Lewis, Julian J. 2001. Three new species of subterranean asellids from western North America, with a synopsis of the species of the region (Crustacea: Isopoda: Asellidae). Texas Memorial Museum, Speleological Monographs, 5:1-15.

THREE NEW SPECIES OF SUBTERRANEAN ASELLIDS FROM WESTERN NORTH AMERICA, WITH A SYNOPSIS OF THE SPECIES OF THE REGION (CRUSTACEA: ISOPODA: ASELLIDAE)

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ABSTRACT

Three new species of subterranean asellids are described from western North America: *Lirceolus nidulus* (Border Cave, Culberson Co., Texas), *Lirceolus cocytus* (Texas and Coahuila, Mexico), and *Salmasellus howarthi* (Deadhorse Cave, Skamania Co., Washington). Two other undescribed species are reported, *Lirceolus* sp. (Dandridge Spring, Val Verde Co., Texas) and *Calasellus* sp. (Malheur Cave, Harney Co. Oregon), but the existing specimens are too damaged for descriptive purposes. New collection localities are given for several other western species: *Lirceolus hardeni, Salmasellus steganothrix, Calasellus californicus, Caecidotea sequoiae, C. reddelli,* and *C. bilineata.* A total of 18 subterranean asellid species are now known to occur in western North America.

INTRODUCTION

The purpose of this paper is to describe three new species as well as provide a summary of the taxa of subterranean asellid isopods known to occur in the western part of North America. The area covered herein starts in the tier of states encompassing Texas and includes 17 western states, southwestern Canada, and a part of Coahuila, Mexico (figure 1). Thirteen obligate subterranean species of asellids are presently described from this region, with four of the six known genera occurring in groundwaters of the U.S. represented: *Caecidotea, Lirceolus, Salmasellus* and *Calasellus.* All but *Caecidotea* are endemic to western North America. *Caecidotea* contains five western species that have clear zoogeographic affinities with the fauna of the eastern U.S.: *C. reddelli* and *C. bilineata* from Texas, *C. adenta* and *C. acuticarpa* from Oklahoma, and *C. tridentata* in Kansas. Several other species of *Caecidotea* occur in the sliver of the Ozark Plateau extending into southeastern Kansas and northeastern Oklahoma, but have been discussed elsewhere (Lewis, 1982; 1999; Lewis & Bowman, 1981). Thus, the subterranean asellids of the western U.S. are a mixture of the fauna predominant in eastern North America and a group of species unique to the west. Three epigean species have also been reported, *Asellus alaskensis, Caecidotea occidentalis* and *C. tomalensis,* as well as two species introduced from the eastern U.S., *Caecidotea communis* and *Caecidotea racovitzai* (Bowman, 1974; 1975a). The epigean species will not be considered further since their morphology suggests little discernible relationship to the subterranean species.

A review of the systematics literature of western subterranean asellids reveals a sparse collection of papers featuring a less than auspicious beginning. The first subterranean asellid discovered in the western U.S.,

Caecidotea smithii, was created as a *nomen nudum* by Eigenmann (1900). Ulrich (1902) subsequently described this species from the artesian well at San Marcos, Hays County, Texas. Hungerford (1922) described *Caecidotea tridentata* from specimens pumped from a cistern in Lawrence, Kansas. Miller (1933) described *Asellus californicus* from a well in Lake County, California. Mackin & Hubricht (1940) described seven new species of subterranean asellids from the central United States, including *Caecidotea acuticarpa* from caves, springs and wells in southeastern Oklahoma, and *C. adenta* from a cave in Kiowa County, Oklahoma. Steeves (1968) added three more species from caves in central Texas: *Asellus reddelli* from Bell, Coryell, Travis and Williamson counties; *A. pilus* from Valdina Farms Sinkhole, Medina County; and *A. bisetus* from Gorman Cave, San Saba County.

Much of our present understanding of western asellids is due to a series of papers by Bowman (1975b; 1981; Bowman & Longley, 1976; Lewis & Bowman, 1996). In the first, he described *Caecidotea sequoiae* (from Lilburn Cave, Tulare County, California), redescribed *Asellus californicus*, and erected the genus *Salmasellus* for a subterranean species discovered in the stomachs of salmon taken from a lake in Alberta, Canada (Bowman, 1975b). New material of *C. smithii* became available and proved to be so unusual that the genus *Lirceolus* was created to receive it (Bowman & Longley, 1976). A third paper erected the new genus *Calasellus* to receive *A. californicus* and another new species, *C. longus*, from a spring near Shaver Lake, in Fresno County, California (Bowman, 1981).

Lewis (1983) emended the description of *Lirceolus* and transferred *A. pilus* to *Lirceolus*. Bowman's final contribution on the western fauna was our collaboration on the subterranean asellids of Texas (Lewis & Bowman, 1996). In that paper we described *Lirceolus hardeni*, transferred *A. bisetus* to *Lirceolus*, described *Caecidotea bilineata*, and refigured *C. reddelli*.

Three new western species are described herein, and new records are provided for *Caecidotea sequoiae, C. bilineata, C. reddelli, Calasellus californicus, Salmasellus steganothrix* and *Lirceolus hardeni*. Records of two undescribed species are given, but not

Table 1.—A summary of the subterranean asellid taxa known to occur in western North America.

Taxon	References	Range
Caecidotea acuticarpa	Mackin & Hubricht, 1940 Lewis & Bowman, 1981	Arbuckle uplift, southeastern Oklahoma
Caecidotea adenta	Mackin & Hubricht, 1940	Kiowa Co., Oklahoma
Caecidotea bilineata	Lewis & Bowman, 1996	eastern Texas
Caecidotea reddelli	Steeves, 1968 Lewis & Bowman, 1996	eastern Texas
Caecidotea tridentata	Hungerford, 1922 Lewis & Bowman, 1981	eastern Kansas
Calasellus longus	Bowman, 1981	Fresno Co., California
Calasellus californicus	(Miller, 1933) Bowman, 1975b; 1981	northwestern coastal California
Caecidotea sequoiae	Bowman, 1975b	Tulare County, California
Calasellus undescribed sp.		Harney Co., Oregon
Lirceolus smithii	Ulrich, 1902 Bowman & Longley, 1976 Lewis & Bowman, 1996	Hays Co., Texas
Lirceolus bisetus	Steeves, 1968 Lewis & Bowman, 1996	San Saba & Travis counties, Texas
Lirceolus cocytus		Jeff Davis Co., Texas to Coahuila, Mexico
Lirceolus hardeni	Lewis & Bowman, 1996	central Texas
Lirceolus nidulus		Culberson Co., Texas
Lirceolus pilus	Steeves, 1968 Lewis & Bowman, 1996	Medina and Bandera counties, Texas
Lirceolus undescribed sp.		Val Verde Co., Texas
Salmasellus steganothrix	Lewis & Bowman, 1996 Holsinger, Mort & Recklies, 1983	Alberta, Canada to northwestern Montana
Salmasellus howarthi	N. sp.	Skamania Co., Washington

described, due to the damaged condition of the single male specimens available. This brings the list of subterranean asellid species known from western North America to a total of 18 (table 1).

Family Asellidae G. O. Sars, 1897

Lirceolus Bowman & Longley, 1976

Lirceolus nidulus, new species
Figures 2-3

Undescribed species of asellid: Holsinger, 1992: 5.
Caecidotea species: Lewis and Bowman, 1996: 499.

Material examined.—TEXAS: *Culberson County*, Border Cave, deep phreatic lake, 15 August 1986, Scott J. Harden, C.F. Linblom, 1 male, 1 female. An 8.0 mm male is designated as the holotype (USNM 291382), an 8.8 mm ovigerous female is a paratype (USNM 291383), deposited in the U.S. National Museum of Natural History, Smithsonian Institution, Washington, D.C.

Description.—Eyeless, unpigmented, only known male 8.0mm, female 8.8mm. Body about 4X as long as wide, moderately setose, coxae visible in dorsal view. Antenna 1, flagellum of 7 segments, esthetes on distal 4 segments. Antenna 2 missing in both specimens. Mandibles with 4-cuspate incisors and lacinia mobilis, palp with plumose setae on distal segments. Maxilla 1, inner lobe with 5 plumose setae in male, 6 in female; outer lobe with 13 stout spines.

