Holsinger, J.R. 1992. Four new species of subterranean amphipod crustaceans (Artesiidae, Hadziidae, Sebidae) from Texas, with comments on their phylogenetic and biogeographic relationships. Texas Mem. Mus., Speleol. Monogr., 3:1-22.

FOUR NEW SPECIES OF SUBTERRANEAN AMPHIPOD CRUSTACEANS (ARTESIIDAE, HADZIIDAE, SEBIDAE) FROM TEXAS, WITH COMMENTS ON THEIR PHYLOGENETIC AND BIOGEOGRAPHIC RELATIONSHIPS

John R. Holsinger

Department of Biological Sciences
Old Dominion University
Norfolk, Virginia 23529

ABSTRACT

Four new stygobiont amphipod crustaceans are described from a variety of groundwater habitats (e.g., caves, springs, interstitial media) in south-central and western Texas. The new species are *Artesia welbourni* (Artesiidae), *Holsingerius smaragdinus* (Hadziidae), *Mexiweckelia hardeni* (Hadziidae), and *Seborgia hershleri* (Sebidae). The new locality records for *Artesia* in Culberson County, and *Holsingerius* and *Seborgia* in Val Verde County are the first for these genera outside the artesian well in San Marcos, Texas, whereas the new record for *Mexiweckelia* in Medina County documents a significant range extension for this genus from north-central Mexico to south-central Texas. *Seborgia relicta,* previously described from the artesian well in San Marcos, is also newly recorded from Medina County.

Both the phylogenetic and biogeographic implications of these new taxa are discussed at some length because they provide further insight into the origin and evolutionary biology of stygobiont crustaceans in southern Texas and northern Mexico.

INTRODUCTION

By far the greatest taxonomic diversity of subterranean amphipod crustaceans in North America is found in Texas, primarily in groundwater habitats of the Edwards Aquifer and associated Balcones fault zone in the south-central part of the state. In the most recently published paper on Texas subterranean amphipods (Holsinger and Longley, 1980), one new family, four new genera, and six new species were described from an artesian well in San Marcos. Some of these species were also recorded from nearby San Marcos Springs and deep artesian wells near San Antonio. Collecting of subterranean amphipods in Texas has continued since this study was published in 1980, resulting in many new locality records for previously described species and the discovery of a significant number of taxa new to science. In this paper four of these newly discovered species, all with close morphological affinities to the previously noted Edwards Aquifer well amphipod fauna, are described from subterranean groundwaters in Medina, Val Verde and Culberson counties. In addition, one species previously known only from the artesian well in San Marcos is recorded from Medina County.

Descriptions of the four new species raise the total number of stygobiont amphipods described from Texas to 21. This remarkably diverse fauna encompasses representatives of five families and nine genera. One of the new species belongs to the genus *Mexiweckelia*, which was previously recorded from

the state of Coahuila in northern Mexico (see Holsinger and Minckley, 1971) and is herein reported from Texas for the first time. The taxa treated in this paper are listed under their respective families, which are in turn arranged alphabetically.

SYSTEMATICS

FAMILY ARTESIIDAE HOLSINGER, 1980

Remarks.—Botosaneanu and Stock (1989) do not accept Artesiidae and Bogidiellidae as separate families and suggest that the two be united in the family Bogidiellidae. Their opinion is based in part on the recent description of *Aequigidiella* from two caves in Thailand, a genus which possesses certain characters that appear to bridge the gap between the two family groups.

Artesia welbourni, new species
Figs. 1-3

Material examined.—TEXAS: *Culberson County:* Border Cave, ca. 26 km SW of White City (New Mexico), female holotype and 2 female paratypes, W. C. Welbourn, 15 Apr. 1976.

The holotype is deposited in the National Museum of Natural History (Smithsonian Institution) (USNM 239480); paratypes are in the author's collection.

Diagnosis.—Medium-sized stygobiont species distinguished from *A. subterranea,* to which it is closely allied, by more spinose and/or setose appendages, especially gnathopods, pereopods, uropods and telson; reaching sexual maturity at larger size; and other small differences noted below. Largest female, 10.5 mm; male unknown.

Female.—Antenna 1: 55-60% length of body, ca. 33% longer than antenna 2; primary flagellum with 18 segments, esthetascs on most flagellar segments; accessory flagellum 1-segmented. Antenna 2 more setose than that of *A. subterranea,* flagellum with 7 segments. Mandible: molars conical, feeble, each with 1 apical seta; spine row with 7-8 plumose spines; cutting plates rather broad, lacinia mobilis of left finely serrate, that of right 4-dentate; palp segment 2 with 2-3 setae on convex inner margin, segment 3 subequal in length to segment 2 and bearing mixture of few long and short C(?) and E setae on inner margin toward distal end (apparently right mandible with more setae than left), outer margin of segment 3 with 2 or 3 B setae. Lower lip: inner lobes very broad, broader than outer lobes; lateral processes very short. Maxilla 1 very similar to that of *A. subterranea,* except apical spines on outer plate are weakly pectinate; palps symmetrical. Maxilla 2 similar in shape to that of *A. subterranea* but with more apical setae. Maxilliped: inner and outer plates and segments of palp with few more setae each than those of *A. subterranea.*

Gnathopod 1: propod large and prominent, palm elongate, becoming slightly convex distally, bearing row of about 18 short, peg-like spines on outer margin and row of 8 rather short setae on inner margin, proximal part of palm extending from end of dactyl nail to sharp defining angle nearly straight and bearing row of ca. 6 spines of unequal length; posterior margin very short, without setae. Dactyl curved, not reaching to defining angle. Carpus short and squat, with posterior lobe bearing setae and pubescens. Coxa very small, shallow, with 2 short marginal setae at anterolateral corner. Gnathopod 2: propod as long as, but only ca. 2/3 as broad as that of gnathopod 1; palm elongate, slightly convex distally, bearing ca. 19 rather short, peg-like spines on outer margin and few short setae on inner margin, part of palm between end of dactyl nail and defining angle with ca. 3 long spines and long setae; posterior margin of propod relatively short, with 1 set of 2 short setae; superior medial setae singly inserted, inferior medial setae in 1 cluster near defining angle. Dactyl curved, not reaching to defining angle when closed. Carpus with posterior lobe bearing 2 or 3 clusters of setae. Coxa small, shallower than corresponding body segment, bearing 3 short marginal setae.

Pereopods 3 and 4 subequal, although one or the other sometimes with few more spines and/or setae; coxae about as deep as corresponding body segments, longer than broad, margins with 4 or 5 setae and lateral faces with few hair-like setae; bases with 5-6 short spines on anterior margin, 5-8 setae of varying lengths on posterior margin. Pereopod 7 little longer than pereopod 6, ca. 55-60% length of body, ca. 20% longer than pereopod 5. Coxae of pereopods 5 and 6 broadly expanded and deeper than corresponding body segments, that of 5 broader and more setose than that of 6; ventral margins broadly rounded, with 1 to 4 setae, lateral faces with few hair-like setae; coxa of pereopod 7 shallow and not expanded. Bases of pereopods 5 and 6 comparatively narrow, widening distally but lacking distoposterior lobes; anterior and posterior margins rather spinose, anterior with short spines, posterior with longer spines; basis of pereopod 7 broader than those of pereopods 5 and 6, narrowing distally but

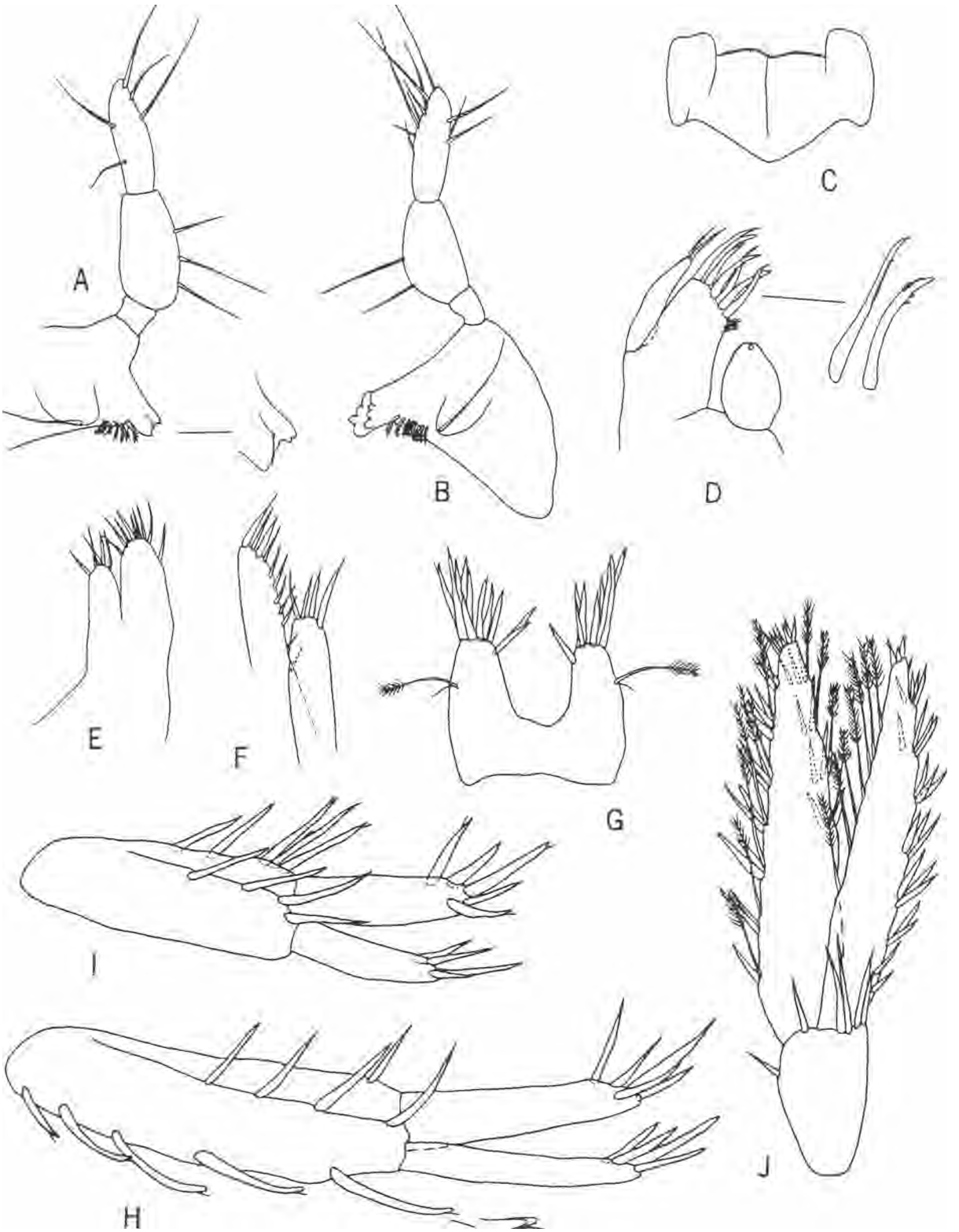

Fig. 1.—Artesia *welbourni*, new species, paratype female (10.5 mm), Border Cave, Culberson Co., TX: A, B, left & right mandibles (cutting plates of left enlarged, incisor probably broken); C, lower lip; D, E, maxillae 1, 2; F, inner and outer plates of maxilliped; G, telson; 1-1, I, J, uropods 1, 2, 3. (Maxillae and plates of maxilliped to larger scale than other mouthparts; telson and uropods to same scale.)

