29 December 2000
PROCEEDINGS OF THE BIOLOGICAL SOCIETY OF WASHINGTON
113(4):1079–1088. 2000.

Grievella shanki, a new genus and species of scolecitrichid calanoid copepod (Crustacea) from a hydrothermal vent along the southern East Pacific Rise

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Abstract.—Four derived states separate the calanoid copepod *Grievella shanki,* new genus and species, from other scolecitrichids: small integumental bumps on the genital complex; an ear-like extension on articulating segment 22 of antenna 1; two lateral setae on the distal exopodal segment of swimming leg 2; a denticle-like attenuation of the proximal praecoxal lobe of maxilla 2. The first probably is an autapomorphy for the species; the second, third and fourth are presumed synapomorphies for species of the new genus. The last derived state is convergent with some species of the calanoid superfamilies Epacteriscoidea, Centropagoidea and Megacalanoidea, but it is a synapomorphy within the Clausocalanoidea to which *Grievella shanki* belongs. Five setae on the proximal praecoxal lobe of maxilla 2 and three setae on the distal praecoxal lobe of the maxilliped separate *Grievella shanki* from species of Diaixidae, Parkiidae and Tharybidae, and species of Phaennidae, respectively. The states of these characters for *Grievella shanki* may be plesiomorphic to the states expressed in Diaixidae, Parkiidae, Tharybidae and Phaennidae so assignment of this species to the Scolecitrichidae is tentative. The number and kind of sensory setae on the distal basal lobe plus exopod of maxilla 2 alone are not adequate to diagnose the Scolecitrichidae, or to separate all of its species from those of the other families with these sensory setae.

Calanoid copepods belonging to the family Scolecitrichidae usually are collected from pelagic or benthopelagic habitats of marine waters below 200 m. There are over 250 nominal species in 22 genera in the family. Eight of the 22 genera in this family have been described within the last quarter century, reflecting a general increase in interest in the biology of the deep waters of the world's ocean. Here we describe the 23rd genus of the family.

Materials and Methods

The copepod was collected at Droopy Vent, 21°24.027′S, 114°16.184′W on 17 October 1998 with a slurp vacuum sampler less than a meter above the surface on the side of a small diffusing vent chimney during *Alvin* dive 3287; bottom depth, 2788 m, water temperature, 4.5°C. The specimen was fixed in 70% ethanol/30% seawater. During laboratory examination, the specimen was cleared in steps through 50% lactic acid/50% deionized freshwater to 100% lactic acid, stained by adding a solution of chlorazol black E dissolved in 70% ethanol/30% deionized freshwater, dissected, and examined with bright-field and with differential interference optics. Drawings were made with a camera lucida. The dissected specimen is preserved in 70% ethanol/30% deionized freshwater with a drop of glycerin added.

Cephalic appendages are abbreviated A1 = antenna 1; A2 = antenna 2; Mn = mandible; Mx1 = maxilla 1; Mx2 = maxilla 2. Thoracic somites are Th1–7; appendages on thoracic somites are Mxp = maxilliped (thoracopod 1); P1–5 = swimming legs (thoracopods 2–6). The caudal ramus is CR. Designations of appendage segments are according to Ferrari (1995) as follows: medial lobe of a segment = li, lateral lobe = le; rami are exopod = Re and endopod = Ri; ramal segments of Mx2 are exopodal; the Mxp has a basipod with a distal medial lobe, and with at most five endopodal segments in calanoids (Ferrari & Dahms 1998). Armament elements of appendages are termed setae regardless of their position or degree of rigidity. Two setae and one aesthetasc on a segment of A1 are designated 2+1. Setules are epicuticular extensions of a seta; denticles are epicuticular extensions of an appendage segment; spinules are epicuticular extensions of a somite.

Grievella, new genus

Diagnosis.—Presumed unique synapomorphies of *Grievella* are an ear-like extension anteriorly near distal margin of articulating segment 22 of antenna 1; distal exopodal segment of swimming leg 2 with 2 lateral setae; single denticle-like attenuation of the proximal praecoxal lobe of maxilla 2.

Remarks.—A distal exopodal segment of swimming leg 2 with 2 lateral setae is convergent with some species of the superfamilies Megacalanoidea and Centropagoidea, and with all species of the superfamily Epacteriscoidea. It is assumed to be a synapomorphy for this genus within the Clausocalanoidea to which this species belongs.