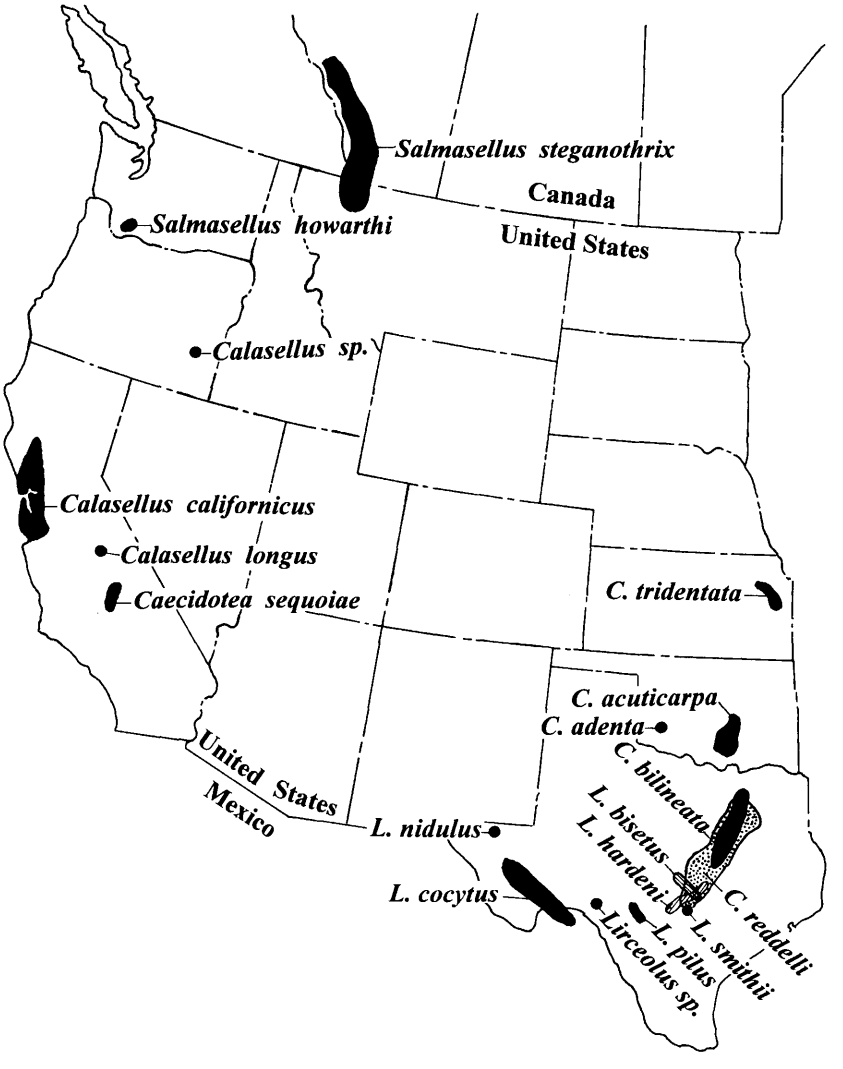

Fig. 1.—The approximate ranges of subterranean asellid isopods known from western North America.

Male pereopod 1, propus about 2.8X as long as wide in male, 3.0X in female; palmar margin lacking processes. Pereopod 4 sexual dimorphism of carpus barely discernible.

Pleotelson about 1.4X as long as wide, sides subparallel, caudomedial lobe weakly produced. Pleopod 1, protopod with 3 retinacula; exopod ovate, about 1.2X length of protopod, with about 20 setae along distal and distolateral margins. Pleopod 2 of male, protopod very elongate compared to endopod; exopod distal segment slender, subtriangular, with 4 plumose setae along distal margin. Endopod with moderately pronounced basal apophysis, short basal spur; tip with 4 elements: (1) cannula slender, conical,

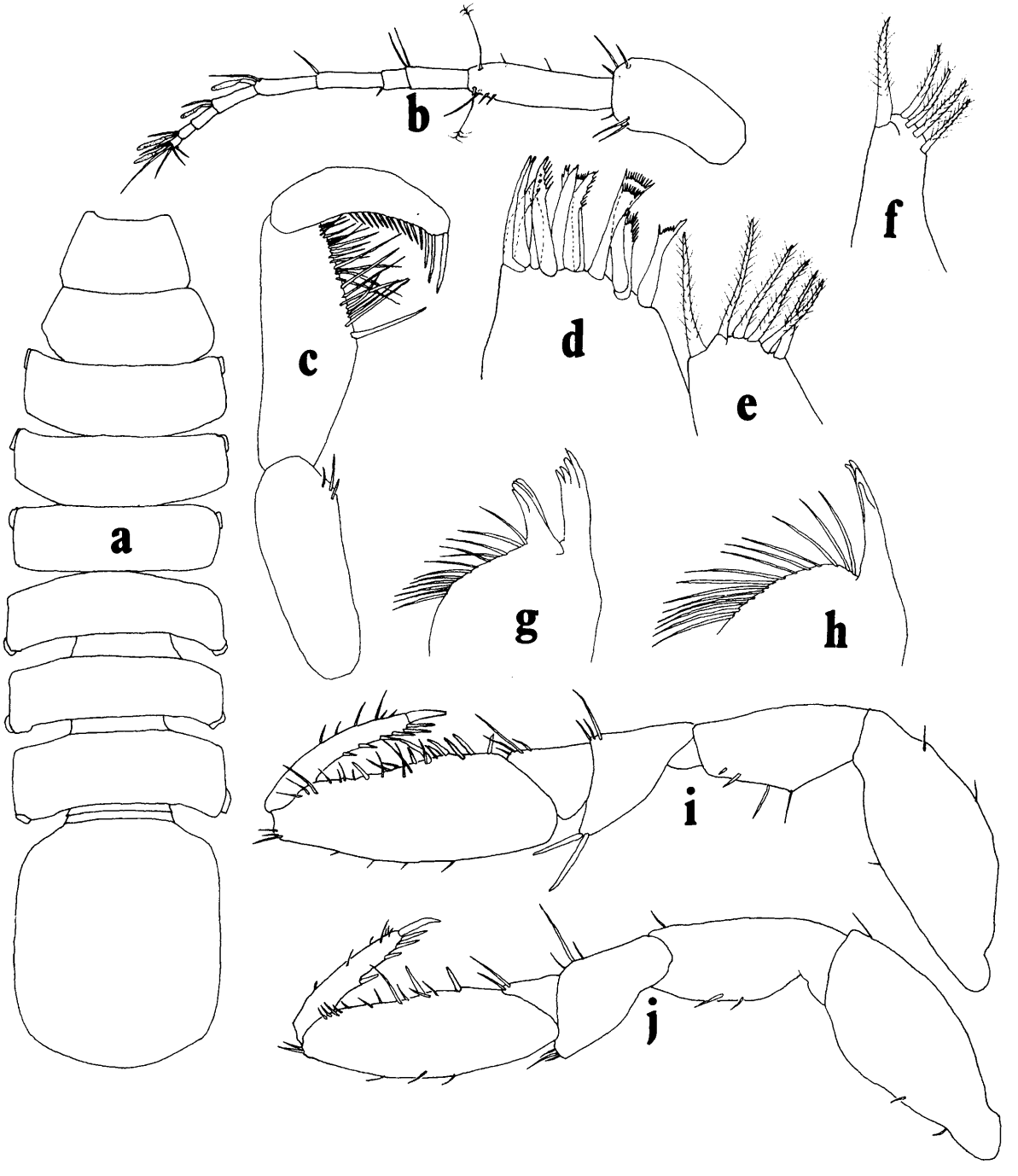

Fig. 2.—*Lirceolus nidulus*, new species, Border Cave, Culberson County, Texas, 8.0 mm holotype male (f, i), 8.8 mm paratype female (a-e, g-h, j): (a) habitus; (b) antenna 1; (c) mandibular palp; (d) maxilla 1, outer lobe; (e) maxilla 1, inner lobe; (f) maxilla 1, inner lobe; (g) left mandible; (h) right mandible; (i) pereopod 1; (j) pereopod 1.

blunt apically, extending roughly parallel to axis of endopod, slightly decurved laterad, nested between and partially obscured by mesial and lateral processes, terminating below apex of endopod; (2) mesial process broadly digitiform, obscuring much of the cannula; (3) lateral process shorter than mesial process, subtriangular; and (4) caudal rim of endopod connecting mesial and lateral processes. Pleopod 2 of female subtriangular, sparsely setose. Pleopod 3, exopod with slightly oblique suture. Pleopods 4 & 5 exopods with two sutures, oblique suture and second suture creating an oval area on lateral margin. Uropods about 0.75X length of pleotelson, exopod slightly shorter than endopod.