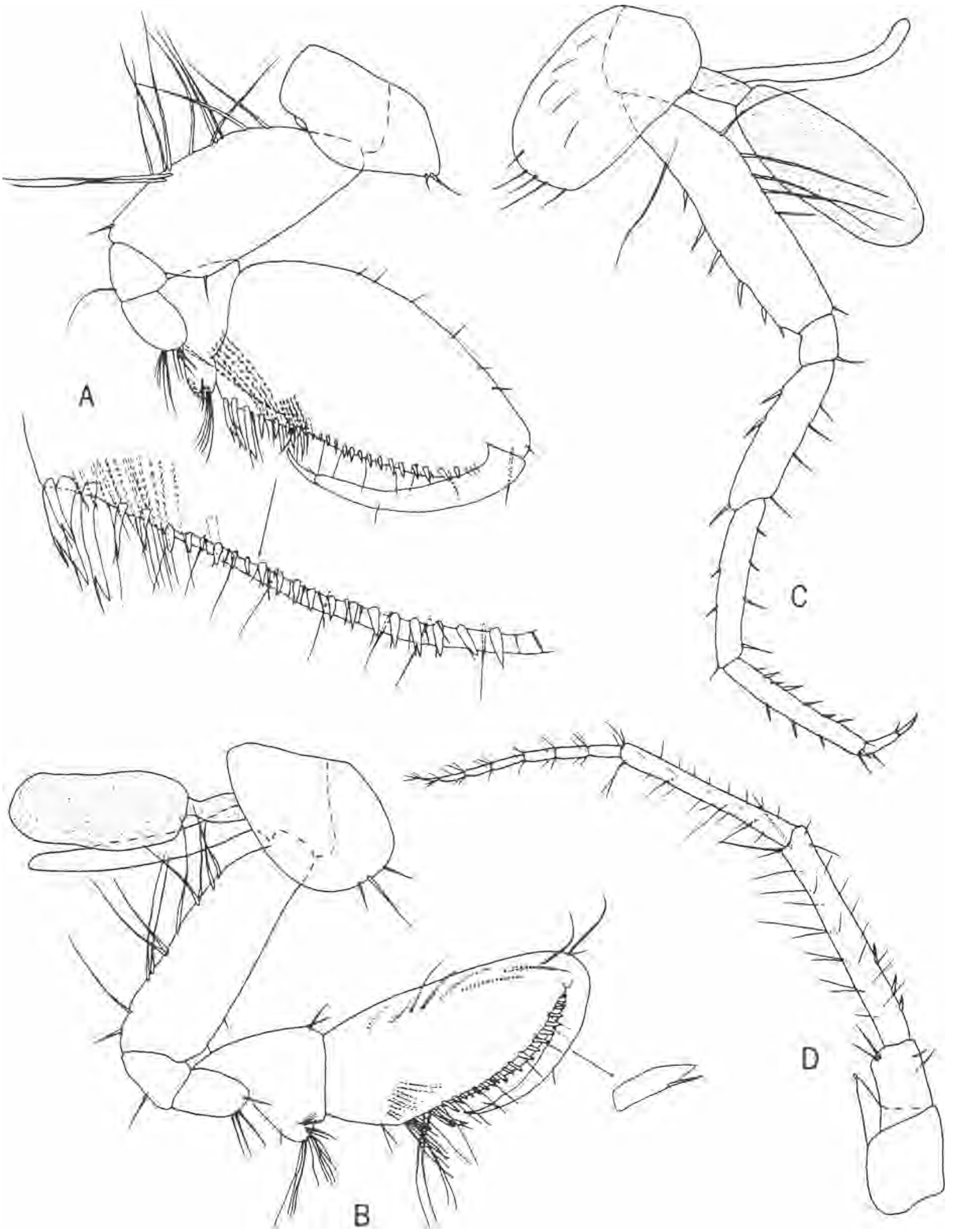

Fig. *2.—Artesia welbourni,* new species, paratype female (10.5 mm), Border Cave, Culberson Co., TX: A, gnathopod 1 (lateral m enlarged); B, gnathopod 2 (lateral view; palmar spine enlarged); C, pereopod 4; **D,** antenna 2. (All structures to same scale.)

also lacking distoposterior lobe. Segments 5 and 6 of pereopod 7 with long setae, those of pereopods 5 and 6 without long setae. Dactyls of pereopods 5-7 relatively long, those of 5 and 6 about 50% length of corresponding propods, that of 7 about 38% length of corresponding propod. Dactyl of pereopod 5 with 1 ventral seta, that of pereopod 6 with 1 set of 2 setae and that of pereopod 7 with 2 sets of 2 setae each. Coxal gills 2-6 oblong, peduncles short but distinct. Brood plates narrow, lacking setae in specimens examined.

Pleonal plates with small, distoposterior corners and 1 short seta each; ventral margins lacking spines. Pleopods: inner and outer rami with nearly twice number of flagellar segments as those of *A. subterranea, all* setae plumose, none clothespin like; peduncles with 2 coupling spines each. Uronites like those of *A. subterranea,* i.e., uronites 1 and 2 each bearing 2 dorsolateral spines. Uropod 1 very similar to that of *A. subterranea,* except peduncle usually with 5, instead of 4, basofacial spines (becoming progressively larger toward distal end). Uropod 2 rami about like those of *A. subterranea,* but peduncle more spinose and bearing up to 9 long spines on distal half. Uropod 3 approximately 16% length of body: inner and outer rami subequal in length; outer little less broad, armed with clusters of spines on outer margin and row of plumose setae on distal half of inner margin; outer ramus bearing spines and plumose setae on inner and outer margins and spines only on apex. Telson little broader than long, with deep U-shaped cleft; lobes with 9-10 apical spines each; lateral margins bearing 1 long, threadlike, partly plumose seta each toward distal end.

Type-locality.—Border Cave, Culberson Co., Texas, is developed in an outcrop of gypsum bedrock of the Permian-aged Castile formation that floors a rather broad gypsum plain just east of the Guadalupe and Delaware mountains (see Fig. 11). The cave is over 305 m long and gives access in two places to lower level lakes of deep phreatic water. Unconfirmed reports by SCUBA divers indicate that one or both of these lakes may be more than 40 m deep. The single entrance to Border Cave is situated at the end of a relatively deep desert arroyo, which, along with the entire cave, apparently floods completely during any heavy rainfall.

Distribution and ecology.—This species is known only from its type locality, where it is apparently quite rare and is known only from three specimens that were collected by W. C. Welboum in 1976 from one of two deep lakes situated approximately 152 to 213 m from the entrance. I visited Border Cave and this lake with colleagues in June 1978, but we failed to find additional specimens at that time. However, more recent visits to this lake in 1985 and 1986 by S. J. Harden and associates, resulted in the collection of 37 specimens of an undescribed species of the *hubbsi* group of the subterranean amphipod genus *Stygobromus* and specimens of an undescribed species of asellid isopod. But additional specimens of *A. welbourni* were not found. To my knowledge, the second, more remote, deep lake of this cave has not been biologically explored. However, according to S. J. Harden (in litt.), SCUBA divers have reported seeing numerous "crustaceans" [probably both amphipods and isopods] on dives in both Border Cave and nearby Wiggley Cave, which is located just east of the former and probably gives access to the same groundwater aquifer.

In response to rumored sightings of amphipods in caves to the north of Border Cave, I visited the Parks Ranch-Resurgence caves complex in June 1986. These caves are located in New Mexico approximately 21 km NE of Border Cave and on the same gypsum plain. Rather diligent searching in several parts of this system revealed only an occasional specimen of the widely distributed, epigean amphipod *Hyalella azteca* but no other crustaceans. These caves are shallow, apparently flood very quickly after a rainfall, and do not extend deep enough to intersect phreatic water. Thus, any potential they might have as habitats for populations of stygobiont amphipods is severely limited.

Because of their great size and depth (over 300 meters), both Carlsbad Caverns and Lechuguilla Cave, which are located in New Mexico only approximately 24 km north-northeast of Border Cave, would appear to have the potential for stygobiont crustacean faunas. Unlike Border Cave, however, they are excavated in limestone bedrock at higher elevations in the Guadalupe Mountains just west of the gypsum plain. To date, despite extensive explorations, neither is known to access phreatic water or contain any aquatic organisms.

Etymology.—It is a pleasure to name this species in honor of its collector, W. Calvin Welboum, Curator of the Acarology Laboratory at Ohio State University.

FAMILY HADZIIDAE S. KARAMAN, 1943

Genus *Mexiweckelia* Holsinger and Minckley

Mexiweckelia Holsinger and Minckley, 1971:426 [in part]; Barnard and Barnard, 1983:644.

Revised diagnosis.—Without eyes and pigment,

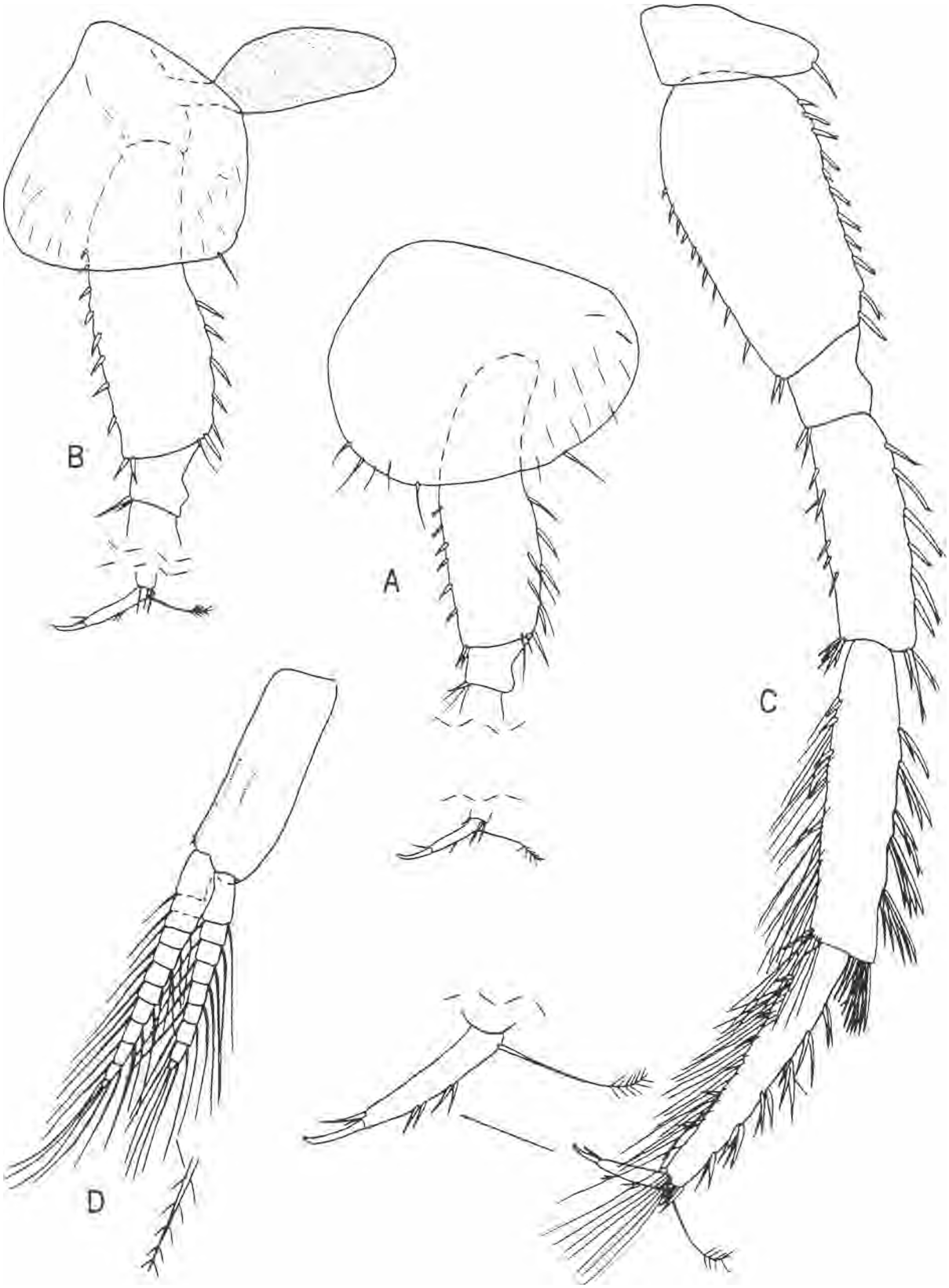

Fig. 3.—*Artesia welbourni*, new species, paratype female (10.5 mm), Border Cave, Culberson Co., TX: A, B, pereopods 3 & 4 (in part); C, pereopod 7 (dactyl enlarged); **D,** pleopod 3. (All structures to same scale.)

of stygobiont facies. Interantennal lobe small, rounded anteriorly. Antenna 1 longer than antenna 2; flagellum with esthetascs present only in male; accessory flagellum vestigial (?) or absent. Peduncular segment 4 of antenna 2 longer than segment 5. Buccal mass prognathous. Upper lip symmetrical, rounded and unnotched apically. Mandible: molar prominent, triturative, left lacking seta; lacinia mobilis present on both right and left mandibles; palp absent. Lower lip: inner lobes vestigial or absent, outer lobes (shoulders) high, lateral processes slender but distinct. Maxilla 1: inner plate not greatly expanded, with apical setae (sometimes plumose); outer plate with 7 apical serrate spines; palps usually asymmetrical (i.e., right broader apically and more spinose). Maxilla 2: inner plate narrowing toward apical end, with oblique row of naked facial setae, inner margin slightly convex. Maxilliped: inner plate rather long, expanded distally but not greatly so; outer plate extending beyond inner plate, broadening medially or distally, inner margin with short row of bladespines at or toward apex; palp segment 2 longest, segment 3 with distomedial lobe, segment 4 (dactyl) not greatly elongate, nail relatively short.

