

TWO NEW DIOSACCIDS (COPEPODA, HARPACTICOIDA) FROM THE NORTHERN GULF OF MEXICO

BY

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ABSTRACT

We describe two new species of Diosaccidae (Copepoda, Harpacticoida) from an unvegetated sand at 18 m depth in the northern Gulf of Mexico. One is assigned to the genus *Protopsammotopa*; the other is assigned to *Actopsyllus*, and traits in common with *Eoschizopera* Wells & Rao, 1976, are noted.

RÉSUMÉ

Nous décrivons deux espèces nouvelles de Diosaccidae (Copepoda, Harpacticoida) provenant de sables sans végétation prélevés à 18 m de profondeur au nord du golfe du Mexique. L'une est attribuée au genre *Protopsammotopa*, l'autre au genre *Actopsyllus*, et les caractères en commun avec *Eoschizopera* Wells & Rao, 1976, sont notés.

INTRODUCTION

In the course of an ecological experiment in the northern Gulf of Mexico (Thistle et al., 1995), many of the harpacticoid copepod species studied could be identified only to genus level. Here we describe two of these species from the related Diosaccidae genera *Protopsammotopa* and *Actopsyllus*. Neither genus is well known taxonomically. *Protopsammotopa* is composed of one completely described (Geddes, 1968) and one partially described (Wells, 1977) species; *Actopsyllus* is monotypic. The descriptions of two additional species will provide further understanding of both the variability within each genus and the phylogenetic relationships in this branch (sensu Wells & Rao, 1976) of the Diosaccidae.

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MATERIALS AND METHODS

Specimens were obtained from sediment samples that had been preserved in sodium-borate-buffered seawater formaldehyde (9 : 1, v : v). Harpacticoids were dissected in lactophenol, and the parts were mounted on H-S slides (Shirayama et al., 1993) in Hoyer's mounting medium (Pfannkuche & Thiel, 1988). Pencil drawings were made with a camera lucida on a Zeiss Optiplex compound microscope equipped with differential interference contrast. Habitus views were drawn at 1024 ×; other views were drawn at 2560 ×. Plates were produced with Adobe Illustrator® (Bouck & Thistle, 1999). Terminology follows Huys & Boxshall (1991). Abbreviations used in the text and figures are: ae, aesthetasc; P1-P6, first to sixth thoracopods; exp(enp)-1(2,3), to denote an exopod's (endopod's) first or proximal (second, third) segment.

SYSTEMATICS

Family DIOSACCIDAE G. O. Sars, 1906

Protopsammotopa Geddes, 1968

Diagnosis (amended). — Diosaccidae. Body cylindrical, without clear demarcation between prosome and urosome. Genital double somite with spherical epicopulatory bulb. Rostrum elongate, defined at base. Antennule 8-segmented; second segment longest; with aesthetascs on fourth and eighth segments. Antenna with incomplete division of basis and first endopodal segment; exopod 1-segmented with 2 terminal setae; second endopodal segment with lateral armature of 2 large spines and 2 smaller elements, with distal armature of 4 geniculate spines plus 2 other free elements. Mandible with biramous palp; basis with 2 terminal setae; endopod length less than 1.5 times width, with 5 setae. Maxillule praecoxa with 7 spines along distal margin; coxa with 1 seta; endopod represented by single seta subdistal to terminal setae on basis; exopod 1-segmented with 2 setae. Maxilla syncoxa with 3 endites, proximal and middle endites each with single seta. Maxilliped syncoxa with seta at distal corner; endopod with 1 claw and 1 seta extending approximately half the length of the claw.

P1 endopod prehensile, 2-segmented, first segment approximately equal in length to exopod; exopod 3-segmented. P2-P4 with 3-segmented endopods and exopods; bases with an outer spine or seta; rami segments elongate; exp-3 of each leg with 2 outer spines. P5 with distinct rami; baseoendopod with 4 setae on endopodal lobe; exopod longer than wide, with 5 prominent setae.

Sexual dimorphisms in male include haplocer antennule; P2 endopod 2-segmented, enp-2 distinctly modified, with large outer spine; P5 endopodal lobe with 2 setae; exopod shorter than in female, with 4 prominent setae.

Type species: *Protopsammotopa norvegica* Geddes, 1968.

Other species: *Protopsammotopa wilsoni* Wells, 1977; *Protopsammotopa tipperi* sp. nov.

***Protopsammotopa tipperi* sp. nov. (figs. 1-4)**

Material examined. — National Museum of Natural History (Smithsonian Institution, Washington, D. C.): holotype female in alcohol (reg. no. 1019131); allotype male in alcohol (reg. no. 1019132); additional paratypes (11 females, 24 males) in alcohol (reg. nos. 1019133-1019134) or dissected on slides (5 females, 3 males; reg. no. 1019135).

Type locality. — Northern Gulf of Mexico: 29°40.63'N 84°22.80'W, 18 m depth, unvegetated medium sand; see Thistle et al. (1995) for additional description.

Description. — All illustrations are from paratypes except fig. 1C, which is from the holotype.

Female holotype body length measured from anterior margin of rostrum to posterior margin of caudal rami (not including caudal setae) 365 μ m. Body (fig. 1A-C) slender, cylindrical. Sensilla present dorsally and ventrally on genital double somite and fourth urosomite and dorsally on sixth urosomite (fig. 1A-B). Genital double somite with fused P6's, each side bearing 3 setae (fig. 1B), and spherical epicopulatory bulb. Serrated hyaline fringe present dorsally on genital double somite, urosomites 4-5, and ventrally on urosomite 5 (fig. 1A-B). Posterior, dorsal margin of urosomite 5 drawn out into pseudoperculum (fig. 1A). Anal somite partially divided with spinules along dorsal and ventral posterior margin (fig. 1A-B); anus triradiate, bordered by incised frill (not illustrated). Caudal rami (fig. 1A-B) slightly longer than wide, with 7 setae: seta I thick with blunt tip, setae II-VI bare, dorsal seta (VII) carried on a biarticulate socle.

Rostrum (fig. 1D) slender, defined at base, with subapical sensillum on each side.

Antennule (fig. 1E) 8-segmented; second segment longest; third and sixth segments with blunt setae; fourth segment with an aesthetasc; eighth segment with an acrothek of 2 setae and an aesthetasc; with armature formula 1-[1], 2-[10], 3-[6 + 1 blunt], 4-[2 + (1 + ae)], 5-[2], 6-[2 + 1 blunt], 7-[4], 8-[4 + acrothek].

Antenna (fig. 2A) coxa short and unornamented; basis and first endopodal segment incompletely subdivided; basis with proximal spinular row; second endopodal segment with spinules and hyaline fringe as indicated in fig. 2A; lateral armature consisting of 1 pinnate and 1 bare spine and 2 slender setae; distal armature consisting of a pinnate spine, 1 slender seta, and 4 geniculate spines, the posterior one bears spinules and is fused at base to a seta; exopod 1-segmented with 1 bare and 1 pinnate distal setae.