Etymology.—The name is derived from the Latin noun *nidulus* = small nest, referring to the nested appearance of the structures of the male second pleopod endopod tip. The subapical termination of the cannula is one of the structural features separating *Lirceolus nidulus* from *L. cocytus*. The suggested vernacular name for this species is the Border Cave isopod.

Habitat & range.—*Lirceolus nidulus* is known only from Border Cave, which is about 26 kilometers southwest of White City, New Mexico. This cave is formed in gypsum of the Permian Castile Formation. It is about 300 meters in length, with two deep phreatic lakes accessible from the passage. The isopods occur in the same habitat with two subterranean amphipods that are also endemic to Border Cave: *Artesia welbourni* and an undescribed species of *Stygobromus* of the *hubbsi* Group (Holsinger, 1992). It is with some misgivings that I describe *L. nidulus* based on a single damaged male specimen. However, the difficulties reported entailed in attempting to collect additional material have encouraged me to describe the species with the material available.

Relationships.—Many of the structures of *Lirceolus nidulus* closely resemble those of *L. cocytus*. *Lirceolus nidulus* is separated by (1) its larger size (twice that of the known specimens of *L. cocytus*); (2) the more elongate palmar margin of the propus of pereopod 1; (3) the very elongate male second pleopod protopod, (4) the male second pleopod endopod tip cannula that ends proximal to the apex of the endopod; and (5) the fourth pleopod exopod with an oblique suture and a second suture forming an ovate lateral area.

Lirceolus cocytus, new species
Figures 4-5

Material examined.—TEXAS: *Jeff Davis County*, Phantom Lake Spring Cave, 10-11 December 1995, B. Tucker, 10 males, 6 females; COAHUILA: Sótano de Amezcua, 35 miles west & 8 miles north of Ciudad Acuña, 25 June 1994, Dean A. Hendrickson, 2 males, 6 females; same locality, 15-17 June 1998, Jean Krecja, 3 males, 2 females. A 3.1mm male from Phantom Lake Spring Cave is designated the holotype (USNM 291384), the other specimens from that locality are designated as paratypes (USNM 291385), all deposited in the U.S. National Museum of Natural History, Smithsonian Institution, Washington, D.C.

Description.—Eyeless, unpigmented, longest male 3.2mm, longest female 4.0mm; body slender, linear, about 5.2X as long as wide. Antenna 1, flagellum to about 4 segments, esthete on distal segment. Antenna 2 flagellum to 35 segments. Mandibles with 4-cuspate incisors and lacinia mobilis, palp with plumose setae on distal segments. Maxilla 1, inner lobe with 5 plumose setae, outer lobe with 13 stout spines.

Pereopod 1, propus about 2.3X as long as wide in male, 2.7X in female; palmar margin lacking processes. Pereopod 4, carpus about 2.7X as long as wide in male, 2.2X in female.

Pleotelson about 2.7X as long as wide, sides subparallel, caudomedial lobe not produced. Pleopod 1, protopod with 3-4 retinacula; exopod ovate, with short setae on distal margin. Pleopod 2 of male, exopod distal segment slender, subtriangular, with 3 elongate setae along distal margin. Endopod with distinct basal apophysis and short basal spur, tip with 4 elements: (1) cannula slender, conical, apically truncate, extending roughly parallel to axis of endopod, slightly decurved to the lateral side, terminating beyond the apex of the endopod; (2) mesial process subtriangular; (3) lateral process slightly shorter, rounded, subtriangular; (4) caudal rim of endopod connecting mesial and lateral processes. Pleopod 2 of female subtriangular, single distal seta present. Pleopod 3, exopod with transverse suture, short setae sparsely distributed along distal margin. Pleopod 4 exopod with oblique suture extending to second transverse suture, setae absent. Pleopod 5 exopod with transverse suture. Uropods about 0.7X length of pleotelson.

Etymology.—The Latin noun *cocytus* is the name of one of the mythological rivers of the underworld crossed by phantoms to reach hell, and refers to the habitat at the type-locality of *L. cocytus*, the underground waters of Phantom Lake Spring Cave. The suggested vernacular name is the Phantom Cave isopod.

Habitat and range.—The type series of *Lirceolus cocytus* was collected by a scuba diver in the spring conduit from which Phantom Lake Spring emerges. This cave is the longest known in an isolated area of Cretaceous limestone, although most of the approximately 2000 meters of passage is underwater (Reddell, pers. comm.). Over 200 kilometers separate the type-locality and Sótano de Amezcua, the widest

range of any of the known species of *Lirceolus* (fig. 6) To demonstrate the morphological similarities exhibited by the specimens from these two populations I have presented illustrations of the male second pleopod structures side by side (figs 5b & d; c & e).

Cole (1976) described the spring amphipod *Gammarus hyalelloides* from Phantom Lake Spring and included information on other members of the spring fauna as well as notes and references on the water chemistry of the spring.

Relationships.—This species is clearly morphologically similar to *Lirceolus nidulus*, from which it can be separated by: (1) its smaller size; (2) the shorter palmar margin of the propus of pereopod 1;

