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Three new species of misophrioid copepods from oceanic islands

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Three new species of misophrioid copepods are described from anchialine habitats on oceanic islands. *Expansophria galapagensis* n.sp. is described from two localities on Santa Cruz, Galapagos Islands, *Speleophria campaneri* n.sp. from Ngamduk Cave, Angaur Island, Palau and *S. scottodicarloi* n.sp. from Chalk Cave on Bermuda.

KEYWORDS: Misophrioid copepods, anchialine caves, oceanic islands.

Introduction

Half of the described species of the order Misophrioida are known from anchialine habitats on oceanic islands. They have been found in caves on Bermuda (Boxshall and Iliffe, 1986) and in flooded lava tubes and lava pools on the Canary Islands (Boxshall and Iliffe, 1987; Huys, 1988) in the Atlantic, and in caves and sinkholes on islands in the Palau group (Boxshall and Iliffe, 1987) in the Indo-Pacific. During an expedition to the Galapagos islands in 1987 one of us (T.M.I.) collected a large number of misophrioids on Santa Cruz island. These represent a new species of *Expansophria* Boxshall and Iliffe, 1987 and are described below. This is the third species of *Expansophria* to be discovered, the other two being found on Lanzarote in the Canaries and on Ngeruktabel Island, Palau (Boxshall and Iliffe, 1987). Two new species of *Speleophria* are also described, one from a cave on Angaur island in the Palau archipelago, the other from a cave in Bermuda. The only known species of this genus, *S. bivexilla* Boxshall & Iliffe, was the first misophrioid to be described from an anchialine cave (Boxshall and Iliffe, 1986), also on Bermuda.

Description

Expansophria galapagensis n. sp.

Adult female with mean body length 664 μm, range 624–699 μm based on 10 specimens. Prosome (Fig. 1A) large, 5-segmented; integument of anterior part of first pedigerous somite thin and highly folded, capable of expansion dorsally and laterally. Rostrum (Fig. 2A) broad, posteroventrally directed, free from labrum. Surface of prosome smooth. Urosome (Fig. 1A) 6-segmented; genital and first abdominal somites separated by complete suture line but not articulating (Fig. 1B). Caudal rami just over twice as long as wide; armed with two long distal margin setae, a medium length inner distal angle seta, a short outer distal angle seta, a dorsal seta near the posterolateral margin and a short lateral seta.

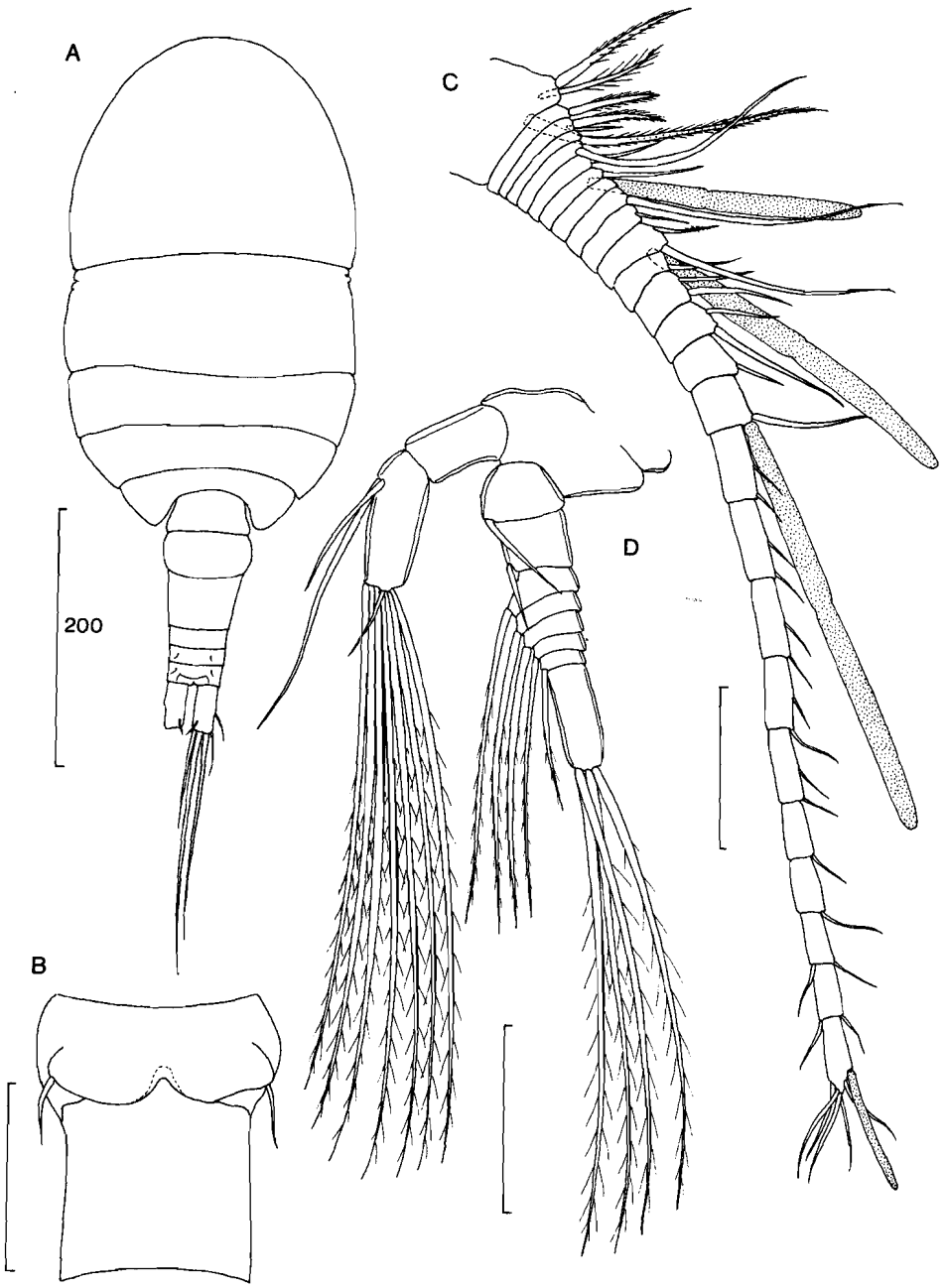

FIG. 1. *Expansophria galapagensis* n.sp. female. A, dorsal view; B, genital and first abdominal somites, ventral; C, antennule; D, antenna. Scale bars 50 μm unless otherwise stated.

Antennule (Fig. 1C), 26-Segmented; segments armed as follows I-3, II-1, III-2, IV-0, V-1, VI-1, VII-1 + 1 aesthetasc, VIII-0, IX-1, X-1, XI-2 + 1 aesthetasc, XII-1, XIII-2, XIV-2, XV-1, XVI-1 + 1 aesthetasc, XVII-2, XVIII-2, XIX-2, XX-2, XXI-2, XXII-1, XXIII-1, XXIV-2, XXV-2, XXVI-5 + 1 aesthetasc.