Mandible (fig. 2E) cutting edge with many slender teeth, spinular row near insertion of basis; palp biramous, comprising basis and 1-segmented exopod and

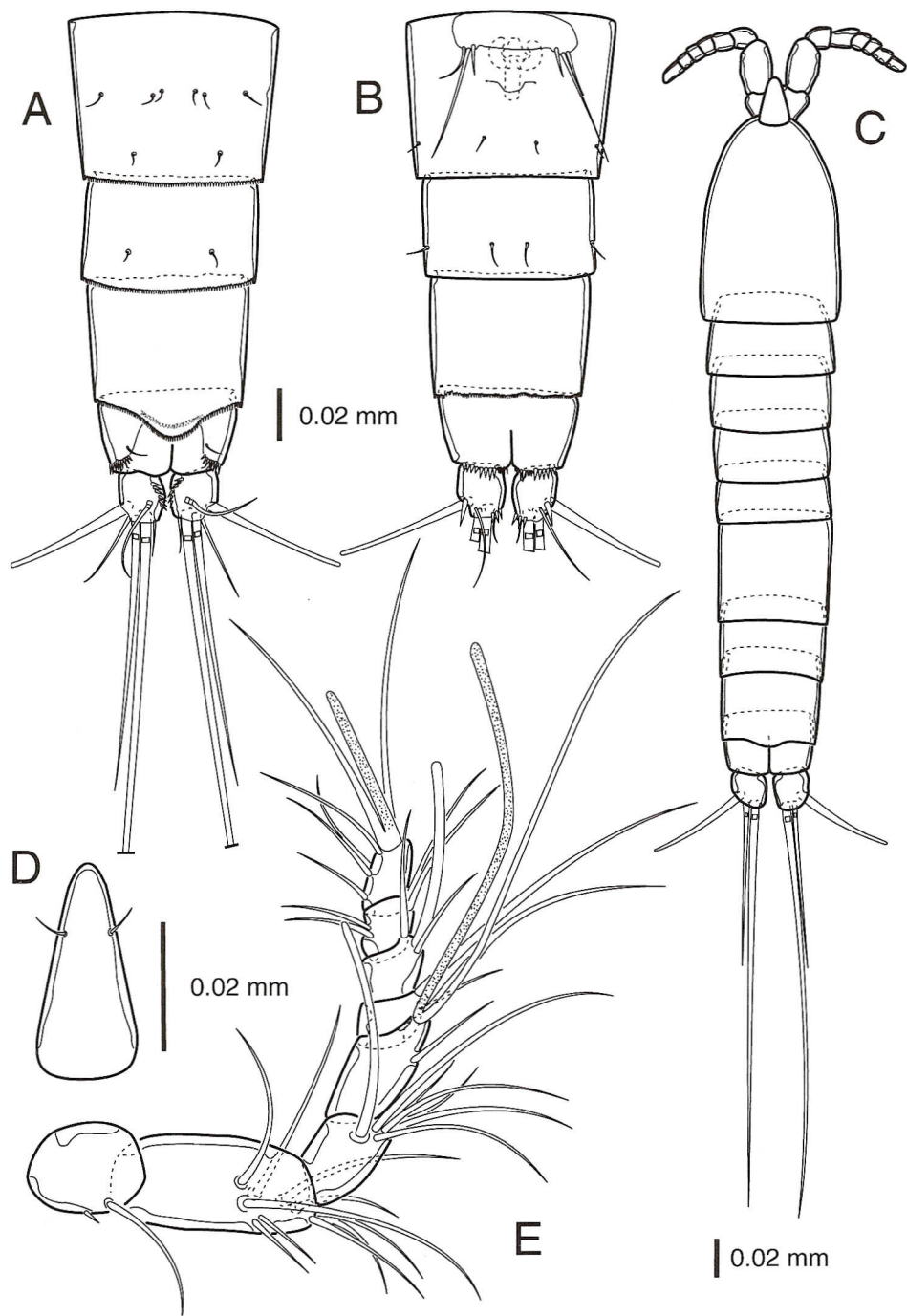


Fig. 1. *Protosammotopa tipperi* sp. nov., female. A, urosome, dorsal; B, urosome, ventral; C, habitus; D, rostrum; E, antennule.

