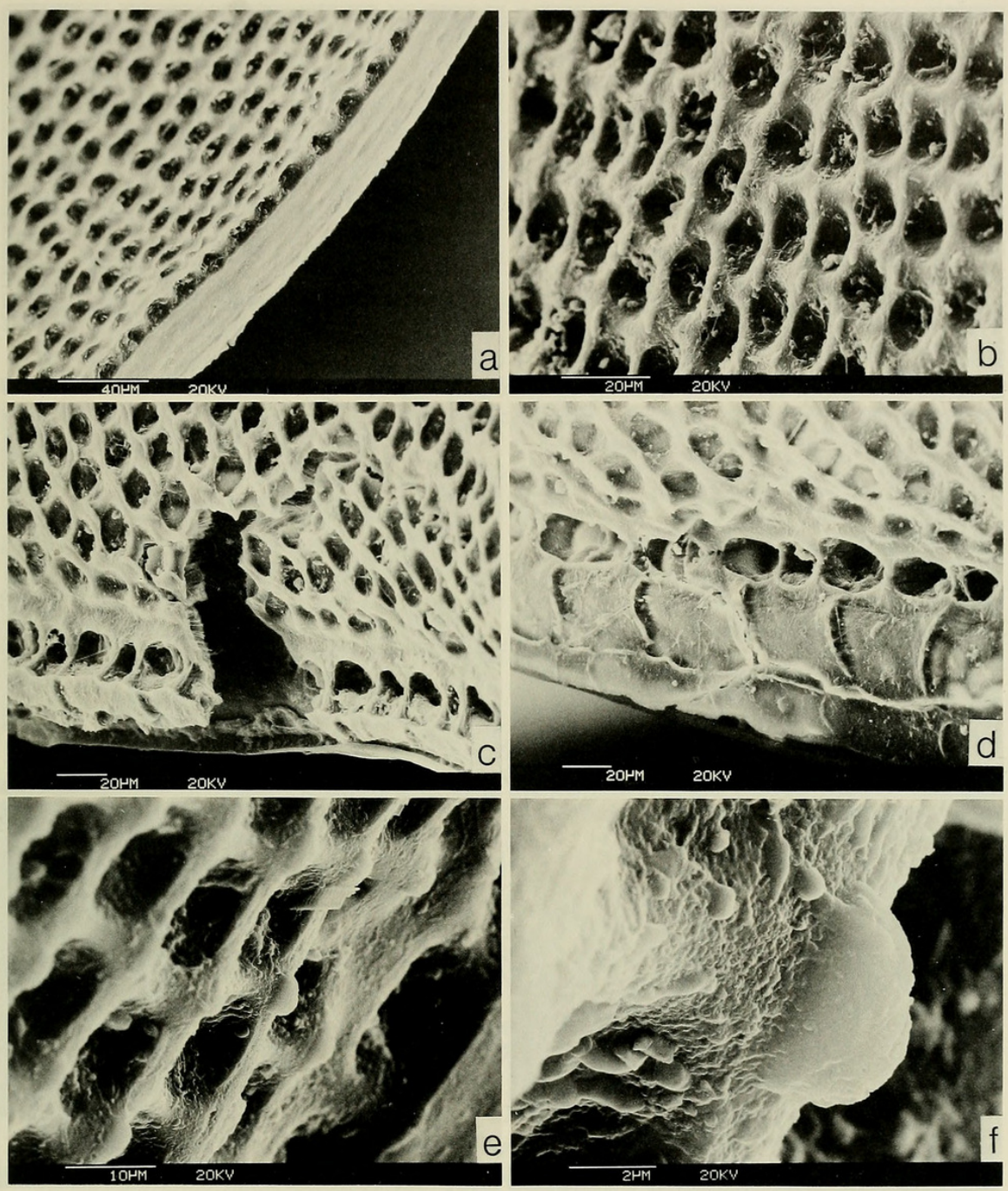

Fig. 5. *Deeveya spiralis,* SEM micrographs of left valve of holotype: a, Posteroventral corner, from Fig. 4a; b, Surface near anterior, from Fig. 4a; c, Surface near anterior showing fracture, from Fig. 4c; d, Surface at ventral margin, from Fig. 4c; e, Detail from a; f, Detail of protuberances shown in e.

like). Second and third segments forming right angle with first segment on holotype and paratype. Exopodite 9-segmented: First segment weakly divided into long proximal and short distal parts; proximal part with minute dorsal spines; distal part with slender, bare, medial bristle reaching past distal end of fifth segment. Segment 2 with long bristle bearing ventral spines and natatory hairs; joints 3–8 each with long bristle with natatory hairs; ninth joint with 4 bristles (2 short with marginal spines, 1 medium length with ventral marginal spines, 1 long with ventral