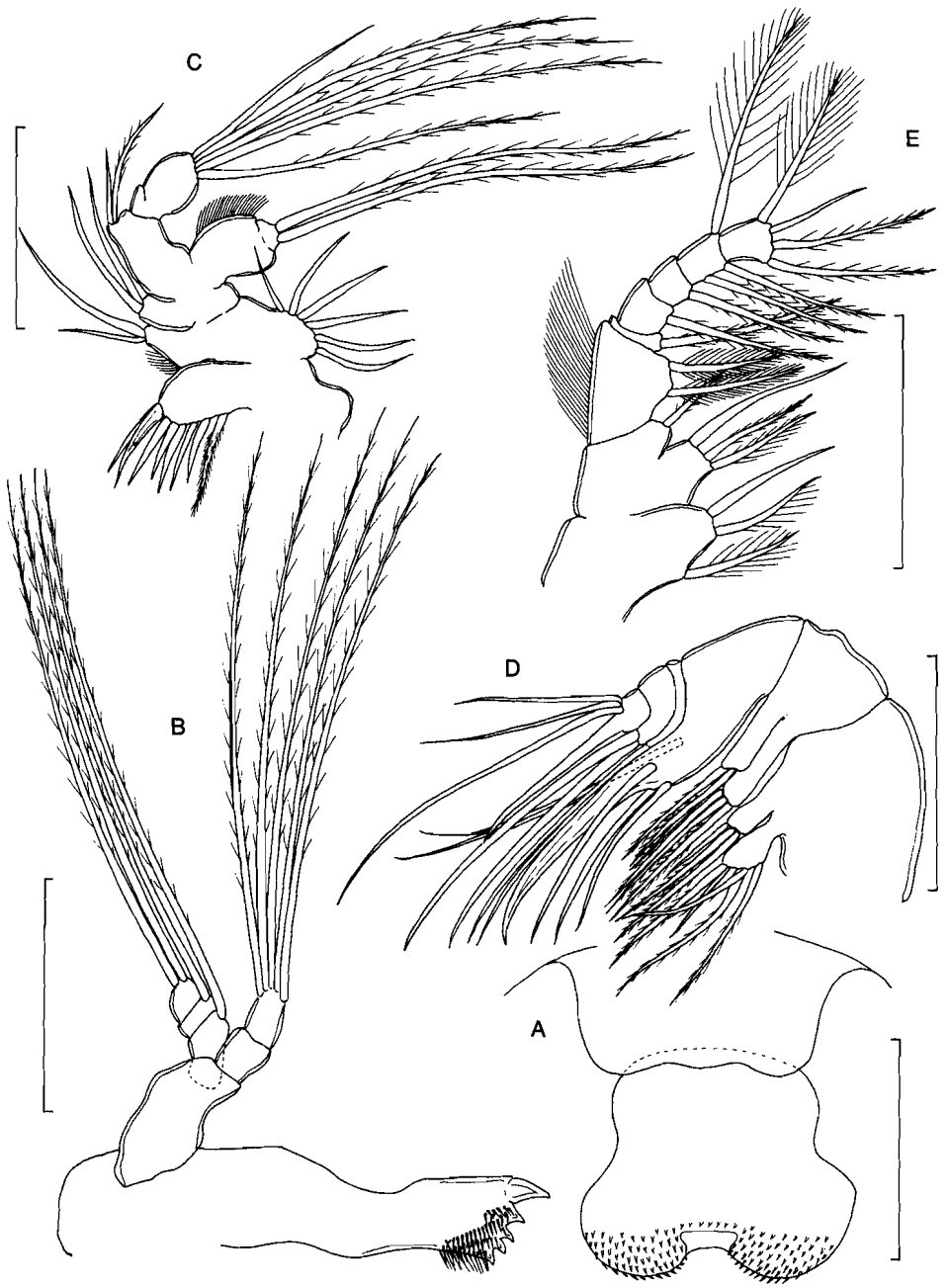

FIG. 2. *E. galapagensis* n.sp. female. A, labrum and rostrum; B, mandible; C, Maxillule; D, maxilla; E, maxilliped. All scale bars 50 μm.

Antenna (Fig. 1D). Sympod partly subdivided into coxa and basis, both unarmed; endopod 2-segmented; first segment unarmed, second segment with two proximal setae on medial margin and 1 short plus seven long, apical setae. Exopod 8-segmented; first and second segments each with a short seta on medial margin, third to seventh each

with a long plumose seta on medial margin, eighth bearing four long plumose setae around apex.

Labrum (Fig. 2A). Medially incised; armed with surface spinules distally.

Mandible (Fig. 2B). With slender gnathobase bearing along its distal margin five simple blades and several rows of long pinnules on surface. Palp comprising unarmed basis, 2-segmented endopod and indistinctly 3-segmented exopod. Endopod segment 1 unarmed, segment 2 with five long plumose setae apically. First and second exopod segments each with a long medial seta, third with two similar setae distally.

Maxillule (Fig. 2C). With praecoxal arthrite bearing 8 elements on and around the distal margin. Coxal endite ornamented with marginal spinules, armed with two apical setae; outer lobe of coxa represented by six setae on lateral surface of segment. Basal endites armed with two apical setae. Maxillulary palp biramous with 2-segmented endopod and 1-segmented exopod. First endopod segment fused to second, unarmed second segment with five apical setae. Exopod bearing two long plumose setae on distal margin, medial margin with row of spinules.

Maxilla (Fig. 2D). 6-Segmented; praecoxa with five setae on proximal endite, and three setae on distal endite. Coxa bearing three setae on each endite. Basis drawn out into curved medial claw bearing five setae proximally. Ramus of three short segments bearing a total of eight setae.

Maxilliped (Fig. 2E). 8-Segmented, with 3-segmented protopod comprising praecoxa, coxa and basis, and 5-segmented ramus. Praecoxa bearing one proximal and two distal setae on medial margin. Coxa with three setae on proximal endite and one on distal endite. Basis with two medial setae and ornamented with row of long pinnules along lateral margin. First endopod segment partly fused to basis, armed with one seta; second and third segments each with one seta, segment 4 with one lateral and two medial setae, and segment 5 with four setae.

Legs 1–4 (Figs 3A–D). Biramous with 3-segmented rami; spine and seta formula as follows:

	Coxa	Basis	Endopod	Exopod
Leg 1	0-1	0-1	0-1; 0-1; I, 2, 3	I-1; I-1; III, I, 3
Leg 2	0-1	0-0	0-1; 0-2; I, 2, 3	I-1; I-1; III, I, 4
Leg 3	0-1	1-0	0-1; 0-2; I, 2, 3	I-1; I-1; III, I, 4
Leg 4	0-1	1-0	0-1; 0-2; I, 2, 2	I-1; I-1; III, I, 4

Pinnule row present on lateral margins of all endopod segments and on medial margins of all exopod segments. Lateral margins of exopod segments armed with rows of small denticles. Intercoxal sclerites unarmed, that of leg 4 reduced in size. Lateral spines on exopod armed with strips of fine membrane on legs 1 to 4. Apical spine on exopod armed with fine membrane laterally and short pinnules medially. Setae on distal segments of rami with swollen shafts and short pinnules. Distolateral angle of first endopod segment of leg 1 drawn out into slender spinous process. Distolateral angle of second endopod segment bifid in legs 3 and 4.

Leg 5 (Fig. 3E). Positioned adjacent to ventral midline, intercoxal sclerite absent; uniramous, comprising unarmed coxa, basis bearing outer seta, and a 2-segmented exopod. Exopod segment 1 unarmed, segment 2 with 2 apical setae.

Leg 6 (Fig. 1B). Represented by plate overlying the genital opening, armed with a long seta.

Adult male (Fig. 4A); body form as in female; mean length 498 μm, range 481–512 μm based on three specimens. Genital somite wider than long. Anal somite