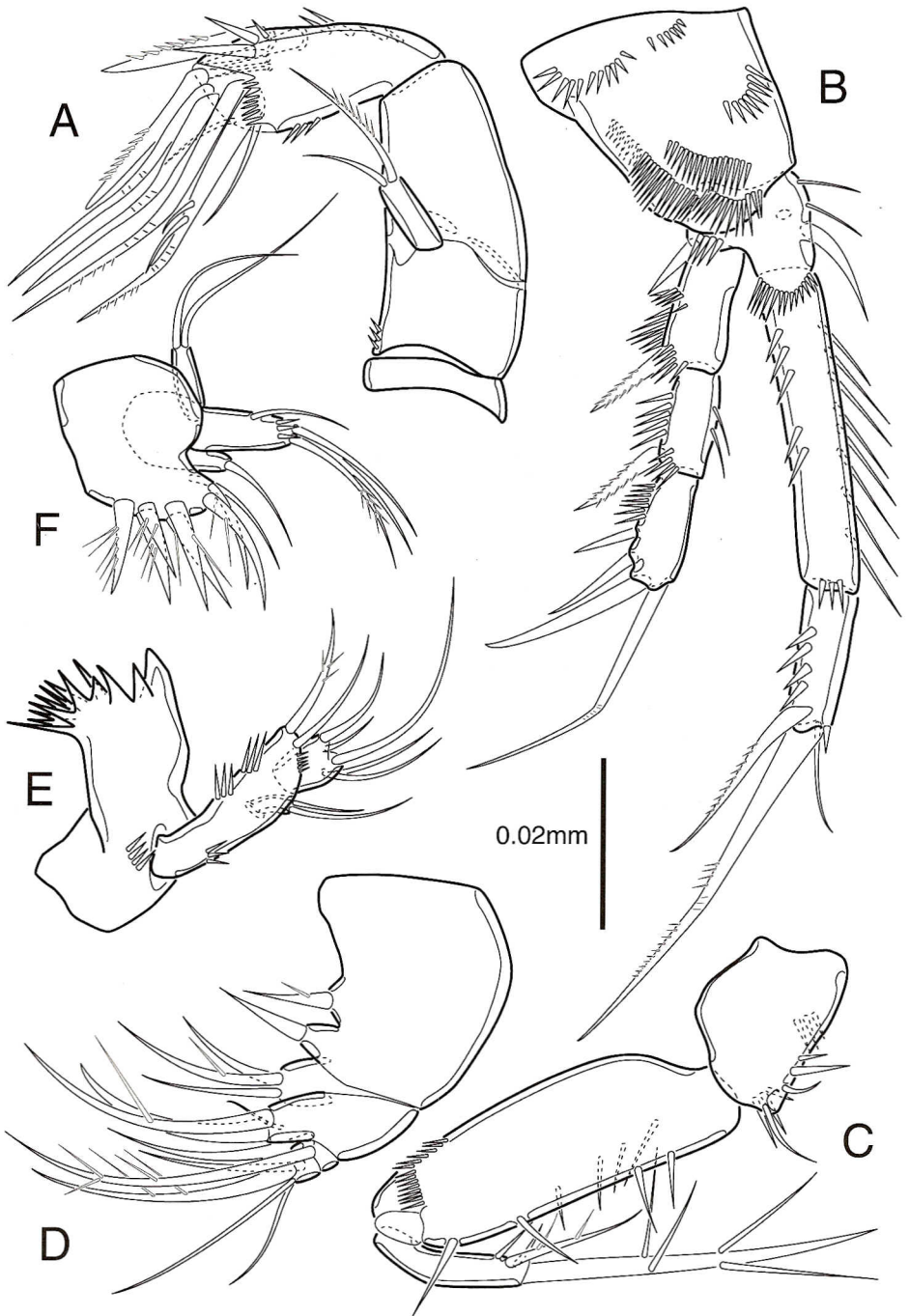


Fig. 2. *Protosammotopa tipperi* sp. nov., female. A, antenna; B, P1; C, maxilliped; D, maxilla; E, mandible; F, maxillule.

endopod; basis with several spinular rows, 1 pinnate and 1 bare setae; endopod with 2 subdistal and 3 distal setae; exopod with 2 distal setae.

Maxillule (fig. 2F) praecoxa with 7 spines along distal margin and 1 seta; coxa with 1 seta; basis with subdistal spinular row and 3 distal setae; endopod represented by single seta subdistal to basis setae; exopod with 2 setae.

Maxilla (fig. 2D) syncoxa with 3 endites; proximal endite with unipinnate seta, middle endite with single seta; distal endite with 1 unipinnate and 2 bare setae; allobasis with 1 short, slender seta, 1 bare and 1 unipinnate setae; endopod 2-segmented, proximal segment with 1 bare and 1 pinnate setae, distal segment with 1 pinnate and 3 bare setae.

Maxilliped (fig. 2C) syncoxa with 1 slender subdistal seta, 1 longer distal seta and spinules as indicated in figure; basis with several inner spinules, 2 subdistal setae along palmar margin, and a row of spinules along outer margin; endopod with 1 strong, pinnate seta drawn into a claw, 1 slender, pinnate seta, and 2 minute bare setae.

P1 (fig. 2B) coxa with many spinular rows; basis with inner spinules and spinules at insertion of endopod and exopod, with 1 inner and 1 outer spine; exopod 3-segmented, with outer margins and inner margin of exp-2 spinulose, exp-3 with 1 geniculate and 3 shorter spines; endopod 2-segmented, prehensile, and longer than exopod; enp-1 roughly equal in length to exopod, with inner, outer, and distal spinular rows; enp-2 with spinules, 1 slightly curved, pinnate and 1 geniculate, pinnate spines and 1 slender seta distally.

P2-P4 (fig. 3A-C) with 3-segmented exopods and endopods. Coxae with several anterior spinular rows and a posterior spinular row. Bases with outer short, bipinnate spine (P2) or bipinnate (P3) or bare (P4) seta. Endopods roughly equal to (P2) or slightly longer than (P3-P4) exopods. Seta and spine formula as follows:

	Exopod	Endopod
P2	0.0.022	0.1.021
P3	0.0.022	1.1.121
P4	0.0.022	1.1.121

P5 (fig. 3D) baseoendopod with 1 short, bare and 3 bipinnate inner setae; outer basal seta long and arising from conical process. Exopod 2.6 times as long as wide (excluding distal setae) with inner spinules, 1 inner, 1 long, pinnate, apical, and 3 prominent, outer setae, outer margin also with 2 very short tube-like elements.

Male allotype. — Body length equal to that of female (365 μm). P6 asymmetrical, each side with 3 setae (fig. 4B; the P6 illustration is a composite: the far left seta was drawn based on a second specimen). Caudal rami without seta III (fig. 4A-B).