Type species.—*Grievella shanki* by monotypy and present designation.

Etymology.—The name *Grievella* honors Janet Bradford-Grieve New Zealand National Institute of Water and Atmospheric Research for her contributions to copepod systematics. The gender of the generic name is feminine.

Grievella shanki, new species
Figs. 1–5

CVI Female.—Holotype, USNM 261784, (Fig. 1A, B) Cephalon, Th1 and Th2 fused; Th3 and Th4 separate; Th5 fused with Th6. Posterior corners of prosome rounded laterally and not reaching beyond the anterior margin of genital complex. Genital complex (Fig. 1G–J) symmetrical in ventral view; in lateral view, asymmetry results from small integumental bumps; with slight bulge ventrally at copulatory opening; seminal receptacle extending to middle of complex dorsally, and slightly curved posteriorly; oviducal pore anterior. Three articulating abdominal somites posterior to genital complex.

Rostrum (Fig. 1C–E): 2 filaments, each on robust base.

A1 (Fig. 2A–D): reaching Th3, of 24 articulating segments with groups of setae: 3, 6+1, 2+1, 2, 2+1, 2, 2+1, 4+1, 1, 1, 2+1, 1, 2+1, 1, 2, 1, 2, 1+1, 1, 1, 2, 2, 2, 5+1. One denticle proximally on ventral face of segment 7; several smaller denticles distally on dorsal face of segments 19 and 20. Segment 22 with ear-like extension anteriorly with ear cavity facing proximally.

A2 (Fig. 2E): coxa with 1 seta and denticles. Basis with 2 setae. Ri 2-segmented with 2 and 15 (6+1 posterior terminal and 8 subterminal) setae (Fig. 2F). Re 7 articulating segments with 0, 3, 1, 1, 1, 1, 3 setae.

Mx1 (Fig. 3C): praecoxa elongate with 9 terminal, and 3 posterior setae; coxal epipodite with 7 long, thick and 2 short, thin setae; coxal endite with 2 setae; proximal and distal basal endites each with 4 setae. Ri with 10 setae in groups of 3 and 7; Re with 6 setae.

Mx2 (Fig. 4A–C): proximal praecoxal endite with 5 setae and attenuate point, distal endite with 3 setae. Proximal coxal endite with 3 setae, distal coxal endite with 3 setae. Proximal basal endite with 1 long, thick seta, 2 long, thin seta and 1 poorly sclerotized setae. Distal basal lobe + Re

