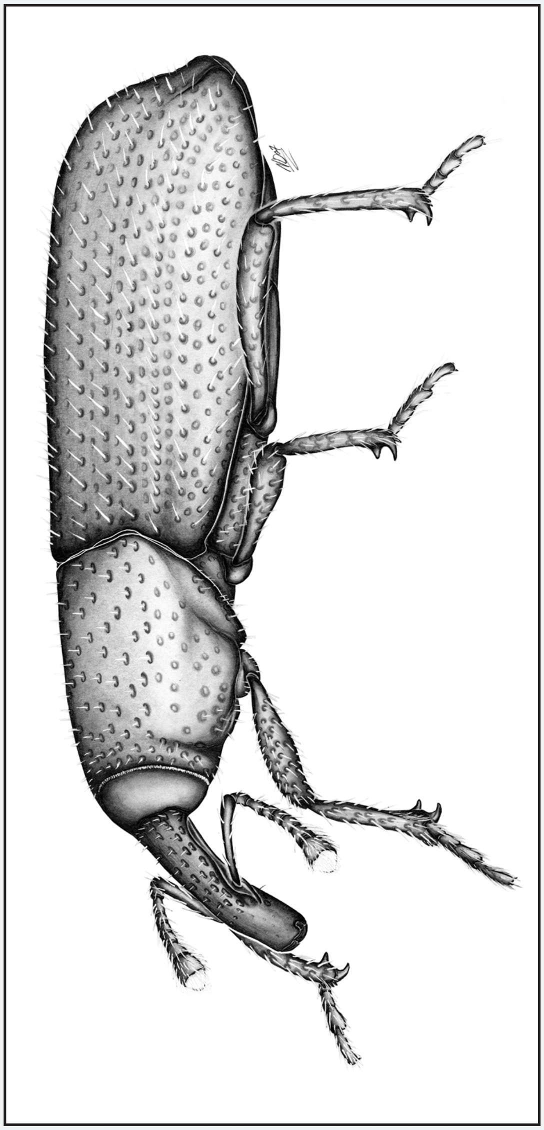
TEXAS MEMORIAL MUSEUM
Speleological Monographs, Number 7



Studies on the **CAVE AND ENDOGEAN FAUNA** of North America **Part V**

Edited by James C. Cokendolpher and James R. Reddell

TEXAS MEMORIAL MUSEUM
SPELEOLOGICAL MONOGRAPHS,
NUMBER 7

STUDIES ON THE CAVE AND ENDOGEAN FAUNA OF NORTH AMERICA, PART V

Edited by

James C. Cokendolpher

Invertebrate Zoology, Natural Science Research Laboratory
Museum of Texas Tech University, 3301 4th Street
Lubbock, Texas 79409 U.S.A.
Email: james.cokendolpher@ttu.edu

and

James R. Reddell

Texas Natural Science Center
The University of Texas at Austin, PRC 176, 10100 Burnet
Austin, Texas 78758 U.S.A.
Email: jreddell.caves@mail.utexas.edu

March 2009

TEXAS MEMORIAL MUSEUM and the TEXAS NATURAL SCIENCE CENTER
THE UNIVERSITY OF TEXAS AT AUSTIN, AUSTIN, TEXAS 78705

Printed in the United States of America

Cover, The first troglobitic weevil in North America, *Lymantes*
Illustration by Nadine Dupérré

Layout and design by James C. Cokendolpher
Printed by the Texas Natural Science Center, The University of Texas at Austin, Austin, Texas

PREFACE

This is the fifth volume in a series devoted to the cavernicole and endogean fauna of the Americas. Previous volumes have been limited to North and Central America. Most of the species described herein are from Texas and Mexico, but one new troglophilic spider is from Colorado (U.S.A.) and a remarkable new eyeless endogean scorpion is described from Colombia, South America.

The second known species of the scorpion family Troglotayosicidae is described from leaf litter in Colombia, South America. The only other species in the family is from Cueva de Los Tayos, Ecuador.

Recent explorations in the caves of Mexico by American and Mexican speleologists have resulted in the discovery of a new species of vaejovid scorpion from northern Mexico, a new species of the schizomid genus *Agastoschizomus* from Guerrero, a new species of the pholcid genus *Modisimus* from Chiapas, the first male of the troglobitic pseudoscorpion genus *Typhloroncus*, and new species of nicoletiid silverfish from Nuevo León and Coahuila.

The cave scorpions of Mexico and the U.S.A. are reviewed with new records for several species, including many records for the Texas troglophile *Pseudouroctonus reddelli.*

A new species of the linyphiid spider genus *Agyneta* is described from a cave in Colorado and all records are given for the widespread Texas troglophile *Agyneta llanoensis* (including surface and cave collections from other states). A study of the silverfish genus *Texoreddellia* utilizing morphological and genetic characters includes descriptions of four new species from Texas and one from Coahuila, Mexico. A new species of the carabid beetle genus *Rhadine* is described from Hays County, Texas, an area undergoing rapid urbanization. A new species of the weevil genus *Lymantes* is described from three caves in Travis and Williamson Counties. This is the first troglobitic species of the family Curculionidae in the U.S.A. A review of the cavernicole ant fauna of Texas includes new records for many species and observations on the use of caves by *Labidus coecus.*

Continuing studies of the cave fauna of Camp Bullis and Fort Hood have resulted in the discovery of several new species and important records of others. The second troglobitic species from Texas of the pseudoscorpion genus *Tyrannochthonius* is described from one cave on Fort Hood. A third contribution on the Pselaphinae of Texas caves includes numerous new records, including one new troglobite from Camp Bullis and four from Fort Hood. Many new records of the Fort Hood endemic millipede *Speodesmus castellanus* are given. Studies of the fauna of caves and springs on Fort Hood have resulted in the discovery of new records for two stygobitic species and the first Fort Hood record for a third species.

We express our deepest appreciation to the numerous cave explorers who have provided specimens and assisted in the field. Our knowledge of the cave fauna of Texas and Mexico would be far less without their help. Jean Krejca and Peter Sprouse contributed much of the material from Texas and Mexico included in this volume. Jerry Fant, Charles Pekins, Marcelino Reyes, and Mike Warton are largely responsible for specimens obtained on Fort Hood.

We thank the authors of the papers in this volume for their contributions. Their taxonomic efforts will be invaluable in the understanding and conservation of the cave fauna of Texas and Mexico.

The contributions in this volume have been much improved by the meticulous reviews of Monika Baker, Thomas C. Barr, Jr., Donald J. Buckle, Darence Ca Thong, Chris Carlton, Donald S. Chandler, James C. Cokendolpher, Oscar F. Francke, Abel Pérez González, Mark S. Harvey, Bernard Huber, Marshal C. Hedin, Joe MacGown, William P. MacKay, Luis Mendez, Pierre Paquin, Norman I. Platnick, Stewart B. Peck, Lorenzo Prendini, James R. Reddell, Edward G. Riley, W. David Sissom, Graeme Smith, Darrell Ubick, and Juan A. Zaragoza. Oscar F. Francke, Alejandro Valdez Mondragón, Tania López Palafox and Nicté Ordóñez-Garza corrected and in some case rewrote the Spanish throughout the volume. ¡Muchas gracias to all of them!

Much of the funding for studies on Fort Hood and publication of this volume was provided by the Texas Nature Conservancy. Funding for studies on Camp Bullis was provided by the U.S. Army.

PREFACIO

Éste es el quinto volumen en una serie dedicada a la fauna cavernícola y endógea de las Américas. Los volúmenes anteriores se han limitado a Norte y América Central. La mayor parte de las especies descritas aquí son de Texas y de México, pero una nueva araña troglófila es de Colorado (E.U.) y un nuevo escorpión ciego endógeo se describe de Colombia, Sudamérica.

La segunda especie conocida de la familia de escorpiones Troglotayosicidae se describe de un ejemplar colectado en hojarasca en Colombia. La otra especie de esta familia es de la Cueva de los Tayos, Ecuador.

Las exploraciones recientes en las cuevas de México por espeleólogos norteamericanos y mexicanos han dado lugar al descubrimiento de una nueva especie de escorpión de la familia Vaejovidae del norte de México; una nueva especie de esquizómido del género *Agastoschizomus* de Guerrero; una nueva especie de araña de la familia Pholcidae del género *Modisimus* de Chiapas; el primer macho de pseudoescorpiones del género troglobio *Typhloroncus*, y una nueva especie de pescadito de plata de la familia Nicoletiidae de Nuevo León y Coahuila.

Se actualizan con nuevos registros para varias especies los escorpiones de las cuevas de México y de los E.U., incluyendo muchos registros para el escorpión troglófilo de Texas *Pseudouroctonus reddelli*.

Se describe una nueva especie de araña de la familia Linyphiidae del género *Agyneta* de una cueva en Colorado, E.U., y se dan todos los registros para la especie troglófila de amplia distribución en Texas, *Agyneta llanoensis* (incluyendo las colecciones de ejemplares epigeos y de cuevas en otros estados). Un trabajo que utiliza caracteres morfológicos y genéticos del género *Texoreddellia* de pescaditos de plata, incluye la descripción de cuatro nuevas especies de Texas, E.U. y una de Coahuila, México. Se describe una nueva especie de escarabajo de la familia Carabidae del género *Rhadine* del condado Hays, Texas, un área con urbanización acelerada. Se describe una nueva especie de gorgojo del género *Lymantes* procedente de tres cuevas en los condados de Travis y Williamson; esta es la primera especie troglobia de la familia Curculionidae en los E.U. Una revisión de la fauna de hormigas cavernícolas de Texas incluye nuevos registros para muchas especies y observaciones respecto al uso de cuevas por las especies *Labidus coecus* y *Solenopsis invicta*.

Los continuos estudios de la fauna de la cueva de Camp Bullis y Fort Hood han dado lugar al descubrimiento de varias nuevas especies y registros importantes de otras especies. Se describe la segunda especie troglobia de pseudoescorpion del género *Tyrannochthonius* de una cueva en Fort Hood, Texas. Una tercera contribución sobre la subfamilia Pselaphinae de las cuevas de Texas incluye varios nuevos registros, incluyendo una nueva especie troglobia de Camp Bullis y cuatro Fort Hood. Se presentan varios nuevos registros del milpiés endémico, *Speodesmus castellanus* de Fort Hood. Los estudios de la fauna de cuevas y de manantiales en Fort Hood han generado nuevos registros para dos especies estigobiontes y el primer registro de una tercera especie en Fort Hood.

Expresamos nuestro más profundo aprecio a los numerosos exploradores de cuevas que han colectado especimenes y han asistido en el trabajo de campo. Nuestro conocimiento de la fauna de cuevas de Texas y de México sería menor sin su valiosa ayuda. Jean Krejca y Peter Sprouse proporcionaron la mayoría de los ejemplares de Texas y de México incluidos en este volumen. Jerry Fant, Charles Pekins, Marcelino Reyes, y Mike Warton son en gran parte responsables de los especimenes obtenidos en Fort Hood.

Agradecemos a los autores de los trabajos en este volumen por sus contribuciones. Sus esfuerzos taxonómicos son fundamentales para el conocimiento y conservación de la fauna de cuevas de Texas y de México.

Los trabajos presentados en este volumen han sido mejorados por las meticulosas revisiones de Monika Baker, Thomas C. Barr, Jr., Donald J. Buckle, Darence Ca Thong, Chris Carlton, Donald S. Chandler, James C. Cokendolpher, Oscar F. Francke, Abel Pérez González, Mark S. Harvey, Bernhard Huber, Marshal C. Hedin, Joe MacGown, William P. MacKay, Luis Mendez, Pierre Paquin, Stewart B. Peck, Norman I. Platnick, Lorenzo Prendini, James R. Reddell, Edward G.. Riley, W. David Sissom, Graeme Smith, Darrell Ubick, y Juan A. Zaragoza. Oscar F. Francke, Alejandro Valdez Mondragón, Tania López Palafox y Nicté Ordóñez-Garza corrigieron y en algunos casos reescribieron al español partes de los trabajos de este volumen. ¡Muchas gracias a todos!

Gran parte del financiamiento para los estudios en Fort Hood y la publicación de este volumen fue proporcionado por la Texas Nature Conservancy. El financiamiento para los estudios en Camp Bullis fue proporcionado por el U.S. Army.

TABLE OF CONTENTS - ÍNDICE DE CONTENIDOS

BOTERO-TRUJILLO, RICARDO, and OSCAR F. FRANCKE. A new species of troglomorphic leaf litter scorpion from Colombia belonging to the genus *Troglotayosicus* (Scorpiones, Troglotayosicidae) [Nueva especie de escorpión troglomórfico de hojarasca de Colombia perteneciente al género *Troglotayosicus* (Scorpiones: Troglotayosicidae)] 1

FRANCKE, OSCAR F. Description of a new species of troglophile *Pseudouroctonus* (Scorpiones: Vaejovidae) from Coahuila, Mexico [Descripción de una nueva especie de *Pseudouroctonus* troglófilo (Scorpiones: Vaejovidae) de Coahuila, México] 11

REDDELL, JAMES R., and W. DAVID SISSOM. Cave scorpions of Mexico and the United States [Escorpiones de cuevas de México y Estados Unidos] 19

MONTAÑO MORENO, HECTOR, and OSCAR F. FRANCKE. A new species of *Agastoschizomus* (Schizomida: Protoschizomidae) from Guerrero, Mexico [Nueva especie de *Agastoschizomus* (Schizomida: Protoschizomidae) de Guerrero, México] 33

DUPÉRRÉ, NADINE, PIERRE PAQUIN, and JAMES R. REDDELL. A new troglophilic *Agyneta* from Colorado, the female of *Agyneta llanoensis* from Texas, and a first classification of North American Linyphiidae as troglobites or troglophiles [Una nueva *Agyneta* troglófila de Colorado, la hembra de *Agyneta llanoensis* de Texas, y una primera clasificación de Linyphiidae norteamericanos como troglobios o troglófilos] 37

VALDEZ-MONDRAGON, ALEJANDRO, and OSCAR F. FRANCKE. A new species of *Modisimus* (Araneae: Pholcidae) from Chiapas, Mexico [Nueva especie de *Modisimus* (Araneae: Pholcidae) de Chiapas, México]....... 57

VILLEGAS-GUZMAN, GABRIEL A., and OSCAR F. FRANCKE. Description of the male of the genus *Typhloroncus* Muchmore, 1979 (Pseudoscorpiones: Ideoroncidae) [Descripción del macho del género *Typhloroncus* Muchmore, 1979 (Pseudoscorpiones: Ideoroncidae)] 63

COKENDOLPHER, JAMES C. New troglobitic *Tyrannochthonius* from Fort Hood, Texas (Pseudoscorpionida: Chthoniidae) [Un nuevo *Tyrannochthonius* troglobio de Fort Hood, Texas (Pseudoscorpionida: Chthoniidae)] 67

ESPINASA, LUIS, and YEVGENIYA BOYKO. A new troglobitic species of *Anelpistina* (Hexapoda: Zygentoma: Nicoletiidae) from northern Mexico [Nueva especie troglobia de *Anelpistina* (Hexapoda: Zygentoma: Nicoletiidae) del norte de México].. 79

ESPINASA, LUIS, and GONZALO GIRIBET. Living in the dark—species delimitation based on combined molecular and morphological evidence in the nicoletiid genus *Texoreddellia* Wygodzinsky, 1973 (Hexapoda, Zygentoma, Nicoletiidae) in Texas and Mexico [Viviendo en la obscuridad—delimitación de especies basada en evidencia combinada molecular y morfológica en el género nicoletiido *Texoreddellia* Wygodzinsky, 1973 (Hexapoda, Zygentoma, Nicoletiidae) en Texas y México].. 87

REDDELL, JAMES R., and NADINE DUPÉRRÉ. A new species of troglobitic *Rhadine* (Coleoptera: Carabidae) from Hays County, Texas [Nueva especie troglobia de *Rhadine* (Coleoptera: Carabidae) del condado Hays, Texas] 111

PAQUIN, PIERRE, and ROBERT S. ANDERSON. First troglobitic weevil (Coleoptera: Curculionidae) in North America? Description of a new eyeless species of *Lymantes* Schoenherr from Central Texas caves. [¿Primer gorgojo troglobio (Coleoptera: Curculionidae) en Norteamérica? Descripción de una nueva especie ciega de *Lymantes* Schoenherr de cuevas del centro de Texas]..115

CHANDLER, DONALD S., JAMES R. REDDELL, and PIERRE PAQUIN. New cave Pselaphinae and records from Texas with a discussion of the relationships and distributions of the Texas troglobitic Pselaphinae (Coleoptera: Staphylinidae: Pselaphinae). [Nuevos Pselaphinae de cuevas y registros de Texas, con una discusión de las relaciones y distribuciones de Pselaphinae troglobios de Texas (Coleoptera: Staphylinidae: Pselaphinae)] 125

HOLSINGER, JOHN R., and JAMES R. REDDELL. Amphipoda from caves and springs on Fort Hood, Bell and Coryell Counties, Texas [Amphipoda de cuevas y manantiales en los condados de Fort Hood, Bell y Coryell, Texas] 141

ELLIOTT, WILLIAM R., and JAMES R. REDDELL. New records of *Speodesmus* (Diplopoda: Polydesmida: Polydesmidae) from Fort Hood, Bell and Coryell Counties, Texas [Nuevos registros de *Speodesmus* (Diplopoda: Polydesmida: Polydesmidae) de los condados Fort Hood, Bell y Coryell, Texas] 147

.

COKENDOLPHER, JAMES C., JAMES R. REDDELL, STEVEN J. TAYLOR, JEAN K. KREJCA, ANDREW V. SUAREZ, and CHARLES E. PEKINS. Further ants (Hymenoptera: Formicidae) from caves of Texas [Hormigas (Hymenoptera: Formicidae) adicionales de cuevas de Texas] 151

INDEX OF NEW TAXA - ÍNDICE DE NUEVOS TAXA 169

Botero-Trujillo, Ricardo, and Oscar F. Francke. 2009. A new species of troglomorphic leaf litter scorpion from Colombia belonging to the genus *Troglotayosicus* (Scorpiones: Troglotayosicidae) [Nueva especie de escorpión troglomórfico de hojarasca de Colombia perteneciente al género *Troglotayosicus* (Scorpiones: Troglotayosicidae)]. Texas Memorial Museum Speleological Monographs, 7. Studies on the cave and endogean fauna of North America, V. Pp. 1-10.

A NEW SPECIES OF TROGLOMORPHIC LEAF LITTER SCORPION FROM COLOMBIA BELONGING TO THE GENUS *TROGLOTAYOSICUS* (SCORPIONES: TROGLOTAYOSICIDAE)

Ricardo Botero-Trujillo

Laboratorio de Entomología, Unidad de Ecología y Sistemática,
Departamento de Biología,
Pontificia Universidad Javeriana,
Bogotá, Colombia.
Email: pachyurus@yahoo.com

and

Oscar F. Francke

Colección Nacional de Arácnidos,
Departamento de Zoología,
Instituto de Biología,
Universidad Nacional Autónoma de México,
Apartado Postal 70-153,
México D. F. 04510, México.
Email: offb@ibiologia.unam.mx

ABSTRACT

Troglotayosicus humiculum, n. sp., is described from a specimen collected by Winkler trap in La Planada Natural Reserve, Nariño Department, southwestern Colombia. With this description, both the number of described species and known specimens in the genus is raised to two. The new species was collected from leaf litter, rather than inside a cave as was the only other known species, *Troglotayosicus vachoni* Lourenço, 1981; and differs from it particularly in the arrangement of the ventral setae of the telotarsi and the metasomal carination. This finding represents the first record of the family and genus from Colombia, and it is the first troglomorphic leaf litter scorpion reported from South America.

RESUMEN

Se describe *Troglotayosicus humiculum*, n. sp., con base a un ejemplar colectado con trampa Winkler en la Reserva Natural La Planada, Departamento de Nariño, Colombia suroccidental. Con esta descripción, el número de especies descritas y ejemplares conocidos en el género se incrementa a dos. La nueva especie habita en hojarasca, en lugar de una cueva como la única otra especie conocida, *Troglotayosicus vachoni* Lourenço, 1981; y difiere de esta particularmente en la disposición de sedas ventrales de los telotarsos y la carinación del metasoma. Este hallazgo representa el primer registro de esta familia y género de escorpiones para Colombia, y es el primer escorpión troglomórfico de hojarasca conocido de Suramérica.

INTRODUCTION

Recording scorpions from caves is a relatively frequent phenomenon, but troglobite scorpions are very rarely found. Troglobites are not the only ones exhibiting troglomorphies such as the loss or reduction of eyes, depigmentation, and appendage attenuation, since there are troglomorphs that occur outside caves, i.e., among leaf litter in montane forests. There are four known non-cavernicolous scorpion species with pronounced troglomorphies, *Belisarius xambeui* Simon, 1879 from the Pyrenees of France and Spain; *Typhlochactas mitchelli* Sissom, 1988 and *Typhlochactas sylvestris* Mitchell and Peck, 1977 from the Mexican State of Oaxaca; and *Typhlochactas sissomi* Francke, Vignoli and Prendini (in press) from the State of Querétaro, also in Mexico (Mitchell and Peck, 1977; Sissom, 1988; Volschenk and Prendini, 2008; Francke, et al., in press; Vignoli and Prendini, in press).

The concepts of cavernicolous, troglobitic and troglomorphic scorpions were recently revised and discussed by Volschenk and Prendini (2008), according to whom there are 21 unequivocally recognizable troglobitic scorpions. Two troglobitic scorpion genera, each with a single species, have been described from South America: *Troglorhopalurus* Lourenço, Baptista and Giupponi, 2004 from Brazil; and *Troglotayosicus* Lourenço, 1981 from Ecuador (Lourenço, 1981; Lourenço, et al., 2004). The latter genus has been the subject of different opinions regarding its phylogenetic placement, having been repeatedly transferred among the families Chactidae Pocock, 1893, Superstitioniidae Stahnke, 1940 and Troglotayosicidae Lourenço, 1998 (Lourenço, 1981, 1998; Lourenço and Francke, 1985; Stockwell, 1989; Sissom, 1990; Fet and Sissom, 2000; Soleglad and Fet, 2003; Coddington, et al., 2004; Fet and Soleglad, 2005; Prendini and Wheeler, 2005; Volschenk and Prendini, 2008). Indeed, it was recently

Figs. 1–2.—Holotype of *Troglotayosicus humiculum*, n. sp. 1. Dorsal view. 2. Ventral view. Scale bar = 3 mm.

suggested that it should be considered *incertae sedis* (Lourenço, 2006). The classification followed in the present paper is that accepted by Prendini and Wheeler (2005).

Troglotayosicus was created by Lourenço (1981) for the species *Troglotayosicus vachoni* Lourenço, 1981, known from a single female collected in the cave of Los Tayos, Ecuador. This genus has remained monotypic and no other specimens have been found, thus being a remarkably rare and poorly known genus. Even though *Troglotayosicus* may have been thought to have evolved after long-time isolation in that cave, a specimen recently found from leaf litter in Colombia is clearly recognized as a member of this genus. The specimen was found through the examination of several arthropod samples obtained from a permanent plot in La Planada Natural Reserve, southwestern Colombia (Map 1). The specimen, unequivocally a new species, is described herein.

METHODS

The specimen is currently preserved in 70% ethanol, and the internal organs are quite dehydrated (rendering dissections inappropriate). Terminology follows Stahnke (1970), except for metasomal carinae after Francke (1977) and trichobothrial terminology after Vachon (1973). Measurements were obtained following the methodology of Sissom, et al. (1990) with an ocular micrometer calibrated at 30X with a Nikon SMZ 800 stereomicroscope. Illustrations were prepared with the aid of a camera lucida with the same stereomicroscope. The distribution map was produced with the program ArcView GIS version 3.2. [Environmental Systems Research Institute (ESRI), Redlands, California].

TAXONOMY

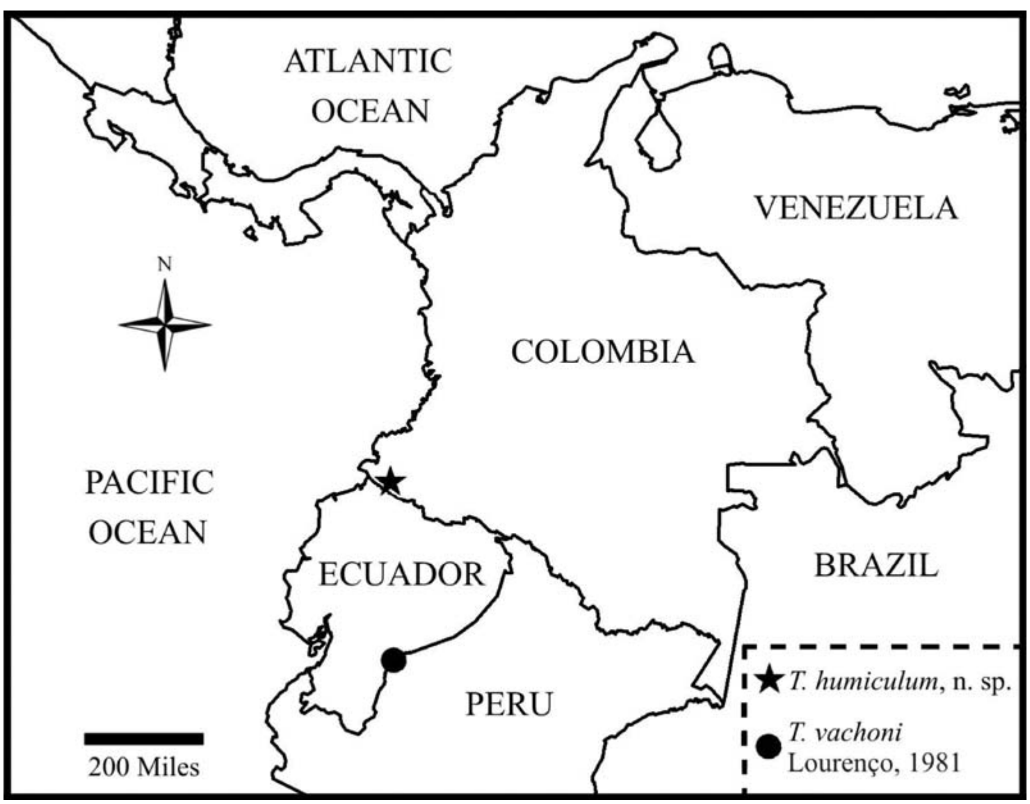
Family Troglotayosicidae Lourenço, 1998
Genus *Troglotayosicus* Lourenço, 1981

Troglotayosicus humiculum, new species
Map 1; Figs. 1–24; Table 1

Type data.—Holotype male from La Planada Natural Reserve, permanent plot at 01°15'N 78°15'W, 1885 m elevation, Nariño Department, Colombia, Winkler trap, 16–20 May 2000, col. G. Oliva. Deposited in the Instituto de Investigación de Recursos Biológicos Alexander Von Humboldt, Villa de Leyva, Colombia (IAvH-E 100809). No additional specimens are known.

Distribution.—Known only from the type locality (Map 1).

Diagnosis.—*Troglotayosicus humiculum*, n. sp., differs from the only other species described in the genus, *T. vachoni*, by the following: i) the setae on the telotarsus



Map 1.—Known distribution of the genus *Troglotayosicus*.

of all legs are arranged in two longitudinal rows (Fig. 24); ii) the anterior margin of the carapace is very slightly convex (Fig. 3); iii) lateral ocular areas have three ocelli each (Fig. 3); and iv) metasomal segments I–IV have six carinae with ventral submedian and ventral lateral carinae completely absent (Figs. 7–9). In contrast, in *T. vachoni* the setae on the telotarsi are not arranged in rows (see Lourenço, 1981: fig. 43), the anterior margin of the carapace is markedly convex (see Lourenço, 1981: figs. 37, 40), lateral ocular areas have two ocelli each (see Lourenço, 1981: fig. 40), and metasomal segments I–IV have eight carinae with only the ventral submedian carinae absent (Lourenço, 1981) (see "Remarks" for further comments on the metasomal carination of *T. vachoni*).

Description of the holotype.—*Color*: Entire body and appendages yellow to orange and immaculate. Carapace orange with an ovoid yellowish median region and each lateral ocellus (except for the tiny medio-external one) surrounded by black pigment. Tergites orange throughout. Coxosternal region predominantly orange with some diffuse yellowish areas; sternum predominantly yellow. Genital operculum, pectinal basal piece, pectines and sternites III–V completely yellow; sternites VI and VII orange medially and entirely, respectively. Metasomal segments orange; segment V lighter than the preceding; telson vesicle yellowish. Chelicerae yellow, teeth orange. Pedipalps uniformly orange throughout. Legs yellowish, each turning lighter distally.

Carapace. Smooth, with a shallow median longitudinal furrow; other furrows and carinae absent; anterior margin with three pairs of setae; anterior and posterior margins very slightly convex; lateral margins not parallel (carapace narrowing anteriorly); median eyes completely absent; lateral ocular tubercles each with three ocelli, anteriormost greater in size, the posterior of medium size, and the medio-external very small (Fig. 3).

Tergites. With very few small setae; I–VI completely smooth and acarinate; VII also without any vestige of median or submedian carinae but with two/three conspicuous granules located posteriorly on the position of the lateral carinae.

Coxosternal region. Smooth and with very few small setae; sternum subpentagonal, almost flat with very shallow median depression posteriorly, wider than long and with posterior margin concave (Fig. 4).

Genital operculum and pectines. Genital operculum divided longitudinally, formed by small subtriangular plates; pectinal basal piece wider than long, notched anteriorly, posterior margin slightly convex (Fig. 4). Pectines as long as coxae IV, with few setae, devoid of fulcra; with 7 thick teeth each, of which the distal one is markedly rounded; marginal lamellae symmetrical, with 3:3 pieces; middle lamellae asymmetrical, with 1:2 (right:left) pieces (Fig. 4).

Sternites. Smooth and shiny; with few setae especially on the posterior and lateral margins; without any vestige of submedian or lateral carinae; spiracles small and rounded (Fig. 4); sternite V posterior margin with a broad white inverted V-shaped patch.

Metasoma. With few setae; segments I–IV with complete dorsal lateral and lateral supramedian carinae formed by conspicuous aligned granules; lateral inframedian carinae only present posteriorly, represented by two to four granules; ventral lateral and ventral submedian carinae completely absent (Figs. 7–9); dorsal lateral carinae elevated and converging distally (Fig. 7); lateral supramedian carinae parallel to the longitudinal axis of the metasoma (Fig. 8); lateral inframedian cari-

Table 1.—Meristic data for *Troglotayosicus humiculum*, n. sp., holotype male. Measurements in millimeters. [1]Sum of prosoma, mesosoma and metasoma. [2]Sum of tergites I–VII. [3]Sum of metasomal segments I–V and telson. [4]Sum of femur, patella and chela. [5]Measured from the commissure of the junction with the movable finger to the finger tip.

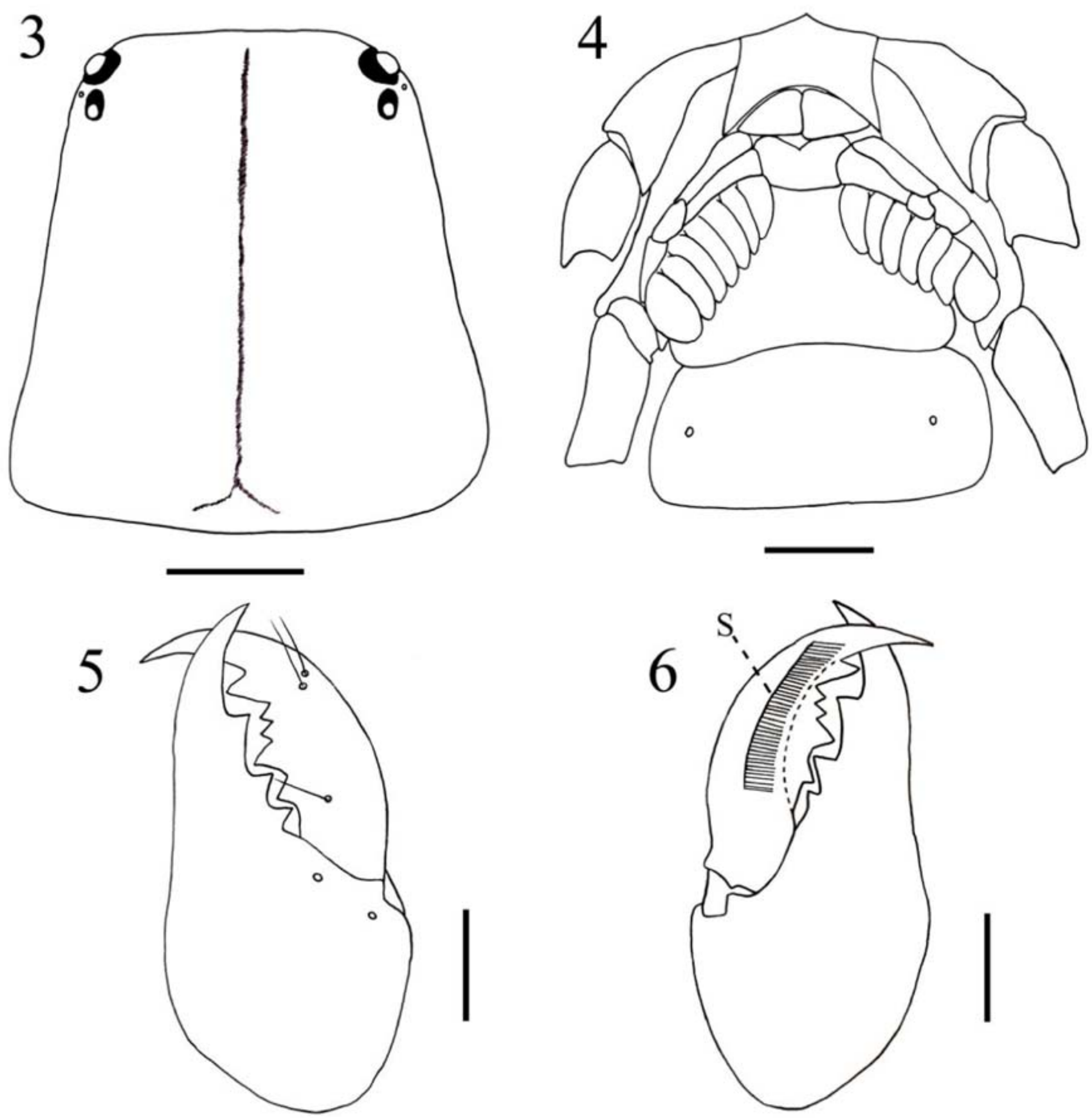
Body:[1]	total length:	1.90
Carapace:	length:	1.83
	anterior width:	1.00
	posterior width:	1.77
Mesosoma:	total length:[2]	3.20
Metasoma:	total length:[3]	6.97
Metasomal segment I:	length:	0.67
	width:	1.27
	depth:	1.00
Metasomal segment II:	length:	0.70
	width:	1.17
	depth:	0.97
Metasomal segment III:	length:	0.80
	width:	1.17
	depth:	0.97
Metasomal segment IV:	length:	1.13
	width:	1.17
	depth:	1.00
Metasomal segment V:	length:	1.90
	width:	1.17
	depth:	0.93
Telson:	length:	1.77
	vesicle width:	0.83
	vesicle depth:	0.60
Pedipalp:	total length:[4]	5.90
Pedipalp femur:	length:	1.40
	width:	0.47
	depth:	0.54
Pedipalp patella:	length:	1.77
	width:	0.57
	depth:	0.57
Pedipalp chela:	length:	2.73
	width:	0.63
	depth:	0.73
	fixed finger length:[5]	1.20
	movable finger length:	1.50
	palm length:	1.33
Pectines:	teeth count (left/right):	7/7

nae obliquely inclined (Fig. 8); intercarinal spaces of segments I–IV smooth; segment V with only the dorsal lateral carinae present, complete and granulose, with strong granules on the ventral surface and a deep dorsal depression (Figs. 7–9). Telson smooth dorsally (Fig. 10); vesicle sparsely granular with two longitudinal ventral submedian smooth areas (Figs. 11–12); subaculear tubercle completely absent; aculeus short, slightly curved, thick basally, and lacking laterobasal aculear serrations (Figs. 10–12).

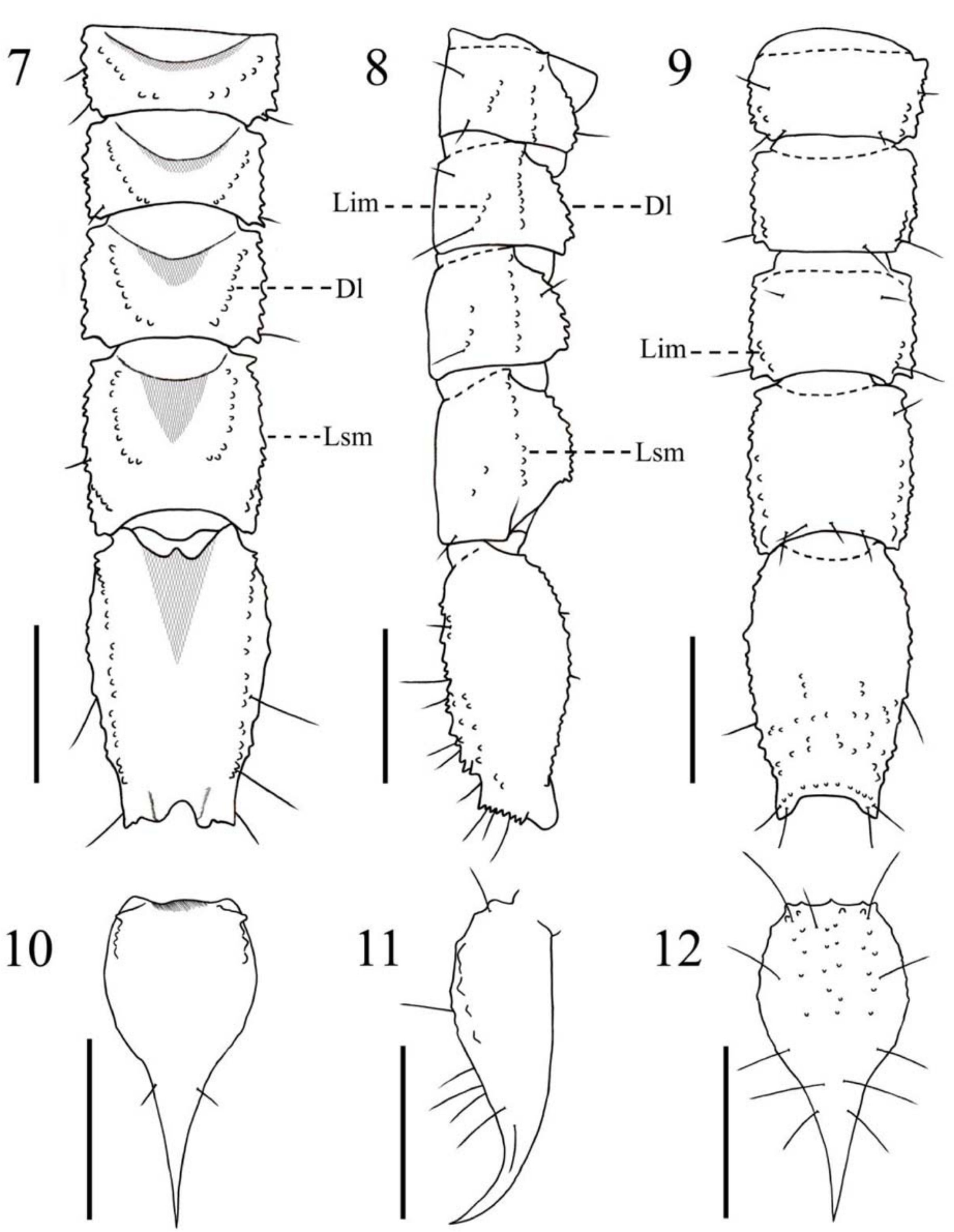
Chelicerae. With long transparent setae on the internal and ventral surfaces. Movable finger dorsally with one basal tooth, one sub-basal pronounced, two subdistal small, and one distal tooth (Fig. 5); ventrally without teeth and with well developed serrula (Fig. 6). Fixed finger dorsally with one basal and one median tooth not forming a bicuspid, one subdistal, and one distal tooth (Fig. 5); ventrally without teeth.

Pedipalps. Femur with few setae, smooth, and without clearly defined carinae (Fig. 17); patella with few setae, acarinate (Figs. 18–20), and with very few and inconspicuous granules internally; chela acarinate, with abundant setae on the fingers (Figs. 13–16); both movable and fixed fingers of both pedipalps with a well developed terminal hook and 7/6 very slightly imbricate rows of granules, respectively (Figs. 13–16, 21, 22).

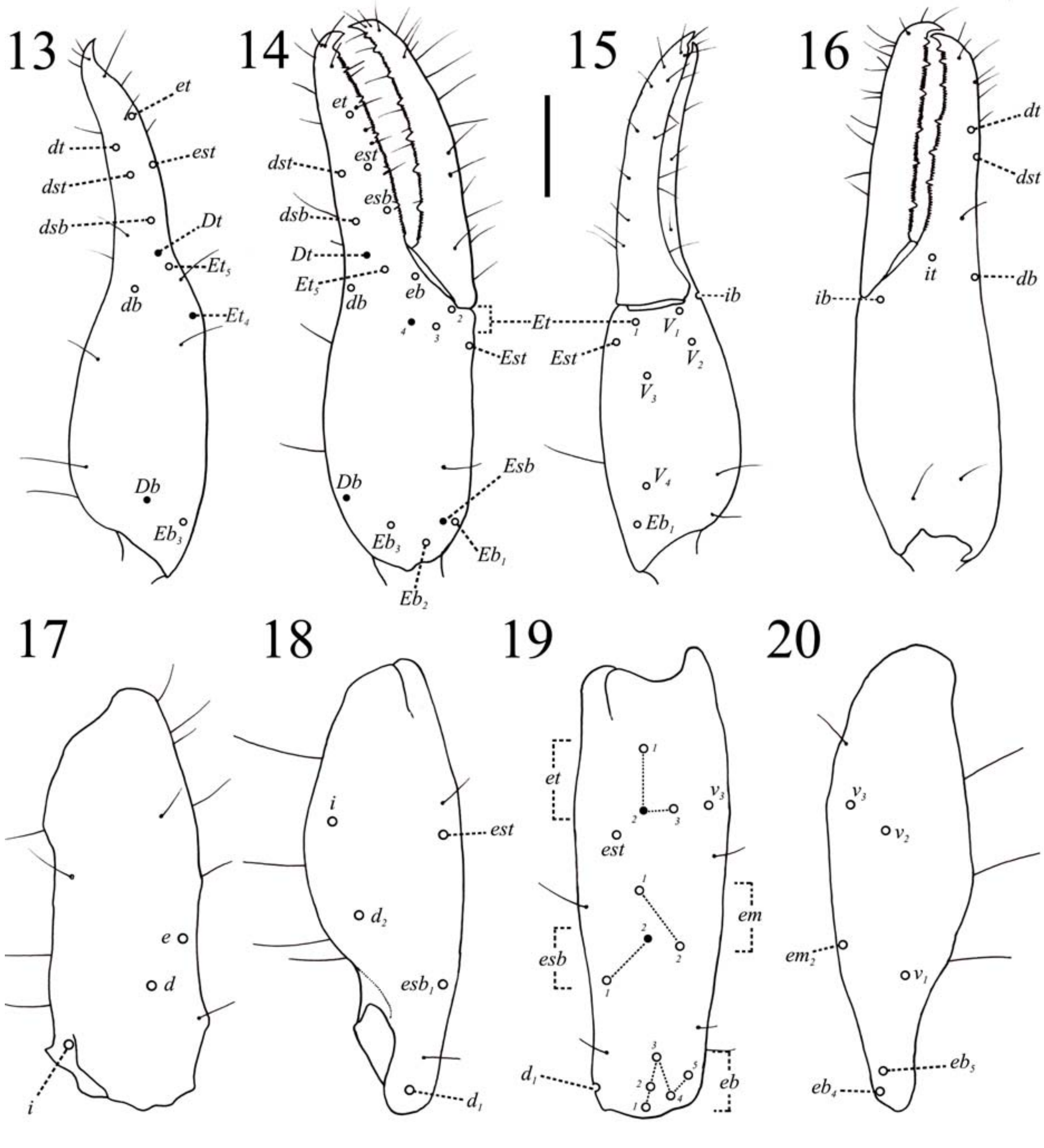
Trichobothria. Orthobothriotaxic C pattern



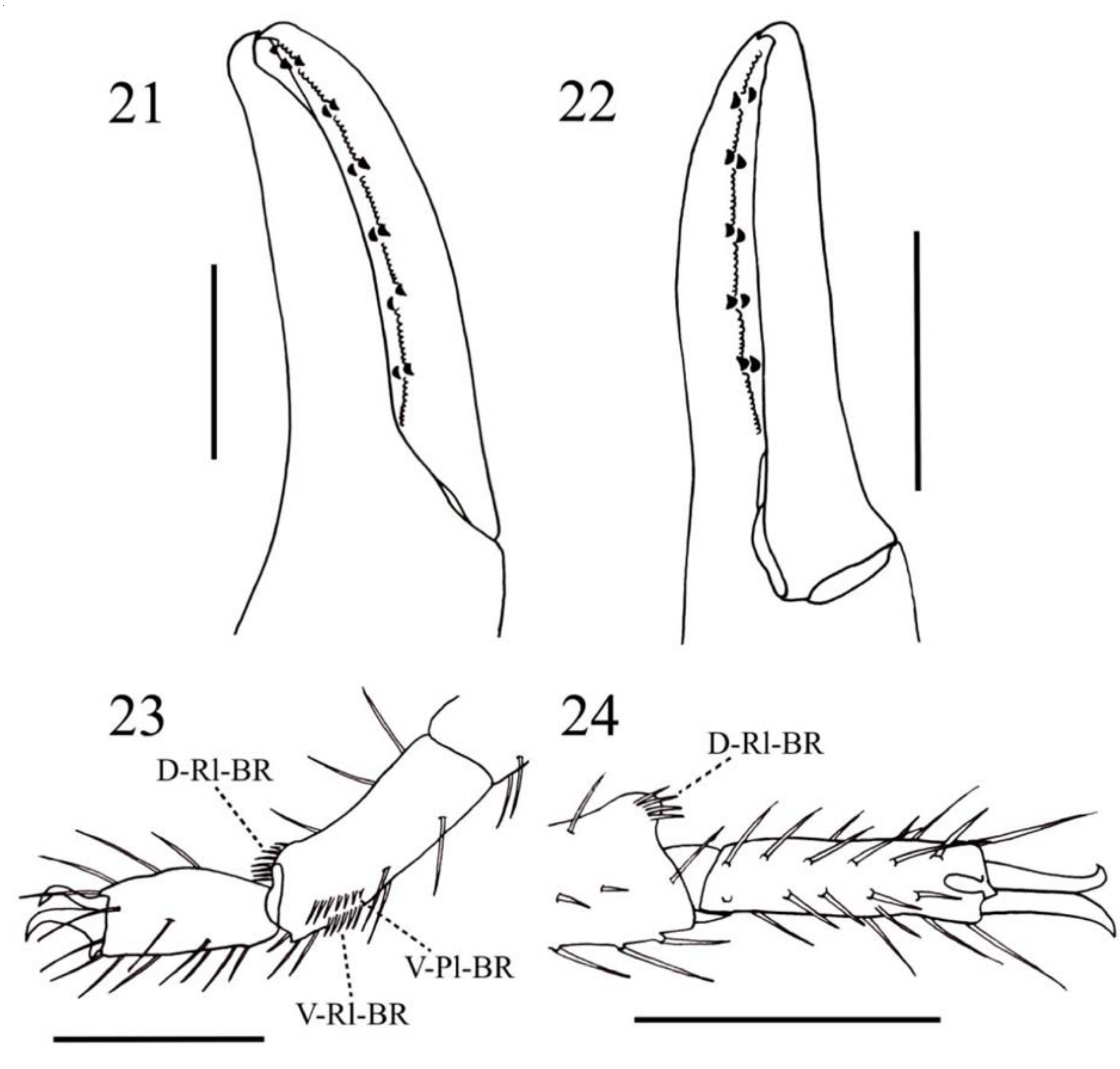
Figs. 3–6.—Holotype of *Troglotayosicus humiculum*, n. sp. 3. Carapace. 4. Sternum, pectinal basal piece, pectines and sternites III–IV. 5. Right chelicera, dorsal view. 6. Right chelicera, ventral view. S = Serrula. Scale bars = 0.5 mm (Figs. 3–4); 0.25 mm (Figs. 5–6).



Figs. 7–12.—Holotype of *Troglotayosicus humiculum*, n. sp. 7–9. Metasomal segments I–V. 7. Dorsal view. 8. Lateral view. 9. Ventral view. 10–12. Telson. 10. Dorsal view. 11. Lateral view. 12. Ventral view. Dl = Dorsolateral carina; Lsm = Lateral supramedian carina; Lim = Lateral inframedian carina. Scale bars = 1 mm.



Figs. 13–20.—Holotype of *Troglotayosicus humiculum*, n. sp., distribution of the trichobothria; colored trichobothria are petite. 13. Chela, dorsal view. 14. Chela, external view. 15. Chela, ventral view. 16. Chela, internal view. 17. Femur, dorsal view. 18. Patella, dorsal view. 19. Patella, external view. 20. Patella, ventral view. Scale bars = 0.5 mm.



Figs. 21–24.—Holotype of *Troglotayosicus humiculum*, n. sp. 21. Granulation on the internal surface of movable finger. 22. Idem for fixed finger. 23. Basitarsus and telotarsus of right leg II, prolateral view. 24. Basitarsus and telotarsus of right leg III, ventral view. D-Rl-BR = Dorsal Retrolateral Brush; V-Pl-BR = Ventral Prolateral Brush; V-Rl-BR = Ventral Retrolateral Brush. Scale bars = 0.5 mm

(Vachon, 1973) (Figs. 13–20). Total number of trichobothria per pedipalp, 48: Femur with 3 (1 *d*, 1 *i*, 1 *e*), patella with 19 (2 *d*, 1 *i*, 13 *e*, 3 *v*) of which esb_2 and et_2 are petite (Fig. 19), chela with 26 (2 *D*, 10 *E*, 4 *V*, 4 *d*, 4 *e*, 2 *i*) of which *Esb*, Et_4, *Db* and *Dt* are petite (Figs. 13, 14).

Legs. Basitarsi I–IV with a dorsal brush of spinules located distally on the retrolateral surface (Figs. 23, 24), vestigial in leg IV; basitarsi I–III with a second brush located ventro-subdistally on the prolateral surface (Fig. 23), which is absent on leg IV; basitarsi I and II with a third brush located ventro-subdistally on the retrolateral surface (Fig. 23), which is absent on legs III and IV. Legs I–IV with prolateral pedal spur present; tibial spur and retrolateral pedal spur absent in all the legs; tibiae, basitarsi and telotarsi with abundant setae (Figs. 23, 24). Telotarsi with ventral setae arranged in two longitudinal rows (Fig. 24), one prolateral and one retrolateral, with apparent number of setae as follows (some setae appear to have fallen off): prolateral row made up of 6 setae on legs I and II, 7 setae on legs III and IV; retrolateral row apparently made up of 5 setae on legs I and II, 6 setae on legs III and IV.

Etymology.—Latinized adjective referring to the habitat of the species, leaf litter.

Ecology and sympatric species.—The holotype of *T. humiculum*, n. sp., was extracted from leaf litter using Winkler trap, suggesting that this species is a leaf litter dweller. The new species was found in sympatry with the buthids *Tityus cuellari* Lourenço, 1994, and *Ananteris dorae* Botero-Trujillo, 2008. Curiously, all these three species share La Planada Natural Reserve as the type locality (Lourenço, 1994; Botero-Trujillo, 2008) and have not been recorded elsewhere, suggesting that this area may be a center of scorpion endemism.

Collection locality.—La Planada is a private natural reserve located in the municipality of Ricaurte, western slope of the Andes in southwestern Colombia (Map 1). It contains 3200 ha of Humid Premontane Forest according to the classification of Holdridge (1987), that cover an altitudinal range of 1300 to 2100 m. La Planada is enclaved into one of the most diverse ecoregions, the Northwestern Andean Montane Forests. Ecosystems of this ecoregion exhibit a diverse array of distinctive communities with unusual high levels of species endemism, due to Andean topography and pronounced glacial period of isolation (National Geographic Society, 2001). Inside the reserve lies the 25 ha La Planada Permanent Plot, where the holotype of *T. humiculum*, n. sp., was collected.

Remarks.—While this paper was being revised, L. Prendini (pers. comm.) made us aware of a discrepancy in Lourenço's (1981) description of the holotype and only known specimen of *T. vachoni*: in the description of the metasoma Lourenço (1981: 654) stated that the "carénes… latéro-dorsales" (= lateral supramedian carinae) are incomplete, the "intermédiaires" (= lateral inframedian carinae) are complete, and the "latéro-ventrales" (=ventrolateral carinae) are incomplete. However, judging from his figure 37 it is likely that that author may have mistakenly switched "latéro-dorsales" and "intermediaires" in the text of the description, since this figure shows the lateral supramedian carinae complete, at least on segments III and IV. According to L. Prendini (pers. comm.) it is doubtful that the lateral inframedian carinae would be complete and the lateral supramedian incomplete. Under these considerations, there is room for the possibility that the metasomal segments I–IV of the holotype of *T. vachoni* actually have the dorsolateral and lateral supramedian carinae complete, and the lateral inframedian and ventrolateral keels incomplete.

ACKNOWLEDGMENTS

We are most grateful to the personnel (directors, researchers and assistants) of the Instituto de Investigación de Recursos Biológicos Alexander Von Humboldt (Villa de Leyva, Colombia) for the loan of the holotype. Special thanks are due to Dr. Lorenzo Prendini (American Museum of Natural History, New York, U.S.A.) and Dr. W. David Sissom (West Texas A&M University, Canyon, Texas, U.S.A.) for reviewing the manuscript and making valuable comments that led to its improvement. Finally, thanks are due to Giovanny Fagua (Pontificia Universidad Javeriana, Bogotá, Colombia) for the loan of some laboratory equipment and material.

LITERATURE CITED

Botero-Trujillo, R. (2008). The scorpion genus *Ananteris* in Colombia: comments on the taxonomy and description of two new species. Journal of Arachnology, 36(2):287-299.

Coddington, J. A., G. Giribet, M. S. Harvey, L. Prendini, and D. E. Walter. 2004. Arachnida. Pp. 296-318 in: J. Cracraft and M. Donoghue, eds. Assembling the Tree of Life. Oxford University Press.

Fet, V., and W.D. Sissom. 2000. Family Troglotayosicidae Lourenço, 1998. Pp. 501-502 in: V. Fet, W. D. Sissom, G. Lowe, and M. E. Braunwalder, eds. Catalog of the Scorpions of the World (1758–1998). The New York Entomological Society, New York.

Fet, V., and M. E. Soleglad. 2005. Contributions to scorpion systematics. I. On recent changes in high-level taxonomy. Euscorpius, 31:1–13.

Francke, O. F. 1977. Scorpions of the genus *Diplocentrus* from Oaxaca, México. Journal of Arachnology, 4:145–200.

Francke, O. F., V. Vignoli, and L. Prendini. (in press). A new species of *Typhlochactas* (Scorpiones, Typhlochactinae) from eastern Mexico. American Museum Novitates.

Holdridge, L. R. 1987. Ecología basada en zonas de vida. Instituto Interamericano de Cooperación para la Agricultura, San José, Costa Rica, 215 pp.

Lourenço, W. R. 1981. Scorpions cavernicoles de l'Équateur: *Tityus demangei* n.sp. et *Ananteris ashmolei* n.sp. (Buthidae); *Troglotayosicus vachoni* n. gen., n.sp. (Chactidae), scorpion troglobie. Bulletin du Muséum national d'Histoire naturelle, Paris (Zoologie, Biologie et Écologie Animale), 3 :635–662.

Lourenço, W. R. 1994. Scorpions Chelicerata de Colombie. VI. Quatre nouvelles espèces de Buthidae des régions Amazonienne, Sud-Pacifique et de la Cordillère Orientale. Revista de la Academia Colombiana de Ciencias, 19(73):387–392.

Lourenço, W. R. 1998. Panbiogéographie, les distributions disjontes et le concept de famille relictuelle chez les scorpions. Biogeographica, 74:133–144.

Lourenço, W. R. 2006. Further considerations on the genus *Troglotayosicus* Lourenço, 1981 (Scorpiones: Troglotayosicidae or *Incertae sedis*). Boletín de la Sociedad Entomológica Aragonesa, 39:389–395.

Lourenço, W. R., R. L. C. Baptista, and A. P. de L. Giupponi. 2004. Troglobitic scorpions: a new genus and species from Brazil. Comptes Rendus Biologie, 327:1151–1156.

Lourenço, W. R.. and O. F. Francke. 1985. Revision des connaissances sur les scorpions cavernicoles (troglobies) (Arachnida, Scorpions). Memoires de Biospéléologie, 11 :3–7.

Mitchell, R. W., and S. B. Peck. 1977. *Typhlochactas sylvestris*, a new eyeless scorpion from montane forest litter in Mexico (Scorpionida, Chactidae, Typhlochactinae). Journal of Arachnology, 5:159–168.

National Geographic Society. (2001). Terrestrial ecoregions of the world. Online at http://www.nationalgeographic.com/wildworld/terrestrial.html (accessed 30 July 2008).

Prendini, L., and W. C. Wheeler. 2005. Scorpion higher phylogeny and classification, taxonomic anarchy, and standards for peer review in online publishing. Cladistics, 21:446–494.

Sissom, W. D. 1988. *Typhlochactas mitchelli*, a new species of eyeless, montane forest litter scorpion from northeastern Oaxaca, Mexico (Chactidae, Superstitioninae, Typhlochactini). Journal of Arachnology, 16:365–371.