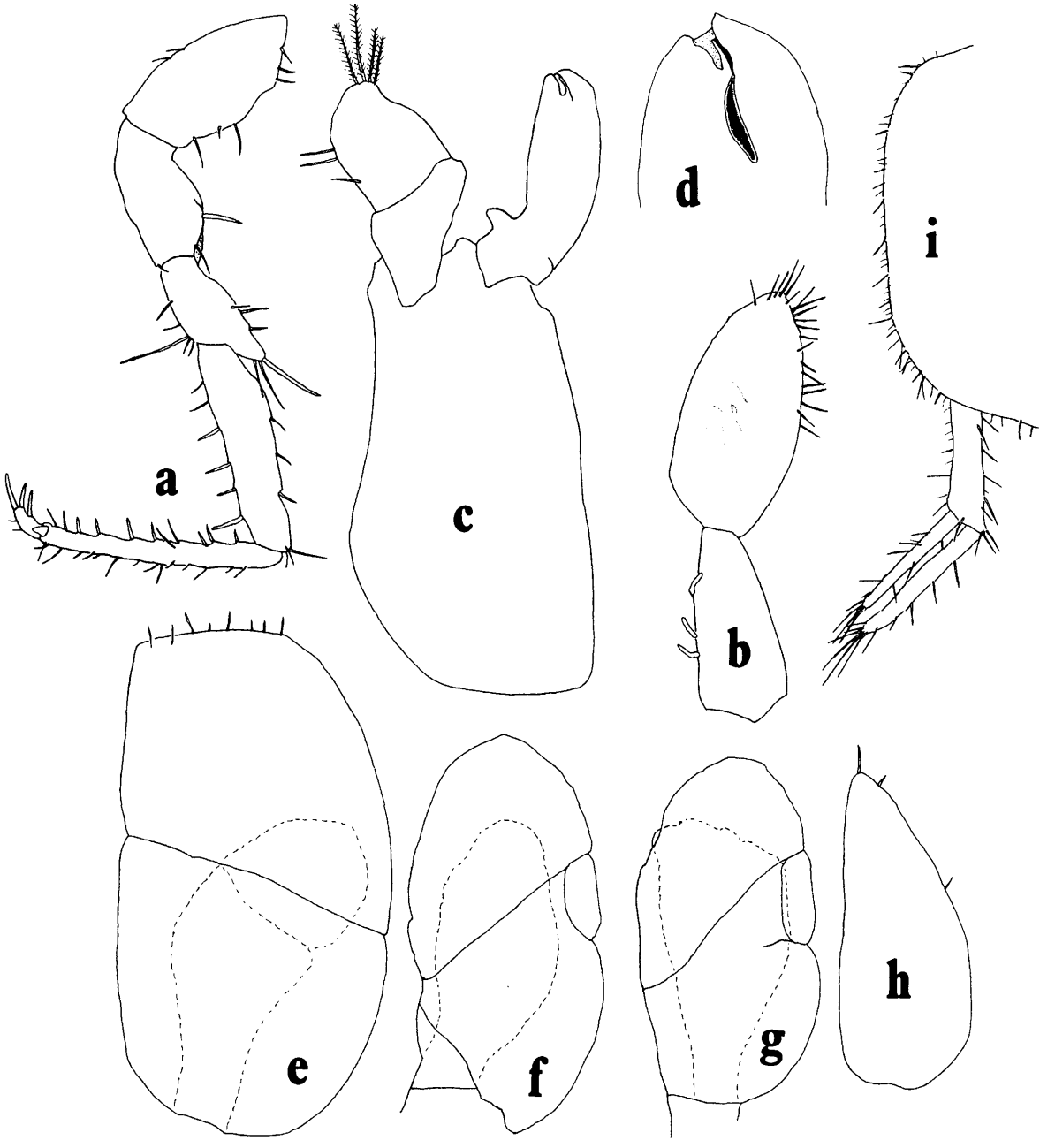

Fig. 3.—*Lirceolus nidulus*, new species, Border Cave, Culberson County, Texas, 8.0 mm holotype male (b-d), 8.8 mm paratype female (a, e-h): (a) pereopod 4; (b) pleopod 1; (c) pleopod 2; (d) pleopod 2 endopod tip; (e) pleopod 3; (f) pleopod 4; (g) pleopod 5; (h) pleopod 2; (i) pleotelson and uropod.

(3) the shorter male second pleopod protopod; (4) the cannula that ends beyond the apex of the endopod; and (5) the absence of two sutures on the exopods of pleopods 4 and 5, creating a small oval area on the lateral margin.

Lirceolus undescribed species

Material examined.—TEXAS: *Val Verde County*: Dandridge Spring on east bank of Devils River, about 3 miles above the mouth of the Dry Devils River, 22 February 1998, Dean A. Hendrickson, Jean Krejca, Peter Sprouse, Charlie Savvas, et. al., 1 male.

Range.—This species is known only from the tiny unique male from the above locality. It remains undescribed since the antennae, pereopods and uropods are absent from the specimen. Dissection of the remnant revealed a *Lirceolus* similar to *L. smithii*, but with maxilla 1 inner lobe with 5 apical setae and pleopod 2 endopod tip consisting of a simple conical cannula lacking other associated processes.

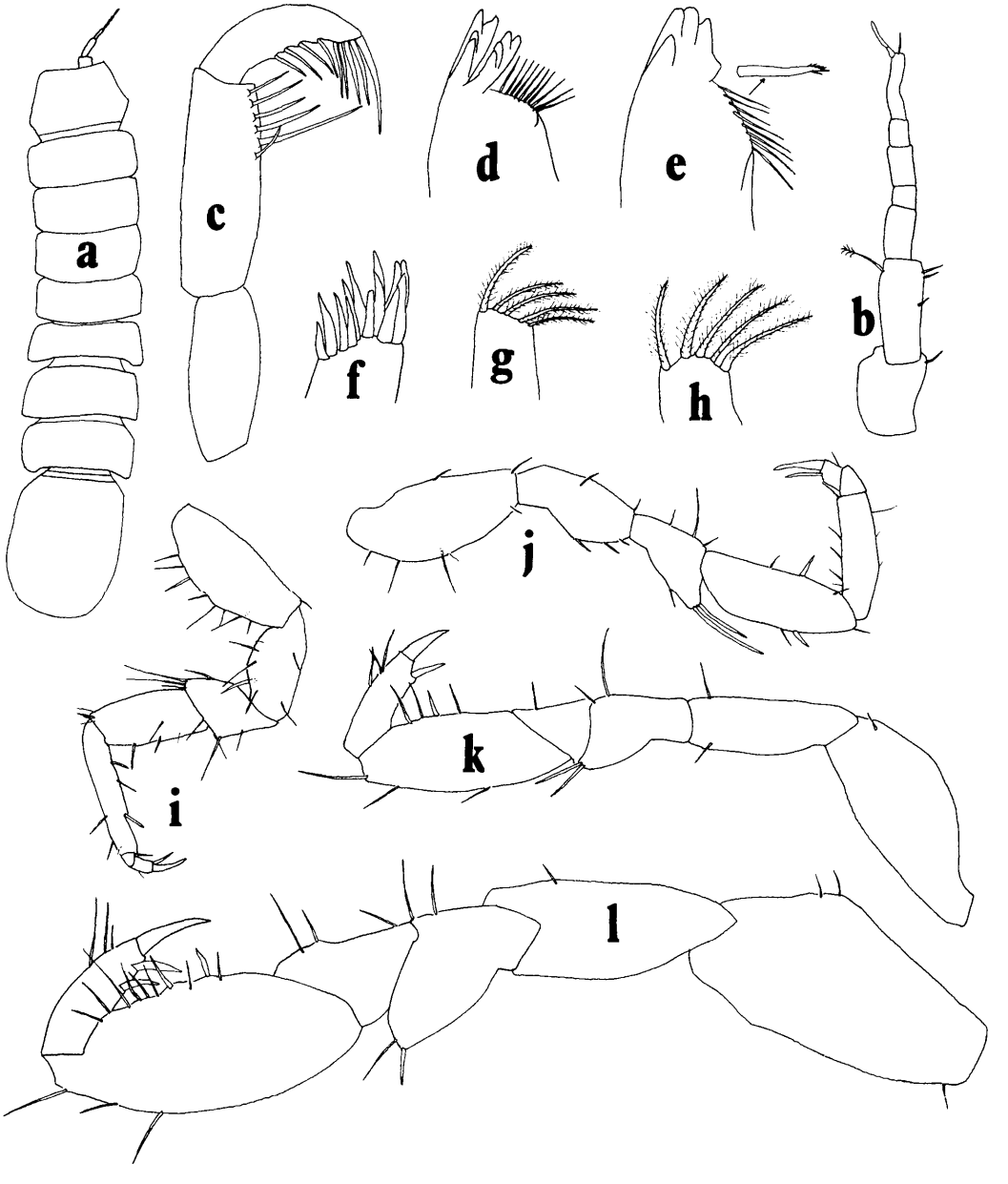

Fig. 4.—*Lirceolus cocytus*, new species, Phantom Lake Spring Cave, Jeff Davis County, Texas, 3.2 mm male (a, g), 3.0 mm male (b-f, j, l), 3.4 mm female (i, k); Sótano de Amezcua, Coahuila, 4.7 mm female (h): (a) habitus; (b) antenna 1; (c) mandibular palp; (d) left mandible; (e) right mandible; (f) maxilla 1, outer lobe; (g) maxilla 1, inner lobe; (h) maxilla 1, inner lobe; (i) pereopod 4; (j) pereopod 4; (k) pereopod 1; (l) pereopod 1.

Lirceolus hardeni Lewis & Bowman, 1996

Material examined.—TEXAS: *Williamson County*: PC Spring, Robinson Ranch, taken from mophead, 9 September 1999, P. Sprouse, 3 males, females; same locality, 10 September 1999, P. Sprouse, 1 female; same locality, 13 September 1999, P. Sprouse, 10 males, females; 22 September 1999, J. Reddell, M. Reyes, P. Sprouse, 21 males, females; same locality, 27 September 1999, P. Sprouse, 5 males, females.

Habitat and range.—A male from the 22 September 1999 collection from PC Spring was fully dissected and possessed the maxilla 1 inner lobe with 4 terminal setae characteristic of this tiny, difficult to identify species.