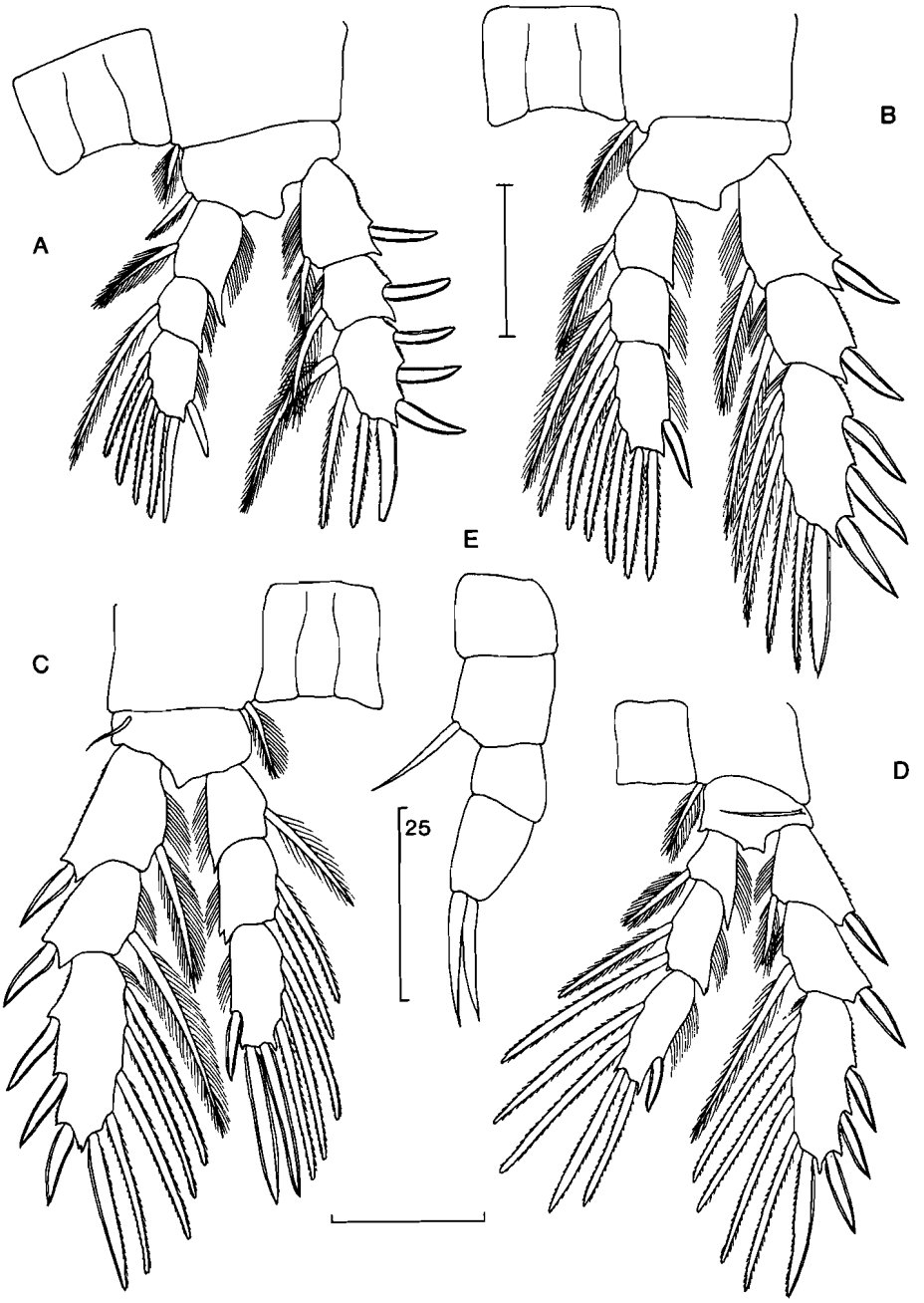

FIG. 3. *E. galapagensis* n.sp. female. A, leg 1; B, leg 2; C, leg 3; D, leg 4; E, leg 5. Scale bars 50 μm unless otherwise stated.

with row of minute denticles ventrally along posterior margin (Fig. 4B). Caudal rami and appendages as for female except antennules and legs 5 and 6.

Antennules (Fig. 4C). 24-Segmented, geniculate on both sides with geniculation located between segments XIX and XX. Segments XVIII and XIX fused at an angle to

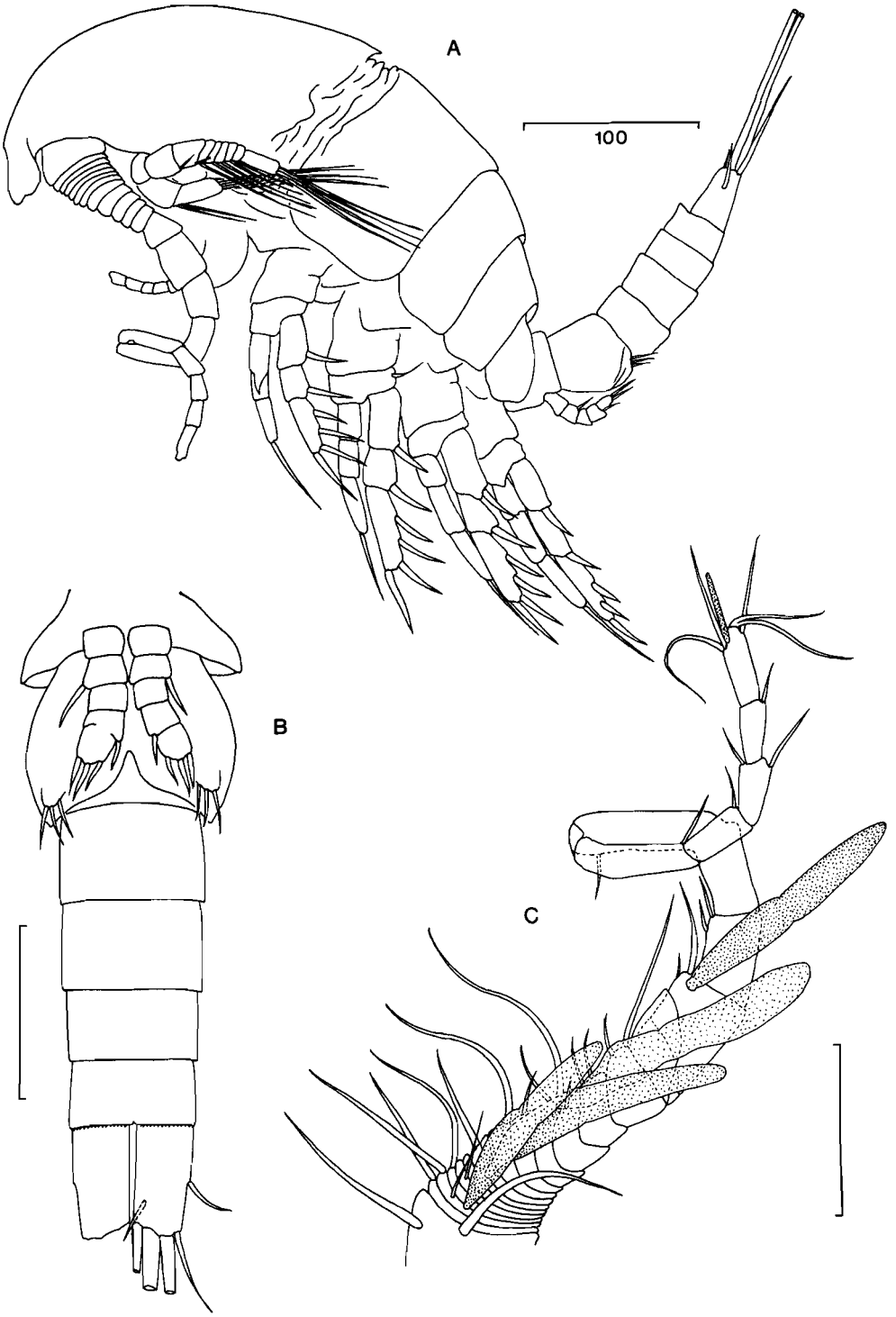

FIG. 4. *E. galapagensis* n.sp. male. A, lateral view; B, urosome, ventral; C, antennule. Scale bars 50 μm unless otherwise stated.

one another. Segment XIV produced anteriorly into a sheath overlapping much of segment XV. Segments armed as follows: I-2, II-1, III-2 + 1 aesthetasc, IV-1, V-1, VI-0, VII-1 + 1 aesthetasc, VIII-0, IX-1, X-1, XI-2 + 1 aesthetasc, XII-1, XIII-2, XIV-2 + sheath, XV-1, XVI-2 + 1 aesthetasc, XVII-2, XVIII-0, XIX-1, XX-1, XXI-1, XXII-2, XXIII-1, XXIV-5 + 1 aesthetasc.

Leg 5 (Fig. 4B). Positioned adjacent to ventral midline as in female; uniramous, 5-segmented comprising unarmed coxa, basis bearing outer seta, and 3-segmented exopod. Exopod segment 1 unarmed, segment 2 with an inner seta, segment 3 with three distal setae. Exopod segments partly fused on right side in some specimens.

Leg 6 (Fig. 4B). Represented by plate closing off genital apertures, armed with three setae on small process.

Material examined

HOLOTYPE female; 28♀♀, 3♂♂ and 19 copepodid paratypes collected from the grieta north of the trail to Tortuga Bay (Stn. 87–021B), Santa Cruz Island, Galapagos Islands, on 18 June 1987 with a 93 μm mesh plankton net towed at depths of 9–10 m, below the halocline; leg. T. M. Iliffe. Material stored in collections of BM(NH), Registration Nos 1989.936 (holotype), 1989.937–946 (paratype females), 1989.947–950 (paratype males), 1989.951–959 (paratype copepodids).

Additional material: 1♀ and 1 copepodid collected from the deep grieta at Tortuga Bay (Stn. 87-005), Santa Cruz Island, Galapagos Islands, on 3 May 1987 with a 93μm mesh plankton net towed at depths of 6–12 m; leg. T. M. Iliffe. BM(NH) Reg. Nos 1989.960–961.

Habitat

The southern part of Santa Cruz Island, Galapagos Islands, was formed by lava flows from the island's massive shield volcanoes. Extensive recent faulting has occurred along the south coast producing deep, shear-walled rifts, up to 20 km long, running parallel to the shore. The most recent of these may be only a few thousand years old (McBirney and Williams, 1969). All the faulting is normal faulting in which a block has moved up or down with respect to its neighbour along a nearly vertical fault plane (Simkin, 1984). Deeper faults close to the coast often extend below sea level and contain anchialine pools locally referred to as 'grietas'. Typically, grieta pools are several metres wide, a few to tens of metres long and up to 30 m deep. Large collapse blocks produced during the faulting process make up the floor of the fissures and occasionally form dark cave-like sections between fault walls and beneath wedged breakdown blocks.