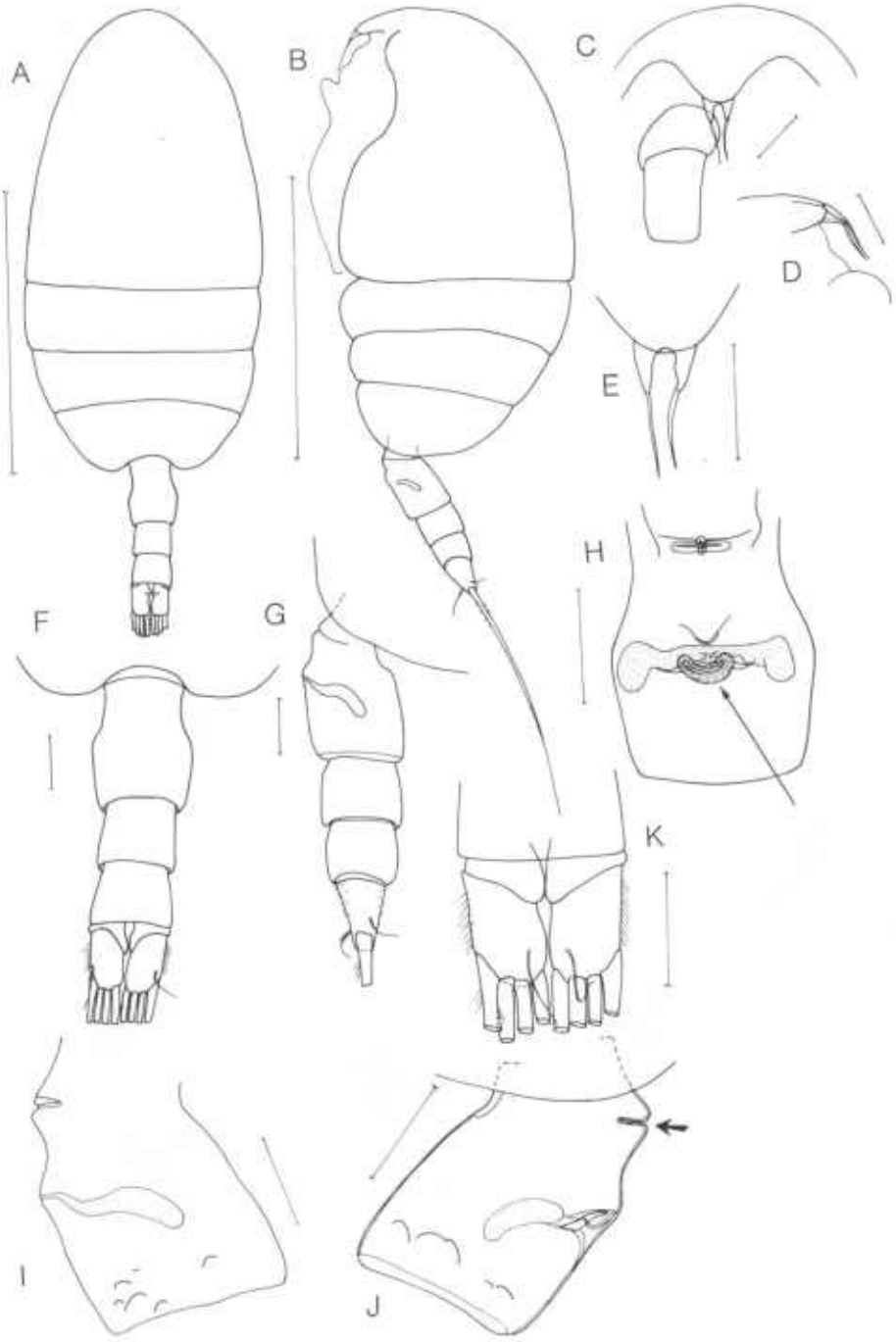

Fig. 1. *Grievella shanki,* new genus and species. A, habitus, dorsal; B, habitus, left lateral; C, rostrum, ventral; D, rostrum, right lateral; E, rostrum, ventral; F, urosome, dorsal; G, urosome, left lateral; H, genital complex, ventral, arrow to location of copulatory opening; I, genital complex, left lateral; J, genital complex, left lateral, arrow to oviducal opening; K, caudal rami, ventral. Scale lines are 0.1 mm.