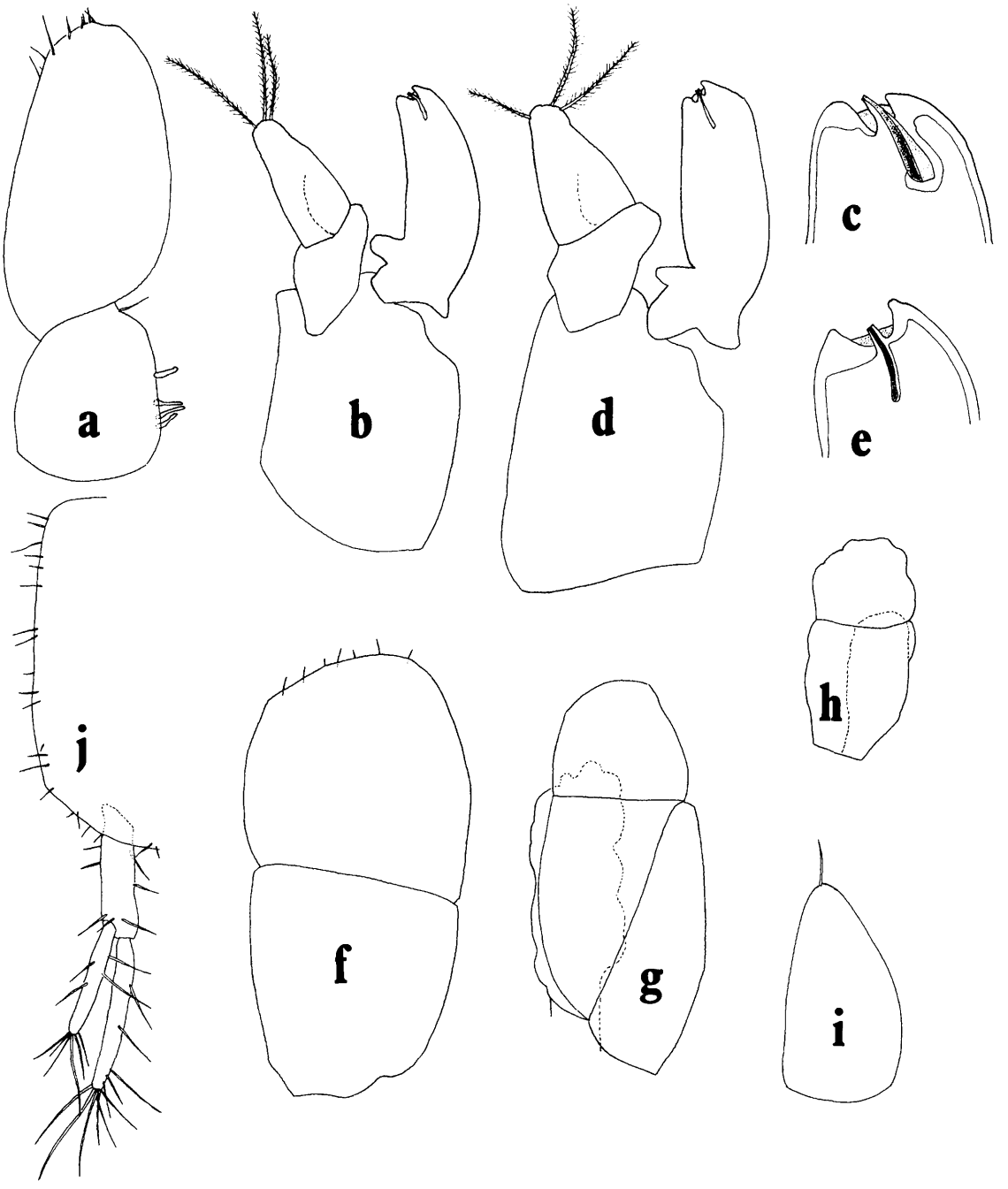

Fig. 5.—*Lirceolus cocytus*, new species, Phantom Lake Spring Cave, Jeff Davis County, Texas, 3.0 mm male (a-c, f-h), 3.3 mm female (i-j); Sótano de Amezcua, Coahuila, 3.0 mm male (d-e): (a) pleopod 1; (b) pleopod 2; (c) pleopod 2 endopod tip; (d) pleopod 2; (e) pleopod 2 endopod tip; (f) pleopod 3; (g) pleopod 4; (h) pleopod 5; (i) pleopod 2; (j) pleotelson and uropod.

The above series from PC Spring is the first locality for *L. hardeni* in Williamson County, otherwise reported from caves and springs in Blanco, Comal and Travis counties in Texas (Lewis & Bowman, 1996).

Salmasellus, Bowman, 1975b
***Salmasellus howarthi*, new species**
Figures 7-9

Asellus: Holsinger, 1974: 19.
Salmasellus steganothrix: Holsinger, Mort and Recklies, 1983: 545.

Material examined.—WASHINGTON: *Skamania County*, Deadhorse Cave, 14 August 1972, F.G. Howarth, 5 males (5.2, 6.0, 6.2, 6.5, 6.8mm), 1 female (5.5mm);Upper Falls Creek Cave System, 24 August 1972, F.G. Howarth, L. Nieuwenhuis, 1 female (3.0mm). The 6.8mm male is designated the holotype (BPBM-16249), the other specimens from the 14 August 1972 collection are paratypes, all deposited in the Bernice P. Bishop Museum, Honolulu, Hawaii.

Description.—Eyeless, unpigmented, largest male 6.8mm, longest female 5.5mm; body slender, linear, about 4.5X as long as wide; pereonites increasing slightly in width to pereonite 6, pereonite 7 slightly narrower, pleotelson narrower than pereonite 7. Coxae visible in dorsal view. Margins of head, pereonites and pleotelson moderately setose. Head about twice as wide as long, anterior margin with small rostrum, post-mandibular lobes moderately produced. Pleotelson about 1.4X as long as wide, sides convex, caudomedial lobe absent, caudal margin broadly rounded.

Antenna 1 flagellum of 6-7 segments, reaching to about distal end of 4th segment of antenna 2, last 3-4 segments each bearing esthete. Antenna 2 flagellum with about 34-35 segments. Mandibles, palp 3-segmented; incisors 4-cuspate, lacinia mobilis 3-cuspate, spine rows with about 11 spines per row. Maxilla 1, outer lobe with 13 stout spines, inner lobe with 5, 6 or 7 plumose setae. Maxilliped with 3-4 retinacula.

Pereopod 1 of male, propus about 2.7X as long as wide, margin straight, processes absent, about 3 stout spines present; dactyl relatively short in comparison to length of palmar margin of propus, flexor margin with about 2 spines. Pereopod 1 of female similar, slightly more elongate, spines fewer and less stout. Pereopods 2-7 long, slender, moderately spinose/setose, carpus of male about 3.5X as long as wide, 3.3X in female.

Pleopod 1 longer than pleopod 2 of male; protopod about 0.4X length of exopod, with 2 retinacula; exopod

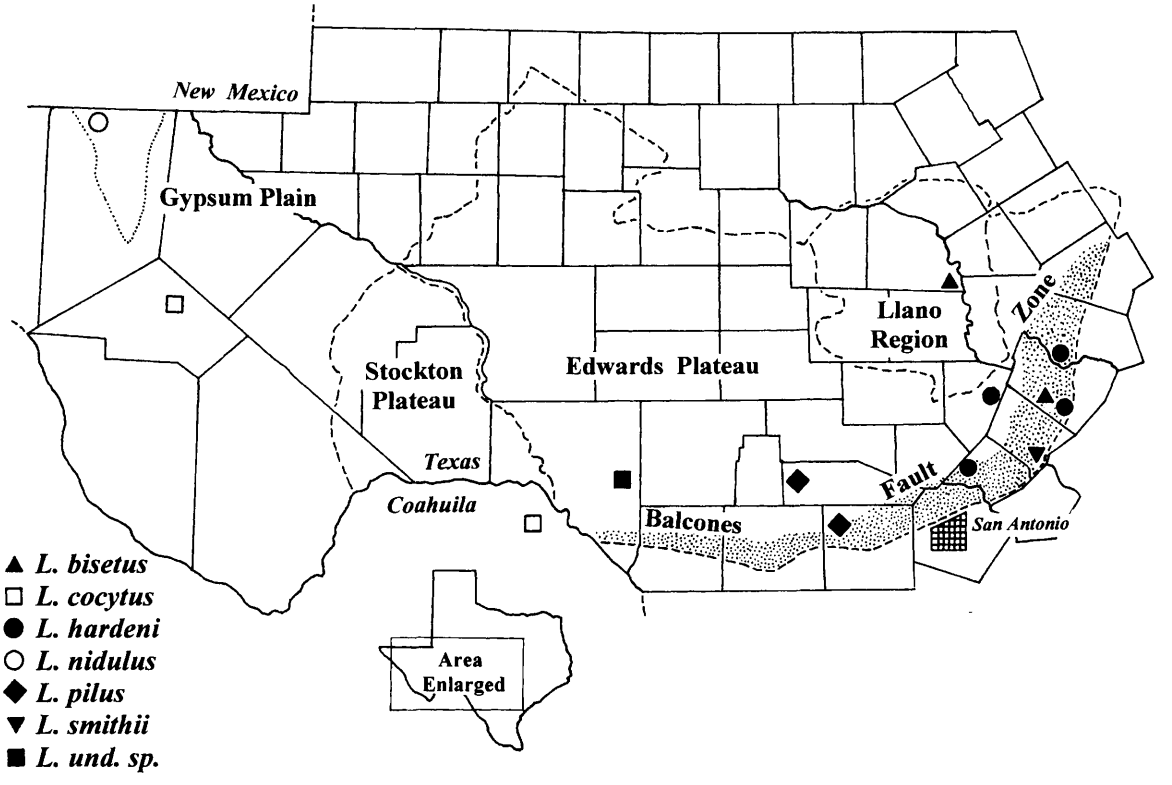

Fig. 6.—The distribution of *Lirceolus* species in Texas.