Gnathopod 1 weakly sexually dimorphic. Propod of female gnathopod 1 shorter than carpus, palm short, generally transverse, weakly armed with few small spines and setae; dactyl short and thick, nail short; carpus large, subtriangular, with prominent pubescent posterior lobe and several long setae. Propod of male gnathopod 1 proportionately little longer, palm with few more spines. Gnathopod 2 strongly sexually dimorphic. Propod of female gnathopod 2 relatively long and narrow, longer than carpus, palm short, oblique, bearing 2 rows of short, unnotched spines; posterior margin longer than palm, with several clusters of setae; carpus subtriangular, with pubescent posterior lobe and several sets of long setae. Propod of gnathopod 2 of male much broader distally, palm longer, oblique, bearing double row of short, unnotched spines; carpus comparatively shorter but also with distinct pubescent posterior lobe. Coxae of gnathopods 1 and 2 subequal, about as broad as deep; coxae 3 and 4 similar; coxa 4 unlobed; coxa 5 lobate. Pereopods 3 and 4 subequal. Pereopod 7 at least 50% length of body, little longer than pereopod 6, much longer than pereopod 5; bases of pereopods 5-7 not much expanded, distoposterior lobes usually distinct but not large; segment 6 moderately spinose and/or setose; dactyls rather short, lacking setules on upper margins. Coxal gills 2-6 relatively large, typically ovate and/or ellipsoidal, with distinct peduncles. Brood plates small and narrow, not bearing setae in material examined.

Pleonal plates variable, corners not produced, each bearing 1 setule. Pleopods normal, not sexually dimorphic, peduncles with few (typically 3) coupling spines on inner margins distally. Uronites free (not fused), 1 and 2 each armed with 2 dorsal spines, 3 with 2 or often more. Uropods 1 and 2 not sexually dimorphic; peduncle of 1 bearing 1 or 2 basofacial spines. Uropod 3 elongate, magniramous; outer ramus 1-segmented, outer margin with strong spines in clusters but lacking setae. Telson relatively short,about as long as broad; depth of apical incision (cleft) variable, very shallow or up to ca. 2/3 distance to base; lobes with 1 to 3 apical spines each.

Relationship.—Despite some fundamental differences that are noted below, *Mexiweckelia* is apparently closely related to *Holsingerius,* a genus originally based on *H. samacos* (Holsinger) (in Holsinger and Longley, 1980) from the artesian well in San Marcos and described by Barnard and Karaman (1982). These two genera have a number of important morphological characters in common. *Mexiweckelia* is also closely related to *Texiweckelia,* another genus recorded from the artesian well in San Marcos, as well as San Marcos Springs (see Holsinger and Longley, 1980).

Remarks.—The addition to *Mexiweckelia* of the new species described below, re-examination of the two species previously assigned to this genus, and re-evaluation of the closely allied genus *Holsingerius,* necessitates the revised diagnosis given above.

Mexiweckelia hardeni, n. sp., is the first record for *Mexiweckelia* outside Mexico and brings the total number of species in the genus to three. Two of these species occur in northern Mexico: *M. colei* from groundwaters of the Bolsón de Cuatro Ciénegas in Coahuila and *M. mitchelli* from Cueva de la Siquita in Durango (see Holsinger and Minckley, 1971; Holsinger, 1973).

Two discrepancies in the original descriptions of *M. colei* (see Holsinger and Minckley, 1971) and *M. mitchelli* (see Holsinger, 1973) are noted and should be corrected as follows. Structures on the flagellum of antenna 1 referred to erroneously as "tiny" or "slender" calceoli are esthetascs; basofacial spines were inadvertently omitted from the illustrations of uropod 1 (1 for *M. mitchelli* and 2 for *M. colei); in M. mitchelli,* the right molar has a seta, the left does not.

Mexiweckelia hardeni, new species
Figs. 4-6

Material **examined.—TEXAS:** *Medina County:* Hondo Creek hyporheic, 6.5 km E of Hondo, female holotype and 4 female paratypes, S. J. Harden, 18 Mar. 1988; additional paratypes collected by S. J. Harden include 1 female, 20 Jan. 1986 and 1 male, 23 Feb. 1988.

The holotype is deposited in the National Museum of Natural History (USNM 239477); paratypes are in the author's collection.

Diagnosis.—A small, interstitial species closely allied to *M. colei* from northern Mexico, but easily distinguished from that species and also from *M. mitchelli* by the telson, which has a very shallow apical notch, and peduncle of uropod 2, which is heavily spined toward distal end along dorsomedial margin. Largest male, 3.2 mm; largest female, 4.5 mm.

Female.—Antenna 1 about as long as body, ca. 50% longer than antenna 2; primary flagellum with 35 segments, esthetascs absent. Antenna 2 with 14 flagellar segments. Mandible very similar to that of *M. colei:* incisor 7-dentate; right mandible with 3-dentate lacinia mobilis, 2 accessory spines in spine row and molar seta; left mandible with 4-dentate lacinia mobilis, 3 accessory spines and molar seta absent. Lower lip like that of *M. colei*. *Maxilla* 1: inner plate with 11-12 apical, plumose setae; outer plate with 7 apical, serrate spines; palps asymmetrical, right distally expanded and bearing about 7 short, "thick" spines; left not expanded and bearing only about 4 generally weaker spines. Maxilla 2: inner plate narrowing distally, with oblique row of 15-16 facial setae. Maxilliped: inner plate with 3 bladespines and setae on apex and 2 medial setae subapically; outer plate broadening medially or distally, with short row of bladespines apically and subapically on inner margin; palp segment 2 longest, segment 3 narrower and with small distomedial lobe.

Gnathopod 1 very similar to those of *M. colei* and *M. mitchelli*; propod about nearly as long as carpus, palm very short, scarcely armed, bluntly rounded just below tip of closed dactyl, posterior margin rather long, without setae; dactyl short and thick, nail short and indistinct; carpus subrectangular, widening distally into broad pubescent lobe, lobe broadest at distal end, bearing several long setae; coxa about 4/5 as deep as broad, margin with 2 setae. Propod of gnathopod 2 narrow, elongate, palm short and oblique, with double row of 3 or 4 small spines, defining angle with 1 spine and 2 long setae; posterior margin long, with 3 sets of setae; superior medial setae singly inserted in row near anterior margin. Dactyl of gnathopod 2 bearing small bladespines on inner margin, nail rather short; carpus subtriangular, posterior margin broadly lobiform and pubescent toward distal end, lobe broadest at distal end, with 4 or 5 clusters of long setae. Coxa of gnathopod 2 subequal in size to that of gnathopod 1. Pereopods 3 and 4 subequal, coxae little broader than deep, each with 2 marginal setae, 4 not excavate or lobate. Pereopod 7 about 66% length of body, little longer than pereopod 6, about 33% longer than pereopod 5. Bases of pereopods 5-7 relatively narrow, distoposterior lobes small, scarcely produced; dactyls 30% to 40% length of corresponding propods. Coxal gills 2-6 large, prominent, ellipsoidal and/or subovate, with distinct peduncles. Brood plates small, narrow, nonsetose in material examined.

Pleonal plates: posterior margins slightly convex or nearly straight, corners rounded, each bearing 1 seta; plate 3 with 1 ventral margin spine. Pleopod peduncles with 3 coupling spines on inner margins. Uronites 1 and 2 each with 2 small, dorsodistal spines, 3 with 6 such spines in groups of 3. Uropod 1: inner ramus little longer than outer, shorter than peduncle, armed with about 5 apical spines; outer ramus with about 4 apical spines and 2 short spines on outer margin; peduncle with 10 spines, 2 of which are basofacial. Uropod 2: inner ramus longer than outer, shorter than peduncle, with about 5 apical spines; outer ramus bearing about 5 spines; peduncle rather spinose, bearing 3 or 4 spines on outer anterior margin distally and 9 spines (in row) on distal 3/5 of dorsomedial margin. Uropod 3 relatively long, ca. 22% length of body, rami subequal in length; outer ramus slightly narrower, outer margin armed with sets of spines in clusters of 3 but lacking setae, medial margin with singly inserted spines and plumose setae, apex with cluster of ca. 6 spines; inner ramus with singly inserted spines and plumose setae on both margins, apex with cluster of about 5 spines. Telson about as broad at base as long, narrowing distally, apical margin with very shallow notch, apical lobes with 3 spines each.

Male.—Differing principally from female in having esthetascs on antenna 1 and in structure of gnathopods as follows. Propod of gnathopod 1 little longer, palm with few more small spines, 1 or 2 relatively long inferior medial setae; dactyl little longer. Propod of gnathopod 2 proportionately larger, palm rather long, oblique, armed with double row of about 7 small, unnotched spine teeth, posterior margin about equal to palm in length, with

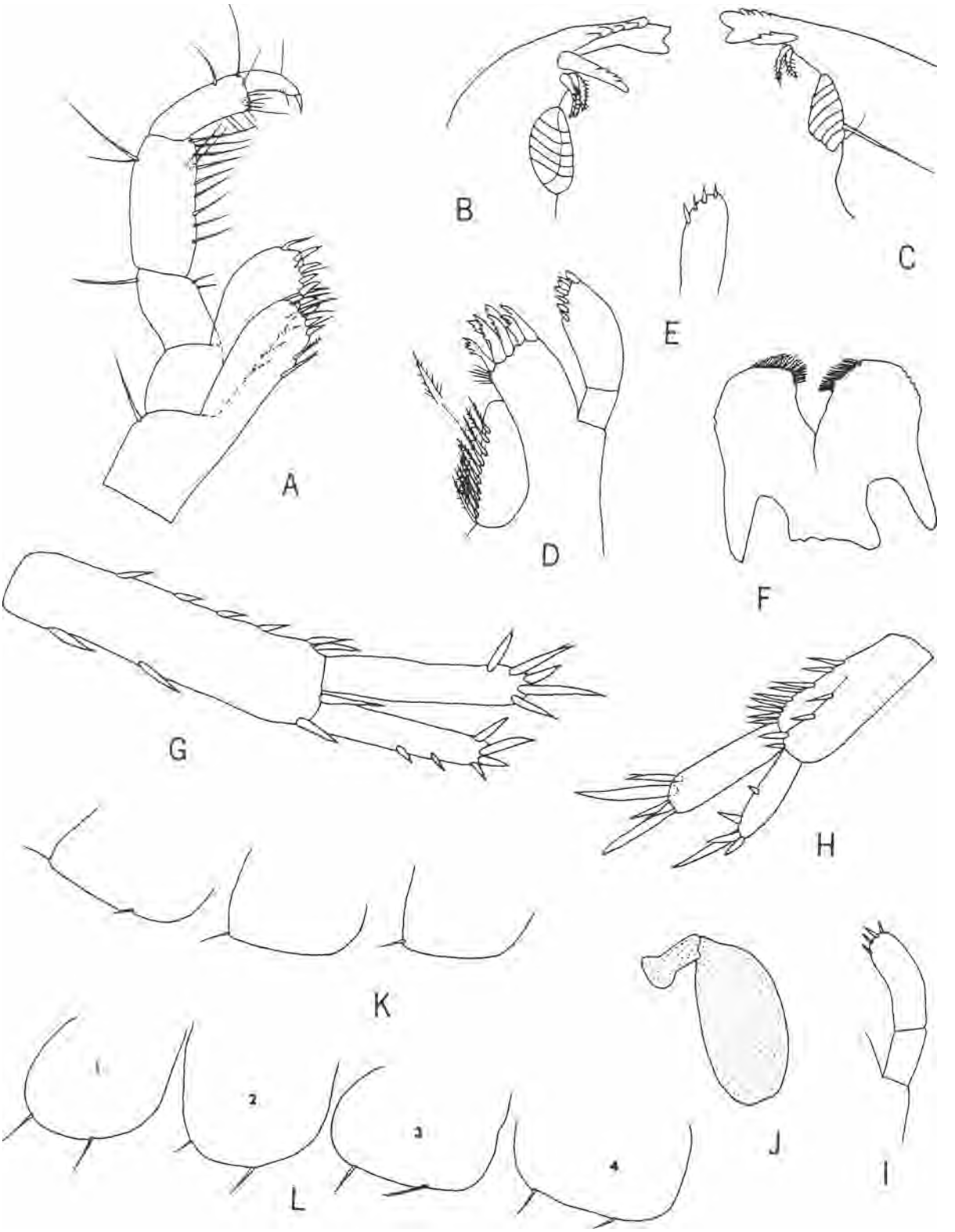

Fig. *4.—Mexiweckelia hardeni,* new species, paratypes, Hondo Creek hyporheic, Medina Co., TX, female (4.5 mm): A, maxilliped; B, C, left & right mandibles; D, right maxilla 1; E, apex of palp of left maxilla 1; F, lower lip; G, H, uropods 2, 2. Female (3.7 mm): I, palp of left maxilla 1; J, coxal gill; K, pleonal plates; L, coxae 1-4. (Lower lip to smaller scale than other mouthparts; coxae and pleonal plates to same scale, coxal gill to smaller scale.)