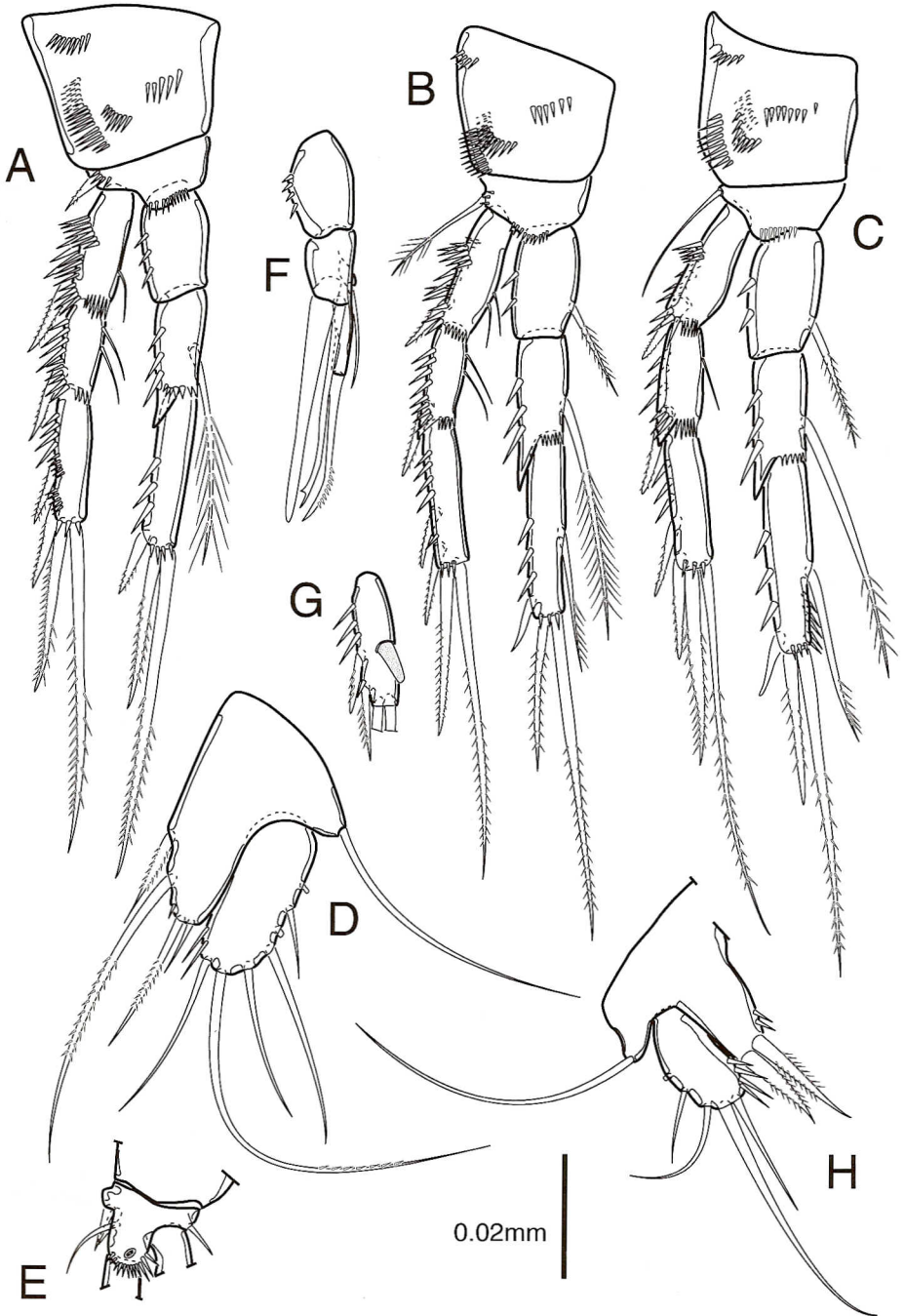


Fig. 3. *Protosamnotopa tipperi* sp. nov. Female: A, P2; B, P3; C, P4; D, P5. Male: E, P1 basis; F, P2 endopod; G, P3 exp-3; H, P5.

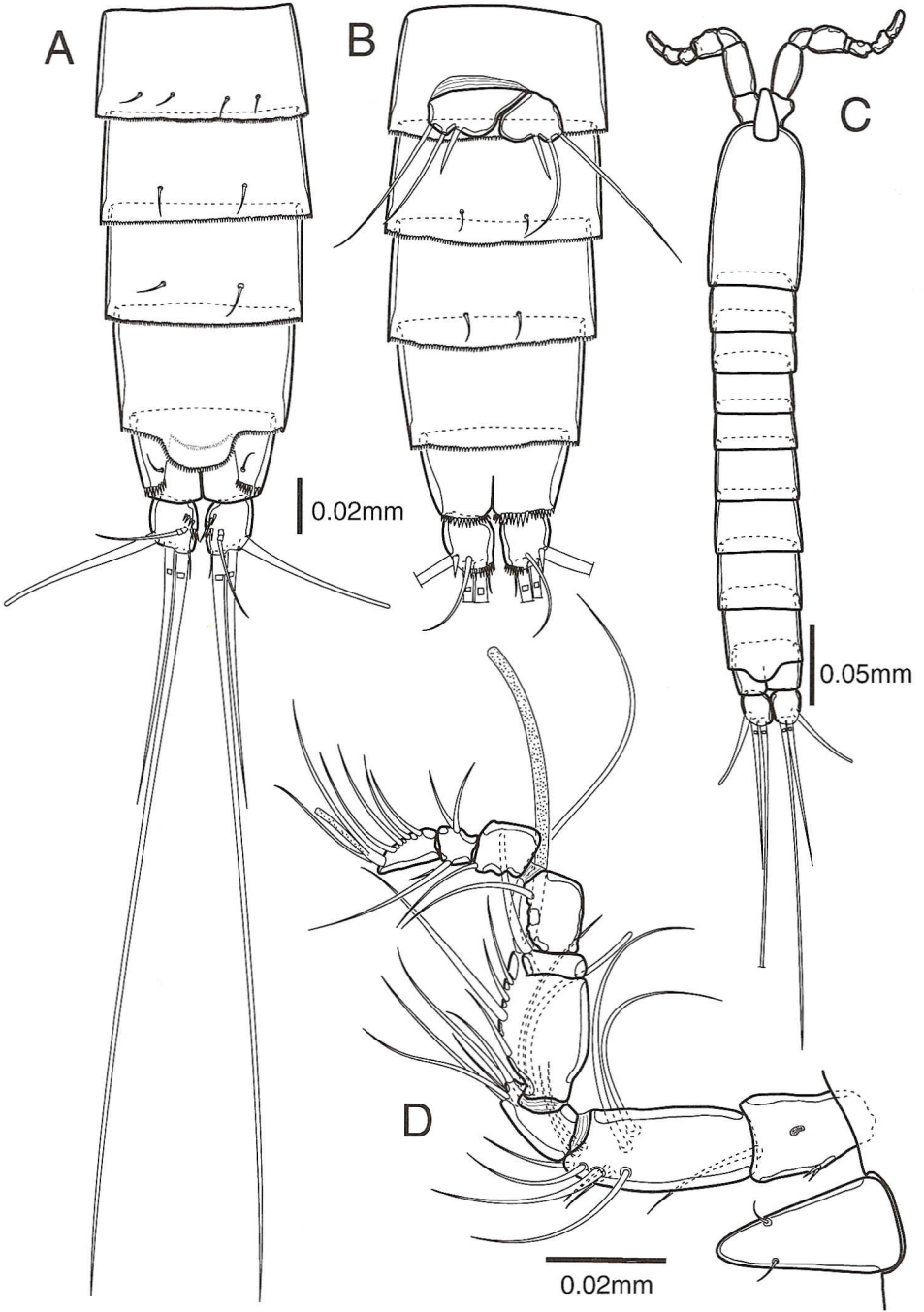


Fig. 4. *Protosammotopa tipperi* sp. nov., male. A, urosome, dorsal; B, urosome, ventral; C, habitus; D, rostrum and antennule.

Antennule (fig. 4D) haplocer, 9-segmented; third and fifth segments with blunt setae; fourth segment with an aesthetasc; ninth segment with an acrothek of 2 setae and an aesthetasc; with armature formula 1-[1], 2-[10], 3-[6 + 1 blunt], 4-[4 + (1 + ae)], 5-[1 blunt], 6-[1], 7-[1], 8-[4], 9-[4 + acrothek].

P1 (fig. 3E) basis with modified shape, inner seta more slender than in female, inner spinules thicker than in female.

P2 (fig. 3F) endopod 2-segmented; enp-2 distinctly modified with 1 inner, bare and 1 apical, distally pinnate setae and with outer subdistal elements modified into 1 bifurcate seta and 1 thick spine.

P3 (fig. 3G) exp-3 with anterior hyaline spine.

P5 (fig. 3H) baseoendopods fused medially; endopodal lobe with 2 bipinnate spines; outer basal seta long and arising from conical process; exopod with 4 setae and 1 short, tube-like element.

Etymology. — The species is named for Ronald C. Tipper.