Sissom, W. D. 1990. Systematics, biogeography, and paleontology. Pp. 64-160 in: G.A. Polis, ed., The Biology of Scorpions. Stanford University Press, Stanford, California.

Sissom, W. D., G. A. Polis, and D. D. Watt. 1990. Field and laboratory methods. Pp. 445-461 in: G. A. Polis, ed.. The biology of scorpions. Stanford University Press, Stanford, California.

Soleglad, M. E., and V. Fet. 2003. High-level systematics and phylogeny of the extant scorpions (Scorpiones: Orthosterni). Euscorpius, 11:1–175.

Stahnke, H. L. 1970. Scorpion nomenclature and mensuration. Entomological News, 81:297–316.

Stockwell, S. A. 1989. Revision of the phylogeny and higher classification of Scorpiones (Chelicerata). Ph. D. Dissertation, University of California, Berkeley, California, 413 pp.

Vachon, M. 1973 [1974]. Étude des caractères utilisés pour classer les familles et les genres de Scorpions (Arachnides). 1. La trichobothriotaxie en arachnologie. Sigles trichobothriaux et types de trichobothriotaxie chez les Scorpions. Bulletin du Muséum national d'Histoire naturelle, Paris (3) 104:857–958.

Vignoli, V., and L. Prendini. (in press). Systematic revision of the troglomorphic scorpion subfamily Typhlochactinae (Chactoidea: Superstitioniidae). American Museum Novitates.

Francke, Oscar F. 2009. Description of a new species of troglophile *Pseudouroctonus* (Scorpiones: Vaejovidae) from Coahuila, Mexico [Descripción de una nueva especie de *Pseudouroctonus* troglófilo (Scorpiones: Vaejovidae) de Coahuila, México]. Texas Memorial Museum Speleological Monographs, 7. Studies on the cave and endogean fauna of North America, V. Pp. 11-18.

DESCRIPTION OF A NEW SPECIES OF TROGLOPHILE *PSEUDOUROCTONUS* (SCORPIONES: VAEJOVIDAE) FROM COAHUILA, MEXICO

Oscar F. Francke

Colección Nacional de Arácnidos
Departamento de Zoología
Universidad Nacional Autónoma de México
Aprtado Postal 70-153, México, D. F. 04510
Email: offb@ibiologia.unam.mx

ABSTRACT

Pseudouroctonus savvasi, n.sp., is described from specimens collected in two separate caves in the state of Coahuila, México, though it does not exhibit any marked troglomorphies. It is most closely related to *Pseudouroctonus apacheanus* (Gertsch and Soleglad), from which it is clearly differentiated by size, the number of teeth on the movable finger of the chelicerae, hemispermatophore morphology and pedipalp chela morphometrics.

RESUMEN

Se describe *Pseudouroctonus savvasi,* n.sp., en base a ejemplares colectados en dos cuevas del estado de Coahuila, México. La nueva especie no presenta troglomorfismos y está emparentada con *Pseudouroctonus apacheanus* (Gertsch y Soleglad), de la cual es claramente separable por tamaño, el número de dientes en el dedo móvil de los quelíceros, la morfología del hemiespermatóforo y morfometría de la quela de los pedipalpos.

INTRODUCTION

The genus *Pseudouroctonus* Stahnke was originally proposed for *Vaejovis reddelli* Gertsch and Soleglad, a medium sized troglophile known from many caves in central Texas and from several caves in the neighboring states of Coahuila and Nuevo León in México. A second cave inhabiting species, *Pseudo-uroctonus sprousei* Francke and Savary, 2006, was recently described from a single specimen collected in Coahuila. In this paper, a third cave-dwelling species of *Pseudouroctonus* is described, from several specimens collected in two caves, also in Coahuila. In addition to these three cavernicolous species in the genus, *Pseudouroctonus apacheanus* (Gertsch and Soleglad) is fairly common in Arizona, New Mexico and Texas in the U.S.A., and in northern Chihuahua, México; and its presence in northern Coahuila is expected.

The taxonomic history of the genus *Pseudo-uroctonus* Stahnke was reviewed recently by Francke and Savary (2006), and no further commentary is deemed necessary here; however see the "Comparisons" for a recapitulation of important relationships.

METHODS

Nomenclature and mensuration follow Stahnke (1970), except for trichobothrial terminology after Vachon (1974), metasomal carinal terminology after Francke (1977), metasomal segments setation after Sissom (1993, and subsequent publications on Vaejovidae), and tarsal armature after McWest (in press). Hemispermatophore preparation follows Sissom, et al. (1990) and hemi-spermatophore mating plug terms after Stockwell (1989). Measurements were taken with an ocular micrometer calibrated at 10X and are given in millimeters; abbreviations are L=length, W=width, D=depth. Illustrations were prepared with a camera lucida mounted on a Nikon SMZ 800 stereoscope. Photography of the male chelae under ultraviolet light follows Volschenk (2005). All the specimens used in the description are deposited in the Colección Nacional de Arácnidos (CNAN) at the Instituto de Biologia, Universidad Nacional Autónoma de México (IBUNAM). Two additional juvenile specimens were preserved in 96 % ethanol for molecular analyses and are deposited at the American Museum of Natural History (AMNH), New York.

TAXONOMY

Family Vaejovidae Thorell, 1876
Genus *Pseudouroctonus* Stahnke, 1972

Pseudouroctonus savvasi, new species
Figs. 1-9

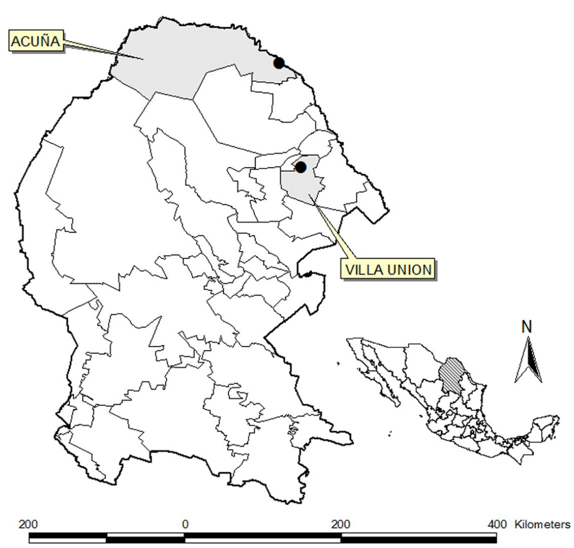
Type data.—Holotype male from Cueva de Casa Blanca (N 29° 22' 37.451" W 101° 02' 15"), Municipio de Ciudad Acuña, Coahuila, México, 20 Febuary 2005 (Charley Savvas). Deposited in the Colección Nacional de Arácnidos (CNAN-T0289), IBUNAM. Five paratypes: one subadult male, two juvenile males and two juvenile females, same data as holotype (CNAN-T0290 to T0294)

Distribution.—Known from the type locality and from Cueva de la Azufrosa (N 28° 14' 12.552" W 100° 48' 01.692"), Municipio de Allende, Coahuila, México (Map 1).

Diagnosis.—Differs from all other *Pseudouroctonus* in having a single subdistal tooth on the dorsal edge of the movable finger of the chelicerae (Fig. 5); all other described species currently placed in that genus have two subdistal teeth (see "Comparisons").

Description of the holotype (Fig.1).**—**Color. Medium brown, pedipalps and metasoma slightly darker, especially on the more heavily sclerotized carinae; chelicera, legs and opisthosomal venter yellow brown.

Carapace. Longer than wide. Median eyes on anterior 35%. Ocular tubercle low, without superciliary carinae. Median eyes slightly reduced in size relative to its epigean congeners; 0.2 mm in diameter. Three lateral ocelli on right side, two on left. Anterior margin broadly bilobed, with 3 pairs of setae. Entire surface with dense, minute granulation, and with scattered small and medium granules.



Map 1.—The state of Coahuila, Mexico, indicating the location of the caves where *Pseudouroctonus savvasi* has been collected.

Tergites. Anterior half shagreened; posterior half densely, minutely granular. I-VI without carinae, VII with four longitudinal, coarsely granular carinae.

Sternum. Pentagonal, with five pairs of stout, reddish macrosetae.

Genital operculum. Each side with 6 macrosetae. Genital papillae well developed.

Hemispermatophore. Lamelliform; hooks on distal half of the lamella on a strongly sclerotized ridge adnate to it (Figs. 2-3). Hemi-mating plug strongly sclerotized, with distal barb margin smooth (Fig. 4).

Pectines. Ten teeth on each comb. Six middle lamellae on each side. Fulcra each with approximately five reddish small setae.

Sternites. Smooth except for scattered medium-sized granules along the sides. Stigmata about four times longer than wide. VII without submedian carinae; lateral carinae represented by row of few medium granules, with two stout reddish macrosetae on each one.

Metasoma. Dorsolateral carinae on I-V strong, coarsely granular. Lateral supramedian carinae on I-IV strong, coarsely granular. Lateral inframedian carinae on I strong, complete, coarsely granular; on II present on distal third to half, granular, tapering anteriorly; on III only a few medium-sized granules distally; on IV absent. Lateral median carinae on V present on basal two-thirds, moderately strong, coarsely granular. Ventrolateral carinae on I-V, ventral submedian carinae on I-IV and ventromedian carina on V strong, coarsely granular. Setation on I-IV: dorsolaterals 0,0,1,1; lateral supramedian 0,1,1,1; lateral inframedian 1,0,0,0; ventrolateral 2,2,2,2; ventral submedian 2,3,3,3. Setation on V: dorsolateral 2, lateromedian 1, ventrolateral 4, ventromedian 4. Intercarinal spaces shagreened to densely, minutely granular.

Telson. Slightly longer and wider than segment V; smooth to vestigially granular on ventrobasal region. Aculeus lacking basal microdenticles.

Chelicera. Fixed finger shorter than chela width; movable finger shorter than chela length. Chela with two macrosetae dorsally near finger articulation. Ventral edge of both fixed and movable fingers smooth; movable finger with distinct serrula.

Pedipalp femur. Dorsointernal, dorsoexternal and ventrointernal carinae strong, coarsely granular; ventroexternal carina obsolete; internomedian carina represented by few scattered granules on basal half; externomedian carina present on distal two-thirds, moderately strong, granular. Orthobothriotaxic Type C.

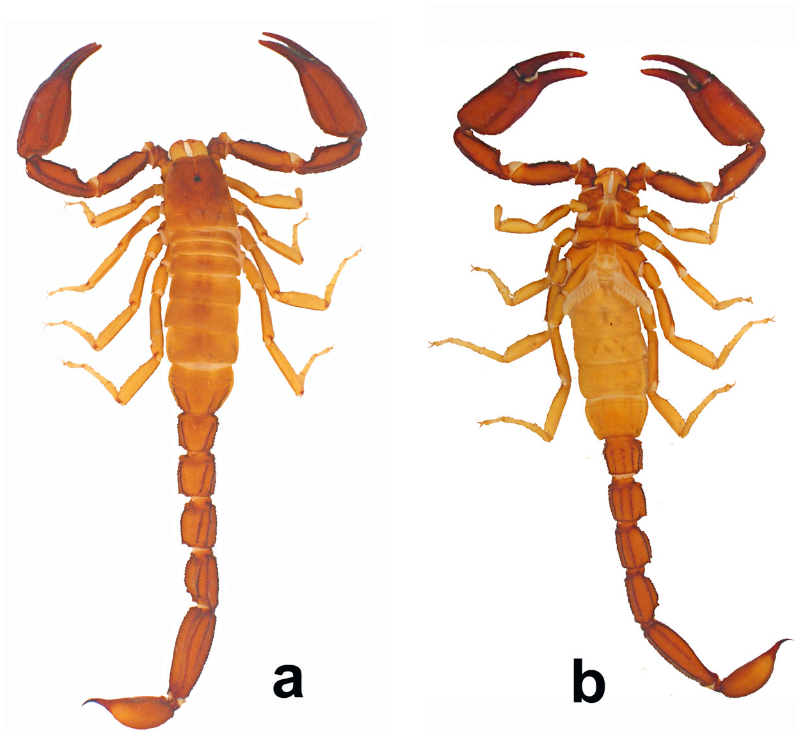
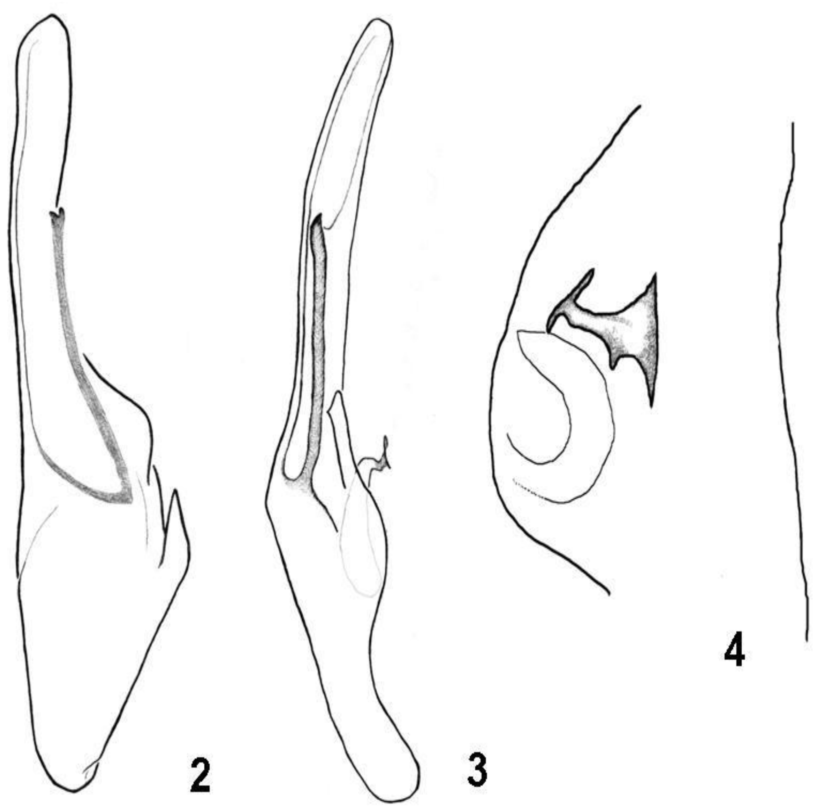


Fig. 1.—Dorsal (a) and ventral (b) habitus of the holotype male of *Pseudouroctonus savvasi*, n.sp.

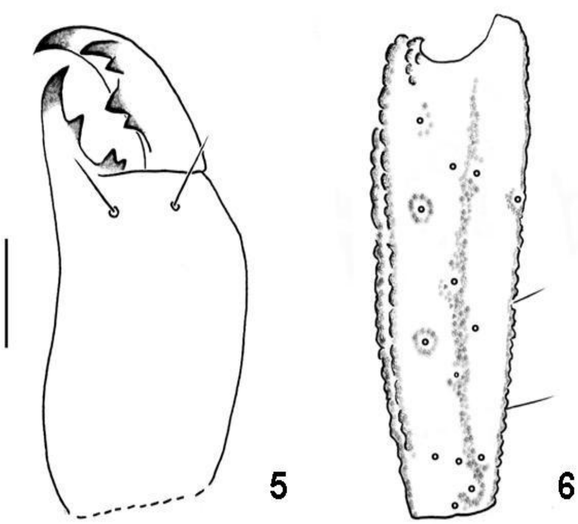


Figs. 2-4.—Hemispermatophore from holotype of *Pseudouroctonus savvasi,* n.sp., 2, dorsal aspect, 3, mesal aspect, 4, detail of ventral view showing hemi-mating plug.

Table 1.—Measurements (in millimeters) of adult specimens of *Pseudouroctonus* spp. L=length, W=width, D =depth

		P. savvasi		*P. apacheanus*	
		Male[1]	Female[2]	Male[3]	Female[4]
Total	L	38.8	31.5	28.8	22.8
Carapace	L	4.6	4.1	4.0	3.2
	W	3.8	3.1	2.9	2.4
Mesosoma	L	10.8	10.2	8.5	7.3
Metasoma	L	23.4	17.2	16.3	12.3
I	L	2.4	1.7	1.6	1.2
	W	2.5	2.0	2.0	1.7
II	L	2.6	1.9	1.8	1.3
	W	2.5	1.9	1.9	1.6
III	L	2.8	2.0	2.0	1.5
	W	2.4	1.8	1.8	1.6
IV	L	3.4	2.6	2.6	1.9
	W	2.2	1.7	1.7	1.5
V	L	5.9	4.1	4.0	3.0
	W	2.1	1.6	1.7	1.4
Telson	L	6.3	4.9	4.3	3.4
	W	2.4	1.8	1.4	1.3
Pedipalp					
Femur	L	4.3	2.4	3.3	2.6
	W	1.5	1.2	1.1	1.0
	D	1.0	0.8	0.8	0.7
Patella	L	4.5	2.6	3.4	2.8
	W	1.6	1.3	1.4	1.1
	D	1.5	1.3	1.2	1.0
Chela	L	8.9	7.1	6.3	5.0
	W	2.7	2.4	2.2	1.7
	D	2.5	2.0	1.9	1.3

[1]Holotype male from Cueva de la Casa Blanca, Coahuila, Mexico.
[2]Female from Cueva de la Azufrosa, Coahuila, Mexico.
[3]Male from the Chiricahua Mountains, Cochise County, Arizona (type locality).
[4]Female from The Davis Mountains, Jeff Davis County, Texas.



5

6

Figs. 5-6.—Holotype male of *Pseudouroctonus savvasi*, n.sp., 5, right chelicera dorsal aspect, 6, right pedipalp patella external view.

Dorsal face flat, with dense small and medium granulation. Internal face moderately granular.

Pedipalp patella. Internomedial carina represented by 3-4 granules only, decreasing in size distally. Dorsointernal, dorsoexternal, external, ventrointernal and ventroexternal carinae strong, coarsely granular. Orthobothriotaxia C (Fig. 6). Intercarinal spaces shagreened.

Pedipalp chela (Figs. 7-9). Digital and ventromedian carinae strong, scabrous to granular; other carinae moderately strong, granular. Fixed finger with six rows of granules and six inner accessory denticles; movable finger with seven rows of granules and seven inner accessory denticles. Orthobothriotaxia C.

Leg III tarsal armature. Basitarsus with a single superior macrosetae basally (Sb of McWest), lacking the distal superior macroseta (Sd of McWest). Telotarsus with four distal spinules (sd) and lacking macrosetae promedially (pm), retromedially (rm) and retrosubterminally (rsub).

Measurements.—See Table 1.

Paratypical variability.—The variation in size among the paratypes is presented in Table 2. The larger paratypes (not adult) are straw-colored, with the pedipalp chela fingers and the aculeus darker (medium brown); the smaller paratypes are pale, cream-colored, with the pedipalp chela fingers and the aculeus light brown. Among the three paratype males, four pectinal combs have 10 teeth and two combs have 11 teeth; among the two female paratypes the four pectinal combs have 9 teeth. Like the holotype, the 12 movable fingers of the chelicera of the six paratypes have a single subdistal tooth. Likewise, the metasomal setation of the six paratypes is the same as for the holotype, except for one specimen which shows asymmetry on the dorsolaterals on II, with 0 on one side and 1 on the other (0 on all others, including the holotype).

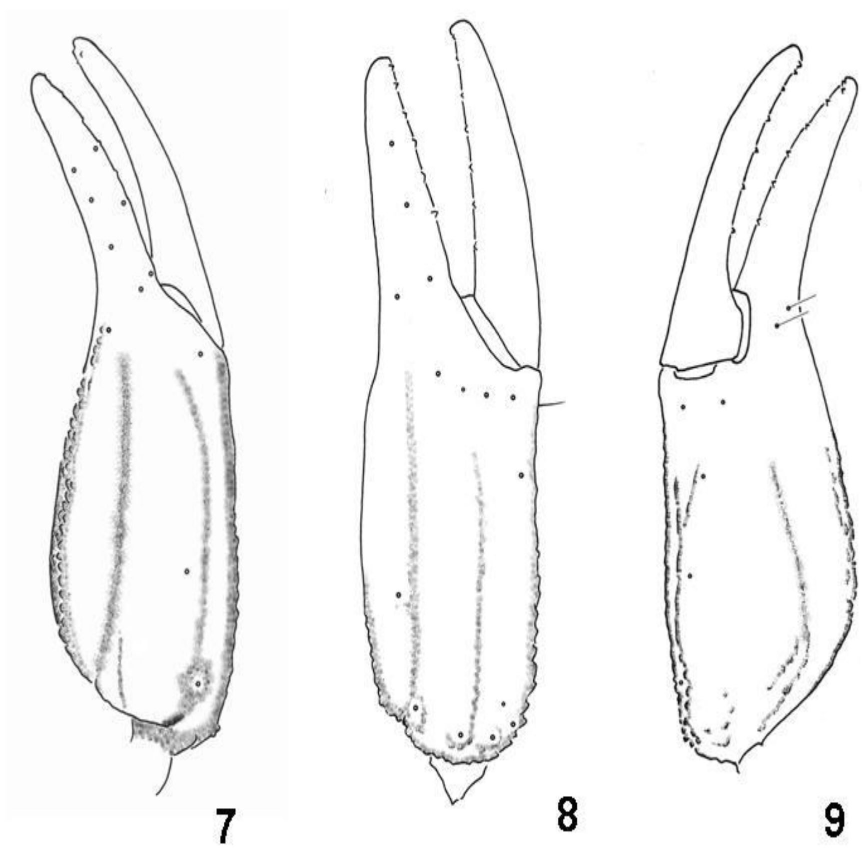
Other specimens examined.—An additional eight specimens belonging to this species were examined, all from Cueva de la Azufrosa (N 28° 10’ W 100° 45’), Municipio de Allende, Coahuila, México, collected on 29 January 2006, as follows: 1 adult female, 1 subadult female, 2 juvenile males and 1 juvenile female (C. Savvas); 2 adult females (C. Savvas and J. Krejca); 1 subadult female (P. Sprouse). One adult female deposited at the AMNH, all others at CNAN-IBUNAM.

The two males have 10 teeth on each pectinal comb (n=4); the six females have 9 teeth on each pectinal comb (n=12). All specimens have a single subdistal tooth on the movable finger of the chelicerae (n=16).

Etymology—This species is dedicated to Mr. Charley Savvas, a tireless caver who collected most of the known specimens.

Table 2.—Selected measurements of type series of *Pseudouroctonus savvasi*, new species.

		Male Holotype	Male subadult	Male juvenile	Male juvenile	Female juvenile	Female juvenile
Carapace	L	4.7	3.5	3.5	2.7	2.7	2.9
	W	3.8	2.7	2.6	1.9	2.0	2.1
Femur	L	4.2	2.8	2.7	2.1	2.2	2.1
	W	1.4	1.1	1.1	0.8	0.8	0.9
Patella	L	4.5	3.2	3.0	2.4	2.4	2.5
	W	1.5	1.2	1.2	0.9	0.9	1.0
Chela	L	9.0	5.9	5.6	4.2	4.4	4.4
	W	2.9	1.8	1.8	1.2	1.1	1.4
	D	2.5	1.3	1.3	0.9	0.9	1.0
Fixed finger	L	3.3	2.3	2.2	1.7	1.7	1.7
Movable finger	L	4.5	3.1	3.1	2.2	2.2	2.2
Metasoma V	L	5.7	3.7	3.5	2.6	2.7	2.7
	W	2.2	1.5	1.5	1.2	1.2	1.2
Pectinal teeth	R	10	10	11	10	9	9



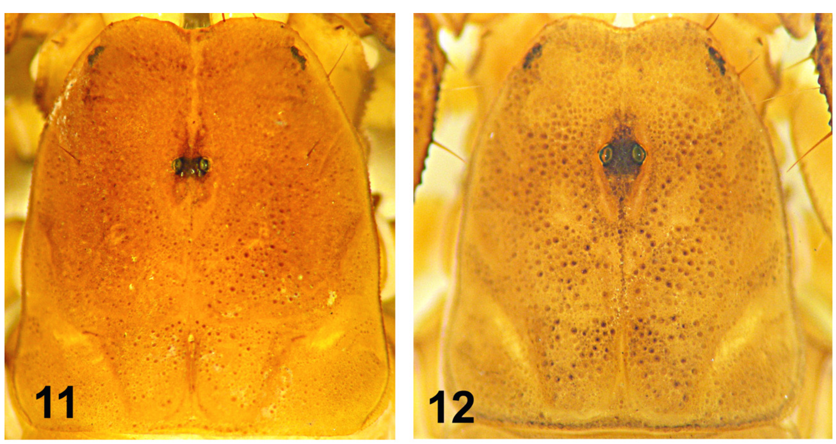
Figs. 7-9.—Trichobothrial pattern on the right pedipalp chela of holotype of *Pseudouroctonus savvasi*, n.sp., 7, dorsal aspect, 8, external aspect, 9, ventral aspect.

Fig. 10.—Adult holotype male of *Pseudouroctonus savvasi*, n.sp., and an adult male of *Pseudouroctonus apacheanus* showing the larger size of the former.

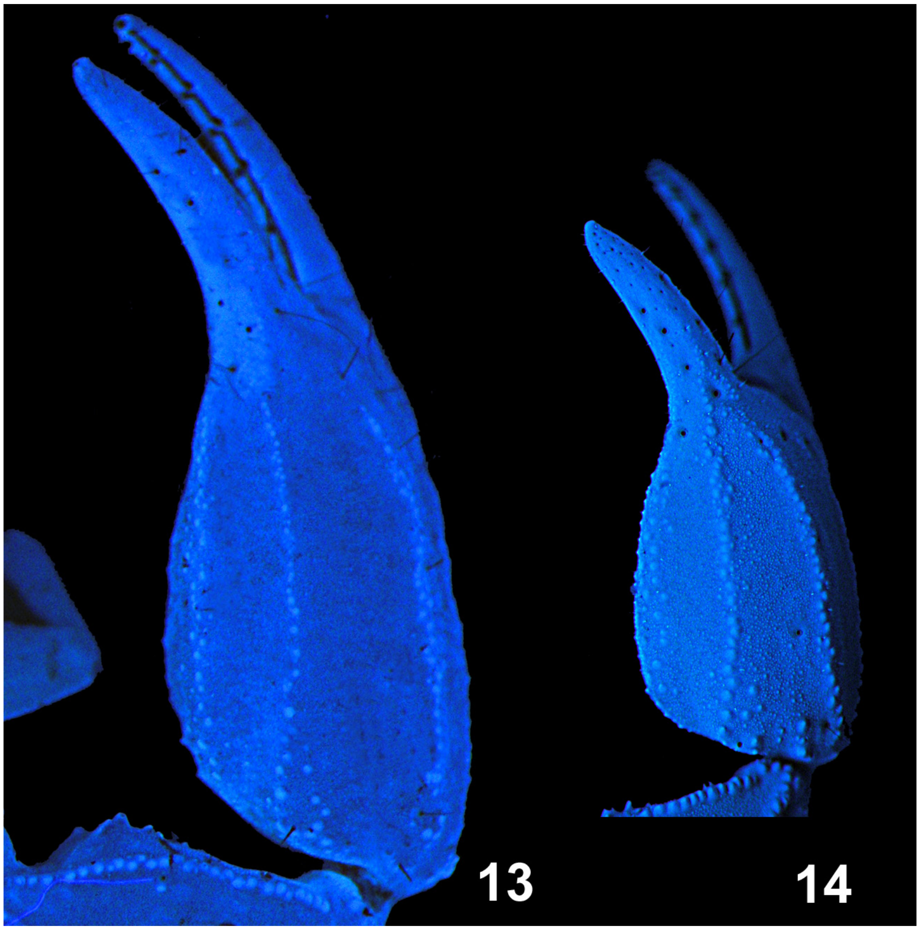
Comparisons.—The taxonomic history of the "uroctonoid" group of vaejovid scorpions was reviewed by Francke and Savary (2006). It currently contains three genera and 21 species: *Uroctonus* Thorell with 3 species, *Uroctonites* Williams and Savary with 4 species, and *Pseudouroctonus* Stahnke with 14 species. Of all the previously described species in this complex, only two have a single subdistal tooth on the movable finger of the chelicera; all others have two subdistal teeth. Those two species are currently placed in *Uroctonites,* namely *Uroctonites sequoia* (Gertsch and Soleglad) and *Uroctonites montereus* (Gertsch and Soleglad). These two species were originally described as belonging to *Uroctonus* (see Gertsch and Soleglad, 1972)*,* and were subsequently transferred to *Uroctonites* when that genus was created on the basis of distinctive telotarsal armature (Williams and Savary, 1991). In addition, Williams and Savary (1991) indicated that *Uroctonites* shows a reduction or loss of the sclerotized mating plug of the spermatophore (or a hemi-plug in the dissection of a hemispermatophore), and the lamellar hooks on the spermatophore are located basally. *Pseudouroctonus savvasi* has hair-like macrosetae on the telotarsi, rather than spiniform setae; has a strongly sclerotized mating plug (Fig. 4), and has elevated lamellar hooks that are adnate to the lamella (Figs. 2-3), and thus clearly does not belong in *Uroctonites*, despite sharing similar cheliceral dentition with two of the four species currently placed in that genus.

Pseudouroctonus savvasi appears most closely related to *P. apacheanus,* from which it differs, in addition to the number of subdistal teeth on the cheliceral movable finger, as follows: (a) in size (Table 1 and Fig. 10); (b) in the slight reduction of the size of the ocelli on the carapace (Figs. 11, 12); (c) on the hemispermatophores of *P. savvasi* the paired dorsal hooks are on a sclerotized ridge extending past the mid-point of the lamella, whereas on *P. apacheanus* the hooks are on the basal fifth to fourth of the lamella; (d) on adult males the ratio pedipalp chela L/carapace L in *P. savvasi* is approximately 2, whereas on *P. apacheanus* it is approximately 1.6; the ratio pedipalp chela L/chela W is 3.3 versus 2.8 (Figs. 13 and 14); and the underhand L/fixed finger length is 1.6 versus 1.3 [i.e., the chelae of *P. savvasi* are longer and narrower].

Remarks.—Although I did not receive any details of the scorpion collections at Cueva de la Azufrosa (Fig. 16), some interesting facts were gathered at



Figs. 11-12.—Dorsal view of carapace of *Pseudouroctonus savvasi*, n.sp. (11) and *Pseudouroctonus apacheanus* (12), indicating the slight ocellar reduction in the former.



Figs. 13-14.—Ultraviolet light photographs of the right pedipalp chela of *Pseudouroctonus savvas*, n.sp. (13) and *Pseudouroctonus apacheanus* (14), at the same magnification, showing size and morphometric differences.

Fig. 15.—Adult female *Pseudouroctonus* savvasi, n.sp. from Cueva de la Azufrosa, Coahuila, México (photo courtesy of Peter Sprouse).

Cueva de Casa Blanca, the type locality. First, Peter Sprouse wrote on 21 February 2005:

"We discovered a very interesting cave two days ago near Cd. Acuña, Coahuila. It has a hydrogen sulfide stream in it, and is very extensive. It also has scorpions, which appear to have only vestigial eyes ..."

Subsequently, Andy Gluesenkamp wrote on 23 February 2005:

"Charley and I saw a few individuals that escaped capture. All of them were small (1.2 cm) and very pale. All exuvia were collected under rock flakes. Most live individuals were collected either under rock flakes lying on guano; under rocks next to, or on small rock "islands" in, a small sulfurous stream below the main passage ... Charley collected one individual on a wall where it was eating a small *Ceuthophilus* [Orthoptera, Rhaphidophoridae]. All specimens were found roughly 30-150m from the entrance."

ACKNOWLEDGMENTS

My thanks to the biospeleologists (Charley Savvas, Jean Krejca, Andrew Gluesekamp, Peter Sprouse) from Zara Environmental of Austin, Texas, for their continuing efforts to discover the diversity of living organisms in Mexican caves, particularly scorpions. Dr. W. David Sissom and Dr. Lorenzo Prendini kindly reviewed the manuscript and made valuable suggestions.

LITERATURE CITED

Francke, O. F. 1977. Scorpions of the genus *Diplocentrus* from Oaxaca, Mexico. Journal of Arachnology, 4:145-200.

Francke, O. F., and W.E. Savary. 2006.A new troglobitic *Pseudouroctonus* Stahnke (Scorpiones: Vaejovidae) from northern México. Zootaxa, 1302:21-30.

Gertsch, W. J., and M. E. Soleglad, M. E. 1972. Studies of North American scorpions of the genera *Uroctonus* and *Vejovis* (Scorpionida, Vejovidae). Bulletin of the American Museum of Natural History, 148:547-608.

McWest, K. J. in press. Survey of the tarsal spinules and setae of vaejovid scorpions (Scorpiones, Vaejovidae). Zootaxa

Sissom, W. D. 1990. Systematics, biogeography and paleon-tology. Pp. 64-160 in: G. A. Polis, ed., The Biology of Scorpions. Stanford University Press, Stanford, California.

Sissom, W. D. 1993. A new species of *Vaejovis* (Scorpiones, Vaejovidae) from western Arizona, with supplemental notes on the male of *Vaejovis spicatus* Haradon. Journal of Arachnology, 21:64-68.

Sissom, W. D., G. A. Polis, and D. D. Watt. 1990. Laboratory and field methods. Pp. 445-461 in: G. A. Polis, ed., The Biology of Scorpions. Stanford University Press, Stanford, California.

Stahnke, H. L. 1970. Scorpion nomenclature and mensuration. Entomological News, 81:297-316.

Stockwell, S. A. 1986. The scorpions of Texas (Arachnida, Scorpiones). M. S. Thesis, Texas Tech University, Lubbock, 193 pp.

Stockwell, S. A. 1989. Revision of the Phylogeny and Higher Classification of Scorpions (Chelicerata). Ph. D. Dissertation, University of California, Berkeley, California, 413 pp.

Stockwell, S. A. 1992. Systematic observations on North American Scorpionida with a key and checklist of the families and genera. Journal of Medical Entomology, 23:407-422.

Vachon, M. 1974. Étude de caractéres utilisés pour classer les familles et les genres de Scorpions (Arachnides). Bulletin du Muséum National d´Historie Naturelle (Paris) (sér. 3), 104:857-958.

Volschenk, E. S. 2005. A new technique for examining surface morphosculpture of scorpions. Journal of Arachnology, 33:820-825.

Williams, S. C., and W. E. Savary. 1991. *Uroctonites,* a new genus of scorpion from western North America (Scorpiones: Vaejovidae). Pan-Pacific Entomologist, 67:272-287.

Sissom, W. David, and James R. Reddell, 2009. Cave scorpions of Mexico and the United States [Escorpiones de cuevas de México y Estados Unidos]. Texas Memorial Museum Speleological Monographs, 7. Studies on the cave and endogean fauna of North America, V. Pp. 19-32.

CAVE SCORPIONS OF MEXICO AND THE UNITED STATES

W. David Sissom

Department of Life, Earth, and Environmental Sciences
West Texas A&M University
WTAMU, Box 60808
Canyon, Texas 79016 U.S.A.
Email: dsissom@mail.wtamu.edu

and

James R. Reddell

Texas Natural Science Center
The University of Texas at Austin, PRC 176, 10100 Burnet
Austin, Texas 78758 U.S.A.
Email: jreddell.caves@mail.utexas.edu

ABSTRACT

Scorpions reported from caves in Mexico and the United States are reviewed. New records are included for: *Centruroides gracilis, C. vittatus, Troglocormus willis, Alacran tartarus, Pseudouroctonus apacheanus, P. reddelli, Uroctonites sequoia, Serradigitus gertschi striatus, S. wupatkiensis, Vaejovis carolinianus, V. chisos, V. intermedius, V. nigrescens,* and *V. rossmani.*

RESUMEN

Se actualizan registros de escorpiones de cuevas en México y Estados Unidos. Se presentan nuevos registros para: *Centruroides gracilis, C. vittatus, Troglocormus willis, Alacran tartarus, Pseudouroctonus apacheanus, P. reddelli, Uroctonites sequoia, Serradigitus gertschi striatus, S. wupatkiensis, Vaejovis carolinianus, V. chisos, V. intermedius, V. nigrescens y V. rossmani.*

INTRODUCTION

Scorpions are comparatively uncommon in caves. They are best represented in tropical and subtropical caves where energy input is greater. Volschenk and Prendini (2008) in a review of the troglobitic and troglomorphic scorpions of the world record 32 species that are known only from caves or else exhibit troglomorphic features. With few exceptions all are known from the tropics or subtropics.

The vast majority of troglobitic scorpions are known from the New World. The most remarkable of these are the troglobitic species assigned to the family Superstitioniidae. Mitchell (1968) described *Typhlochactas reddelli* and *T. rhodesi*, the first eyeless scorpions, from caves in Mexico. Mitchell (1971) added a third eyeless species from Mexico with the description of *T. elliotti* (now *Sotanochactas elliotti*). Subsequently, three more superstitioniids were discovered in Mexican caves. *Alacran tartarus,* the most highly troglomorphic scorpion in the world, was described from more than 700 m below the surface in Sistema Huautla, Oaxaca (Francke, 1982). Francke (1986) then described *Typhlochactas cavicola* from a cave in Tamaulipas, and Sissom and Cokendolpher (1998) added *T. granulosus* from a cave in Veracruz.

The first cave-associated vaejovid scorpions were described by Gertsch and Soleglad (1972) from Mexico and the United States. They provided descriptions of *Vaejovis reddelli* (now in *Pseudouroctonus*) from caves in Texas; *Uroctonus grahami* and *U. sequoia* (now in *Uroctonites*) from California; and *Vaejovis gracilis* from a small juvenile taken in Veracruz, Mexico. Of these *Uroctonus grahami* and *Vaejovis gracilis* are probably troglobites. Soleglad (1975) redescribed *Vaejovis gracilis* based on some new specimens from Oaxaca, Puebla, and Veracruz, but these were misidentifications (Sissom 1986). In the last decade, several more vaejovids were described from caves: Sissom and González-Santillán (2004) described the troglophilic *Vaejovis norteno* from caves in Tamaulipas, Mexico; Soleglad and Fet (2005) described the possible troglobitic *Vaejovis davidi* from a cave in Puebla, Mexico (two of the specimens erroneously assigned to V. gracilis in 1975); Francke and Savary (2006) described *Pseudouroctonus sprousei,* the first troglobitic species of the genus, from Coahuila, Mexico; and Francke (2009) added another troglophilic species, *P. savvasi* from other caves in Coahuila.

Francke (1977) described the first Diplocentridae from caves in a study of scorpions from the Yucatan Peninsula of Mexico. Of these *Diplocentrus anophthalmus* is a highly modified troglobite, *D. mitchelli* a possible troglobite, and *D. reddelli* a probable accidental. A third possible troglobite, *D. cueva*, was described in 1978 from Oaxaca, Mexico (Francke, 1978). Two more diplocentrids have more recently been described from Mexican caves: *Diplocentrus magnus* from Guerrero (Beutelspacher and López-Forment C. 1991) and the troglobitic *Diplocentrus actun* from Yucatán (Armas and Palacios-Vargas 2002).

Francke (1981) erected the genus *Troglocormus* for the two troglobitic species *T. ciego* and *T. willis* from caves in Mexico, and these represent a fourth family of troglomorphic scorpions (Euscorpiidae) in North America.

From a geographical perspective, outside of California and Texas the only three species identified from caves in the United States are *Serradigitus wupatkiensis* in Idaho, *Vaejovis carolinianus* in Alabama, and *Pseudouroctonus apacheanus* in New Mexico. The first two of these are presumably accidentals, but *P. apacheanus* might be considered troglophilic.

Five species have been recorded from caves in California: *Serradigitus gertschi striatus, Uroctonites sequoia, Uroctonus grahami, U. mordax,* and *Vaejovis iviei.* Of these *Uroctonus grahami* is a troglobite; the other species are either troglophiles or accidentals.

The scorpion fauna of Texas includes three identified species from caves and one from within a highway tunnel. The only troglophile is *Pseudouroctonus reddelli*. This species is widespread in caves along the Balcones Fault Zone and Edwards Plateau (Fig. 4). It is frequently abundant in caves and has been observed feeding on cave crickets of the genus *Ceuthophilus* (Fig. 5). The other species are accidentals.

Thirty-four species in five families have been identified from caves in Mexico, with others awaiting identification or description. Thirteen species (62% of world troglobites) are unquestionably troglobitic, while an additional three are known only from caves and show slight troglomorphic adaptations. Two troglomorphic species, *Typhlochactas mitchelli* Sissom (1988) and *T. sylvestris* Mitchell and Peck (1977) are de-pigmented eyeless species known only from leaf litter.

Except as otherwise noted identifications of new records are by W. David Sissom and specimens deposited in the Texas Natural Science Center, The University of Texas at Austin. Acronyms are: American Museum of Natural History, New York (AMNH); W. David Sissom collection (WDS); AM-NMSU, The Arthropod Museum, New Mexico State Univeristy, Las Cruces.

Family Buthidae

Centruroides gracilis (Latreille)

New records.—MEXICO: QUINTANA ROO: Cenote Azul, July 1992 (A.G. Grubbs), 1 juvenile. SAN LUIS POTOSÍ: Hoya de las Guaguas, 4 Aug. 1982 (A.G. Grubbs, M. Minton), 1 (det. O. F. Francke); Cueva del Salitre, 20 July 1969 (W. Elliott, S. and J. Peck), 1 female (det. W. J. Gertsch) (AMNH). TAMAULIPAS: Cueva de los Cuarteles (det. W. J. Gertsch) (AMNH). YUCATÁN: Actun Kaua, July 1992 (A.G. Grubbs). 1 female.

Comment.—This accidental is occasionally found in entrance areas.

Centruroides ochraceus Pocock

Records.—MEXICO: YUCATÁN: Actun Kaua (Wagner, 1977); Actun Loltun (Chamberlin and Ivie, 1938; Wagner, 1977); Actun Tucil (Wagner, 1977); Actun Xpukil (Wagner, 1977); Actun (=Cenote) Xtacabihá (Wagner, 1977).

Comments.—This is an accidental. Chamberlin and Ivie (1938) described *Centrurus yucatanus* (a synonym of *C. ochraceus*) from Actun Loltun.

Centruroides vittatus (Say)

Records.—U.S.A.: TEXAS: *Edwards County*: Chivo Cave (Rowland and Reddell, 1976). *Travis County*: Tooth Cave (Rowland and Reddell, 1976). *Williamson County*: Elm Water Cave (Rowland and Reddell, 1976); Steam Cave (Rowland and Reddell, 1976).

New records.—MEXICO: TAMAULIPAS:

Sistema Purificación, 26 Nov. 1979 (P. Sprouse), 1 juvenile.

U.S.A.: TEXAS: *Bell County*: Jagged Walls Cave, Fort Hood, 3 Nov. 1998 (J. Cokendolpher, M. Reyes), 1. *Bexar County*: Charley's Annex, Camp Bullis, 2 Dec. 1994 (W. Elliott), 1 female; Chimney Cricket Cave, 14 June 2001 (J. Cokendolpher), subadult female; Power Pole 60 Feature, Camp Bullis, 30 April 2003 (J. Reddell, M. Reyes, G. Veni), 1; Power Pole Pit, Camp Bullis, 14 Nov. 2002 (B. Shade), 1**.** *Brewster County*: 400 Foot Cave, 30 June 1985 (A.G. Grubbs), 1. *Edwards County*: Punkin Cave, 4 Sept. 1965 (J. Reddell), 1 male (det. W. J. Gertsch) (AMNH). *Mason County*: Zesch Ranch Cave, 10 June 1967 (R.W. Mitchell), 1 female (det. W. J. Gertsch) (AMNH). *Sutton County*: Caverns of Sonora, near Popcorn Alley, 15 April 1995 (G. Veni), 1 subadult female. *Travis County*: Barbed Wire Sink, July 1983 (W. Russell), 1 (det. O. F. Francke); Garden Hoe Cave, 2 Sept. 2002 (M. Reyes, M. Warton), 1 female; Karst Feature F4, 28 Sept. 2006 (J. Krejca), 1 male; Travis Water Treatment Plant, Karst Feature F-5, Sept. 2002 (M. Reyes, M. Warton), 2 males. *Val Verde County*: Seminole Sink, 11 March 1984 (C. Alexander, W. Elliott) (det. O. F. Francke), 1; 26 May 1984 (L. Bement, S. Turpin, et al.), 2; 27 May 1984 (L. Bement, W. Elliott), 1. *Williamson County*: Cobb Drain Cave, 1 June 2001 (L.J. Graves, J. Reddell, M. Reyes), 1 female; LakeLine Cave, 17 May 1996 (P. Sprouse), 1 subadult female.

Comments.—This medium-sized straw-colored scorpion with a dark interocular triangle and dorsal submedian stripes is occasionally found in the entrance area of caves in Texas. It is clearly an accidental, and is widely distributed over the south central U.S.A. and northeastern Mexico.

Family Diplocentridae
Cazerius n.sp.

Record.—MEXICO: YUCATÁN: Actun Loltun (Reddell, 1977)

Comment.—This was originally identified as an undescribed genus and species but it has since been determined to belong to the genus *Cazerius* (O. F. Francke, pers. comm.).

Diplocentrus sp.

Record.—MEXICO: YUCATÁN: Actun Xkyc (Francke, 1977)

Comment.—A single large chela was collected deep in the cave. It belongs to a large species.

Diplocentrus actun Armas and Palacios-Vargas

Record.—MEXICO: YUCATÁN: Actun Xpukil (=Gruta de Calcehtok) (Armas and Palacios-Vargas, 2002).

Comment.—This troglobite possesses elongate appendages, lacks the ocular tubercle and median eyes, and has reduced pigmentation and lateral eyes.

Diplocentrus anophthalmus Francke
Fig. 1

Record.—MEXICO: YUCATÁN: Actun Chukum (Francke, 1977).

Comment.—This troglobite is pale, elongated, and lacks median eyes.

Diplocentrus cueva Francke

Record.—MEXICO: OAXACA: Cueva Desapareciendo (Francke, 1978).

Comments.—This species, known only by the holotype male, has attenuated legs and the median eyes and ocular tubercle are reduced. The cave may have been destroyed by quarrying.

Diplocentrus magnus
Beutelspacher and López-Forment

Records.—MEXICO: GUERRERO: cave 2 km W of Puerto Marques (Beutelspacher and López-Forment, 1991); cave 5 km W of Puerto Marqués (Beutelspacher and López-Forment, 1991).

Comments.—This large dark species has slightly reduced median eyes and ocular tubercle. It is probably an accidental. Records of the species from Puerto Marqués, 2 km from Puerto Marqués, and 4 km N of Puerto Marqués were taken from cracks in granitic boulders. It has also been found on the surface (O. F. Francke, pers. comm.).

Diplocentrus mitchelli Francke

Record.—MEXICO: CAMPECHE: Actun Halmensura (Francke, 1977).

Comments.—This possibly troglobitic species has slightly elongated appendages and reduced median eyes. It is known only from a juvenile.

Diplocentrus reddelli Francke

Record.—MEXICO: YUCATÁN: Actun Xpukil (Francke, 1977).

Fig. 1.—*Diplocentrus anophthalmus* from Actun Chukum, Yucatán, México.

Fig. 2.—*Alacran tartarus* from Sistema Huautla, Oaxaca, México.

Comments.—This small species is known only from this cave. It was found in the entrance sink and is probably an accidental.

Family Euscorpiidae
Megacormus n. sp. 1

Record.—MEXICO: PUEBLA: Sótano de Ocatempa (Sissom, 1994).

Comment.—This species was originally reported as *M. gertschi* but it has since been determined to be an undescribed species; the description is currently in preparation (O. F. Francke, pers. comm.)

Megacormus n. sp. 2

Records.— MEXICO: QUERÉTARO: Cave No. 29, 20 km N Pinal de Amoles, 6 June 1972 (W. Russell), 1 juvenile (AMNH) (det. W. J. Gertsch); Sótano del Buque, 2 June 1972 (T. Raines, R. Ralph), 1 juvenile (AMNH) (det. W. J. Gertsch).

Comment.—The description of this species is currently in preparation (O. F. Francke, pers. comm.).

Megacormus n. sp. 3

Record.— MEXICO: SAN LUIS POTOSÍ: Cueva de la Puente, San Francisco, 26 Sept. 1998 (C. Savvas), 1.

Comment.—The description of this species is currently in preparation (O. F. Francke, pers. comm.).

Megacormus gertschi Diaz

Records.—MEXICO: HIDALGO: cave 15 mi. northeast Jacala (Soleglad, 1976).

Comment.—This possible troglophile is also known from surface habitats in the Sierra Madre Oriental.

Troglocormus ciego Francke

Record.—MEXICO: SAN LUIS POTOSÍ: Cueva de Elías (Francke, 1981).

Comments.—This pale troglobitic species lacks the median eyes. The lateral eyes are more reduced than in *T. willis.*

Troglocormus willis Francke

Records.—MEXICO: TAMAULIPAS: Cueva de Esperanza (Francke, 1981); Cueva X (Francke, 1981); Sistema Purificación (Cueva del Brinco Section) (Francke, 1981).

New records.—MEXICO: TAMAULIPAS: Cueva del Borrego, 18 April 1982 (Peter Sprouse), 1 (det. O. F. Francke); 26 Dec. 1986 (Terri Treacy Sprouse), 1; Sótano de la Cuchillo (PEP59), Purificación area, 31 May 2000 (P. Sprouse), upper level, 1; Cueva de La Llorona, 26 May 1991 (P. Sprouse), 1 female; Cueva de la Onza (det. O. F. Francke);Cueva del Río Corona, Purificación area, 13 Dec. 1995 (C. Savvas, D. Lloyd, J. Krejca), 1 male; Sótano de Trejo, 20 Nov. 1988 (Paul Fambro, Terri Treacy), 1 female.

Comments.—This troglobitic species is known only from caves in the Purificación area of Tamaulipas. It lacks median eyes and the lateral eyes are reduced compared to *Megacormus gertschi.*

Family Superstioniidae
Alacran tartarus Francke
Fig. 2

Records.—MEXICO: OAXACA: Sótano de Agua Carrizo (Francke, 1982); Cueva del Escorpión (Francke, 1982); Sistema Huautla (Sótano de San Agustín Section) (Francke, 1982).

New record.—MEXICO: OAXACA: Sistema Huautla, Sótano de San Agustín Section, May 1985 (A.G. Grubbs, J.H. Smith, F. Holladay), 2.

Comments.—This is the most highly cave-adapted scorpion in the world. It is pale, attenuated, and completely eyeless. It has been taken at more than 700 meters below the surface. Some specimens have been observed crawling under water.

Sotanochactas elliotti (Mitchell)
Fig. 3

Record.—MEXICO: SAN LUIS POTOSÍ: Sótano de Yerbaniz (Mitchell, 1971).

Comment.—This is a highly troglomorphic eyeless species known only from this cave.

Typhlochactas cavicola Francke

Record.—MEXICO: TAMAULIPAS: Cueva del Vandalismo (Francke, 1986).

Comment.—This eyeless species is known only from the holotype male.

Typhlochactas granulosus
Sissom and Cokendolpher

Record.—MEXICO: VERACRUZ: Sótano de Poncho (Sissom and Cokendolpher, 1998).

Comment.—This eyeless species is known only from the holotype male.

Fig. 3.—*Sotanochactas elliotti* from Sótano de Yerbaniz, San Luis Potosí, México.

Typhlochactas reddelli Mitchell

Record.—MEXICO: VERACRUZ: Cueva del Ojo de Agua de Tlilapan (Mitchell, 1968).

Comment.—This eyeless species was previously known only from the holotype female. Three juveniles have recently been collected from the cave (O. F. Francke, pers. comm.).

Typhlochactas rhodesi Mitchell

Record.—MEXICO: TAMAULIPAS: Cueva de la Mina (Mitchell, 1968).

Comment.—This eyeless species is known from three females.

Family Vaejovidae
Pseudouroctonus apacheanus
(Gertsch and Soleglad)

New records.—U.S.A.: ARIZONA: *Cochise County*: Outlaw Cave, 24 July-2 Aug. 1962 (R. Graham), 1 female, 1 subadult female (AMNH); Outlaw Cave, 27 July 1963 (J. Franklin), 1 subadult female (AMNH). NEW MEXICO: *Eddy County*: Doc Brito Cave, 5.3 km E, 5.1 km N Whites City, 14 Feb. 1976 (C. Welbourn), 1 juvenile (AMNH); Hidden Cave (under rock, 20 ft. SW of cave), 17 May 1992 (J. C. Cokendolpher, et al.), 1 female, 1 juvenile (AM-NMSU); Hidden Cave, 15-16 Aug. 1992 (J. C. Cokendolpher, et al.), 2 males (AM-NMSU); Hidden Cave (under rock on surface, within 200 ft. of entrance), 25 Oct 1992 (J. C. Cokendolpher), 1 juvenile (AM-NMSU); Helen's Cave, Carlsbad Caverns National Park, 31 Aug. 1974 (W. C. Wellbourn), 1 juvenile (AMNH); Jurnigan #1 Cave, 4.3 km E, 4.8 km N Whites City, 16 Feb. 1974 (C. Welbourn), 1 subadult female, 2 juveniles (AMNH), 26 Apr. 1975, 1 juvenile female (AMNH), 14 Feb. 1976, 1 male, 1 female, 2 juveniles (AMNH); Lincoln National Forest, Three Fingers Cave (Dark Zone), 28 March 1975 (W. C. Welbourn), 1 female, 1 subadult female (AMNH). TEXAS: *Sutton County*: Caverns of Sonora, 22, 24 Nov. 1996 (G. Veni), 1 chela and telson. *Terrell County*: Longley Cave, 27 June 1963 (J. Reddell, B. Russell), 1 juvenile. *Val Verde County*: Four Mile Cave, 1 Sept. 1974 (S. Sweet), 1 female (AMNH). Seminole Sink, 27 May 1984 (W. Elliott, L. Bement), 1.

Comments.—This species, which is found in southeastern Arizona, southern New Mexico, and southwestern Texas, is probably a troglophile. Recently (Francke, 2009) described *Pseudouroctonus savvasi* from two caves in Coahuila, Mexico, not far from the Val Verde County, Texas localities. The species is distinguishable from *P. apacheanus* on the basis of having a single subdistal tooth on the dorsal margin of the cheliceral movable finger and by differences in the male hemispermatophore. Only the female from Four Mile Cave was available for examination, and that specimen bears a single subdistal tooth on the chelicerae, as in *P. savvasi*. However, variation in this character occurs throughout the range of *P. apacheanus* (WDS, personal observation), rendering identification of female specimens questionable. Tentatively, we have assigned these specimens to *P. apacheanus*, pending collection of males. Welbourn (1978) reported the Helen's Cave specimen as "*Vaejovis* sp."

Pseudouroctonus iviei (Gertsch and Soleglad)

Records.—U.S.A.: CALIFORNIA: *Eldorado County*: Crystal Cave, Somerset (Gertsch and Soleglad, 1972); Crystal Cosumnes Cave (Gertsch and Soleglad, 1972). *Shasta County*: Potter Creek Cave (Gertsch and Soleglad, 1972); Samwell Cave (Gertsch and Soleglad, 1972).

Comment.—This is probably a troglophile.

Pseudouroctonus reddelli (Gertsch and Soleglad)
Figs. 4-5

Records.—U.S.A.: TEXAS: *Bandera County*: Fog Fissure (Gertsch and Soleglad, 1972). *Bexar County*: Government Canyon Bat Cave (Gertsch and Soleglad, 1972); John Wagner Ranch Cave No. 3 (Gertsch and Soleglad, 1972—as Adam Wilson's Cave); Madla's Cave (Gertsch and Soleglad, 1972—as Madla's Ranch Cave); *Burnet County*: Pie Cave (Gertsch and Soleglad, 1972). *Comal County*: Brehmer Cave (Gertsch and Soleglad, 1972); Little Brehmmer-Heidrich Cave (Rowland and Reddell, 1976). *Edwards County*: Deep Cave (Gertsch and Soleglad, 1972); Jacoby Cave (Gertsch and Soleglad, 1972). *Hays County*: Donaldson Cave (Gertsch and Soleglad, 1972); Ezell's Cave (Gertsch and Soleglad, 1972). *Kimble County*: Flemming Bat Cave (Gertsch and Soleglad, 1972). *Real County*: Orell Crevice Cave (Gertsch and Soleglad, 1972); Skeleton Cave (Gertsch and Soleglad, 1972). *Travis County*: Bandit Cave (Gertsch and Soleglad, 1972); Beckett's Cave (Gertsch and Soleglad, 1972); Bee Creek Cave (Gertsch and Soleglad, 1972); Broken Straw Cave (Gertsch and Soleglad, 1972); Cave X (Gertsch and Soleglad, 1972); Cotterell Cave (Gertsch and Soleglad, 1972); Goat Cave (Gertsch and Soleglad, 1972); Ken Harrell Cave (Gertsch and Soleglad, 1972); Kretschmarr Cave (Gertsch and Soleglad, 1972); Tooth Cave (Gertsch and Soleglad, 1972). *Uvalde County*: McNair Cave (Gertsch and Soleglad (1972); North Well Cave (Gertsch and Soleglad, 1972); Tampke Ranch Cave (Gertsch and Soleglad, 1972). *Williamson County*: Cave 31 (Gertsch and Soleglad, 1972); Inner Space Cavern (Gertsch and Soleglad, 1972); Steam Cave (Gertsch and Soleglad, 1972); Williams Cave (Gertsch and Soleglad, 1972).

New records.—MEXICO: NUEVO LEÓN: Cueva de Cuchillo, 2.5 km S of Minas Viejas, 1270 m, 22 April 1988 (P. Sprouse, A. Cobb), 1.