2 sets of 1 or 2 setae each; dactyl rather long and slightly curved, closing beyond palm spines, nail rather short.

Type-locality.--Interstitial medium of shallow gravel banks of Hondo Creek, just south of the Balcones escarpment, in Medina Co., Texas (see Fig. 12). The bedrock in this area is composed of shales and sandstones of Late Cretaceous age.

Distribution and ecology.—This species is presently known only from the type locality, where it has been collected on three occasions from shallow pits dug into gravel banks of Hondo Creek or from baited jars placed in these pits. The amphipods apparently inhabit an interstitial habitat in the hyporheic (and/or parafluvial) zone of this stream. A rather detailed investigation of the hyporheic zone of Hondo Creek by S. J. Harden (in litt.) over a period of several years has resulted in the collection of flatworms, oligochaetes, hydrobiid snails, ostracodes, stenasellid isopods *(Mexistenasellus coahuda* Cole and Minckley — see Bowman, 1992, in this vol.), and amphipods. In addition to *M. hardeni,* the

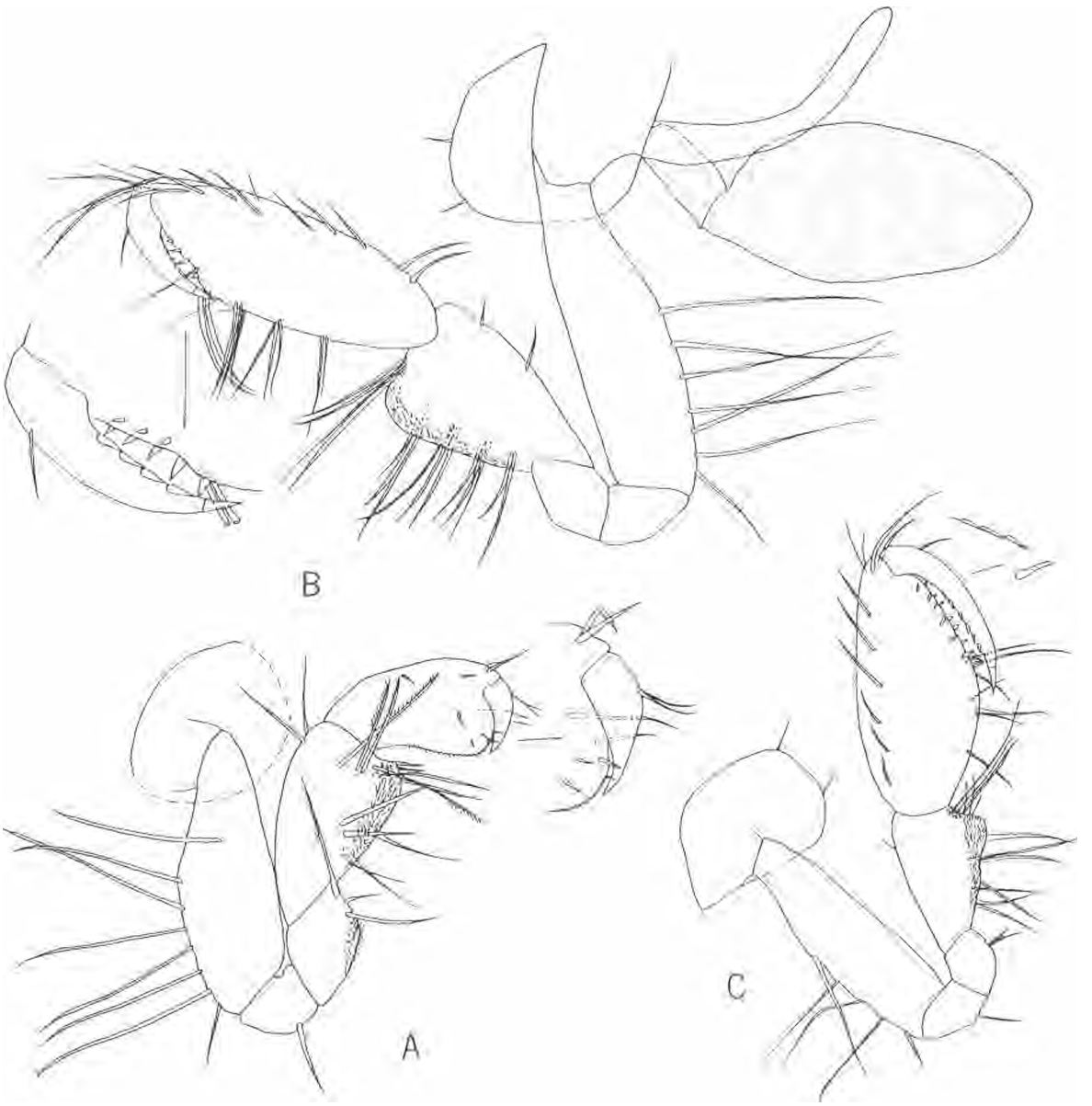

Fig. *5.—Mexiweckelia hardeni,* new species, paratypes, Hondo Creek hyporheic, Medina Co., TX, female (4.5 mm): A, **B,** gnathopods 1, 2 (palms and dactyls enlarged). Male (3.2 mm): C, gnathopod 2 (spines enlarged). (All gnathopods to same scale).

amphipod samples included a few specimens of the stygobionts *Stygobromus russelli* (Crangonyctidae) and *Seborgia relicta* Holsinger (Sebidae) (see below), and the common, epigean *Hyalella azteca* (de Saussure) (Hyalellidae).

Etymology.—It is a pleasure to name this species in honor of its collector, Scott J. Harden, who has made many important collections and observations of subterranean amphipods in Texas.

Genus *Holsingerius* Barnard and Karaman

Holsingerius Barnard and Karaman, 1982:180; Barnard and Barnard, 1983:650.

Remarks.—Holsingerius is known at present from the artesian well in San Marcos, Hays Co., Texas, where only 13 specimens have been recorded to date (see Holsinger and Longley, 1980), and from the new species described below from Emerald Sink, Val Verde County. This genus was recognized by Barnard and Karaman (1982) principally on the basis of: a) lacinia mobilis absent from right mandible; b) greatly expanded inner plate of maxilla 1, bearing approximately 40 apical setae; c) elongate inner plate of maxilla 2, with relatively straight inner margin and oblique row of approximately 100 facial setae; d) elongate, rectangular-shaped inner plate of maxilliped, which bears a row of setae on medial margin that extends well below base of the

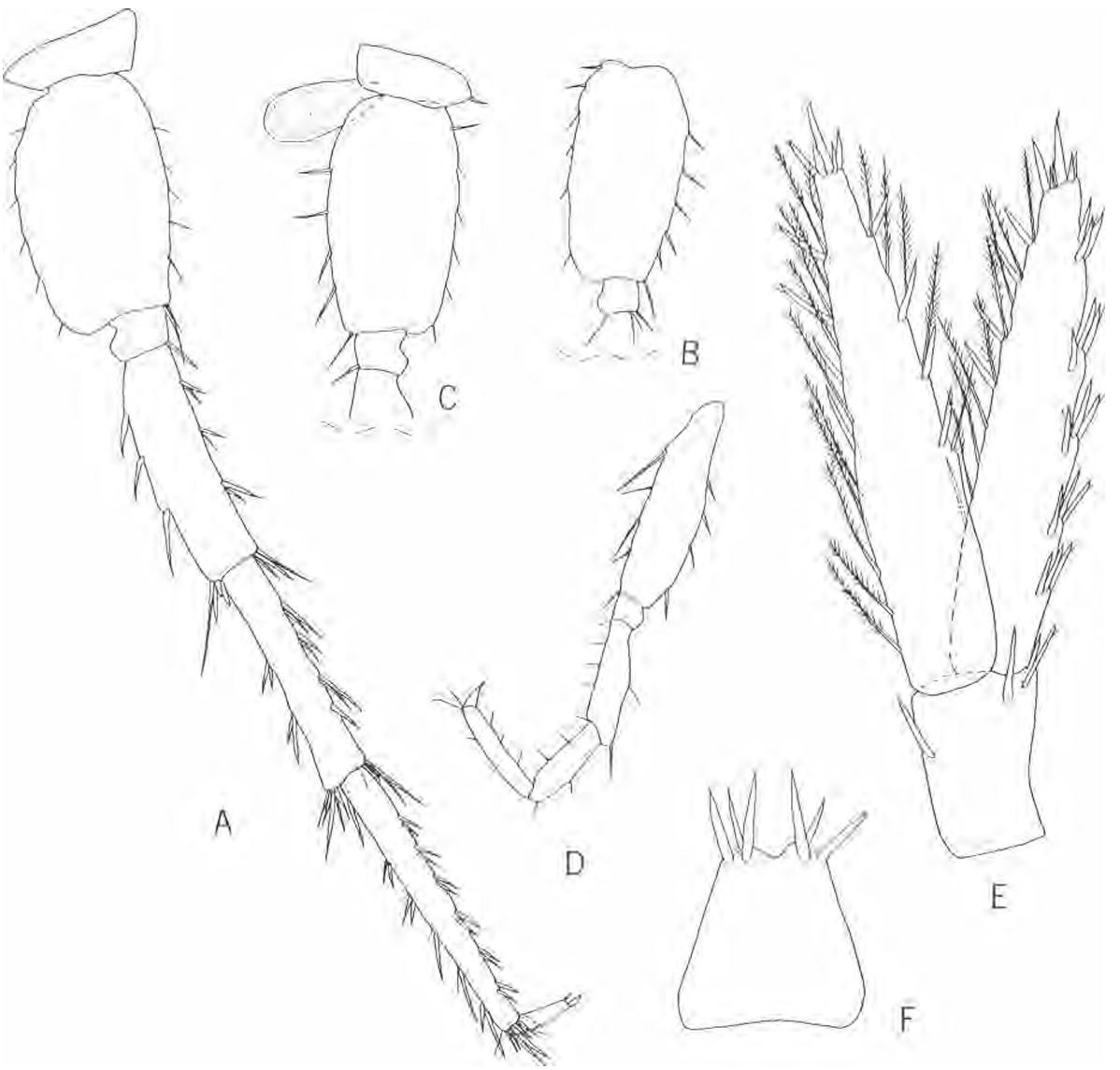

Fig. *6.—Mexiweckelia hardeni,* new species, paratype female (4.5 mm), Hondo Creek hyporheic, Medina Co., TX: A, pereopod 7; **B,** C, pereopods 5 & 6 (in part); D, pereopod 3 (without coxa); E, uropod 3; F, telson. (Uropod and telson to larger scale than pereopods.)

plate; and e) coxa 1 larger than coxa 2. Despite these important differences, this genus and *Mexiweckelia* are apparently closely related, as already indicated. This relationship is strongly supported by several mouthpart characters of the new species described below that appear to be intermediate between the two genera. *Holsingerius* is also closely related to *Texiweckelia,* as evidenced by their number of shared similarities, which include especially the structure of the gnathopods, coxae, and uropods (see Holsinger and Longley, 1980).

Holsingerius smaragdinus, new species
Figs. 7-9

Material examined.—TEXAS: *Val Verde County:* Emerald Sink (Cave), 3.2 km N of Langtry, female holotype and 3 female paratypes, D. Canny and S. J. Harden, 25 May 1985; 2 female paratypes, R. M. Waters, 31 Mar. 1984.

The holotype is deposited in the National Museum of Natural History (USNM 239478); paratypes are deposited in the author's collection.