The deep grieta at Tortuga Bay (Stn. 87-005) is located about 250 m east of the beach at Tortuga Bay and 80 m inland, behind a conspicuous lava mound. It is situated between 10 m high cliffs and runs parallel to the coast. The pool itself is about 8 m wide, 40 m long, with a maximum depth of 12 m. The rear part of the pool is roofed over with collapse blocks and is in darkness. Several large root masses extend into the water in this section of the pool. Salinities measured on 3 May 1987 ranged from 8‰ at the surface to 22‰ at 12 m, while water temperatures at the same depths decreased from 24·8 to 23·1°C. Previously biological collections at this site were reported by Peck and Peck (1986) and Peck and Kulalova-Peck (1986). In addition to misophrioids, large numbers of the blind shrimp *Typhlatya galapagensis* Monod & Cals are present in the deeper parts of the pool, together with the troglobitic ostracods *Skogsbergia*

galapagensis Kornicker & Iliffe and *Danielopolina styx* Kornicker & Iliffe (Kornicker and Iliffe, 1989a) and epacteriscid copepods under study by Audun Fosshagen.

The grieta north of the trail to Tortuga Bay (Stn. 87-021B) is situated about 100 m east of the cliff which forms an inland extension of the western edge of the harbour at Puerto Ayora. About 30 m north of the trail, along a vertical-walled 1–2 m wide fissure is a 30 m long pool divided into two sections by breakdown. In one section a deep crack extends down past a marked halocline at 9 m before ending in a collapse plug at 10 m. On 18 June 1987 water above the halocline had a salinity of 1·5‰, while below (at 10 m) it was 13‰. Water temperatures were uniform at 22·7°C. Marked tidal currents were apparent at the surface of the pool. In addition to misophrioids, the amphipod *Galapiellus lelouporum* Monod, the ostracod *S. galapagensis*, the shrimp *T. galapagensis*, plus other copepods, tanaidaceans and anthurid isopods were also found.

Remarks

The new species is placed in *Expansophria* primarily because it has the same modification of the prosome at the level of the first pedigerous somite. The extensive folding of the integument allows distension of the prosome to take place. The midgut in some specimens of the new species was full and visible through the body wall. It has large lateral caeca and is capable of significant swelling. This arrangement was interpreted as an adaptation to an opportunistic gorging strategy by Boxshall and Iliffe (1987). The posterior extension of the dorsal shield of the cephalosome is minimal and resembles the typical hyaline frill of other copepods (Moore, 1976) rather than the carapace of other misophrioids like *Benthomisophria* (Boxshall, 1982). Other generic level similarities include the 26-segmented antennules of the female, the reduced setation of the maxillule, the modified setae on the swimming legs and the prolongation of the inner distal angle of the first endopod segment of leg 1 into a slender spiniform process.

Boxshall and Iliffe (1987) also interpreted the presence of aesthetascs on segments VII, XI, XVI and XXVI as an apomorphy of the genus *Expansophria*. However, aesthetascs are retained on these same segments in *Archimisophria* and this aesthetasc pattern probably represents an apomorphy of a larger group of misophrioids (Boxshall, 1989).

The new species can readily be distinguished from *E. apoda* Boxshall & Iliffe, 1987 which lacks fifth legs in the adult female. It resembles the type species, *E. dimorpha* from the Canaries, very closely. For example, the highly reduced setation of the maxillule is virtually the same in both species, differing only in the relative lengths of some armature elements. There is sexual dimorphism expressed in the fifth legs of both the type species and *E. galapagensis*, but in the former the exopod of the female fifth leg is 1-segmented whereas it is 2-segmented in the latter. The apical segment of the male fifth leg bears two setae in *E. dimorpha* and three in *E. galapagensis*.

The biogeography of *Expansophria* is remarkable. Each of its three species exists on only one oceanic island, one (*E. dimorpha*) in the Atlantic, the other two at opposite sides of the Pacific. Other anchialine taxa have similar distributions, including ostracods of the genus *Danielopolina* and shrimps of the genus *Typhlatya* (Kornicker and Iliffe, 1989 a, b), with species recorded at widely separated locations.

Speleophria campaneri n.sp.

Adult female with body length 526 μm. Prosome (Fig. 5A) large, apparently 4-segmented; with first pedigerous somite enclosed laterally and dorsally by posterior

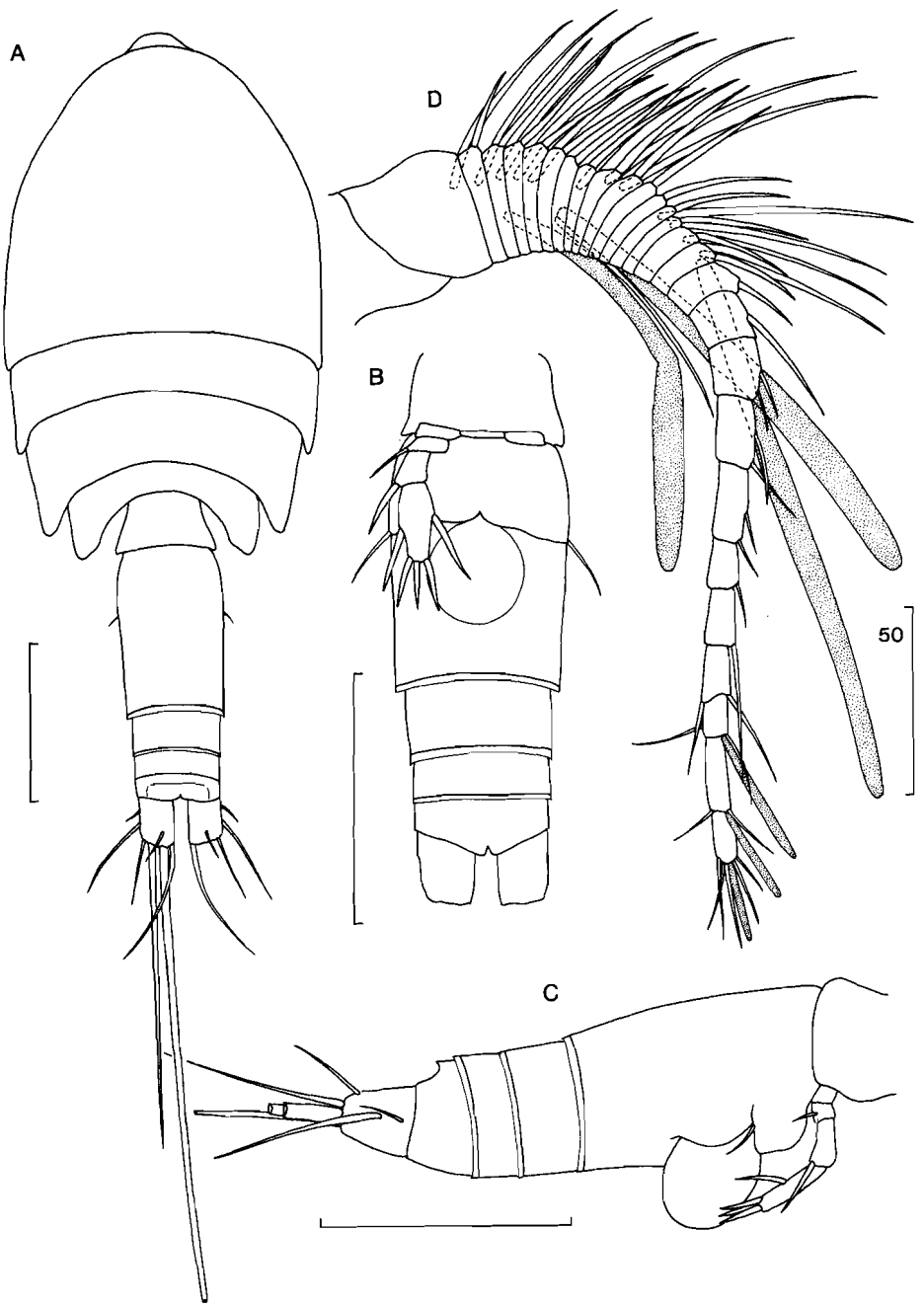

FIG. 5. *Speleophria campaneri* n.sp. female. A, dorsal; B, urosome, ventral; C, urosome, lateral; D, antennule. Scale bars 100 μm unless otherwise stated.

carapace-like extension from posterior margin of dorsal cephalic shield. Rostrum (Fig. 6A) tapering, ventrally directed, free from labrum. Surface of prosome smooth. Urosome (Fig. 5B, C) 5-segmented; genital and first abdominal somites fused to form genital double somite, bearing partial suture line ventrally. Caudal rami about 1·3