Remarks. — *Protopsammotopa tipperi* sp. nov. shares several traits with the two currently described *Protopsammotopa* species (Geddes, 1968; Wells, 1977). Based on the male P2 endopod of *P. norvegica* Geddes, 1968, Geddes assigned his newly created genus, *Protopsammotopa*, and moved the obviously related *Psammotopa* to the Diosaccidae. He suggested that both *Protopsammotopa* and *Psammotopa* be placed near the genus *Schizopera*, with which they share a reduced limb armature. Wells & Rao (1976) split *Schizopera*, creating the genus *Eoschizopera* (note Mielke, 1992, rejected this genus), and suggested a close relationship between *Eoschizopera* and *Protopsammotopa*-*Psammotopa*. *P. tipperi* sp. nov. has the reduced limb armature of the species in this group of genera. The structure of the male P2 endopod of *P. tipperi* sp. nov. is similar to that found in species of *Protopsammotopa* and *Eoschizopera*. We assigned *P. tipperi* sp. nov. to *Protopsammotopa*, rather than *Eoschizopera*, based on the mandibular endopod, which has a distinct, squarish shape that can be contrasted with the typical, rectangular shape found in genera that are more distantly related, as defined by Wells & Rao's (1976) phylogeny. The lack of an inner seta on the P1 enp-1 and an antenna with a 1-segmented exopod also support placing the species within *Protopsammotopa*.

Protopsammotopa tipperi sp. nov. differs from other *Protopsammotopa* in the following aspects. Geddes' (1968) description of the *P. norvegica* male antennule notes that the fourth segment is "partially sub-divided by an indistinct suture line". In *P. tipperi* sp. nov., this division is complete, resulting in two distinct segments. The male P3 exp-3 in *P. tipperi* sp. nov. has a membranous projection not found in other *Protopsammotopa*. The membranous projection is more similar in structure to the hyaline spines reported for species of the genera *Schizopera*

and *Eoschizopera* (e.g., Lang, 1965; Wells & Rao, 1976; Apostolov, 1982; Mielke, 1992, 1995) than to the tube pores described by Gee & Fleeger (1990) in other diosaccids. The structure does not appear to have the opening at the tip found in Gee & Fleeger's (1990) tube pores. The presence of a hyaline spine would seem to support the assignment of the species to *Eoschizopera*. Considering the close relationship between *Eoschizopera* and *Protopsammotopa* and the ubiquity of a sexually dimorphic structure on the male P3 exp-3 within the Diosaccidae, we feel it is reasonable to allow species with hyaline spines to be assigned to *Protopsammotopa*.

Actopsyllus Wells, 1967

Diagnosis (amended). — Diosaccidae. Body cylindrical, without clear demarcation between prosome and urosome. Rostrum elongate, defined at base. Genital double somite with dorso-lateral strip of chitin and mildly produced epicopulatory bulb; P6's fused with 3 setae on each side. Pseudopericulum present.

Antennule 8-segmented; first through fourth segments elongate; fourth segment with aesthetasc. Antenna with distinct or incompletely divided basis; exopod 2- or 3-segmented. Mandible with biramous palp; basis with 3 setae; endopod 1-segmented with 4 terminal and 2 lateral setae; exopod 1- or 2-segmented with 5 setae. Maxilla syncoxa with 3 endites; allobasis with claw; endopod 1-segmented with 3 setae. Maxilliped syncoxa with slender seta at distal corner; basis with 2 setae along palmar margin; endopod with claw, 1 long, strong seta, and 2 minute setae.

P1 endopod prehensile, first segment distinctly longer than exopod, with inner seta; exopod 3-segmented, third segment with 4 spines. P2-P4 with 3-segmented endopods and exopods; bases with an outer spine or seta; rami segments elongate; enp-2 of each leg with outer distal corner acutely produced; exp-3 of each leg with 2 outer spines. P5 with distinct rami; exopod longer than wide.

Sexual dimorphisms in male include haplocer antennule; P1 basis with inner projection; P2 endopod 2-segmented, enp-2 distinctly modified, with large outer spine; P5 baseoendopods fused medially, with 2 setae.

Type species: *Actopsyllus longipes* Wells, 1967.

Other species: *Actopsyllus matthewi* sp. nov.

Actopsyllus matthewi sp. nov. (figs. 5-8)

Material examined. — National Museum of Natural History (Smithsonian Institution, Washington, D. C.): holotype female in alcohol (reg. no. 1019136); allotype male in alcohol (reg. no. 1019137); additional paratypes (11 females, 11 males) in alcohol (reg. nos. 1019138-1019139) or dissected on slides (5 females, 5 males; reg. no. 1019140).

Type locality. — Northern Gulf of Mexico: 29°40.63'N 84°22.80'W, 18 m depth, unvegetated medium sand; see Thistle et al. (1995) for additional description.

Description. — All illustrations are from paratypes except fig. 5A, which is from the holotype.

Female holotype body length measured from anterior margin of rostrum to posterior margin of caudal rami (not including caudal setae) 335 μm . Body (fig. 5A,C-D) slender, cylindrical. Sensilla present dorsally on genital double somite, fourth and sixth urosomites, and ventrally on fourth urosomite (fig. 5C-D). Genital double somite with dorso-lateral strip of chitin, fused P6's, each side bearing 3 setae (fig. 5C), and mildly produced epicopulatory bulb. Serrated hyaline fringe present dorsally and ventrally on urosomite 5 (fig. 5C-D). Posterior, dorsal margin of urosomite 5 drawn out into slight pseudopericulum (fig. 5D). Anal somite mildly indented at posterior margin with spinules along posterior margin; with minute spinular ornamentation dorsally (fig. 5C-D); anus triradiate, bordered by incised frill (not illustrated). Caudal rami (fig. 5C-D) slightly longer than wide, with 6 setae: setae I-II bare, seta III absent, setae IV-VI bare, dorsal seta (VII) carried on a biarticulate socle.

Rostrum (fig. 5E) slender, defined at base; with subapical sensillum on each side.

Antennule (fig. 5B) 8-segmented; second segment longest; fourth segment with an aesthetasc; an acrothek was not obvious on the eighth segment; with armature formula 1-[1], 2-[8], 3-[6], 4-[3 + (1 + ae)], 5-[2], 6-[3], 7-[3], 8-[7].

Antenna (fig. 6B) coxa short and unornamented; basis and first endopodal segment incompletely subdivided; second endopodal segment with spinules and hyaline fringe as indicated in fig. 6B; lateral armature consisting of 2 bare spines and 2 slender setae; distal armature consisting of 1 pinnate spine, 1 slender seta and 4 geniculate spines, the posterior one bearing spinules and fused at base to a seta; exopod 2-segmented, exp-1 with bipinnate seta, exp-2 with distal seta.

Mandible (fig. 6C) cutting edge with many slender teeth, spinular row near insertion of basis; palp biramous, comprising basis and 1-segmented exopod and endopod; basis with spinular row and 3 pinnate setae; endopod with 2 lateral and 4 distal setae; exopod with 2 lateral, pinnate setae and 3 distal, bare setae. No complete mandible was obtained, so the drawing is a composite; the 3 basis setae are based on a second specimen.

Maxillule (fig. 6D) praecoxa with 7 pinnate spines along distal margin and 2 setae; coxa with 1 bipinnate seta; basis with spinular rows and 1 pinnate and 1 bare setae; endopod represented by single seta (indicated by arrow in illustration) adjacent to basis setae; exopod with 2 pinnate setae and lateral spinules.