Diagnosis.—A medium-sized cavernicolous species intermediate in some mouthpart characters between *Mexiweckelia* and *Holsingerius* but having more characters of the latter and herein provisionally assigned to this genus. Distinguished from *Holsingerius samacos,* the only other species in this genus, by presence of a vestigial lacinia mobilis on right mandible; smaller inner plate of maxilla 1 with approximately 1/2 as many medial setae; shorter inner plate of maxilla 2, which is not sub-rectangular in shape and has significantly fewer facial setae; shorter row of plumose setae on inner margin of inner plate of maxilliped; absence of setules from upper margins of dactyls of pereopods 5-7; and presence of long, plumose setae on inner or outer rami of uropods 1 and 2. Largest female, 8.5 mm; male unknown.

Female.—Antenna 1 85-90% length of body, ca. 65% longer than antenna 2, primary flagellum with 39-42 segments, lacking esthetascs; accessory flagellum absent. Antenna 2 with 13 flagellar segments. Mandible: molars prominent; right mandible with spine apparently representing vestigial lacinia mobilis, 2 long plumose accessory spines and molar seta; left with well developed, 4-dentate lacinia mobilis, 2 accessory spines, but lacking molar seta. Inner lobes of lower lip vestigial or absent. Maxilla 1: inner plate with 19-20 medial, plumose setae; outer plate with 7 apical, serrate spines; palps symmetrical, broadest distally, bearing 4 spines at or near apex and 4-5 setae subapically (cf., *Holsingerius samacos).* Maxilla 2: inner plate narrowing distally, with oblique, submarginal row of ca. 29 naked, facial setae. Maxilliped: inner plate rather broad, bearing 4 bladespines apically and setae apically/subapically, and row of plumose setae on inner margin; outer plate broadest medially, bearing short row of bladespines on inner margin near apex; palp segment 3 with inner distal lobe.

Gnathopod 1: propod proportionately small, palm short, with few tiny spines and several setae, medial facial setae few, posterior margin longer than palm, with setae; carpus longer than propod, produced posteriorly into prominent, pubescent lobe which is broadest proximal to distal end (as in *H. samacos),* bearing several groups of long setae; posterior margin of basis setose; coxa rather deep and broadly expanded, with 2 short, marginal setae. Gnathopod 2: propod relatively narrow, elongate, narrowing slightly and unevenly distally, palm oblique, short, armed with double row of ca. 6 small spine teeth, defining angle with several tiny spines and 2 long setae, medial (inner facial) setae absent, but both anterior and posterior margins bearing row of long setae; dactyl short, rather stout, nail short; carpus subtriangular, posterior margin lobiform and pubescent, lobe broadest proximal to distal end (as in gnathopod 1 and in *H. samacos),* bearing 5 or 6 clusters of long setae; coxa smaller than that of gnathopod 1, little deeper than broad. Pereopods 3 and 4 subequal, bases rather broad and bearing short spines on anterior margin and longer (slender) spines on posterior margin; coxa about as deep as broad, with 2 marginal setules; coxa 4 not lobate. Pereopod 7 65-70% length of body, little longer than pereopod 6, ca. 25% longer than pereopod 5. Bases of pereopods 5-7 moderately broad, posterior margins broadly convex, distoposterior lobes well developed; dactyl of pereopod 5 about 50% length of corresponding propod, dactyls of pereopods 6 and 7 ca. 35-40% length of corresponding propods; dactyls without setules on upper margins. Coxal gills large, prominent, usually ellipsoidal, sometimes subovate, with distinct peduncles. Brood plates small, narrow, and nonsetose in material examined.

Pleonal plates similar to those of *H. samacos,* corners produced (especially plates 2 and 3), bearing 1 setule each. Pleopod peduncles with 6-7 coupling spines each on inner margins. Uronites 1 and 2 with 2 small dorsodistal spines each, uronite 3 with 6-8 such spines. Uropod 1: inner ramus subequal in length to outer, shorter than peduncle, with about 5 apical and 2 lateral spines; outer ramus with apical and lateral spines and row of 5 rather long, plumose

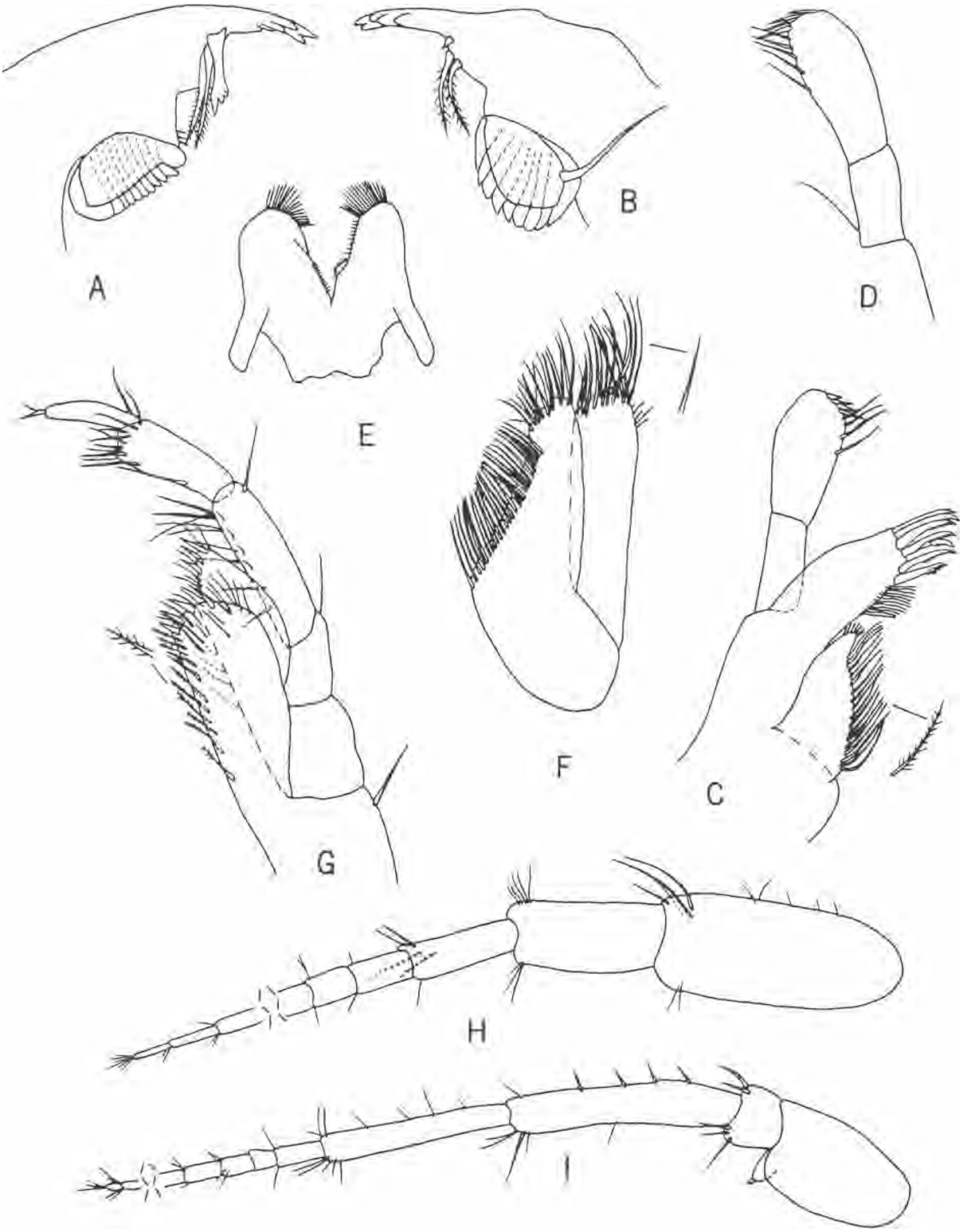

Fig. 7.—Holsingerius smaragdinus, new species, paratype female (8.0 mm), Emerald Sink, Val Verde Co., TX: A, **B,** left & right mandibles; C, left maxilla 1; D, palp of right maxilla 1; E, lower lip; **F,** maxilla 2; G, maxilliped; **H,** I, antennae 1, 2. (Lower lip to smaller scale than other mouthparts; antennae to same scale).

setae on upper margin; peduncle bearing about 12 spines, 3 of which are relatively large basofacial (cf. *H.* samacos). Uropod 2: inner ramus subequal in length to outer, with apical spines and row of rather long plumose setae on lower margin; outer ramus with about 5 apical spines; peduncle subequal to rami in length, armed with about 3 spines. Uropod 3 relatively long, about 22% length of body; rami of equal length but outer bearing spines only (in clusters of 2 or 3) on outer margin; inner margin of outer ramus and both margins of inner ramus with spines and plumose setae. Telson rather long, about 25% longer than broad; apical margin with deep, V-shaped cleft extending ca. 75% distance to base; apical lobes bearing 4 or 5 apical spines each; lateral margins lacking spines.

Type-locality.—Emerald Sink (or Emerald Cave), located on the Stockton Plateau in Val Verde Co., Texas (see Fig. 12), extends to a depth of approximately 91 m below the entrance and contains a deep lake of phreatic water on the lower level. The cave is excavated in limestones of the Buda and Devils River formations of Cretaceous age; a description of the cave was published by Kunath and Smith (1968).

Relationship.—Although this species does not

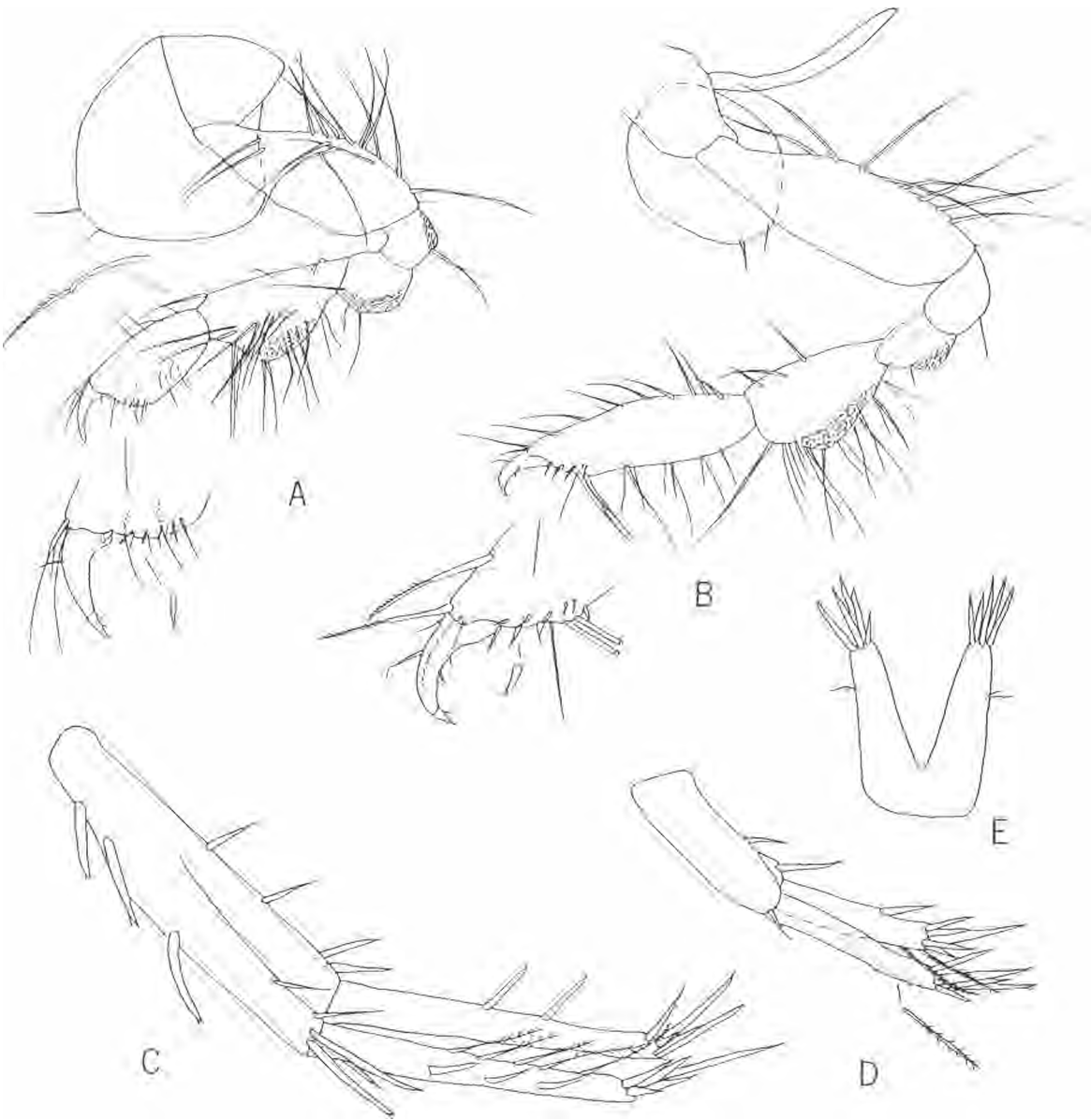

Fig. *8.—Holsingerius smaragdinus,* new species, paratype female (8.0 mm), Emerald Sink, Val Verde Co., TX: A, **B,** gnathopods 1, 2 (palms enlarged), C, **D,** uropods 1, 2; E, telson. (Gnathopods to smaller scale than uropods and telson.)