slightly over twice as long as wide, with about 25 setae along distal and distolateral margins. Pleopod 2 of female subtriangular. Pleopod 2 of male, exopod, distal segment with single plumose seta on apex; proximal segment with about 6 plumose setae along lateral margin. Endopod without basal spur or basal apophysis, L-shaped, with 2 long setae arising from base of the L, terminating prior to apex of endopod; subterminal spine directed laterad; rounded shoulder-like apex of cannula without setae; cannula extending beyond this shoulder as a grooved stylet containing the elongate setae, with elongate dentate extending along basal part of lateral margin. Pleopod 3 exopod with transverse suture, about 20 setae along distal and distolateral margin of distal segment; about 8 setae along lateral margin of proximal segment. Pleopods 4 and 5 with exopods lacking prominent sutures or marginal setae. Uropods slightly shorter than pleotelson.

Etymology.—It is with pleasure that I name this species after its collector, Dr. Francis G. Howarth, of the Bernice P. Bishop Museum, Honolulu. The suggested vernacular name is Howarth's cave isopod.

Habitat and range.—*Salmasellus howarthi* is known from Deadhorse Cave, located about 8 km

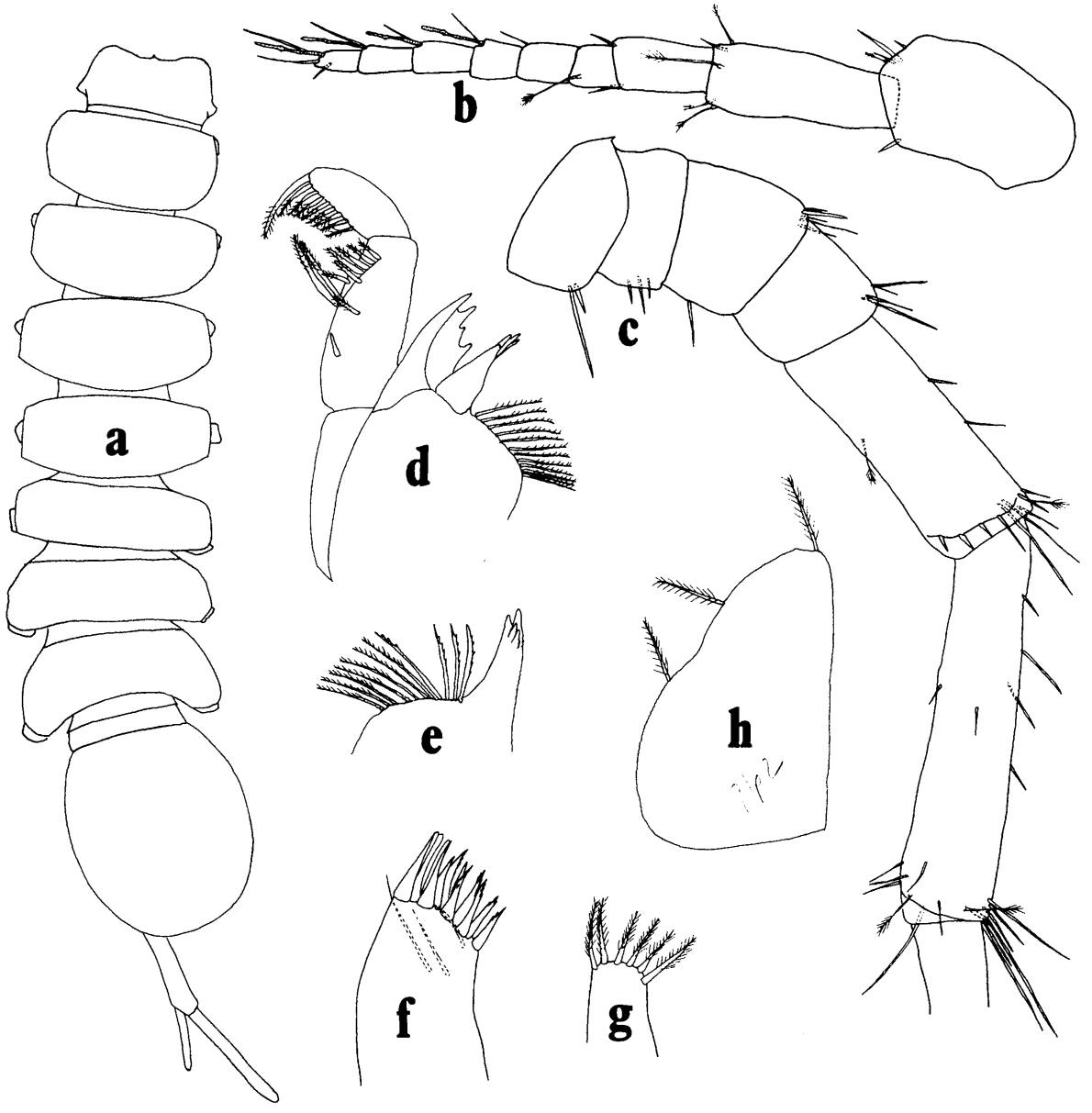

Fig. 7.—*Salmasellus howarthi,* new species, Deadhorse Cave, Skamania County, Washington, 6.5 mm male (a, d-g), 6.2 mm male (b-c), 6.3 mm female (h): (a) habitus; (b) antenna 1; (c) antenna 2; (d) left mandible and palp; (e) right mandible; (f) maxilla 1, outer lobe; (g) maxilla 1, inner lobe; (h) pleopod 2.

northwest of Trout Lake, Washington, and the Upper Falls Creek Cave System, approximately 20 km south-southwest of Deadhorse Cave. The Upper Falls Creek Cave System record should be considered provisional, since it is based on an immature female specimen (a mature male is required to confirm this identification). Both of these caves are lava tubes located within undated young pahoehoe lava flows on the slopes of Mount Adams, a volcano in the southern Cascade Range. Deadhorse Cave is particularly complex for a lava tube. The cave contains a stream with about 1300 meters of surveyed passage (Halliday, 1972). Howarth (pers. comm.) reported that the isopods were taken from a quiet stream pool with water temperature of 40° F. Holsinger (pers. comm.) reported visiting Deadhorse Cave on 16 July 1980, where he found the isopods to be common on rocks throughout most of the stream. In the Upper Falls Creek Cave System, Howarth (pers. comm.) collected the isopod from an isolated pool perched above the stream, with the water temperature 42° F.

The subterranean amphipod *Stygobromus elliotti* has also been reported from Deadhorse Cave and the Upper Falls Creek Cave System (Holsinger,1974).

Relationships.—*Salmasellus howarthi* closely resembles *S. steganothrix,* particularly in the elongate, unarmed propus of the first pereopod; the short pleopod 1 protopod; and the nearly identical male second pleopod, particularly the endopod. The two species may be separated by the following differences: (1) propus of male pereopod 1 is more elongate in *S. steganothrix* at about 3.2X as long as wide vs. 2.7X in *S. howarthi;* palmar margin of *S. steganothrix* has about 8 spines, whereas *S. howarthi* has only about 3; (2) mandibles with 3-cuspate lacinia mobilis in *S. howarthi*, 4 cuspate in *S. steganothrix*; incisor on left 4-cuspate in *S. howarthi*, 5-cuspate in *S. steganothrix*; (3) maxilla 1 inner lobe typically has 6-7 apical setae (one specimen had one side with 5) in *S. howarthi*, usually 5 in *S. steganothrix*; (4) pleopod 3 exopod with numerous setae on lateral margin of proximal segment in *S. howarthi,* setation sparse in *S. steganothrix*. From a zoogeographic standpoint, the two species are easily separated based on their ranges, with *S. steganothrix* occurring in the northern Rocky Mountains of Alberta and Montana, while *S. howarthi* occurs in the Cascade Mountains about 700 kilometers to the west.