U.S.A.: TEXAS: *Bandera County*: Albino Bat Cave, 3 March 1984 (R. Waters, B. Cowell, J. Ivy) (det. O. F. Francke), 1; Bob Clark Cave, Hill Country State Natural Area, 23 Sept. 2000 (J. Reddell, M. Reyes), 1 juvenile; Can Creek Cave No. 2, Lost Maples State Natural Area, 30 Oct. 2000 (J. Reddell, M. Reyes), 1 female; Fossil Cave, 21 March 1971 (J. Reddell, T. Mollhagen, S. Wylie), 1 female (AMNH); Harvestman Cave, Hill Country State Natural Area, 28 March 1992 (C. Biegert), 1 juvenile; Keese Cave, 11 July 1974 (W. Elliott, D. McKenzie), 1 juvenile (det. W. J. Gertsch) (AMNH); Keese Cave, 6 mi NW Medina, 11 July 1974 (W. Elliott, D. McKenzie), 1 male, 1 juvenile female (AMNH). *Bexar County*: 40mm Cave, Camp Bullis, 29 Nov. 1993 (J. Ivy, J. Reddell, M. Reyes), 2; 5 Oct. 1995 (J. Reddell, M. Reyes), 1; B-52 Cave, Camp Bullis, 10 Sept. 1998 (J. Cokendolpher, J. Krejca, J. Reddell, M. Reyes), 1; 29 Oct. 2001 (J. Krejca, P. Sprouse), 1 juvenile; Black Cat Cave, 28 Nov. 1982 (S. Harden, R.M. Waters) (det. O. F. Francke), 1; 7 Feb. 1987 (L. Palit, A. Cobb), 1 male (WDS); Charley's Cute Little Hole, Camp Bullis, 30 March 1995 (J. Reddell, M. Reyes), 1; Cross the Creek Cave, Camp Bullis, 31 March 1995 (J. Reddell, M. Reyes), 1; 6 Oct. 1995 (J. Reddell, M. Reyes), 1; 31 Oct, 2000 (J. Reddell, M. Reyes), 1 female; Crownridge Canyon Cave, 9 June 2002 (J. Reddell, M. Reyes), 1 juvenile; Dancing Rattler Cave, Government Canyon State Natural Area, 21 April 2001 (K. Scanlon), 1 male; Elmore Cave, 24 Oct. 1982 (R. Waters) (det. O. F. Francke), 1; Genesis Cave, June 1985 (R. Waters, A. Cobb), 1; 14 Sept. 1986 (R. Waters, W. Elliott), 1; 2 Dec. 2004 (A. Gluesenkamp, P. Sprouse), 2; Hold Me Back Cave, Camp Bullis, Zone 1, 3 March 1994 (W. Elliott, G. Veni), 1; HPD Cave, Government Canyon State Natural Area, 2 Nov. 2001 (K. White, H. Bechtol), 1 female; Isopit, March 1983 (E. Short), 1 (det. O. F. Francke); Kick Start Cave, 30 May 2002 (G. McDaniel, C. Savvas), 1 juvenile; Logan's Cave, 8 June 1993 (J. Loftin, J. Reddell, M. Reyes, G. Veni), 1 juvenile; Madla's Cave, 7 June 1969 (R. Bartholomew), 1 juvenile (AMNH). 24 May 1993 (J. Reddell, M. Reyes), 1 late instar juvenile female; MARS Pit, Camp Bullis, 4 April 1996 (W. Elliott), Zone

3, 1 male; 10 Sept. 1998 (J. Cokendolpher, J. Krejca), 1; 29 Oct. 2001 (J. Krejca, P. Sprouse), 1 juvenile; Mattke Cave, 10 June 1993 (D. McKenzie, J. Reddell, M. Reyes), 1 late instar juvenile male, 1 late instar juvenile female; Phil's Line Cave, Iron Horse Canyon, Helotes, 7 April 2005 (M. Warton), 1; Plethodon Pit (=site #602, #604), Stone Oak Karst Region, north of 1604 and 218 intersection, 19 Sept. 1999 (Kemble White) 1; Jan. 2000 (K. White), 1; Por Boy Ranch Cave, 13 Aug. 1983 (G. Veni), 1; Porcupine Cave, Government Canyon State Natural Area, 12 Sept. 2001 (G. Veni), 1 female; Robbers Cave, no date (A.G. Grubbs), 1 juvenile; Root Toupee Cave, Camp Bullis, 5 Dec. 1994 (G. McDaniel, B. Johnson), 1; Scenic Overlook Cave, 11 May 2000 (K. White), 2; Scorpion Cave, 1 June 1993 (J. Loftin, J. Reddell, M. Reyes, G. Veni), 1 female; Strange Little Cave, Camp Bullis, 29 Nov. 1993 (J. Reddell, M. Reyes), 1; 22 March 2004 (B. Shade, G. Veni), 1; Surprise Sink, Government Canyon State Natural Area, 21 April 1996 (G. Veni, K. Veni, J. Kennedy), 1 juvenile; 29 May 2002 (J. Krejca, T. Engelhard, M. Holmback), 1 juvenile; 10K Cave, Government Canyon State Natural Area, 16 Dec. 2007 (M. Miller), 1 juvenile; Three Fingers Cave, 22 June 1993 (J. Loftin, J. Reddell, M. Reyes), 1 juvenile, 1 late instar juvenile female; Tick 'n Delight Cave, 16 March 1993 (G. Veni, J. Ivy), 1 late instar juvenile male; Well Done Cave, Camp Bullis, 15 April 2002 (J. Reddell, M. Reyes, G. Veni), 2 juveniles; Winston's Cave, Camp Bullis, 13-14 Dec. 1993 (J. Ivy, L. McNatt, G. Veni), 1; Young Cave No. 1, 6 Aug. 1983 (G. Veni, J. Ivy) (det. O. F. Francke), 1; 6 Sept. 1993 (J. Reddell, M. Reyes), 1 late instar juvenile female. *Burnet County*: M.V.N. Cave, 20 March 1993 (A. Grubbs, T. Whitfield), 1 juvenile. *Comal County*: Coreth Bat Cave, 28 Oct. 1995 (J. Reddell, M. Reyes), 1; May 2000 (J. Krejca), 1 female; Little Bear Creek Cave, 30 Jan. 1988 (C. Biegert, P. Reavely, P. Jauk, C. Grant, D. McKenzie), 1 juvenile; Natural Bridge Caverns, 23 Sept. 1989 (O. Knox, J. Reddell, M. Reyes), 1 female; Shadow Cave, Kuhn Ranch, 8 Jan. 2006 (A. Gluesenkamp), 1; Tall Tales Cave, Camp Bullis, 12 Jan. 2000 (Peter Sprouse),

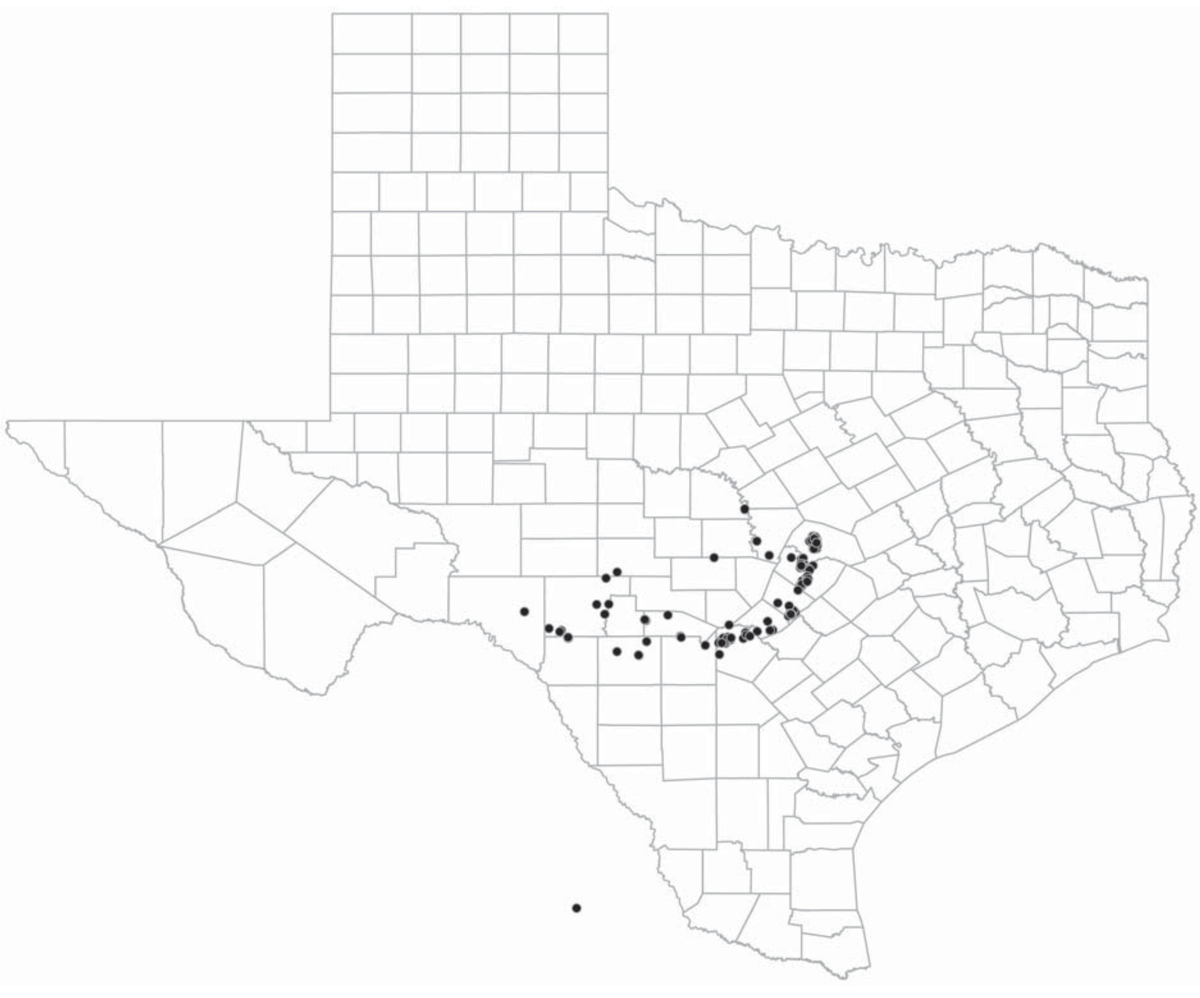


Fig. 4.—Map showing distribution of *Pseudouroctonus reddelli.*

3; 17 Jan. 2000 (J. Reddell, M. Reyes), 1. *Edwards County*: Blue Elm Cave, 2 April 1988 (J. Ivy, S. Tomsett), 1 female; Cueva de la Cola Blanca, 29 Oct. 1988 (W. Elliott), 1 male, 1 female; Deep Cave, 3 March 2005 (A. Gluesenkamp), 12; Fountain Cave, 26 March 1994 (A.G. Grubbs, D. Allen, J.M. Walsh), 1 juvenile; Glynn Cave, 20 Sept. 1969 (C. Kunath, N. Lucas), 2 males (AMNH) Sky High Cave, 3 Sept. 2005 (M. Reyes, M. Warton, 1; Skylight Cave, 27 Sept. 1969 (B. Burney), 1 male (det. W. J. Gertsch (AMNH); Sumac Cave, 2 April 1988 (S. Tomsett), 1 juvenile. *Hays County*: Sinkhole, 5 Willow Court, Wimberley, 18 June 2005 (A. Gluesenkamp, S. Summers, L. Adams), 4; Anyway Cave, San Marcos, 11 April 2001 (G. Veni), 1 adult; Assassin Cave, 7 Sept. 1985 (A. Cobb), 1; Autumn Woods Well, potato peel bait trap, 22 Aug. 1993 (W. Russell), 1; Boggus Cave, 21 June 1984 (A. Cobb), 1; 20 April 1986 (W. Elliott), 1; 4 April 2001 (J. Reddell, M. Reyes), 1 male; Donaldson Cave, 16 Jan. 1986 (A. Cobb), 1; 20 April 1986 (W. Elliott, J. Cradit, R. Green), 2; 4 April 2001 (J. Reddell, M. Reyes), 1 subadult female, 1 juvenile; Ezell's Cave, 28 Dec 1977, 1 juvenile (AMNH); 2 Feb. 1979, 3 juveniles (AMNH); 6 Aug. 2000 (P. Sprouse, X. de la Rosa), 1 male; Fern Cave, 26

Fig. 5.—*Pseudouroctonus reddelli* feeding on *Ceuthophilus* cave cricket.

May 1989 A. Grubbs, J. Reddell, M. Reyes), 1 male (WAS); Fox Cave, San Marcos, 7 Nov. 2001 (G. Veni), 1 juvenile; Ladder Cave, 26 May 1989 (A. Grubbs, J. Reddell, M. Reyes), 1 subadult male; McCarty Cave, 1988 (A. Grubbs), 2 juveniles; 6 March 2000 (J, Kennedy), 1; 15 Dec. 2000 (J. Kennedy), 1 female; McGlothlin Sink, 16 May 1989 (A. Grubbs, J. Reddell, M. Reyes), 1 subadult male; Rattlesnake Cave, San Marcos, 19 Nov. 2000 (J. Krejca), 1 juvenile. *Kendall County*: Cueva de los Tres Bobos, 2 Aug. 1987 (A. Cobb, S. Harden, G. Veni), 1 juvenile male; Falcon Point Cave, Cordillera Ranch, 4 Nov. 2000 (M. Warton), 1 adult; Grand Column Cave, 1-5 March 1999 (M. Reyes), 1 female. *Kinney County*: Kickapoo Cave, 17 Oct. 1987 (A. Cobb), 1 juvenile; 17 Oct. 1987 (W. Elliott), 1 male; 28 Nov. 1987 (G. Veni), 1 female; Scorpion Cave, 17 Oct. 1987 (G. Veni, J. Ivy), 1 female, 1 juvenile. *Llano County*: Enchanted Rock Cave, 14 April 1985 (J. Reddell, M. Reyes), 1. *Medina County*: Nisbet Cave, 4 March 2001 (G. Veni, R.M. Waters), 1 juvenile. *Real County*: Red Arrow Cave, 12 March 2005 (J. Kennedy, A. Cobb, S. Summers, T. Scott, A. Scott), 1. *San Saba County*: Sour Cave, Feb. 1996 (J. Kennedy), 1 subadult male. *Travis County*: Airman's Cave, 14 May 1984 (J. Reddell, M. Reyes), 2; Amber Cave, 8 April 1984 (J. Reddell, M. Reyes) (det. O. F. Francke), 1; Bandit Cave, 6 May 1973 (T. Byrd, R. Fieseler), 1 subadult female (det. W. J. Gertsch), (AMNH); Bee Creek Cave, 4 Oct. 1975 (T. Byrd, M. Cossey, A. Grubbs), 1 juvenile (det. W. J. Gertsch) (AMNH); Cave X, 4 May 2004 (C. Collins, K. White), 1; Cortana Cave (F17), 14 Sept. 2006 (Bev Shade), 1 female (probably subadult); Deer Stand Cave, Dec. 1988 (J. Reddell, M. Reyes), 2 juveniles; Disbelievers Cave, 4 Jan. 1995 (M. Warton), 1; Down Dip Sink, 29 March 2007 (Peter Sprouse), 1 male; Feather Sink, 2 July 1990 (J. Reddell, M. Reyes), 1 juvenile female; Flint Ridge Cave, 19 Jan. 1989 (M. Grimm, J. Reddell, M. Reyes), 1 female, 1 subadult female, 1 juvenile male; 22 Dec. 1999 (G. Veni), 1 juvenile; Four Points Karst Feature F-14, 22 Dec. 1994 (M. Warton), 1; Gallifer Cave, 20 April 1991 (J. Reddell, M. Reyes), 1 juvenile; GCWA Cave, 15 May 1996 (W.R. Elliott), 1 subadult male; Jest John Cave, 26 Jan. 1991 (M. Warton), 1 juvenile; 29 May 1993 (W. Russell, J. Sigmond), 1 juvenile; Jester Estates Cave, 4 June 1990 (J. Reddell, M. Reyes), 1 juvenile male; 10 June 1990 (J. Reddell, M. Reyes), 1 juvenile; Karst Feature F1, 15 Aug. 2006 (Andy Gluesenkamp, Peter Sprouse), 1 male, 1 female; Kretschmarr Double Pit, 20 April 1991 (J. Reddell, M. Reyes), 1 juvenile male, 1 subadult female; LaCrosse Cave, 3 May 1990 (J. Reddell, M. Reyes), 1 juvenile female; 8 May 1990 (J. Reddell, M. Reyes), 1 female; Little Black Hole, 9 June 1994 (W. Elliott, P. Sprouse), 3; Little Shoal Creek Storm Sewer, 31 Oct. 1993 (W. Russell), 1; Live Oak Cave, 11 July 1998 (W. Russell, J. Jenkins), 2; Lost Gold Cave, March 1973 (W. Elliott, R. Fieseler), 1 male (det. W. J. Gertsch) (AMNH); 29 March 1974 (W. Elliott, R. Fieseler), 1 subadult female (AMNH); Lost Oasis Cave, 31 Oct. 1985 (D. Pate, W. Russell), 1; McDonald Cave, 18 May 1984 (D. Pate, J. Reddell, M. Reyes) (det. O. F. Francke), 1; 15 Dec. 1988 (J. Reddell, M. Reyes), 1 juvenile; Maple Run Cave, 31 Jan. 1991 (J. Reddell, M. Reyes), 1 juvenile; Moonmilk Cave , 9 Feb. 1995 (W. Elliott), 1; 28 Feb. 1995 (P. Sprouse), 1; New Comanche Trail Cave, 26 Jan. 1989 (J. Reddell, M. Reyes), 1 juvenile; Pickle Pit, 7 May 1989 (W. Elliott, J. Reddell, M. Reyes), 1 juvenile; Pipeline Cave, outside entrance, Oct. 1983 (W. Russell), 1; Rock Joint Sink, 4 Sept. 2002 (M. Reyes, M. Warton), 1 female; Singletary Cave, 27 June 1990 (J. Reddell), 1 female; Spyglass Cave, 8 Dec. 1997 (M. Sanders), 1; Stovepipe Cave, 25 Oct. 1990 (J. Reddell, M. Reyes), 1 male; Substation Sink, 4 June 1990 (M. Reyes), 1 male; Tooth Cave, 7 April 1984 (M. Reyes), 1 (det. O. F. Francke); Travis Water Treatment Plant Karst Feature F-5, Sept. 2002 (M. Reyes, M. Warton), 1 male; Twisted Elm Cave, 22 Dec. 1994 (M. Warton), 1; West Rim Cave, 9 April 1992 (M. Warton), 1 juvenile. *Uvalde County*: Big Foot Cave, 13 May 1989 (M. Warton), 2 juveniles; Cement Tank Cave, 12 July 1974 (W. Elliott, P. Lynn, D. McKenzie), 1 male, 1 female, 1 juvenile (det. W. J. Gertsch) (AMNH); Cristin's Cave, 27 April 1983 (R. Waters), 1 (det. O. F. Francke); Crom Cave, Summer 1983 (R. Waters), 1 (det. O. F. Francke); Frio King Cave, 8 June 1985 (A. Grubbs, M. Warters, A. Cobb), 3; Jester's Gold Cave, 4 April 1993 (J. Loftin), 1 juvenile; Maybe Stream Cave, 24 July 1974 (W. Elliott, S. Sweet), 1 juvenile (AMNH); Moss Pit Cave, 13 May 1989 (M. Warton), 1 subadult male, 1 juvenile; Secret Valley Cave, Feb. 1984 (R. Waters), 2 (det. O. F. Francke); Tampke Ranch Cave, 25 July 1974 (W. Elliott, S. Sweet), 1 juvenile (AMNH); West Holler Cave, 13 July 1974 (D. McKenzie, K. Morton), 1 juvenile (AMNH). *Val Verde County*: Fawcett's Cave, 10 April 1968 (J. Reddell), 1 female, 1 juvenile (det. W. J. Gertsch) (AMNH); 29 March 1975 (R.W. Mitchell), 1 female (det. W. J. Gertsch) (AMNH); 8 Aug. 1987 (D. Pate), 1 subadult male; 16 Nov. 2003 (J. Kennedy), 1. *Williamson County*: Abused Cave, 21 April 1993 (M. Warton), 1 female, 2 juveniles; Apache Cave, Sun City, 9 Dec. 1993 (J. Reddell, M. Reyes), 1; Bone Cave, 4 June 1989 (W. Elliott, J. Reddell, M. Reyes), 1 subadult female; Broken Plate Cave, 20 April 1993 (M. Warton), 1 juvenile; Deliverance Cave No. 1, Sun City, 18 Nov. 1993 (J. Reddell, M. Reyes), 1; Double Dog Hole Cave, Sun City, 25 March 1994 (J. Reddell, M. Reyes), 1; East Fork Fissure, 5 July 1991 (W. Elliott, D. Green), 1 juvenile; 13 June 1995 (J.

Reddell, M. Reyes), 1; Electro-Mag Cave, Sun City, 24 July 1995 (J. Reddell, M. Reyes), 1; Flat Rock Cave, 25 May 1992 (R. Aalbu, J. Reddell, M. Reyes), 1 late instar juvenile female; Kiva Cave No. 1, Sun City, 6 March 1994 (J. Reddell, M. Reyes), 1; Ku Klux Klan Cave, 2 Sept. 1990 (D. Allen, W. Elliott), subadult male, 1 female; Lobo's Lair, 28 July 1991 (J. Reddell, C. Savvas, M. Warton), 1 juvenile female; 1 Sept. 1991 (W. Elliott, J. Reddell, M. Reyes, M. Warton), male, 1 female; 1 Sept. 1991 (J. Reddell, M. Reyes), Berlese of litter, 1 juvenile; 13 Sept. 1991 (J. Reddell, M. Reyes), 1 male; Lorfing's Unseen Rattler Cave, 10 Nov. 1990 (W. Elliott, J. Reddell, M. Reyes), 1 juvenile female; Marigold Cave, 18 Sept. 1988 (P. Sprouse), 1 juvenile; Off Campus Cave, 8 April 1989 (W. Elliott, J. Reddell, M. Reyes), 1 female, 1 subadult female, 1 juvenile female, 1 juvenile; Papoose Cave, Sun City, 9 Dec. 1993 (J. Reddell, M. Reyes), 1; Polaris Cave, 19 April 1994 (J. Reddell, M. Reyes), 1; Pussy Cat Cave; 5 June 1991 (J. Reddell, M. Reyes), 1 male; Quahadi Cave, Sun City, 20 April 1994 (J. Reddell, M. Reyes), 1; Red Crevice Cave, 24 April 1991 (W. Elliott, J. Reddell, M. Reyes), 1; Shaman Cave, Sun City, 29 Sept. 1994 (J. Reddell, M. Reyes), 1; Smoke Signal Cave, Sun City, 25 March 1994 (J. Reddell, M. Reyes), 1; 8 April 2000 (J. Reddell, M. Reyes), 1; Sting Cave, Sun City, 28 Sept. 1995 (P. Sprouse), 1; Susana Cave, 7 March 1991 (J. Reddell, M. Reyes), 1 subadult male; Temples of Thor Cave, 10 May 1991 (L. J. Graves, M. Warton), 1 juvenile; 13 May 1991 (J. Reddell, M. Reyes), 1 male, 1 juvenile female; 17 May 1991 (W. Elliott, L. J. Graves), 1 female; 13 Nov. 1999 (J. Krejca, P. Sprouse), 2; 20 Nov. 1998 (J. Krejca), 1 juvenile; 14 Jan. 2003 (J. Krejca, P. Sprouse), 1; Terrell's Cave, 20 Nov. 1991 (J. Reddell, M. Reyes), 1 juvenile; Testudo Tube, July 2002 (J. Krejca, P. Sprouse), 2; Texella Cave, 28 Sept. 1981 (J. Reddell, M. Reyes), 1 female; Turner Goat Cave, Sun City, 17 Nov. 1993 (J. Reddell, M. Reyes), 1; 16 April 1994 (J. Reddell, M. Reyes), 1; 8 April 2000 (J. Reddell, M. Reyes), 1; 13 Dec. 2006 (J. Reddell, M. Reyes), 1 subadult female. Undercut Cave, Sun City, 18 Nov. 1993 (J. Reddell, M. Reyes), 1; Unearthed Cave, 17 Nov. 1993 (J. Reddell, M. Reyes), 1; Venom Cave, Sun City, Zone 1, 17 Nov. 1993 (J. Reddell, M. Reyes), 1; 29 Sept. 1995 (P. Sprouse), 1; Waterfall Canyon Cave, 22 May 1992 (J. Reddell, M. Reyes), 1 female; Wolf's Cave, 7 Aug. 1983 (W. Elliott, B. Vinson, D. Pate) (det. O. F. Francke), 4; 19 Jan. 1991 (A. Cobb, W. Elliott), 1 chela; Woodruff's Well Cave, Sun City, 8 April 2000 (J. Reddell, M. Reyes), 1; Zee End Cave, Sun City, 25 Oct. 1994 (J. Reddell).

Comment.—This species is seasonally abundant in some caves. It reproduces in caves and is a troglophile. It is occasionally common on the surface, especially under rocks in oak litter on slopes. It has been observed feeding on cave crickets (Rhaphidophoridae: *Ceuthophilus*).

Pseudouroctonus savvasi Francke

Records.—MEXICO: COAHUILA: Cueva de la Azufrosa (Francke, 2008); Cueva de Casa Blanca (Francke, 2008).

Comments.—This species is known only from these two caves, but the species shows no troglomorphic adaptations and is a troglophile. See also the Comments for *Pseudouroctonus apacheanus*.

Pseudouroctonus sprousei Francke and Savary

Record.—MEXICO: COAHUILA: El Abra (cave) (Francke and Savary, 2006).

Comments.—This large species is known only by the male holotype. It has slightly reduced eyes and pigmentation and is more attenuated than its closest relative, *P. reddelli.*

Serradigitus sp.

New record.—MEXICO: NUEVO LEÓN: Sótano del Anticlino, Sept. 1971 (Terry Raines), 1 juvenile (det. W. J. Gertsch) (AMNH).

Comments.—The specimen, which could not be located in the AMNH collection, was identified by Gertsch as belonging to the *wupatkiensis* group of *Vaejovis*, which now comprises the genus *Serradigitus*. The genus is not otherwise known from Nuevo Leon.

Serradigitus gertschi striatus (Hjelle)

New records.—U.S.A.: CALIFORNIA: *Tuolumne County*: Indian Quarry Cave, SW ¼ Sec 26, T3N R14E, 3 mi NE Columbia, 28 March 1979 (D. C. Rudolph, B. Martin, S. Winterath), 1 juvenile (AMNH); Scorpion Cave, in entrance area, rocks and soil, 12.6 km NNW Sonora, 1 Feb. 1978 (no collector given), 1 juvenile (AMNH); Vulture Cave, NE ¼ Sec 34, T3N R14E, 3 mi NW Columbia, 22 Feb. 1974 (D. C. Rudolph, S. Winterath, B. Martin), 1 juvenile (AMNH).

Comments.—*Serradigitus gertschi striatus* is common outside of caves throughout the California Coast Range (Hjelle, 1972). Like other members of the genus, it specializes in rocky habitats, often associated with cracks and cliff faces. Its presence inside caves is accidental.

Serradigitus wupatkiensis (Stahnke)

New record.—U.S.A.: IDAHO: *Adams County*: Ashmead Cave, 1972 (no day, month, or collector), 1 male (AMNH).

Comment.—This species is widespread over western U.S.A., and can be common on rocky slopes, rocky outcrops, and cliff faces. Its presence in the cave is certainly accidental.

Uroctonites sequoia (Gertsch and Soleglad)

Record.—U.S.A.: CALIFORNIA: *Tulare County*: Clough Cave (Gertsch and Soleglad, 1972).

New Record.—U.S.A.: CALIFORNIA: *Tulare County*: Windy Pit, 4 May 2004 (J. Krejca, S. Fryer, J. Snow, P. Sprouse), 1 (fragments) (AMNH).

Comment.—This species was described from Clough Cave but it shows no adaptations for cave existence and is at best a troglophile.

Uroctonus grahami Gertsch and Soleglad

Record.—U.S.A.: CALIFORNIA: *Shasta County*: Samwell Cave (Gertsch and Soleglad, 1972).

Comments.—This probable troglobite is known only from this cave. The median eyes are reduced.

Uroctonus mordax Thorell

Record.—U.S.A.: CALIFORNIA: *Eldorado County*: Crystal Cave, Somerset (Gertsch and Soleglad, 1972).

New Record.—U.S.A.: CALIFORNIA: *Mariposa County*: Water Pit Cave, Sec. 29? T2S R18E, 10 mi E Coulterville, 7 Apr 1979 (D. C. Rudolph, B. Martin, S. Winterath, D. Cowan, T. Lakner), 1 male, 1 juvenile female (AMNH).

Comments.—This is probably an accidental. The species is widespread on the surface in California, Oregon, and extreme southern Washington.

Vaejovis spp.

New records.—MEXICO: DURANGO: Cueva de los Riscos, 15 June 1972 (E. Alexander, W. Elliott, C. Kunath, J. Reddell), 5 juveniles (det. W. J. Gertsch) (AMNH). *Nuevo León*: Cueva del Chorros de Agua, 19 June 1969 (S. and J. Peck, R. Norton), 1 juvenile (det. W. J. Gertsch) (AMNH). TAMAULIPAS: Cueva de San Rafael de los Castros, 10 April 1966 (J. Fish, D. McKenzie), 1 female (det. W. J. Gertsch) (AMNH).

U.S.A.: TEXAS: *Val Verde County*: Litterbarrel Cave, 1 Sept. 1974 (M. Reaka, S. Sweet), 2 juveniles (det. W. J. Gertsch) (AMNH).

Vaejovis n.sp (*nitidulus* group)

Records.—MEXICO: OAXACA: Cueva del Lencho Virgen (Soleglad, 1975). *Veracruz*: Cueva del Volcancillo (Soleglad, 1975).

New record.—MEXICO: OAXACA: Sótano de Yusuhillo, Putla de Guerrero, 7 Jan. 1990 (T. Raines), 1 subadult male.

Comment.—Soleglad (1975) originally identified the specimens from Cueva del Lencho Virgen and Cueva del Volcancillo as *Vaejovis gracilis.*

Vaejovis carolinianus (Beauvois)

Record.—U.S.A.: ALABAMA: *Jackson County*: Sheldons Cave (Peck, 1989).

New record.—U.S.A.: ALABAMA: *Dekalb County*: Mose's Tomb. Dec. 1985 (A. Grubbs), 1 pedipalp.

Comment.—This common species is an accidental.

Vaejovis sp. nr. *chisos* Sissom

New records.—MEXICO: COAHUILA: Pozo del Hongo, 1540 m N of Los Llanitos, 5 km NW of Mesa de Las Tablas, Ejido de Potrero, 2450 m, 16-17 July 1993 (P. Sprouse), 1 juvenile female; Cueva de Los Llanitos, 5 km NW Mesa de las Tablas, 2540 m, 3 Sept. 1995 (A. Cobb), 1 female.

Comment.—These specimens are very close to *Vaejovis chisos*, known from the Chisos Mountains of Big Bend National Park, Texas. Unfortunately, males are not known from the Mexican localities, and it is very difficult to say with certainty whether they are actually *V. chisos* or a new species. The species is possibly a troglophile.

Vaejovis davidi Soleglad and Fet

Records.—MEXICO: PUEBLA: Cueva de la Barranca (Soleglad and Fet, 2005); Grutas de Jonotla (Soleglad and Fet, 2005).

Comment.—This species with slightly reduced eyes was erroneously reported as *V. gracilis* by Soleglad (1975). It is possibly a troglobite.

Vaejovis gracilis Gertsch and Soleglad

Records.—MEXICO: VERACRUZ: Cueva de Atoyac (Gertsch and Soleglad, 1972; Soleglad, 1975); Cueva del Cabrito (Sissom and González-Santillán, 2004); Sótano de las Golondrinas (Sissom, 1986); Gruta del Ojo de Agua, Paraje Nuevo (Sissom and González-Santillán, 2004); Cueva del Ojo de Agua de Tlilapan (Volschenk and Prendini, 2008).

Comments.—This species was described from a small juvenile. Soleglad (1975) published a re-description of the species based on adults from Oaxaca, Puebla, and Veracruz. These specimens have since been demonstrated not to be *V. gracilis* (Sissom 1986). The specimens from Puebla were recently described as *V. davidi*. Sissom (1986) re-described *V. gracilis* based on a male from nearby Sótano de las Golondrinas.

Vaejovis intermedius Borelli

Record.—MEXICO: CHIHUAHUA: Clarines Mine, 5 mi. NW Santa Barbara (Sissom, 1991).

New record.—U.S.A.: TEXAS: *Brewster County*: Inside highway tunnel NW of Boquillas del Carmen, May 1987 (Peter Sprouse), 1 female.

Comments.—This accidental is widespread in western Texas and southwestern Mexico. It is not known if the specimen from Clarines Mine was taken from within the mine.

Vaejovis mexicanus C.L. Koch

Record.—MEXICO: MORELOS: Cueva del Diablo (Palacios-Vargas and Morales-Malacara, 1983).

Comments.—*Vaejovis mexicanus* is widespread in forested, montane habitats in the states of Distrito Federal and Mexico. Its appearance in caves is probably accidental.

Vaejovis minckleyi Williams

Record.—MEXICO: COAHUILA: Cave 5.3 km NW of Cuatro Ciénegas (Williams, 1968).

Comments.—The holotype was collected "inside a cave, 20 meters from the entrance on an exposed wall" (Williams, 1968). It is also known from the surface in Coahuila. It is possibly a troglophile.

Vaejovis mitchelli Sissom

Record.—MEXICO: SAN LUIS POTOSÍ: Cueva de Cristián (Sissom, 1991).

Comment.—This possible troglophile is also known from epigean localities in Querétaro.

Vaejovis nigrescens Pocock

New record.—MEXICO: SAN LUIS POTOSÍ: Cueva de Las Rusias, 5 Aug. 1966 (J. Reddell, J. Fish), 2 juvenile females (det. W. J. Gertsch) (AMNH).

Comment.—This is probably an accidental. The specimen was not found at the AMNH and the identifcation could not be verified.

Vaejovis norteno Sissom and González-Santillán

Records.—MEXICO: COAHUILA: Cueva de Los Llanitos (Sissom and González-Santillan, 2004). *Nuevo León*: Hoya Aporrear (Sissom and González-Santillán, 2004); Cueva Oyamal (Sissom and Gonález-Santillán, 2004); Cueva San Francisco de Asis (Sissom and González-Santillán, 2004).

Comment.—This species is known only from caves but is a troglophile.

Vaejovis rossmani Sissom

Records.—MEXICO: TAMAULIPAS: Cueva de la Boca (Sissom, 1989); Sistema Purificación (Cueva de Oyamel Section) (Sissom, 1989).

New record.—MEXICO: TAMAULIPAS: Cueva de Mas Cable, Nov. 1994 (S. Lasko), 1.

Comment.—This troglophile is otherwise known from the surface in Nuevo León and Tamaulipas, Mexico.

Vaejovis rubrimanus Sissom

Record.—MEXICO: NUEVO LEÓN: Gruta Sur de San Bartolo (Sissom, 1991).

Comment.—This probable accidental was also taken on slopes in the same canyon.

Vaejovis sprousei Sissom

Records.—MEXICO: NUEVO LEÓN: Cueva del Escorpión (González-Santillán, Sissom, and Pérez, 2004); Cueva del Mono (González-Santillán, Sissom, and Pérez, 2004).

Comment.—This is a probable troglophile; it has also been found in surface habitats in the Purificación area, Nuevo León and Tamaulipas.

ACKNOWLEDGMENTS

Identifications of earlier specimens were made by the late Willis J. Gertsch (American Museum of Natural History) and Oscar F. Francke (Universidad Nacional Autónoma de México).

We are grateful to Lorenzo Prendini and Jeremy Huff of the American Museum of Natural History for the loan of specimens.

We thank the numerous cave explorers listed in the records section for each species. They have contributed specimens for more than 40 years. The project would not have been possible without their assistance. Special thanks go to James C. Cokendolpher, William R. Elliott, Jean Krejca, Marcelino Reyes, Peter Sprouse, and George Veni for their contribution of specimens and assistance in the field.

David McKenzie is thanked for preparing the distribution map of *Pseudouroctonus reddelli*.

Robert W. Mitchell generously allowed use of his photographs of cave scorpions.

LITERATURE CITED

Armas, L. F. de, and J. J. Palacios-Vargas. 2002. Nuevo *Diplocentrus* de Yucatán, México (Scorpiones: Diplocentridae). Solenodon, 2:6-10.

Beutelspacher, B., R. Carlos, and W. López-Forment C. 1991. Una especie nueva de *Diplocentrus* (Scorpionida: Diplocentridae) de México. Anales del Instituto de Biología, Universidad Nacional Autónoma de México, Séries Zoología, 62:33-40.

Chamberlin, R. W., and W. Ivie. 1938. Arachnida of the orders Pedipalpida, Scorpionida and Ricinulida. Carnegie Institute of Washington Publication, 491:101-107.

Francke, O. F. 1977. The genus *Diplocentrus* in the Yucatan Peninsula with description of two new troglobites (Scorpionida, Diplocentridae). Association for Mexican Cave Studies Bulletin, 6:49-61.

Francke, O. F. 1978. New troglobite scorpion of genus *Diplocentrus* (Scorpionida, Diplocentridae). Entomological News, 89:39-45.

Francke, O. F. 1981. A new genus of troglobitic scorpion from Mexico (Chactoidea, Megacorminae). Bulletin of the American Museum of Natural History, 170:23-28.

Francke, O. F. 1982. Studies of the scorpion subfamilies Superstitioninae and Typhlochactinae, with description of a new genus (Scorpiones, Chactoidea). Association for Mexican Cave Studies Bulletin, 8:51-61/Texas Memorial Museum Bulletin, 28:51-61.

Francke, O. F. 1986. A new genus and a new species of troglobite scorpion from Mexico (Chactoidea, Superstitioninae, Typhlochactini). Texas Memorial Museum Speleological Monographs, 1. Pp. 5-9.

Francke, O. F. 2009. Description of a new species of troglophile *Pseudouroctonus* (Scorpiones, Vaejovidae) from Coahuila, Mexico. Texas Memorial Museum Speleological Monographs, 7. Studies on the cave and endogean fauna of North America, V. Pp. 11-18.

Francke, O. F., and W. E. Savary. 2006. A new troglobitic *Pseudouroctonus* Stahnke (Scorpiones: Vaejovidae) from northern Mexico. Zootaxa, 1302:21-30.

Gertsch, W. J., and M. Soleglad. 1972. Studies of North American scorpions of the genera *Uroctonus* and *Vejovis* (Scorpionida, Vejovidae). Bulletin of the American Museum of Natural History, 148:547-608.

González-Santillán, E., W. D. Sissom, and T. María Pérez. 2004. Description of the male of *Vaejovis sprousei* Sissom, 1990 (Scorpiones, Vaejovidae). Texas Memorial Museum Speleological Monographs, 6. Studies on the cave and endogean fauna of North America, IV. Pp. 9-12

Hjelle, J. T. 1972. Scorpions of the Northern Californian coast ranges. Occasional Papers of the California Academy of Sciences, 92: 1-59.

Mitchell, R. W. 1968. *Typhlochactas*, a new genus of eyeless cave scorpion from Mexico (Scorpionida, Chactidae). Annales de Spéléologie, 23:753-777, unnumbered plate.

Mitchell, R. W. 1971. *Typhlochactas elliotti*, a new eyeless cave scorpion from Mexico (Scorpionida, Chactidae). Annales de Spéléologie, 26:135-148.

Mitchell, R. W., and S. B. Peck. 1977. *Typhlochactas sylvestris*, a new eyeless scorpion from montane forest litter in Mexico (Scorpionida, Chactidae, Typhlochactinae). Journal of Arachnology, 5:159-168.

Palacios-Vargas, J. G., and J. B. Morales-Malacara. 1983. Biocenois del algunas cuevas de Morelos. Mémoires de Biospéologie, 10:163-169.

Peck, S. B. 1989. The cave fauna of Alabama: Part I. The terrestrial invertebrates (excluding insects). NSS Bulletin, 51:11-33.

Reddell, J. R. 1977. A preliminary survey of the caves of the Yucatan Peninsula. Association for Mexican Cave Studies Bulletin, 6:215-296.

Rowland, J. M., and J. R. Reddell. 1976. Annotated checklist of the arachnid fauna of Texas (excluding Acarida and Araneida). Occasional Papers of The Museum, Texas Tech University, no. 38. 25 pp.

Sissom, W. D. 1986**.** Description of the male of *Vaejovis gracilis* Gertsch and Soleglad (Scorpiones: Vaejovidae), with a clarification of the identity of the species. Texas Memorial Museum Speleological Monographs, 1. Pp. 11-16.

Sissom, W. D. 1988. *Typhlochactas mitchelli*, a new species of eyeless, montane forest litter scorpion from northeastern Oaxaca, Mexico (Chactidae, Superstitioninae, Typhlochactini). Journal of Arachnology, 16:365-371.

Sissom, W. D. 1989. Systematic studies on *Vaejovis granulatus* Pocock and *Vaejovis pusillus* Pocock, with descriptions of six new related species (Scorpiones, Vaejovidae). Revue Arachnologique, 8:131-157.

Sissom, W. D. 1991. Systematic studies on the *nitidulus* group of the genus *Vaejovis*, with descriptions of seven new species (Scorpiones, Vaejovidae). Journal of Arachnology, 19:4-28.

Sissom, W. D. 1994. Systematic studies on the genus *Megacormus* (Scorpiones, Chactidae, Megacorminae), with descriptions of a new species from Oaxaca, Mexico and of the male of *Megacormus segmentatus* Pocock. Insecta Mundi, 8:265-272.

Sissom, W. D., and J. C. Cokendolpher. 1998. A new troglobitic scorpion of the genus *Typhlochactas* (Superstionidae) from Veracruz, Mexico. Journal of Arachnology, 26:285-290.

Sissom, W. D., and E. González-Santillán. 2004. A new species and new records for the *Vaejovis nitidulus* group, with a key to the Mexican species (Scorpiones, Vaejovidae). Texas Memorial Museum Speleological Monographs, 6. Studies on the cave and endogean fauna of North America, IV. Pp. 1-8.

Soleglad, M. E. 1975. A redescription of *Vejovis gracilis* Gertsch & Soleglad based on the adult (Scorpionida: Vejovidae). Wasmann Journal of Biology, 33:107-120.

Soleglad, M. E. 1976. A revision of the scorpion subfamily Megacorminae (Scorpionidae: Chactidae). Wasmann Journal of Biology, 34:251-303.

Soleglad, M. E., and V. Fet. 2005. A new scorpion genus (Scorpiones: Vaejovidae) from Mexico. Euscorpius, 24:1-13.

Volschenk, Erich S., and Lorenzo Prendini. *Aops oncodactylus,* gen. et sp. nov., the first troglobitic urodacid (Urodactidae: Scorpiones), with a re-assessment of cavernicolous troglobitic and troglomoprhic scorpions. Invertebrate Systematics, 22:235-257.

Wagner, F. W. 1977. Descriptions of *Centruroides* Marx from the Yucatan Peninsula (Arachnida, Scorpionida, Buthidae). Association for Mexican Cave Studies Bulletin, 6:39-47.

Welbourn, W. C. 1978. Biology of Ogle Cave with a list of the cave fauna of Slaughter Canyon. NSS Bulletin, 40:27-34.

Williams, S. C. 1968. Scorpions from northern Mexico: Five new species of *Vejovis* from Coahuila, Mexico. Occasional Papers of the California Academy of Sciences, 68:1-24.

Montaño Moreno, Héctor, and Oscar F. Francke. 2009. A new species of *Agastoschizomus* (Schizomida: Protoschizomidae) from Guerrero, Mexico [Nueva especie de *Agastoschizomus* (Schizomida: Protoschizomidae) de Guerrero, México]. Texas Memorial Museum Speleological Monographs, 7. Studies on the cave and endogean fauna of North America, V. Pp. 33-36.

A NEW SPECIES OF *AGASTOSCHIZOMUS* (SCHIZOMIDA: PROTOSCHIZOMIDAE) FROM GUERRERO, MEXICO

Héctor Montaño Moreno and **Oscar F. Francke**

Colección Nacional de Arácnidos, Instituto de Biologia
Universidad Nacional Autónoma de México
Apto, Postal 70-153, México, D. F. 04510
Email: hmontano@ibiologia.unam.mx, offb@ibiologia.unam.mx

ABSTRACT

Agastoschizomus juxtlahuacensis is described from Grutas de Juxtlahuaca, Guerrero. It is a troglobite, as are the other four known species in the genus. This is the first species in this genus reported from the Sierra Madre Occidental.

RESUMEN

Se describe *Agastoschizomus juxtlahuacensis* de las Grutas de Juxtlahuaca, Guerrero. La nueva especie es troglobia, al igual que las cuatro conocidas anteriormente. Es la primera especie de dicho género reportada para la Sierra Madre Occidental.

INTRODUCTION

Mexico has one of the more diverse schizomid faunas of the World: two families (one of which is endemic), seven genera (five endemic), and 34 named species distributed throughout most of the country. The family Protoschizomidae has two troglobitic genera: *Protoschizomus* Rowland with seven species, and *Agastoschizomus* Rowland with four. The family Hubbardiidae is represented by five genera: *Pacal* Reddell and Cokendolpher with three species, *Mayazomus* Reddell and Cokendolpher with two species, *Schizomus* Cook with one, *Sotanostenochrus* Reddell and Cokendolpher with two, and *Stenochrus* Chamberlin with fifteen (Cokendolpher and Reddell, 1992).

The four named species of *Agastoschizomus* come from caves in the Sierra Madre Oriental, in the states of Hidalgo (one species), San Luis Potosí (two) and Tamaulipas (one). Recently, a juvenile specimen was reported from Guerrero (Armas and Palacios-Vargas, 2006). The objective of this contribution is to describe the first species from a cave in the Sierra Madre Occidental, representing the southernmost distribution record for the family. This is the smallest species in the genus, requiring slight revisions to the generic diagnosis.

METHODS

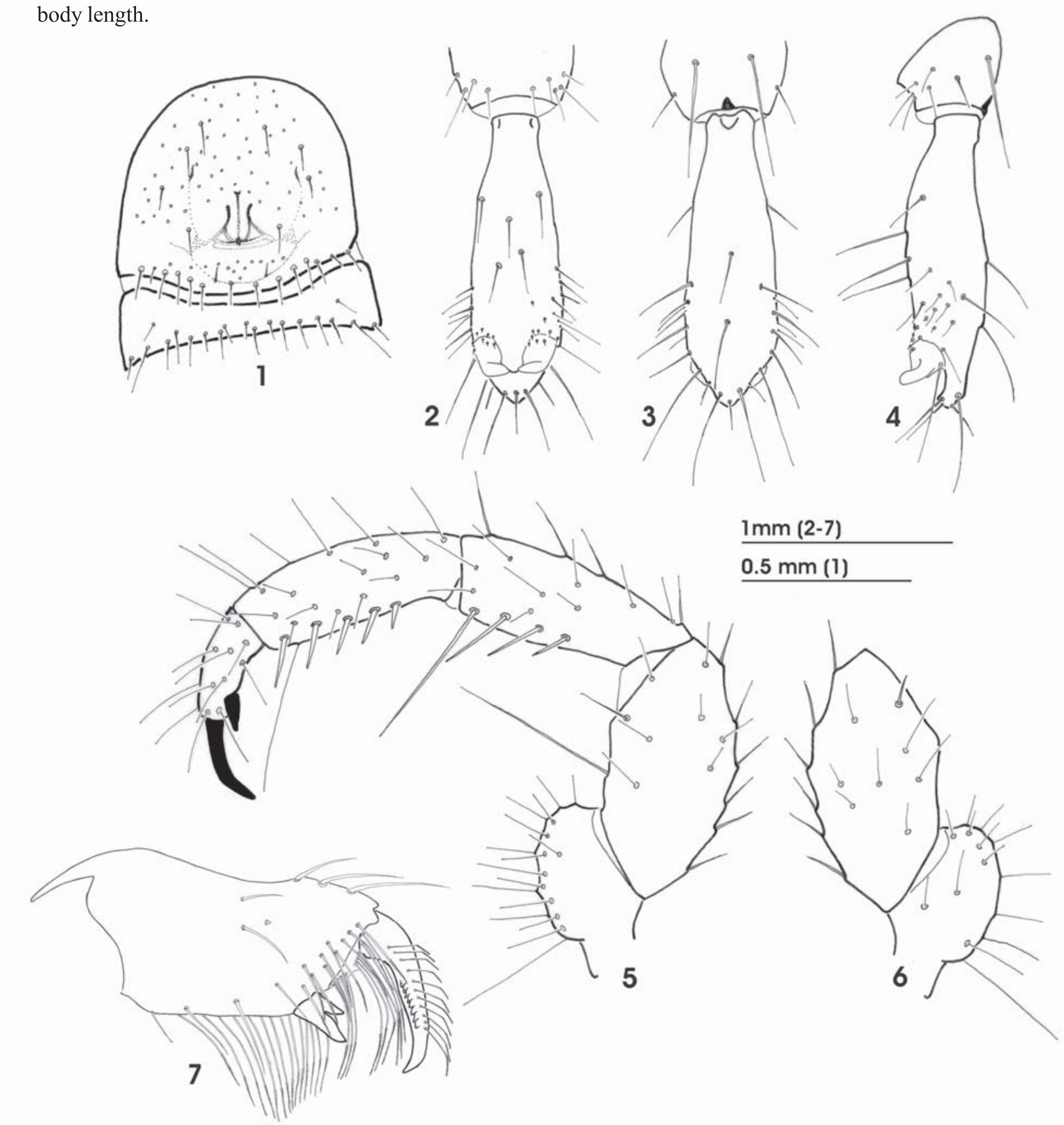
Eight specimens were collected during two visits to the cave, 700 m or more beyond the entrance. The specimens were immediately fixed in 80% ethanol. Dissections (chelicera and female genital plate) were done under a Nikon SMZ-800 stereoscope fitted with a camera lucida for the illustrations. Detailed observations were done with a Nikon Optiphot II microscope with differential phase interference. The male genital sclerites were not chemically treated for the illustration; the female genital sclerites and chelicera were cleared with lactophenol for two minutes. The description follows those by Cokendolpher and Reddell (1992).

Genus *Agastoschizomus* Rowland

Diagnosis.—Cavernicolous. Relatively large, 6.57 to 12.40 mm in total length (excluding the flagellum). Propeltidium with one seta on anterior process. Anterior process downturned or not apically. Anterior sternum with one or two sternapophysial setae. Gap between mesopeltidial plates 0.1 to 0.3 times anterior width of the plates. Sternites V-VIII of male with two distinct rows of setae. Sternite VI 2.0 to 3.0 times wider than long; width/length ratio versus body length 2.2 to 5.4. Female flagellum with or without segments and articles. Male flagellum not expanded distally, with or without retractable ventrolateral lobes. Female pedipalp in proportion to body length 0.9 to 1.2 times relative length of male pedipalp. Pedipalpal spur 0.33 to 0.7, claw about 0.88 to 1.3 dorsal length of basitarsus-tarsus. Femur IV 4.8 to 8.2 times longer than deep. Legs I and IV longer than body length.

Agastoschizomus juxtlahuacensis, new species
Figs. 1-10

Material examined.—MEXICO: *Guerrero*, Grutas de Juxtlahuaca, N 17° 26.324', W 99° 09.570' (938 m), Juxtlahuaca, Municipio de Quechultenango: holotype male (T-0245), one adult male paratype (T-0246), one juvenile female paratype (T-0249), and one unsexed juvenile paratype (T-0252) collected on 5 April 2007 (H.



Figs. 1-7.—Holotype male of *Agastoschizomus juxtlahuacensis.* 1. genital plate; 2. ventral view of flagellum; 3. dorsal view of flagellum; 4. lateral view of flagellum; 5. retrolateral view of left pedipalp; 6. prolateral view of basal segments of left pedipalp; 7. prolateral view of left chelicera.

Montaño, O. F. Francke, A. Valdez, C. Santibáñez); one adult male paratype (T-0247), one juvenile male paratype (T-0248), and two juvenile female paratypes (T-0250 and T-0251) collected on 14 June 2007 (H. Montaño, O. F. Francke, J. Ponce-Saavedra, A. Ballesteros, M. Córdova). All specimens deposited in the Colección Nacional de Arácnidos (CNAN), Instituto de Biología, UNAM.

Etymology.—The specific name refers to the cave where the species was found.

Diagnosis.—Relatively small, adult length 6.57 mm (excluding flagellum); metapeltidium divided as in *Agastoschizomus lucifer* Rowland, from which it differs in having four ventrolateral spinose setae on the pedipalp patellae; pedipalp claw shorter (0.88) than dorsal length of tarsus-basitarsus, whereas it is longer in the other four species in the genus; flagellum with ventrolateral lobes present; serrula on movable finger of the chelicera with eight teeth.

Description.—Male holotype (length from distal edge of propeltidium to base of flagellum) 6.57 mm. Color: Pedipalps and propeltidium light orange, opisthosoma brownish.

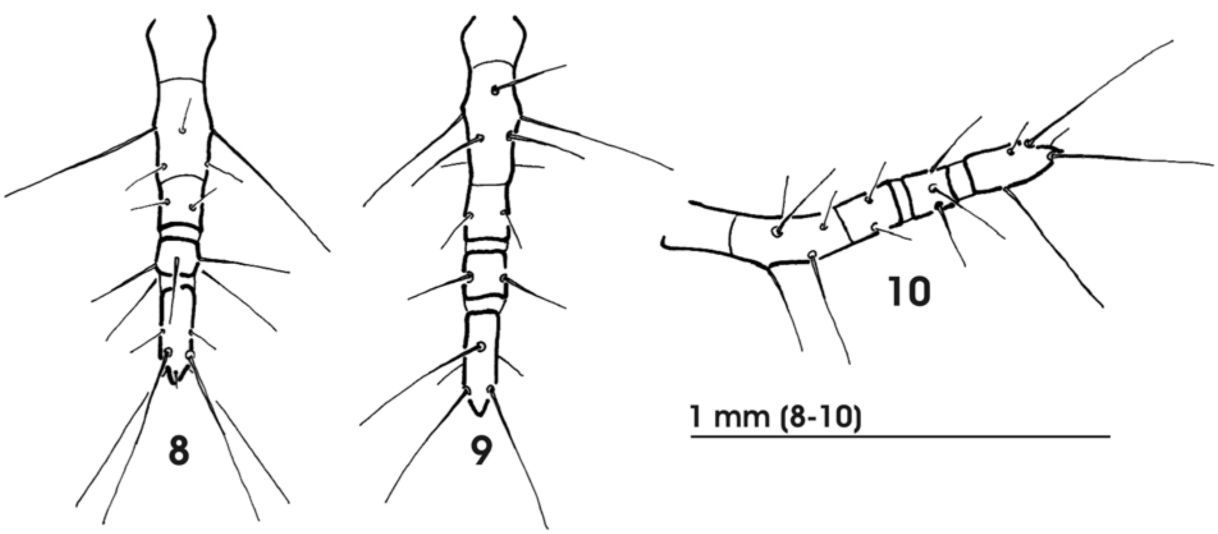
Cephalothorax: Propeltidium 2.05 mm long, 1 mm wide; anterior process slightly curved downward, with one apical seta and one pair of setae at base of process; with three pairs of medial setae with the second pair longer than the others, and a pair of shorter setae posteriorly; without ocular spots. Mesopeltidial plates 0.5 mm long; gap between the plates about 0.21 anterior width of one plate. Metapeltidium divided, each plate about 0.55 mm wide. Anterior sternum triangular, with 10 setae. Posterior sternum with four setae.

Abdomen: Tergite I with two pairs anterior microsetae (in row) and one pair large posterior setae; tergite II with three pairs anterior microsetae (in row) and one pair large posterior setae; tergites III and IV with one pair dorsal setae each; tergites V-VII with one pair dorsal and one pair smaller dorsolateral setae; tergite VIII with two pairs dorsal setae and one pair dorsolaterally; tergite IX with one pair dorsal, and one pair dorsolateral setae; Tergites X-XII semi-telescopic, XII being longest. Ventrally with a series of three pairs of branchial spots slightly more pigmented than the sclerites. Genital plate clearly sclerotized (Fig. 1), with four pairs longer setae. Sternite VI three times longer than wide; width/length ratio versus body length, 2.2. Sternites V-IX with two distinct submarginal rows of setae. Flagellum (Figs. 2-4) 1.33 mm long, 0.3 mm wide, tubular with one pair short non-sclerotized retractable ventrolateral lobes with 9-11 small setae distally under each lobe; two setae dorsally along midline, and five ventral setae.

Pedipalps (Figs. 5-6): Trochanter semi-ovate, without sharp distal margins, without mesal spur. Femur with two thickened setae on ventral margin, basal one longer (0.44 mm) and spiniform; with six spiniform setae dorsally. Patella with four ventrolateral spinose setae, basalmost shorter (0.11 mm) and distalmost longest (0.61 mm). Tarsus-basitarsus with two symmetrical spurs, 0.33 dorsal length of segment; claw 0.88 length of segment.

Chelicera (Fig. 7): Serrula with eight teeth. Seta: 1=3, 2=6, 3=11, 4=5, 5=0, 6=3.

Legs: Leg 1, including coxa, 10 mm long; basitarsal-tarsal proportions 43:9:11:9:9:8:34. Femur IV 5.15 times longer than deep.



Figs. 8-10.—Juvenile female of *Agastoschizomus juxtlahuacensis*. 8. dorsal view of flagellum; 9. ventral view of flagellum; 10. lateral view of flagellum.