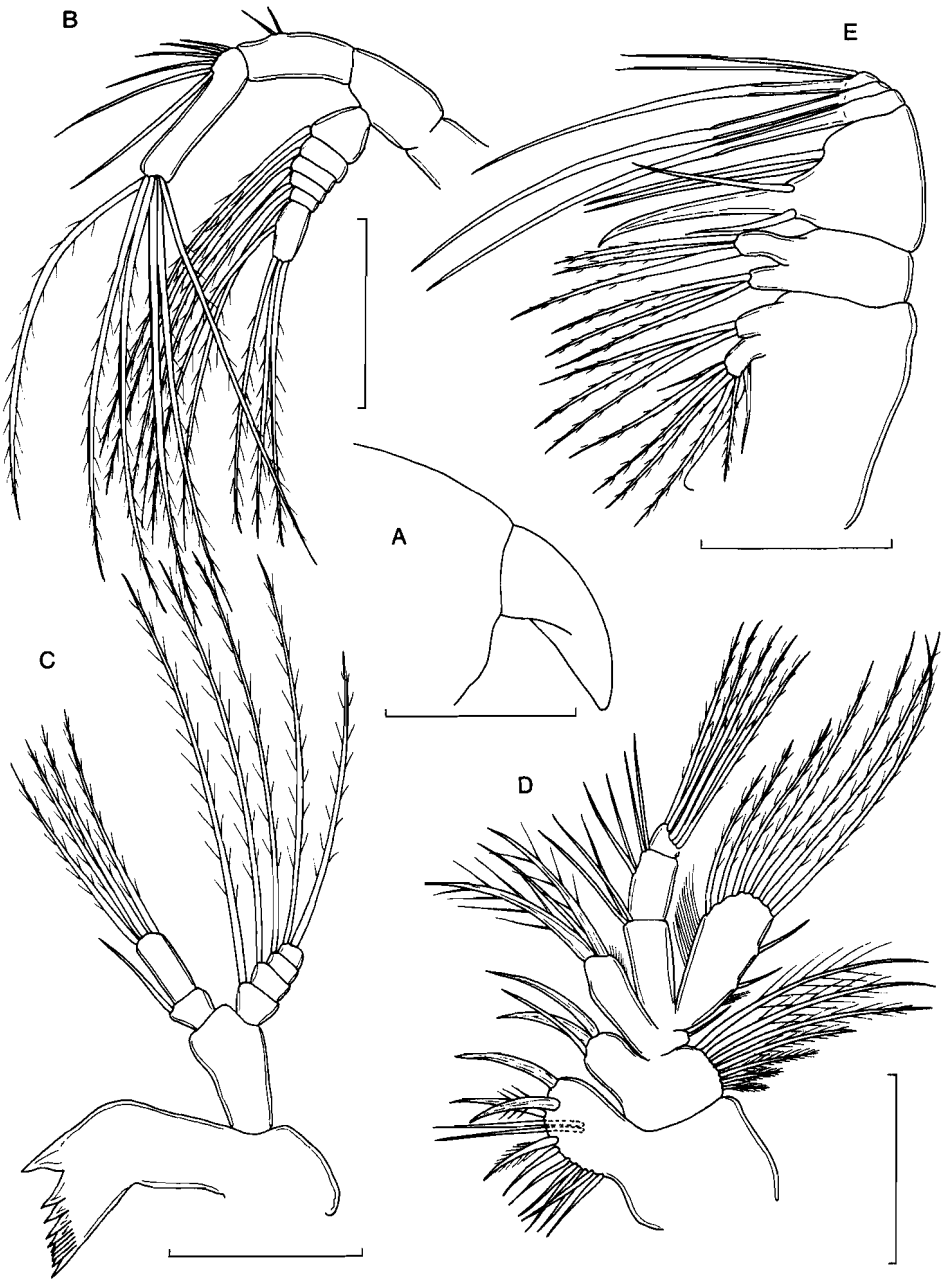

FIG. 6. *Speleophria campaneri* n.sp. female. A, rostrum, lateral; B, antenna; C, mandible; D, maxillule; E, maxilla. All scale bars 50 μm.

times longer than wide; armed with 2 long distal margin setae, a medium length inner distal angle seta, a short outer distal angle seta, a dorsal seta near the posterolateral margin, a long midlateral seta and a short seta proximally on lateral margin.

Antennule (Fig. 5C). 27-Segmented; segments armed as follows I-1, II-2, III-2+1 aesthetasc, IV-2, V-2, VI-1, VII-2+1 aesthetasc, VIII-2, IX-2, X-2, XI-1, XII-1, XIII-2, XIV-2, XV-2, XVI-2+1 aesthetasc, XVII-1, XVIII-1, XIX-2, XX-2, XXI-2, XXII-

1, XXIII-1, XXIV-2, XXV-2+1 aesthetasc, XXVI-2+1 aesthetasc, XXVII-5+1 aesthetasc.

Antenna (Fig. 6B). Sympod partly subdivided into coxa and basis, both unarmed; endopod 2-segmented; first segment with two setae; second segment elongate, with six proximal setae on medial margin and six long, apical setae. Exopod 6-segmented; first to fifth segments each with a long plumose seta on medial margin, sixth bearing one plumose seta on medial margin and three long plumose setae at apex.

Mandible (Fig. 6C). With slender gnathobase bearing along its distal margin 1 large ventral tooth and a row of about nine smaller teeth packed close together. Palp comprising unarmed basis, 2-segmented endopod and 4-segmented exopod. Endopod segment 1 with single inner seta, segment 2 with four long plumose setae apically. First to third exopod segments each with a long medial seta, fourth with two similar setae distally.

Maxillule (Fig. 6D). With praecoxal arthrite bearing 14 elements on and around the distal margin, including two setae on posterior surface. Coxal endite armed with three apical setae; outer lobe of coxa represented by seven setae on lateral surface of segment. Basal endites armed with three long curved setae; basal exite represented by small seta on outer surface of segment. Maxillulary palp biramous with 2-segmented endopod and 1-segmented exopod. First endopod segment with two midmargin and two distal setae; second segment small, with five setae on outer surface. Exopod armed with two short setae on lateral margin and seven long plumose setae distally; medial margin with row of spinules.

Maxilla (Fig. 6E). 6-Segmented; praecoxa with seven setae on proximal endite and three setae on distal endite. Coxa bearing three setae on each endite. Basis drawn out into curved medial claw bearing four setae proximally. Ramus of three short segments bearing a total of five setae, each segment with one large seta with stout basal section and flexible distal section.

Maxilliped (Fig. 7A). 8-Segmented, with 2-segmented protopod comprising syncoxa and basis, and 6-segmented ramus. Syncoxa bearing four endites; first and second endites represented by one and two setae respectively; third endite larger, armed with four setae; fourth with three setae. Basis with two medial setae. First endopod segment with one medial seta, second to fourth segments each with two medial setae, fifth segment with one lateral and two medial setae, and sixth segment with three setae.

Legs 1 to 4 (Figs 7B-E). Biramous with 3-segmented rami, except for 2-segmented endopod of leg 1; spine and seta formula as follows:

	Coxa	Basis	Endopod	Exopod
Leg 1	0-1	I-I	0-1; 1, 2, 3	I-0; I-1; III, 1, 4
Leg 2	0-1	1-0	0-1; 0-2; 1, 2, 3	I-1; missing
Leg 3	0-1	1-0	0-1; 0-2; 1, 2, 3	I-1; I-1; III, I, 5
Leg 4	0-1	1-0	0-1; 0-2; 1, 2, 2	I-1; I-1; III, I, 5

Pinnule row present on lateral margins of all endopod segments and on medial margin of all exopod segments. Lateral margins of exopod segments armed with rows of minute denticles. Intercoxal sclerites unarmed, that of leg 4 reduced in size. Lateral spines on exopod armed with strips of finely serrated membrane on legs 1 to 4. Apical spine on exopod armed with finely serrated membrane laterally and short pinnules medially. Setae on distal segments of rami with swollen shafts and short pinnules. Distolateral angle of second endopod segment bifid in legs 2 to 4.