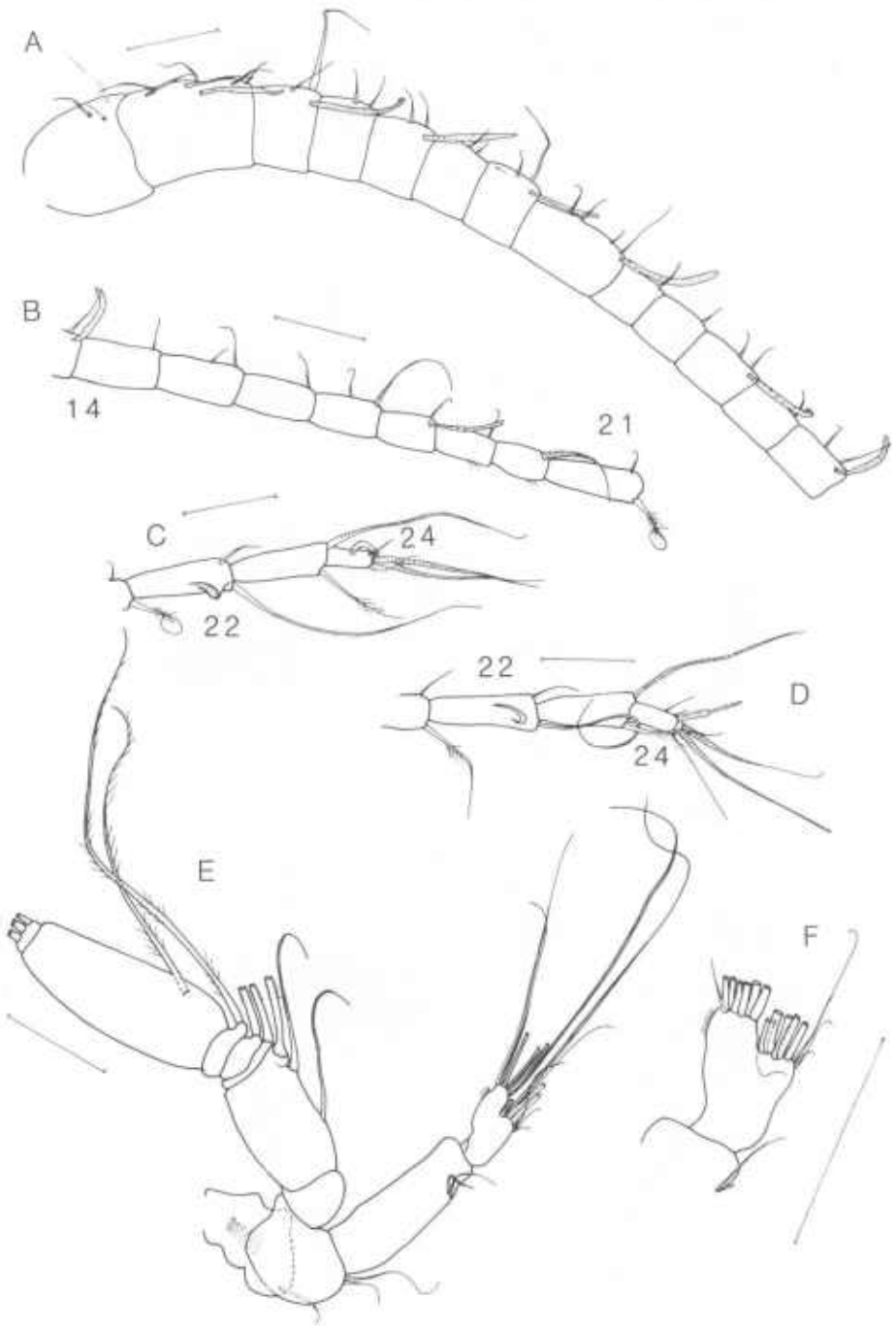

Fig. 2. *Grievella shanki,* new genus and species. A, left antenna 1, articulating segments 1–13; B, left antenna 1, articulating segments 14–21; C, left antenna 1, articulating segments 22–24; D, right antenna 1, articulating segments 22–24; E, antenna 2, posterior; F, antenna 2, distal segment of endopod. Scale lines are 0.1 mm.