Salmasellus steganothrix Bowman, 1975b

Material examined.—MONTANA: *Flathead County*, Glacier National Park, Algal Cave near west glacier, from pool, 25 August 1977, J.M. Chester, 1 male; same locality, 27 September 1999, 3 males, 7 females; site unspecified, Kalispell Valley, Flathead River System, J.V. Ward, 3 males, 3 females, 1 dessicated; ALBERTA: Banff National Park, Castleguard Cave, 16 April 1977, J.S. Mort, et. al., 6 males, 4 females (in 4 vials).

Habitat and Range.—This species was reported by Clifford & Bergstron (1976) from a cave spring near Cadomin, Alberta. Holsinger (1980) described *Stygobromus canadensis* from Castleguard Cave, Alberta, and reported *Salamasellus steganothrix* identified by T.E. Bowman from the same site (the material that I examined from this cave noted above is presumably the same specimens examined by Bowman). A detailed account of the occurrence of *S. steganothrix* in Castleguard Cave was presented by Holsinger, Mort & Recklies (1983). This species occurs in caves and springs in the Rocky Mountains from central Alberta south into northern Montana.

Calasellus Bowman, 1981

Calasellus californicus (Miller, 1933)

Material examined.—CALIFORNIA: *Marin County*, taken 40cm deep from gravel bed of Cronair Creek, 15 July 1997, Rosalie del Rosario, 3 males, 2 females; *Santa Cruz County*, Empire Cave, in flooded room, 4 December 1983, T. Briggs, 2 females.

Habitat and range.—This species is known only from subterranean habitats in California, where it has also been reported from Lake (Miller, 1933), Santa Clara and Napa counties (Bowman, 1975). The identification of the Empire Cave specimens as *C. californicus* is based on the strong similarity of pleopods 3, 4 and 5 with the illustrations of Miller (1933). Specifically, the Empire Cave specimens possess a pleopod 3 exopod with the same oblique suture, pleopod 4 has the elongate triangular exopod, and pleopod 5 has a rudimentary exopod (unlike *C. longus*, in which the exopod is absent), all identical to Miller's figures 3-5. A male from Empire Cave will be required to confirm this identification.

Calasellus longus Bowman, 1981

Habitat and range.—The location given for the only known population of this species contained an error. Bowman (1981) reported the type-locality at Shaver Lake as 35 miles northwest of Fresno. Inspection of a highway map for the preparation of Figure 1 revealed that Shaver Lake, and the town of the same name, is 35 miles northeast of Fresno.

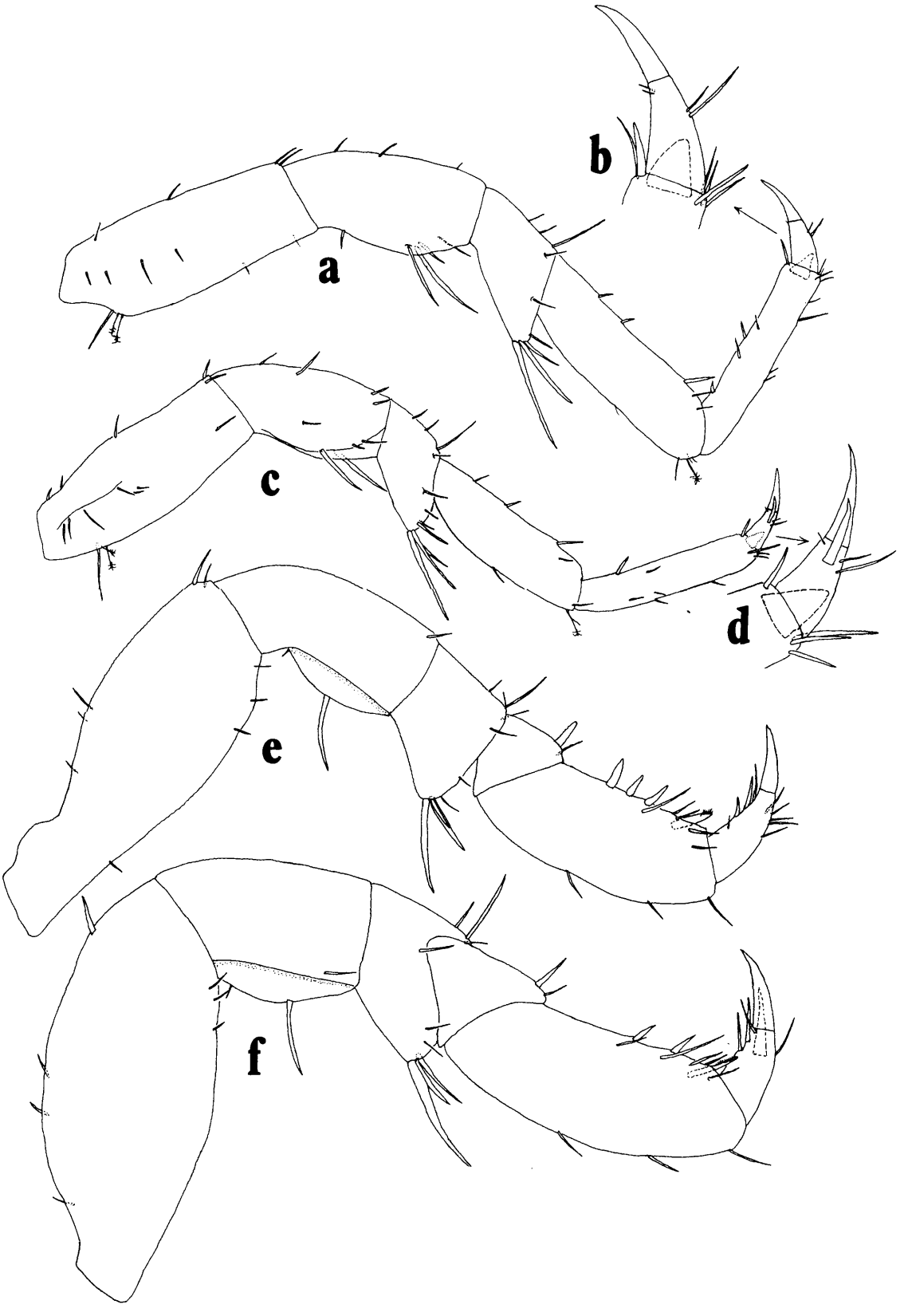

Fig. 8.—*Salmasellus howarth*i, new species, Deadhorse Cave, Skamania County, Washington, 6.5 mm male (a-b, e), 6.3 mm female (c-d, f): (a) pereopod 4; (b) pereopod 4, dactyl; (c) pereopod 4; (d) pereopod 4, dactyl; (e) pereopod 1; (f) pereopod 1.