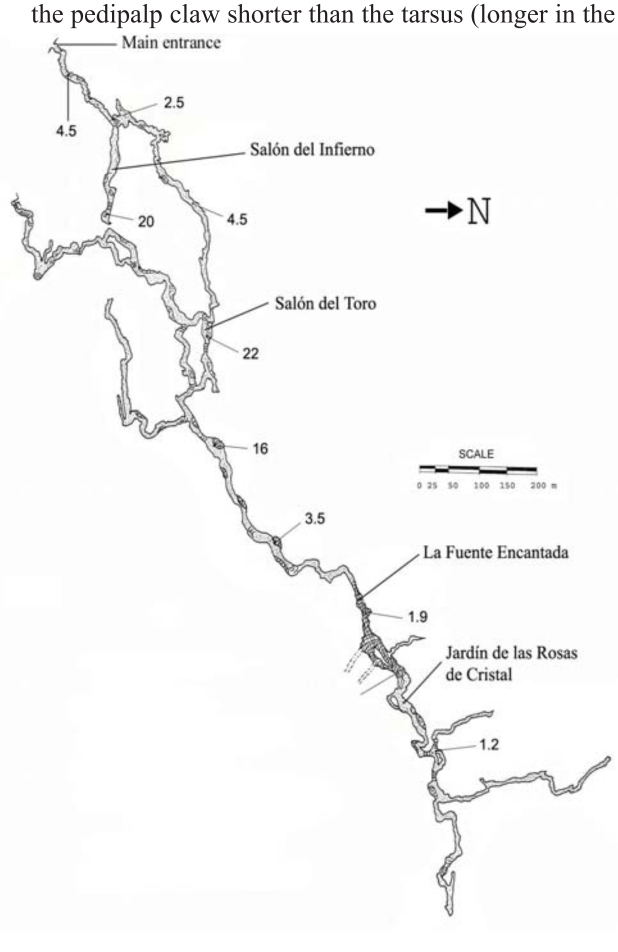
Presumed juvenile female. Without apparent sexual dimorphism; 6.2 mm long. Genital plates not sclerotized, so spermathecae could not be observed despite having cleared them with lactophenol and examined with phase contrast microscopy. Flagellum (Figs. 8-10) with five segments, distalmost two with articulated rings (=annuli); 15 thick and 10 thin setae.

Variation: Dorsal setae (type 6) on chelicera vary from two to three. The spines on the pedipalp femur vary from three to four. There can be three or four dorsal setae on segment V. One juvenile had an extra pair of dorsal median setae on the propeltidium. The number of teeth on the serrula of the chelicera varies between seven (3 specimens) and eight (4 specimens).

Measurements (mm).—Holotype male: Pedipalp: trochanter 0.63; femur 1.00; patella 0.93; tibia 0.87; basitarsus-tarsus 0.45; total 3.88. Leg I: coxa 0.65; trochanter 0.72; femur 2.33; patella 2.65; tibia 2.00; basitarsus 0.53; tarsus 1.12; total 10. Leg IV: trochanter 1.06; femur 2.29; patella 1.10; tibia 1.80; basitarsus 1.48; tarsus 0.90; total 8.63.

Comparisons.—*Agastoschizomus juxtlahuacensis* differs from the other four species in the genus in having the pedipalp claw shorter than the tarsus (longer in the others), and in having four tarsal spines on the pedipalp patella (the others have three or less). *Agastoschizomus juxtlahuacensis* shares with *A. lucifer* the split metapeltidium (in the other three species it is not divided), and on males of both species the flagellum is similar in size and shape, although in lateral view it is more bulbous in *A. lucifer*. The new species shares with *A. lucifer* and with *A. huitzmolotitlensis* Rowland the presence of ventrolateral lobes on the male flagellum (absent in the other three species).

Habitat.—The cave entrance is located at an elevation of 938 m, in tropical deciduous scrub forest. The main passage is approximately 1900 m long, with several side branches (Fig. 11). The specimens were found in Salón del Toro and beyond, at least 700 m from the entrance; and approximately 630 m from Salón del Infierno, which is where large bat colonies roost, and from where potential food is available. At that depth the temperature and relative humidity are quite stable throughout the year (Valdez, 2006). The cave is "exploited" for ecotourism by the local inhabitants, and the impact of human visitors is increasing inside the cave; therefore, we consider this population of schizomids to be threatened.



ACKNOWLEDGMENTS

We are thankful to the inhabitants of Juxtlahuaca for allowing us to enter the cave, for acting as guides, and for permission to collect inside the cave. We thank our friends and colleagues for help inside the cave: A. Jesus Ballesteros, Milagros Córdova A., Javier Ponce, Carlos Santibáñez and Alejandro Valdez M. Finally, James C. Cokendolpher and James R. Reddell kindly provided us with some of the references cited in this paper.

LITERATURE CITED

Armas, L. F. de, and J. G. Palacios-Vargas. 2006. Primer registro de Protoschizomidae (Arachnida: Schizomida) para el estado de Guerrero, México. Boletín de la Sociedad Entomológica Aragonesa, 38:345-346.

Cokendolpher, J. C., and J. R. Reddell. 1992. Revision of the Protoschizomidae (Arachnida: Schizomida) with notes on the phylogeny of the order. Texas Memorial Museum, Speleological Monographs, 3: Studies on the cave and endogean fauna of North America, II. Pp. 31-71.

Reddell, J. R., and J. C. Cokendolpher. 1995. Catalogue, bibliography, and generic revision of the order Schizomida (Arachnida). Texas Memorial Museum, Speleological Monographs, 4: Studies on the cave and endogean fauna of North America, III. Pp. 1-170.

Valdez, A. 2006. Diversidad de arañas (Arachnida: Araneae) relacionadas con Las Grutas de Juxtlahuaca, Guerrero, Mexico. Tesis, Facultad de Ciencias, Universidad Nacional Autonoma de Mexico. 115 pp.

Paquin, Pierre, Nadine Dupérré, and James R. Reddell. 2009. A new troglophilic *Agyneta* from Colorado, the first description of the female of *Agyneta llanoensis* from Texas caves, and a first classification of North American Linyphiidae as troglobites or troglophiles [Una nueva *Agyneta* troglófila de Colorado, la hembra de *Agyneta llanoensis* de Texas, y una primera clasificación de Linyphiidae norteamericanos como troglobios o troglófilos]. Texas Memorial Museum Speleological Monographs, 7. Studies on the cave and endogean fauna of North America, V. Pp. 37-55.

A NEW TROGLOPHILIC *AGYNETA* FROM COLORADO, THE FIRST DESCRIPTION OF THE FEMALE OF *AGYNETA LLANOENSIS* FROM TEXAS CAVES, AND A CLASSIFICATION OF NORTH AMERICAN CAVE LINYPHIIDAE (ARANEAE) AS TROGLOBITES OR TROGLOPHILES.

Pierre Paquin

Cave and Endangered Invertebrate Research Laboratory
SWCA Environmental Consultants
4407 Monterey Oaks Boulevard, Building 1, Suite 110
Austin, Texas, 78749 U.S.A.
Email: ppaquin@swca.com

Nadine Dupérré

American Museum of Natural History
Division of Invertebrate Zoology
Central Park West at 79th Street,
New York, New York, 10024 U.S.A
Email: nduperre@amnh.org

and

James R. Reddell

Texas Natural Science Center
The University of Texas at Austin
10100 Burnet Rd., Bldg. 176
Austin, Texas 78758 U.S.A.
Email: jreddell.caves@mail.utexas.edu

ABSTRACT

Agyneta llanoensis (Gertsch and Davis, 1936) and *Agyneta hedini,* new species are described from Texas and Colorado caves, respectively. The female of *A. llanoensis* is documented for the first time. Both species are illustrated and their distributions assessed. *Agyneta llanoensis* is a species commonly found in Texas caves and its distribution extends to caves in Alabama and Tennessee, although it includes two surface records from Texas and one from Wisconsin. All known North American Linyphiidae species associated with caves were scored according to their eye reduction and specificity to cave habitat, in order to produce a first classification of these species as troglophiles or troglobites. *Anthrobia mammouthia* is restored as the correct spelling for this troglobitic Linyphiidae.

RESUMEN

Agyneta llanoensis (Gertsch y Davis, 1936) y *Agyneta hedini,* especie nueva, se describen de cuevas de Texas y Colorado, respectivamente. La hembra de *A. llanoensis* se reporta por primera vez. Ambas especies se ilustran y se analizan sus distribuciones. *Agyneta llanoensis* es una especie encontrada comúnmente en las cuevas de Texas y su distribución se extiende a cuevas en Alabama y Tennessee, e incluye dos registros superficiales de Texas y uno de Wisconsin. Todas las especies norteamericanas conocidas de Linyphiidae asociadas a cuevas fueron evaluadas en base a reducción del tamaño de los ojos y a la especificidad al hábitat cavernícola, para producir una primera clasificación de estas especies como troglófilas o troglobias. El nombre *Anthrobia mammouthia* se restaura como el deletreo correcto para este Linyphiidae troglobio.

INTRODUCTION

Linyphiidae associated with caves in North America display different degrees of adaptations to subterranean life with species that are highly troglobitic, to some that show little or no morphological modifications. For instance, the reduction of eyes is variable among these species and ranges from totally absent to no obvious reduction. The exclusivity to karst habitat is also variable; some species have only been collected in caves, while others are also known from surface records. The traditional ecological classification of species as trogloxenes (roost in caves but must emerge for food), troglophiles (reproduce in caves but may also live on the surface) and troglobites (obligate cavernicoles) (Barr and Holsinger, 1985) is a useful and widespread terminology, although the assignment of some species as a troglophile or a troglobite is not always straightforward (Paquin and Anderson, 2009).

In this paper, we re-describe the male of *Agyneta llanoensis* (Gertsch and Davis, 1936) and provide the first description of the female. The species is known from many Texas caves, but the type specimen is a surface record. We also describe *Agyneta hedini* new species, known only from two specimens collected in a Colorado cave. In order to provide a reliable assignment of *A. llanoensis* and *A. hedini,* new species, as troglophiles or troglobites, we are proposing a first ecological classification of 20 North American Linyphiidae species associated with caves based on their degree of eye reduction and exclusivity to cave habitat.

METHODS

Specimens were examined in 70% ethanol under a SMZ-U Nikon dissection microscope. A Nikon Coolpix 950 digital camera was attached to the microscope for photographing the structures to be illustrated. The digital photos obtained were traced to establish proportions and the illustrations detailed and shaded by referring back to the structure under the microscope. Female genitalia were excised using a sharp entomological needle and cleared in lactic acid. For the study of the embolic divisions (Figs. 4-6, 14, 16-17) and female cleared epigynums (Figs. 9–11, 20–22), structures were placed for ~10 minutes in warm KOH, washed in 80% alcohol, mounted on a slide in lactic acid and observed under an AmScope XSG Series T-500 compound microscope, then photographed and illustrated as explained above. All measurements are in millimeters and were made using a micrometric ruler fitted to a microscope eyepiece. When possible, five specimens of each sex and species were measured for description. Calculation for the location of Tm I follows Denis (1949). Palpal and epigynal terminology follows Saaristo (1973), Saaristo and Tanasevitch (1996), Saaristo and Koponen (1998), and Hormiga (2000). Saaristo and Tanasevitch (1996:171) provide detailed description and definition of female epigynum morphology. Color description was done under halogen lighting, using traditional color names. Subsequently, we matched the color of the specimen to a reference Pantone™ chart (Pantone Formula Guide, solid matte) and added the color code to the description.

Material from the following collections was examined: American Museum of Natural History (AMNH, New York, New York, U.S.A.), Texas Memorial Museum (TMMC, Austin, Texas, U.S.A.), Texas A&M University Insect Collection (TAMUIC, College Station, Texas, U.S.A.) and Collection Paquin-Dupérré (CPAD, Shefford, Québec, Canada).

Latitude and longitude data are not given to preserve the confidentiality of cave locations. Coordinates of surface records are given in decimal degrees.

In order to classify *A. llanoensis* and *A. hedini* new species as troglophiles or troglobites, we have compiled a list of North American Linyphiidae associated with caves – including some taxa awaiting taxonomic description – and ranked the species to produce two tables. Most of the data used to compile these tables are from specimens curated in the CPAD collection, but the following references were also consulted: Ivie (1965, 1969), van Helsdingen (1973, 1981), Millidge (1984), Gertsch (1992), Cokendolpher and Buckle (2004), Miller (2005a, b), Paquin, et al. (in press). Table 1 accounts for the eye reduction and ranged from no obvious adaptations to totally eyeless. Comparison with other members of the genus was taken into account when possible (*Oreonetides, Bathyphantes, Centromerus,* etc.), but this was not possible for the monospecific genus *Phanetta*. This ranking eased the scoring of each species. Table 2 accounts for the dependence to cave habitat and allows an independent ranking according to this criteria. For instance, species which are found in caves at the southern edge of their distribution but are known from some surface records at the northern edge receive a lower score than a species only known from caves. The final ranking of the species is obtained from the addition of the scores of both tables (total – 2), and ranged from 0 to 10 (Fig. 24).

TAXONOMY

Family Linyphiidae Blackwall, 1859
Agyneta Hull, 1911

Type species.—*Agyneta decora* (O. Pickard-Cambridge, 1871).

Diagnosis.—See Saaristo, 1973:461–465.

Agyneta llanoensis (Gertsch and Davis 1936)
Figs. 1–11, 25-26

Microneta llanoensis Gertsch and Davis 1936: 11, figs. 14–16 (Dm).
Meioneta llanoensis (Gertsch and Davis 1936): van Helsdingen 1973: 8 (Tm from *Microneta*);
Agyneta llanoensis (Gertsch and Davis 1936): Buckle, et al., 2001: 91, 92, 100; Reddell and Cokendolpher 2004: 87.

Type material.—*Microneta llanoensis* Gertsch and Davis 1936, Llano, Texas, Dec 1934 (L. Irby Davis), male holotype [30.759’N; -98.675’W], AMNH examined**.**

Other material examined (TMMC except as otherwise noted).—**U.S.A.: ALABAMA:** ***Conecuh County*****:** Turk’s Cave, 12 Aug. 1965 (S. and J. Peck), 1 male, 1 female, 5 juveniles (AMNH). **TENNESSEE:** ***Van Buren County*****:** McElroy Cave, 2 Jan. 1960 (T. Barr), 1 male, 2 females (AMNH). **TEXAS:** ***Bell County*****:** Afternoon Cave, Fort Hood, 4 March 2005 (M. Reyes), 1 male; 4 May 2005 (M. Reyes), 1 female; 4 April 2007 (M. Reyes), 1 juvenile; Awesome Entrance Cave, Fort Hood; 25 Sept. 2004 (J. Reddell, M. Reyes, M. Warton), 1 female; 8 Feb. 2006 (J. Reddell, M. Reyes), 2 males, 1 juvenile; Big Crevice, Fort Hood, Berlese of leaf litter, 13 May 1999 (J. Reddell, M. Reyes), 1 female; Blue Bottle Sink, Fort Hood, 18 Oct. 2005 (M. Warton), 1 female; Blue Green Hole Cave, Fort Hood, 5 April 2007 (J. Fant), 1 male, 1 female; Boca Verde Cave, Fort Hood, 25-26 Feb. 2006 (J. Fant, M. Reyes, M. Warton), 1 male, 1 juvenile; 16 May 2006 (J. Reddell, M. Reyes), 1 female; Born Again Cave, Fort Hood, 8 March 2004 (J. Fant), 1 male, 1 female, 2 juveniles; Buchanan Cave, Fort Hood, 4 Nov. 1998 (J. Cokendolpher, J. Krejca, J. Reddell, M. Reyes), 3 males, 2 juveniles; 4 Nov. 1998 (matured 22 Nov. 1998) (J. Cokendolpher, J. Krejca, J. Reddell, M. Reyes), 1 female; 4 Nov. 1998 (matured 29 Nov. 1998) (J. Cokendolpher, J. Krejca, J. Reddell, M. Reyes), 1 female; 4 Nov. 1998 (matured 18 Nov. 1998) (J. Cokendolpher, J. Krejca, J. Reddell, M. Reyes), 1 female; 4 Nov. 1998 (molted 18 Nov. 1998; matured 1 Jan. 1999) (J. Cokendolpher, J. Krejca, J. Reddell, M. Reyes), 1 male; 4 Nov. 1998 (matured 22 Jan. 1999) (J. Cokendolpher, J. Krejca, J. Reddell, M. Reyes, 1 female; 4 Nov. 1998 (matured 5 Dec. 1998) (J. Cokendolpher, J. Krejca, J. Reddell, M. Reyes), 1 female; 7 May 1998 (L. J. Graves, J. Reddell, M. Reyes), 2 females, 1 juvenile; 5 May 1999 (J. Reddell, M. Reyes), 1 female; 13 June 2000 (J. Krejca, P. Sprouse), 1 female, 1 juvenile; 13 June 2000 (J. Reddell, M. Reyes), 2 males, 2 females, 1 juvenile; 14 Dec. 2001 (J. Reddell, M. Reyes), 1 male; 31 July 2007 (J. Krejca), 1 male; 19 Oct. 2007 (J. Reddell, M. Reyes), 1 female, 3 juveniles; Bumelia Well Cave, Fort Hood, 4 Nov. 1998 (matured 29 Nov. 1998) (J. Cokendolpher, J. Krejca), 1 male; 4 Nov. 1998 (matured 8 Jan. 1999) (J. Cokendolpher, J. Krejca), 1 male; C. B. Cave, Fort Hood, 21 April 1998 (J. Reddell, M. Reyes), 2 females, 1 juvenile; Camp 6 Cave No 1, Fort Hood, 5 May 1999 (J. Reddell, M. Reyes), 1 female, 1 juvenile; 5 May 1999 (J. Reddell, M. Reyes), 1 male; 5 May 1999 (matured 1 June 1999) (J. Reddell, M. Reyes), 1 female; 5 May 1999 (matured 5 July 1999) (J. Reddell, M. Reyes), 1 male; 5 May 1999 (matured 10 July 1999) (J. Reddell, M. Reyes), 1 female; 5 May 1999 (matured 11 July 1999) (J. Reddell, M. Reyes), 1 female; Cellular Cave, Fort Hood, 9 April 2007 (J. Fant), 1 female; Chupacabra Pit Cave, Fort Hood, 3 May 2006 (J. Fant, M. Reyes), 1 male, 1 female, 1 juvenile; Cicurina Cave, Fort Hood, 10 Jan. 2007 (J. Fant, M. Reyes), 1 female; 6 April 2007 (C. Pekins, J. Reddell, M. Reyes, 1 female, 1 juvenile; Copperdead Cave, Fort Hood, 22 May 2005 (J. Fant, M. Reyes), 1 female, 2 juveniles; Corkscrew Cave, Fort Hood, 3 May 2003 (M. Reyes, M. Warton), 1 female; Craggy Rock Cave, Fort Hood, 19 May 2004 (J. Fant), 1 male, 1 juvenile; Deceiving Sink, Fort Hood, 22 Oct. 2005 (M.

Reyes), 1 female; Deep in Dis Bear Cave, Fort Hood, 18 May 1998 (J. Reddell, M. Reyes), 1 female, 3 juveniles; Dual Sinks Cave, Fort Hood, 22 Nov. 2005 (J. Fant, M. Reyes), 1 female; Dying Oak Cave, Fort Hood, 20 April 2007 (J. Fant); Endless Pit Cave, Fort Hood, 15 Oct. 2004 (J. Fant, C. Pekins, J. Reddell, M. Reyes), 1 male, 3 females, 2 juveniles; 9 March 2005 (J. Fant), 1 male, 1 female; Estes Cave, Fort Hood, 28 June 2000 (M. Reyes, M. Warton), 1 male; 28 June 2000 (matured 6 July 2000) (M. Reyes, M. Warton), 1 male; Falling Hat Cave, Fort Hood, 21 April 2006 (J. Fant, M. Reyes), 1 female; Falling Turtle Cave, Fort Hood, 20 March 2004 (J. Fant, R. Ralph), 1 male, 3 females; Fellers Cave, Fort Hood, 6 May 1998 (L. J. Graves, J. Reddell, M. Reyes), 1 male, 1 female; Figure 8 Cave, Fort Hood, 20 April 1998 (L. J. Graves, J. Reddell, M. Reyes), 1 male, 2 females, 5 juveniles; 3 Nov. 1998 (J. Cokendolpher, M. Reyes), 1 male, 1 female; 10 April 2002 (J. Reddell, M. Reyes), 1 female, 1 juvenile; Fire Break Cave, Fort Hood, 2 Oct. 2004 (J. Fant, C. Murray, M. Warton), 1 female; Fools Cave, Fort Hood, 1 April 1999 (J. Reddell, M. Reyes), 1 male, 1 female; Forbidden Chasm Cave, Fort Hood, 4 March 2005 (J. Fant), 2 males, 1 female,1 juvenile; Forgotten Cave, Fort Hood, 1 April 1999 (J. Reddell, M. Reyes), 4 females, 1 juvenile; 16 May 2006 (J. Reddell, M. Reyes), 1 female; Geocache Cave, Fort Hood, 27 June 2004 (C. Pekins, J. Reddell, M. Reyes), 1 female; 11 June 2005 (J. Fant), 2 females, 1 juvenile; 27 April 2007 (J. Fant, J. Reddell), 1 juvenile; Gnarla Cave, Fort Hood, 20 April 1998 (L. J. Graves, J. Reddell, M. Reyes), 3 females, 1 juvenile; Berlese of leaf litter from cave, 24 April 1998 (J. Reddell, M. Reyes), 1 female, 1 juvenile; 24 April 1998 (J. Reddell, M. Reyes), 2 males, 2 females; Green Carpet Cave, Fort Hood, 10 Oct. 2004 (J. Fant, C. Murray, M. Reyes, M. Warton), 1 male, 1 female, 3 juveniles; 4 May 2005 (J. Fant), 2 females; Hammer Crack Cave, Fort Hood, 5 April 2007 (J. Reddell), 1 female; Hidey Ho Cave, Fort Hood, 1 April 2006 (J. Fant, M. Reyes, M. Warton), 1 female; 6 April 2007 (J. Fant, C. Pekins), 1 female, 2 juveniles; Hope Well Sink, Fort Hood, 2 April 2006 (J. Fant, M. Reyes), 1 male; Humpty Cave, Fort Hood, 19 March 2005; (J. Fant, M. Reyes), 1 male, 2 females, 1 juvenile; 3 May 2006 (M. Reyes), 1 female; 20 May 2007 (J. Fant, J. Reddell, M. Reyes), 1 female, 4 juveniles; Jagged Walls Cave, Fort Hood, 14 March 1992 (J. Reddell, M. Reyes), 1 male; L. Z. Sid Cave, Fort Hood, 3 May 2000 (J. Reddell, M. Reyes), 1 female; Legless Visitor Cave, Fort Hood, 22 Oct. 2005 (M. Warton, H. Johnson), 1 male, 1 juvenile; 19 May 2007 (J. Fant, J. Reddell, M. Reyes), 2 males, 2 females, 8 juveniles; 17 Oct. 2007 (J. Reddell, M. Reyes), 1 male; 20 July 2008 (J. Reddell, M. Reyes), 1 male, 2 juveniles; Leopard Frog Cave, Fort Hood, 8 Feb. 2006 (J. Reddell, M. Reyes), 1 female; Long Joint Sink, Fort Hood, Oct. 1995 (M. Warton), 1 female, 1 juvenile; Lost Chasm Cave, Fort Hood, 20 Jan. 2005 (M. Reyes), 1 male; 4 May 2005 (J. Fant, J. Reddell, M. Reyes), 1 male; 18 Oct. 2007 (J. Reddell, M. Reyes), 1 female; Lucky Rock Cave, Fort Hood, 22 Feb. 1996 (D. Allen, L. J. Graves, D. Love), 2 males, 1 juvenile; 10 Sept. 1997 (L. J. Graves, J. Reddell, M. Reyes), 2 females, 4 juveniles; 25 March 1999 (L. J. Graves, J. Reddell, M. Reyes), 1 male, 1 female; 25 March 1999 (J. Reddell, M. Reyes), 1 male, 1 female, 3 juveniles; 5 May 1999 (J. Reddell, M. Reyes), 1 female; 5 May 1999 (matured 1 June 1999) (J. Reddell, M. Reyes), 1 female; 30 April 2002 (J. Reddell, M. Reyes), 1 male; 28 Dec. 2007 (J. Fant, J. Reddell, M. Reyes), 1 male; Marcelino's Cave, Fort Hood, 2 May 2000 (M. Reyes), 2 males, 1 female; Molly Hatchet Cave, Fort Hood, 8-9 Oct. 2005 (J. Fant, M. Reyes), 1 male, 3 females, 1 juvenile; 19 May 2007 (J. Fant, J. Reddell, M. Reyes), 2 females, 3 juveniles; Nolan Creek Cave, Fort Hood, 19 May 1998 (J. Reddell, M. Reyes), 1 juvenile; 28 Dec. 2004 (J. Fant, J. Reddell, M. Reyes), 4 males, 3 females, 2 juveniles; 11 March 2005 (J. Fant, M. Reyes), 2 juveniles; 27 April 2007 (J. Fant, J. Reddell), 1 male, 12 females, 7 juveniles; 20 May 2007 (J. Fant, J. Reddell, M. Reyes), 1 female; Owl Mountain Cave, Fort Hood, 24 Oct. 1995 (D. Allen, L. J. Graves), 1 female, 1 juvenile; 28 May 2000 (J. Reddell, M. Reyes), 1 male; 27 June 2000 (J. Reddell, M. Reyes), 1 female; Peep in the Deep Cave, Fort Hood, 3 Nov. 1998 (J. Cokendolpher, J. Reddell), 1 female, 1 juvenile; 21 April 1998 (J. Reddell, M. Reyes), 1 female, 1 juvenile; 8 May 1998 (J. Reddell, M. Reyes), 2 females; 10 April 2002 (J. Reddell, M. Reyes), 1 male; Plethodon Cave, Fort Hood, 25 July 2004 (J. Fant, M. Reyes), 1 female; 8 May 2005 (J. Fant, J. Reddell, M. Reyes), 1 female, 1 juvenile; 4 May 2006 (J. Fant, M. Reyes), 1 female, 1 juvenile; Plethodon Pit Cave, Fort Hood, 24 March 2004 (J. Fant, C. Pekins, J. Reddell, M. Reyes), 1 male, 2 females, 4 juveniles; 2 May 2005 (J. Fant, M. Reyes), 1 male, 2 females, 3 juveniles; Raining Rattler Cave, Fort Hood, 28 Nov. 2007 (M. Reyes), 1 male, 1 female; Road Side Sink, Fort Hood, 1 July 1993 (M. Warton), 1 female; 3 Nov. 1998 (M. Reyes), 2 females; Rugger's Rift Cave, Fort Hood, 5 Nov. 1998 (J. Reddell, M. Reyes), 2 males, 2 females; Rusty Cans Cave, Fort Hood, 4 Sept. 2004 (J. Fant), 1 male; 19 May 2007 (J. Fant, J. Reddell), 1 female; Sanford Pit Cave, 4 Nov. 1998 (J. Cokendolpher), 1 male, 3 females, 4 juveniles; 4 Nov. 1998 (matured 1 Dec. 1998) (J. Cokendolpher, J. Krejca), 1 female; 4 Nov. 1998 (matured 16 Nov. 1998) (J. Cokendolpher, J. Krejca), 1 male; 4 Nov. 1998 (matured 17 Nov. 1998) (J. Cokendolpher, J. Krejca), 1 female; 4 Nov. 1998 (matured 18 Nov. 1998) (J.

Cokendolpher, J. Krejca), 1 female; 4 Nov. 1998 (matured 8 Dec. 1998) (J. Cokendolpher, J. Krejca), 1 male, 1 female; 18 May 1998 (J. Reddell, M. Reyes), 1 female; Seven Mile Mountain Cave, Fort Hood, 29 April 2002 (J. Reddell, M. Reyes), 1 male; 23 April 2004 (C. Pekins, J. Reddell, M. Reyes ; 11 June 2005 (M. Reyes), 1 female; Skeeter Cave, Fort Hood, 18 May 1999 (L. J. Graves, J. Reddell, M. Reyes), 2 males; 25 Aug. 2003 (C. Pekins, J. Reddell), 1 female, 2 juveniles; Sledgehammer Cave, Fort Hood, 25 June 2003 (J. Reddell, M. Reyes), 1 female; Sleepy Hollow Cave, Fort Hood, 20 April 2006 (J. Fant, M. Reyes), 1 female; Sleepy Hollow Pit, Fort Hood, 1 July 2005 (J. Fant, M. Reyes), 1 female, 13 juveniles; Slotsky Pit Cave, Fort Hood, 6 June 2004 (M. Reyes, M. Warton), 1 male, 1 female; 19 Sept. 2004 (J. Fant, M. Reyes), 3 males, 1 female; Soldiers Cave, Fort Hood, 25 March 1999 (J. Reddell, M. Reyes), 2 females, 1 juvenile; Southern Cross Cave, Fort Hood, 21 Aug. 2003 (C. Pekins, J. Reddell, M. Reyes), 1 male, 2 females, 3 juveniles; Stand-Off Sink, Fort Hood, 14 Jan. 2006 (M. Reyes), 1 male; Stone Eyes Sink, Fort Hood, 4 April 2007 (J. Reddell, M. Reyes), 1 male, 1 female; Streak Cave, Fort Hood, 6 Oct. 1995 (M. Warton), 1 male, 2 females; 26 Sept. 1997 (L. J. Graves, J. Reddell, M. Reyes), 1 male, 3 females, 5 juveniles; 14 June 2000 (J. Krejca, J. Reddell, M. Reyes, P. Sprouse), 1 juvenile; 18 Oct. 2007 (J. Reddell, M. Reyes), 1 female; 15 July 2008 (J. Reddell, M. Reyes), 1 female, 1 juvenile; Talking Crows Cave, Fort Hood, 20 April 1998 (L. J. Graves, J. Reddell, M. Reyes), 2 males, 3 females, 2 juveniles; 2 Nov. 1998 (M. Reyes), 1 male, 1 female; 2 Nov. 1998 (matured 20 Jan. 1999) (M. Reyes), 1 male; 6 June 2000 (J. Reddell, M. Reyes), 1 male, 1 female, 3 juveniles; 6 June 2000 (matured 17 Oct. 2000) (J. Reddell, M. Reyes), 1 female; 18 Aug. 2003 (C. Pekins, J. Reddell, M. Reyes), 2 males, 1 female; 2 June 2005 (J. Fant, J. Reddell, M. Reyes), 1 male, 4 females, 3 juveniles; 4 May 2006 (J. Fant, M. Reyes), 7 males, 4 females; 6 April 2007 (J. Fant, J. Reddell, M. Reyes), 4 females, 3 juveniles; 21 July 2008 (J. Reddell, M. Reyes), 1 male; Thumbs Up Cave, Fort Hood, 12 Oct. 2005 (M. Reyes), 1 female; Tinaja Cave, Fort Hood, 13 May 2007 (J. Fant), 1 female; Tony's Can Cave, Fort Hood, 20 April 2007 (J. Fant), 1 juvenile; 20 May 2007 (J. Reddell, M. Reyes), 1 female; Treasure Cave, Fort Hood, 2 Nov. 1998 (matured 22 Nov. 1998) (J. Cokendolpher, J. Reddell, M. Reyes), 1 female; 2 Nov. 1998 (matured 29 Nov. 1998) (J. Cokendolpher, J. Reddell, M. Reyes), 1 female; 2 Nov. 1998 (matured 28 Dec. 1998) (J. Cokendolpher, J. Reddell, M. Reyes), 1 female; 2 Nov. 1998 (J. Cokendolpher, M. Reyes), 1 female; 21 April 1998 (L. J. Graves, J. Reddell, M. Reyes), 1 female, 1 juvenile; Triple J Cave, Fort Hood, 23 April 1998 (L. J. Graves, J. Reddell, M. Reyes), 1 male, 6 juveniles; Tweedledum Cave, Fort Hood, 14 Oct. 2004 (J. Fant), 1 male; Valentine Cave, Fort Hood, 18 Sept. 1997 (J. Reddell, M. Reyes), 1 male, 3 females; Vine Cave, Fort Hood, 25 Aug. 2004 (J. Fant, M. Reyes), 2 females; Violet Cave, Fort Hood, 5 June 2000 (J. Reddell, M. Reyes), 1 male, 2 juveniles; Viper Den Cave, Fort Hood, 27 Jan. 1990 (J. Reddell, M. Reyes), 1 female; Weep Hole Cave, Fort Hood, 14 Nov. 2002 (M. Reyes, M. Warton), 1 male, 2 juveniles; West Corral Cave No 1, Fort Hood, 3 May 2000 (J. Reddell, M. Reyes, M. Warton), 1 female; 30 Oct. 2002 (M. Reyes, M. Warton), 1 male, 3 females, 5 juveniles; West Corral Cave No 2, Fort Hood, 11 May 2007 (J. Fant), 1 male, 3 females, 5 juveniles; West Corral Cave No 4, Fort Hood, 10 May 2003 (J. Fant, M. Reyes), 1 male, 1 female. ***Bexar County*:** B-52 Cave, Camp Bullis, 6 Dec. 1994 (W. Elliott, J. Ivy), 1 male; 10 Oct. 1998 (J. Cokendolpher, J. Krejca, J. Reddell, M. Reyes), 1 male, 2 females, 1 juvenile; Bexar (=Bear) Cave, 3 July 1968 (J. Reddell, A.R. Smith), 1 female; Bunny Hole, Camp Bullis, 9 Sept. 1998 (J. Cokendolpher, J. Krejca, J. Reddell, M. Reyes), 1 male, 3 females; 9 Sept. 1998 (matured 4 Oct. 1998) (J. Cokendolpher, J. Krejca, J. Reddell, M. Reyes), 1 female; 9 Sept. 1998 (matured 18 Oct. 1998) (J. Cokendolpher, J. Krejca, J. Reddell, M. Reyes), 1 male; 31 March 1995 (J. Reddell, M. Reyes), 1 female; 24 Oct. 1995, (J. Reddell, M. Reyes), 2 females, 2 juveniles; Cannonball Cave, Camp Bullis, 6 Nov. 2001 (P. Sprouse), 1 female, 1 juvenile; 21 Nov. 2001 (J. Reddell, M. Reyes), 1 female; 15 April 2002 (J. Reddell, M. Reyes, G. Veni), 1 female, 1 juvenile; Hairy Tooth Cave, 21 Jan. 1994 (W. Elliott, J. Ivy, G. Veni), 3 males; Dangerfield Cave, Camp Bullis, 5 Dec. 1997 (G. Veni), 1 female; 21 April 1999 (J. Reddell, M. Reyes), 7 females; 25 Jan. 1999 (P. Sprouse, G. Veni), 1 male, 3 females, 1 juvenile; 31 Oct. 2000 (J. Reddell, M. Reyes), 3 males, 6 females, 2 juveniles; Dogleg Cave, Camp Bullis, 25 March 1998 (M. Reyes); 1 male, 2 females; Droll Cave, 2 June 1993 (J. Reddell, M. Reyes, G. Veni), 1 female; Eagles Nest Cave, Camp Bullis, 9 Nov. 1993 (J. Ivy, J. Treviño, G. Veni), 1 female; Elm Springs Cave, no date (A. G. Grubbs), 1 male, 1 female, 1 juvenile; Elm Water Hole Cave, 10 May 2000 (M. Reyes), 2 females; Flying Buzzworm Cave, Camp Bullis, 31 July 2006 (J. Krejca), 1 male, 1 female; Forked Pit, 13 June 1993 (J. Loftin, S. Woods), 1 female; Game Pasture Cave No 1, 2 June 1993 (J. Loftin, J. Reddell, M. Reyes, G. Veni), 1 female; Government Canyon Bat Cave, 11 Aug. 1965 (J. Reddell, J. Fish), 1 female (AMNH); 24 May 1998 (J. Reddell, M. Reyes), 2 males, 2 females; King Toad Cave, 1 June 1993 (J. Loftin, M. Reyes), 1 female; Linda's First Cave Find, 13 June 1993 (J. Loftin, L. Loftin, S. Woods), 1 female; La Cantera Cave No. 3, 20 Sept. 2000 (K. White), 2 females; Lone

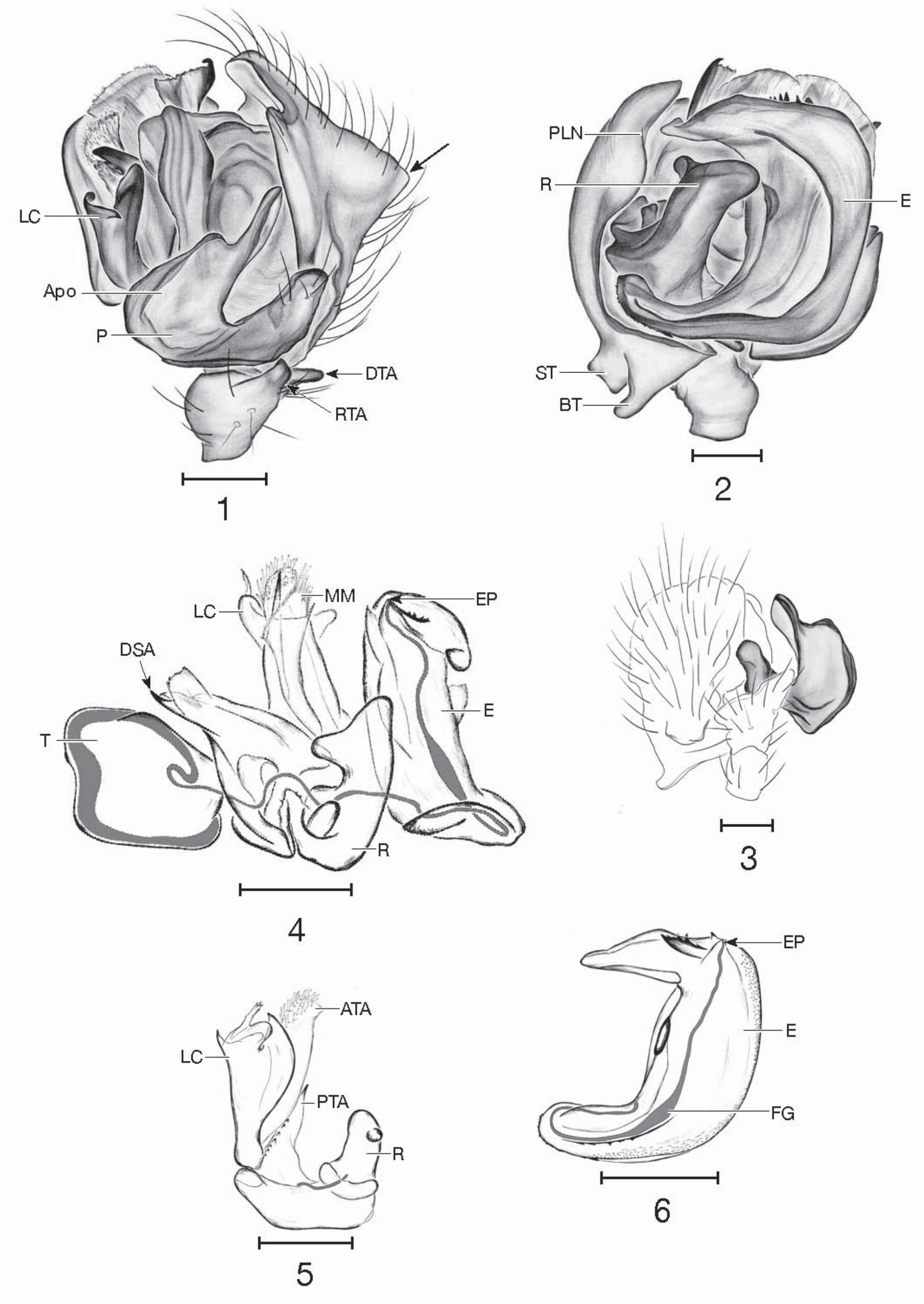
Gunman Pit, Camp Bullis, 8 Sept. 1998 (J. Cokendolpher, M. Reyes), 1 female; 21 April 1999 (matured 15 May 1999) (J. Reddell, M. Reyes), 1 female; Low Priority Cave, Camp Bullis, 29 March 1995 (J. Reddell, M. Reyes), 1 male, 1 female; Max and Roberts Cave, 28 Sept. 2000 (K. White, H. Bechtol), 1 female; Meusebach Flats Cave, 21 Nov. 1997 (G. Veni), 1 male; Obvious Little Cave, 14 June 2001 (J. Cokendolpher), 1 male, 1 female; Peace Pipe Cave, Camp Bullis, 5 Feb. 2001 (P. Sprouse), 1 male; 7 March 2001 (G. Veni), 1 female; 17 April 2001 (J. Reddell, M. Reyes), 1 female; 30 April 2003 (J. Reddell, M. Reyes), 1 female, 1 juvenile; 7 May 2003 (J. Reddell, M. Reyes), 1 female; Plethodon Pit, Stone Oak Karst Region, north of 1604 and 281 intersection, 12 Sept. 1999 (K. White), 3 females, 6 juveniles; Porcupine Parlor Cave, Camp Bullis, 29 March 2001 (G. Veni), 1 female; Raging Cajun Cave, no date (A.G. Grubbs), 1 female; Root Canal Cave, Camp Bullis, 20 April 1999 (J. Reddell, M. Reyes), 1 male; 26 Oct. 2001 (J. Krejca, P. Sprouse), 1 female; Root Toupee Cave, Camp Bullis, 1 Nov. 2000 (J. Reddell, M. Reyes), 1 male, 3 females; Stevens Ranch Trash Hole Cave, 12 June 1993 (J. Loftin), 1 male, 2 females; 19 July 2007 (P. Paquin, B. Weissling, K. White, C. Crawford, C. Collins), 1 female (CPAD); Strange Little Cave, Camp Bullis, 29 Nov. 1993 (J. Reddell, M. Reyes), 1 male, 3 females, 1 juvenile; 5 Oct. 1995, (J. Reddell, M. Reyes), 1 male, 1 juvenile; 22 Oct. 2004 (J. Reddell, M. Reyes), 1 female; 31 July 2006 (R. Myers), 1 male, 1 female; 4 Oct. 2006 (R. Myers), 1 female; Tin Pot Cave, Camp Bullis, 18 April 2001 (J. Reddell, M. Reyes), 2 males, 2 juveniles; 6 March 2001 (G. Veni), 1 male; Wurzbach Bat Cave, 25 June 1993, (D. Bowles, A. Grubbs, J. Reddell, M. Reyes, R. Stanford), 1 female; 22 May 1993 (J. Loftin, J. Reddell, M. Reyes), 1 female, 2 juveniles; Yellow Ball Cave, Camp Bullis, 7 Dec. 1999 (P. Sprouse, G. Veni), 1 female; 17 Feb. 2000 (J. Reddell, M. Reyes), 1 female, 1 juvenile. ***Blanco County*:** Wells Sink, 22 May 1995, (A. G. Grubbs), 1 female, 3 juveniles. ***Burnet County*:** Cricket City Sink, 4 June 1989 (W. Elliott, M. Reyes), 2 males, 1 juvenile; Eckhardt Root Cave, 17 April 1990 (M. Reyes), 1 female; Fenceline Sink, 17 April 1990 (J. Reddell, M. Reyes), 2 females, 1 juvenile; Longhorn Caverns, 24 Sept. 1999 (A. Cobb), 1 male, 1 female, 1 juvenile; Pie Cave, 24 July 1963 (B. Russell), 4 males, 3 females, 2 juveniles (AMNH); Railroad Cave, Marble Falls, 5 Sept. 1996 (A.G. Grubbs, T. Whitfield, G. Hoese), 1 male, 2 females, 2 juveniles; Resurrection Well, 2 July 1989 (M. Grimm), 1 female, 2 juveniles; 10 Feb. 1990 (M. Grimm), 1 juvenile; Simons Pretty Pit, 17 Jan. 1991 (J. Reddell), 1 female; Simons Water Cave, 8 Feb. 1991 (J. Reddell, M. Reyes), 1 male; Washout Cave, 17 April 1990 (M. Reyes, M. Warton), 1 female. ***Comal County*:** Bad Weather Pit, 3 Sept.. 1972 (R. Fieseler), 1 female (AMNH); Camp Bullis Cave No 1, Camp Bullis, 22 Oct. 1996 (G. Veni), 2 males, 1 female, 1 juvenile; Ebert Cave, 30 Jan. 1988 (J. Reddell, M. Reyes), 1 female; Snake Skin Pit, Camp Bullis, 1 Nov. 1996, (G.. Veni, P. Sprouse), 2 females; 19 Nov. 1996 (W. Elliott), 1 female; ***Comanche County*:** Bill Haney Pecan Orchard, FM 1476, 2 mi E. US 377\67 [32.083 N; -98.474 W] pitfall trap, 25 May-1 June 2001 (A. Calixto), 1 male (TAMUIC). ***Coryell County*:** Big Red Cave, Fort Hood, 6 May 1999 (J. Reddell, M. Reyes), 2 females; 14 June 2000 (J. Krejca, P. Sprouse), 1 female; Chigiouxs' Cave, Fort Hood, 22 Nov. 1994 (M. Warton), 3 females; Copperhead Cave, Fort Hood, 30 April 1998 (J. Reddell, M. Reyes), 1 female; Cornelius Cave, Fort Hood, 21 Feb. 1995 (J. Reddell, M. Reyes), 1 female; Dionne Cave, Fort Hood, 7-8 March 2003 (M. Reyes), 1 male, 1 juvenile; Egypt Cave, Fort Hood, 16 Sept. 1997 (L. J. Graves, J. Reddell, M. Reyes), 1 male; 7 April 1999 (J. Reddell, M. Reyes), 1 female; Formation Cave, Fort Hood, 29 July 2005 (J. Fant, C. Pekins, J. Reddell, M. Reyes), 1 male, 3 females, 6 juveniles; 12 May 2007 (J. Fant, J. Reddell, M. Reyes), 1 female, 13 juveniles; Ingram Cave, Fort Hood, 7 April 1999 (J. Reddell , M. Reyes), 1 female, 1 juvenile; Keyhole Cave, Fort Hood, 20 Feb. 1999 (J. Reddell, M. Reyes), 2 females; 6 May 1999 (J. Reddell, M. Reyes), 1 female; Lucky Day Cave, Fort Hood, 4 June 2003 (J. Reddell, M. Reyes), 1 male, 1 female; 2 April 2007 (J. Fant, M. Reyes), 2 males, 3 females; 4 April 2007 (J. Fant, J. Reddell, M. Reyes), 1 juvenile; New Cave, Fort Hood, 12 May 2007 (J. Fant), 2 females, 6 juveniles; Plateau Cave No 2, Fort Hood, 15 Jan. 1992 (J. Reddell, M. Reyes), 1 female, 1 juvenile; Porter Cave, Fort Hood, 8 April 1999 (J. Reddell, M. Reyes), 1 male, 1 female; Sperry Cave, Fort Hood, 5 June 2006 (C. Pekins, J. Reddell, M. Reyes), 2 males, 2 females; 2 April 2007 (J. Fant, J. Reddell, M. Reyes), 2 juveniles; 12 May 2007 (J. Fant, J. Reddell, M. Reyes), 1 male, 1 female; Tippit Cave, Fort Hood, 8 April 1999 (L. J. Graves), 1 female, 3 juveniles; 24 Jan. 1992 (D. McKenzie, J. Reddell, M. Reyes), 1 male; 16 July 1993 (D. McKenzie, J. Reddell, M. Reyes), 1 male; 22 April 1998 (L. J. Graves, J. Reddell, M. Reyes), 1 male, 1 female. ***Edwards County*:** Jenkins Skylight Stream Cave, 3 Aug. 2008 (P. Paquin, M. Warton), 1 male, 6 females (CPAD); Killer Frog Cave, 9 May 2004 (G. Veni). ***Hays County*:** Boyett's Cave, 23 June 1978 (W. Elliott, J. Holsinger, T. Poulson, F. Howarth), 1 female (AMNH); McCarty Cave, 200 feet from darkness in webs, 5 July 1963 (J. Reddell), 1 male, 3 females, 1 juvenile (AMNH); 14 March 2000 (J. Kennedy, J. Jenkins, J. Fant), 2 males, 3 females; 15 Dec. 2000 (J. Kennedy), 4 females, 2 juveniles; 15 Dec. 2000 (G.

Veni), 1 female, 2 juveniles; Taylor Bat Cave, 4 March 2003 (A. Gluesenkamp, J. Kennedy, J. Fant), 4 females. ***Irion County*****:** Murphy Wells Cave, 24 Feb. 1974 (no collector), 2 females (AMNH); ***Kendall County*****:** Behr's Cave, 30 Aug. 1969 (W. Elliott), 1 female (AMNH); Charley's Downclimb Cave, 4 March 2006 (J. Krejca, V. Loftin), 1 male; Covered Hole, 17 Aug. 1991 (D. Allen, L.G. Graves), 1 female, 2 juveniles (AMNH); Pfeiffer's Water Cave, 18 Oct. 1980 (G. Veni), 1 female (AMNH); Sattler's Deep Pit, 28 April 1990 (D. Pate), 1 female; 10 July 1994 (A.G. Grubbs), 1 male; Schroeder Bat Cave, 31 March 2004 (J. Kennedy, A. Cobb), 2 females, 1 juvenile. ***Kerr County*****:** Seiker's Cave, March 1968 (J. Fish, M. Thomas), 1 male, 1 female (AMNH); Wilson Ranch Cave, 30 Dec. 1956 (W. McAlister, Baker), 1 female, 1 juvenile (AMNH); ***Kinney County*****:,** Kelley Cave, 1 Feb. 2003 (J. Kennedy, J. Germany), 1 female; ***Mason County*****:** Mill Creek Cavern, 30 Jan. 1977 (R. Fieseler, T. Byrd, R. Farr), 1 female (AMNH); 26 July 1978 (R. Fieseler), 1 male, 2 females (AMNH). ***Real County*****:** Red Arrow Cave, 28 July 1974 (W. Elliott, M. Mckenzie), 1 male, 1 juvenile (AMNH); ***San Saba County*****:** Gorman Cave, beyond breakdown, 12 June 1968 (J. Reddell), 7 females (AMNH); Gorman Cave, 14 Sept. 1985 (J. Reddell), 1 female; 14 Sept. 1985 (J. Reddell, S.J. Harden), 1 male, 2 females; 7 April 2007 (P. Paquin, K. O'Connor, M. Sanders), 1 male, 1 female (CPAD); Harrell's Cave, 50-200 ft. inside cave, 20 Oct. 1962 (J. Reddell, D. Mckenzie), 3 males, 3 females (AMNH); Whiteface Cave, 9 Feb. 1964 (J. Reddell, D. Mckenzie, K. Garrett), 3 females, 2 juveniles (AMNH); ***Schleicher County*****:** Cave Y, 12 Dec. 1964 (J. Reddell, T. Raines), 2 females (AMNH). ***Sutton County*****:** Harrison Cave, 21 June 2003 (J. Kennedy), 1 female. ***Terrell County*****:** Goode Cave, twilight zone, 28 June 1963 (J. Reddell, B. Russell), 2 females (AMNH); ***Travis County*****:** Amber Cave, 8 April 1984 (J. Reddell, M. Reyes), 1 male; Armadillo Ranch Sink, 23 Sept. 1990 (J. Reddell, M. Reyes, C. Sexton), 1 male, 1 juvenile; 15 Oct. 1990 (J. Reddell, M. Reyes, M. Warton), 1 female; 15 Oct. 1990 (J. Reddell, M. Reyes, M. Warton), 1 male, 1 female; Broken Arrow Cave, 25 Jan. 1991 (J. Reddell, M. Reyes), 1 female; Cave site #401, near FM620, 1999 (P. Sunby), 1 male, 2 juveniles; Chuck's Joint, 23 Sept. 1990 (J. Reddell, M. Reyes), 1 male; Coon Slide Cave, 21 Jan. 1993 (M. Warton), 1 female (AMNH); Driskill Cave, 6 Sept. 1990 (J. Reddell, M. Reyes), 1 male; GCWA Cave, 20 April 2007 (P. Paquin, K. White, C. Crawford), 3 males, 3 females (CPAD); Jack's Joint Cave, 23 June 1989 (J. Reddell, M. Reyes), 1 male, 5 females, 1 juvenile (AMNH); Jest John Cave, 22 June 1993 (W. Elliott), 1 female; 29 May 1993 (W. Russell, J. Sigmond), 2 males; Jollyville Plateau Cave, 11 April 1995 (A. G. Grubbs, G. Wald), 2 females; Kretschmarr Double Pit, 20 April 1991 (J. Reddell, M. Reyes), 1 female; Lunsford's Cave, April 1963 (B. Russell), 2 males, 2 females, 1 juvenile (AMNH); Midden Sink, 18 Aug. 1990 (J. Reddell, M. Reyes), 1 female; No Rent Cave, 22 June 1990 (J. Reddell, M. Reyes), 1 female; Rolling Rock Cave, 15 Feb. 1991 (J. Reddell, M. Reyes), 1 female, 3 juveniles; Two Trunks Cave, 19 June 1997 (J. Reddell, M. Reyes), 1 male, 3 females; Weldon Cave, April 1996 (M. Warton), 1 female, 1 juvenile; Windmill Cave, 26 Sept. 2000 (J. Reddell, M. Reyes, M. Warton), 1 male, 3 females. ***Uvalde County*****:** Tampke Ranch Cave, 25 July 1974 (E. Elliott, S. Sweet), 1 male, 5 females (AMNH); Whitecotton Bat Cave, 24 April 1966 (J. Reddell, E. Alexander), 2 females (AMNH). ***Val Verde County*****:** Wren Cave, 9 April 1968 (J. Reddell, T. Mollhagen), 1 female (AMNH). ***Williamson County*****:** A. J. & B. L. Wilcox Cave, 4 Dec. 2000 (M. Warton), 1 female; Avant Ranch Cave, 22 Aug. 2008 (P. Paquin, C. Crawford, B. Parker), 1 female (CPAD); Avery Ranch Cave, March 1994 (M. Warton), 1 female, 1 juvenile; Avery Stairstep Cave, March 1994 (M. Warton), 2 females; Ballroom #2 Cave, 4 Aug. 2008 (P. Paquin), 1 female (CPAD); Beck Bat Cave, 24 Oct. 1991 (L. Sherrod), 1 female; 26 Feb. 2007 (P. Paquin, C. Crawford, C. Thibodaux), 1 female (CPAD); Beck Creek Cave, 3 June 1996 (J. Reddell, M. Reyes), 1 female; Beck Crevice Cave, 3 May 1996 (J. Reddell, M. Reyes), 1 male, 3 females, 1 juvenile; Beck Horse Cave, 15 May 1996 (J. Reddell, M. Reyes), 1 male, 2 females; Beck Pride Cave, 21 May 1996 (J. Reddell, M. Reyes), 1 female; Beck Ranch Cave, 24 March 1989 (J. Reddell, M. Reyes), 1 female, 2 juveniles; Beck Rattlesnake Cave, 31 March 1993 (D. Allen, L. J. Graves, D. Love), 1 female; 10 Nov. 2000 (J. Reddell, M. Reyes), 2 males, 4 females, 1 juvenile; 28 Feb. 2007(P. Paquin, C. Crawford, C. Thibodaux), 1 female (CPAD); Behren's Ranch Cave, 9 April 1999 (M. Warton), 1 female, 3 juveniles; Black Cat Cave, April 1995 (A.G. Grubbs), 1 male, 1 female; Blowhole Cave, 2 April 2007 (P. Paquin, C. Crawford, B. Larsen), 1 male, 1 female (CPAD); Boyd's Void Cave, Rasmussen Tract, 14 June 1999 (M. Warton), 1 female; Broken Plate Cave, 20 April1993 (M. Warton), 1 female; Brown's Cave, 23 April 1989 (W. Elliott, J. Reddell, M. Reyes), 1 female, 2 juveniles; Buttercup Blow Hole Cave, 27 Feb. 1995 (D. Allen, D. Love), 1 male, 3 females, 2 juveniles; Cat Cave, 11 April 1994 (J. Reddell, M. Reyes), 2 females; 28 April 1999 (R. Price, M. Warton), 1 female; Cat Hollow Bat Cave, 16 April 1995 (A. G. Grubbs), 2 males, 1 female, 1 juvenile; 13 April 1995 (A. G. Grubbs, G.. Wald), 1 male, 2 females, 5 juveniles; Cat Hollow Cave No. 3, 13 April 1995 (A. G. Grubbs, G.. Wald), 1 male, 1 juvenile; Cave Coral Cave, 14 Jan. 2000 (J. Reddell, M. Reyes), 1 male, 1 female; Chagas