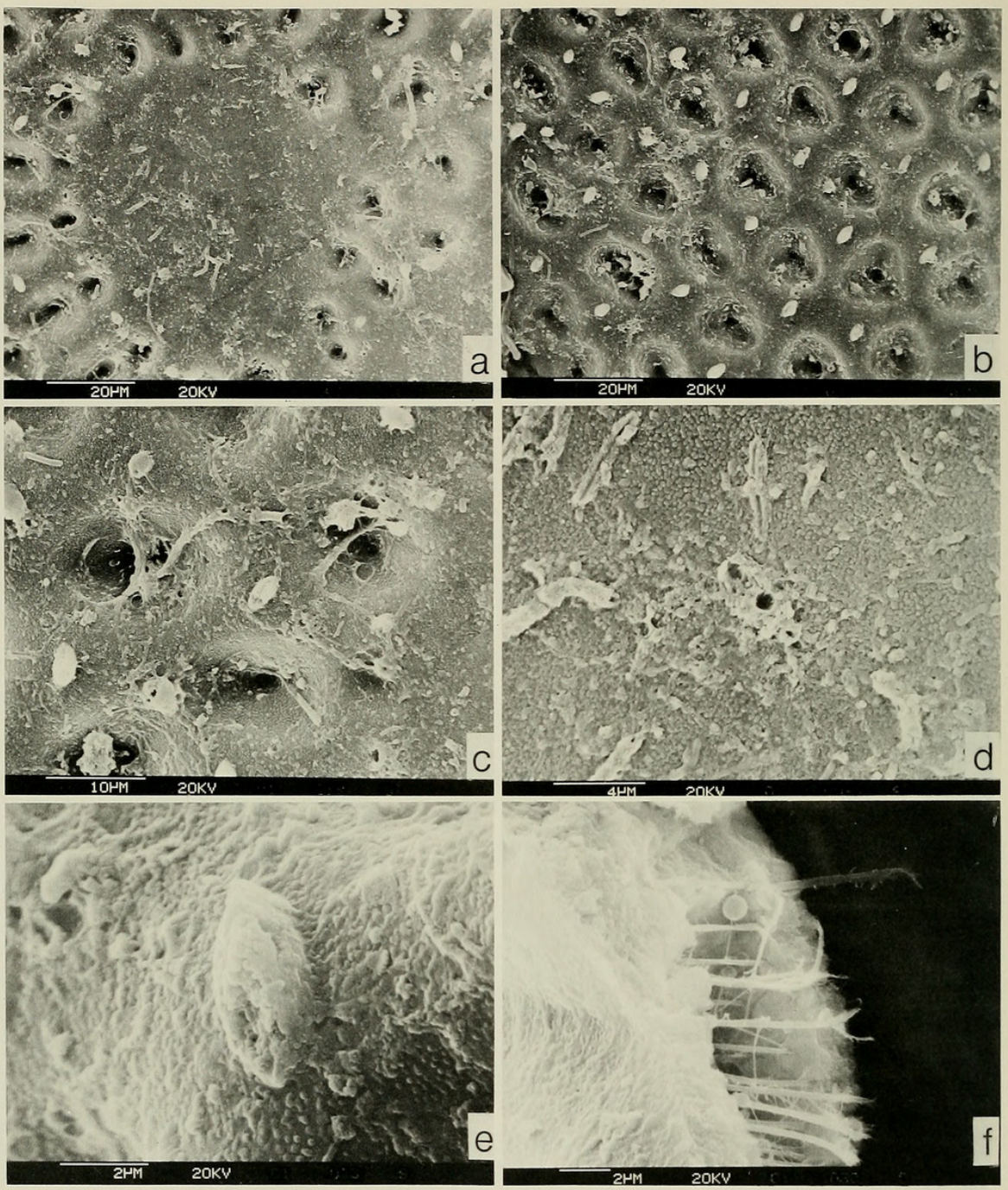

Fig. 6. *Deeveya spiralis,* SEM micrographs of left valve of holotype; a, Anterior muscle scar forming lower row in Fig. 4d; b, Fossae and minute protuberances near adductor muscles, from Fig. 4d; c, Detail from upper left of a; d, Detail of pore near middle of muscle scar shown in a; e, Detail of protuberance, from middle of Fig. 5b; f, Internal fibers perpendicular to shell surfaces, from fracture shown in Fig. 5c.

spines and distal natatory hairs); segments 2–8 decreasing in length distally along stem only slightly; ninth segment about ⅔ length of segment eight; segments 2–8 without basal spines or distal hairs or spines.

Mandible (Fig. 10): Coxal endite with proximal (also anterior) distal (also posterior) sets of teeth separated by small space (Fig. 10a, b): proximal (anterior) set