Maxilla (fig. 6E) syncoxa with 3 endites; proximal endite with pinnate seta, middle endite with 2 pinnate setae; distal endite with 2 pinnate and 1 bare setae;

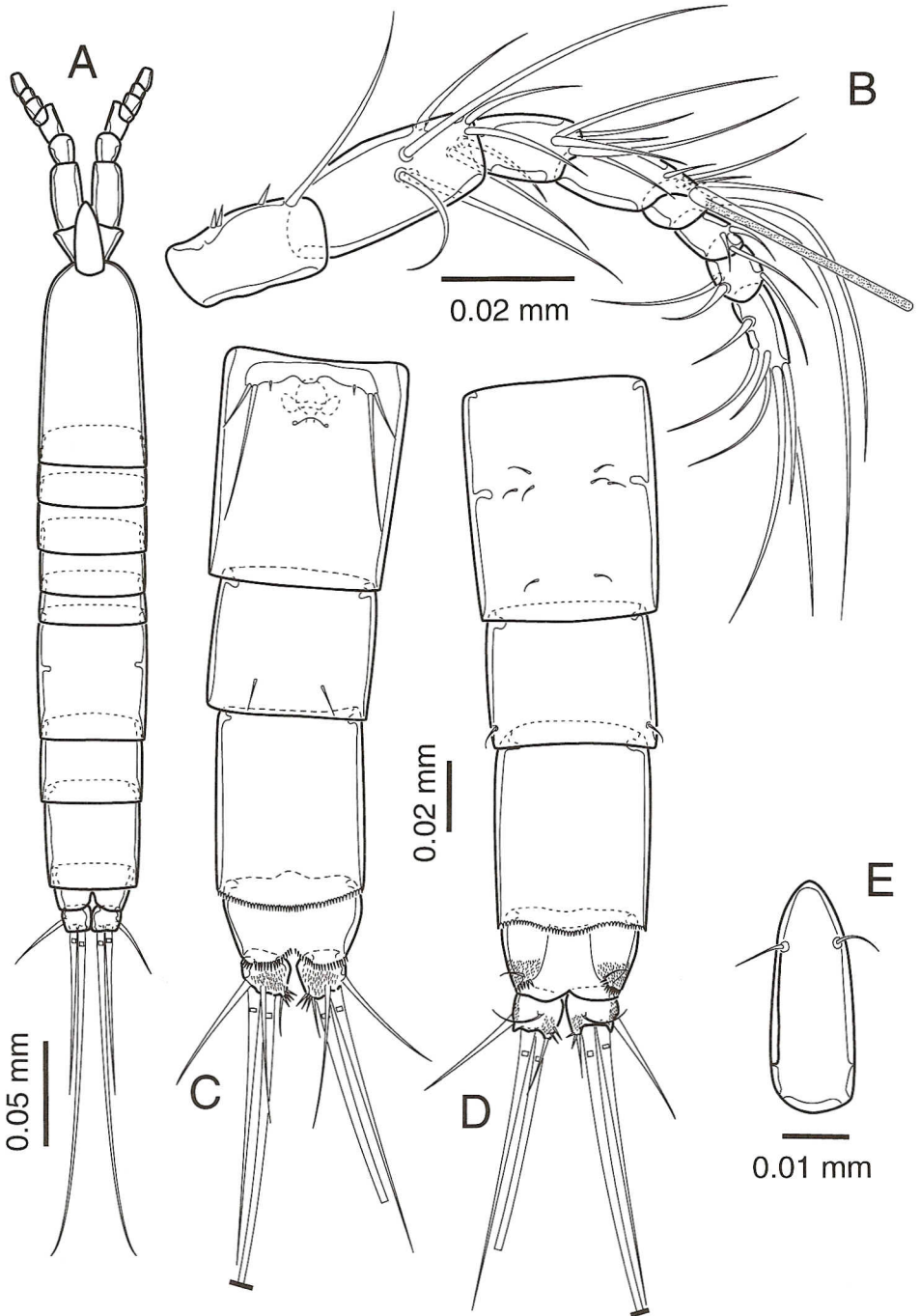


Fig. 5. *Actopsyllus matthewi* sp. nov., female. A, habitus; B, antennule; C, urosome, ventral; D, urosome, dorsal; E, rostrum.