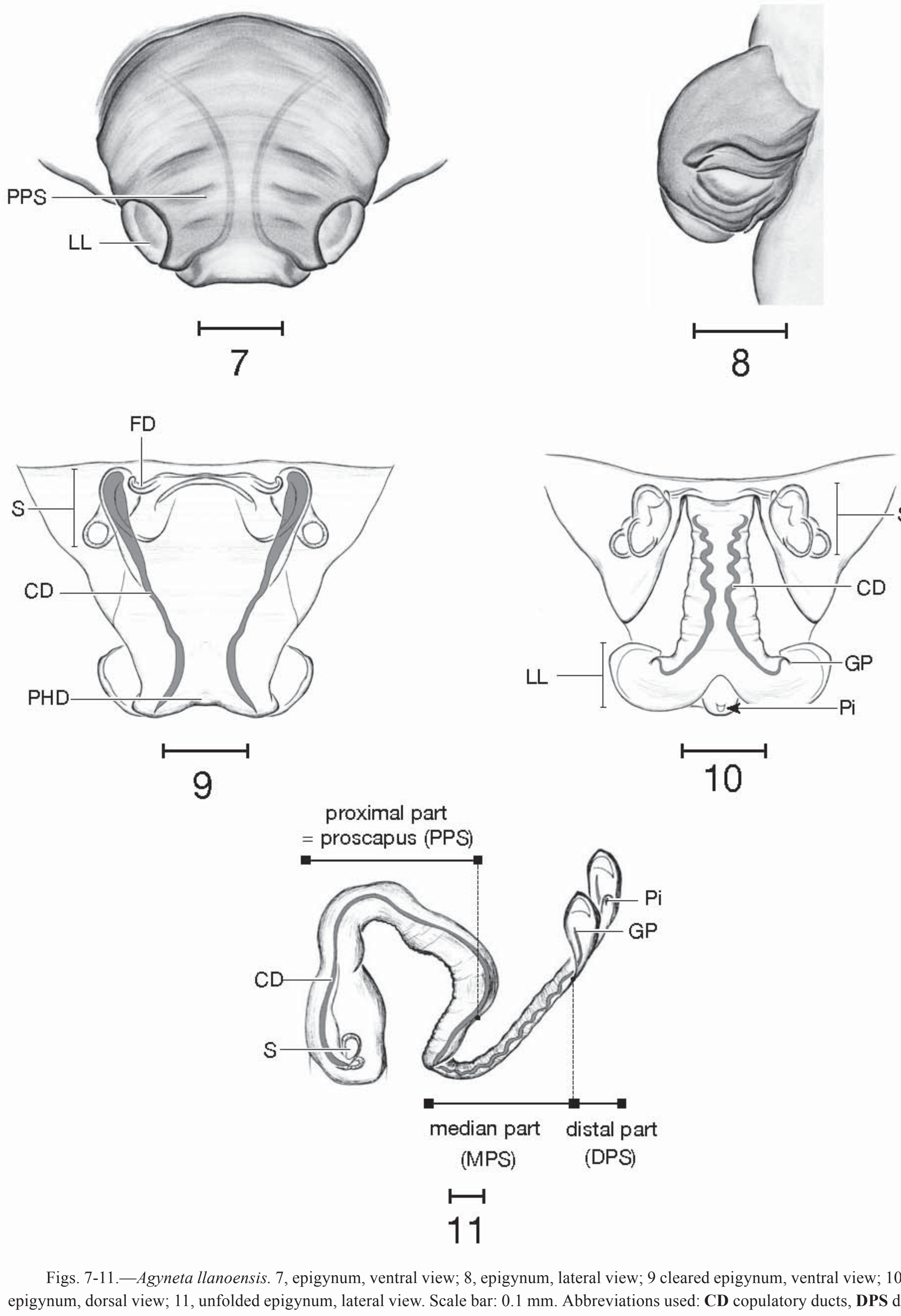
Cave, 24 Aug. 1994 (J. Reddell, M. Reyes), 1 female; Clan Cave, 27 July 2008 (P. Paquin, M. Sanders, K. O'Connor), 1 female (CPAD); Cobb Cavern, 8 April 2004 (M. Warton), 1 male, 1 female; Dion Cave, 6 Feb. 1994 (J. Reddell, M. Reyes), 1 male, 1 female, 3 juveniles; 18 April 1994 (J. Reddell, M. Reyes), 1 female, 1 juvenile; 20 July 1994 (J. Reddell, M. Reyes), 1 male, 1 female, 4 juveniles; Double Nickel Cave, 14 April 1994 (J. Reddell, M. Reyes), 3 females, 6 juveniles; Duckworth Bat Cave, 21 April 1999 (M. Warton), 1 female; Feature No 1, Ronald Regan Blvd., 19 April 2007 (P. Paquin), 1 female, 1 juvenile (CPAD); Fern Cave, March 1994 (M. Warton), 1 female, 3 juveniles; Fortune 500 Cave, 20 April 1998 (M. Warton), 2 females; Godwin's Goat Grave Cave (=Lift Station Cave), 2 Feb. 1991 (W. Elliott, J. Reddell, M. Reyes), 1 male; Grimace Cave, 16 April 1989 (M. Warton), 1 male; Hatchet Cave, 6 March 1994 (J. Reddell, M. Reyes), 1 male, 3 females; Holler Hole Cave, 20 July 1995 (J. Reddell, M. Reyes), 1 female; Hook Cave, 5 March 1994 (J. Reddell, M. Reyes), 1 male, 2 females, 1 juvenile; Ilex Cave, 1 June 1989 (J. Reddell, M. Reyes, M. Warton), 2 females, 1 juvenile; Joker Cave, April 1994 (M. Warton), 1 female; Jug Cave, 18 May 1989 (W. Elliott, J. Reddell, M. Reyes), 1 female; 14 March 2000 (J. Reddell, M. Reyes, P. Sprouse, G. Veni), 1 male; Killian Cavern, Oct. 1998 (M. Warton), 1 female; LakeLine Cave, 30 Oct. 1991 (D. Allen), 1 male; LakeLine Mall Well Trap No. 3, 15 Oct. 1990 (L. Sherrod), 1 female; Leaning Tree Cave, 18 April 1996 (M. Warton), 1 female; Man-With-A-Spear Cave, 2 Sept. 1990 (D. Allen, W. Elliott), 1 female, 1 juvenile; 7 Oct. 1990 (A. Cobb, W. Elliott), 1 male; 27 July 2008 (P. Paquin, M. Sanders, K. O'Connor), 1 female (CPAD); Maverick Cave, 24 Nov. 1998 (M. Warton), 2 males; Mayfield Cave, 27 April 1998 (M. Warton), 1 female; Medicine Man Cave, 25 July 1995 (J. Reddell, M. Reyes), 1 female, 1 juvenile; 13 April 2000 (J. Reddell, M. Reyes), 1 female, 1 juvenile; 28 Dec. 2006 (P. Paquin, C. Crawford), 4 males (CPAD); Millennium Cave, 27 Feb. 2007 (P. Paquin, C. Crawford), 1 female (CPAD); Mongo Cave, April 1999 (M. Warton), 1 male, 1 female; 21 Dec. 2006 (P. Paquin, K. White, C. Crawford), 1 male (CPAD); Mustard Cave, 31 May 1993 (J. Reddell, M. Reyes), 1 male, 1 juvenile; Near Miss Cave, 1 Nov. 2000 (G. Veni), 1 female, 1 juvenile; 2 Nov. 2000 (J. Reddell, M. Reyes), 1 female; O'Connor Cave, 12 April 1993 (M. Warton), 1 male; Off Campus Cave, 8 April 1989 (W. Elliott, J. Reddell, M. Reyes), 2 females; Paleospring Cave, 2 Aug. 1994 (P. Sprouse, B. Larsen), 2 females; Pemmican Cave, 19 April 1994 (J. Reddell, M. Reyes), 2 males, 2 females, 1 juvenile; Prairie Flats Cave, 14 April 1994 (J. Reddell, M. Reyes), 1 female; Price Is Right Cave, 18 Jan. 1999 (M. Warton), 4 females, 2 juveniles; Prospectors Cave, 20 Nov. 2002 (J. Reddell, M. Reyes, M. Warton), 1 male; Raccoon Cave, 16 March 1990 (J. Reddell, M. Reyes), 1 female; Rock Ridge Cave, 21 Dec. 2006 (P. Paquin, K. White, C. Crawford), 2 females (CPAD); Rockfall Cave, 27 April 1993 (J. Reddell, M. Reyes), 1 female; Rootin Tootin Cave, 9 Dec. 1998 (M. Warton), 1 male, 3 females; Salamander Squeeze Cave, 16 Feb. 1995 (D. Allen, J. Wolff), 1 male; Snowmelt Cave, 23-26 March 2003 (A. Gluesenkamp, P. Sprouse), 4 males, 2 females; Squeeze-Down Cave, 11 May 1990 (M. Reyes), 1 female; Stepstone Cave, 14 Jan. 2000 (J. Reddell, M. Reyes), 1 female; Testudo Tube, 11 Nov. 1996 (P. Sprouse), 2 females; Texella Cave, 2 Oct. 1991 (J. Reddell), 1 female; 24 Sept. 1991 (J. Reddell, M. Reyes), 1 female; 8 April 1996 (M. Warton), 1 female, 1 juvenile; The Abyss, March 1994 (M. Warton), 1 female; 6 March 1994 (J. Reddell, M. Reyes), 1 male; Thin Roof Cave, 28 April 1998 (J. Reddell, M. Reyes, J. Wolff), 1 female, 1 juvenile; Two Hole Cave, 20 Feb. 1995 (D. Allen, J. Wolff), 1 male, 1 female; Underline Cave, 30 Oct. 1990 (J. Reddell, M. Reyes), 1 female; Vault Cave, 5 April 1993 (D. Allen, L. J. Graves, D. Love, C. Savvas, M. Warton), 1 male; Velcro Cave, 3 Feb. 2003 (J. Reddell, M. Reyes), 2 males, 2 females; Venom Cave, 17 Nov. 1993 (J. Reddell, M. Reyes), 1 male; 22 Nov. 1993 (J. Reddell, M. Reyes), 1 female; 29 July 1995 (W. Elliott), 1 female; 29 Nov. 1995 (W. Elliott), 1 female; 9 April 2000 (J. Reddell, M. Reyes), 1 male, 1 female, 1 juvenile; Village Idiot Cave, 17 Nov. 1994 (J. Reddell, M. Reyes), 1 female, 1 juvenile; Waterfall Canyon Cave, 30 July 2008 (P. Paquin, C. Crawford, B. Parker), 2 females, 1 juvenile (CPAD); Water Tank Cave, 25 Sept. 1998 (J. Reddell, M. Reyes), 1 female, 1 juvenile; 30 Sept. 1998 (J. Reddell, M. Reyes), 2 females; 28 Oct. 1998 (J. Reddell, M. Reyes), 1 female, 3 juveniles; Water Tower Cave, 15 March 1994 (L. Sherrod), 1 female; White Wall Cave, 9 Dec. 1998 (M. Warton), 1 female; Wild Card Cave, April 1994 (M. Warton), 2 females, 1 juvenile; Zapata Cave, March 1994 (M. Warton), 1 male, 1 female, 1 juvenile. **WISCONSIN:** ***Dane County*:** University of Wisconsin Arboretum, Grady Tract, [43.046 N; -89.416 W] Sandy Prairie, leaf litter, 27 Aug. 1969 (S. E. Riechert), 1 male.

Diagnosis.—Males of *A. llanoensis* are distinguished by the combination of the following characters: palpal tibia with prominent dorsal and retrolateral tibial apophyses, palpal cymbium bearing small and big tubercles, lamella characteristica with fist-like tip. Females are distinguished by the large, squared shape proximal part of the scape bearing dark horizontal lines.

Description.—*Male (n=5)*: Total length: 1.95–1.99; carapace length: 0.87–0.93; carapace width: 0.71–0.75; carapace finely reticulate, shiny, light yellow-



Figs. 1–6.—*Agyneta llanoensis* 1, palpus of male, retrolateral view, arrow points to conical protuberance; 2, palpus of male, prolateral view; 3, palpus of male, dorsal view; 4, expanded male palpus, schematic illustration; 5, excised embolic division, without embolus; 6, excised embolus. Scale bar: 0.1 mm. Abbreviations used: **Apo** anterior pocket, **BT** big tubercle, **DSA** distal suprategular apophysis, **DTA** dorsal tibial apophysis, **E** embolus, **EP** embolus proper, **LC** lamella characteristica, **MM** median membrane, **P** paracymbium, **PLN** prolateral notch, **R** radix, **RTA** retrolateral tibial apophysis, **S** spermatheca, **ST** small tubercle, **T** tegulum. Some abbreviations and terms used in figures are given to facilitate the comprehension of the structures but are not mentioned any further in the descriptions.



Figs. 7-11.—*Agyneta llanoensis*. 7, epigynum, ventral view; 8, epigynum, lateral view; 9 cleared epigynum, ventral view; 10, cleared epigynum, dorsal view; 11, unfolded epigynum, lateral view. Scale bar: 0.1 mm. Abbreviations used: **CD** copulatory ducts, **DPS** distal part of scape, **FD** fertilization ducts, **GP** genital pore, **LL** lateral lobe, **MPS** median part of scape **P** paracymbium, **Pi** pit, **PHD** pit hook depression, **PPS** proximal part of scape, **S** spermatheca. Some abbreviations and terms used in figures are given to facilitate the comprehension of the structures but are not mentioned any further in the descriptions.

orange (141M) to orange (143M), eye region slightly darker, 3 erected setae along midline. Sternum bulbous, light yellow-orange (141M). Chelicerae orange (143M); promargin with 5 teeth, retromargin with 4–5 denticles. Cheliceral stridulatory organ visible, with 25–30 striae; associated stridulatory pick present at base of palpal femur. Abdomen uniformly colored, off-white to light gray (Warm gray 2M) covered with long erected setae; ventral surface of abdomen often suffused with dark gray (Warm gray 8M); book lung cover light gray with darker margins (Warm gray 2M), finely reticulate; coxae IV with stridulatory pick. Legs light yellow-orange (141M); leg formula 1-4-2-3; total length leg I: 4.67–4.81; femur: 1.21–1.22; patella 0.25–0.26; tibia: 1.28–1.31; metatarsus: 1.12–1.19; tarsus: 0.76–0.83; total length leg IV: 4.16–4.26; femur: 1.12 –1.15; patella 0.19–0.22; tibia: 1.08–1.12; metatarsus: 1.05–1.08; tarsus: 0.67–0.71. Tibia I–IV with two long dorsal macrosetae; metatarsus I with dorsal trichobothrium (Tm I 0.21–0.23); Tm IV absent. Palpal femur length: 0.35–0.42; palpus length: 0.48–0.50. Palpal tibia with two apophyses, one smooth retrolateral (RTA) and a rugged dorsal one (DTA) (Fig. 1), palpal tibia bearing two retrolateral and one dorsal trichobothria (Fig. 1); cymbium with dorsal conical protuberance (arrow, Fig. 1), prolateralo-basal small (ST) and big tubercle (BT) (Fig. 2), prolateral notch (PLN) shallow; paracymbium (P) with long anterior pocket (Apo), proximal part bearing five setae (Fig. 1); median membrane (MM) with filiform projections (Fig. 4), lamella characteristica (LC) complex, multifaceted (Figs. 1, 5), anterior terminal apophysis (ATA) elongated with bulbous, transparent apex bearing filiform projections (Fig. 5), posterior terminal apophysis (PTA) with proximal part membranous, bearing a row of several sharp points, converging to a pointed apex (Fig. 5); apical section of embolus (E) long and curved, with pointed tip (Fig. 6), embolus proper (EP) short and concealed in apical part of embolus (Figs. 4, 6); sperm duct (SD) with well developed, elongated Fickert's gland (FG) located in the proximal region of the embolus (Figs. 4, 6), far from the embolus proper.

Female (n=5): Total length: 1.98–2.22; carapace length: 0.80–0.93; carapace width: 0.64–0.72. Coloration as in male. Carapace with 3 erected setae along midline. Sternum flat. Chelicerae promargin with 5 teeth, retromargin with 4–5 denticles. Cheliceral stridulatory organ visible, with 17–20 striae; associated stridulatory pick at base of palpal femur present. Abdomen covered with long erected setae; book lung cover light gray with darker margins (Warm gray 2M), finely reticulate; coxae IV with stridulatory pick. Leg formula 1-4-2-3; total length leg I: 4.49–4.97; femur: 1.15–1.28; patella 0.26–0.29; tibia: 1.19–1.31; metatarsus: 1.12–1.15; tarsus: 0.71–0.83; total length leg IV: 4.04–4.61; femur: 1.06 –1.28; patella 0.19–0.22; tibia: 1.09–1.25; metatarsus: 1.03–1.15; tarsus: 0.61–0.71. Tibia I–IV with two long dorsal macrosetae; metatarsus I with dorsal trichobothrium (Tm I 0.21–0.25); Tm IV absent. Palpal claw absent. Epigynum width: 0.29–0.35; epigynum length (unfolded): 1.07–1.12. Epigynum consisting of a very long (3x longer then wide) folded scape (Fig. 11); proximal part of scape (proscapus) (PPS) large, side parallel, going over the pit (Pi) (Figs. 7, 9); pit hook depression (PHD) shallow (Fig. 9); median part of scape (MPS) narrow, parallel, enlarging apically into distal part of scape (DPS) bearing the lateral lobes (LL) (Fig. 11); spermathecae (S) consisting of three receptacula: one large, elongated and two small rounded ones (Figs. 9, 10); copulatory duct (CD) long, sinuous, undulate in median part of scape; genital pore (GP) situated in basal part of the lateral lobes (Figs. 10–11).

Distribution.—*Agyneta llanoensis* is a widespread species found in caves from southern Texas to Alabama and Tennessee to the northeast. A surface record from Wisconsin also suggests that *A. llanoensis* is not limited to areas characterized by karstic features (Fig. 23). Not all cave localities from Texas could be included on the distribution maps; two records – from Val Verde and Irion counties – are however included despite the lack of precise locations, as they represent important localities for the distribution range.

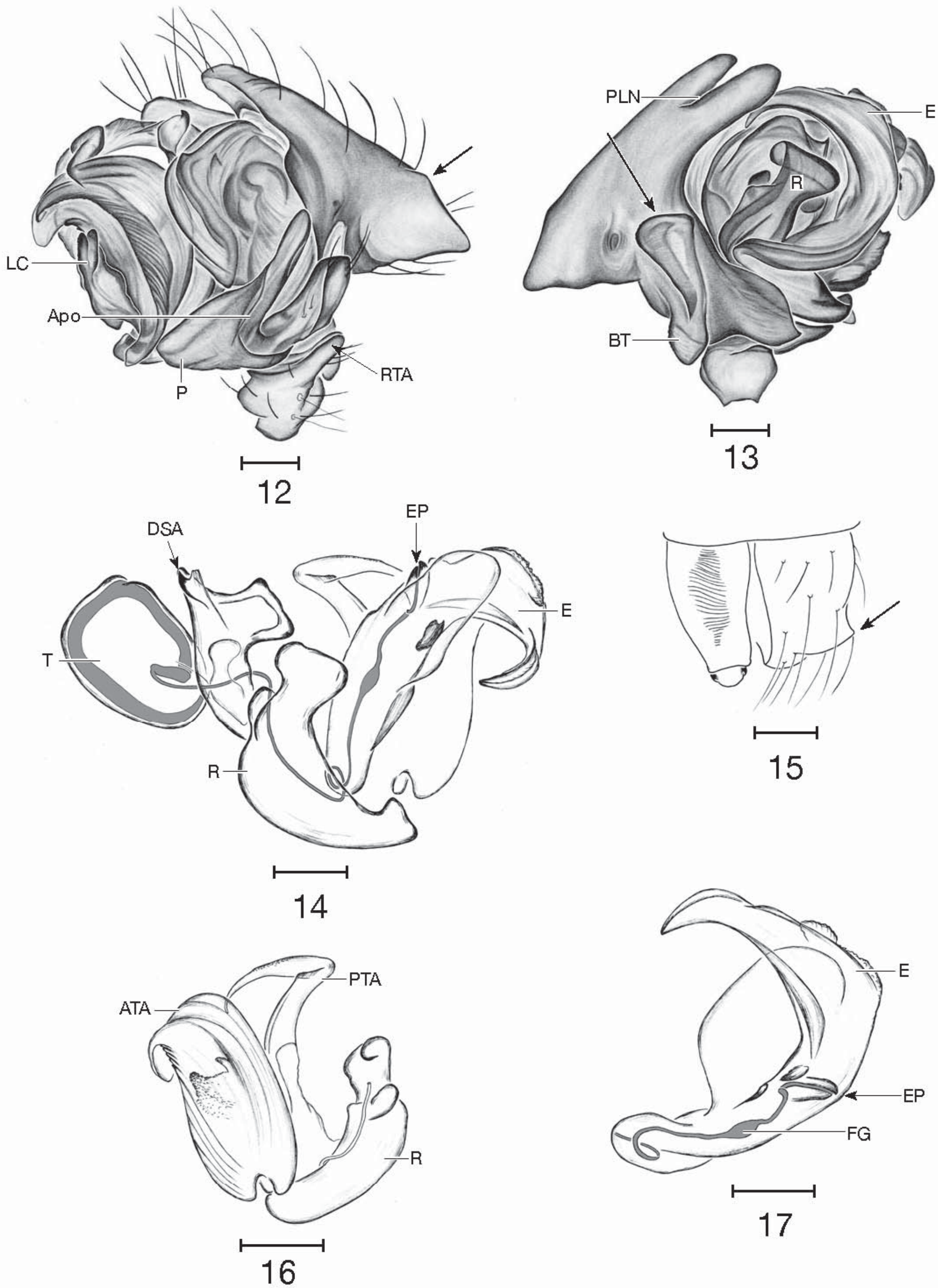
Remarks.—There is no obvious eye reduction or leg elongation in *A. llanoensis* when compared to the surface member of the genus.

Etymology.—The epithet *llanoensis* refers to Llano (Texas), the type locality.

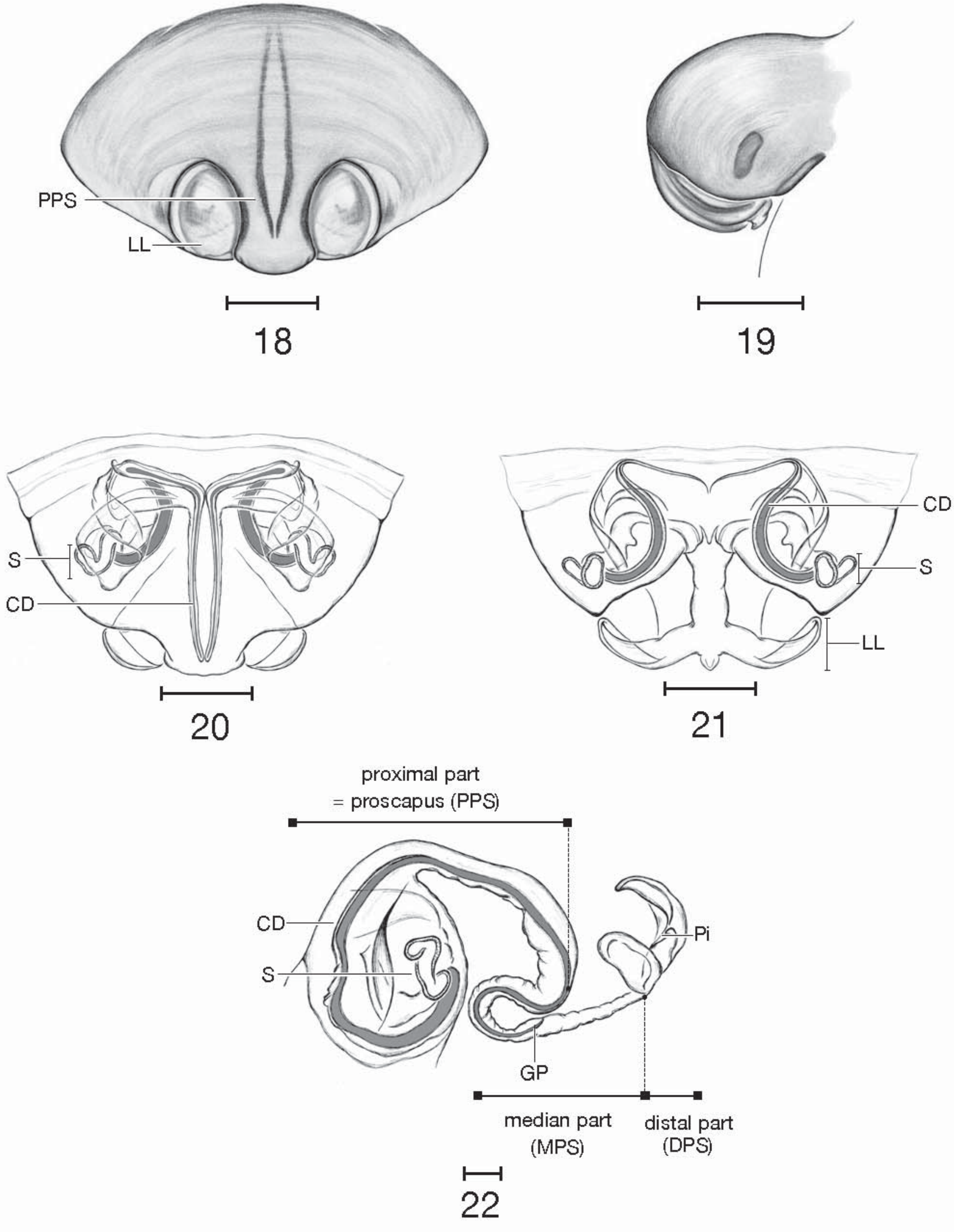
Natural history.—The numerous records from caves clearly demonstrate an affinity for this habitat. Despite three surface records, the species is clearly a troglophile (see discussion). The distribution of the species in caves is variable; it is sometimes found near cave entrances and sometimes in deeper cave conditions. *Agyneta llanoensis* typically spin sizeable sheet webs reaching 15 x 15 cm among rocks on the ground, against cave walls, or in various depressions, in which the spiders hang upside down. This species can sometimes be extremely abundant in a given cave and absent in the neighboring ones.

Agyneta hedini Dupérré and Paquin, new species
Figs. 12–23

Type material.—**HOLOTYPE: U.S.A.:** *Colorado*: Fremont County, Marble Cave, Four Mile Creek, 13 mi. N Cañon City, 6 May1992 (M. Hedin), male, hand collected, in dark zone cave on flood (?)



Figs. 12–17.—*Agyneta hedini,* new species. 12, palpus of male, retrolateral view, arrow points to conical protuberance; 13, palpus of male, prolateral view, arrow points to cymbial outgrowth; 14, expanded male palpus, schematic illustration; 15, male endite, lateral; 16, excised embolic division, without embolus; 17, excised embolus. Scale bar: 0.1 mm. Abbreviations used: **Apo** anterior pocket, **ATA** anterior terminal apophysis, **BT** big tubercle, **DSA** distal suprategular apophysis, **E** embolus, **EP** embolus proper, **FG** Fickert's gland, **LC** lamella characteristica, **P** paracymbium, **PLN** prolateral notch, **PTA** posterior terminal apophysis, **R** radix, **RTA** retrolateral tibial apophysis, **T** tegulum. Some abbreviations and terms used in figures are given to facilitate the comprehension of the structures but are not mentioned any further in the descriptions.



Figs. 18–22.—*Agyneta hedini,* new species. 18, epigynum, ventral view; 19, epigynum, lateral view; 20 cleared epigynum, ventral view; 21, cleared epigynum, dorsal view; 22, unfolded epigynum, lateral view. Scale bar: 0.1 mm. Abbreviations used: **CD** copulatory ducts, **DPS** distal part of scape, **GP** genital pore, **LL** lateral lobe, **Pi** pit, **PPS** proximal part of scape, **S** spermatheca. Some abbreviations and terms used in figs. 1–22 are given to facilitate the comprehension of the structures but are not mentioned any further in the descriptions.

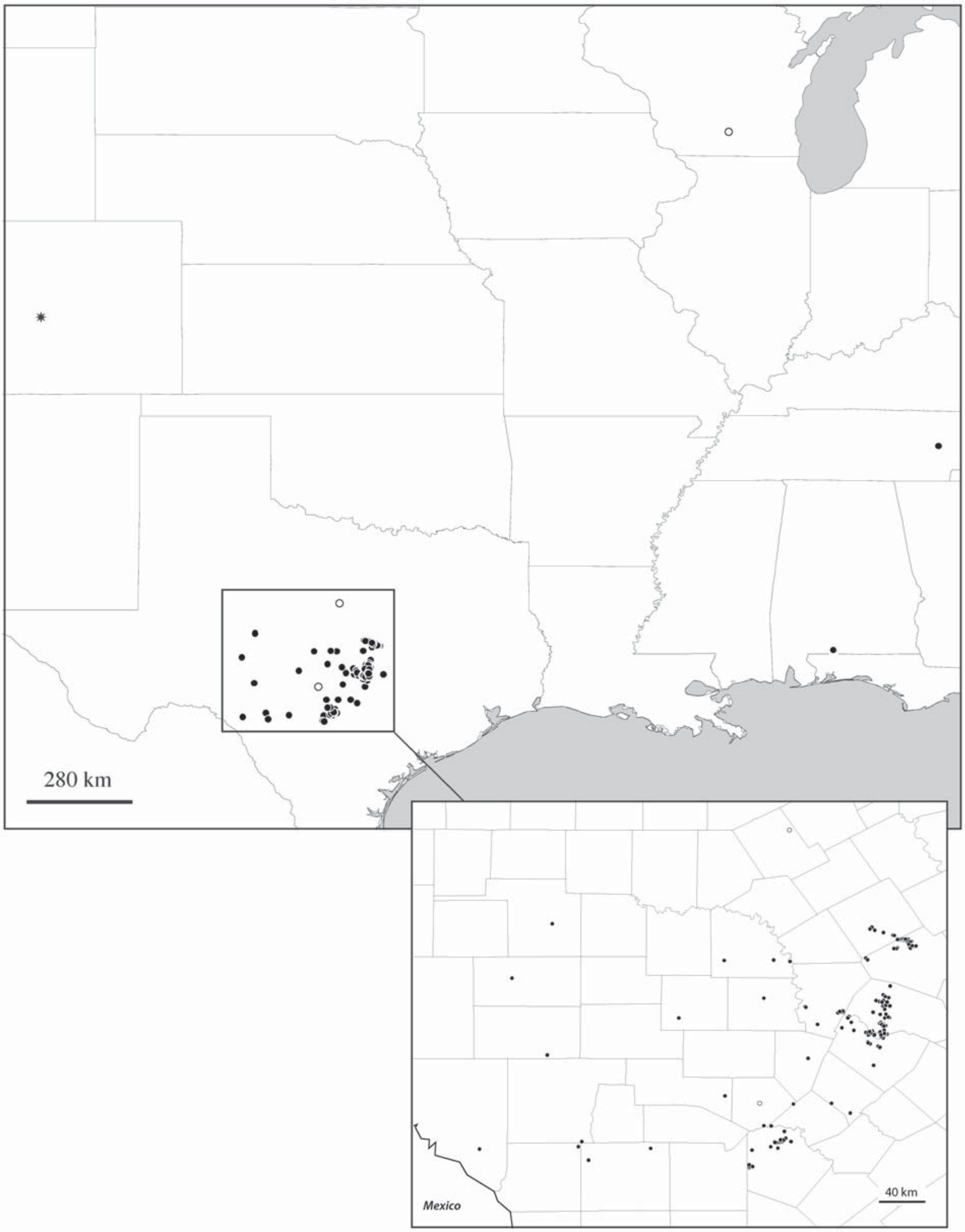


Fig. 23.—Distribution of *A. llanoensis* (circles) and *A. hedini,* new species (star). Dark symbols refer to cave records and open symbols refer to surface records.

debris (AMNH). **ALLOTYPE:** female, same data as holotype (AMNH).

Diagnosis. —Males of *A. hedini,* n.sp. are distinguished from all other *Agyneta* by the following characters; male palpal cymbium with large dorsal conical protuberance, absence of small tubercle, bearing a rugose big tubercle and a large outgrowth. Females are diagnosed by the narrow proximal part of the scape, slightly enlarging apically bearing two dark converging vertical lines.

Description.—*Male (n=1)*: Total length: 2.02; carapace length: 0.83; carapace width: 0.71; carapace finely reticulate, shiny, orange (143M), 2 erected setae along midline. Sternum bulbous, orange (143M), margins suffuse with dark gray (Cool gray 9M). Chelicerae orange (143M); promargin and retromargin carinated, 5 denticles and 3 denticles respectively. Endites with a single tubercle (Fig. 15). Cheliceral stridulatory organ visible, with ~31 striae; associated stridulatory pick present at base of palpal femur. Abdomen off-white, with 4 pairs of dark gray spots (Cool gray 9M), covered with long erected setae; ventral surface of abdomen suffused with dark gray (Warm gray 8M) pattern; book lung cover light gray with darker margins (Warm gray 8M), finely reticulate; coxae IV with stridulatory pick. Legs light yellow-orange (141M); leg formula 1-4-2-3; total length leg I: 5.67; femur: 1.44; patella 0.28; tibia: 1.63; metatarsus: 1.39; tarsus: 0.93; total length leg IV: 4.83; femur: 1.44; patella 0.29; tibia: 1.28; metatarsus: 1.12; tarsus: 0.70. Tibia I–IV with two long dorsal macrosetae; metatarsus I with dorsal trichobothrium (Tm I 0.23); Tm IV absent. Palpal femur length: 0.41; palpus length: 0.58. Palpal tibia with one smooth retrolateral apophysis (RTA), two retrolateral and a dorsal trichobothria (Fig. 12); cymbium with dorsal conical protuberance (Fig. 12, arrow), prolateralo-basal rugose big tubercle (BT) and a large outgrowth (Fig. 13, arrow), prolateral notch (PlN) very deep, making the apex of cymbium bifurcate (Fig. 13); paracymbium (P) with long anterior pocket (Apo), proximal part bearing five setae (Fig. 12); median membrane not observed; lamella characteristica (LC), multifaceted with two rugose tips (Fig. 12); anterior terminal apophysis (ATA) large, bearing several ridges (Fig. 16); posterior terminal apophysis (PTA) elongated, proximal part membranous, distal part sickle-shaped and rugose (Fig. 16); apical section of embolus (E) long and curved, with pointed tip, embolus proper (EP) short and concealed in proximal part of embolus (Figs. 14, 17); sperm duct (SD) with well developed, elongated Fickert's gland (FG) located in the proximal section of embolus (Figs. 14, 16), close to the embolus proper.

Female (n=1): Total length: 2.02; carapace length: 0.74; carapace width: 0.71. Coloration as in male.

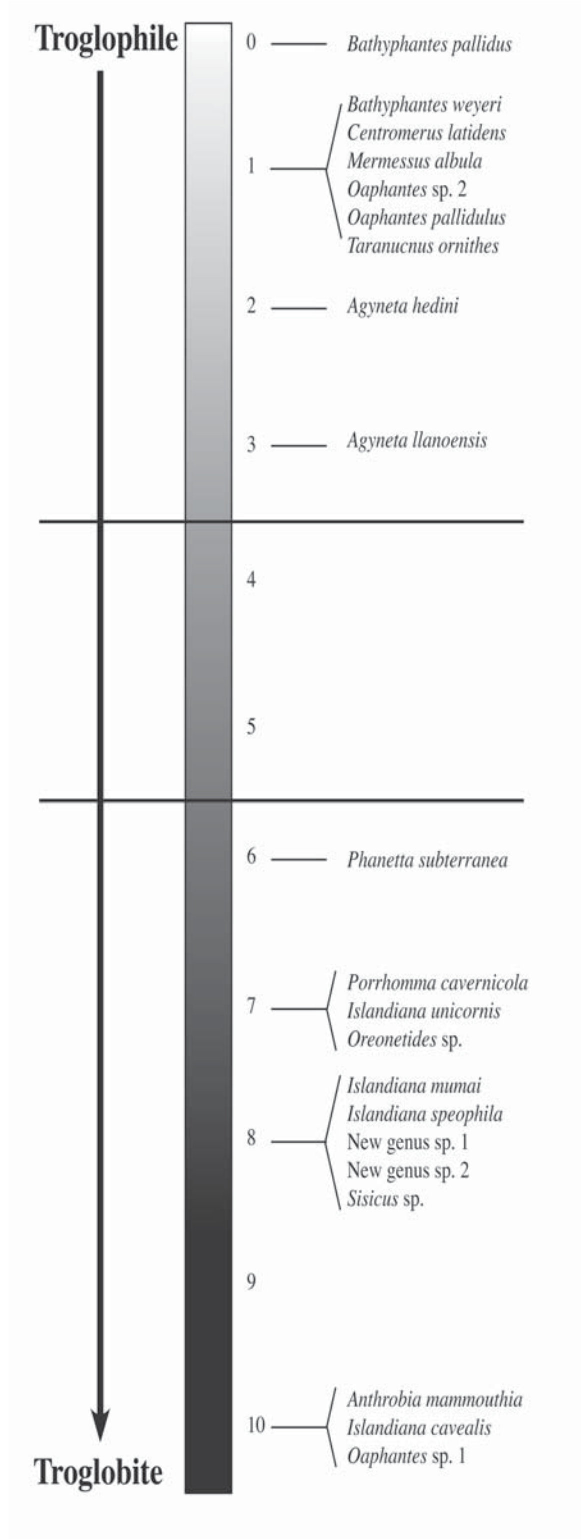


Fig. 24.—Ranking of North American Linyphiidae associated with caves based on the cumulative ranking of their eye reduction and specificity to cave habitat (see Tables 1 and 2). The score 0-3 relates to troglophiles and 6–10 to troglobites.

Table 1.—Ranking of Linyphiidae species associated with caves according to their degree of eye reduction.

Species	Eyes reduction	Rank
Agyneta hedini Dupérré and Paquin, this paper	Not reduced	1
Agyneta llanoensis (Gerstch and Davis, 1936)	Not reduced	1
Bathypantes weyeri (Emerton, 1875)	Not reduced	1
Bathyphantes pallidus (Banks, 1892)	Not reduced	1
Centromerus latidens (Emerton, 1882)	Not reduced	1
Mermessus albula (Zorsch and Crosby, 1934)	Not reduced	1
Oaphantes sp. 2	Not reduced	1
Oaphantes pallidulus (Banks, 1904)	Not reduced	1
Phanetta subterranea (Emerton 1875)	Not reduced	1
Taranucnus ornithes (Barrows 1940)	Not reduced	1
Oreonetides sp. Paquin, et al., in press	Reduced, a few specimens are highly reduced	2
Porrhomma cavernicola (Keyserling, 1886)	Highly reduced, a few specimens are slightly reduced	3
Islandiana mumai Ivie, 1965	Highly reduced	4
Islandiana speophila Ivie, 1965	Highly reduced	4
Islandiana unicornis Ivie, 1965	Highly reduced	4
New genus sp. 1	Highly reduced	4
New genus sp. 2	Highly reduced	4
Sisicus sp.	Highly reduced	4
Anthrobia mammouthia Tellkampf, 1844	Eyeless	5
Islandiana cavealis Ivie, 1965	Eyeless	5
Oaphantes sp. 1	Eyeless	5

Carapace with 2 erected setae along midline. Sternum flat. Chelicerae promargin with 5 teeth, retromargin with 4 denticles. Cheliceral stridulatory organ visible, with ~30 striae; associated stridulatory pick at base of palpal femur present. Abdomen off-white, with 3 pairs of dark gray spots (Cool gray 9M), covered with long erected setae; ventral surface of abdomen suffused with dark gray (Warm gray 8M) pattern; book lung cover light gray with darker margins (Warm gray 8M), finely reticulate; coxae IV with stridulatory pick. Leg formula 1-4-2-3; total length leg I: 5.04; femur: 1.35; patella 0.29; tibia: 1.41; metatarsus: 1.18; tarsus: 0.81; total length leg IV: 4.46; femur: 1.28; patella 0.26; tibia: 1.19; metatarsus: 1.06; tarsus: 0.67. Tibia I-IV with two long dorsal macrosetae; metatarsus I with dorsal trichobothrium (Tm I 0.22); Tm IV absent. Palpal claw present, highly reduced. Epigynum width: 0.47; epigynum length (unfolded): 1.09. Epigynum consisting of a long (2x longer then wide) folded scape (Fig. 22), proximal part of scape (proscapus) (PPS) narrow, slightly enlarging, going over the pit (Pi) (Fig. 18); median part of scape (MPS) slender, parallel, enlarging apically into distal part of scape (DPS) bearing the lateral lobes (LL) (Figs. 21–22); spermathecae (S) consisting of one long, curved receptacula, and a smaller rounded one (Figs. 20–22); copulatory duct (CD) rather short sinuous; genital pore (GP) situated in the median part of scape (Fig. 22).

Distribution.—Known only from the type locality in Colorado (Fig. 23).

Remarks.—No eye reduction or leg elongation was observed.

Etymology.—This species is named in honor of Dr. Marshal Hedin (San Diego State University), arachnol-ogist and collector of the only known specimens.

Natural history.—Nothing is known about the species, except its occurrence in a cave among organic matter.

RESULTS AND DISCUSSION

In the original description of *A. llanoensis*, the only known record was from Llano, the type locality. Gertsch and Davis (1936) gave no indications about the type specimen being collected in a cave, but in the light of the numerous cave records from Texas, this appeared questionable. However, we are including here two new surface records (one from Comanche County, Texas, and one from Dane County, Wisconsin) that support the occurrence of the species on the surface. Paquin, et al. (in press), reports that some Linyphiidae species are only found in caves in the southern portion of their distribution range and that surface records are known at the northern edge. This cryophilic affinities / relict population hypothesis would explain well the surface Wisconsin record, but not the surface records from Texas. Its occurrence in caves in Tennessee and Alabama is also remarkable and extends considerably its range to the northeast. Surprisingly, the species has only been found once in each of these states despite that cave fauna having received attention, particularly the important inventorial work of T. C. Barr and S. B. Peck, among

Table 2.—Ranking of Linyphiidae species associated with caves according to their exclusivety to cave habitat.

Species	Relationship to cave habitat	Rank
Bathyphantes pallidus (Banks, 1892)	Found in caves, but mostly a surface species	1
Bathypantes weyeri (Emerton, 1875)	Found in caves in southern localities, surface records known for northern localities	2
Centromerus latidens (Emerton, 1882)	Found in caves in southern localities, surface records known for northern localities	2
Mermessus albula (Zorsch and Crosby, 1934)	Found in caves in southern localities, surface records known for northern localities	2
Oaphantes sp. 2	Found in caves in southern localities, surface records known for northern localities	2
Taranucnus ornithes (Barrows, 1940)	Found in caves in southern localities, surface records known for northern localities	2
Oaphantes pallidulus (Banks, 1904)	Almost all records are from caves, but a few surface records are known	2
Agyneta hedini Dupérré and Paquin, this paper	Known only from caves, but only 2 specimens known	3
Agyneta llanoensis (Gerstch and Davis, 1936)	Mainly found in caves, surface records are known without obvious geographical structure	4
Islandiana unicornis Ivie, 1965	Mainly known from caves, but the species is also reported from pocket gopher burrows	5
Porrhomma cavernicola (Keyserling, 1886)	Almost all records are from caves, but a few surface records are also known	6
Anthrobia mammouthia Tellkampf, 1844	Cave records only	7
Islandiana cavealis Ivie, 1965	Cave records only	7
Islandiana mumai Ivi,e 1965	Cave records only	7
Islandiana speophila Ivie, 1965	Cave records only	7
New genus sp. 1	Cave records only	7
New genus sp. 2	Cave records only	7
Oaphantes sp. 1	Cave records only	7
Oreonetides sp. Paquin, et al., in press	Cave records only	7
Phanetta subterranea (Emerton, 1875)	Cave records only	7
Sisicus sp.	Cave records only	7

others. The surface record from Wisconsin suggests that the species could be found in many more areas that are not necessarily characterized by important karstic systems. The classification of *A. llanoensis* as a troglophile is, however, fully justified.

Agyneta hedini is only known from two specimens and it is difficult to make any statement about its distribution or affinities. However, the occurrence of mature male and female in the same cave suggests more than a simple accidental occurrence.

Troglophiles or troglobites?

The ranking used here to classify Linyphiidae as troglophiles or troglobites is rather simplistic, but nonetheless allows an objective assignment to one of the two ecological categories (Fig. 24). The results obtained may change with the gathering of additional specimens and data, especially for species that are only known from a few individuals, but represent however a reliable assessment of actual knowledge. The species included in the classification are ranked according to their adaptations and affinities to the cave habitat. The gap found in the middle portion (score 4 and 5) is used here to establish the boundary between troglophiles and troglobites. The assignment of *Phanetta subterranea* (Emerton 1875) to troglobites is important; despite its lack of eye reduction, the species is known from thousands of records from 11 states and presents a distribution range of more than 600 miles without a single surface record. Its assignment as a troglobite is justified and supports the previous view of Gertsch (1992) that eye reduction is not the only criteria to consider for defining troglobitism. In comparison, *Porrhomma cavernicola* (Keyserling 1886) is a widespread troglobite with highly reduced eyes also known from Alabama to New York (U.S.A.) and Ontario (Canada). Specimens of that species have been recently collected on the surface at the northern edge of its distribution and these individuals show important differences in the degree of eye reduction when compared with individuals collected in southern locations (unpublished data). The degree of eye reduction in the southern edge of the distribution leaves no doubt about its assignment as a troglobite, but these recent surface records suggest that the situation could be complex, even within a single species.

The ranking shown in figure 24, suggests that three species are highly troglomorphic and that 10 species display a lesser degree of affinities for this habitat,

Figs. 25-26. *Agyneta llanoensis,* images by James C. Cokendolpher, 1998. 25, ventral aspect of male, Bunny Hole, Camp Bullis. 26, dorsal view of female from Treasure Cave, Fort Hood.

but should nonetheless be considered troglobites. The remaining species are best considered troglophiles, including *A. llanoensis* and *A. hedini* new species. Considering the variability observed for North American Linyphiidae associated with caves, we suggest that species display different degrees of troglobitism that may represent different steps towards complete adaptations to cave life.

Taxonomic and nomenclature notes

Anthrobia coylei Miller 2005a is not retained in this paper because its distinction from *A. mammouthia* (Telkampf 1844) appears doubtful; the species was erected only on the basis of longer legs and in absence of genitalic differences, this may not support a distinct species. As for the degree of eye reduction, that varies within species and is often geographically structured, longer legs may be a geographical variant or a simple population trait. It seems best to consider all troglobitic *Anthrobia* to belong in *A. mammouthia,* until this question is better addressed.

Miller (2005a) restored the use of the original spelling, *A. monmouthia,* as the appropriate spelling for the species. *Anthrobia monmouthia* however appears a case of *incorrect original spelling* (ICZN 1999, article 32.5.1) as the species may have been named after the type locality, Mammoth Cave (Kentucky, U.S.A.). In the original paper however, Tellkampf (1844) did not specify the origin of the name, therefore this interpretation remains debatable. In 1862 however, Keyserling emended the name to *A. mammouthia* without comments. To favor nomenclatural stability, the Code prevails for the use of an unjustified emendation that is widely used. In any case, either following the incorrect original spelling hypothesis or the wide use of Keyserling unjustified emendation (therefore deemed to be treated as a justified emendation, ICZN 1999, article 33.2.3.1), *A. mammouthia* is the spelling to retain. This spelling is consistent with the usage in scientific publications and speleological documents for about a century and a half, which conforms to ICZN (1999) recommendation (point 12: XXVII) about retaining the prevailing usage for a name despite disagreement with the original spelling. We therefore restore *A. mammouthia* as the appropriate spelling for this species.

In the study of the two species described in this paper, we have re-examined other *Agyneta* species in order to correctly assess the complex genitalic morphology of the species. It appears that the structure identified as an embolic membrane for *Agyneta sheffordiana* in Dupérré and Paquin 2007: fig. 3, is best identified as a median membrane.

ACKOWLEDGEMENTS

This is publication no. 16 of the Karst Biosciences and Environmental Geophysics Research Laboratories, SWCA Environmental Consultants.

We thank J. C. Cokendolpher, C. Crawford, W. Elliott, J. Fant, A. G. Grubbs, L. J. Graves, J. Krejca, K. O'Connor, B. Parker, M. Reyes, M. Sanders, P. Sprouse, C. Thibodaux, G.. Veni, M. Warton, and K. White for assistance with collections. Charles Pekins provided invaluable assistance for field work on Fort Hood. We also thank A. Dean (TAMUIC) and N. Platnick (AMNH) for the permission to work with the material under their care. Particular thanks to J. C. Cokendolpher who has correctly identified a significant portion of the material curated at the TMMC. We are also grateful to M. Hedin for providing the specimens of *A. hedini* and to S. O'Kane for field assistance. Dustin Jones provided a hand in producing the distribution maps and S. B. Peck clarified the location of the Alabama record. We also greatly appreciate the input of A. Tanasevitch for the interpretation of *Agyneta* morphology. We are grateful to D. J. Buckle and N. Platnick for their reviews of the manuscript and input related to the appropriate spelling of *A. mammouthia.* Research on Fort Hood was funded by The Nature Conservancy through cooperative agreement DPW-ENV-02-A-001 between the Department of the Army and The Nature Conservancy. Information contained in this report does not necessarily reflect the position or the policy of the government and no official endorsement should be inferred.

LITERATURE CITED

Barr, T. C., and J. R. Holsinger. 1985. Speciation in cave faunas. Annual Review of Ecology and Systematics, 16:313-337.

Buckle, D. J., D. Carroll, R. L. Crawford, and V. D. Roth. 2001. Linyphiidae and Pimoidae of America north of Mexico: Checklists, synonymy, and literature. Pp. 89-191 In: P. Paquin and D. J. Buckle (editors). Contributions à la connaissance des Araignées (Araneae) d'Amérique du Nord.

Cokendolpher, J. C., and D. J. Buckle. 2004. Rediscovery of *Eperigone albula* in Central Texas caves (Arachnida: Araneae: Linyphiidae). Texas Memorial Museum, Speleological Monographs, 6. Studies on the cave and endogean fauna of North America, IV. Pp. 71-73.

Denis, J. 1949. Notes sur les Érigonides. XVI. Essai sur la détermination des femelles d'érigonides. Bulletin de la Société d'Histoire naturelle de Toulouse, 83:129–158.

Dupérré, N., and P. Paquin. 2007. Description of five new spiders from Canada (Araneae: Linyphiidae). Zootaxa, 1632:1-20.

Emerton, J.H. 1875. Notes on spiders in caves of Kentucky, Virginia and Indiana. The American Naturalist, 9:278-281.

Gertsch, W.J. 1992. Distribution patterns and speciation in North American cave spiders with a list of the troglobites and revision of the cicurinas of the subgenus *Cicurella*. Texas Memorial Museum Speleological Monographs, 3. Studies on the cave and endogean fauna of North America, II:75-122.

Gertsch, W. J., and L. I. Davis. 1936. New spiders from Texas. American Museum Novitates, 881:1-21.
van Helsdingen, P. J. 1973. A recapitulation of the Nearctic species of *Centromerus* Dahl (Araneida, Linyphiidae) with remarks on *Tunagyna debilis* (Banks). Zoologische Verhandelingen Rijksmuseum van Natuurlijke Historie te Leiden, 124:1-45.
van Helsdingen, P. J. 1981. The Nearctic species of *Oreonetides* (Araneae, Linyphiidae). Bulletin of the American Museum of Natural History, 170:229-241.
Hormiga, G. 2000. Higher level phylogenetics of erigonine spiders (Aranea, Linyphiidae, Erigoninae). Smithsonian Contributions to Zoology, 609:1-160.
ICZN. 1999. International Code of Zoological Nomenclature. Fourth Edition. International Trust for Zoological Nomenclature. v-xxix + 1-305 p.
Ivie, W. 1965. The spiders of the genus *Islandiana* (Linyphiidae, Erigoninae). American Museum Novitates, 2221:1-25.
Ivie, W. 1969. North American spiders of the genus *Bathyphantes* (Araneae, Linyphiidae). American Museum Novitates, 2364:1–70.
Keyserling, E. 1862. Beschreibung einer neuen Spinne aus den Hohlen von Lesina. Verhandlungen der kaiserlich-königlichen zoologisch-botanischen Gesellschaft in Wien, 12:539–544.
Miller, J. A. 2005a. Cave adaptation in the spider genus *Anthrobia* (Araneae, Linyphiidae, Erigoninae). Zoologica Scripta, 34:565–592.
Miller, J. A. 2005b. A redescription of *Porrhomma cavernicola* Keyserling (Araneae, Linyphiidae) with notes on Appalachian troglobites. Journal of Arachnology, 33:426-438.
Millidge, A. F. 1984. The erigonine spiders of North America. Part 7. Miscellaneous genera (Araneae, Linyphiidae). Journal of Arachnology, 12:121-169.
Paquin, P., and R. S. Anderson. 2009. The first troglobitic weevil (Coleoptera: Curculionidae) in North America? Description of a new eyeless species of *Lymantes* Schoenherr from Central Texas caves. Texas Memorial Museum, Speleolog-ical Monographs, 7. Studies on the cave and endogean fauna of North America, V. Pp. 116-123.
Paquin, P., N. Dupérré, D. Buckle, and J. J. Lewis, in press. *Oreonetides beattyi*, a new troglobitic spider (Araneae: Linyphiidae) from Eastern North America, and re-description of *Oreonetides flavus*. Journal of Cave and Karst Studies.
Reddell, J. R., and J. C. Cokendolpher. 2004. The cave spiders (Araneae) of Bexar and Comal Counties, Texas. Texas Memorial Museum Speleological Monographs, 6. Studies on the cave and endogean fauna of North America, IV. Pp.75-94.
Saaristo, M. I. 1973. Taxonomical analysis of the type-species of *Agyneta, Anomalaria, Meioneta, Aprolagus*, and *Syedrula* (Araneae, Linyphiidae). Annales Zoologici Fennici, 10:451-466.
Saaristo, M. I., and S. Koponen. 1998. A review of northern Canadian spiders of the genus *Agyneta* (Araneae: Linyphiidae), with descriptions of two new species. Canadian Journal of Zoology, 76:566-583.
Saaristo, M. I., and A.V. Tanasevitch. 1996. Redelimitation of the subfamily Micronetinae Hull, 1920 and the genus *Lepthyphantes* Menge, 1866 with descriptions of some new genera (Aranei, Linyphiidae). Bericht des Naturwissens-Medizinischen Verein Innsbruck, 83:163-186.
Tellkampf, T. 1844. Beschreibung einiger neuer in der Mammuth-Höhle in Kentucky aufgeundener Gattungen von Gliedertieren. Archiv für Naturgeschichte, 10:318-322.

Valdez-Mondragón, Alejandro, and Oscar F. Francke. 2009. A new species of *Modisimus* (Araneae: Pholcidae) from Chiapas, Mexico [Nueva especie de *Modisimus* (Araneae: Pholcidae) de Chiapas, México]. Texas Memorial Museum Speleological Monographs, 7. Studies on the cave and endogean fauna of North America, V. Pp. 57-62.

A NEW SPECIES OF *MODISIMUS* (ARANEAE: PHOLCIDAE) FROM CHIAPAS, MEXICO

Alejandro Valdez-Mondragón and **Oscar F. Francke**

Colección Nacional de Arácnidos (CNAN),
Departamento de Zoología, Instituto de Biología,
Universidad Nacional Autónoma de México (UNAM),
Apto. Postal 70-153, C. P. 04510. Ciudad Universitaria, México D. F.
Email: AV-M: lat_mactans@yahoo.com.mx, OFF: offb@ibiologia.unam.mx

ABSTRACT

Modisimus deltoroi, new species is described from males and females collected in two separate caves in the Chan-Kin Ecological Reserve in the Lacandona rainforest, Municipio de Ocosingo, Chiapas, in southeastern Mexico. It appears to be related to *Modisimus ixobel* Huber, 1998 from Guatemala and *Modisimus propinquus* O. P.-Cambridge, 1896 from Mexico, from which it differs primarily in the setation of the chelicera, palps of males, and epigynum of the female.

RESUMEN

Se describe *Modisimus deltoroi,* nueva especie, de machos y hembras colectados en dos cuevas de la Reserva Ecológica de Chan-Kin en la Selva Lacandona del sureste de México. Esta emparentada con *Modisimus ixobel* de Guatemala y *Modisimus propinquus* de México, diferenciándose principalmente en las sedas de los quelíceros y en los palpos de los machos.

INTRODUCTION

The spider family Pholcidae C. L. Koch, 1851 contains approximately 1,000 species in more than 83 genera distributed world-wide (Platnick, 2008). The genus *Modisimus* Simon, 1893 includes 57 extant species, 17 of which occur in Mexico. The genus is known from North America south to Central America and the West Indies; the species reported from South America may be taxonomically misplaced, introduced, or erroneously assigned to that region (Huber, 1998c). Most species build dome-shaped webs in different habitats, principally in humid places such as under tree trunks and rocks, in dark cavities in the floor, between the vegetation near the ground, and in cave entrances. Males and females are often found together on one web; adults occur in any season, and the population density may fluctuate significantly (Huber, 1998c).

The genus was originally established for a single species: *Modisimus glaucus* Simon, 1893, from Hispaniola. Most subsequent species have been described by Gertsch (1937, 1941, 1971, 1973, 1977, 1992) and Huber (1997, 1998a, 1998b, 1998c) with 16 and 17 species, respectively. Gertsch described 11 of the 17 species known from Mexico.

The genus *Modisimus* is characterized, albeit weakly, by the presence of a long and prominent eye turret, a median elevation of the anterior part of the prosoma that carries the eyes (Figs. 1, 6). The spiders of this genus are small to medium sized (1.5-4 mm body length), usually with six eyes, rarely with punctiform anterior median eyes; and the male pedipalp femur with a pointed, upward projecting ventral apophysis (Huber, 1998c) (Fig. 4).

MATERIAL AND METHODS

Palps and epigyna were dissected in isopropyl alcohol (80%) and cleared in potassium hydroxide solution (10% KOH) for 10 to 15 minutes. All specimens are preserved in isopropyl alcohol (80%). A Zeiss Stemi SV11stereomicroscope with a camera lucida was used to make the illustrations. All measurements are standard for the Araneae, and are in millimeters. Specimens have been deposited in the Colección Nacional de Arácnidos (CNAN), at the Instituto de Biologia, Universidad Nacional Autónoma de México (UNAM), and at the American Museum of Natural History (AMNH), New York, U.S.A.