have as many setae on the inner plates of maxillae 1 and 2 as H. samacos, the number is significantly greater than those observed in species of *Mexiweckelia*. Moreover, a close alliance between H. smaragdinus and H. samacos is evidenced by occurrence of the following character states in the former: elongate 1st antenna; vestigial lacinia mobilis of right mandible; symmetrical palps of maxilla 1; long, narrow propod of female gnathopod 2, which narrows unevenly toward distal end; less than distal position of posterior lobes of the carpus of both gnathopods; coxa 1 larger than 2; broad bases of pereopods with prominent distoposterior lobes; produced corners of pleonal plates; 6 or 7 coupling

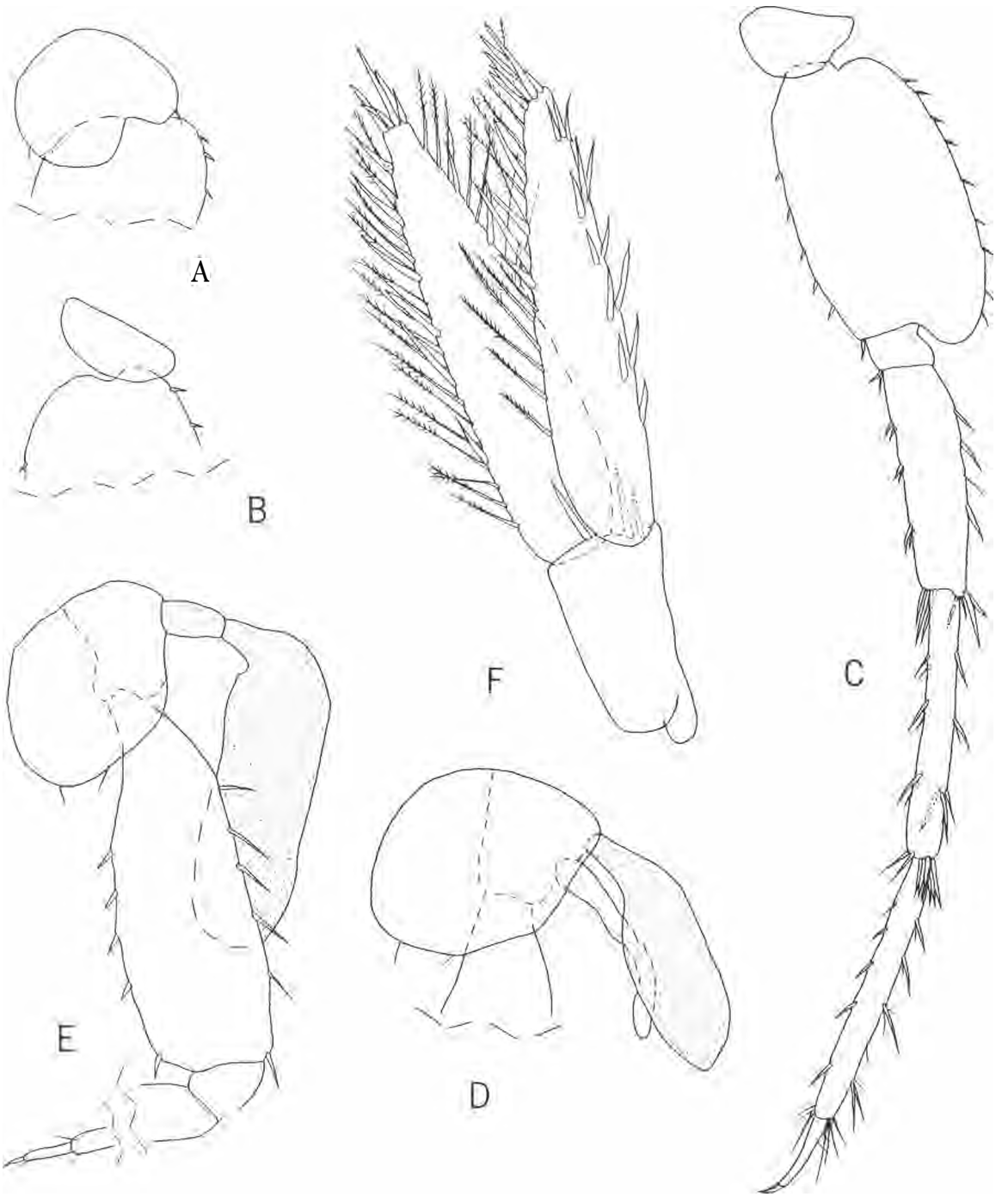

Fig. 9.—Holsingerius smaragdinus, new species, paratype female (8.0 mm), Emerald Sink, Val Verde Co., TX: A, B, coxae and upper part of bases of pereopods 5 & 6; C, pereopod 7; D, coxa, gill and brood plate of pereopod 3; E, pereopod 4 (in part); F, uropod 3. (Pereopods 5, 6 & 7 to smaller scale than pereopods 3 & 4, uropod 3 to larger scale.)

spines on pleopod peduncles; 3 large basofacial spines on peduncle of uropod 1; and deep, relatively wide cleft of telson. Although some of these similarities are probably more variable than others, this high number of shared characters, many of which are synapomorphies, clearly indicates a much stronger phylogenetic relationship of *H. smaragdinus with H. samacos* than with species of *Mexiweckelia.*

Distribution and ecology.—This species is known only from its type locality, where it has been collected twice from a phreatic lake, probably exceeding a depth of 10.6 m. The lake is also inhabited by the stygobiont cirolanid isopod *Speocirolana hardeni,* described by Bowman (1992, in this vol.).

Etymology.—The epithet *smaragdinus* is from Latin, meaning "emerald-green," and is used in reference to the type locality which is sometimes said to contain "emerald-green water."

FAMILY SEBIDAE WALKER, 1908

Genus *Seborgia* Bousfield

Seborgia Bousfield, 1970:164; Karaman, 1982: 86-87.
Relictoseborgia Karaman, 1982:91-92.

Remarks on taxonomic *status.—Seborgia* was erected by Bousfield (1970) for a single species, *S. minima,* which he described from an oligohaline-brackish water lake on Rennell Island in the British Solomon Islands in the South Pacific. A second species, *S. relicta,* was described from the artesian well in San Marcos, Texas, and assigned to this genus by Holsinger and Longley (1980).

On the basis of small differences in morphology between these species, Karaman (1982) proposed the new genus *Relictoseborgia* for *S. relicta,* while retaining *Seborgia* for *S. minima.* In support of his proposal, Karaman (1982) pointed out that the Texas artesian well species differed primarily by having a shallow lateral cephalic (interantennal) lobe combined with an obsolete anteroventral (inferior antennal) sinus, "non-telescopically-shaped" antenna 1, proportionately longer mandibular palp segment 1, larger inner lobes of lower lip, unequal-sized gnathopods, and peduncle of uropod 3 shorter than unisegmented ramus.

In my opinion most of these differences are minor or variable and all are within the accepted range of morphological parameters generally expected between species in the same genus (see also Holsinger and Longley, 1980; Holsinger, 1986a). However, in combination with each other and with the extreme geographic separation and significant habitat difference of these species, I agree with Karaman that these differences probably support some kind of recognition above the species level for these taxa. However, considering the lack of strong morphological differences and the fact that only two (now four) species are involved, full generic status may not be warranted. Instead, I propose dividing *Seborgia* into subgenera along the lines indicated below.

Subgenus *Seborgia* Bousfield, NEW RANK

Seborgia Bousfield, 1970:164; Karaman, 1982: 86-87.

Diagnosis.—Corresponding to the diagnosis for genus *Seborgia* given by Karaman (1982:86), except that eyes may be present and the inferior antennal (anteroventral) sinus is variable in depth.

Remarks.—This subgenus contains two species: *S. minima* Bousfield (1970), already mentioned above; and *S. schieckei* Ruffo (1983) from a brackish mesopsammic habitat on the coast of South Andaman Island in the Indian Ocean. Although *S. schieckei* is more closely allied morphologically with *S. minima* than *S. relicta,* its slightly less produced interantennal lobe and weak inferior antennal sinus are apparently intermediate between the two extremes noted in the other two species. To date, *S. schieckei* is the only eyed member of the genus.

Subgenus *Relictoseborgia* Karaman, NEW RANK

Relictoseborgia Karaman, 1982:91-92.

Diagnosis.—Corresponding to the diagnosis given for genus *Relictoseborgia* by Karaman (1982).

Remarks.—This subgenus contains two species: *S. relicta* (Holsinger, in Holsinger and Longley, 1980) from the artesian well in San Marcos, Hays Co., Texas and a new locality from Medina Co., Texas, noted below; and *S. hershleri,* new species, from Val Verde Co., Texas, described below.

Seborgia (Relictoseborgia) hershleri, new species
Fig. 10

Material examined.—TEXAS: *Val Verde County:* unnamed spring on east side of Devils River, ca. 32 km N of Del Rio, female holotype and 3 female paratypes, R. Hershler, 8 Sept. 1986;

additional paratypes collected by R. Hershler include 1 male (?) and 1 female, 1 Sept. 1986 and 3 females, 4 Sept. 1986.

The holotype is deposited in the National Museum of Natural History (USNM 239479); paratypes are deposited in the Texas Memorial Museum and author's collection.

Diagnosis.—A very small stygobiont species, closely allied with *S. relicta* and differing in only a few minor ways, which include apparent lack of setule on molar of mandible, few less setae on coxae of gnathopods and pereopods 3 and 4, fewer setae on bases of gnathopods; and possibly reaching sexual maturity at smaller size. Largest male, 1.3 mm; largest females, 1.6 mm.

Female.—Without eyes and pigment, of subterranean facies. Head and antennae very similar to those of *S. relicta.* Head with distinct rostrum, interantennal lobe broadly rounded but not produced, inferior antennal sinus very shallow or obsolete.