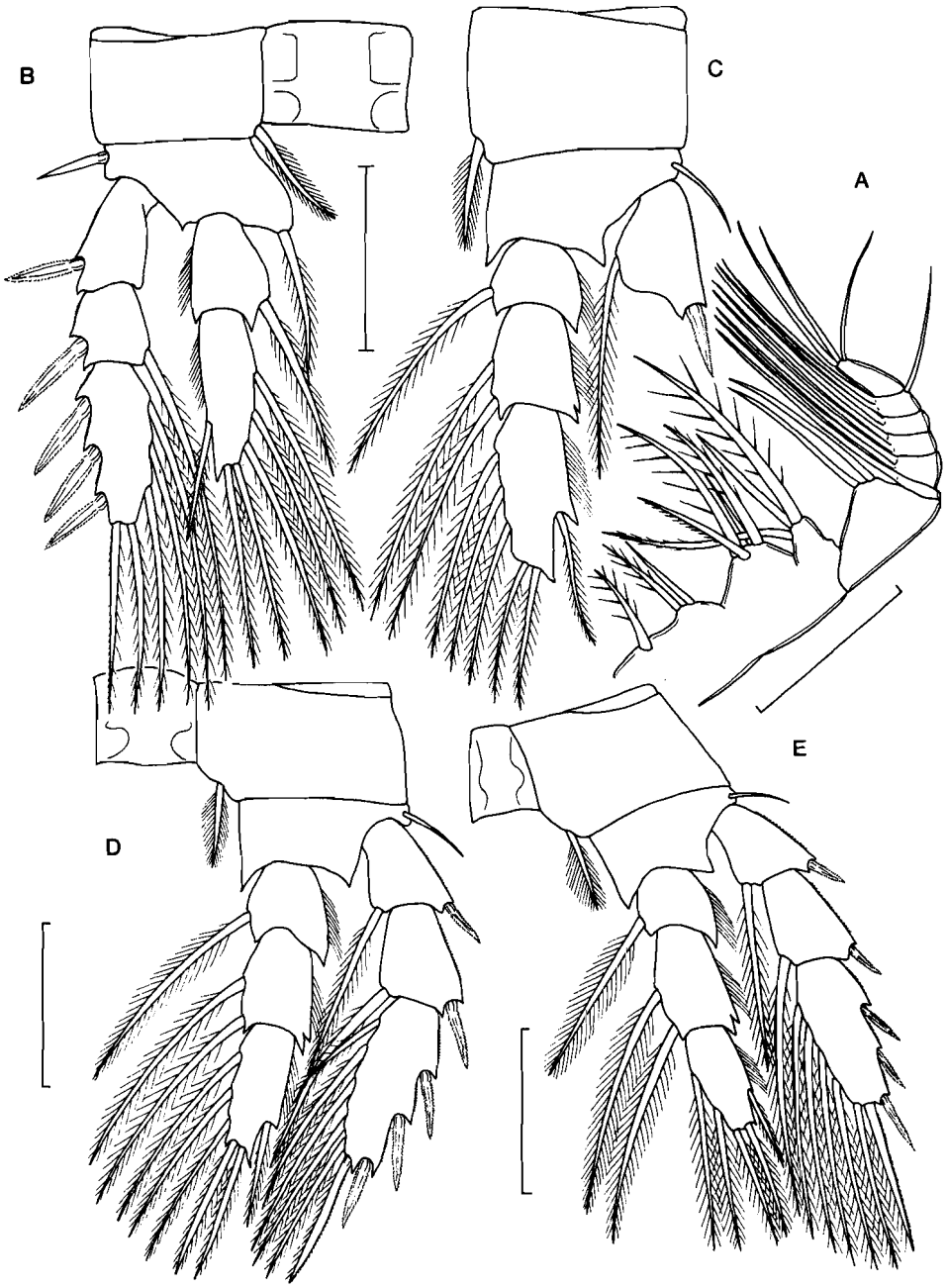

FIG. 7. *Speleophria campaneri* n.sp. female. A, maxilliped; B, leg 1; C, leg 2; D, leg 3; E, leg 4. All scale bars 50 μm.

Leg 5 (Fig. 5B). Uniramous, with small intercoxal sclerite; comprising unarmed coxa, basis bearing outer seta, and a 2-segmented exopod. Exopod segment 1 with a large outer spine, segment 2 with 1 outer and 3 distal spines and an inner seta.

Leg 6 (Fig. 5B). Represented by plate overlying the genital opening, armed with a long seta.

Material examined

HOLOTYPE female collected from Ngamduk Cave (Stn. 85-039), Angaur Island, Palau on 12 March 1985 with a 93 μm mesh plankton net from 0–5 m depths; leg T. M. Iliffe. BM(NH) Reg. No. 1989.962.

Etymology. This species is named in honour of the late Dr A. F. Campaner (University of Sao Paulo) in recognition of his work on planktonic copepods.

Habitat

Angaur Island is separated from the main platform of the Palau archipelago by a 10 km wide, deep-water channel. It is a low island, 5 km long by 2·5 km wide, consisting of uplifted limestone. Ngamduk Cave is located near the northwest corner of the island, about 300 m from the coast. An inclined fissure descends from a low entrance to a long but narrow anchialine pool in total darkness. Surface salinity and temperature in this pool were 10‰ and 26°C respectively. Maximum depth in this clear pool was 5 m. A colony of bats inhabited the cave and guano was present both above and below water level. Also collected from the cave was an eel and several small shrimps.

Remarks

This new species is placed in the genus *Speleophria* despite several differences between the specimen from Palau and the type species *S. bivexilla*. Characters supporting this placement are: the segmentation of the fifth legs, the antennary endopod and exopod, and the maxilliped. The absence of an inner seta from the first exopod segment of leg 1 is also shared by all *Speleophria* species. The form of the mandibular gnathobase, with its series of tightly packed blades, is also characteristic of the genus. The major differences are in the extent of the carapace-like extension to the rear margin of the dorsal cephalic shield, the segmentation of the antennules and the endopod of the maxillule. The carapace of *S. bivexilla* is distinct but very short (Boxshall and Iliffe, 1986) compared to *S. campaneri* and to the new species described below, but this variation can be accommodated within *Speleophria*. The antennules have fewer segments in *S. bivexilla*, however the segments were poorly defined and there was a considerable degree of fusion, especially amongst the proximal segments. The endopod of the maxillule of *S. bivexilla* was misinterpreted by Boxshall and Iliffe (1986) because the tiny apical segment was squashed during dissection and lay on top of the second segment. The maxillule of *S. bivexilla* has the same segmentation as that of *S. campaneri* figured above.

A unique character of the new species is the presence of a seta on the inner margin of the second exopod segment of the fifth legs. Neither *S. bivexilla* nor *S. scottodicarloi*, described below, has an inner margin element on this segment. There are six inner margin setae on the proximal part of the distal endopod segment of the antenna. This part of the segment represents the second segment, which is fused with the third in this genus. The maximum usually found on the second segment in misophrioids is five. The presence of a small outer margin seta on the basis of the maxillule is extremely significant. This seta represents the basal exite and within the podoplean lineage this seta is retained only in one other genus, the harpacticoid *Longipedia* Claus.

A single egg was attached loosely to the ventral surface of the genital double somite (Fig. 5B). It is large, about 40 μm in diameter, and its medial position suggests that eggs are released singly in this species. This may indicate that the genital organs are asymmetrical, with only one functional oviduct, as in the type *S. bivexilla*.

Speleophria scottodicarloi n.sp.

Adult female with body length 583 μm. Prosome (Fig. 8A) large, apparently 4-segmented; with first pedigerous somite enclosed laterally and dorsally by posterior carapace-like extension from posterior margin of dorsal cephalic shield. Rostrum tapering, ventrally directed, free from labrum. Surface of prosome smooth. Urosome