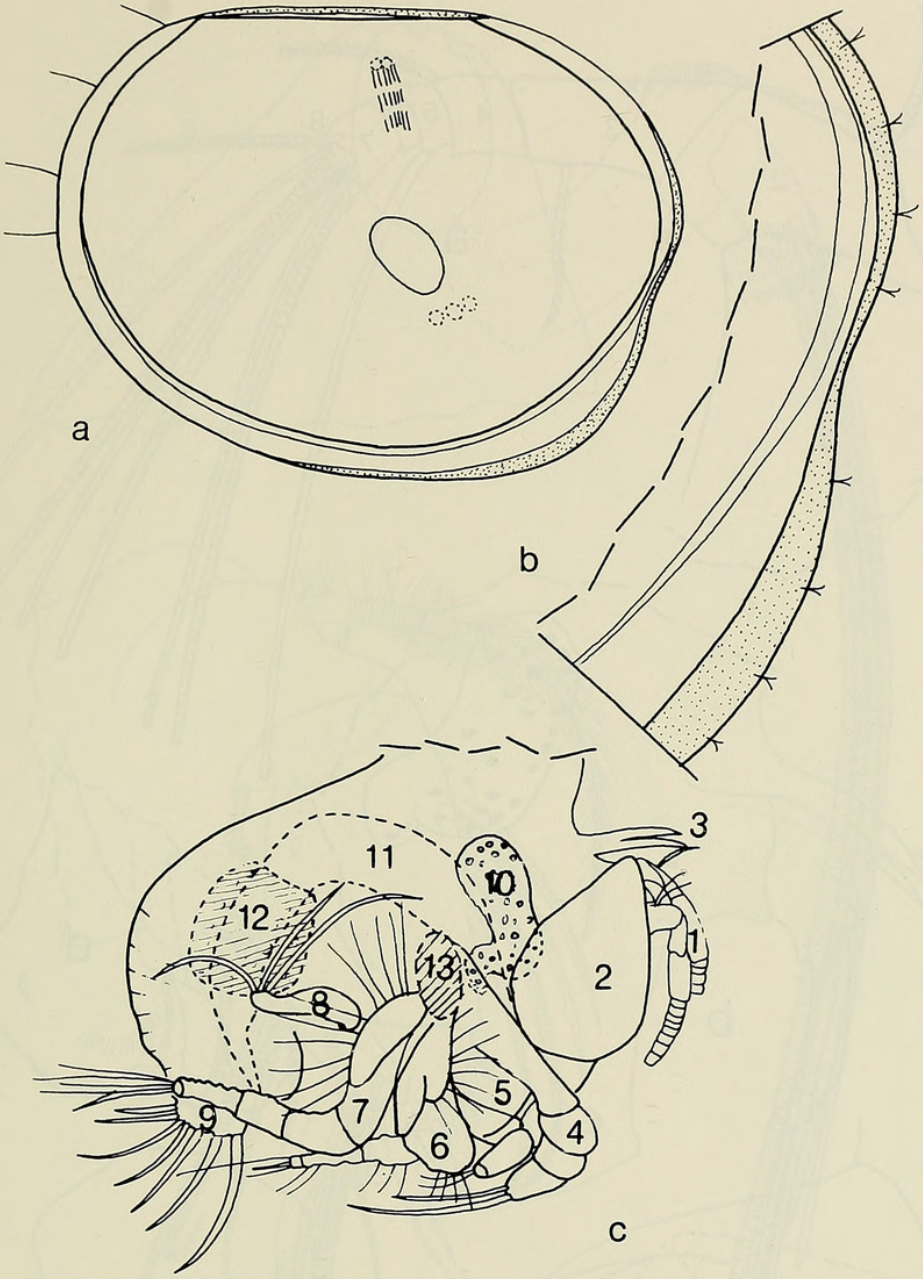

Fig. 7. *Deeveya spiralis,* a, Inside view of left valve of holotype showing infold, list on infold, and some muscles (main cluster of adductor muscles indicated by oval); b, Detail from a showing anterior concavity and bifurcate marginal bristles; c, Body of holotype from right side (1, 1st antenna; 2, 2nd antenna; 3, organ of Bellonci; 4, mandible; 5, maxilla; 6, 5th limb; 7, 6th limb; 8, 7th limb; 9, right lamella of furca; 10, hepatic appendage; 11, gut; 12, unknown receptacle; 13, central adductor muscle).

consisting of 4 broad teeth plus short, stout, spinous bristle near space; densely packed spines present between each tooth and anterior to anterior tooth and posterior to posterior tooth; slender spines also on medial surface proximal to teeth; distal (posterior) set of coxal teeth consisting of 2 terminal rows with 5 broad teeth in inner row and 6 in outer row (posterior tooth of inner row longer than others). Two lists present proximal and medial to inner row of distal coxal teeth; anterior of these consisting of anterior pectinate bristle-like tooth and posterior stout tooth; posterior list consisting of anterior pectinate bristle-like tooth