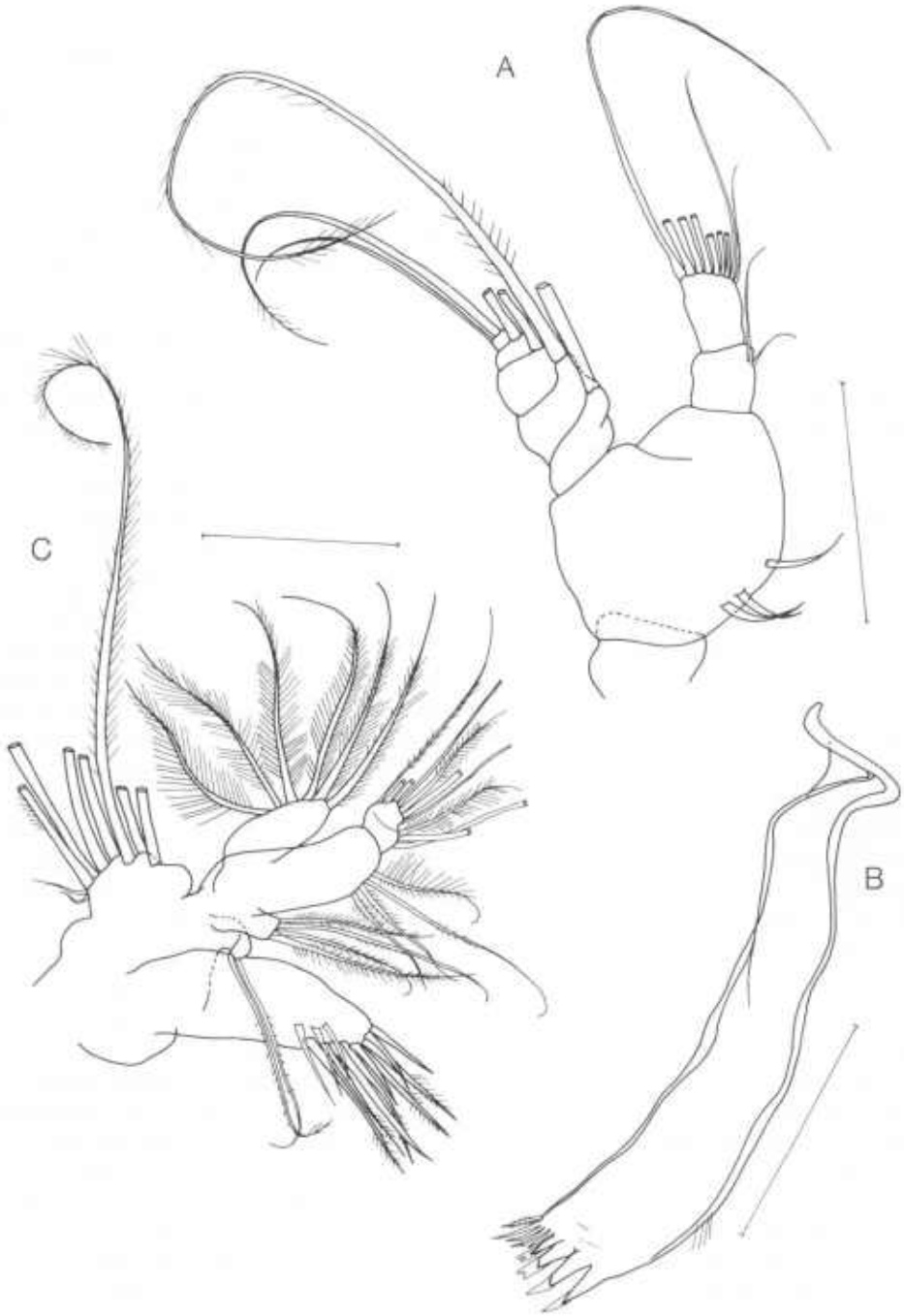

Fig. 3. *Grievella shanki*, new genus and species. A, Mn, palp, posterior; B, Mn, gnathobase, posterior; C, Mx 1, posterior. Scale lines are 0.1 mm.

with 9 sensory setae, 3 worm-like setae distally and 6 brush-like setae, all about the same length and with short setules; 3 brush-like setae of the same thickness, 2 thinner, 1 very thin brush-like setae.

Mxp (Fig. 4D, E): syncoxa with 1 long seta on proximal lobe; 2 long setae on middle lobe, both well-sclerotized but 1 broken at its tip; 3 short setae on distal lobe; coxal lobe with 3 setae and denticles on distal face. Basis with 3 setae on unattentuated proximal lobe and 2 setae on distal lobe; proximal denticles short and thick. Ri 5-segmented from proximal to distal with 4, 4, 3, 4 (1 lateral), 4 (1 lateral) setae respectively.

P1 (Fig. 5A, B): coxa without seta but with medial denticles. Basis with medial seta sharply curved. Re 3-segmented, proximal without a seta, middle with 1 medial seta, distal with 3 medial, 1 terminal, 1 lateral setae. Ri a 1-segmented complex with 3 medial and 2 terminal setae; quadrate protuberence of Von Vaupel Klein's organ with anterior row of denticles proximally and posterior pore on lateral edge.

P2 (Fig. 5C): coxa with medial seta and denticles proximally. Basis without seta. Re 3-segmented, proximal with 1 medial and 1 lateral seta, middle with 1 medial and 1 lateral seta, distal with 4 medial, 1 terminal, 2 lateral setae. Ri 2-segmented, proximal with 1 medial seta, distal with 2 medial, 2 terminal, 1 lateral setae.

P3 (Fig. 5D): coxa with medial seta and denticles proximally. Basis without seta. Re 3-segmented, proximal with 1 medial and 1 lateral seta, middle with 1 medial and 1 lateral seta, distal with 4 medial, 1 terminal, 3 lateral setae. Ri 3-segmented, proximal with 1 medial seta, middle with 1 medial seta, distal with 2 medial, 2 terminal, 2 lateral setae.

P4 (Fig. 5E): coxa with medial seta, without denticles proximally. Basis without seta. Re 3-segmented, proximal with 1 medial and 1 lateral seta, middle with 1 medial and 1 lateral seta, distal with 4 medial, 1 terminal, 3 lateral setae. Ri 3-segmented, proximal with 1 medial seta, middle with 1 medial seta, distal with 2 medial, 2 terminal, 1 lateral setae.