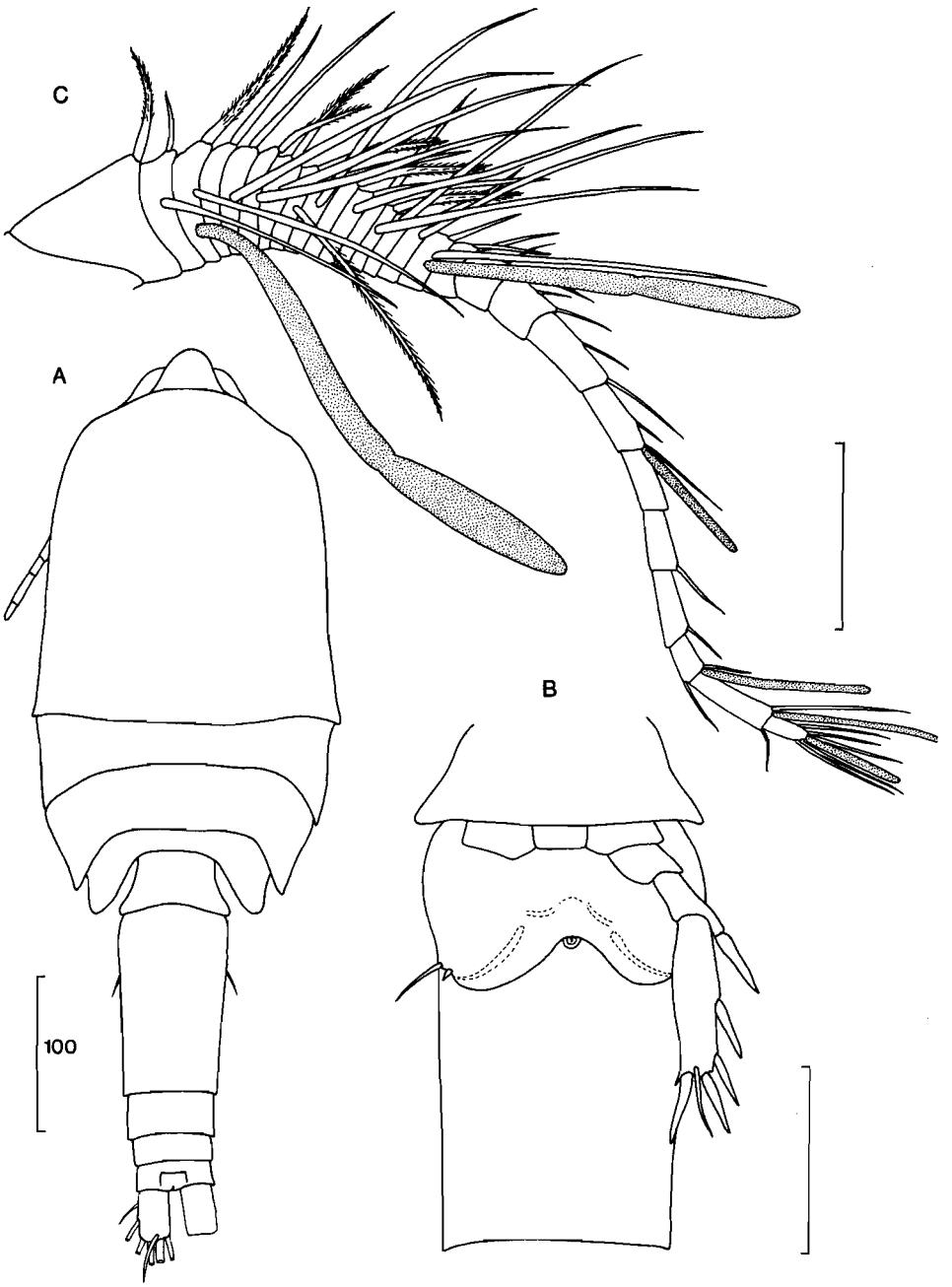

FIG. 8. *Speleophria scottodicarloi* n.sp. female. A, dorsal; B, anterior part of urosome, ventral; C, antennule. Scale bars 50 μm unless otherwise stated.

5-segmented; genital and first abdominal somites fused to form genital double somite, bearing partial suture line ventrally (Fig. 8B). Caudal rami about 1·3 times longer than wide; armed with two long distal margin setae, a medium length inner distal angle seta, a short outer distal angle seta, a dorsal seta near the posterolateral margin, a long midlateral seta and a short seta proximally on lateral margin.

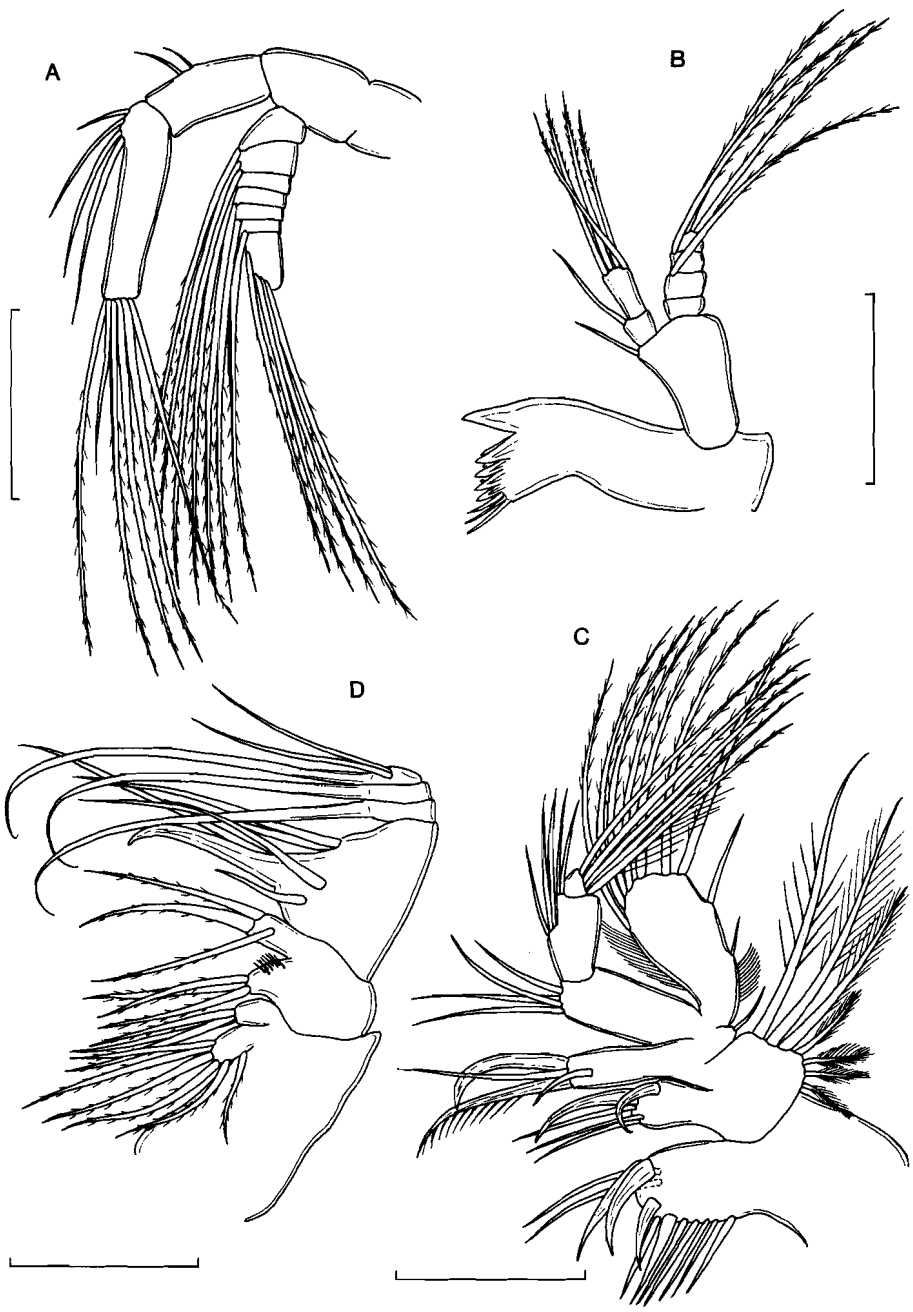

FIG. 9. *Speleophria scottodicarloi* n.sp. female. A, antenna; B, mandible; C, maxillule; D, maxilla. All scale bars 50 μm.

Antennule (Fig. 8C). 27-Segmented; segments armed as follows I-1, II-2, III-2+1 aesthetasc, IV-1, V-2, VI-2, VII-2, VIII-2, IX-2, X-1, XI-2, XII-1, XIII-2, XIV-1, XV-2, XVI-2+1 aesthetasc, XVII-2, XVIII-2, XIX-2, XX-2, XXI-2+1 aesthetasc, XXII-0, XXIII-1, XXIV-1, XXV-2+1 aesthetasc, XXVI-2+1 aesthetasc, XXVII-5+1 aesthetasc.

Antenna (Fig. 9A). Sympod partly subdivided into coxa and basis, both unarmed; endopod 2-segmented; first segment with two setae; second segment elongate, with four proximal setae on medial margin and one short and five long, apical setae. Exopod 7-segmented; first segment with one inner seta, second with two inner setae, third to sixth segment, each with a long plumose seta on medial margin, seventh bearing one plumose seta on medial margin and three long plumose setae at apex.

Mandible (Fig. 9B). With slender gnathobase bearing along its distal margin one large ventral tooth and a row of about eight smaller teeth packed close together. Palp comprising basis bearing a single medial seta, 2-segmented endopod and 4-segmented exopod. Endopod segment 1 with single inner seta, segment 2 with four long plumose setae apically. First exopod segment unarmed, second and third each with a long medial seta, fourth with two similar setae distally.