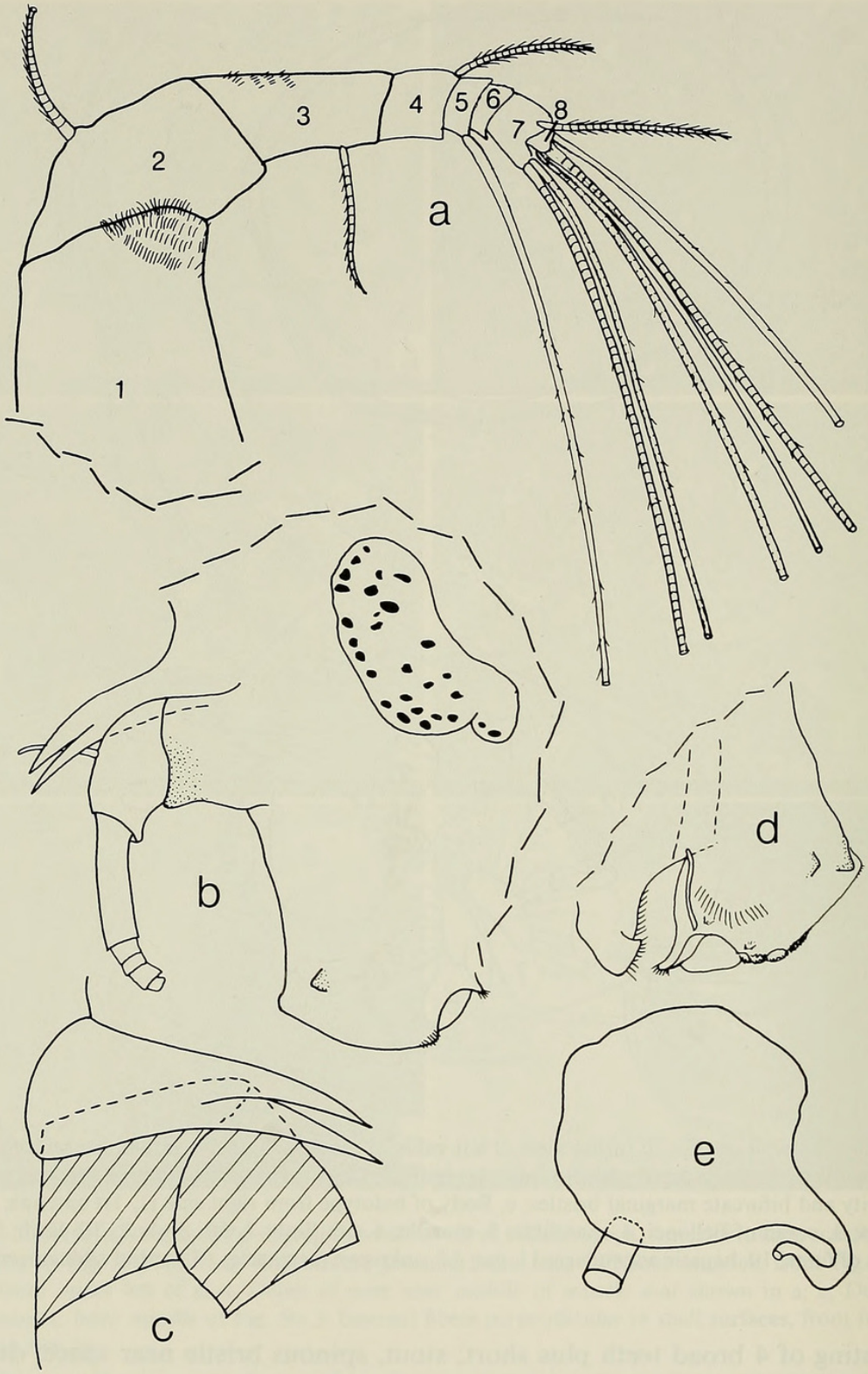

Fig. 8. *Deeveya spiralis,* holotype: a, Right 1st antenna; b, Anterior of body from left showing organ of Bellonci, part of left 1st antenna, and left hepatic appendage (with black spots); c, Anterior of body from right showing organ of Bellonci and first two segments of left 1st antenna; d, Upper and lower lips from right side; e, Unknown receptacle removed from right side of posterior part of gut.