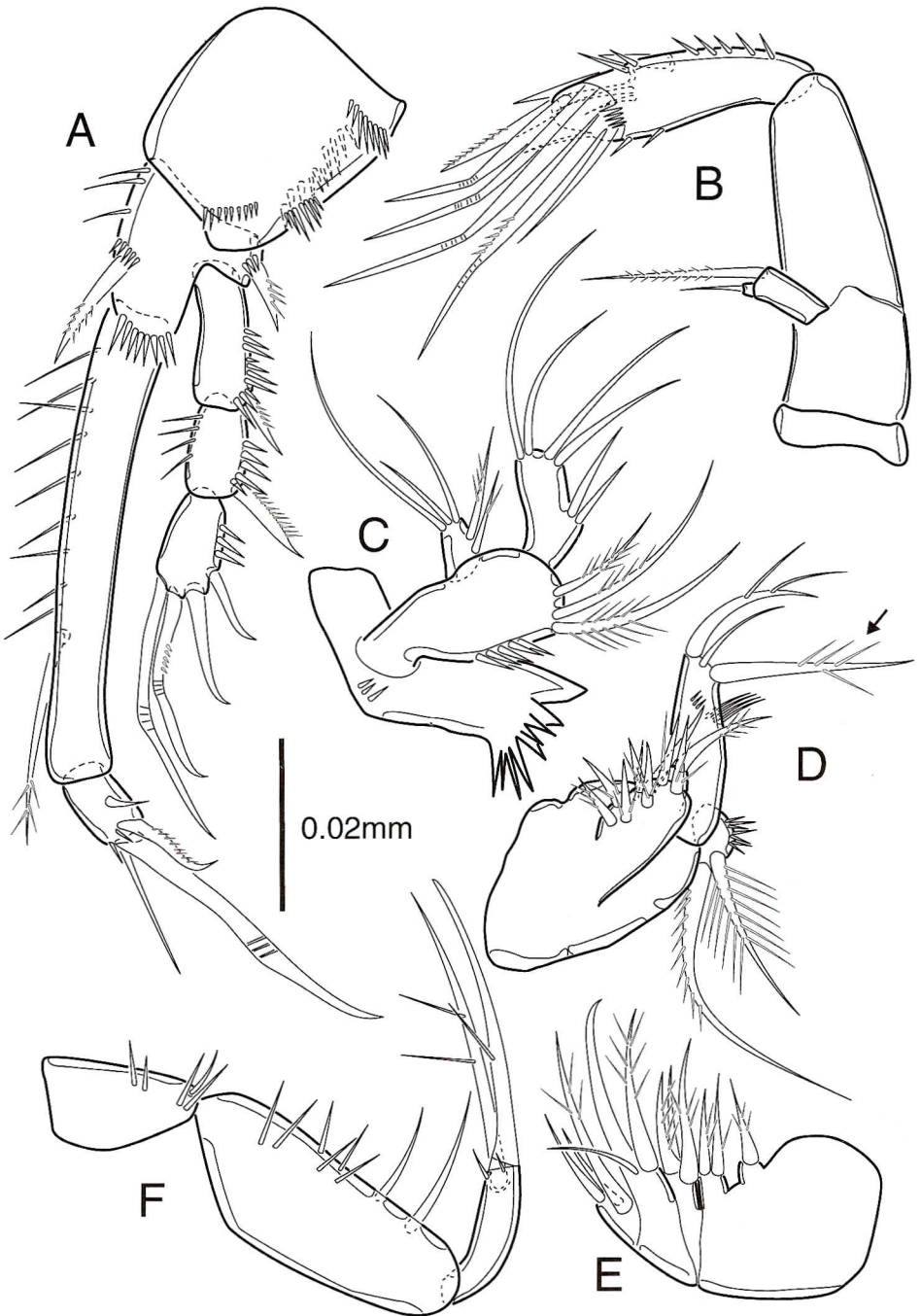


Fig. 6. *Actopsyllus matthewi* sp. nov., female. A, P1; B, antenna; C, mandible; D, maxillule (arrow indicates endopod represented by single seta); E, maxilla; F, maxilliped.

allobasis with claw, 1 bare and 1 pinnate setae; endopod 1-segmented with 2 bare and 1 pinnate setae.

Maxilliped (fig. 6F) syncoxa with slender seta at distal corner and spinules as indicated in figure; basis with several inner spinules and 2 subdistal setae along palmar margin; endopod with 1 pinnate claw, 1 pinnate, long seta, and 2 minute setae.

P1 (fig. 6A) coxa with several spinular rows; basis with spinules along inner margin and at insertions of endopod and inner bipinnate and outer pinnate spines; exopod 3-segmented, with outer margins and inner margin of exp-2 spinulose, exp-3 with 2 curved and 2 geniculate spines; endopod 2-segmented, prehensile, and distinctly longer than exopod; enp-1 distinctly longer than exopod, with inner spinular row and subdistal bipinnate seta; enp-2 with spinules, 1 curved and 1 geniculate spines and 1 slender seta distally.

P2-P4 (fig. 7A-C) with 3-segmented exopods and endopods. Coxae with anterior and posterior spinular rows. Bases with short outer, bipinnate spine (P2) or bare setae (P3-P4). Endopods slightly longer than (P2-P3) or roughly equal to (P4) exopods. Seta and spine formula as follows:

	Exopod	Endopod
P2	0.1.022	1.1.121
P3	0.1.022	1.1.121
P4	0.1.122	1.1.121

P5 (fig. 7D) baseoendopod with 1 long, bare and 2 bipinnate inner setae; outer basal seta long and arising from conical process. Exopod 1.9 times as long as wide (excluding distal setae) with 1 inner, 1 long, apical, and 1 long and 3 shorter outer setae.

Male allotype. — Body length roughly equal to that of female (330 μ m). P6 asymmetrical, each side with 3 setae (fig. 8C). Caudal rami setae III and VI absent (fig. 8C-D).

Antennule (fig. 8A) haplocer, 9-segmented; fourth segment with an aesthetasc; with armature formula 1-[1], 2-[8], 3-[6], 4-[3 + (1 + ae)], 5-[1], 6-[1], 7-[1], 8-[3], 9-[7].

P1 (fig. 7F) basis with slender, bare seta rather than bipinnate spine found in female, inner margin spinules thicker than in female, inner seta and spinules on projection.

P2 (fig. 7G) endopod 2-segmented; enp-1 with bare inner seta and no spinules; enp-2 distinctly modified with 2 inner, bare and 1 apical, bipinnate setae and with outer subdistal elements modified into 1 bifurcate seta and 1 thick spine.

P5 (fig. 7E) baseoendopods fused medially; each side with 2 bipinnate inner setae and long, outer seta arising from conical process; exopod 1.7 times as long as