Maxillule (Fig. 9C). With praecoxal arthrite bearing 12 elements on and around the distal margin, including two setae on posterior surface. Coxal endite armed with five apical setae; outer lobe of coxa represented by seven setae on lateral surface of segment. Basal endites armed with four setae; basal exite represented by small seta on outer surface of segment. Maxillulary palp biramous with 2-segmented endopod and 1-segmented exopod. First endopod segment with three midmargin and two distal setae; second segment small, with five setae on outer surface. Exopod armed with two short setae on lateral margin and seven long plumose setae distally; medial margin with row of spinules.

Maxilla (Fig. 9D). 6-Segmented; praecoxa with six setae on proximal endite, and three setae on distal endite. Coxa bearing three setae on each endite. Basis drawn out into curved medial claw bearing five setae proximally. Ramus of three short segments bearing a total of five setae, each segment with one large seta with stout basal section and flexible distal section.

Maxilliped (Fig. 10A). 8-Segmented, with 2-segmented protopod comprising syncoxa and basis, and 6-segmented ramus. Syncoxa bearing four endites; first and second endites represented by one and two setae respectively; third endite larger, armed with four setae; fourth with two setae. Basis with three medial setae and row of long pinnules on outer margin. First endopod segment with one medial seta, second to fifth segments each with two medial setae and sixth segment with five setae.

Legs 1 to 4 (Figs 10B-E). Biramous with 3-segmented rami, except for 2-segmented endopod of leg 1; spine and seta formula as follows:

	Coxa	Basis	Endopod	Exopod
Leg 1	0-1	I-I	0-1; 1, 2, 3	I-0; I-1; III, 1, 4
Leg 2	0-1	1-0	0-1; 0-2; 1, 2, 3	I-1; I-1; III, I, 5
Leg 3	0-1	1-0	0-1; 0-2; 1, 2, 3	I-1; I-1; III, I, 5
Leg 4	0-1	1-0	0-1; 0-2; 1, 2, 2	I-1; missing

Pinnule row present on lateral margins of all endopod segments and on medial margin of all exopod segments. Lateral margins of exopod segments armed with rows of minute denticles. Intercoxal sclerites unarmed, that of leg 4 reduced in size. Lateral spines on exopod armed with strips of fine membrane on legs 1 to 4. Apical spine on

exopod armed with fine membrane laterally and short pinnules medially. Distolateral angle of second endopod segment bifid in legs 2 to 4.

Leg 5 (Fig. 8B). Uniramous, with small intercoxal sclerite; comprising unarmed coxa and basis, and a 2-segmented exopod. Exopod segment 1 with a large outer spine,

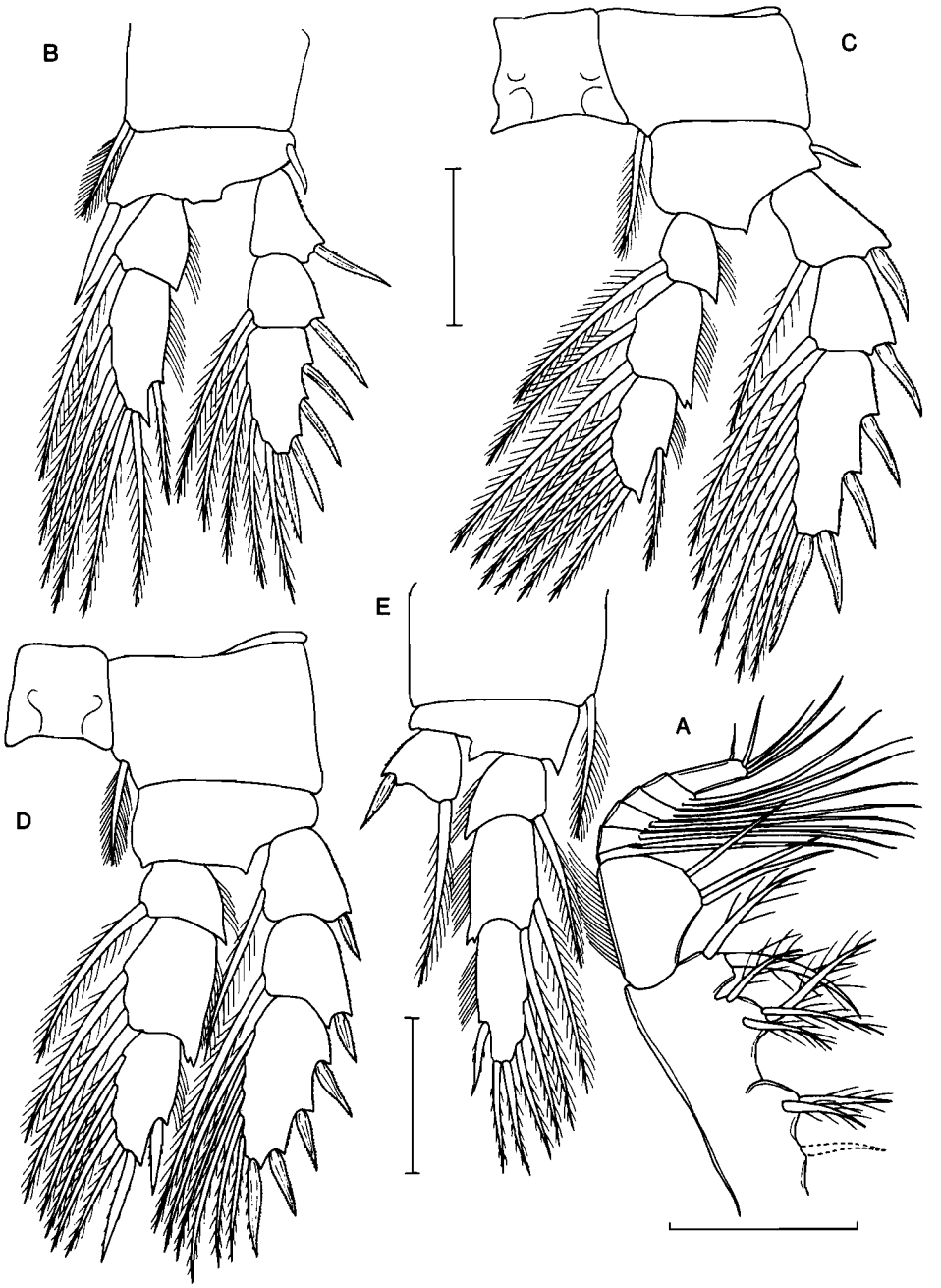

FIG. 10. *Speleophria scottodicarloi* n.sp. female. A, maxilliped; B, leg 1; C, leg 2; D, leg 3; E, leg 4. All scale bars 50 μm.

segment 2 with two outer spines and two distal spines and a slender seta located on anterior surface near apex.

Leg 6 (Fig. 8B). Represented by plate overlying the genital opening, armed with a long seta and a short spine.

Material examined

HOLOTYPE female collected from Chalk Cave, Smith's Parish, Bermuda on 31 August 1982 with a dip net in 0–1·5 m depths from the water column and from the slight dusting of silt over rocks on the floor of the pool; leg. T. M. Iliffe. BM(NH) Reg. No. 1989.963.

Etymology. This species is named after Dr Bruno Scotto di Carlo (Stazione Zoologica di Napoli) who was lost at sea in 1988, in recognition of his many contributions to the study of planktonic copepods.

Habitat

Chalk Cave is a collapsed cave situated near Devil's Hole on a narrow isthmus separating the nearly enclosed inshore water body of Harrington Sound from Bermuda's south shore. It lies approximately 50 m from the edge of Harrington Sound. A pool in total darkness within the cave reaches depths of about 8 m. Surface and 1 m salinities in the pool on 3 November 1981 were 16·0 and 26·3‰, respectively. Corresponding temperatures were 20·8 and 21·6°C. Water in the pool is very clear and appears to be well isolated from direct communication with the open sea. Also present in the pool are the shrimps *Barbouria cubensis* and *Sommersiella sterreri* (Hart and Manning, 1981) and the calanoid copepod *Paracyclopia naesi* (Fosshagen and Iliffe, 1985).

Remarks

The new species from Bermuda is very similar in limb segmentation and armature to *S. campaneri* from Palau. It also shares with this species the presence of a large carapace concealing the first pedigerous somite. It differs from *S. campaneri* by lacking any inner margin seta on the second exopod segment of the fifth leg. In this it resembles *S. bivexilla*. It has seven segments in the exopod of the antenna whereas both *S. bivexilla* and *S. campaneri* have only six. It is interesting to note that in many respects *S. scottodicarloi* is more closely related to *S. campaneri* than the latter is to *S. bivexilla* which is found in a separate cave on the same island. This resemblance may only be apparent because of the inaccuracies in the original description of *S. bivexilla*.

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