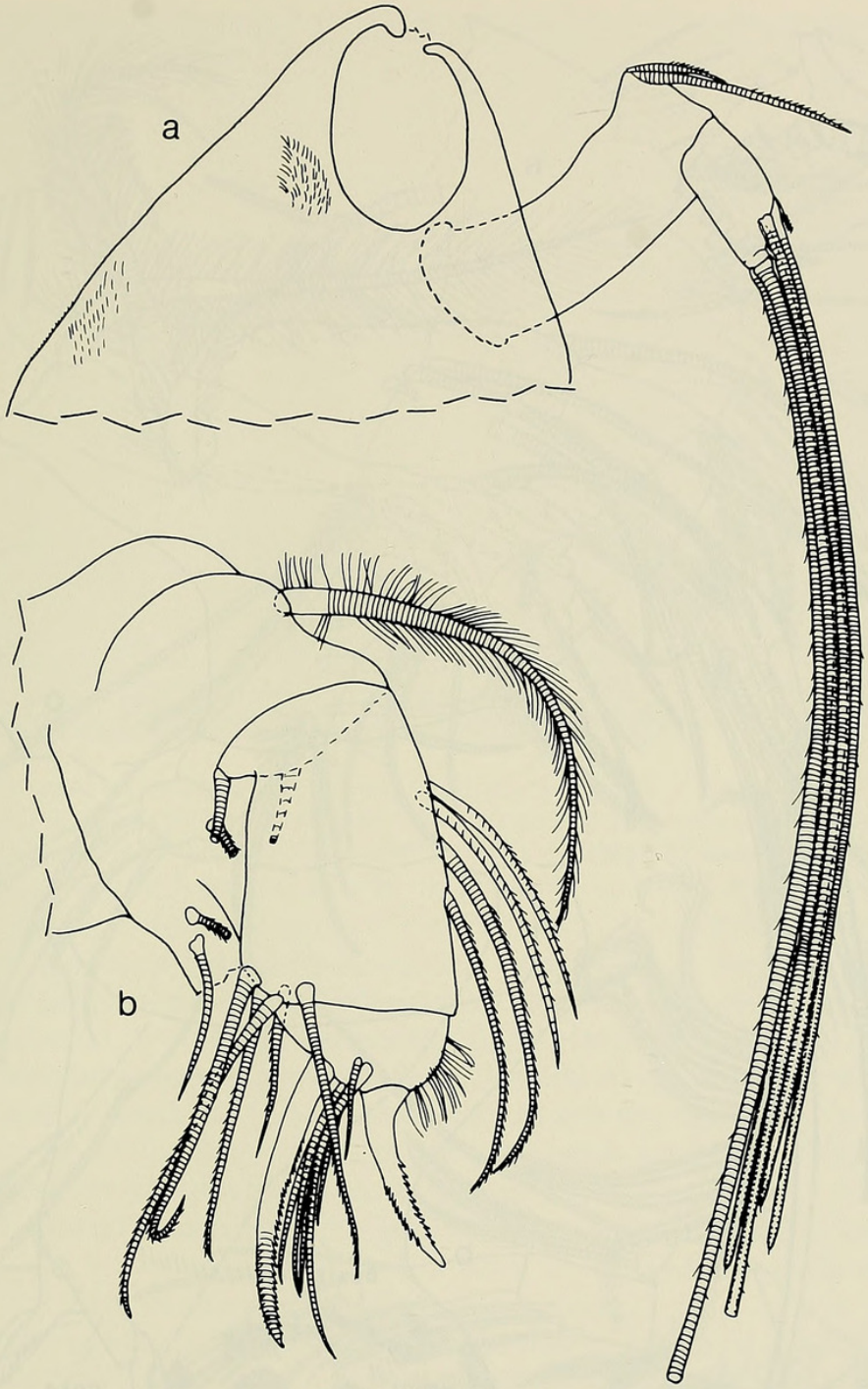

Fig. 9. *Deeveya spiralis,* holotype: a, Endopodite and part of protopodite of right 2nd antenna; b, Right maxilla (endites not shown).

and long curved tooth with rounded tip. Basal endite with 6 terminal non-serrate cusps (appearing worn); posterior cusp smaller than others and separated from them by space (Fig. 10b, c); posterior margin of endite not separated by suture from second segment but with single proximal bristle and distal, blunt, unringed bristle; anterior margin with single spinous bristle; medial surface with long hairs forming proximal cluster near posterior margin, and also forming distal rows;

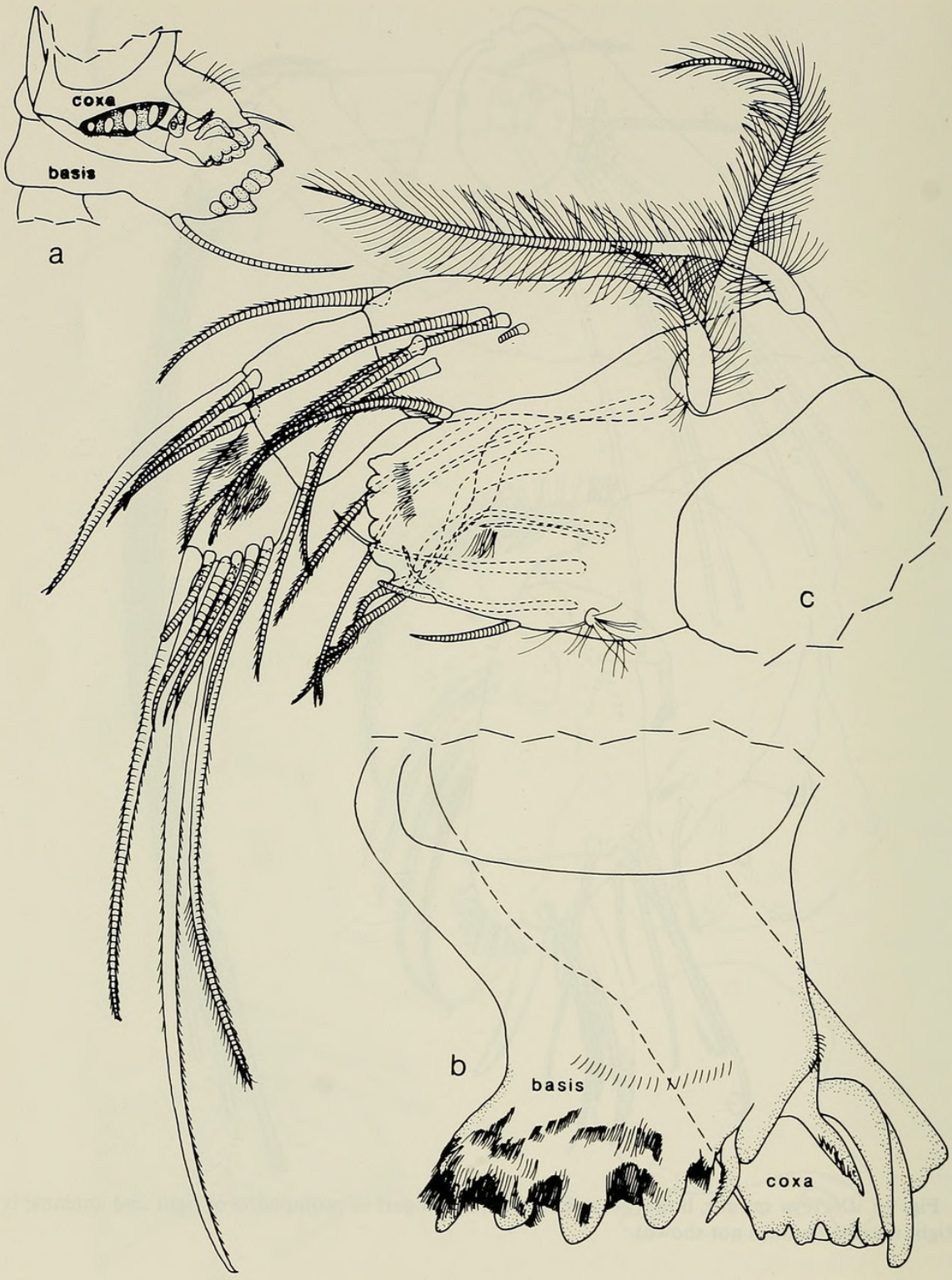

Fig. 10. *Deeveya spiralis,* right mandible of holotype; a, Medial view of distal ends of coxa and basis (not under cover slip); b, Basis and endopodite, medial view; c, Distal ends of coxa and basis (under cover slip).