TAXONOMY

Pholcidae C. L. Koch, 1851

Modisimus Simon 1893

Modisimus deltoroi, new species
Figs. 1-9

Type-data.—Male holotype (CNAN-T0283) from Cueva Ch'en-bajläm "Cueva del Tigre" (N 16° 41' 12", W 90° 49' 30"), 200 m, Reserva Ecológica Chan-Kin, Municipio de Ocosingo, Chiapas, México, 7 November 2006 (A. Valdez, H. Montaño, R. Paredes, G. Montiel, F. Bertoni). 1 female paratype (CNAN-T0284), same locality, 19 October 2006 (A. Valdez, O. Francke, H. Montaño, A. Ballesteros). 1 male paratype (CNAN T-0285) same locality, 10 August 2006 (A. Valdez, H. Montaño, I. Mondragón, S. Rubio, N. Perez). 1 male paratype (CNAN T-0286) from Cueva Kolem-Ch'en "Cueva Grande" (N 16° 41' 28", W 90° 49' 26"), 189 m, Reserva Ecológica Chan-Kin, 10 August 2005 (A. Valdez, J. Castelo, E. Cabrera, R. Paredes, G. Montiel). 1 female paratype (CNAN-T0287), "Cueva del Tigre", 19 October 2006 (A. Valdez, O. Francke, H. Montaño, A. Ballesteros). 1 female paratype (CNAN T-0288), same locality, 10 August 2006 (A. Valdez, H. Montaño, I. Mondragón, S. Rubio, N. Pérez). 1 male 1 female paratypes (AMNH), same locality, 7 November 2006 (A. Valdez, H. Montaño, R. Paredes, G. Montiel, F. Bertoni).

Etymology.—We dedicate this species to Dr. Miguel Alvarez del Toro in recognition of his contributions to the knowledge of the spider fauna of the state of Chiapas, Mexico.

Diagnosis.—Male can be distinguished by the procursus of the palp lacking dorsal spine on the middle (Fig. 4) and distinctly curved dorsally (Figs. 1, 4), long dorsal apophysis in the base of procursus (Figs. 1, 4); and curved embolus (Fig. 5). Female can be distinguished by the epigynum with two sclerotized arches laterally (Fig. 8).

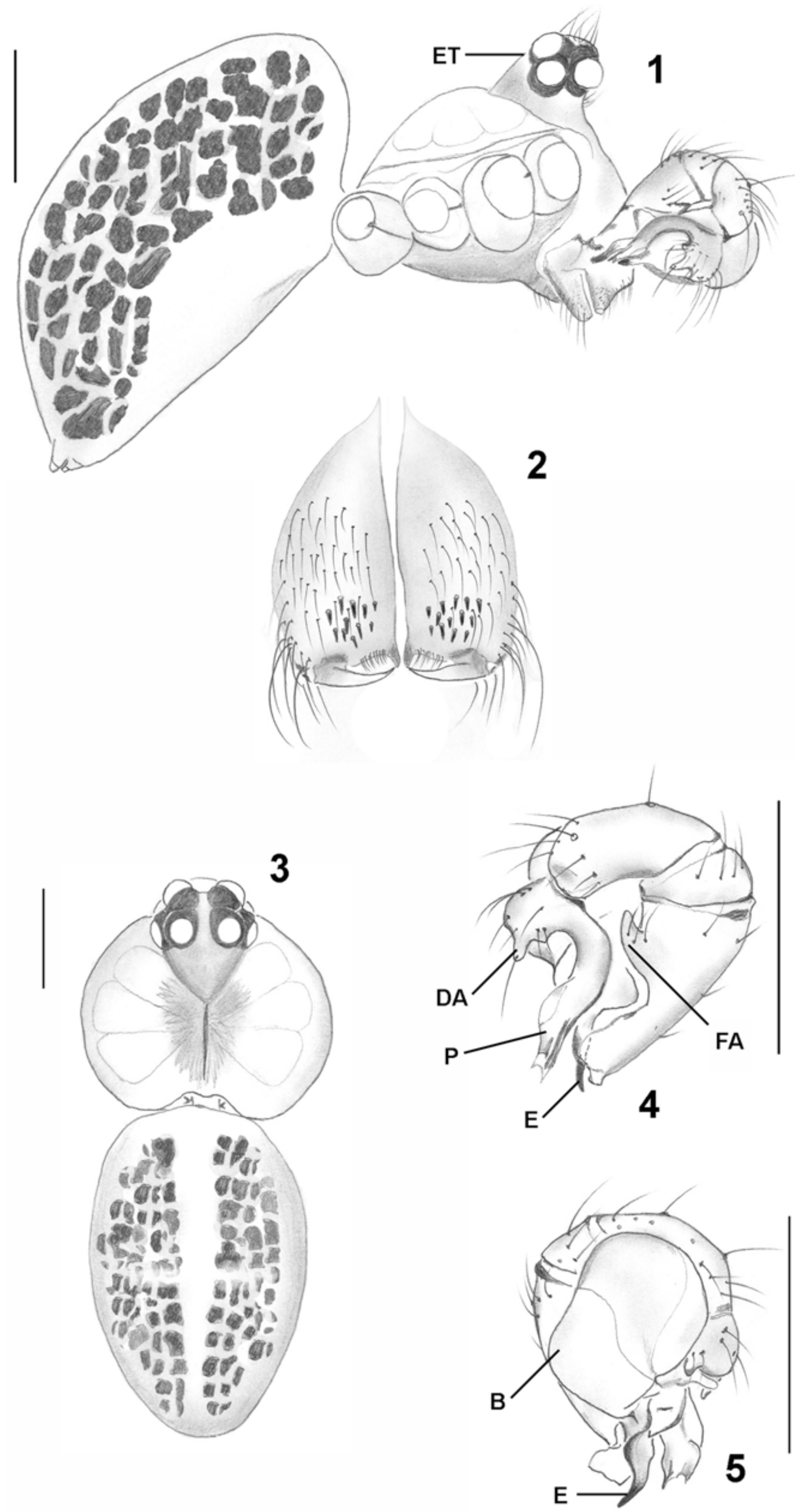
Description.—*Male holotype:* Carapace pale ochre-yellow, with darker median stripe; clypeus pale yellow without markings; chelicerae and pedipalps pale ochre-yellow; sternum pale yellow; legs medium ochre-yellow without darker rings or bands; opisthosoma dorsally light blue with numerous dark blue spots (Figs. 1 and 3), ventrally light ochre-yellow without markings. Pedipalps as shown in Figs. 4 and 5, procursus arching dorsally, bulb as shown in Fig. 5, ventral femoral apophysis pointed, directed towards the tibia as shown in Fig. 4. Frontal aspect of chelicerae with scattered modified hairs on distal half, not forming distinct patches (Fig. 2). Legs without spines. *Measurements:* Total length 2.3, prosoma length: 0.85, width: 1.0. Leg formula: 1-2-4-3. Leg lengths: I- femur 7.5/ patella 0.5/ tibia 7.5/ metatarsus 13.4/ tarsus 1.4/ total 30.3; II- 5.0/ 0.5/ 4.6/ 7.4/ 1.2/ 18.7; III- 3.6/ 0.45/ 3.7/ 5.4/ 0.9/ 14.05; IV- 4.7/ 0.4/ 4.2/ 6.4/ 1.0/ 16.7.

Female paratype (type locality): Coloration as in male (Figs. 6 and 7); epigynum light ochre-yellow with two characteristic dark half-moons (sclerotized arches) laterally as shown in Fig. 8. Internal genitalia as shown in Fig. 9. Legs without spines. *Measurements:* Total length 2.0, prosoma length: 0.8, width: 0.9. Leg formula: 1-2-4-3. Leg lengths: I- femur 4.5/ patella 0.4/ tibia 4.7/ metatarsus 7.8/ tarsus 1.6/ total 19; II- 3.1/ 0.3/ 2.9/ 4.6/ 1.0/ 11.9; III- 2.6/ 0.3/ 2.4/ 3.4/ 0.9/ 9.6; IV- 3.3/ 0.3/ 2.8/ 4.3/ 0.9/ 11.6.

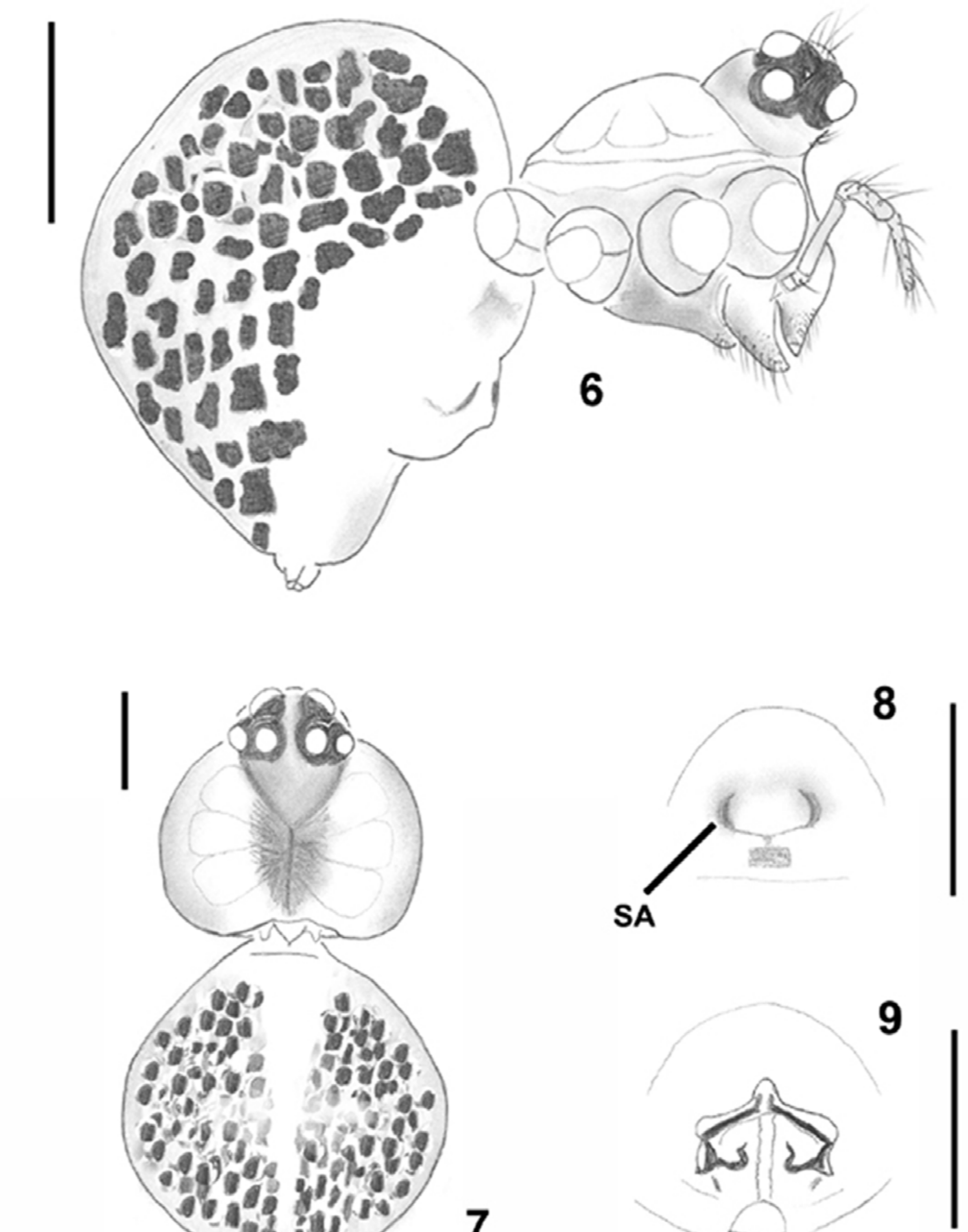
Variation.—The variation observed in *M. deltoroi,* new species is mainly in coloration, males (n=4) and females (n=4) vary in color from light ochre-yellow to dark ochre-yellow on the carapace, opisthosoma and legs. There is no significant variation in body size among males, nor among females; however, as in most congeneric species the males are larger than the females. Palpal sclerites of the males do not show appreciable variation, nor do the epigyna of the females.

Natural History.—The specimens of *Modisimus deltoroi* were collected in cave entrances (Figs. 10-11), in the floor under and between rocks where they spin their webs, and in spaces in the walls inside the caves. The caves are karstic in origin, and are located in tropical rainforest, in the Lacandona region, near the border with Guatemala. They occur at 200 m of elevation on average.

Remarks.—*Modisimus deltoroi* appears to be closely related to *Modisimus ixobel* Huber, 1998 from Guatemala and to *Modisimus propinquus* O. P.-Cambridge, 1896 from Mexico by the similar form of procursus and embolus, respectively. *Modisimus ixobel* has the procursus simple, without long basal apophysis like the new species, and it lacks the strong dorsal curvature of the procursus which characterizes *M. deltoroi*; the embolus on the bulb is shorter in *M. ixobel*, and the modified cheliceral setae are in a different position. In *M. ixobel* they are near the chelicerae and in the new species they are closer to the frontal lamina region of basichelicerae. *Modisimus propinquus* has a dorsal curvature on the procursus somewhat similar to that in *M. deltoroi*, but it has a claw-shaped dorsal spine on the middle of the procursus which the new species lacks.



Figs. 1-5. —*Modisimus deltoroi*, new species. Male: 1, prosoma and opisthosoma, right lateral view. 2, chelicera, frontal view with modified hairs. 3, prosoma and opisthosoma, dorsal view. 4, left palp, retrolateral view. 5, left palp, prolateral view. Abbreviations: B, bulb. DA, dorsal apophysis of procursus. E, embolus. ET, eye turret. FA, femoral apophysis. P, procursus. Scales: 0.5 mm.



Figs. 6-9. —*Modisimus deltoroi* new species. Female: 6, prosoma and opisthosoma, right lateral view. 7, prosoma and opisthosoma, dorsal view. 8, epigynum, ventral view. 9, epigynum, dorsal view. Abbreviation: SA, sclerotized arches. Scales: 0.5 mm.

Fig. 10.—View of Cueva Ch´en-bajläm "Cueva del Tigre" where *Modisimus deltoroi*, new species, was collected in cave entrance in a tropical rainforest.

Fig. 11.—View of Cueva Ch´en-bajläm "Cueva del Tigre" where *Modisimus deltoroi*, new species, was collected in the entrance, in the floor under and between rocks (where they spin their webs), and in cracks in the inside wals of the cave.

Map 1.—Distribution of *Modisimus deltoroi*, new species (triangles) and species closely related: *Modisimus propinquus* O. P.-Cambridge, 1896 (circles) and *Modisimus ixobel* Huber, 1998 (diamonds).

The embolus in *M. propinquus* is longer and straight, whereas on *M. deltoroi* it is shorter and bent distally. In these two species the modified cheliceral setae are similar in form, although in *M. propinquus* they are lined up in the distal region and in *M. deltoroi* they are scattered on the frontal lamina region of basichuelicerae. The epigynum of *M. deltoroi* has two sclerotized arches which both *M. ixobel* and *M. propinquus* lack. The distributions of *M. deltoroi* and related species are shown on Map 1.

ACKNOWLEDGMENTS

Thanks to the project directed by Dra. Elena Álvarez-Buylla "*Lachandonia schismatica*: recurso genético estratégico para México y conservación de la Selva Lacandona" (CONACYT No. COI-043/B1), for financial support. To Dr. Bernhard Huber and two anonymous reviewers for their corrections and comments on the manuscript. To the inhabitants of the community of Frontera Corozal, Municipio de Ocosingo, Chiapas for allowing us to work in the zone, guiding us to the caves and their assistance with fieldwork.

LITERATURE CITED

Gertsch, W. J. 1941. Report on some arachnids from Barro Colorado Island, Canal Zone. American Museum Novitates, 1146:1-14.

Gertsch, W. J. 1971. A report on some Mexican cave spiders. Bulletin of the Association for Mexican Cave Studies, 4:47-111.

Gertsch, W. J. 1973. A report on cave spiders from Mexico and Central America. Bulletin of the Association for Mexican Cave Studies, 5:141-163.

Gertsch, W. J. 1977. Report on cavernicole and epigean spiders from the Yucatan Peninsula. Bulletin of the Association for Mexican Cave Studies, 6:103-131.

Gertsch, W. J., and L. I. Davis. 1937. Report on a collection of spiders from Mexico. I. American Museum Novitates, 961:1-29.

Gertsch, W. J., and S. B. Peck. 1992. The pholcid spiders of the Galapagos Islands, Ecuador (Araneae: Pholcidae). Canadian Journal of Zoology, 70:1185-1199.

Huber, B. A. 1997. On the distinction between *Modisimus* and *Hedypsilus* (Araneae, Pholcidae), with notes on behavior and natural history. Zoologica Scripta, 25:233-240.

Huber, B. 1998a. Report on some pholcid spiders collected in Guatemala and Honduras (Araneae, Pholcidae). Revue Suisse de Zoologie, 105:49-80.

Huber, B. 1998b. The pholcid spiders of Costa Rica (Araneae: Pholcidae). Revista de Biología Tropical, 45:1583-1634.

Huber, B. 1998c. Notes on the Neotropical spider genus *Modisimus* (Pholcidae, Araneae), with descriptions of thirteen new species from Costa Rica and neighboring countries. Journal of Arachnology, 26:19-60.

Platnick, N. I. 2008. The world spider catalog, version 8.5. American Museum of Natural History, online at http://research.amnh.org/entomology/spiders/catalog/index.html

Villegas-Guzmán, Gabriel A., and Oscar F. Francke. 2009. Description of the male of the genus *Typhloroncus* Muchmore, 1979 (Pseudoscorpiones: Ideoroncidae) [Descripción del macho del género *Typhloroncus* Muchmore, 1979 (Pseudoscorpiones: Ideoroncidae)]. Texas Memorial Museum Speleological Monographs, 7. Studies on the cave and endogean fauna of North America, V. Pp. 63-66.

DESCRIPTION OF THE MALE OF THE GENUS *TYPHLORONCUS* MUCHMORE, 1979 (PSEUDOSCORPIONES: IDEORONCIDAE)

Gabriel A. Villegas-Guzmán and **Oscar F. Francke**

Colecciones Nacionales de Ácaros y de Arácnidos,
Departamento de Zoología, Instituto de Biología,
Universidad Nacional Autónoma de México,
Avenida Universidad 3000; Ciudad Universitaria;
C. P. 04510, Distrito Federal; México.
Email: GAV-G: gabrvill@yahoo.com, OFF: offb@ibiologia.unam.mx.

ABSTRACT

We describe the males of *Typhloroncus attenuatus*, Muchmore, 1982, which were collected in the Purificación Cave System, Tamaulipas, Mexico. Five species of the genus *Typhloroncus* are known, and all the descriptions are based on females; this is the first description of adult males for the genus. Males lack eyes, the pedipalps are extremely elongated, and the body is pale yellow-brown, as in the female. Males present some differences from the female: the number of contiguous marginal teeth on the fixed and movable fingers of the pedipalps is lower in males; males are slightly smaller than females and have the modified, longitudinally striate setae on tarsus IV diagnostic for the species.

RESUMEN

Se describen los machos de la especie *Typhloroncus attenuatus*, Muchmore, 1982, la cual fue colectada en cuevas del Sistema Purificación, Tamaulipas, México. Se conocen cinco especies del género *Typhloroncus*; todas las descripciones se han realizado en base a hembras, esta es la primera descripción de machos adultos para el género. Los machos difieren de la hembra en el número de dientes en los dedos de la quela del pedipalpo y poseen sedas modificadas, longitudinalmente estriadas e infladas basalmente en el tarso de la pata IV, que son diagnósticas de la especie. Al igual que la hembra, los machos carecen de ojos, los pedipalpos son alargados y el cuerpo es de color amarillo castaño.

INTRODUCTION

The genus *Typhloroncus* Muchmore was established for *Typhloroncus coralensis* Muchmore (1979), known from a single female from Coral Bay, U. S. Virgin Islands in the Caribbean. Four additional species have been found in Mexico, all of them collected in caves: *Typhloroncus troglobius* Muchmore 1982, *Typhloroncus diabolus* Muchmore, 1982, *Typhloroncus attenuatus* Muchmore, 1982, and *Typhloroncus xilitlensis* Muchmore, 1986 (Muchmore, 1982, 1986) and the four are known only from females. In this paper we describe the males of *T. attenuatus*, which show typical troglomorphies, such as lack of eyes, the color is pale yellow-brown, and they have extremely elongated legs and pedipalps. This is the first male description for the genus.

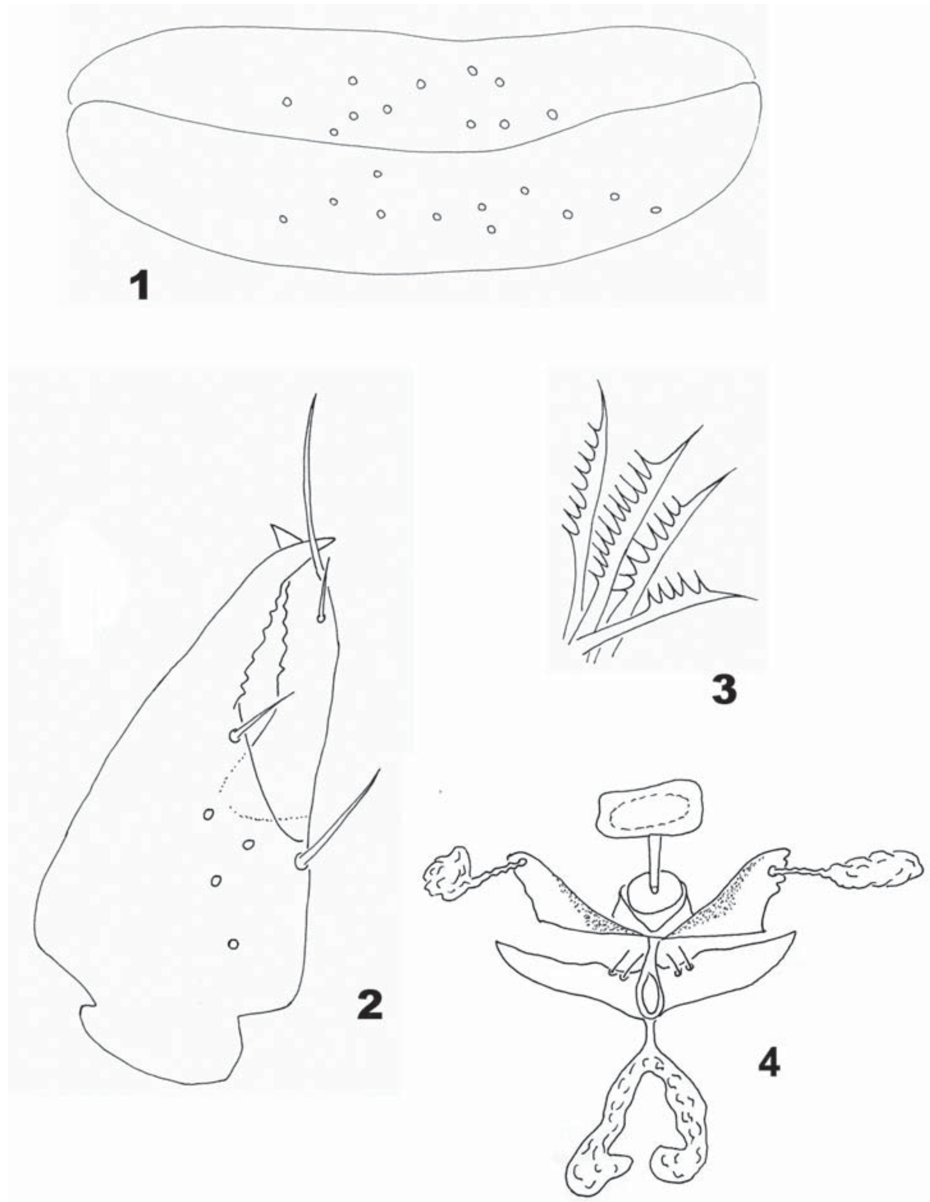
MATERIAL AND METHODS

The males were preserved in 80% ethanol upon collection, and were processed using Hoff's (1949) technique, modified after Wirth and Marston (1968). Measurements are given in millimetres and were obtained using Chamberlin's (1931) method, as modified by Benedict and Malcolm (1977). The morphological terminology mostly follows Chamberlin (1931) and Harvey (1992). Abbreviations used in the description are: L = length, W = width, L/W = length/width ratio. The specimens are deposited in the Colección Nacional de Arácnidos (CNAN), Instituto de Biología, Universidad Nacional Autónoma de México.

TAXONOMY

Family Ideoroncidae Chamberlin, 1930
Genus *Typhloroncus* Muchmore 1979

Type species.—*Typhloroncus coralensis*



Figures 1-4.—*Typhloroncus attenuatus*, male (CNAN-Ps000404). 1. Genital opercula, ventral view; 2. Right chelicera, dorsal view; 3. Rallum; 4. Male genitalia, dorsal/ventral aspect (CNAN-Ps000405).

Muchmore 1979, by original designation.

Other species.—*T. attenuatus* Muchmore, 1982; *T. diabolus* Muchmore, 1982; *T. troglobius* Muchmore, 1982 and *T. xilitlensis* Muchmore, 1986.

Typhloroncus attenuatus Muchmore, 1982
Figs.1-7

Material examined.—México: Tamaulipas: Male (CNAN-Ps000404) collected in the Infiernillo section, Sistema Cavernario Purificación (UTM NAD27 450559 2653383), 1121m asl, 15 June 2006, collected by Paul Bryant. Male (CNAN-Ps000405) with the same data, except that it was collected by Victoria Siegel and Marcela Ramirez.

Diagnosis.—Troglobite lacking eyes. Body with pale coloration, appendages very elongate: pedipalp (L = 8.45-8.95), leg I (L= 4.15-4.34), and Leg IV (L = 5.45-5.75). Chelal fingers with numerous teeth, movable finger 123-125, fixed finger 139-145. Carapace with four setae on anterior margin and two on posterior margin, and eight other setae. Leg IV tarsus distally with modified, longitudinally striate setae which are swollen basally.

Male description.—Body uniformly light yellow-brown throughout. Carapace as wide as long; the surface reticulated, without transverse furrow; with 4 setae on anterior margin, 9 on posterior margin, and 47 others.

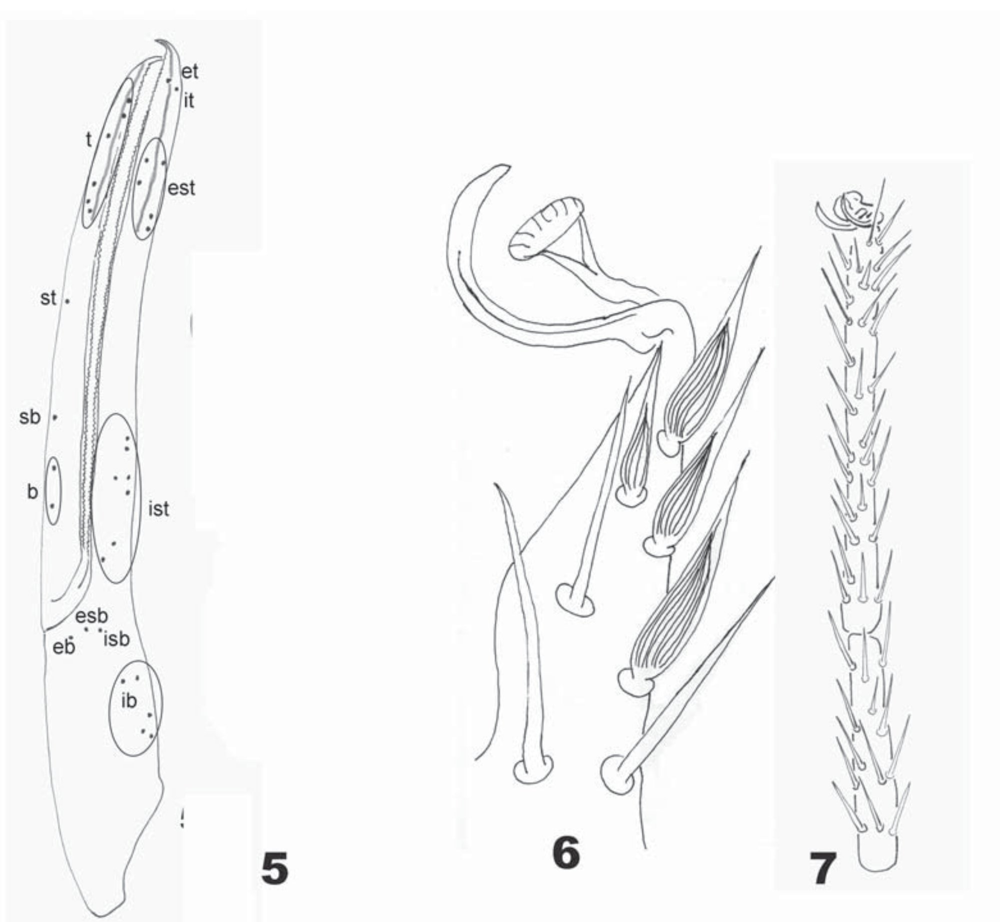
Abdomen with twelve segments; tergites and sternites entire, finely reticulated, and setae acuminate. Tergal chaetotaxy 2:2:2:2:4:4:4:4:4:4:2:2, setae of last tergite acuminate. Sternites: the first three are occupied by the genitalia, formed by two opercula, anterior with 11 setae, posterior with 12, those without particular disposition (Fig. 1), general appearance of male genitalia as illustrated, sclerotic genital sacs and a globular uterus masculinus internus (Fig. 4); IV-XII less sclerotized than tergites, chaetotaxy of sternites IV-XII 6:6:8:8:8:8:6:4:2, with one seta associated with spiracular plates. Chaetotaxy of the pedipalpal coxae 7:7:4:3, with two setae on manducatory process. Median maxillary lyrifissure located near margin left of maxilla.

Chelicera long, L/W = 3-3.5, with 6 setae on hand; margins of both fingers with teeth, movable finger with 7 and fixed with 9 (Fig. 2). Rallum of four serrated blades, three subequal and one slightly smaller (Fig. 3); serrula exterior with 30 blades and interior with 26. Galea long and slender, without branches; and subgaleal setae short and thin. Lamina exterior absent.

Genitalia: with median genital sac divided in two branches (Fig. 4), with two pairs of glandular setae, and lateral genital sac lengthened.

Pedipalps very long, surface reticulated. Trochanter L/W = 1.6-1.8; femur L/W = 8-10; patella L/W = 7.3-8.4; chela long and thin, with 32 trichobothria, venom apparatus present in both fingers. Movable finger with 123-125 marginal teeth, continuous, truncated, some of them are rounded; with 10 trichobothria, region *b* with two, *sb* and *st* with one, and region *t* with six (Fig. 5), in this region is the nodus ramosus. Fixed finger with 139-145 teeth; with 22 trichobothria, *eb*, *esb* and *isb* in straight row at base of finger, *ib* region with five setae near the internal margin of the finger (Fig. 5). Region *ist* with seven setae; region *est* with five and in this region is the nodus ramosus; *it* and *et* with one setae each.

Legs are elongated, reticulated, pale yellow-brown; arolium not divided, slightly indented and shorter than claws (Fig. 6). Leg I: trochanter robust L/W = 1.2-1.5; femur long, L/W = 8.3-9; patella short and robust, L/W = 3.3; tibia long and thin, L/W = 8.5-9; metatarsus short



Figures 5-7.—*Typhloroncus attenuatus,* male (CNAN-Ps000404). 5. Left pedipalp chela, lateral view showing distribution of the trichobothria; 6. Arolium, claw and setae of tarsus leg IV, dorsal view showing longitudinally striate setae; 7. Metatarsus and tarsus, leg IV, dorsal view showing setal arrangement.

and thin, L/W = 4.2-5.1; tarsus long, L/W = 7.8-8.3. Leg IV: trochanter short and robust, L/W = 2; femur+patella long, L/W = 7.4-8; tibia long and thin, L/W = 6.7-8.6; metatarsus short and robust, L/W = 5; tarsus long, L/W = 13-14. Metatarsus and tarsus, in both legs, have subterminal simple setae (Fig. 7). Ventrodistally on tarsus IV are present modified setae, longitudinally striate and swollen basally (Fig. 6).

Dimensions. (n=2).—Body L 3.95-4.15, W 1.1-1.3. Carapace L 1.0, W 1.0-1.1. Chelicera L 0.65-0.7, W 0.2-0.3. Pedipalps: trochanter L 0.4-0.45, W 0.25; femur L 2.4-2.5, W 0.25-.3; patella L 2.1-2.2, W 0.25-0.3; chela (with pedicel) L 3.55-3.8, W 0.45-0.5; hand L 1.1-1.25; movable finger 2.3-2.5. Leg I: trochanter L 0.3, W 0.2-0.25; femur L 1.25-1.35, W 0.2-0.25; patella L 0.5, W 0.15; tibia L 0.85-0.9, W 0.1; metatarsus L 0.42-0.52, W 0.10; tarsus L 0.78-0.83, W 0.1. Leg IV: trochanter L 0.5, W 0.25; femur+patella L 1.85-2.0, W 0.25; tibia L 1.30-1.35, W 0.15-0.20; metatarsus L 0.5, W 0.10; tarsus L 1.3-1.40, W 0.10.

Remarks.—Males differ slightly from the female: on the female the movable finger of the pedipalp chela has 133 teeth and the fixed finger has 149 (Muchmore, 1982), whereas the males have 123-125 teeth on the movable finger and 139-145 on the fixed finger. The size of the males is slightly smaller than the female: total length of the males is 3.95-4.15, and the female is 4.5; male carapace measures 1.00, and the female 1.37, the palpal femur measures 2.54 on the female and 2.4-2.5 on the males. The female has five setae on the left chelicera and six on the right, whereas the males have six setae on both sides. Furthermore, on the tarsus of leg IV the males have modified setae similar to the female, a character that distinguishes *Typhloroncus attenuatus* from the other species of the genus. The number of setae on carapace is low. The specimens of both sexes were collected in the same cave system, but in different places and time.

The bipartite median genital sac of *T. attenuatus* males is noteworthy because in most pseudoscorpions this structure is rounded or elliptical. However, several genera of Ideoroncidae share the bipartite condition (Harvey and Volschenk, 2007), and *Typhloroncus* can now be added to that list.

ACKNOWLEDGMENTS

We express our sincere thanks to the speleologists that collected the specimens, and to Peter Sprouse for making them available for study. Dr. Abel Pérez González and Dr. Mark Harvey kindly reviewed the manuscript and made significant recommendations for its improvement.

LITERATURE CITED

Chamberlin, J. C. 1931. The arachnid order Chelonethida. Stanford University Publications, Biological Science, 7:1-284.

Benedict, E. M., and D. R. Malcolm. 1977. Some garypoid false scorpions from western North America (Pseudoscorpionida: Garypidae and Olpiidae). Journal of Arachnology, 5:113-132.

Harvey, M. S. 1992. The phylogeny and classification of the Pseudoscorpionida (Chelicerata: Arachnida). Invertebrate Taxonomy, 6:1373-1435.

Harvey, M. S., and E. S. Volschenk. 2007. Systematics of the Gondwanan pseudoscorpion family Hyidae (Pseudo-scorpiones: Neobisioidea): new data and a revised phylogenetic analysis. Invertebrate Systematics, 21:365-406.

Hoff, C. C. 1949. The pseudoscorpions of Illinois. Illinois Natural History Survey Bulletin, 24:409-498.

Muchmore, W. B. 1979. Pseudoscorpions from Florida and the Caribbean area 9. *Typhloroncus*, a new genus from the Virgin Islands (Ideoroncidae). Florida Entomologist, 62:317-320.

Muchmore, W. B. 1982. Some new species of pseudoscorpions from caves in Mexico. (Arachnida: Pseudoscorpionida). Bulletin of the Association for Mexican Cave Studies, 8:63-78.

Muchmore, W. B. 1986. Additional pseudoscorpions, mostly from caves, in México and Texas (Arachnida: Pseudoscorpionida). Texas Memorial Museum, Speleological Monographs, 1:17-30.

Wirth, W. W., and N. Marston. 1968. A method for mounting small insects on microscope slides in Canada balsam. Annals of the Entomological Society of America, 61:783-784.

Cokendolpher, James C. 2009. New troglobitic *Tyrannochthonius* from Fort Hood, Texas (Pseudoscorpionida: Chthoniidae) [Un nuevo *Tyrannochthonius* troglobio de Fort Hood, Texas (Pseudoscorpionida: Chthoniidae)]. Texas Memorial Museum Speleological Monographs, 7. Studies on the cave and endogean fauna of North America, V. Pp.:67-78.

A NEW TROGLOBITIC *TYRANNOCHTHONIUS* FROM FORT HOOD, TEXAS (PSEUDOSCORPIONIDA: CHTHONIIDAE)

James C. Cokendolpher

Invertebrate Zoology, Natural Science Research Laboratory
Museum of Texas Tech University
3301 4th Street
Lubbock, Texas 79409 U.S.A.
Email: james.cokendolpher@ttu.edu

ABSTRACT

A review, list, and map of the 36 species of pseudoscorpions known from caves in Texas are provided. Member species are from the families and genera: Family Bochicidae: *Leocohya*; Family Cheiridiidae: *Apocheiridium, Cheiridium*; Family Chernetidae: *Dinocheirus, Hesperochernes, Neoallochernes*; Family Chthoniidae: *Aphrastochthonius*, *Chthonius*, *Lechytia*, *Mexichthonius, Mundochthonius, Tyrannochthonius;* Family Garypidae: *Archeolarca*; Family Neobisiidae: *Microbisium, Tartarocreagris*; Family Syarinidae: *Chitrella*. A new species of *Tyrannochthonius* is named as a patronym honoring Bill and Midge Muchmore. The new species is a troglobite from Geocache Cave, Fort Hood, Texas.

RESUMEN

Se proporcionan una revisión, lista, y mapa de las 36 especies de los pseudoescorpiones conocidos de cuevas en Texas. Las especies pertenecen a las familias y los géneros: Familia Bochicidae: *Leocohya*; Familia Cheiridiidae: *Apocheiridium, Cheiridium*; Familia Chernetidae: *Dinocheirus, Hesperochernes, Neoallochernes*; Familia Chthoniidae: *Aphrastochthonius*, *Chthonius*, *Lechytia*, *Mexichthonius, Mundochthonius, Tyrannochthonius;* Familia Garypidae: *Archeolarca*; Familia Neobisiidae: *Microbisium, Tartarocreagris*; Familia Syarinidae: *Chitrella*. Una nueva especie de *Tyrannochthonius* se nombra como un patronímico que honra a Bill y Midge Muchmore. La nueva especie es troglobia de la cueva Geocache, Fort Hood, Texas.

INTRODUCTION

Continued speleobiological explorations at Fort Hood, Texas, are generating further undescribed species, including a new species of pseudoscorpion. In this contribution, that species is described and found to be a troglobite. Thus far, it is only known from one locality, Geocache Cave. The only other troglobite discovered in that cave thus far is a spider, *Cicurina coryelli* Gertsch, 1992 (1 female, Texas Memorial Museum, collected 18 May 2004, J. Fant, J. Reddell, M. Reyes). This spider is also known from three other nearby caves on the opposite side (north and east) of Cowhouse Creek (Cokendolpher and Reddell, 2001: fig. 22-map). The creek is known to cut through the limestone layer and thus now isolates the caves on each side. The only other troglobitic pseudoscorpion known from Fort Hood, is *Tartarocreagris hoodensis* Muchmore, 2001. At about twice the body size of the new species, *T. hoodensis* has been recorded only from six caves located north and east of Cowhouse Creek. Numerous other pseudoscorpions are known from caves at Fort Hood, but all of them are known from litter or other dry conditions in the entrances of caves and show no morphological characteristics suggesting that they are restricted to life in caves. These epigean/hypogean pseudoscorpions are: *Dinocheirus* sp. (Bell County: Trapper Sink], *Hespero-chernes* sp. maybe *occidentalis* (Hoff and Bolsterli, 1956) (Coryell County: Goathead Cave), *Neoallochernes* sp. (Bell County: BLORA Shelter Cave No. 1, Dripping Harvestman Cave), *Mundochthonius* sp. maybe *sandersoni* Hoff, 1949 (Coryell County: Runoff Cave), *Microbisium parvulum* (Banks, 1895) [Bell County: Jagged Walls Cave; Keilman Cave, Nolan Creek Cave, Pump House Cave, Treasure Cave; Coryell County: 1923 Cave; Plateau Cave No. 2; Rocket River Cave System (B.R.'s

Table 1.-Texas counties from which pseudoscorpions have been collected (surface records for the same species are not included), and citations to the original description and papers recording specimens from caves. Cave names are listed in the references. Identifications listed as Reddell (pers. comm.) are from his catalog of material identified previously by Muchmore- Texas Natural History Collections (TMM), Austin, and the Florida State Collection of Arthropods (FSCA), Gainesville. Colored symbols correspond to those on Map 1.

Family Bochicidae
- ▲ *Leocohya texana* Muchmore, 1986: Muchmore, 1992 (Uvalde County)

Family Cheiridiidae
- ► *Apocheiridium reddelli* Muchmore, 1992 (Edwards County)
- ▼ *Cheiridium reyesi* Muchmore, 1992 (Kinney County)

Family Chernetidae
- ◄ *Dinocheirus cavicola* Muchmore, 1992 (Edwards, Kinney, Val Verde Counties)
- ■ *Dinocheirus texanus* Hoff and Clawson, 1952: Muchmore, 1992 (Uvalde County)
- ● *Dinocheirus venustus* Hoff and Clawson, 1952: Muchmore, 1992 (Comal, Edwards, Medina, Val Verde Counties)
- ♦ *Hesperochernes molestus* Hoff, 1956: Muchmore, 1992 (Val Verde County)
- ▲ *Hesperochernes occidentalis* (Hoff and Bolsterli, 1956): Muchmore, 1992 (Edwards County)
- ► *Hesperochernes riograndensis* Hoff and Clawson, 1952: Muchmore, 1992 (Irion, Terrell Counties)
- ▼ *Hesperochernes unicolor* (Banks, 1908): Muchmore, 1992 (Hays County)
- ◄ *Neoallochernes stercoreus* (Turk, 1949): Muchmore, 1992 (Bexar, Blanco, Burnet, Comal, Edwards, Kendall, Kerr, Kinney, Mason, Medina, Terrell, Uvalde, Val Verde Counties)

Family Chthoniidae

- ■ *Aphrastochthonius* n. spp. (Bandera, Comal, Travis, Williamson Counties)
- ● *Chthonius* (*Ephippiochthonius*) sp. cf. *tetrachelatus* (Preyssler, 1790): Reddell (pers. comm.) (Bexar County)
- ♦ *Lechytia* sp. Reddell (pers. comm.) (Bexar, Williamson Counties)
- ▲ *Mexichthonius exoticus* Muchmore, 1996a (Travis County)
- ► *Mundochthonius* sp. possibly *sandersoni* Hoff, 1949: Reddell (pers. comm.) (Bell, Coryell Counties)
- ▼ *Tyrannochthonius muchmoreorum* Cokendolpher (this publication) (Bell County)
- ◄ *Tyrannochthonius texanus* Muchmore, 1992 (Bexar, Blanco, Coryell, Edwards, Hays, Travis, Val Verde Counties)
- ■ *Tyrannochthonius troglodytes* Muchmore, 1986: Muchmore, 1992 (Llano County)

Family Garypidae
- ● *Archeolarca guadalupensis* Muchmore, 1981: Muchmore, 1992 (Culberson County)

Family Neobisiidae
- ♦ *Microbisium parvulum* (Banks): Muchmore, 1992 (Bexar, San Saba, Travis Counties. Reddell (pers. comm.) also had specimens identified by Muchmore from Bell, Burnet, Coryell Counties)
- ▲ *Tartarocreagris altimana* Muchmore, 2001 (Travis County)
- ► *Tartarocreagris amblyopa* Muchmore, 2001 (Bexar County)
- ▼ *Tartarocreagris attenuata* Muchmore, 2001 (Travis County)
- ◄ *Tartarocreagris cookei* Muchmore, 2001 (Hays County)
- ■ *Tartarocreagris comanche* (Muchmore, 1992): Muchmore, 2001 (Burnet, Travis Counties)
- ● *Tartarocreagris domina* Muchmore, 2001 (Travis County)
- ♦ *Tartarocreagris grubbsi* Muchmore, 2001 (Hays County)
- ▲ *Tartarocreagris hoodensis* Muchmore, 2001 (Bell, Coryell County)
- ► *Tartarocreagris infernalis* (Muchmore, 1969): Muchmore, 2001 (Travis, Williamson Counties)
- ▼ *Tartarocreagris intermedia* Muchmore 2001 (Travis County)
- ◄ *Tartarocreagris proserpina* Muchmore, 2001 (Travis County)
- ■ *Tartarocreagris reyesi* Muchmore, 2001 (Bexar County)
- ● *Tartarocreagris texana* (Muchmore, 1969): Muchmore, 2001 (Travis County)

Family Syarinidae
- ♦ *Chitrella elliotti* Muchmore, 1992 (Sutton County)
- ► *Chitrella major* Muchmore, 1992 (Val Verde County)

Secret Cave), Royalty Ridge Cave]. There is also an older record from Rocket River Cave at Fort Hood of a 4-eyed *Tyrannochthonius* sp. maybe *texanus* Muchmore, 1992. The current whereabouts of that specimen is unknown.

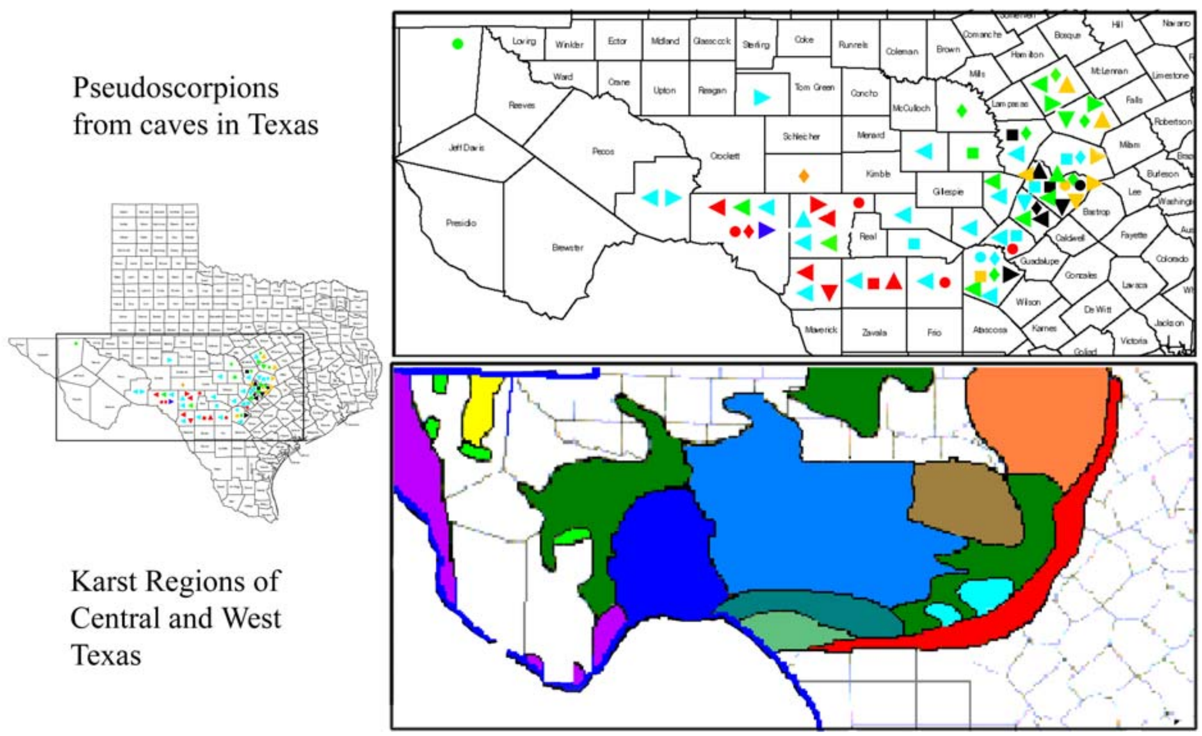
There are 32 described species known from caves in Texas, as well as at least 4 others that are not yet identified/described to species (Table 1). Not surprisingly, the general distributions of known pseudoscorpions from caves corresponds with the occurences of exposed limestones in Texas (Map 1). Hopefully, future collections of pseudoscorpions will be from surface habitats as well as karst, so that species restricted to caves can be better recognized.

The description of the new pseudoscorpion is based heavily on light (LM) and scanning electron microscopy (SEM) photographs. What started as a simple description has grown into an atlas of certain anatomical features and a discussion of methodologies. This manuscript and name of the new species are dedicated to Dr. William B. Muchmore (retired professor of Rochester University) and his wife Midge (Fig. 1). Bill is the reigning authority on pseudoscorpions of North America, especially those from endogean habitats. He has described and redescribed the majority of cavernicolous pseudoscorpions from the northern Americas (Harvey, 2008), including many species of the genus from which the new species is described. Midge passed away in spring of this year [Rochester (New York) Democrat and Chronicle, 13 April 2008 Obituary].

METHODS AND RESULTS

Specimen preparation: The single male known of the species was collected directly into 70% ethyl alcohol. From there it was placed in lactophenol on a shallow depression slide and cleared. While clearing, the right palp and chelicera were detached from the body and placed on a separate microscope slide with lactophenol. After study with LM, the specimen was returned to 70% ethyl alcohol. Later, for SEM study the body was critical point dried (CPD), mounted with alcohol soluble shellac on the tip of a 250 mm diameter copper wire that was taped (copper SEM tape) to an aluminum stub and sputter coated (Hummer V Sputter Coater) with 15 nm layer of gold-palladium.

Image and examination: Light microscopy included use of a Nikon/SL-3D and Leica MS5 microscopes with photo attachments and an 8 megapixel Nikon Coolpix 8700. Montaged digital photographs (see Automontage, http://www.syncroscopy.com/syncroscopy/automontageshort.asp) rendering the greatest depth of



Map 1.—Outline map of the state of Texas, showing the county locations of caves from which pseudoscorpions have been identified. Symbols and colors are matched to taxa in Table 1. Map insert of karst areas slightly modified, with permission, from map "Texas Karst & Pseudokarst Regions" by W. R. Elliott (http://www.utexas.edu/tmm/sponsored_sites/tss/images/tk1.gif, 22 June 2008)

field (most highly 'in-focus' images) for LM. Adobe Photoshop was used to enhance these and all other photographs. Electron microscopy was achieved by the use of a Hitachi S-570 SEM. Digital images presented herein as well as others to photo document the specimen are included in the museum digital catalog (TTU-Z 29,677).

Measurements were made following the directions in Chamberlin (1931, p. 32-35); using an ocular micrometer with LM, or read directly off enlarged SEM images and photograph scales. Trichobothria names follow those used by Harvey (1992), not Chamberlin (1931) nor those authors up to Harvey, in that names follow the developmental first occurrences in nymphs, not finally positions found in adults. Thus, the first emergence of trichobothrial positions of the palp in the three nymphal and adult stage are: fixed finger, external (*eb*, *et*>*est*>*esb*) fixed finger, internal (*ist*>*ib*, *it*>*isb*); moveable finger (*t*>*b*>*st*>*sb*). Harvey (1992) noted that the leg basifemur and telofemur were not both femoral segments, and showed that they were correctly the femur and patella. The cheliceral "flagellum" has recently (Judson, 2007) been renamed the rallum. Positions of lyrifissures based on descriptions and illustrations in Edward and Harvey (2008).

Damage to specimens: Collection and preservation of specimens results in the loss of data regarding habits in life and biological functions and features. Later storage results in loss/changes in pigmentation and physical damage to minute structures as the specimens become brittle and brush against the vial, labels, or air bubbles. Any shipping or handling of a minute pseudoscorpion probably results in further damage (loss of setae, etc.). A balance should be sought where the maximal information is gained with the least damage. This especially is a problem when single specimens are involved. It is apparent many would prefer not to examine the material in hopes of keeping it more pristine for some later study. In the present situation, the identity of the specimen was urgent so that its uniqueness could be recognized in habitat conservation plans for Fort Hood (Reddell, pers. com. 2008). Each process of examination results in some damage. The single male was treated with lactophenol and temporarily mounted on a cover-slipped slide. The lactophenol clears and digests some of the chitin and especially softer material inside the body. While this makes it easier for viewing with LM, it does some damage. Even so, it is relatively rapid (as compared to the methods of permanent slide mounting). As can be seen in the figures, setae and denticles were broken and the appendages show obvious desiccation issues. The CPD further severely damaged the specimen. It is suspected that the initial mixing of 100% ethyl alcohol with acetone was too rapid or the alcohol used was not pure. Further sample preparations, with these two items fixed, resulted in much better specimens. The description is excessive for strict taxonomy (just showing diagnostic structures) and for documenting the specimen condition before drying as well as structures not recorded before for this genus. If a view of the genitalia is ever sought with the holotypic specimen, it should be noted that the specimen is mounted to the SEM stub by an ethyl alcohol soluble shellac that is sputtercoated lightly. Because of the sputter-coating such an investigation would require the removal of the tergites for an examination of the genitalia. From the external damage visible, it is likely that such an effort would result in a totally shattered specimen.

Fig. 1.—Dr. William (Bill) B. and Margery (Midge) Muchmore, at their home in Rochester, New York, 11 June 2006. Midge passed on 7 April 2008.

TAXONOMY

Chthoniidae: *Tyrannochthonius* Chamberlin

This genus is large with 137 described species (Edward and Harvey, 2008; Harvey, 2008). They are known from around the world, with species occurring in both epigean and hypogean situations. Edwards and Harvey (2008) provided an amended diagnosis (see below) for the genus and a complete synonymy can be found in that paper combined with that of Harvey (2008). It is the only genus of pseudoscorpion known from caves in Texas which has coxal spines only on coxae II. Member species of this genus cannot be recognized in the field; adults of *Aphrastochthonius* Chamberlin and nymphs of other troglobitic species of *Tartarocreagris* Curcic, like the new species, are minute in size and have very long and slender pedipalp fingers. Any biological monitoring of this rare species will be very difficult, and probably for conservation any pseudoscorpion found in the cave should be considered this species unless it can be examined with a microscope. The problem with this notion is

Table 2.—Comparisons amoung five species of *Tyrannochthonius* (m= male, f= female).

	alabamensis	*floridensis*	***muchmoreorum***	*texanus*	*troglodytes*
Total length	1.40-1.52 f mm	1-1.4 mm (m&f)	**1.17 mm m**	1.08-1.41 mm (m&f)	1.5 m, 2.06 f mm
Carapace length	0.44-0.48 f mm	0.34-0.45 mm (m&f)	**0.38 mm** m	0.35-0.45 mm (m&f)	0.55 m, 0.56 f mm
Preocular seta	0	1 pair	**0**	0	0
Eyes	ALE corneate, PLE flat	ALE & PLE corneate	**ALE small PLE absent**	ALE corneate, PLE flat	ALE small PLE absent
Coxa I process seta	0	1	**0**	0	0
Anterior tergal chaetotaxy	4:4:4:4/5:6:6:6	4:4:4:4:6:6:6	**4:4:4:4:6:6:6**	4:4:4:6:6:6:6	4:4:4:4:6:6:6
Cavernicolous	epigean	epigean	**troglobitic**	troglophilic? accidental	troglobitic

that population size might be inflated by counting other species that might be present. For a review of this genus in the Americas see Muchmore (1992, 1995, 1996b) and Harvey (2008).

Diagnosis (from Edwards and Harvey, 2008).—"Species of *Tyrannochthonius* can be distinguished from those of other genera by the following combination of character states: trichobothrium *sb* positioned midway between *st* and *b*, or nearer to *st*; trichobothria *ib* and *isb* positioned close together in a median or subbasal position on dorsum of chelal hand; chelal hand usually with one large, medial acuminate spine-like seta near the base of the fixed finger, but can be reduced or absent; chelal hand not distally constricted or 'flask-shaped' and lacks enlarged, heavily sclerotised condyles or condylar apodeme; chelal fingers much longer than hand, with finger length generally 1.6–2.2 X hand length; inter-coxal tubercle absent; coxal spines generally long, incised for only part of their length, and present exclusively on coxae II; epistome usually small, triangular, and closely flanked by two carapacial setae; the epistome is reduced or absent in some species (particularly troglobites); without distal sensorium near *xs* of fixed chelal finger (Chamberlin 1962; Muchmore 1984, 1991; Muchmore and Chamberlin 1995)."

***Tyrannochthonius muchmoreorum*, new species**

Tables. 1-2, Map 1, Figs. 2-24

Type-data.—Holotype male collected within Geocache Cave, Fort Hood, Bell County, Texas, 27 June 2004, by C. Pekins, J. Reddell, and M. Reyes. Specimen is now mounted on SEM stub housed in the Invertebrate Zoology collection of the Museum of Texas Tech University (TTU-Z 29,677); right palp in 75 % ethyl alcohol (same catalogue #).