P5 (Fig. 5F): 2 articulating sections. Coxa is proximal; basis without seta fused to 1-segmented Re with 1 medial, 1 terminal and 1 lateral setae is distal complex. CR (Fig. 1F, K): 4 large, terminal setae, 1 small medial-ventral seta, and 1 small lateral-dorsal seta.

Etymology.—The name of this species honors Timothy M. Shank, Woods Hole Oceanographic Institution, who collected this copepod. The epitheton is a noun in the genitive singular.

Remarks.—Four derived character states separate this species from other scolecitrichids: small integumental bumps on the genital complex, an ear-like extension on articulating segment 22 of antenna 1, two lateral setae on the distal endopodal segment of swimming leg 2, and a denticle-like attenuation of the proximal praecoxal lobe of maxilla 2. We believe the first of these may be an autapomorphy.

Grievella shanki shares the absence of an outer spine on both the proximal and middle exopodal segments of swimming leg 1 with a number of other scolecitrichids, e.g., *Scaphocalanus curtus* (Farran, 1926), *S. bogorovi* Brodsky, 1955, *Scolecithricella aspinosa* Roe, 1975 and *S. canariensis* Roe, 1975. We believe this apomorphy of *Grievella shanki* that is shared with these other scolecitrichid species results from convergence; it is not evidence for monophyly.

Grievella shanki shares five setae on the proximal praecoxal lobe of maxilla 2 with the scolecitrichids *Xantharus renatehaassae* Schulz, 1998, one of only two species in this genus, with *Neoscolecithrix antarctica* Hulsemann, 1985, one of six species in this genus, and with all five species of the genus *Landrumius* (see Park 1983). The remaining species of Scolecitrichidae have three or four setae on the proximal praecoxal lobe of maxilla 2. Species of the Phaennidae have five setae on this proximal praecoxal lobe, except for a few species of *Xantho-*

Fig. 4. *Grievella shanki*, new genus and species. A, Mx 2, with setation of praecoxal and coxal lobes, posterior; B, Mx 2, proximal lobe of basis, posterior; C, Mx 2, distal lobe basis plus exopod, posterior; D, syncoxa and basis of Mxp, anterior; E, distal lobe of basis and endopod, posterior. Scale lines are 0.1 mm.