lateral surface with 7 bristles (2 stouter than others and twisted together on both limbs of holotype and paratype); proximal lobe on medial surface with 2 hirsute bristles; dorsal margin of basis with long hirsute bristle. Endopodite 3-segmented with first segment about twice length of second and third segments; first segment

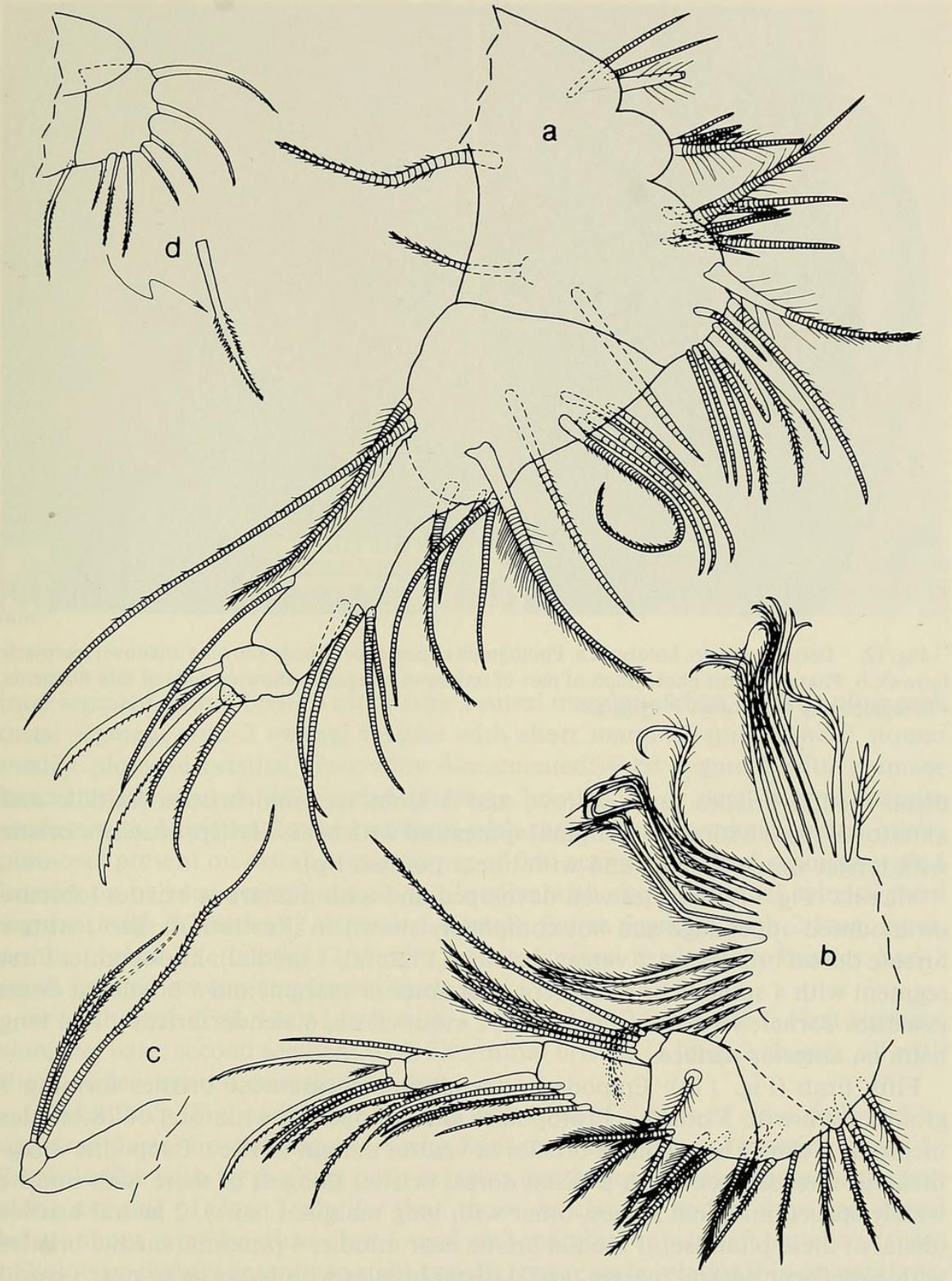

Fig. 11. *Deeveya spiralis,* holotype, limbs of right side: a, 5th limb; b, 6th limb; c, 7th limb; d, Right lamella of furca and single posterior bristle.

with 1 spinous anterior bristle, 1 spinous posterior bristle (behind basis on illustrated limb), and 5 medial bristles; second joint with medial bristle near distal posterior corner, and 3 terminal bristles at distal anterior corner (1 of bristles stout, claw-like); third joint hirsute medially and along anterior margin, with 5