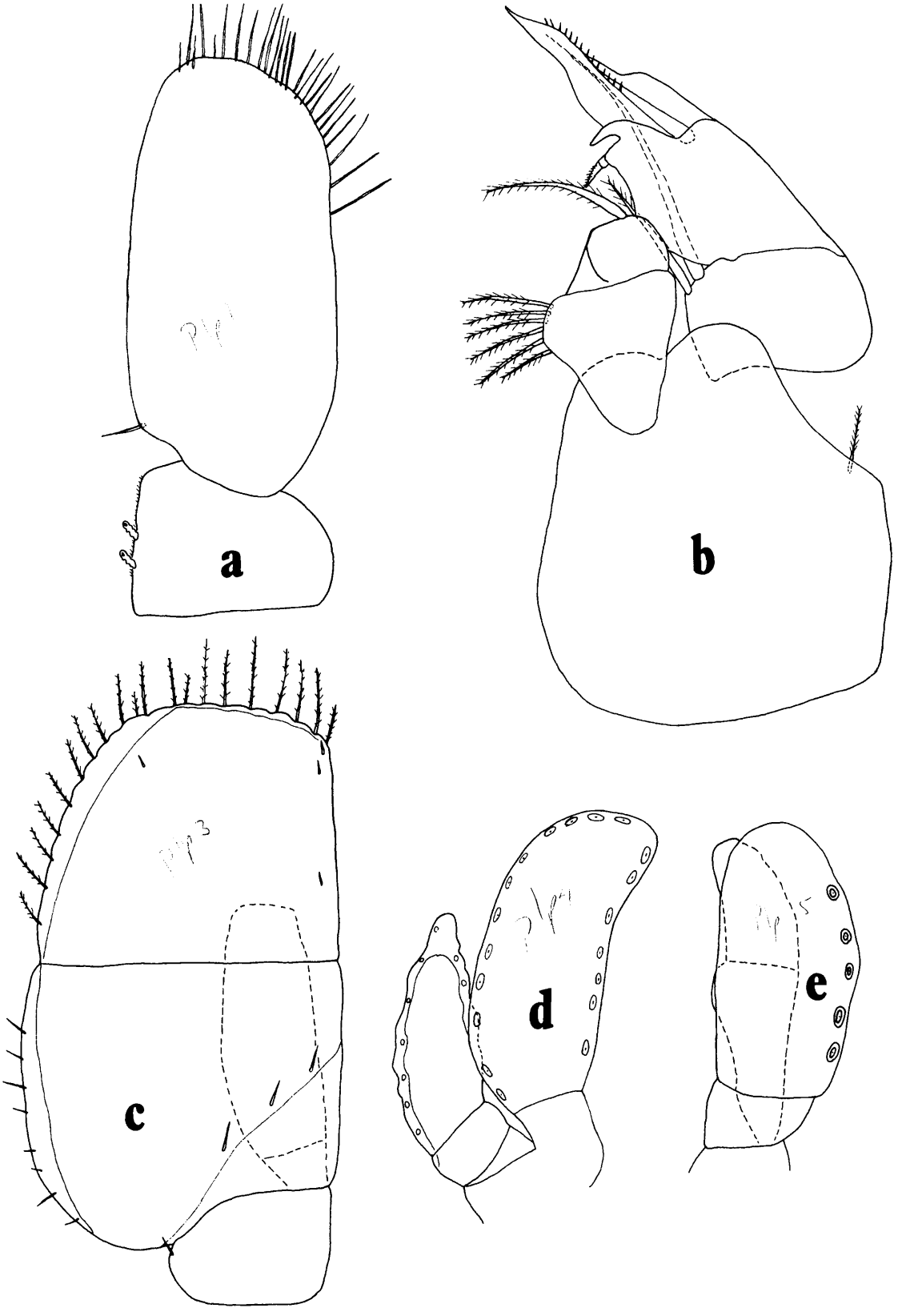

Fig. 9.—*Salmasellus howarthi*, new species, Deadhorse Cave, Skamania County, Washington, 6.5 mm male (a-e): (a) pleopod 1; (b) pleopod 2; (c) pleopod 3; (d) pleopod 4; (e) pleopod 5.

Calasellus undescribed species

Material examined.— OREGON: *Harney County*, Malheur Cave, 6 October 1978, E. Gruber, E. Benedict, 1 male, 5 females.

Habitat and range.— This undescribed species is known only from Malheur Cave. All of the specimens are in the 3-4mm range, damaged, with nearly all of the antennae, pereopods and uropods missing. Although the cave is not commercialized, it is well known and the entrance is marked on highway maps (A.A.A., 1999). Malheur Cave is a lava tube about 1000 meters in length, of which about half is filled with deep water requiring a raft to traverse (N.S.S., 1975). Holsinger (pers. comm.) reported visiting Malheur Cave on 13 July 1980 and 6 July 1982 without finding any isopods despite diligent searching, including baiting. The final 175 meters of the cave are totally filled with water and accessible only to divers, who reported seeing small isopods on two dives (Hill, 1999).

Holsinger (1976) redescribed the subterranean amphipod *Stygobromus hubbsi*, originally described by Shoemaker (1942) from Malheur Cave, and reported the presence of the troglobitic flatworm *Kenkia rhynchida* and "a tiny, white, eyeless isopod of the genus *Asellus*."

Caecidotea Packard, 1876

Caecidotea sequoiae Bowman, 1975b

Material examined.—CALIFORNIA: *Tulare County*, Kings Canyon National Park, Big Springs, Redwood Canyon, October 1997, Thomas M. Iliffe, 2 males, 3 females.

Habitat and range.—This species was previously known only from the type-locality at Liburn Cave (sic, Bowman, 1975b), Sequoia National Park. This is presumably a reference to Lilburn Cave. *Caecidotea sequoiae* is now known from two localities in Tulare County, California..

Discussion.—In the description this species was placed in the genus *Caecidotea*, but was clearly unlike other members of that genus in some ways (Bowman, 1975). In my conversations with Dr. Bowman at the Smithsonian Institution he related that he was not very comfortable with the placement of this species in *Caecidotea*, but had decided to take a conservative approach at the time of its description. *Caecidotea sequoiae* will probably be moved to *Calasellus* or another genus at some later date, but this would be premature prior to a better understanding of the asellid fauna of California.

Caecidotea bilineata Lewis & Bowman, 1996

Material examined.—TEXAS: *Collin County*, Parkhill Prairie, from crayfish burrow, 30 August 1995, B. Hall, 7 males, 5 females.

Habitat and range.—This is a non-cavernicolous groundwater species previously recorded from Bell and Dallas counties, Texas (Lewis & Bowman, 1996). *Caecidotea bilineata* appears to be morphologically similar to *C. adenta*. Both have a pereopod 1 propus that lacks processes, a male first plepod exopod with concave lateral margin and elongate setae along the apical edge, and uropods that are shorter than the pleotelson. The male second pleopod endopod tip of *C. adenta* appears to be very similar to that of *C. reddelli,* as noted by Steeves (1968).

Caecidotea reddelli (Steeves, 1968)

Material examined.—TEXAS: *Bell County*: Buchanan Cave, Fort Hood, 4 November 1998, J. Cokendolpher, J. Krejca, J. Reddell, M. Reyes, 4 males, 8 females; Bumelia Well Cave, 28 October 1994, D. Allen, D. Love, 2 males; Nolan Creek Cave, Fort Hood, 19 May 1999, J. Reddell, M. Reyes, 1 male, 1 female; Tres Dedos Cave, Fort Hood, 24 March 1999, J. Reddell, M. Reyes, 1 male. *Coryell County*: Royalty Ridge Seep, Fort Hood, 31 March 1999, J. Reddell, M. Reyes, 5 males, 3 females; Taylor's Branch Spring, Fort Hood, 30 April 1998, L.J. Graves, J. Reddell, M. Reyes, 11 males, 8 females; Wagontop Spring Cave, 21 January 1992, J. Reddell, M. Reyes, C. Savvas, 12 males, 12 females. *Travis County*: Broken Arrow Cave, 29 April 1999, M. Sanders, G. Veni, 2 males, 6 females. *Williamson County*: Cis Springs, 8 July 1985, M. Maudlin, 3 males (2 vials); same locality & collector, 5 July 1985, 1 male; Water Tank Cave, 29 October 1998, J. Ivy, P. Sprouse, 1 male, 1 female.

Habitat and range.—This species is known from caves in the area of the north Balcones Fault Zone along with seeps and wells in the adjacent Gulf Coastal Plain. It is endemic to Texas, where it has been reported from Bell, Coryell, Dallas, Hays, Henderson, Travis and Williamson counties (Steeves, 1968; Mitchell & Reddell, 1971; Lewis & Bowman, 1996). *Caecidotea reddelli* appears to be morphologically (particularly in the structures of the male second pleopod) and zoogeographically (figure 1) related to *C. acuticarpa* and *C. adenta* in Oklahoma, and *C. tridentata* in Kansas.

ACKNOWLEDGEMENTS

The specimens examined for this paper were supplied by numerous individuals to whom I am indebted: Dr. Ellen Benedict, Dr. Thomas Briggs, Mr. Scott Harden, Dr. Frank Howarth, Dr. Thomas Iliffe, Mr. James Reddell and Ms. Rosalie de Rosario. I would also like to thank Dr. Brian Kensley, Dr. John R. Holsinger, Dr. Frank Howarth, and Mr. James Reddell for reviewing the manuscript. In addition, Dr. Kensley kindly provided the loan of specimens from the collection of the Smithsonian Institution.

The descriptions of the new species were prepared at the National Museum of Natural History, funded by a Visiting Scientist Grant from the Smithsonian Institution.

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