Diagnosis and comparisons.—Minute in size (Fig. 2- male body 1.17 mm long, carapace 0.38 mm long). ALE (anterior lateral eyes) present but weakly corneate and small, PLE absent (no hint of eyespots with LM, possible remnant indicated in Fig. 6 SEM). Similar to the other two congeneric species described from Texas caves by having flat epistome; without small seta at base of apical projection of coxae I; without preocular dwarf seta on carapace: *Tyrannochthonius texanus* Muchmore, 1992; *Tyrannochthonius troglodytes* Muchmore, 1986. For a more detailed comparison, the three species from Texas (only species described from the West) are listed below alongside two species that at different times (Muchmore, 1996b) were considered the ancestral form of the genus from east of the Mississippi River:

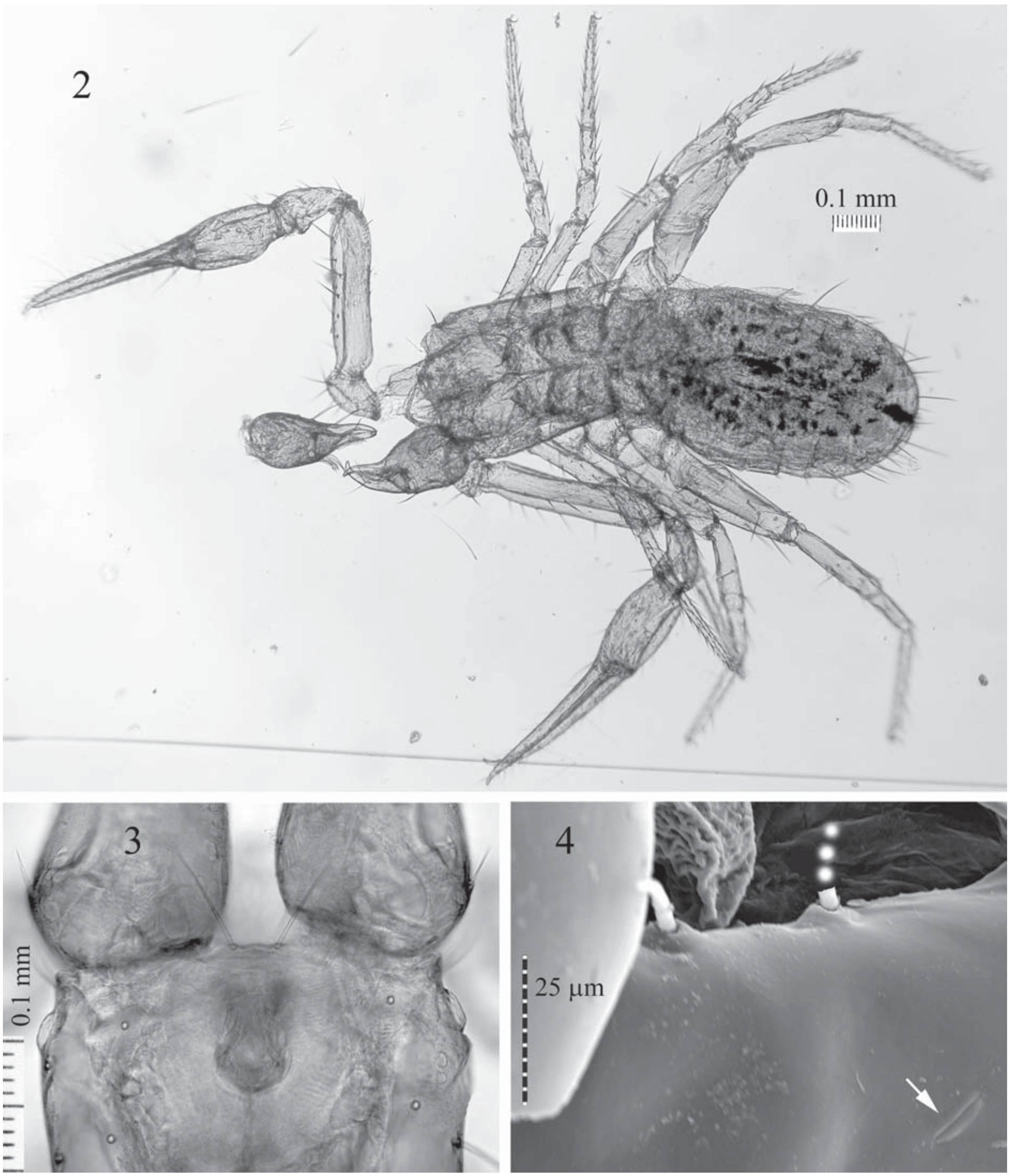
The new species and *T. troglodytes* share the loss of the second pair of eyes and reduction in size of the anterior eyes.

These two are easily separated by the overall smaller size of the new species. It is commonly accepted (and there is a lot of literature about it) that the reduction of posterior eyes in different degrees in Chthoniidae is quite frequent, even in the same species. Moreover, Muchmore (1986) in his description of *T. troglodytes* mentions: "posterior eyes reduced" and the presence of "4 distinct eyes." Both species also have the microdenticles alternated with macrodenticles on the palp fingers. However, the smaller size of the new species is quite decisive.

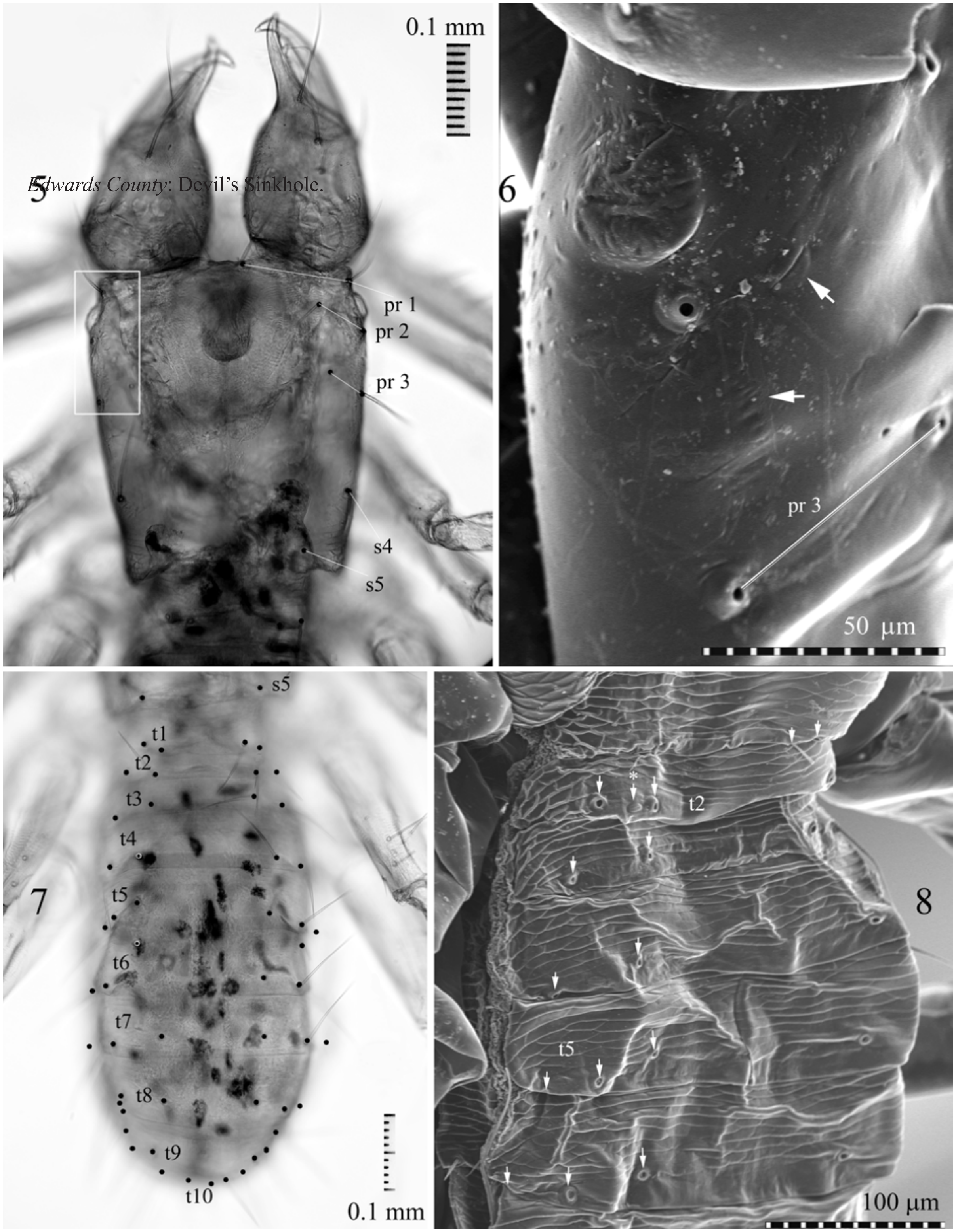
Etymology.—The new species name is a patronym honoring Bill and Midge Muchmore.

Description.—Female unknown. Male coloration in alcohol light yellowish-brown, chelicerae and palps more reddish-brown, soft parts pale. Carapace widest in front, slightly longer than broad (Figs. 1, 5); epistome missing, low and broad, flanked by pair of setae (Figs. 3-5); ALE corneate (Figs. 2, 3, 5, 6,), reduced in size (Fig. 6, diameter 30 µm), no PLE; chaetotaxy 4:4:4:2:2, pre-ocular setae absent; two pairs of lyrifissures on ocular row (arrows to right 2nd lyrifissure in Fig. 4, left 1st lyrifissure Fig. 6), 3rd pair not observed near posterior row of setae; 1 pair of small circular pits (about 1.75 µm diameter) near inner, 3rd pair setae. Chaetotaxy of coxae 2-3:3:4: 6:5. Coxa I with long pointed anteriomedial process (arrow in Fig. 9); process without seta; each coxa I with about 6 terminինally, deeply, incised coxal spines (exact number uncertain with LM and SEM, Figs. 10, 11). Abdomen typical for genus (Figs. 2, 7, 8), tergites wider than long, almost as tall as wide (shallow depth of field with LM required focusing through depths to count setae; SEM preparation collapsed abdomen hiding sockets on sides) (Figs. 7, 8) anterior, tergal chaetotaxy tergites I-X: 4:4:4:4:6:6:6:6:6. Sternal chaetotaxy and internal genitalia not photographed or recorded with LM (now hidden by SEM stub attachment).

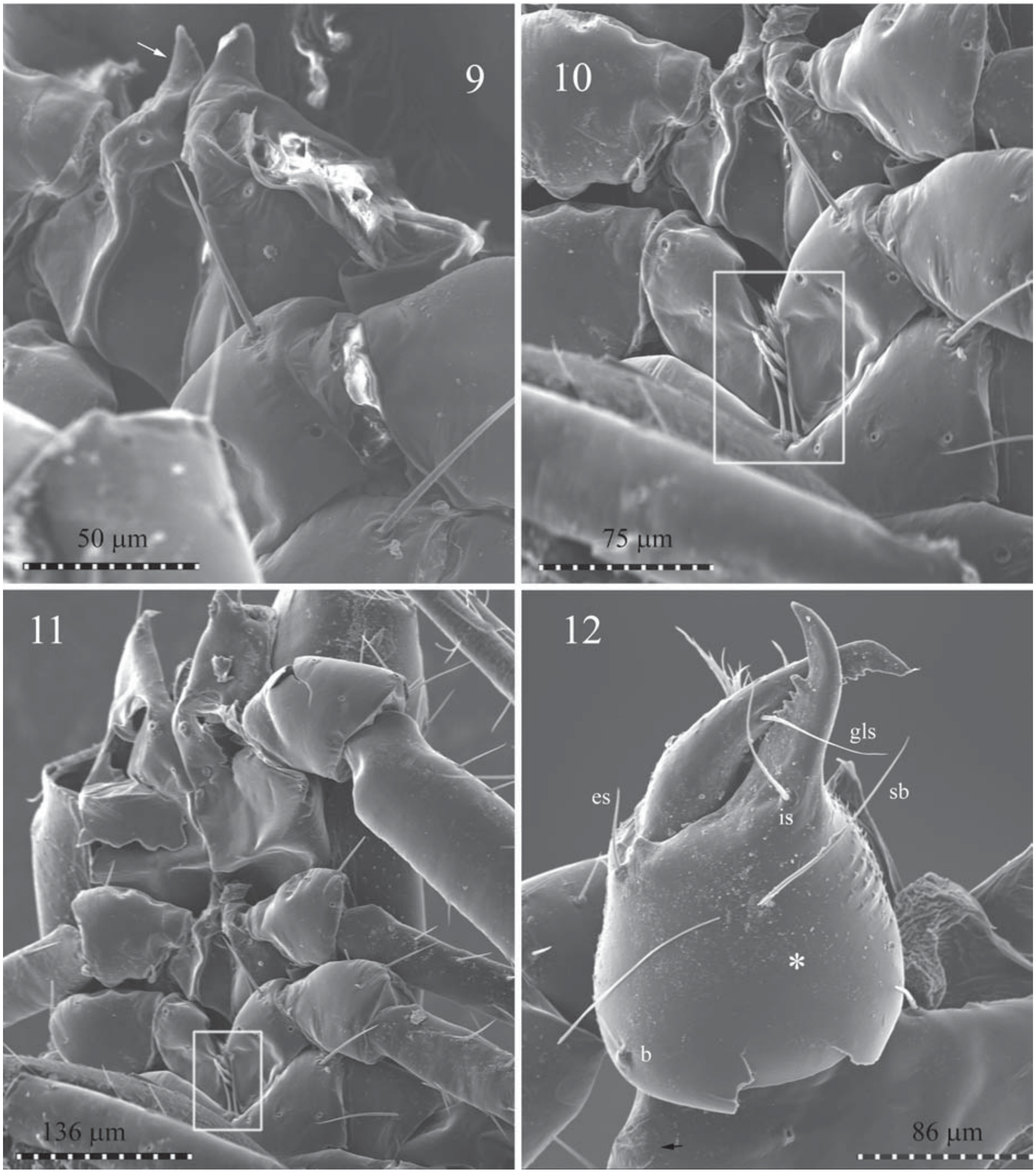
Chelicera about 5/7 as long as carapace; hand with 5 (4 on left side, Figs. 5, 12) setae; rallum with 9 setae, 2 distal-most enlarged at base, furrow for rallum longitudinally grooved. (Figs. 15, 16); dentition of fingers typical (Figs. 13, 14, boxed denticle was broken off in SEM preparation, not a hollow tip); galeal/spinneret eleva-



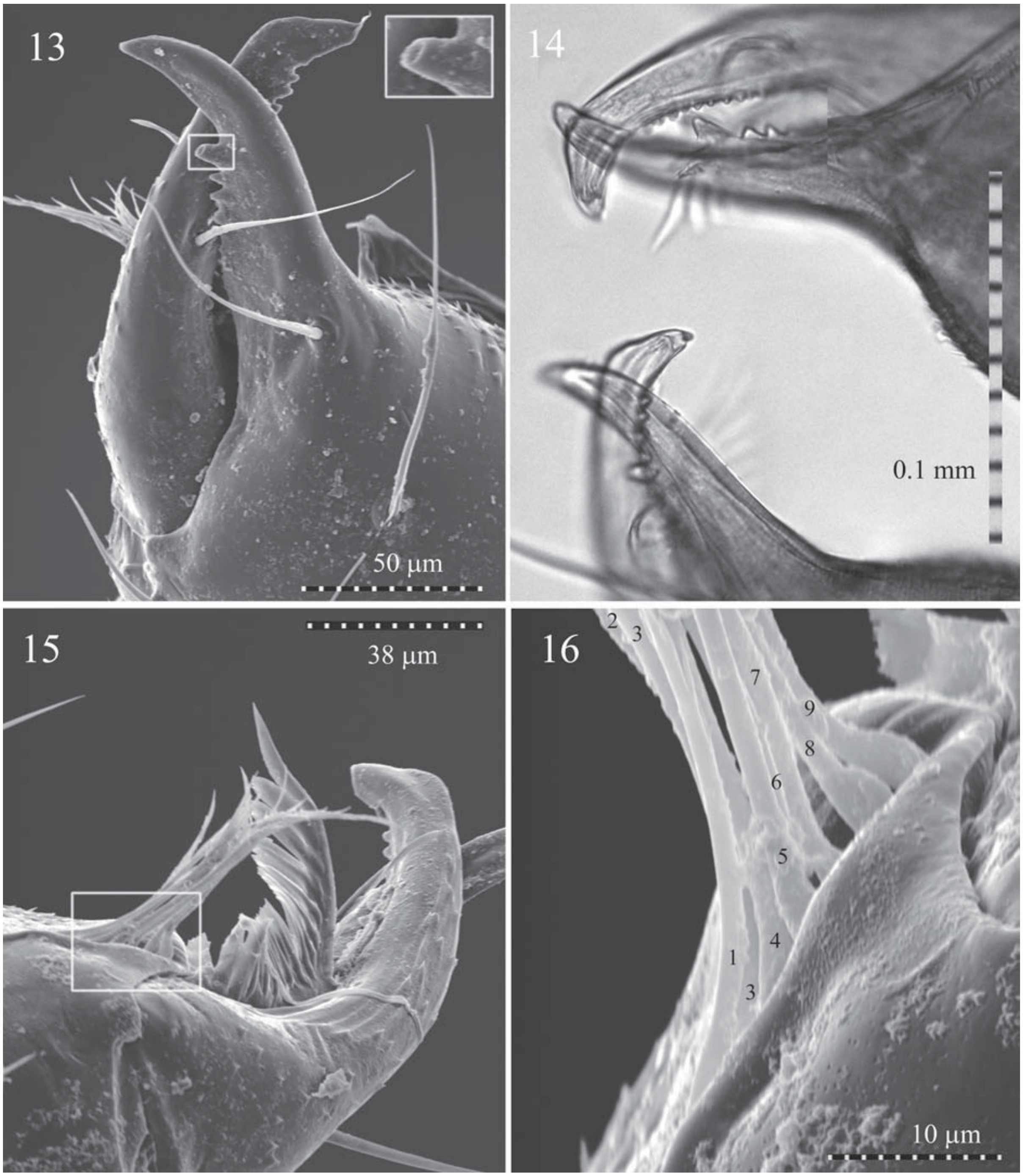
Figs. 2-4.—*Tyrannochthonius muchmoreorum,* n.sp., dorsal aspect of male holotype: 2, partially cleared in lactophenol and dissected (right palp and chelicera), light microscopy-LM; 3, eye region and base of chelicerae, LM; 4, epistome and flanking setae on carapace (lyrifissure indicated by arrow), scanning electron microscopy-SEM.



Figs. 5-8.—*Tyrannochthonius muchmoreorum,* n.sp., male holotype: 5, carapace and chelicerae, dorsal aspect, LM (boxed area enlarged in next image); 6, dorsolateral view of chelicera base and eye region (note lyrifissure and possible indication of PLE indicated by arrows, see text), SEM; 7, tergites 1-10, LM; 8, anterior 6 tergites, SEM (pr = pair, s = seta, t = tergite, * = lyrifissure on t2).



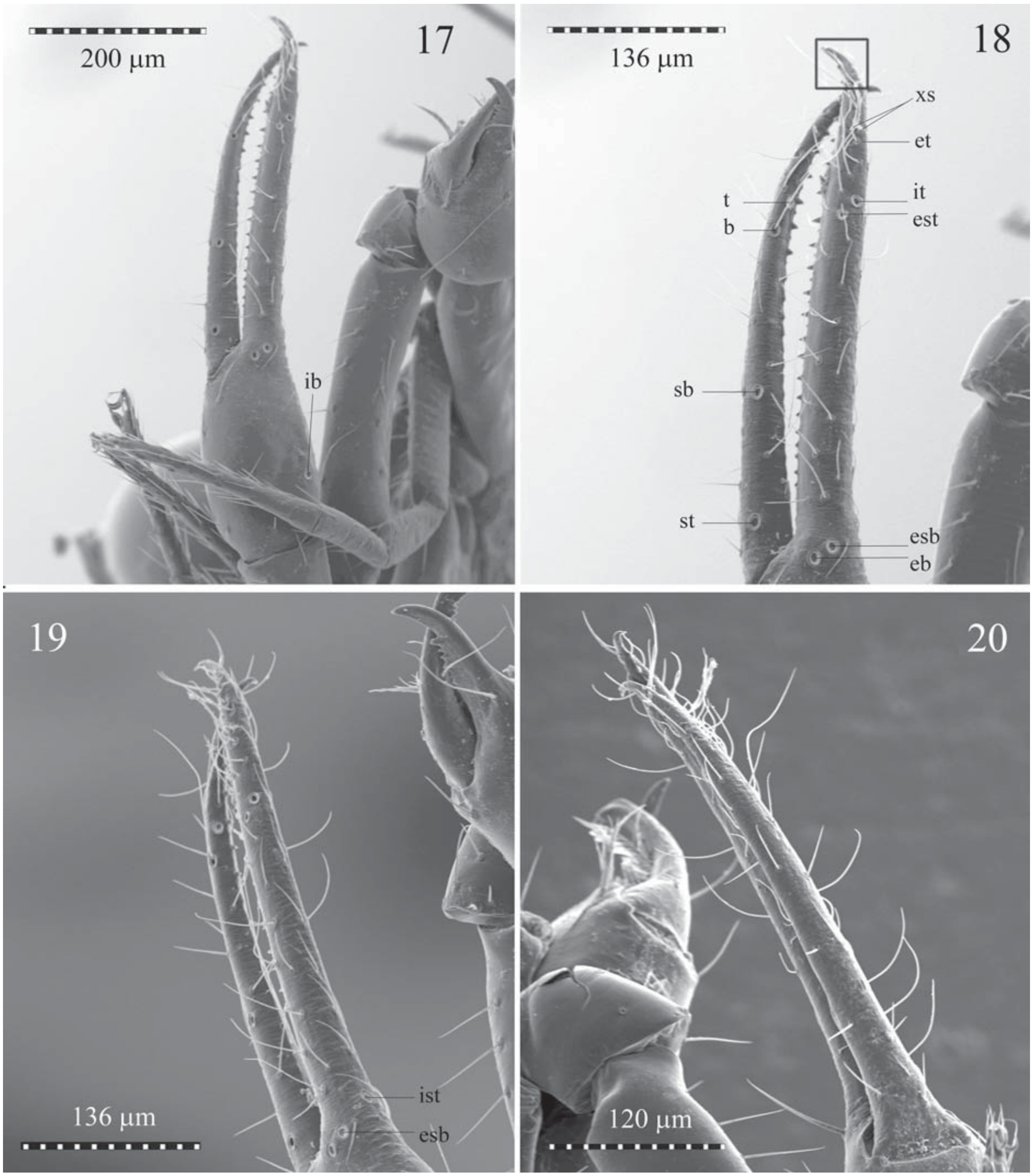
Figs. 9-12.—*Tyrannochthonius muchmoreorum,* n.sp., male holotype, SEM: 9, ventral aspect coxae I, rest of leg removed on left side, arrow indicates right, anteriomedial process; 10, ventral aspect of coxae and trochanters I-III; 11, ventral aspect of appendage bases (chelicera of left side removed); 12, exterior lateral aspect of left chelicera, * indicates placement of 5th seta on right cheliceral. Boxes in Figs. 10, 11, show placement of coxae II spines.



Figs. 13-16.—*Tyrannochthonius muchmoreorum,* n.sp., male holotype: 13, dorsal aspect of distal end of left chelicera, SEM (box showing enlargement of broken-off denticle tip); 14, dorsal aspect of cheliceral fingers, LM; 15, ventrolateral aspect of left, moveable, cheliceral finger (boxed area enlarged in next image), SEM; 16, ventral aspect of basal region of cheliceral rallum, SEM.

tion smooth, small, slightly compressed longitudinally (Figs. 13-15); 1 seta (*gls*) on lateral surface of moveable finger; inner surface of chelicerae and external surface of moveable finger with sharp, small denticles (Figs. 12, 13, 15).

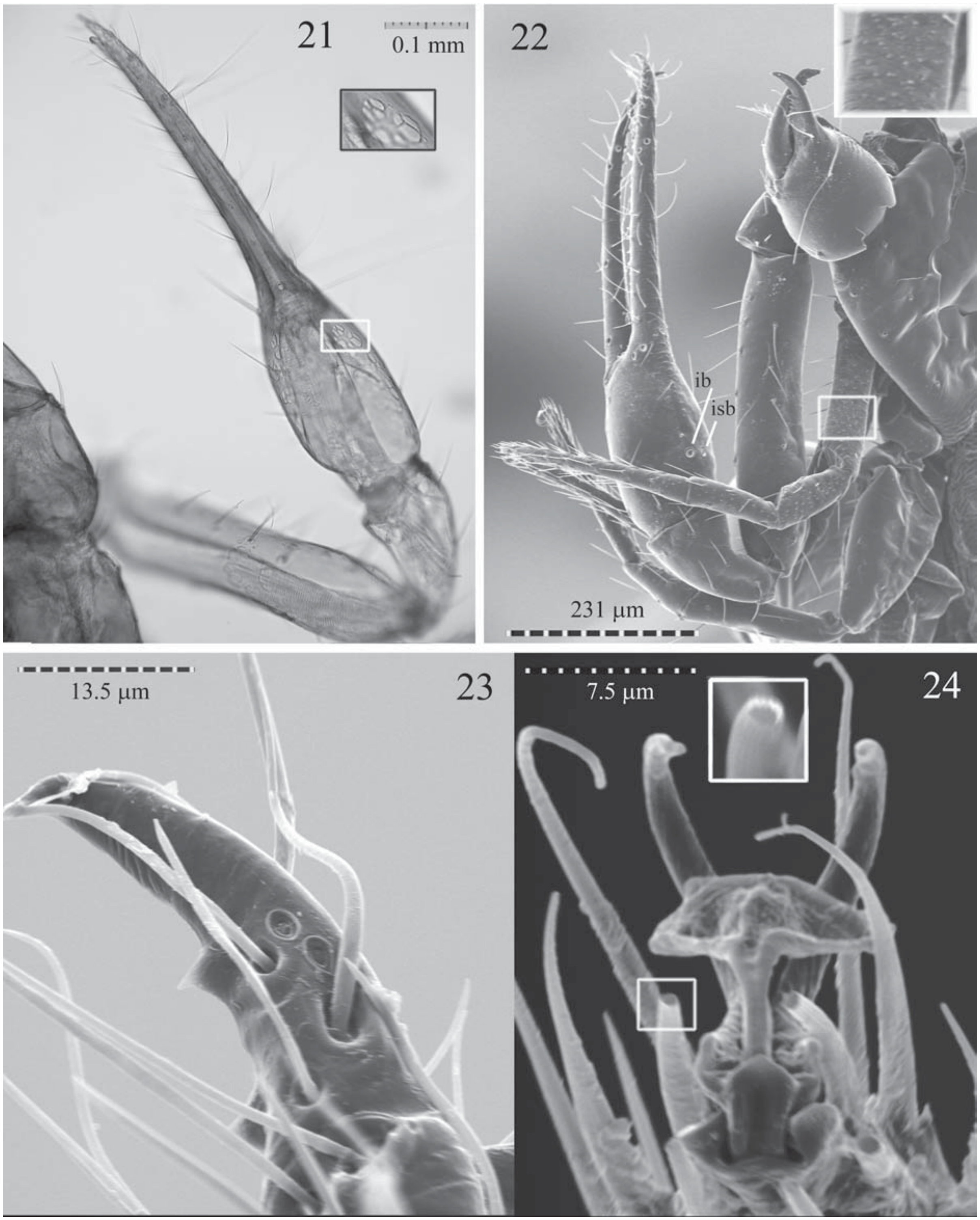
Palp relatively long and slender (Figs. 2, 21, 22); femur about 1.0 and chela about 1.6 times as long as carapace. Femur 4.15, patella 1.6, and chela 4.15 times as long as broad; hand 1.6 times as long as deep; movable finger 1.6 times as long as hand. Chelal trichobothriotaxy typical (Figs. 17-19, 22): *b* close to *t*, *sb* closer to *st* than to *b*; on fixed finger *it* and *est* near distal end, *ist*, *esb*, and *eb* at base, and *ib* and *isb* on dorsum of hand proximad of middle. Fixed chelal finger with 21 spaced macrodenticles and 9 interspaced microdenticles; movable finger with 8 spaced



Figs. 17-20.—*Tyrannochthonius muchmoreorum,* n.sp., male holotype, SEM: 17, dorsolateral aspect of palpal hand; 18, dorsolateral aspect of palpal fingers (boxed area is enlarged in Fig. 23); 19; slightly off dorsal aspect of palpal fingers; 20, ventral aspect of cheliceral fingers.

macrodenticles and 7 or 8 interspaced microdenticles, and 12 low, rounded teeth basally; *xs* on fixed finger on level of macrodenticles 4 and 5. What appears to be sculpturing on the chela hand with LM (Fig. 21), is revealed to not be on the surface of the cuticle with SEM examination.

Legs relatively long and thin; leg I covered with small, short setae. From photograph it is unclear if these structures are small setae or denticles. Leg IV with femur + patella 2.5 and tibia 4.5 times as long as deep.



Figs. 21-24.—*Tyrannochthonius muchmoreorum,* n.sp., male holotype: 21, dorsal aspect of palpal hand, LM; 22, left side of anterior end of appendages (boxed area of femur II enlarged showing covering of minute setae) SEM; 23, distal tip of palpal finger showing two denticles, SEM; 24, ventral aspect of distal end of tarsus (boxed area shows enlargement of hollow projection), SEM.

Long tactile setae on tibia and both tarsi of leg IV. Claws long and smooth, arolium shorter than claws, and unguitractor plate encircled by 5 hollow tubes. Tubes longitudinally ridged distally.

Measurements.—Body length 1.17 mm; carapace length 0.34 mm; chelicera 0.155 mm long; Palpal femur 0.41 mm long, 0.08 mm wide; patella 0.17 mm long, 0.09 mm wide; chela 0.63 by 0.08 mm; hand 0.21 by 0.12 mm ratios and measurements of chela and hand should indicate if pedicel is included.; movable finger 0.21 mm long. Leg IV: (femur + patella) 0.27 mm long, 0.09 mm wide; tibia 0.17 mm long by 0.08 mm wide.

Remarks.—The hollow tubes encircling the leg unguitractor plate were originally thought to be created when denticle or spine tips were accidently broken off (see boxed enlargement in Fig. 13 for such a broken structure). Apparently, this is the first record of these structures and will have to be studied in greater detail in better preserved and CPD tarsi.

ACKNOWLEDGMENTS

My colleague, fellow caver, and often co-author, James R. Reddell, provided specimens, data, and stimulating discussions on biospeleology, Fort Hood, and my ever-growing slowness in completing projects. Without his pushing this manuscript would still be a long way from publication. I thank the Texas Tech University Imaging Center and Department of Biological Sciences for facilities and guidance to all things related to Electron Microscopy. I am especially indebted to Mark Grimson (my SEM guru) for his patience and ability to explain matters of electrons. Further, I thank Bill Muchmore for his friendship and guidance with my study of pseudoscorpions. Mark Harvey (Western Australian Museum, Perth), James R. Reddell, and Juan A. Zaragosa provided helpful reviews of the manuscript. Thanks also to William (Bill) R. Elliott (Missouri Department of Conservation, Jefferson City) for allowing the modification of his map which is part of Map 1 (herein).

LITERATURE CITED

Banks, N. 1895. Notes on the Pseudoscorpionida. Journal of the New York Entomological Society, 3:1-13.

Banks, N. 1908. The pseudoscorpions of Texas. Bulletin of the Wisconsin Natural History Society, 6:39-42.

Chamberlin, J.C. 1931. The arachnid order Chelonethida. Stanford University Publications, Biological Sciences, 7(1): 1-284.

Chamberlin, J.C. 1962. New and little-known false scorpions, principally from caves, belonging to the families Chthoniidae and Neobisiidae (Arachnida, Chelonethida). Bulletin of the American Museum of Natural History 123:303-352.

Cokendolpher, J. C. and J. R. Reddell 2001. Cave spiders (Araneae) of Fort Hood, Texas, with descriptions of new species of *Cicurina* (Dictynidae) and *Neoleptoneta* (Leptonetidae). Texas Memorial Museum Speleological Monographs, 5. Studies on the cave and endogean fauna of North America, III. Pp. 35-55.

Edward, K. L., and M. S. Harvey 2008. Short-range endemism in hypogean environments: the pseudoscorpion genera *Tyrannochthonius* and *Lagynochthonius* (Pseudoscorpiones: Chthoniidae) in the semiarid zone of Western Australia. Invertebrate Systematics 22:259–293.

Harvey, M. S. 1992. The phylogeny and classification of the Pseudoscorpionida (Chelicerata: Arachnida). Invertebrate Taxonomy, 6:1373-1435.

Harvey, M. S. 2008. Pseudoscorpions of the World, version 1.1. Western Australian Museum, Perth. http://www.museum.wa.gov.au/arachnids/pseudoscorpions/

Hoff, C. C. 1949. The pseudoscorpions of Illinois. Bulletin of the Illinois Natural History Survey, 24:407-498.

Hoff, C. C. 1956. Pseudoscorpions of the family Chernetidae from New Mexico. American Museum Novitates, 1800:1-66.

Hoff, C. C., and J. E. Bolsterli. 1956. Pseudoscorpions of the Mississippi River drainage basin area. Transactions of the American Microscopical Society, 75:155-179.

Hoff, C. C., and D. L. Clawson, 1952. Pseudoscorpions from rodent nests. American Museum Novitates, 1585:1-38.

Judson, M. J. 2007. A new and endangered species of the pseudoscorpion genus *Lagynochthonius* from a cave in Vietnam, with notes on chelal morphology and the composition of the Tyrannochthoniini (Arachnida, Chelonethi, Chthon-iidae). Zootaxa, 1627:53-68.

Muchmore, W. B. 1969. New species and records of cavernicolous pseudoscorpions of the genus *Microcreagris* (Arachnida, Chelonethida, Neobisiidae, Ideobisiinae). American Museum Novitates, 2392:1-21.

Muchmore, W. B. 1981. Cavernicolous species of *Larca*, *Archeolarca* and *Pseudogarypus* with notes on the genera, (Pseudoscorpionida, Garypidae and Pseudogarypidae). Journal of Arachnology, 9:47-60.

Muchmore, W. B. 1984. Pseudoscorpions from Florida and the Caribbean area. 13. New species of *Tyrannochthonius* and *Paraliochthonius* from the Bahamas, with discussion of the genera (Chthoniidae). Florida Entomologist 67:119-126.

Muchmore, W. B. 1986. Additional pseudoscorpions, mostly from caves, in Mexico and Texas (Arachnida: Pseudoscorpionida). Texas Memorial Museum Speleological Monographs, 1:17-30.

Muchmore, W. B. 1992. Cavernicolous pseudoscorpions from Texas and New Mexico (Arachnida: Pseudoscorpionida). Texas Memorial Museum Speleological Monographs, 3:127-153.

Muchmore, W. B. 1996a. A third species of the genus *Mexichthonius* (Pseudoscorpionida: Chthoniidae), from a cave in Texas. Journal of Arachnology 24: 155-157.

Muchmore, W. B. 1996b. The genus *Tyrannochthonius* in the eastern United States (Pseudoscorpionida: Chthoniidae). Part II. More recently discovered species. Insecta Mundi, 10(1-4):153-168.

Muchmore, W. B. 2001. Review of the genus *Tartarocreagris*, with descriptions of new species (Psedudoscorpionida: Neobisiidae). Texas Memorial Museum Speleological Monographs, 5. Studies on the cave and endogean fauna of North America, III. Pp. 57-72.

Muchmore, W. B., and J. C. Chamberlin 1995. The genus *Tyrannochthonius* in the eastern United States (Pseudoscorpionida: Chthoniidae). Part I. The historical taxa. Insecta Mundi, 9(3-4):249-257.

Preyssler, J. D. 1790. Verzeichniss Böhmischer Insekten. Schönfeld-Meissnerischen: Prague.

Turk, F. A. 1949. *Dinocheirus stercoreus*, a new pseudoscorpion from the Bracken Cave, Texas, U.S.A. Annals and Magazine of Natural History, (12)2:120-126.

Espinasa, Luis, and Yevgeniya Boyko, 2009. A new troglobitic species of *Anelpistina* (Hexapoda: Zygentoma: Nicoletiidae) from northern Mexico [Nueva especie troglobia de *Anelpistina* (Hexapoda: Zygentoma: Nicoletiidae) del norte de México]. Texas Memorial Museum Speleological Monographs, 7. Studies on the cave and endogean fauna of North America, V. Pp. 79-86.

A NEW TROGLOBITIC SPECIES OF *ANELPISTINA* (HEXAPODA: ZYGENTOMA: NICOLETIIDAE) FROM NORTHERN MEXICO

Luis Espinasa and **Yevgeniya Boyko**

School of Science
Marist College
3399 North Road
Poughkeepsie, New York 12601, U.S.A.
Email: luis.espinasa@marist.edu and yevgeniya.boyko1@marist.edu

ABSTRACT

We describe a new species of cave adapted *Anelpistina* from Pozo Cokendolpher cave, Coahuila, México. Its affinities within the genus were assessed using its 16S rRNA sequence.

RESUMEN

Describimos una nueva especie cavernícola de *Anelpistina* de la cueva Pozo Cokendolpher, Coahuila, México. Sus afinidades dentro del género fueron establecidas usando secuencias de rRNA 16S.

INTRODUCTION

In 2007, Espinasa, et al., studied the relationships within the subfamily Cubacubaninae, the dominant subfamily of Nicoletiidae in America, based on morphology and sequence data from five loci (nuclear 18S, 28S rRNA and histone H3 genes, and mitochondrial 16S rRNA and cytochrome *c* oxidase subunit I). The data indicated that the presence of articulated submedian appendages on urosternum IV is not a valid discriminating character in taxonomy. Species within the traditional genera *Anelpistina*, *Cubacubana* and *Neonicoletia* were found to belong to a group in which no clear morphological or molecular distinction was present and it was proposed that members of these three genera should be united within a single taxon of *Anelpistina*.

In the study, members of *Anelpistina* appeared to segregate according to their biogeography into Antillean, South Mexico and Central Mexico species. At the time of the study no specimens were available from northern Mexico. In this study, we describe a new species of *Anelpistina* from Coahuila, in northern Mexico. Its 16S rRNA was sequenced and its general affinities within the group are described.

MATERIAL AND METHODS

Specimens were provided by James Reddell. All illustrations were made with aid of a camera lucida attached to a Motic k series stereomicroscope. Specimens will be deposited in the American Museum of Natural History (AMNH) in New York, and the Texas Memorial Museum (TMMC), Invertebrate Zoology Collection in Austin, Texas.

Genomic DNA samples were extracted using Qiagen's DNEasy® Tissue Kit by digesting a leg from two individuals in lysis buffer. One of the legs came from the holotype. Markers were amplified and sequenced as a single fragment using the 16Sar and 16Sb primer pair for 16S rRNA (Edgecombe, et al., 2002). Amplification was carried out in a 50 µl volume reaction, with 1.25 units of AmpliTaq® DNA Polymerase (Perkin Elmer, Foster City, California, U.S.A.), 200 µM of dNTPs, and 1 µM of each primer. The PCR program consisted of an initial denaturing step at 94 ºC for 60 sec, 35 amplifica-

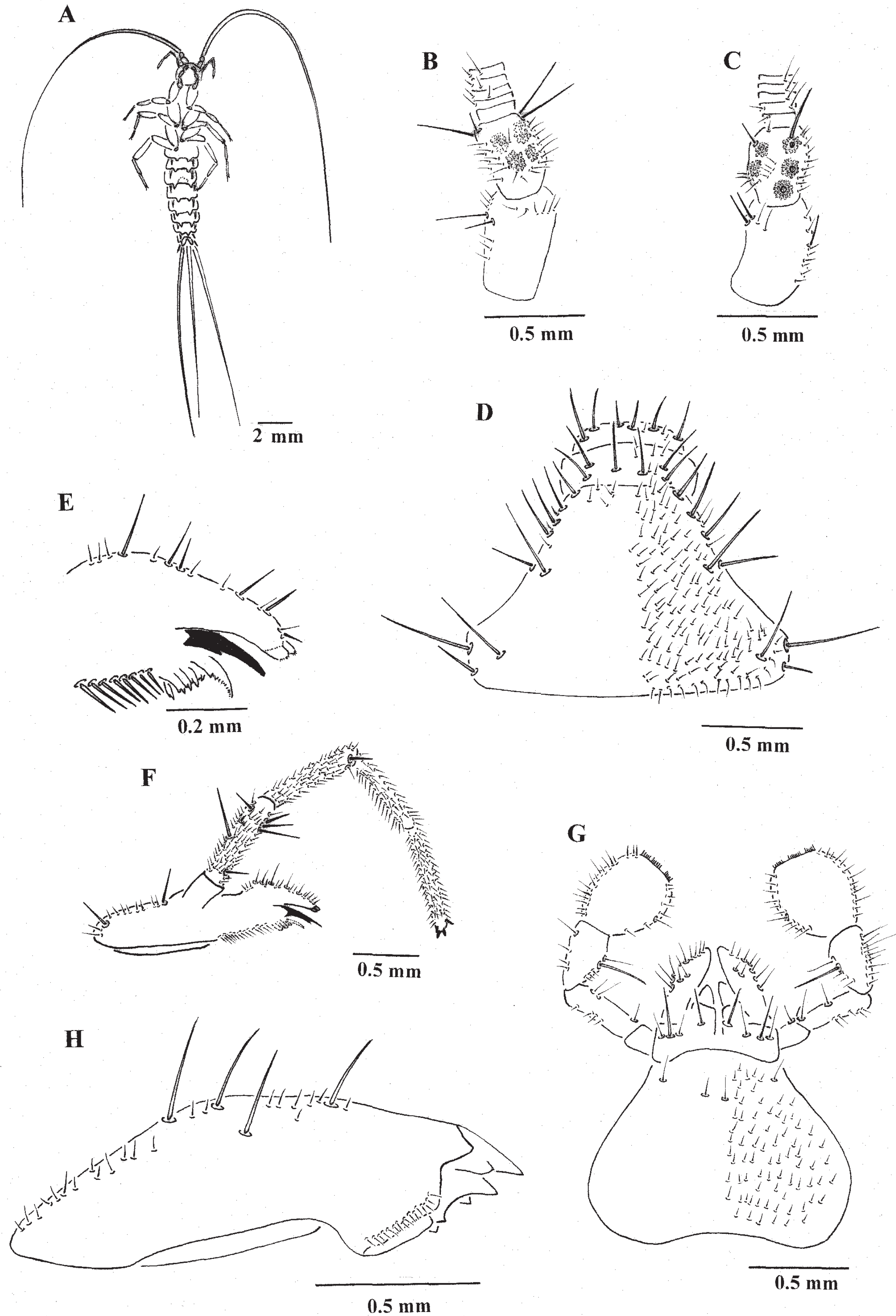


Fig. 1. *Anelpistina multispinata,* n.sp. male: A, body proportions; B, base of antennae, ventral; C, base of antennae, lateral; D, head; E, galea and lacinia; F, maxilla; G, labium; H, mandible.

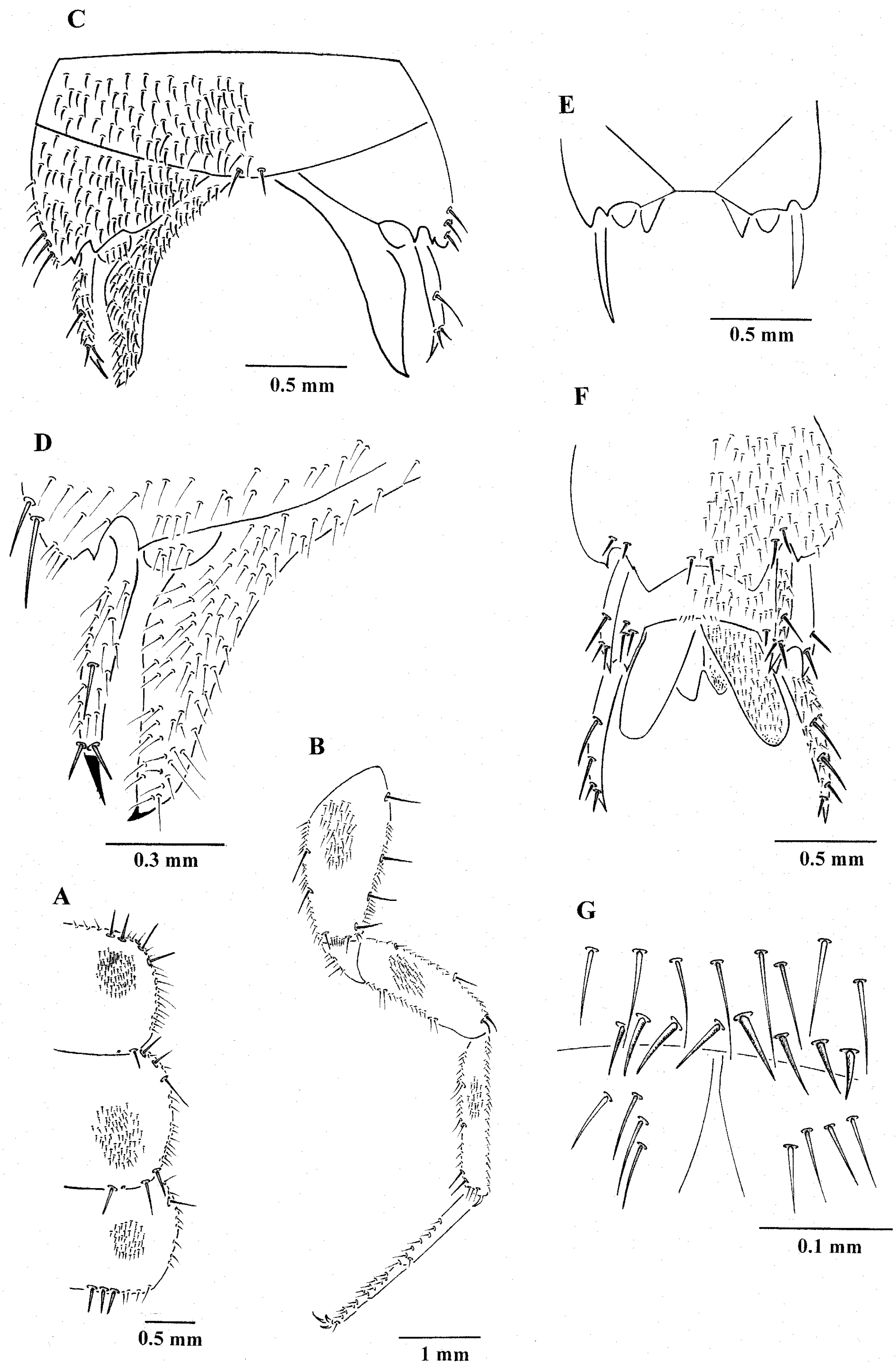


Fig. 2. *Anelpistina multispinata,* n.sp.: A, nota; B, hind leg; C, urosternum IV; D, articulated appendage of male urosternum IV; E, urosternum IV in juvenile male; F, male genital area; G, sclerotized microchaetae on base of male Urosternum IX.

tion cycles (94 ºC for 15 sec, 49 ºC for 15 sec, 72 ºC for 15 sec), and a final step at 72 ºC for 6 min in a GeneAmp® PCR System 9700 (Perkin Elmer). PCR amplified samples were purified with the Qiagen's QIAquick® Gel Extraction Kit and directly sequenced using an automated ABI Prism® 3700 DNA analyzer as in Espinasa, et al. (2007). Chromatograms obtained from the automated sequencer were read and contigs made using the sequence editing software Sequencher™ 3.0. External primers were excluded from the analyses. Sequences were aligned with ClustalW2 and numbers of bp differences were estimated. A phylogram tree was obtained using the Neighbor Joining method of Saitou and Nei, as implemented in ClustalW2.

RESULTS AND DISCUSSION

Anelpistina multispinata, new species
Figs. 1A-H, 2A-G, 3A-F

Type-data.—Mexico, Coahuila, Ramos Arizpe, Pozo Cokendolpher cave, NAD27 14 286662 2898384, 1177 masl., 27 Jan. 2006 (B. Shade, J. Krejca, C. Savvas, P. Sprouse). Holotype male (13 mm) (AMNH). Paratypes: 1 juvenile, 6 males, 3 females (TMMC #50,517).

Description.—Maximum body length 13 mm. Maximum conserved length of antennae 20 mm and of cerci 16 mm. When complete, antennae measure about

Table 1: *Anelpistina multispinata,* n. sp,. can be differentiated from most of the species of *Anelpistina* by a unique combination of characters: galea with conules of different size, head with five macrochaetae near insertion of antennae, and mandible with four macrochaetae. This set of characters is only shared with *A. parkerae, A. specusprofundi, A. asymmetrica* and *A. yatbalami*. Characters not described in original description are labeled with a question mark (?).

	Galea conules (0)=equal (1)=not	Head macrochaetae (0)~=5 (1)~=8	Mandible macrochaetae (0)=4 (1)=+4	Appendages IV (0)=no (1)=yes
Anelpistina anophtalma	1	1	1	1
Anelpistina boneti	1	1	1	1
Anelpistina cuaxilotla	1	1	1	1
Anelpistina doradoi	1	1	1	1
Anelpistina inappendicata	1	1	1	0
Anelpistina n.sp. Aire	1	1	1	1
Anelpistina n.sp. Alpuyeca	1	1	1	1
Anelpistina n.sp. Iglesia	1	1	1	1
Anelpistina n.sp. Naranjo Rojo	1	1	1	1
Anelpistina luticola	1	1	1	1
Anelpistina acanthocrus	1	1	1	1
Anelpistina ariasea	0	0	0	1
Anelpistina weyrauchi	0	0	0	1
Anelpistina arubana	0	0	0	1
Anelpistina negreai	0	0	0	1
Anelpistina mexicana	0	0	0	0
Anelpistina ramos	0	1	0	0
Anelpistina decui	0	1	1	0
Anelpistina puertoricensis	0	1	1	1
Anelpistina miranda	?	?	?	1
Anelpistina wheeleri	1	?	?	1
Anelpistina ruckeri	?	?	?	1
Anelpistina bolivari	?	?	?	1
Anelpistina carrizalensis	?	?	?	1
Anelpistina parkerae	**1**	**0**	**0**	**0**
Anelpistina yatbalami	**1**	**0**	**0**	**0**
Anelpistina specusprofundi	**1**	**0**	**0**	**0**
Anelpistina asymmetrica	**1**	**0**	**0**	**0**
***Anelpistina multispinata,* n.sp.**	**1**	**0**	**0**	**1**

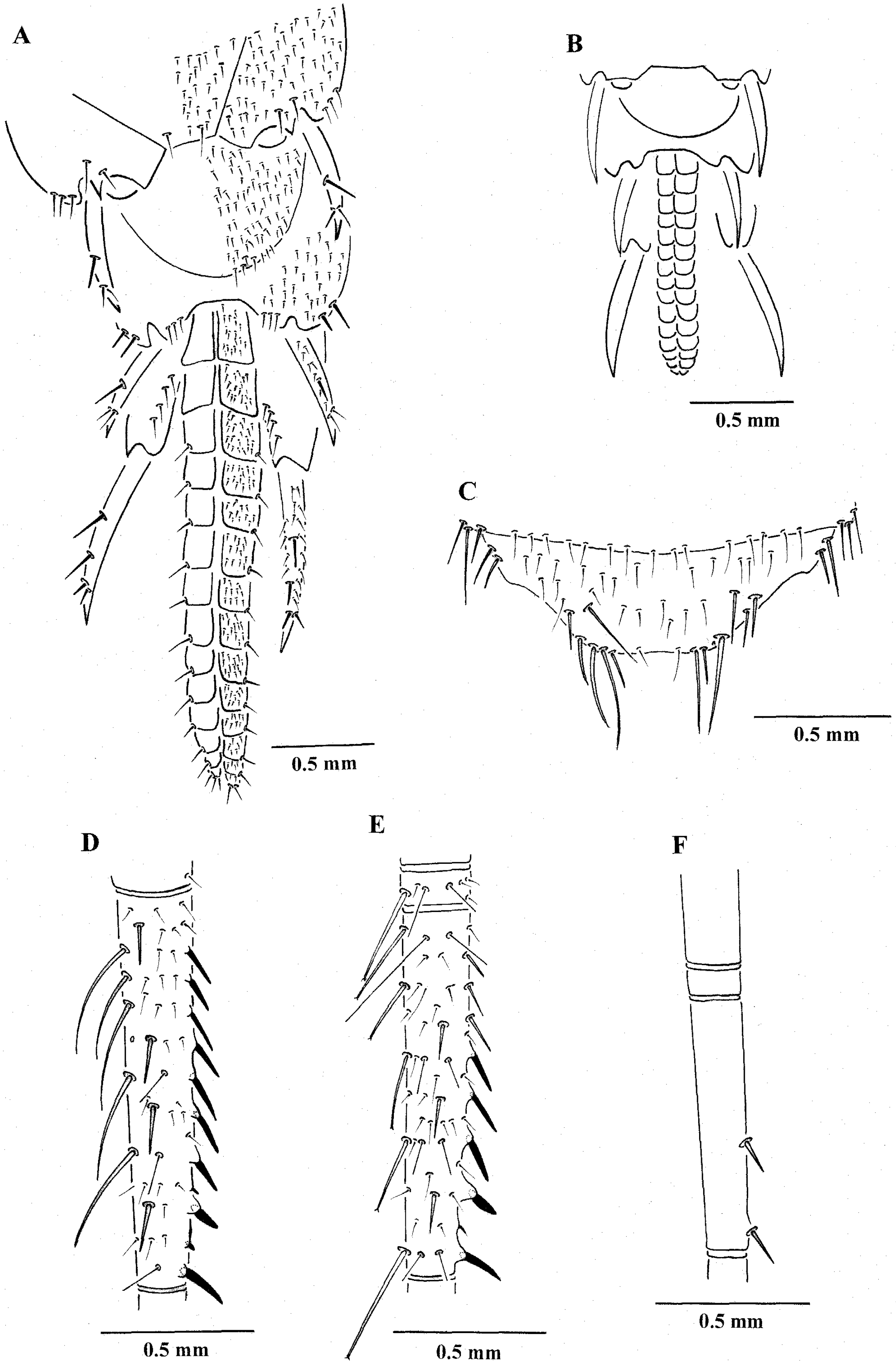


Fig. 3. *Anelpistina multispinata,* n.sp.: A, female genital area; B, ovipositor in juvenile female; C, urotergite X; D-F, postembryonic development of male cercus.

1.5 times body length and cerci slightly more than body length (Fig. 1A). General color light yellow to white. Pedicellus in adult males about 3/4 the length of first article of antennae. Unicellular glands on ventral surface of pedicellus clustered approximately in four groups. These clusters are bordered by a row of microchaetae in the form of a "U" (Fig. 1B) and on outside lateral border an extra three clusters (Fig. 1C). Female basal articles of antenna simple and pedicellus slightly more than half the length of first article of antennae. Head with approximately 5 + 5 macrochaetae on border of insertion of antenna (Fig. 1D).

Mouthparts not too long or slender when compared to other cave nicoletiids. Ultimate article of maxillary palp barely longer than penultimate article and approximately six times longer than wide (Fig. 1F). Apex of galea with two conules, one longer than wide and the other wider than long (Fig. 1E). Labial palp robust (Fig. 1G). Its apical article slightly longer than its width, and longer than penultimate article. Penultimate article has a bulge with two macrochaetae. Labium and first article of labial palp with macrochaetae. Mandible chaetotaxy as in figure 1H, with four macrochaetae.

Thoracic nota as in figure 2A. Legs relatively long and slender (Fig. 2B). Hind tibia approximately 5.3 times longer than wide and approximately 4/5 length of tarsus. Claws with a hairy appearance (similar to other *Anelpistina;* Espinasa, et al., 2007) and long.

Abdominal sterna II-VII subdivided into coxites and sternites and sterna VIII and IX of male entire, as in

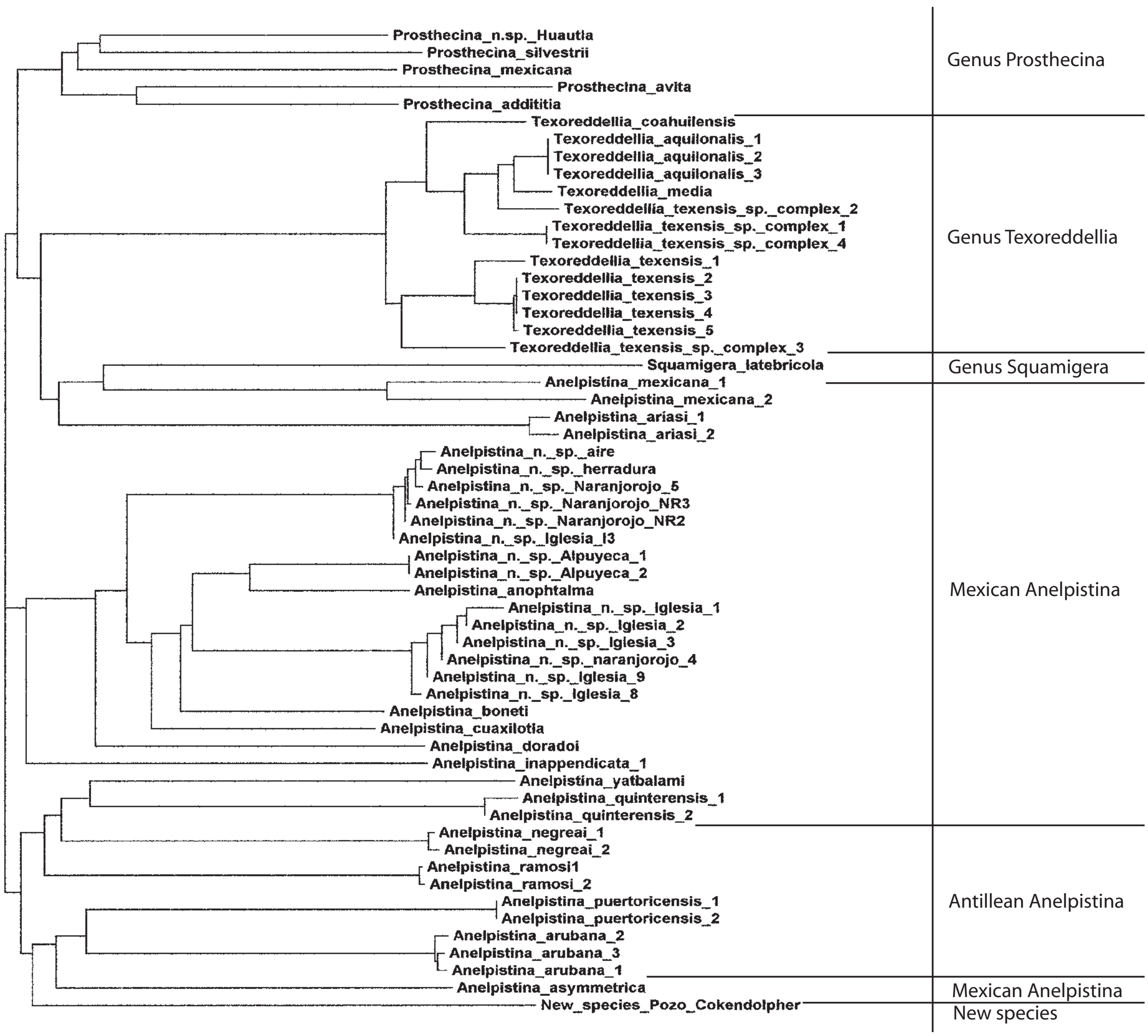


Fig. 4. Neighbor joining phylogram tree obtained with the 16S rRNA data. The long branch of the new species appears to indicate that its phyletic line diverged rather early in the history of the *Anelpistina* and it does not have particularly close affinities with any of the described species. The phylogram positioned the new species in a deep branch within the morphologically diverse group that includes the Antillean species and three Mexican species. The exact topology of the phyletic tree is only tentative, as a single sequence fragment (16s rRNA) was analyzed.

other members of subfamily. No apparent modifications in male's urosternum III. Urosternum IV of adult male with 1 + 1 slender articulated submedian appendages, their length being three times their width (Fig. 2C-D). The appendages barely surpass apex of stylets of this segment. Apex of appendages with a small hook projection (Fig. 2D). Urosternum VIII of adult male deeply emarginated, its projections slightly acute and relatively large (Fig. 2F). Urosternum IX of adult male as in figure 2F. Point of insertion of parameres in urosternum IX deep and coxal processes with a few sclerotized setae (Fig. 2F). A few small, sclerotised microchaetae on urosternum IX centrally above the parameres (Fig. 2F-G).