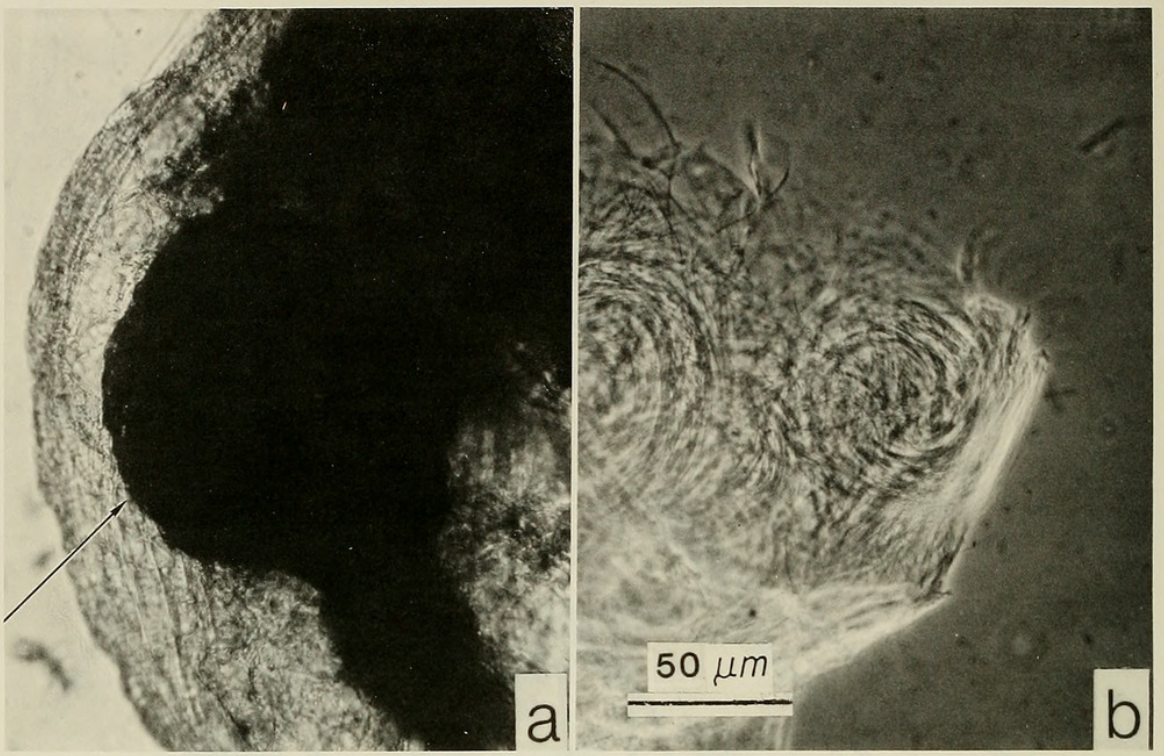

Fig. 12. *Deeveya spiralis*, holotype: a, Photograph of posterior of body showing unknown receptacle (arrow); b, Phase contrast photograph of part of unknown receptacle showing coils of thin filaments. Photographs by Dr. Robert P. Higgins.

distal medial bristles forming row, and 3 stout terminal bristles (middle and anterior of these with short marginal spines and with beak-like tip; posterior bristle with longer spines distally and with linear pointed tip).

Maxilla (Fig. 9b): Endites well developed and with numerous bristles (obscure on mounted appendage and not completely shown in illustration). Basis with 1 hirsute dorsal bristle and 2 ventral bristles (1 lateral, 1 medial). Endopodite: First segment with 4 spinous bristles on or near anterior margin, and 5 bristles at distal posterior corner; second segment with 2 stout claws, 6 slender bristles, and long hairs on anterior surface.

Fifth limb (Fig. 11a): Epipodial appendage with plumose bristles forming 3 groups, each with 5 bristles. Protopodite and endopodite with total of 28 bristles including 2 claw-like pectinate bristles at ventral margin of knee. Exopodite 3-segmented: First segment with 2 distal dorsal bristles (longest of these with minute widely spaced marginal spines, other with long marginal hairs), 2 lateral bristles (distal of these plumose), 1 medial bristle near middle, 4 proximal medial bristles with bases near ventral margin, and 4 distal bristles with bases on or near ventral margin; suture separating first and second segments more defined on medial side; elongate second segment with 4 bristles (1 dorsal, 3 ventral); small third joint with 2 stout pectinate claw-like bristles and 3 slender ringed bristles (bases of slender bristles medial to claw-like bristles).