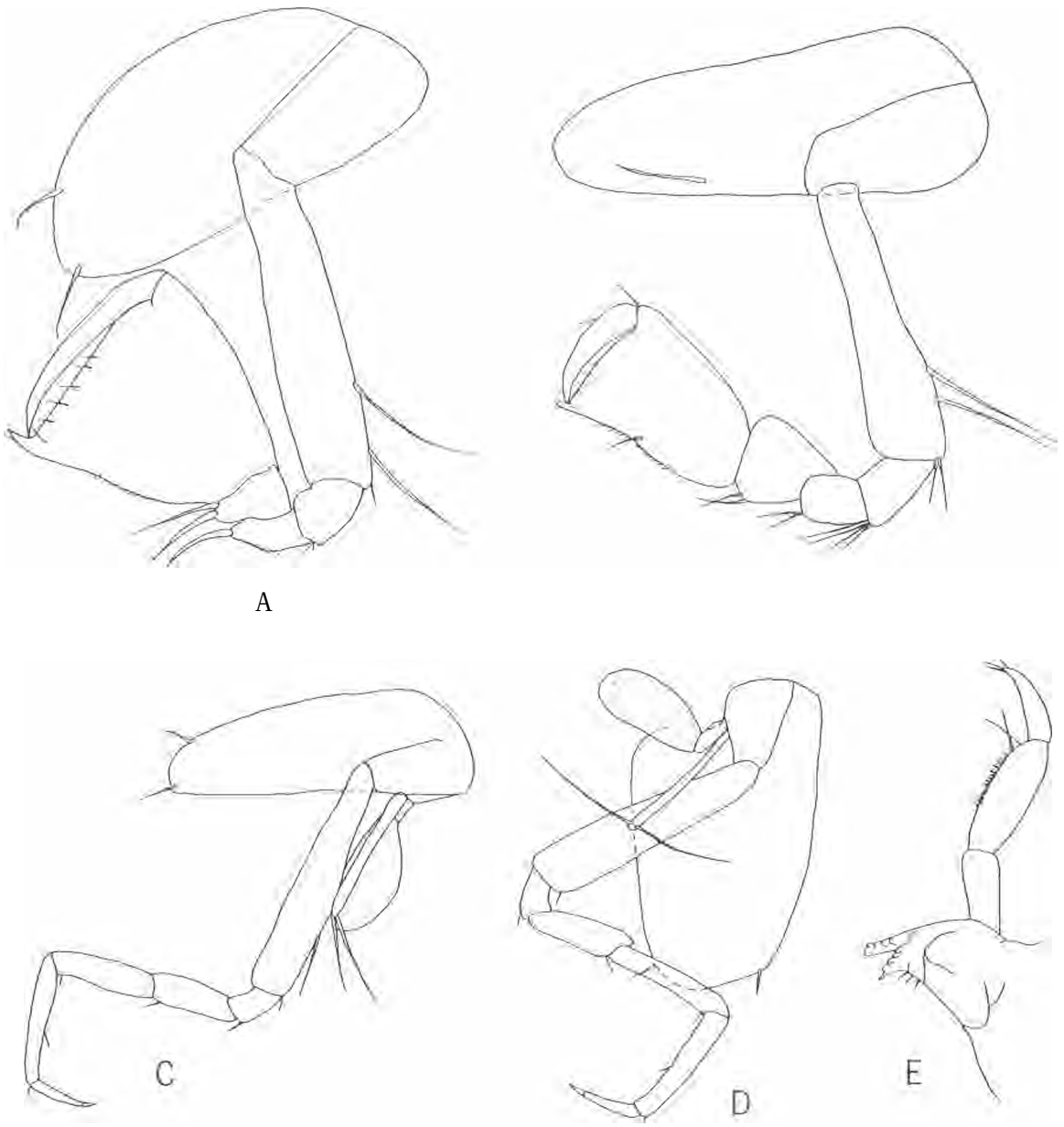

Fig. 10.—*Seborgia (Relictoseborgia) hershleri,* new species, paratype female (1.6 mm), unnamed spring, Val Verde Co., TX: A, **B,** gnathopods 1, 2; C, **D,** pereopods 3, 4; E, left mandible. (Gnathopods to larger scale than pereopods.)

Antenna 1 about 33% length of body, about 25% longer than antenna 2; primary flagellum with esthetascs; accessory flagellum 2-segmented (terminal segment rudimentary). Mouthparts generally like those of *S. relicta,* except for differences in mandible (but note that left and right mandibles are reversed in original description of *S. relicta* in Holsinger and Longley, 1980, fig. 23(e and f). Mandible: molar apparently lacking setule, incisor 5-dentate, lacinia mobilis of left 5-dentate; palp segment 1 relatively long, 2/3 to 3/4 as long as segment 2; palp segment 2 apparently little broader than that of *S. relicta,* with pilose inner margin and 2 setae distally; segment 3 lacking all but ca. 3 apical (E) setae. Lower lip with relatively large inner lobes. Maxilla 1: inner plate tapering distally, lacking apical setae; outer plate with 7 very weakly serrate spines; palps symmetrical, with few setae apically and subapically. Maxilla 2 reduced to single plate with broad base and 4-5 apical setae. Maxilliped: inner plate sublinear, with few apical setae; outer plate much broader, rounded apically, with fine setae on apex and few longer setae on inner margin distally.

Gnathopods subchelate. Gnathopod 1: propod prominent, almost twice size of propod of gnathopod 2, widest distally, palm transverse, bearing row of few setules on inside, defining angle produced into large spine-like process, posterior margin long, oblique, and piliferous in part; dactyl long, closing against inside of defining angle boss, nail indistinct; carpus short, squat, posterior lobe bearing 2 thick setae; basis long and slender, with 2 long setae on posterior margin near distal end; coxa deep, about 2 times deeper than broad, ventral margin with 2 relatively long setae. Gnathopod 2: propod little wider distally than proximally, not much expanded, palm short, transverse, bearing few setules on inside, defining angle produced into small spine-like process, posterior margin long and partly piliferous, with 1 or 2 short setae; dactyl closing against inside of defining angle, nail indistinct; carpus about 50% length of propod, slightly lobed posterior margin with 2 short setae; basis long and slender, bearing 2 long setae on outer margin near distal end; coxa deep and rather narrow, bearing 1 or 2 long setae toward distal margin. Pereopods 3 and 4 subequal except coxae differ; coxa 3 very deep, subrectangular, extending perhaps 90% length of corresponding basis, distal margin with 2 short setae; coxa 4 also very deep, but much broader, extending to end of corresponding basis, distal margin with 2 short setae; dactyls long, at least 50% length of corresponding propods. Pereopod 7 subequal in length to pereopod 6, longer than pereopod 5, ca. 50% length of body. Bases of pereopods 5-7 with broad distoposterior lobes, posterior margins convex and partly serrate; dactyls rather long, ca. 50% length of corresponding propods. Coxal gills and brood plates like those of *S. relicta.*

Posterior corners of pleonal plates weakly produced, acuminate, without setules. Pleopods normal for genus. Uronites without dorsal spines. Uropod 1: inner ramus little longer than outer ramus and peduncle, bearing 2 short spines near distal end, outer ramus with 1 or 2 short spines near distal end; peduncle with 2 spines distally. Uropod 2: inner ramus short, only about 1/2 length of outer ramus and peduncle; armed with 2 short spines near distal end; outer ramus with 1 or 2 short spines near distal end; peduncle with 2 spines distally. Uropod 3 uniramus; peduncle at least 2/3 length of ramus; ramus without spines. Telson little longer than broad, gently tapering distally, lacking spines or setae; apical margin entire (not cleft).

Type-locality.—Unnamed spring on east side of Devils River in a canyon just downstream from Slaughter Bend, Val Verde Co., Texas (see Fig. 11). This spring is also the type locality for a stygobiont hydrobiid snail, *Phreatodrobia coronae* Hershler, and is described in some detail by Hershler and Longley (1987).

Distribution and ecology.—This species is known only from its type locality, where it has been found in association with two other stygobiont amphipods: *Stygobromus* (possible new species of the *flagellatus* group) and an undescribed new genus of the family Hadziidae; the latter being much more common than the former. *Seborgia hershleri* was also collected with planarians, the hydrobiid snails mentioned above, copepods, and cirolanid isopods *(Cirolanides texensis* Benedict — see Bowman, 1992, this vol.). Of a total of 9 specimens collected to date (all during September), 8 were females and 5 of them were ovigerous. The females measured 1.4 to 1.6 mm in length; 4 were carrying 1 egg each, whereas the other had 2 eggs.

Devils River, which drains south to the Rio Grande, lies on the southwest corner of the Edwards Plateau and just west of the area included within the confines of the Edwards Aquifer (see Holsinger and Longley, 1980; Longley, 1981). The springs along the east side of Devils River emerge from subterranean aquifers developed in the Georgetown limestone of Cretaceous age. Much of the stygobiont fauna from these springs is closely allied taxonomically with that found farther east in the San Antonio and San Marcos pools of the Edwards Aquifer.

Etymology.—It is a pleasure to name this species in honor of its collector, Dr. Robert Hershler, Associate Curator of Mollusks at the Smithsonian Institution.

Seborgia (Relictoseborgia) relicta Holsinger

Seborgia relicta Holsinger (in Holsinger and Longley, 1980):45, figs. 23-25 [Type-locality: Artesian well in San Marcos, Hays Co., Texas]; Holsinger, 1986a:568; 1986b:102, 104.
Relictoseborgia relicta (Holsinger): Karaman, 1982:92.

Material examined.—TEXAS: *Medina County:* Hondo Creek hyporheic, 6.5 km E of Hondo, 1 female, S. J. Harden, 10 Apr. 1986.

Remarks.—The single ovigerous female collected from a shallow pit dug into a gravel bank along Hondo Creek is the first recorded occurrence for this species outside the artesian well in San Marcos. It also marks a range extension of approximately 120 km to the southwest, as shown in Fig. 11.

DISCUSSION

Recent discoveries of new species of subterranean amphipod genera from south-central and western Texas that were previously known only from the artesian well in San Marcos, Hays Co., Texas, or from isolated localities in the Basin and Range Province of north-central Mexico shed new light on the taxonomic and biogeographic relationships of stygobiont amphipods in southern North America. As indicated below, these discoveries have several important implications for the evolutionary biology

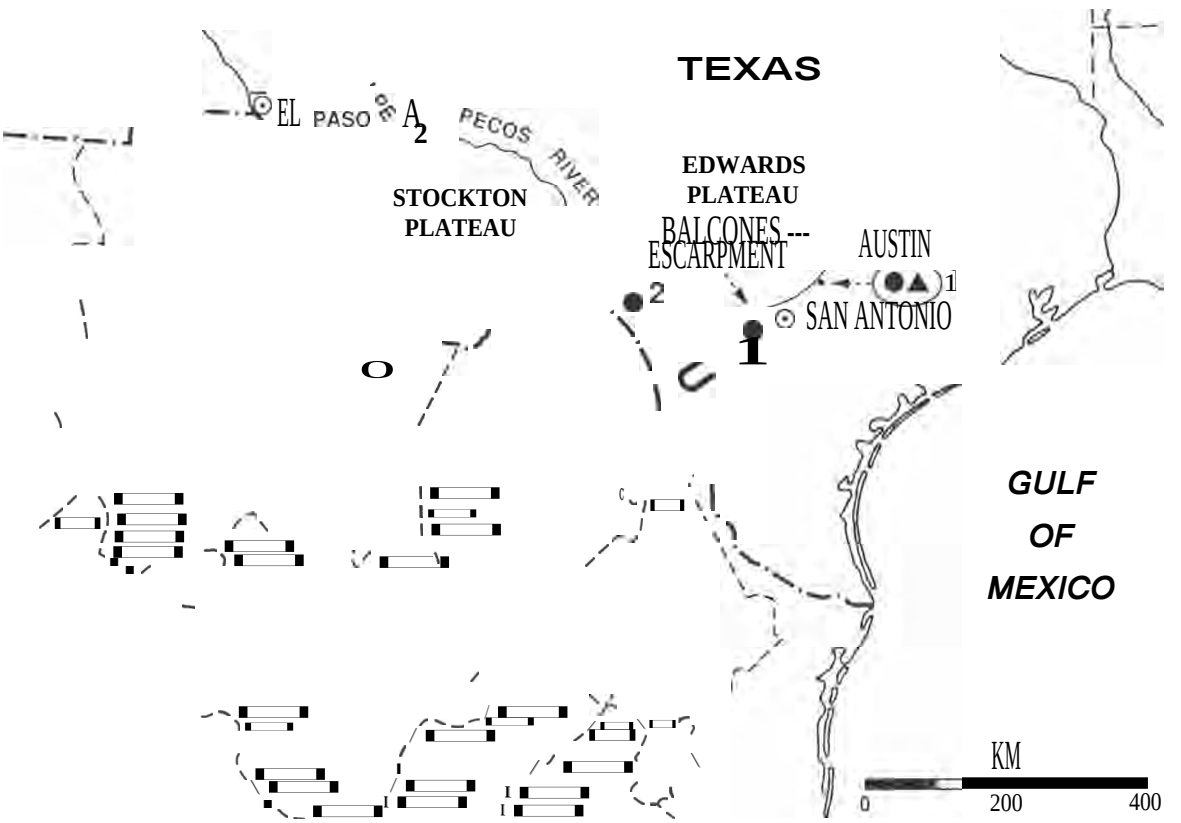

Fig. 11.—Geographic distribution of *A.* and *S.* in Texas. Localities for *A.* indicated by closed triangles: 1, *A.* (artesian well in San Marcos, Hays Co.); 2, *A. welbourni* (Border Cave, Culberson Co.). Localities for *S.* indicated by closed circles: 1, *S.* (artesian well in San Marcos and Hondo Creek hyporheic, Medina Co.); 2, *S.* (unnamed spring on Devils River, Val Verde Co.).

of subterranean amphipod faunas of Texas and Mexico.