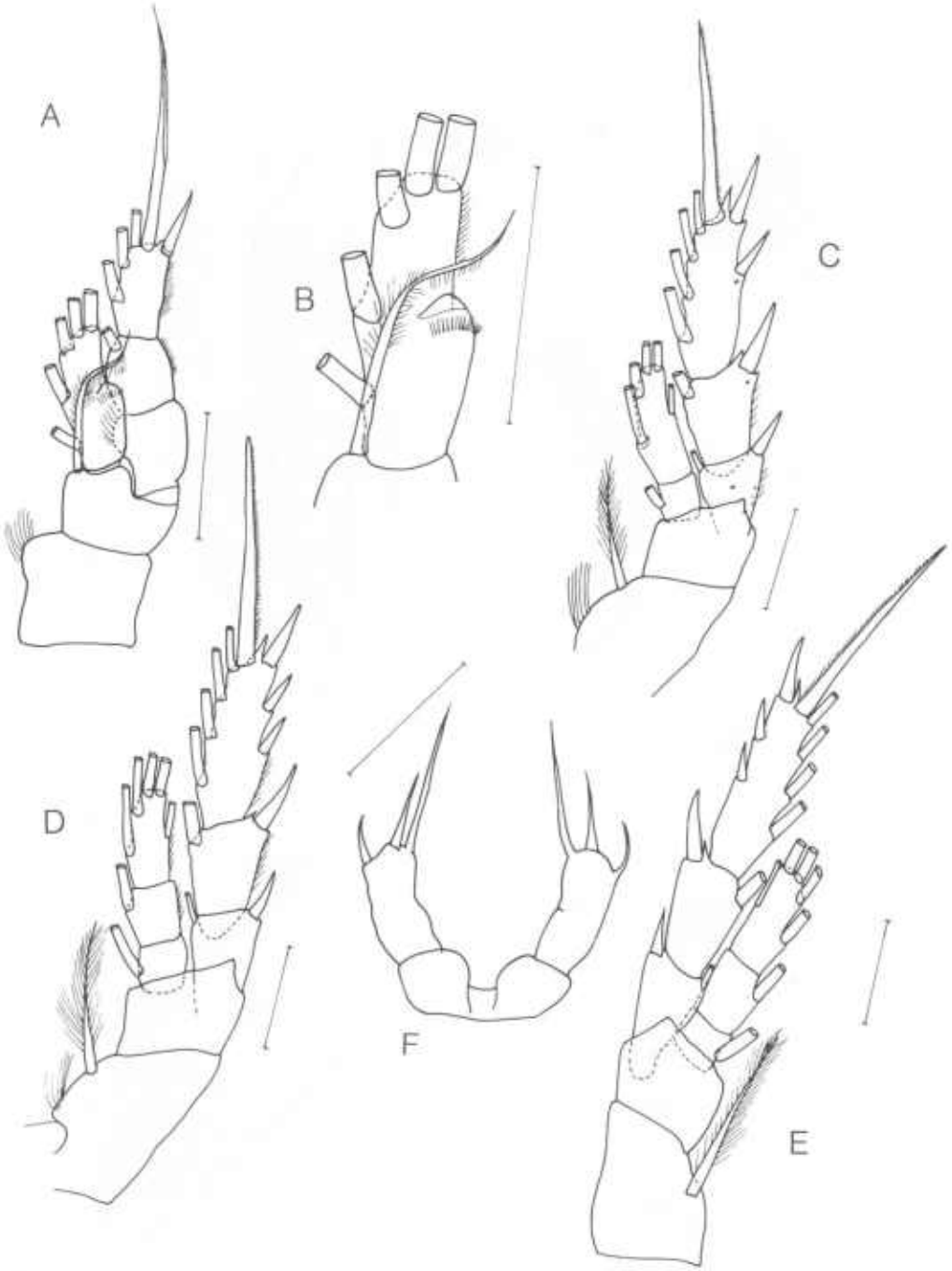

Fig. 5. *Grievella shanki,* new genus and speeies. A, P1, anterior; B, Von Vaupel Klein's organ of P1, anterior; C, P2, posterior; D, P3, posterior; E, P4, posterior; F, P5, posterior. Scale lines are 0.1 mm.

calanus with four setae. Species of Diaixidae, Parkiidae, and Tharybidae have three or four setae.

Grievella shanki shares nine sensory setae on the distal basal lobe plus exopod of maxilla 2 with all five species of *Landrumius*. The remaining species of Scolecitrichidae have eight sensory setae on the distal basal lobe plus exopod of maxilla 2, with the exception of *Xantharus renatehaassae* which has eight sensory setae and one sclerotized seta. Eight sensory setae is the number most often reported for Phaennidae, Diaixidae, and Tharybidae, although nine sensory setae have been reported for some phaennids (see Ferrari & Markhaseva 2000) and several tharybid-like copepods (unpubl. obs.).

Grievella shanki shares 1, 2, and 3 setae, from proximal to distal, on the three praecoxal lobes of the maxilliped with *Xantharus renatehaassae,* with all five species of *Landrumius,* with *Neoscolecithrix antarctica* and *N. magna* Grice, 1972; however, these latter two species differ quite significantly in other morphological features. Praecoxal lobes with 1, 2, and 3 setae also are known for some diaixids and tharybids (see Ferrari & Markhaseva 1996). Setation for the remaining Scolecitrichidae usually is 1, 2, and 1 setae. For Phaennidae setal numbers 1, 2, and 2 seem to have been conserved.

If we assume that the larger number of elements is the plesiomorphic state (Dogiel 1954, Monchenko & Von Vaupel Klein 1999) for these above three characters of the maxilla 2 and maxilliped, then the states for *Grievella shanki* provide no direct information about its phylogenetic relationships with other copepods sharing the same character states. Among related families Phaennidae, Diaixidae, Tharybidae and Parkiidae, synapomorphies have been proposed only for the latter family. Our decision to place *Grievella shanki* within the Scolecitrichidae is tentative. The number and kind of sensory setae on the distal basal lobe plus exopod of maxilla 2 alone is not adequate to diagnose the the Scolecitrichidae, or to separate all of its species from those of the Phaennidae and other families with these kinds of sensory setae. Careful redescriptions of the setation of antenna 2, maxilla 1, maxilla 2 and maxilliped are required before the different synapomorphies of the five familes with their included genera can be clarified.

Acknowledgments

E. L. M. thanks the American Philosophical Society for travel support to the National Museum of Natural History, Smithsonian Institution, Washington, D.C.

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