Sixth limb (Fig. 11b): Epipodial appendage with plumose bristles forming 3 groups having 7 bristles in proximal group, 5 in distal group, and 6 in middle group. Protopodite divided distally by suture evident only on medial side; prox-

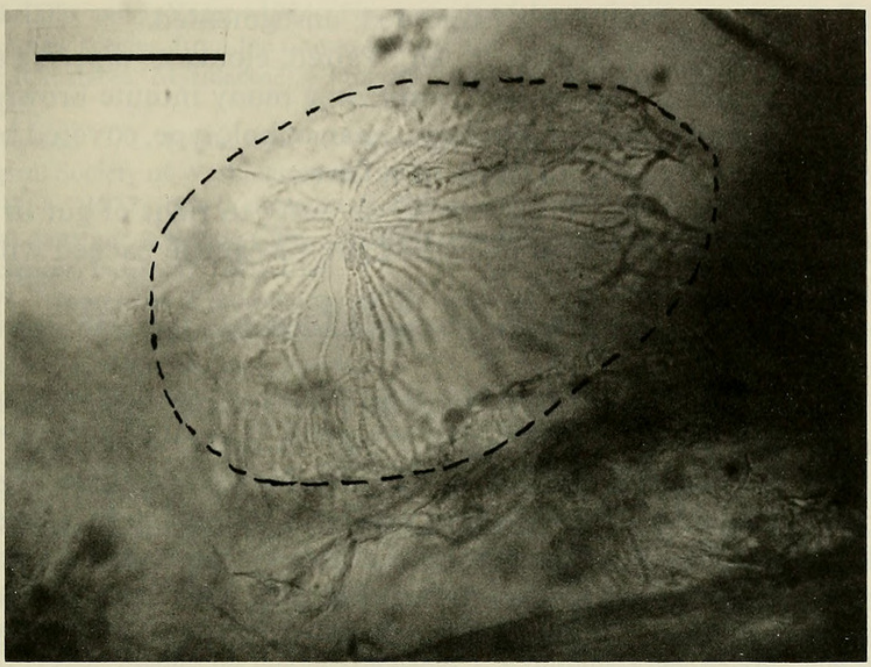

Fig. 13. *Deeveya spiralis*, holotype: photograph of elliptical organ (heart?) posterior to organ of Bellonci. Note network on surface. Photograph by Dr. Robert P. Higgins. Length of scale bar 0.10 mm.

imal segment with 4 bristles on or near ventral margin (all but 1 bristle plumose); distal segment with 2 ventral bristles with short marginal spines and 2 stouter medial plumose bristles. Exopodite 4-segmented: First segment with plumose lateral bristle near middle and 6 plumose bristles on or near ventral margin; process with 4 bristles (longest of these with short, faint, marginal spines, others plumose) present on distal dorsal corner of first segment; second segment with 4 bristles on or near ventral margin (all bristles with short marginal spines); third segment with 3 bristles (2 ventral, 1 dorsal); fourth segment with 2 long, stout, pectinate claw-like bristles, 2 slender bristles ventral to claw-like bristles, and 1 small bristle between and lateral to claw-like bristles.

Seventh limb (Fig. 11c): Limb with 1 segment or 2-segmented: First segment elongate, bare; second segment wtih 3 terminal bristles (1 long, 2 shorter, all with short, widely spaced, marginal spines).

Caudal furca (Fig. 11d): Each lamella with total of 7 pairs of claws followed by unpaired dorsal bristle; claws 1–4 with faint teeth along dorsal margins; claws 5–7 bristle-like with teeth along both margins (teeth stouter near midlength); teeth along margins of claw 7 smaller than those on claws 5 and 6; unpaired dorsal bristle about same length as claw 1, and with marginal spines; left lamella of furca of holotype slightly anterior to right lamella, but reverse relationship on paratype; ventral edge of lamellae between claw 7 and unpaired dorsal bristle with minute spines; minute spines also present on distal medial surface of lamellae.

Organ of Bellonci (Fig. 8b, c): Well-developed, cone-shaped, bifurcate distally, with tips of branches tapering to point.

Lips (Fig. 8b, d): Upper lip with about 6 glandular openings along ventral face and spines along posterior edge. Lower lip with triangular processes on each side and anterior spines.

Posterior of body (Fig. 7c): Evenly rounded, unsegmented.

Hepatic appendage (lumen) (Figs. 7c, 8b): Paired, elongate, tapering to narrow opening at esophagus near mouth, and containing many minute brown bodies.

Heart: Ellipsoid, just posterior to Bellonci organ of holotype, covered by unusual and unidentified network (Fig. 13) may be a heart.

Unknown receptacle (Figs. 7c, 8e, 12): Oval body to right of gut in posterior part of body; with pearly sheen in reflected light; receptacle packed with coils of long thin thread-like filaments.

Eggs: Both holotype and paratype with unextruded eggs that vary in size within same specimen.

Remarks.—Skogsberg (1920:560) referring to the seventh limb of halocyprids, which generally bears two bristles, noted "only in exceptional cases, in single specimens, are three bristles found." In the present species, three bristles were found on both limbs of the holotype and paratype, indicating that three bristles are normal. The basal endite of the mandible of this species bears two stout lateral bristles that are twisted around each other (Fig. 8c). This occurred on all four limbs of the two specimens on hand, suggesting that this unusual morphological character is normal for the species.

The "unknown receptacle" was initially thought to be a seminal receptacle and the coiled filaments spermatozoa. In order to verify that the filaments were spermatozoa the receptacle was sectioned with a microtome and the sections stained with hematoxylin and eosin. This treatment failed to stain the filaments, showing them not to be spermatozoa. The receptacle wall has nuclei and appears to be epithelium. No cells or nuclei were present inside the receptacle or within the filaments. The filaments were not identified. It is not known if the receptacle is part of the genitalia, gut, or unrelated to either. Because only two specimens are on hand it can not be ascertained if the organ is present on all specimens of the species, and not a foreign inclusion.

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