It has already been hypothesized that most of the non-crangonyctid subterranean amphipods of Texas and Mexico (e.g., artesiids, bogidiellids, hadziids, sebids) as well as other groups of stygobiont crustaceans (such as cirolanid and stenasellid isopods, and thermosbaenaceans), originated from marine ancestors through stranding in Late Cretaceous and/or early Cenozoic times (Holsinger and Longley, 1980; Bowman, 1982; Holsinger, 1986b). The inland, freshwater stygobiont members of these groups occur at present in areas that were once covered by shallow marine embayments. The distribution patterns of the new taxa fall well within areas previously subjected to Cretaceous embayments, and therefore offer further corroboration of the stranding theory.

The new locality for Artesia from Border Cave in Culberson County on the western fringe of the Great Plains, approximately 650 km west of the only other known locality for this genus in San Marcos (Fig. 11), is a significant range extension for this poorly understood stygobiont group. However, considering the great distance and potential dispersal barriers between these widely separate localities, the morphological similarity of A. subterranea from the artesian well in San Marcos and A. welbourni from Border Cave is surprising.

Border Cave is of further interest biogeographically for subterranean amphipods because it is inhabited by an undescribed species of the hubbsi group of Stygobromus. With one exception, this group is restricted to far western United States and southwestern Canada (Holsinger and Shaw, 1986). In the southwestern United States only one other species is recorded from southeastern Arizona, approximately 500 km to the west of Border Cave.

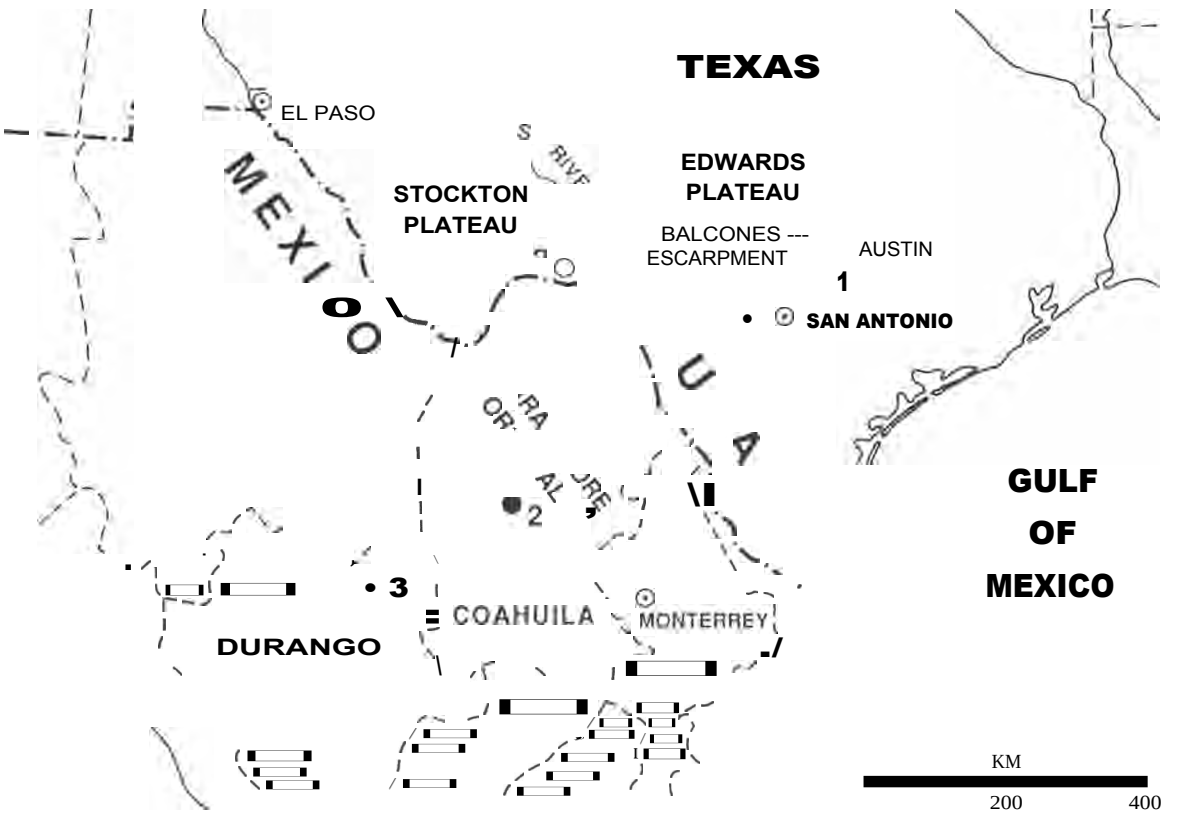

Fig. 12.—Geographic distribution of *Holsingerius* and *Mexiweckelia* in Texas and Mexico. Localities for *Holsingerius* indicated by open circles: 1, H. *samacos* (artesian well in San Marcos, Hays Co.); 2, H. *smaragdinus* (Emerald Sink, Val Verde Co.). Localities for *Mexiweckelia* indicated by closed circles: 1, M. *hardeni* (Hondo Creek hyporheic, Medina Co.); 2, M. *colei* (Bolsón de Cuatro Ciénegas, Coahuila); 3, M. *mitchelli* (Cueva de la Siquita, Durango).

Of biogeographic interest for the hadziid amphipods is the newly extended range of *Mexiweckeha* from Cuatro Ciénegas, Mexico northeastward across the Sierra Madre Oriental for approximately 400 km to Medina Co., Texas. The present distribution track of this genus (see Fig. 12) extends from northeastern Durango, Mexico to a point just southwest of San Antonio in Medina Co., Texas. This track overlaps the northern part of the distribution track of the stygobiont stenasellid isopod *Mexistenasellus* (see Bowman, 1982; 1992, this vol.). The congruence of these tracks can be interpreted to suggest that the evolutionary history of these two crustacean genera was influenced by the same factors.

The high number of characters shared by *M. colei* in Mexico and *M. hardeni* in Texas suggest that these taxa are probably sister-species with an immediate common ancestor. Paralleling the close phylogenetic relationship of the amphipods is the finding by Bowman (1992, in this vol.) that populations of the stygobiont isopod genus *Mexistenasellus* from the same localities as the amphipods are so similar that they apparently represent the same species. There is also significant overlap of this northern *Mexiweckelia-Mexistenasellus* track with the northern part of the range of the stygobiont cirolanid isopod *Speocirolana* (see also Bowman, 1992, this volume), offering further evidence for an important generalized crustacean track from north-central Mexico north and northeast into south-central Texas.

Also of interest for hadziids is *Holsingerius smaragdinus,* the second described species for this genus and the first record outside the artesian well in San Marcos. The new locality extends the range of the genus westward for approximately 350 km, from the Edwards Plateau across the Pecos Valley to the Stockton Plateau (Fig. 12). With respect to some of its mouthparts, *H. smaragdinus* appears to be intermediate between *Holsingerius* and *Mexiweckelia,* suggesting that these two genera are closely allied phylogenetically. This close relationship is strongly supported by a cladistic analysis (Holsinger, in prep.), which shows that *Mexiweckelia* and the several hadziid genera from the Edwards aquifer, including both *Holsingerius* and *Texiweckelia,* compose a nested subset of genera with a relatively recent common ancestry.

Finally, two new localities are noted for the rare, "dwarf" genus *Seborgia,* marking both significant range extensions and additional habitats for this group. The new locality for *S. relicta* in the hyporheic zone of Hondo Creek in Medina County is the first for this species outside the artesian well in San Marcos and extends the range of this species southwest for approximately 120 km (Fig. 11). It also documents the occurrence of this species from a shallow groundwater (hyporheic) habitat outside the deep phreatic waters of the Edwards Aquifer, per se.

Signifying an even greater range extension for this genus is the discovery of the closely similar species, *Seborgia hershleri,* from a spring in the Devils River gorge, approximately 250 km west of San Marcos (Fig. 11) and just west of the Uvalde pool of the Edwards Aquifer. The morphological similarities of *S. relicta* from Hays and Medina counties and *S. hershleri* from Val Verde County are striking, and the few differences noted between the two are conceivably within the limits of geographic variation. However, because nothing is presently known about variation in the few rare species of this genus, and because of the apparent geographic isolation of the populations, I have elected to treat the Val Verde populations as a separate species.

ACKNOWLEDGMENTS

I am deeply grateful to Scott J. Harden, Robert Hershler, W. Calvin Welbourn and others for collecting the material utilized in this study. These workers and James R. Reddell also provided me with critical information on localities and habitats. A final draft of the manuscript was improved by helpful comments from Thomas E. Bowman and Jan H. Stock. I also thank Jun Zhang for inking the drawings and helping with preparation of the figures, and the Publications and Graphics Services Office at Old Dominion University for preparation of the distribution map.

LITERATURE CITED

Barnard, J.L., and C.M. Barnard. 1983. Freshwater Amphipoda of the World (Parts I & II). Mt. Vernon, Virginia: Hayfield Associates. 830 pp.

Barnard, J.L., and G.S. Karaman. 1982. Classificatory revisions in Gammaridean Amphipods (Crustacea), part 2. Proc. Biol. Soc. Washington, 95(1):167-187.

Botosaneanu, L., and J.H. Stock. 1989. A remarkable new genus of cavernicolous Bogidiellidae (Crustacea, Amphipoda) from Thailand. Studies in honour of Dr. Pieter Wagenaar Hummelinck. Foundation for Scientific Research in Surinam and the Netherlands Antilles, Amsterdam, 123:171-184.

Bousfield, E.L. 1970. Terrestrial and aquatic amphipod Crustacea from Rennell Island. The Natural History of Rennell Island British Solomon Islands, 6:155-168.

Bowman, T.E. 1982. Three new stenasellid isopods from Mexico (Crustacea: Asellota). Assoc. Mexican Cave Stud. Bull., 8:25-38/Texas Mem. Mus. Bull., 28:25-38.

Bowman, T.E. 1992. Two subterranean aquatic isopod crustaceans new to Texas: *Mexistenasellus coahuila* (Cole and Minckley, 1972) (Asellota: Stenasellidae), and *Speocirolana hardeni,* new species (Flabellifera: Cirolanidae). Texas Mem. Mus., Speleol. Monogr., 3:21-

Hershler, R., and G. Longley. 1987. *Phreatodrobia coronae,* a new species of cavesnail from southwestern Texas. The Nautilus, 101(3):133-139.

Holsinger, J.R. 1973. Two new species of the subterranean amphipod genus *Mexiweckelia* (Gammaridae) from Mexico and Texas, with notes on the origin and distribution of the genus. Assoc. Mexican Cave Stud. Bull., 5:1-12.

Holsinger, J.R. 1986a. Amphipoda: Sebidae. Pp. 568-569 in: L. Botosaneanu, ed., Stygofauna Mundi. Leiden: Brill.

Holsinger, J.R. 1986b. Zoogeographic patterns of North American subterranean crustaceans. Pp. 85-106 in: R.D. Gore and K.L. Heck, eds., Crustacean Issues 4, Crustacean Biogeography. Rotterdam: A.A. Balkema.

Holsinger, J.R., and W.L. Minckley. 1971. A new genus and two new species of subterranean amphipod crustaceans (Gammaridae) from northern Mexico. Proc. Biol. Soc. Washington, 83(37):425-444.

Holsinger, J.R., and G. Longley. 1980. The subterranean amphipod crustacean fauna of an artesian well in Texas. Smithsonian Contr. Zool., 308:1-62.

Holsinger, J.R., and D.P. Shaw. 1986. A new stygobiont amphipod crustacean (Crangonyctidae, *Stygobromus*) from glaciated karst on Vancouver Island, Canada. Comm. 9th Internatl. Congr. Speleol., Barcelona, 2:98-101.

Karaman, G.S. 1982. Contribution to the knowledge of the Amphipoda 127. New freshwater subterranean genus *Relictoseborgia,* n. gen. with remarks to genus *Seborgia* Bousfield (Fam. Sebidae). Studia Marina, 11-12:85-94.

Kunath, CE., and A.R. Smith, eds. 1968. The caves of the Stockton Plateau Texas. Texas Speleol. Surv., 3(2):1-111.

Longley, G. 1981. The Edwards Aquifer: Earth's most diverse groundwater ecosystem. Internatl. J. Speleol., 2(1-2): 123-128.

Ruffo, S. 1983. Nuovi Anfipodi mesopsammici delle Isole Andamane (Crust. Amphipoda) (Studi sui Crostacei Anfipodi, XCVIII). Boll. Mus. Civ. St. Nat. Verona, 10:485-509.

This is publication No. N.S.-54 of the Texas Memorial Museum.