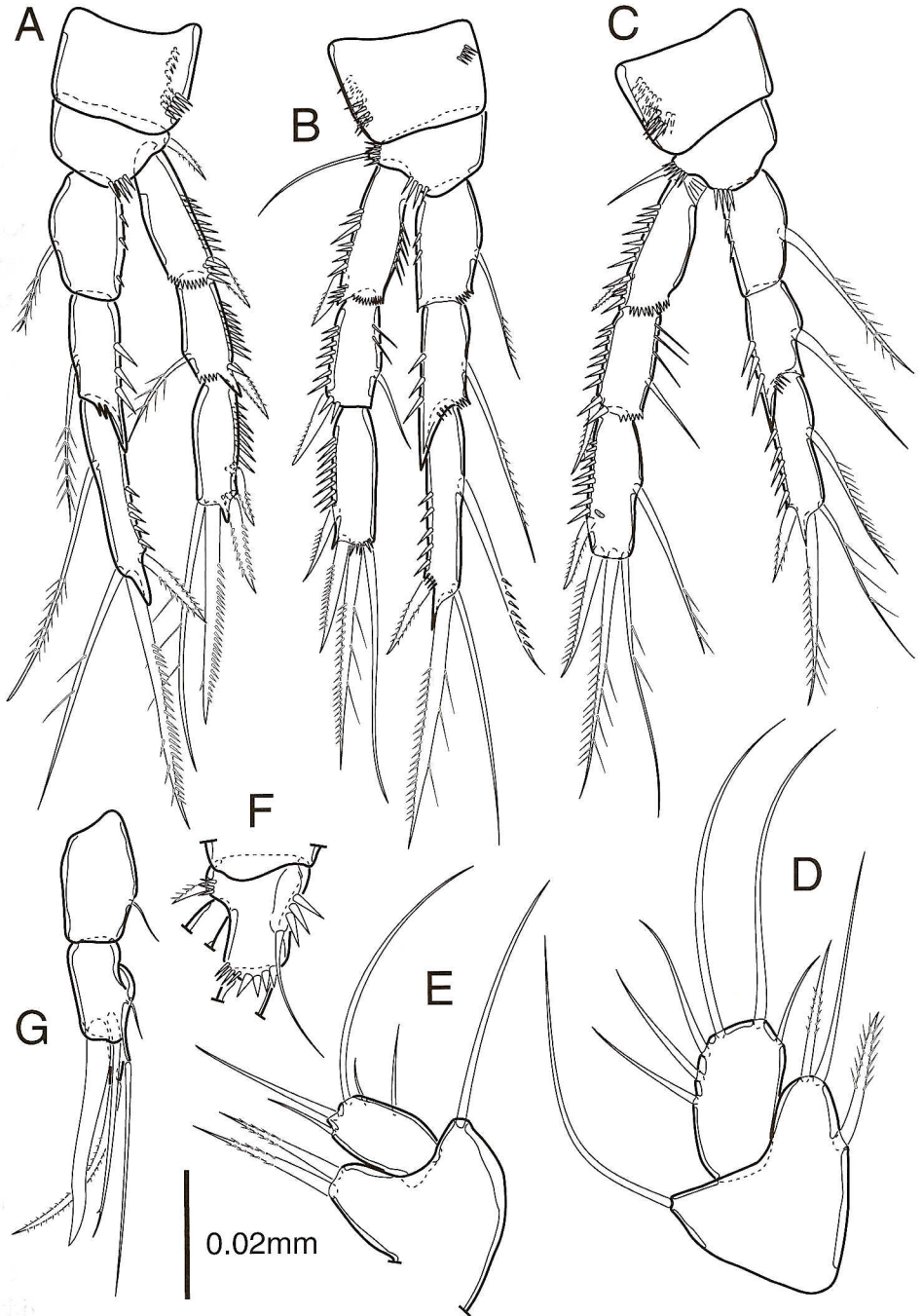


Fig. 7. *Actopsyllus matthewi* sp. nov. Female: A, P2; B, P3; C, P4; D, P5. Male: E, P5; F, P1 basis; G, P2 endopod.

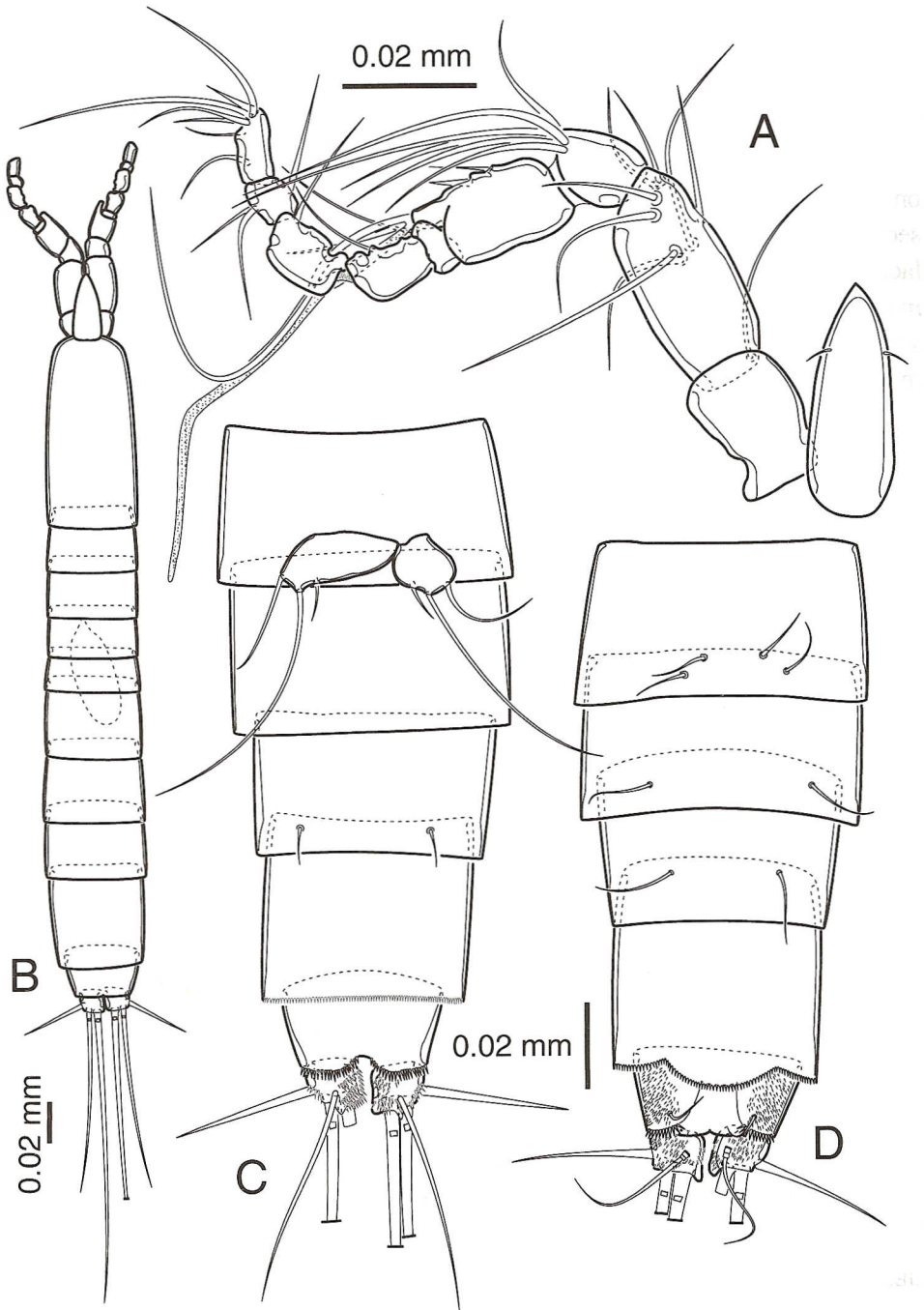


Fig. 8. *Actopsyllus matthewi* sp. nov., male. A, rostrum and antennule; B, habitus; C, urosome, ventral; D, urosome, dorsal.

wide (excluding distal setae) with 1 inner, 1 apical, and 1 long and 2 shorter outer setae.

Etymology. — The species is named for Matthew Bouck, the first author's husband.

Remarks. — Wells (1967) established the monotypic genus *Actopsyllus* based on specimens from Ilha dos Portuguesos, Mozambique. Kunz (1971) added a second species that was later removed by Wells & Rao (1976) because the species lacked a strong claw on the male P2 endopod. We have placed *Actopsyllus matthewi* sp. nov. in *Actopsyllus* based on the male P2 endopod, which is very similar to that of the *Actopsyllus* type species, and the two strong spines on the maxilliped endopod, found in no other related genus. It also has the much greater length of the P1 enp-1 in comparison with the P1 exp and the presence of an inner seta on the male P2 enp-1 as in the type species.

A. matthewi sp. nov. differs from the type species in the position of the P1 enp-1 seta and the setation of the P2-P5. In the male, the second segment of the endopod has an additional strong seta not found in *A. longipes*. *A. matthewi* also has two rather than three segments in the A2 exopod.

As an aside, Gee & Fleeger (1990) identified the presence of a tube pore on the male P3 exp-3 as a common sexual dimorphism within the Diosaccidae. They were able to find tube pores in several species for which the structure had not been previously reported. Although they considered it pertinent, they were unable to examine any *Actopsyllus* specimens. After careful examination, we could find no tube pore, other pore, or hyaline spine present on the male P3 exp-3 of *A. matthewi* sp. nov.

ACKNOWLEDGEMENTS

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