Stylets IX slightly larger than others, with two macrochaetae and an extra subapical pair (Fig. 2F). Other stylets with one macrochaetae plus the subapical pair (Fig. 2D). Terminal spine with small teeth. Stylets IX without modifications in males and females. Penis and parameres of adult males as in figure 2F. Parameres attaining half the length of stylets IX.

Adult female genital area as in figure 3A. Subgenital plate rounded to parabolic (Fig. 3A). Ovipositor surpassing apex of stylets IX by almost once the length of stylets (Fig. 3A). Gonapophyses with about 15 annuli (Fig. 3A-B). Urotergite X shallowly emarginated in both sexes, posterior angles with several macrochaetae and a few relatively strong setae, length of inner macrochaetae almost equal to distance between them (Fig. 3C).

Cercus of adult male typically with a longer than wide basal annuli, followed by a wider than long annuli, and then a very long one with spines. The composition of the spines includes the four spines typical of other *Anelpistina*: a long, acute and slightly curved spine, a very small one, a strong, subacute one and another very small one. The two large spines are inserted in tubercles. These four spines are then followed by a series of long spines and sclerotized macrochaetae of variable number according to development (Fig. 3D-E). Female cercus simple.

Postembryonic development as follows: At 5.5 mm, neither paramera, ovipositor nor other sexual characters are evident. In the five males ranging from 7-8.5 mm long, parameres attain 1/3 the length of stylets IX, pedicellus has some glands, articulated appendages of urosternum IV are either absent or very small (Fig. 2E), and cerci has zero, two (Fig. 3F) or three spines. The next male measures 11 mm and parameres attain half the length of stylets IX, pedicellus has all the clusters of glands although somewhat less defined than in the largest male, articulated appendages of urosternum IV barely surpass apex of stylets of this segment, and cerci has five long spines (Fig. 3E). In the largest male (13 mm) characters are similar to the aforementioned, with just an increase in definition of the clusters of glands in the pedicellus and an increase to nine long spines in cerci (Fig. 3D).

Postembryonic development of females as follows: At 8 mm ovipositor reaches 3/4 of stylets IX and gonapophyses with about 15 annuli. At 8.5 mm ovipositor reaches apex of stylets IX and gonapophyses with about 15 annuli (Fig. 3B). In the largest female (12.5 mm) ovipositor surpasses apex of stylets IX by almost once the length of stylets and gonapophyses with about 15 annuli (Fig. 3A).

Etymology.—Latin multi = many + Latin spinata = spines, spined. It makes reference to the many long spines on the cerci. While other *Anelpistina* species may also have multiple spines on the cerci, at their base they are small and the large spines are restricted to the apex of the very long annuli. In the new species described here, long spines are present in large number and starting at the base, giving a particularly spiny appearance to the cerci in this species.

Distribution.—Specimens of this species have been collected only from the type locality cave.

Remarks.—The new species described here is a member of the subfamily Cubacubaninae. It has stylets on urosternite II, but lacks scales, sensory pegs in the appendix dorsalis, and conspicuous lateral lobes bearing numerous glandular pores. As such, its generic allocation is within *Anelpistina* Silvestri, 1905 (= *Cubacubana* Wygodzinsky and Hollinger, 1977 = *Neonicoletia* Paclt, 1979) as defined by Espinasa, et al. (2007).

Anelpistina multispinata, n. sp,. can be differentiated from most of the species of *Anelpistina* by a unique combination of characters: galea with conules of different size, head with five macrochaetae by insertion of antennae, and mandible with four macrochaetae (Table 1). The only other species with this same combination are *A. yatbalami* Espinasa, et al., 2007*, A. parkerae* (Espinasa and Rishmawi, 2005), *A. specusprofundi* Espinasa and Vuong, in press*, and A. asymmetrica* (Espinasa, 2000). It can be easily differentiated from *A. yatbalami*, the epigean species, because it has short and stout body proportions and lacks the elongated appendages of cavernicolous species, such as *A. multispinata,* n.sp. From *A. parkerae* it can be differentiated because the new species lacks the enlarged pedicellus that creates almost a lobe in the males of *A. parkerae.* It can be differentiated from the other two species because they lack the composition of spines in cerci that includes the four spines typical of other *Anelpistina*: a long, acute and slightly curved spine, a very small one, a strong, subacute one and another very small one. Furthermore, the four aforementioned species lack 1 + 1 articulated submedian appendages on urosternum IV in adult males (Table 1).

When compared to all the species with described articulated submedian appendages on urosternum IV in adult males (which include species where the galea, head and mandible have not been described; Table 1), the morphology of the appendages of *A. multispinata,* n.sp., is similar only to *A. boneti* Wygodzinsky, 1946 and its closely related undescribed species from Aire, Iglesia and Naranjo Rojo caves. In this group the length of the appendages of urosternite IV is about three times their width and barely surpassing the apex of stylets of this segment. All other species have longer, shorter, thinner or thicker appendages. *A. multispinata,* n.sp., can be differentiated from *A. boneti* and its closely related group of species because the coxal processes of *A. multispinata,* n.sp., have a few sclerotized setae instead of many sclerotized and spiniform setae.

The 16S rRNA sequencing products for both specimens were identical. The data appears to indicate that *A. multispinata,* n.sp., is not particularly close to any species of *Anelpistina*. The number of bp differences was at least 95 bp (~=20%) when compared to any species within the genus. Furthermore, the morphology in the new species is not particularly close to any described species. The phylogram (Fig. 4) positioned the new species in a deep branch within the morphologically diverse group that includes the Antillean species and three Mexican species. The exact topology of the phyletic tree is only tentative, as only a single sequence fragment (16s rRNA) was analyzed. Nonetheless, it appears that the phyletic line of *A. multispinata,* n.sp., diverged rather early in the history of the *Anelpistina* and it does not have particularly close affinities with any of the described species. A future study including more genes, as in Espinasa, et al. (2007), will clarify the exact phylogeny of the group.

ACKNOWLEDGMENTS

We thank Dr. Luis Mendes, Graeme Smith, Darence Ca Thong and Monika Baker for reviewing the manuscript, and Dr. Michael Tannenbaum, Dean of School of Science, Marist College, for supporting the publication of this article. The DNA extraction and 16S rRNA sequence was obtained by Kadeine M. Campbell.

LITERATURE CITED

Edgecombe, G. D., G. Giribet., and W. C. Wheeler. 2002. Phylogeny of Henicopidae (Chilopoda: Lithobiomorpha): A combined analysis of morphology and five molecular loci. Systematic Entomology, 27:31-64.

Espinasa, L. 2000. A new species of the genus *Cubacubana* (Insecta: Zygentoma: Nicoletiidae) from a Mexican cave. Proceedings of the Biological Society of Washington, 113:218-223.

Espinasa, L., C. Flick and G. Giribet. 2007. Phylogeny of the American silverfish Cubacubaninae (Hexapoda: Zygentoma: Nicoletiidae): a combined approach using morphology and five molecular loci. Cladistics, 23(1):22–40.

Espinasa, L. and H. V. Vuong. In press. A new species of cave adapted Nicoletiid (Zygentoma: Insecta) from the tenth deepest cave in the world. Journal of Cave and Karst Studies.

Espinasa, L. and I. J. Rishmawi. 2005. A new species of the genus *Cubacubana* (Insecta: Zygentoma: Nicoletiidae) from a cave in Hidalgo, Mexico. Proceedings of the Biological Society of Washington, 107:510-516.

Paclt, J. 1979. Neue Beiträge zur Kenntnis der Apterygoten-Sammlung des Zoologischen Instituts und Zoologischen Museums der Universität Hamburg. VI Weitere Doppel-und Borstenschwänze (Diplura: Campodeidae: Thysanura: Lepismatidae und Nicoletiidae). Entomologische Mitteilungen aus dem Zoologischen Museum Hamburg, 6:221-228.

Silvestri, F. 1905. Materiali per lo studio dei Tisanuri. VI. Tre nuove specie di *Nicoletia* appartenenti ad un nuovo sottogenero. Redia (Firenze), 2:111-120.

Wygodzinsky, P. 1946. Sobre *Nicoletia* (*Anelpistina*) Silvestri, 1905 e *Prosthecina* Silvestri, 1933. Ciencia, 7:15-25.

Wygondzinsky, P. and A. M. Hollinger. 1977. A study of Nicoletiidae from Cuba (Thysanura). Resultats des Expédi-tions Biospéleologiques Cubano-Roumaines à Cuba, 2:313-324.

Espinasa, Luis, and Gonzalo Giribet. 2009. Living in the dark—species delimitation based on combined molecular and morphological evidence in the nicoletiid genus *Texoreddellia* Wygodzinsky, 1973 (Hexapoda: Zygentoma: Nicoletiidae) in Texas and Mexico [Viviendo en la obscuridad—delimitación de especies basada en evidencia combinada molecular y morfológica en el género nicoletiido *Texoreddellia* Wygodzinsky, 1973 (Hexapoda: Zygentoma: Nicoletiidae) en Texas y México]. Texas Memorial Museum Speleological Monographs, 7. Studies on the cave and endogean fauna of North America, V. Pp. 87-110.

LIVING IN THE DARK – SPECIES DELIMITATION BASED ON COMBINED MOLECULAR AND MORPHOLOGICAL EVIDENCE IN THE NICOLETIID GENUS *TEXOREDDELLIA* WYGODZINSKY, 1973 (HEXAPODA: ZYGENTOMA: NICOLETIIDAE) IN TEXAS AND MEXICO

Luis Espinasa

School of Science
Marist Collage, 3399 North Road
Poughkeepsie, New York 12601 U.S.A.
Email: luis.espinasl@marist.edu

and

Gonzalo Giribet

Department of Organismic and Evolutionary Biology and
Museum of Comparative Zoology
Harvard University, 26 Oxford Street
Cambridge, Massachusetts 02138 U.S.A.
ail: ggiribet@oeb.harvard.edu

ABSTRACT

The troglobitic insect genus *Texoreddellia* constitutes an important component of the cave-adapted fauna of the Southern U.S.A. and Northern Mexico. Here we study the representatives of *Texoreddellia* from multiple cave systems across its range using morphological and mitochondrial gene sequence data to unravel the presence of at least six species in a complex. The type species of the genus is redescribed and five new species are erected for groups of individuals with unique combinations of appendage and ovipositor characteristics, as corroborated by the molecular data. The evolutionary origin of the group may be somewhere near the border of Texas and Mexico, although more data are needed. From this central origin various lineages dispersed and diverged morphologically. Furthermore, different species of *Texoreddellia* can also inhabit the same cave.

RESUMEN

El género de insectos troglobios *Texoreddellia* constituye uno de los componentes más importantes de la fauna cavernícola del sureste de los E.E.U.U. y el norte de México. Estudiamos representantes de múltiples sistemas de cavernas a lo largo del rango geográfico del complejo *Texoreddellia* usando información morfológica y secuencias mitocondriales y determinamos la presencia de por lo menos seis especies. Se redescribe la especie tipo del género y se proponen cinco nuevas especies que incluyen grupos de individuos con una combinación única de caracteres de los apéndices y del ovipositor. Dichos grupos son corroborados por datos moleculares. El origen evolutivo del grupo parece estar localizado cerca de la frontera entre Texas y México, aunque se requiere más información. A partir de este centro, varios linajes dispersaron y se diferenciaron morfológicamente. Además se ha encontrado que múltiples especies de *Texoreddellia* pueden habitar en la misma cueva.

INTRODUCTION

In 1902, Ulrich described a troglobitic nicoletiid (Zygentoma) from Ezell's Cave, in Texas, and named it *Nicoletia texensis*. Seventy-one years later, Wygodzinsky (1973) examined material from this and over a dozen other Texan caves and concluded that these specimens did not belong to *Nicoletia* nor did they fit in any other described genus, lumping all the troglobitic nicoletiids from Texas in the species *Texoreddellia texensis* (Ulrich, 1902). Since then, detailed surveys, conducted mostly by James Reddell and colleagues, have shown that *Texoreddellia* is among the most prominent and common cave adapted genera in Texas (Reddell, 1994). They can be found from Jeff Davis County on the western end of Texas to Bell County at the eastern end of the karst regions of Texas. Their northern distribution reaches up to Fort Hood, in Coryell County and their southern distribution has recently been extended to south of the Rio Grande, in northern Coahuila, Mexico.

Although most *Texoreddellia* populations agree in their qualitative characters (Wygodzinsky, 1973), there is considerable variation in the degree of elongation of body parts. Wygodzinsky assumed that such variation was due to ecological factors and not to true phylogenetic variation. However, Reddell (1994) views such variation as the expression of a complex of closely related species.

The objective of this study is to evaluate the degree of morphological and genetic variation among selected *Texoreddellia* populations in order to validate the usage of more than one species. To do so, a mitochondrial ribosomal gene and morphological characters were examined of several specimens from a number of cave localities.

METHODS

(a) Morphology

Samples for morphological study were provided by James Reddell and included the localities used for the molecular study (Table 1) plus other localities from which only morphology could be examined (Table 2). Prominent among these are the western Texas localities for which 16S rRNA amplifications were unsuccessful, but are described here as new species (Identified in Table 2 with Ω and Ψ). Dissections were made with the aid of a Motic k series stereomicroscope. All illustrations were made with the aid of a camera lucida attached to the stereomicroscope.

(b) Molecular data

Genomic DNA samples were obtained from ethanol-preserved tissues following standard methods for DNA purification, as in Espinasa, et al. (2007). Total DNA was extracted using Qiagen's DNeasy® Tissue Kit, by digesting one leg of the individual in the lysis buffer. Markers were amplified and sequenced as a single fragment using the 16Sar and 16Sb primer pair for 16S rRNA (Edgecombe, et al., 2002). Amplification was carried out in a 50 µl volume reaction, with 1.25 units of AmpliTaq® DNA Polymerase (Perkin Elmer, Foster City, California, U.S.A.), 200 µM of dNTPs, and 1 µM of each primer. The PCR program consisted of an initial denaturing step at 94 ºC for 60 sec, 35 amplification cycles (94 ºC for 15 sec, 49 ºC for 15 sec, 72 ºC for 15 sec), and a final step at 72 ºC for 6 min in a GeneAmp® PCR System 9700 (Perkin Elmer).

PCR amplified samples were purified with the AGTC® Gel Filtration Cartridges (Edge BioSystems, Gaithersburg, Maryland, U.S.A.), and directly sequenced using an automated ABI Prism® 3700 DNA analyzer. Cycle-sequencing with AmpliTaq® DNA polymerase, FS (Perkin-Elmer) using dye-labeled terminators (ABI PRISM™ BigDye™ Terminator Cycle Sequencing Ready Reaction Kit, Foster City, California, U.S.A.) was performed in a GeneAmp® PCR System 9700 (Perkin Elmer). Chromatograms obtained from the automated sequencer were read and contigs made using the sequence editing software Sequencher™ 3.0. Complete sequences were edited in MacGDE (Linton, 2005), where they were split into 12 fragments according to conserved secondary structure features (Giribet, 2001, 2002) and numbers of bp differences were estimated. All external primers were excluded from the analyses.

The data were analyzed using the direct optimization method of Wheeler (1996) under the parsimony optimality criterion in the computer program POY v. 3.0 (Wheeler, 2002; see also Wheeler, et al., 2006). Parallel options with 100 random Wagner trees followed by SPR and TBR branch swapping were run for three analytical parameters, including equal weights, the default parameters in POY (indel cost = 2; any base transformation = 1), and the weighting scheme proposed by De Laet (2005) (opening indel cost = 3; extension gap cost = 1; base transformations = 2). Nodal support was assessed via parsimony jackknifing (Farris, et al., 1996) using a deletion function of e -1, as proposed by Farris (1997), for each weighting scheme. Sequences were aligned with ClustalW2. Length variation was small (497-501 bp).

Trees were rooted with the 16S rRNA sequences described in Espinasa, et al. (2007) of the Lepidotrichidae *Tricholepidion gertschi*; the Lepismatidae *Thermobia* *domestica*; and five species of Nicoletiidae within Cubacubaninae: *Squamigera latebricola*, *Prosthecina avita*, *Anelpistina mexicana*, *Anelpistina yatbalami*, and *Anelpistina quinterensis*.

Specimens are deposited in the American Museum of Natural History, New York (AMNH) and the Texas Memorial Museum, Invertebrate Zoology Collection (TMMC).

RESULTS

(a) Morphology

After careful examination of the *Texoreddellia* specimens from multiple populations, a few diagnostic characters were identified that could be relied upon to clearly differentiate among populations: presence or absence of scales on the head, relative proportions of legs and mouth parts, length and segmentation of the ovipositor in females, and the type of projection on the pedicellus of males. When all these characteristics are taken into account, six morphologically distinct groups of *Texoreddellia* can be distinguished, which are here proposed as distinct species (See results below).

With respect to the proportions of legs and mouthparts, the *Texoreddellia* populations studied have either relatively long and slim appendages (hind tibia approximately 6 times longer than wide and approximately 2/3 of tarsus length; terminal article of maxillary palp smaller than penultimate article; second to last article of labial palp about 3 times longer than wide) or relatively short and robust appendages (hind tibia approximately 4.5 times longer than wide and approximately 4/5 of tarsus length; terminal article of maxillary palp approximately equal in length to penultimate article; second to last article of labial palp about 2 times longer than wide). Leg proportion can also be measured by the ratio of body length to tarsus length. Regarding the ovipositor, four basic types of ovipositor were found in adult females: short with approximately 12 annuli, long with about 18 annuli, long with about 14 annuli, and very long with about 14 annuli.

The most striking difference was in the type of projection on the pedicellus of males between the western populations (Rattlesnake Cave in Ward County and Phantom Lake Spring Cave in Reeves County) and all the other populations in central and eastern Texas. While in central and eastern populations the projection is identical to Wygodzinsky's original description; short, not very conspicuous, flat hook-shaped and extending parallel to the antennae, in the western localities the projection on the pedicellus is long and robust, extending perpendicular to the antennae.

(b) Molecular data

Molecular data were obtained for 17 individuals from 13 cave localities, as two specimens of Seven Mile Mountain Cave, three from Accident Sink and two from Ezell's Cave were sequenced (Table 1). The 16S rRNA fragment ranged between 497 (in Accident Sink) and 501 bp (in Cueva de Casa Blanca, Sky High Cave, Red Arrow Cave, Flint Ridge Cave, and Root Canal Cave) in the ingroup specimens sequenced. Alignment trough ClustalW2 was trivial and involved insertion/deletions in only 6 positions (Appendix 1).

The direct optimization analysis under equal weights yielded a single shortest tree at 743 steps, hitting minimum tree length in 98% of the replicates. The analysis with indels = 2 and substitutions = 1 yielded 4 shortest

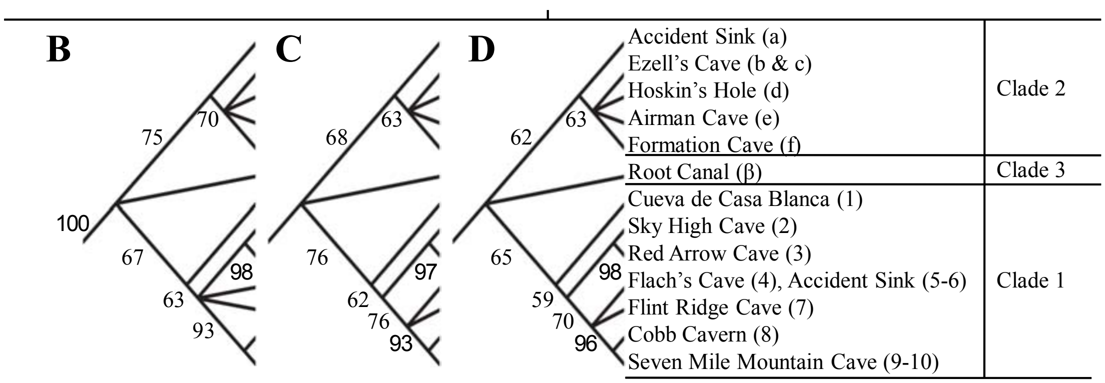


Fig. 1.—Jacknife trees (50% majority consensus of strict consensus) in the three analytical parameters produced very similar results: a) indel=1; b) indel=2; c) indel=3 (extension = 1; base transformation = 2). *Texoreddellia* is monophyletic in all trees, which then appears divided into three clades: **Clade 1:** 1) Cueva de Casa Blanca, Coahuila, Mexico; 2) Sky High Cave, Edwards County; 3) Red Arrow Cave, Real County; 4) Flach's Cave, Bexar County; 5-6) Accident Sink, Bexar County (gonapophysis with 14 annuli); 7) Flint Ridge Cave, Travis County; 8) Cobb Cavern, Williamson County; 9-10) Seven Mile Mountain Cave, Bell County. **Clade 2:** a) Accident Sink, Bexar County (gonapophysis with 12 annuli); b-c) Ezell's Cave, Hays County and type locality of *Texoreddellia texensis*; d) Hoskin's Hole, Hays County; e) Airman's Cave, Travis County, f) Formation Cave, Coryell County. **Clade 3:** β) Root Canal Cave, Bexar County

trees at 871 weighted steps, finding minimum tree length in 77% of the replicates. The analysis with De Laet parameter set yielded 4 shortest trees at 1,517 weighted steps, hitting minimum tree length in 60% of replicates. The jackknife trees and the strict consensus of the minimum tree lengths in the three analytical parameters produced very similar results (Fig. 1a-c). In all trees, monophyly of *Texoreddellia* is supported, which then appears divided into three clades, which from here on will be named: **Clade 1**, with specimens from Cueva de Casa Blanca (Coahuila, Mexico), Sky High Cave (Edwards County), Red Arrow Cave (Real County), Flach's Cave (Bexar County), Accident Sink (Bexar County), Flint Ridge Cave (Travis County), Cobb Cavern (Williamson County), and Seven Mile Mountain Cave (Bell County); **Clade 2**, with specimens from Accident Sink (Bexar County), Ezell's Cave (Hays County)—the type locality of *Texoreddellia texensis*, Hoskin's Hole (Hays County), Airman's Cave (Travis County), and Formation Cave (Coryell County); and **Clade 3**, with Root Canal Cave (Bexar County). The main difference between the different analytical parameters explored is the position of Clade 3, which appears as the sister group to Clade 1 or as the sister group of all the other specimens. The internal topology of the three clades differed minimally with the different analytical parameters.

The topology of the branching order appears to follow a geographical trend: deep branches include specimens from Mexico and south-central Texas while shallower nodes include specimens from northeast Texas (Fig. 2). This trend is most conspicuous for Clade 1 in which the first offshoot is Cueva de Casa Blanca (1), in Mexico, followed by Sky High Cave (2) and Red Arrow Cave (3), which are about 150 km away from Cueva de

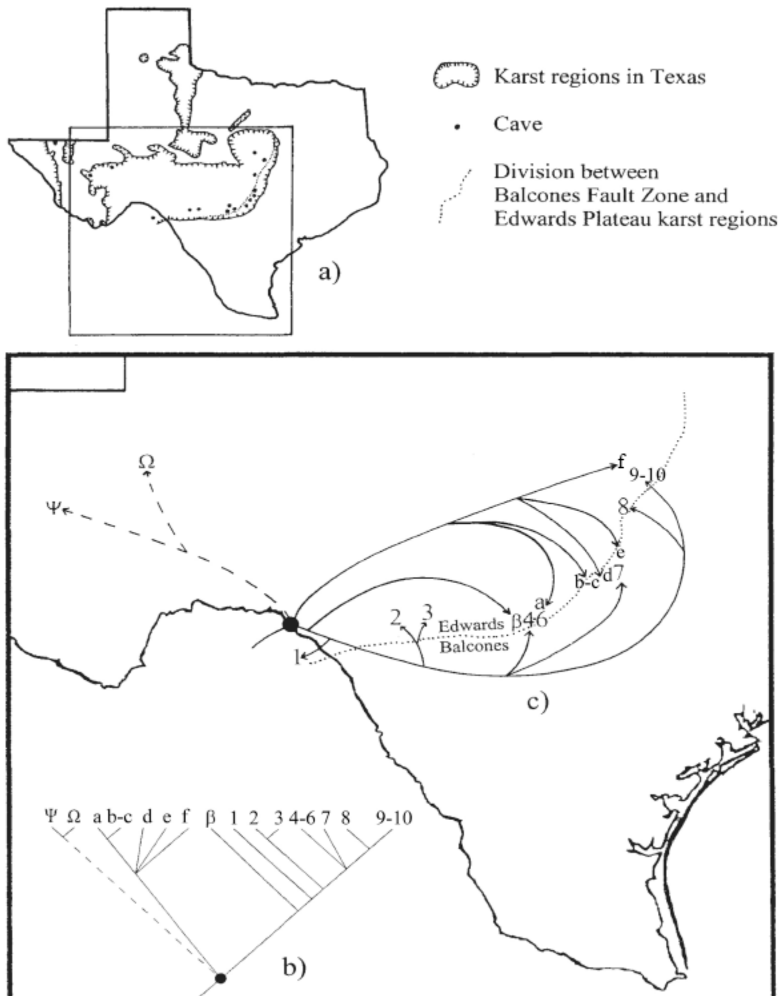


Fig. 2.—Phylogeography of *Texoreddellia*. Numbers = Clade 1; Letters = Clade 2; β = Clade 3; Ψ and Ω = western new species. A) Study area showing the type locality of two western new species and of the caves from which 16S rRNA molecular data were obtained. B) Strict consensus tree under default parameters in POY (indel=2). Branching topology of western species is assumed from morphology. C) The topology of the branching order appears to follow a geographical trend: Haplotypes from populations sampled around Mexico and south-central Texas are relatively early-diverging while shallower nodes are found progressively in the periphery.

Casa Blanca, followed by the trichotomy of Flach's Cave/ Accident Sink (4-6), about 240 km away, Flint Ridge Cave (7), about 330 km away, and a group formed by Cobb Cavern (8), about 360 km away, and Seven Mile Mountain Cave (9-10), about 390 km away. Clade's 2 most-basal group includes Accident Sink (a) and Ezell's Cave (b), which are respectively the first and second southernmost for the clade, and then within the distal branch is Formation Cave (e), which is the northeasternmost population (about 200 km away from Accident Sink). The only member from Clade 3, Root Canal Cave (β), is in south-central Texas. Sequence divergence (*p*-distance in parenthesis) among the populations (Table 3) ranged from zero to 47 bp (0-9.3 %). Several specimens from multiple localities had the same or almost identical haplotypes. From Clade 1, the specimen from Sky High Cave from Edwards County shared haplotype with that of Red Arrow Cave from the neighboring Real County. Seven Mile Mountain Cave specimens from Fort Hood (Bell County) shared haplotypes with Cobb Cavern, in neighboring Williamson County. The same haplotypes could also be found in other specimens from

Table 1.—Collecting site and characteristics of populations from which 16S rRNA molecular data were obtained from at least one individual. Hypothetical center of dispersal was assigned to a spot of the Río Grande closest to Cueva de Casa Blanca, Coahuila. Question marks indicate localities for which no adult females where available and characteristics of ovipositor and gonapophysis are assumed, but could not be confirmed.

#	Locality, collection date, and collection number (when available)	Ovipositor	Gonapophysis # of annuli	Approximate distance from hypothetical center	Species
a) Clade 1					
1	Mexico, Coahuila, Municipio de Ciudad Acuña, Cueva de Casa Blanca. 10 Feb. 2005	short	12	10 km	*T. coahuilensis*
2	Texas, Edwards County, Sky High Cave. 3 Sept. 2005 TMMC #43,563	short (?)	12 (?)	150 km	*T. texensis* species complex
3	Texas, Real County, Red Arrow Cave. 12 Mar. 2005 TMMC #37,698	short	12	150 km	*T. texensis* species complex
4	Texas, Bexar County, Camp Bullis, Flach's Cave. 5 Dec. 2004 TMMC #37,377	long	14	240 km	*T. media*
5	Texas, Bexar County, Camp Bullis, Accident Sink. 9 May 2005 TMMC #38,098	long	14	240 km	*T. media*
6	Texas, Bexar County, Camp Bullis, Accident Sink. 9 May 2005 TMMC #38,098	long	14	240 km	*T. media*
7	Texas, Travis County, Flint Ridge Cave. 11 Jan. 2005	short	12	330 km	*T. texensis* species complex
8	Texas, Williamson County, Cobb Cavern. 30 Mar. 2004 TMMC #36,173	long	18	360 km	*T. aquilonalis*
9	Texas, Bell County, Fort Hood, Seven Mile Mountain Cave. 23 April 2004 TMMC #36,237	long	18	390 km	*T. aquilonalis*
10	Texas, Bell County, Fort Hood Seven Mile Mountain Cave.11 June 2005 TMMC #38,263	long	18	390 km	*T. aquilonalis*
b) Clade 2					
a	Texas, Bexar County, Camp Bullis, Accident Sink. 12 April 2005 TMMC #38,318	short	12	240 km	*T. texensis*
b	Texas, Hays County, Ezell's Cave (**Type locality**) 14 Feb. 2006	short (?)	12 (?)	300 km	*T. texensis*
c	Texas, Hays County, Ezell's Cave (**Type locality**) 7 Dec. 2006	short (?)	12 (?)	300 km	*T. texensis*
d	Texas, Hays County, Hoskin's Hole. 7 Mar. 2005	short	12	300 km	*T. texensis*
e	Texas, Travis County, Airman's Cave. 12 Jan. 2005	short (?)	12 (?)	330 km	*T. texensis*
f	Texas, Coryell County, Fort Hood, Formation Cave, 29 Aug. 2005 TMMC #38,318.	short (?)	12 (?)	390 km	*T. texensis*
c) Clade 3					
β	Texas, Bexar County, Camp Bullis, Root Canal Cave. 9 July 1998 DNA #100187	short	12	240 km	*T. texensis* species complex

Clade 2 even when separated by longer distances; the specimens from Formation Cave from Fort Hood (Coryell County), Airman's Cave (Travis County), and Hoskin's Hole (Hays County), showed no sequence divergence and a single nucleotide difference was found in the specimens from Ezell's Cave (Hays County), the type-loclity of *T. texensis*.

Specimens from neighboring localities can be distantly related. As can be seen from Fig. 2, the two Fort Hood cave populations (f and 9-10) are in different clades despite their geographical proximity of about 30 km. Based on the 16S rRNA fragment studied, Seven Mile Mountain Cave specimens (9-10) are actually more similar (26 bp differences; *p*-distance of 5.1%) to the cave population in Mexico (1) than to its geographic neighbor, Formation Cave (f), in Fort Hood (35 bp differences; *p*-distance of 7%).

When examining the 16S rRNA tree with respect to the type of ovipositor, a phylogenetic pattern emerges; short ovipositors with few annuli apparently are the ancestral state and the enlargement and increase in number of annuli occurred progressively along Clade 1 (Table 1). There also appears to be a geographic component in Clade 1; caves in Mexico and south-central Texas are mostly made up of populations with small ovipositors, while northeastern populations progressively are composed of individuals with longer and more subdivided ovipositors. When multiple cave localities, other than those sampled for the study of 16S rRNA were examined, the trend appears to be general for all *Texoreddellia* populations (Table 2).

Table 2.—Collecting site and characteristics of populations from which no 16S rRNA molecular data were available but were used in descriptions of morphology. Hypothetical center of dispersion was assigned to a spot of the Río Grande closest to Cueva de Casa Blanca, Coahuila.

Locality, collection date, and collection number	Ovipositor	Gonapophysis # of annuli	Approximate distance from hypothetical center	Species
Mexico, Coahuila, Municipio de Ciudad Acuña, Sótano de Amezcua. 26 June 1994 TMMC #23,756	short	12	30 km	*T. coahuilensis*
Texas, Crockett County, 0-9 Well. 15-16 Aug. 1992 TMMC #24,730	long	14	170 km	*T. media*
Texas, Bexar County, Camp Bullis, Accident Sink. 26 Oct. 2004 TMMC #37,387	short	12	240 km	*T. texensis* species complex
Texas, Bexar County, Camp Bullis, Hold Me Back Cave. 25 Oct. 2001	short	12	240 km	*T. texensis* species complex
Texas, Bexar County, Camp Bullis, Logan's Cave. 8 June 1993 TMMC #24423	short	12	240 km	*T. texensis* species complex
Texas, Bexar County, Camp Bullis, Mars Shaft. 25-29 Oct. 2001	short	12	240 km	*T. texensis* species complex
Texas, Bexar County, Camp Bullis, Strange Little Cave. 22Mar. 2004	short	12	240 km	*T. texensis* species complex
Texas, Bexar County, San Antonio, Robber Baron Cave. 26 June 1993 TMMC #24,620	short	12	240 km	*T. texensis* species complex
Texas, Bexar County, San Antonio, Robber Baron Cave. 9,11 Dec. 1983 TMMC #24,559	short and long	12 and 14	240 km	*T. texensis* species complex and *T. media*
Texas, Comal County, Honey Creek. 20 Feb. 1999	short	12	270 km	*T. texensis* species complex
(**Ω**) Texas, Ward County, Rattlesnake Cave. 5 Dec. 1986	Very long	15	300 km	*T. occasus*
(**Ψ**) Texas, Jeff Davis County, Phantom Lake Spring Cave. July 1997 TMMC #24,535	long	14	305 km	*T. capitesquameo*
Texas, Williamson County, Polaris Cave. 19 April 1994 TMMC #24,684	long	18	360 km	*T. aquilonalis*
Texas, Bell County, Fort Hood, Nolan Creek Cave. 17 July 1993 TMMC #24,679	short	12	410 km	*T. texensis* species complex

Table 3.—Number of bp differences in the 16S rRNA among individuals from different cave populations. **Clade 1:** 1) Cueva de Casa Blanca, Coahuila, Mexico. 2) Sky High Cave, Edwards County. 3) Red Arrow Cave, Real County. 4) Flach's Cave, Bexar County. 5-6) Accident Sink, Bexar County (Gonapophysis with 14 annuli). 7) Flint Ridge Cave, Travis County. 8) Cobb Cavern, Williamson County. 9-10) Seven Mile Mountain Cave, Bell County. **Clade 2:** a) Accident Sink, Bexar County (Gonapophysis with 12 annuli). b-c) Ezell's Cave, Hays County and type locality of *Texoreddellia texensis*. d) Hoskin's Hole, Hays County. e) Airman's Cave, Travis County. f) Formation Cave, Coryell County. **Clade 3:** β) Root Canal Cave, Bexar County.

	1	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***	***a***	***b***	***c***	***d***	***e***	***f***	**β**
1	0																
2	29	0															
3	29	0	0														
4	26	19	19	0													
5	27	20	20	1	0												
6	24	19	19	2	3	0											
7	30	25	25	15	16	15	0										
8	26	20	20	10	11	10	15	0									
9	26	20	20	10	11	10	15	0	0								
10	26	20	20	10	11	10	15	0	0	0							
a	41	37	37	38	39	38	41	40	40	40	0						
b	37	34	34	34	35	34	38	36	36	36	12	0					
c	37	34	34	34	35	34	38	36	36	36	12	0	0				
d	36	35	35	33	34	33	38	35	35	35	13	1	1	0			
e	36	35	35	33	34	33	38	35	35	35	13	1	1	0	0		
f	36	35	35	33	34	33	38	35	35	35	13	1	1	0	0	0	
β	34	42	42	42	43	40	47	40	40	40	32	31	31	30	30	30	0

DISCUSSION

(a) Phylogeny

Monophyly of Nicoletiidae is supported in all the analyses and shows a jackknife support value between 69 and 91%. The genus *Texoreddellia* forms a clade with a jackknife support of 100% on the parameter sets analyzed (Fig. 1) and constitutes the sister group to the other genera within the subfamily Cubacubaninae. Both results agree with the analysis of the family by Espinasa, et al. (2007) using five genes and morphology, although in that case only one *Texoreddellia* specimen was included in the analyses.

Molecular data within *Texoreddellia* appear to subdivide the group into three major clades. Haplotypes from populations sampled in a small area between Mexico and Texas are relatively early-diverging on the molecular phylogeny while those in northeast Texas are relatively late-diverging. Morphological characters also follow a similar trend, with disparity among populations increasing proportionally the further away they are from Mexico and south-central Texas. Based on the above considerations, a plausible scenario postulates that the evolutionary origin of *Texoreddellia* may have been from an area near the border between Texas and Mexico (Fig. 2), although more data will be needed to corroborate this.

(b) Taxonomy

Regarding morphology, a set of distinctive characters were identified that allow for clear differentiation of several groups. The appearance of the pedicellus, ovipositor, scales on the head, and the body proportions in *Texoreddellia* allow for easy differentiation among neighboring cave populations. Furthermore, these groups follow specific phylogeographic patterns.

Earlier authors have used the ovipositor to differentiate among species of Nicoletiidae (Mendes, 1986; Wygodzinsky and Hollinger, 1977), but ovipositors typically grow during postembryonic development. An assessment is only valid when adults of comparable size and stage are available, as was done in this study (Table 4).

Using the 16S rRNA fragment sequences of 23 species across the subfamily Cubacubaninae (Espinasa, et al. 2007; Espinasa and Cappuccio, 2008) and of Peruvian and central Mexican nicoletiids (Espinasa, unpublished data), we observed that pairs of specimens within a population differ by an average of 1.8 nucleotides (+/- 2.2 stdev; range 0-7; n=26), by 2.3 nucleotides (+/- 1.9 stdev; range 1-6; n=9) in different populations of the same species, and by 54.7 nucleotides (+/- 9.5 stdev; range 45-64; n=3) among sister species. The gap in this data set between different populations and sister species is rather large and probably due to the small sample size. Since the sample size among sister species in these studies is only of three, it is likely that the range for sister species is actually larger. *Texoreddellia* appears to have a similar molecular clock for the 16S rRNA as other members of the Cubacubaninae given that genetic distances to non-nicoletiid outgroups are comparable. When compared to the nucleotide divergence found within *Texoreddellia*, it can be seen that they span from 0 to 47 differences, which falls within the range observed among the Cubacubaninae individuals of the same population to individuals of sister species.

Genetic information from some cave populations in adjacent areas, such as Formation Cave and Seven Mile Mountain Cave, both from Fort Hood, suggests that despite the proximity of the caves, they are actually in separate lineages (Fig. 2). The specimens analyzed from Seven Mile Mountain Cave are more closely related to a population across the Rio Grande, in Mexico (Clade 1), than to the neighboring Formation Cave (Clade 2). Furthermore, the sequence difference among the two Fort Hood cave populations is large enough (35 bp differences) which would not conflict with them being classified as two different sister species. Based on the genetic data, Formation Cave and Seven Mile Mountain Cave populations are proposed to belong to two different species.

In our opinion, the pattern derived from the molecular data, the genetic divergence found among *Texoreddellia* populations and the identification of unique diagnostic morphological characters corroborate Reddell's (1994) views that *T. texensis* is in fact a complex of closely related species. We propose this group to be divided into six species described below. This number is likely to increase in the future as more cave populations are examined and further molecular and morphologic analyses are performed.

KEY FOR IDENTIFICATION OF *TEXOREDDELLIA* SPECIES

References to appendages: are for adult specimens.
References to ovipositors: are for adult females.

1a. Pedicellus projection in adult males blade-like, not very conspicuous, extending parallel to antennae. Length shorter than 1/3rd the length of pedicellus (Figs. 4B-D, 6B-C and 9C-D) 2

1b. Pedicellus projection in adult males spine-like, very conspicuous, extending perpendicular to antennae. Length about half the length of pedicellus (Fig. 8A-B, H) 5

2a. Legs relatively long (Fig. 3). Hind tibia approximately 6 times longer than wide; approximately 2/3 of tarsus length (Fig. 5A-C). Mouthparts relatively long and slim in large specimens; terminal article of maxillary palp smaller than penultimate article (Fig. 4G-I); second to last article of labial palp about 3 times longer than wide (Fig. 4F). Ovipositor short, barely surpassing stylets IX, with 12 annuli (Fig. 5F) ....… *T. texensis*

2b. Legs relatively short (Fig. 3). Hind tibia approximately 4.5 times longer than wide; approximately 4/5th length of tarsus (Figs. 6G and 7D). Mouthparts relatively short and robust; terminal article of maxillary palp approximately equal in length to penultimate article (Figs. 6E and 7C); second to last article of labial palp about 2 times longer than wide (Figs. 6F, 7B and 9B). Ovipositor short or long, with 12 or more annuli 3

3a. Ovipositor short, barely surpassing stylets IX or shorter, with about 12 annuli (similar to Fig. 5F). Range most likely restricted to south of the Rio Grande …..…............. *T. coahuilensis*

3b. Ovipositor long, surpassing stylets IX by more than 1/3rd of their length, with more than 12 annuli. Range most likely restricted to north of the Rio Grande …......................................… 4

4a. Gonapophysis with about 14 annuli (Fig. 7F-G) ....*T. media*

4b. Gonapophysis with about 18 annuli (Fig. 6I) ....…………...………...… *T. aquilonalis*

5a. Head with setae but no scales (Fig. 8A). Ovipositor very long, surpassing stylets IX by more than once the length of the stylets (Fig. 8F) ....*T. occasus*

5b. Head with setae and scales (Fig. 8G). Ovipositor long, surpassing stylets IX by about 2/3 of their length (Fig. 8J) .... *T. capitesquameo*

Texoreddellia texensis (Ulrich, 1902)
redescription
Figs. 4A-I, 5A-K

Nicoletia texensis Ulrich, 1902, p. 96; Reddell, 1966:28.
Nicoletia (Anelpistina) texensis: Paclt, 1963:48.
Texoreddellia texensis: Wygodzinsky, 1973:1-8

Material examined.—Ezell's Cave (type locality), San Marcos, Hays County, Texas: One immature female, 14 Feb. 2006 (J. Krejca, A. Gluesenkamp); one juvenile, 7 Dec. 2006 (J. Krejca, A. Gluesenkamp) (TMMC).

Other localities.—The individuals used in this redescription came from Ezell's Cave and four other localities. Although specimens from many other localities had the distinct morphological set of characters that distinguishes *T. texensis*, long appendages and small ovipositor with 12 annuli, it was decided to restrict the description to specimens from localities and collection dates from where at least in one individual the 16S rRNA had been sequenced and shown to belong to Clade 2:

1) Formation Cave, Fort Hood, Coryell County: One male, 29 Aug. 2005 (J. Fant, C. Perkins, J. Reddell, M. Reyes (TMMC #38,318).

2) Airman's Cave, Travis County: One immature individual whose sex cannot yet be determined and one immature male, 12 Jan. 2005 (P. Paquin, M. Sanders) (TMMC).

3) Hoskin's Hole, Hays County: Two males and one female, 7 March 2005 (P. Paquin) (TMMC).

4)Accident Sink, Camp Bullis, Bexar County: One female, 12 April 2005 (J. Fant, G. Veni) (TMMC #38,318).

Description.—Specimens used in the new redescription of *T. texensis* are included in Clade 2 of the 16S rRNA sequence fragment analyses. The specimens from Formation Cave from Fort Hood (Coryell County), Airman's Cave (Travis County), and Hoskin's Hole, (Hays County), had no sequence difference among them and just a single nucleotide difference with respect to the specimens from Ezell's Cave (Hays County), the type locality of *T. texensis.* The specimen from Accident Sink (Bexar County) differed from the aforementioned specimens by 12 or 13 nucleotide differences (about 2.5%). In the description, non-italicized text is common to all species in this paper, while italicized portions describe morphology that allow for species differentiation (i.e., non-italicised text is shared by all six species in this paper or hold no taxonomic value). Some figures cited are from Wygodzinsky (1973).

Maximum body length 11.5 mm (Hoskin's Hole). General color light yellow to white. Macrochaetae simple or bifid apically. Scales elongate, multiradiate, apically tricuspid with one long median and two shorter lateral projections (Fig. 1H; Wygodzinsky, 1973). *Head with setae only.* Thoracic terga and abdomen with setae and scales (Figs. 3A-B, F; Wygodzinsky, 1973). Legs with scales on proximal segments. Mouthparts and abdominal stylets only with setae.

In adult males pedicellus about half as long as the first annuli of antennae (Fig. 4B) and with unicellular glands on a slightly protruding ventral surface, clustered approximately in groups and bordered by a "U" shaped row of microchaetae (Fig. 4D). On the outside lateral border there are other unicellular glands at the base of a projection. *The projection is identical to Wygodzinsky's original description (Figs. 4B-D); hook-shaped, heavily sclerotized but not pigmented, and not very conspicuous. The projection is flat, blade-like and it extends parallel to the antennae. Its length is no more than 1/3rd the length of the pedicellus.* Female basal annuli of antenna simple; pedicellus slightly smaller than in males and with no modifications. Head with approximately 8 + 8 macrochaetae on border of insertion of antenna (Fig. 1I; Wygodzinsky, 1973).

Mouthparts relatively long and slim in large specimens, although in small specimens it is less evident and mouthparts appear shorter and more robust as in other species described below. Terminal article of maxillary palp in large specimens smaller than penultimate article (Fig. 4G-I). Apex of galea with two conules of similar widths (Figs. 1L; Wygodzinsky, 1973). Two teeth on lacinia. *Labial palp as in Fig. 4F*, apical article longer than wide and equal or shorter than penultimate article. Penultimate article about 3 times longer than wide and with a slight bulge containing two macrochaetae. Labium and first article of labial palp with macrochaetae. Mandible chaetotaxy as in Fig. 4E, with multiple macrochaetae.

Legs relatively long as shown in Fig. 3 and 5A-C. Hind tibia approximately 6 times longer than wide and approximately 2/3 of the tarsus length. Claws with hairy appearance (Fig. 5D) similar to some members of the genus *Anelpistina* (Espinasa, et al., 2007), otherwise without relevant modifications. Nota as in Wygodzinsky's (1973) figure 2G.

Abdominal terga and sterna as in other members of genus. Abdominal sterna II-VII subdivided into coxites and sternites. Sterna VIII and IX of male entire.

Chaetotaxy of sternites with median portion of sternites with 1 + 1 or 2 + 2 sublateral macrochaetae at posterior hind borders and with 1 + 1 macrochaetae near suture at about middle of segment (Figs 6H, 8I, 9E and Wygodzinsky's 1973 fig. 3E). No apparent modifications in urosterna III and IV. Urosternum VIII of male straight, between the two stylets (Fig. 3K; Wygodzinsky, 1973), without the emargination common in other Cubacubaninae. Urosternum IX of male as in Fig. 5E without sensory cones. Point of insertion of parameres in urosternum IX deep, coxal processes with not many slightly sclerotized setae.

Stylets IX larger than others, with 3 macrochaetae and an extra subapical pair, although in some individuals there are only 2 macrochaetae and the extra subapical pair (Figs. 5E-F). Stylets II-VIII with 2 macrochaetae and an extra subapical pair, although in some individuals there is only 1 macrochaetae and the extra subapical pair. Terminal spine with small teeth. Stylets without modifications in male and female. *Parameres as shown in Fig. 5E, with some scales. Parameres attaining 1/3rd of stylets IX in largest specimen examined (Hoskin's Hole; 11.5 mm)*. Distal portion with a semi-exertile vesicle with distinct setae (Fig. 5E and Wygodzinsky's, 1973 Fig. 3O). Urotergite X shallowly emarginate in both sexes, posterior angles with 2 + 2 macrochaetae and a few relatively strong setae, length of inner macrochaetae slightly longer than distance between them (Fig 3G; Wygodzinsky, 1973).

Subgenital plate of female parabolic and with many setae (Fig. 5G). Ovipositor in largest female examined (Accident Sink; 11 mm) reaching tip of stylets IX (Fig. 5F). Gonapophysis with 12 annuli (Fig. 5F, I-K). Cercus of male and female simple with no spines.

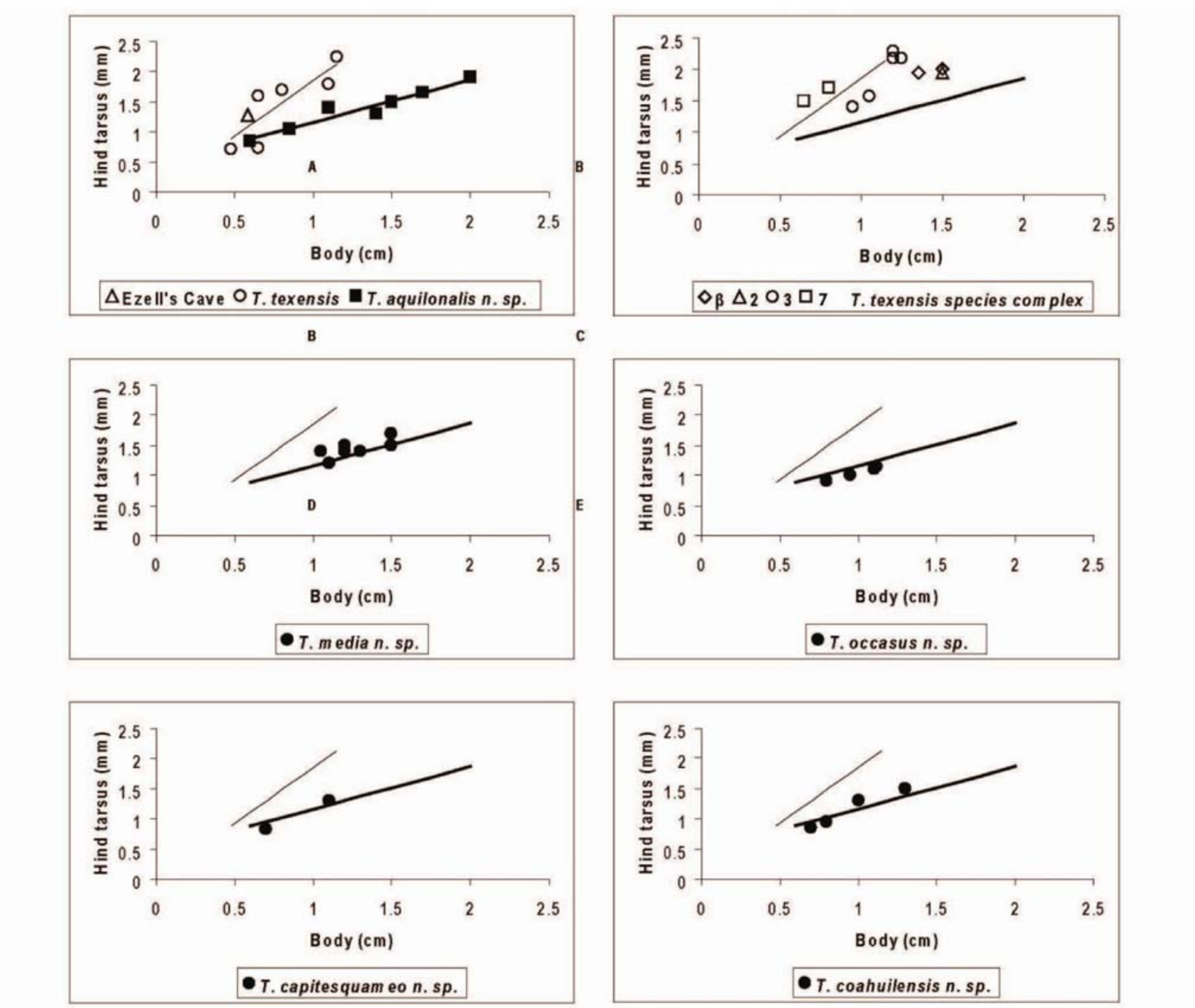


Fig. 3.—Leg proportion across the *Texoreddellia* species measured by the length of the body vs. the length of the hind tarsus. Thin linear trendlines and open figures = trendline of *T. texensis* and long leg ratio for genus. Thick linear trendlines and closed figures = trendline of *T. aquilonalis* and short leg ratio for genus.

Postembryonic development as in Table 4: In the smallest specimen (4.5 mm), parameres or ovipositor not yet present. In males, the next specimen's (4.8 mm) parameres barely reach the base of stylets IX, and has not developed unicellular glands, or projections on its pedicellus. For specimens 6.5 mm long, parameres reach about 1/4th the length of stylets IX and pedicellus has unicellular glands and projection. In the largest specimen (11.5 mm), parameres reach 1/3rd the length of stylets IX and its pedicellus has unicellular glands and the projection. Postembryonic development of females as follows: In the smallest female (5.8 mm) the ovipositor barely surpasses the base of stylets IX and gonapophysis lacks fully developed subdivisions (Fig. 5H). In the next females (8 mm), ovipositor reaches 9/10th the length of stylets IX and gonapophysis is divided in 12 annuli (Fig. 5I-K). In the largest female (11 mm), ovipositor barely surpasses stylets IX by 1/10th the length of the stylets and the gonapophysis is divided in 12 annuli (Fig. 5F).

Distribution.—Individuals from this species span about 200 km. Despite caves being isolated by non-cavernicolous rock (J. Reddell, pers. com.), populations still retained relatively high genetic homogeneity. For example, Accident Sink (Bexar County) and Formation Cave (Coryell County), although 160 km apart, have identical 16S rRNA sequences. It can be found both in the Balcones Fault Zone as well as in the Lampasas Cut Plains karstic region of Texas. Its range overlaps with other *Texoreddellia* species described below. *Texoreddellia texensis* is most likely the most common and widely distributed cave nicoletiid in Texas.

Discussion.—The samples of Ulrich and Wygodzinsky could not be found within the collection of the AMNH. Therefore, in order to redescribe *T. texensis*, it is necessary to ascertain that the specimens from the type locality of Ezell's Cave described in 1902 by Ulrich, the specimens used in 1973 by Wygodzinsky, and the ones collected in 2006 which were examined for this paper are all from the same species. Although Ulrich's and Wygodzinsky's specimens were not available for DNA studies, all share the distinctive features of a terminal article of the maxillary palp smaller than the penultimate article, apical article of labial palp longer than wide, apical article of labial palp equal or shorter than penultimate article, penultimate article of labial palp about 3 times longer than wide, and legs relatively long. It is therefore assumed that the specimens examined by us from Ezell's Cave, from which DNA were analyzed, belong to *T. texensis*.

According to the new redescription, the diagnostic features of *T. texensis* are long appendages (mouthparts and legs) and a small ovipositor with 12 annuli, plus a 16S rRNA within Clade 2 (with a three nucleotide deletion on bp 158-160, when aligned as in ClustalW2, among other sequence characters). Regrettably, members of Clade 3 (Root Canal Cave) and some members of Clade 1 (Sky High Cave, Red Arrow Cave, and Flint Ridge Cave) also share the same suite of morphological characters, but have very different haplotypes. Despite careful examination, they remained mostly qualitatively uniform in their morphology. Although it is apparent that the populations with long appendages and short ovipositors may belong to multiple species, we do not feel it is suitable to designate different species based solely on haplotypes, especially when considering the limited information available for study. Future analyses based on more individuals and more genetic markers may resolve the issue. It is therefore recommended that when identifying cave populations with individuals with long appendages and a small ovipositor with 12 annuli for which molecular data are not available, they should be identified as belonging to the "*T. texensis* species complex."

Since morphology in the following species are similar to the original description of *Texoreddellia* by Wygodzinsky (1973) and the redescription of *T. texensis*, only the diagnostic characters of the new species are presented.

Texoreddellia aquilonalis Espinasa and Giribet, new species
Fig. 6A-G

Type data.—Seven Mile Mountain Cave, Fort Hood, Bell County, Texas. 31°19' N, 97°50' W: Female holotype, 23 April 2004 (C. Pekins, J. Reddell, M. Reyes) (AMNH); three male paratypes, one of them immature, 22 April 1999 (R. Price) (TMMC #20,484); 28 June 2000 (J. Reddell, M. Reyes) (TMMC #24,752);, and 23 April 2004 (C. Pekins, J. Reddell, M. Reyes) (TMMC #36,237 and one immature female 11 June 2005 (M. Reyes) (TMMC #38,263).

Other localities.—Cobb Cavern, Williamson County, Texas. UTM NAD27 620953 3406319: Two female paratypes, 30 March 2004 (M. Warton) (TMMC #36,173).

Polaris Cave, Williamson County, Texas: One female paratype, 19 April 1994 (J. Reddell, M. Reyes) (TMMC #24,684).

Description.—Maximum body length 20 mm (Cobb Cavern). Individuals from which molecular data are available belong to a distal branch within Clade 1. Head with setae only (Fig. 6A). Antennal pedicellus projection (Fig. 6B-C) identical to Wygodzinsky's redescription of *T. texensis* (Fig. 4B-D); hook-shaped, heavily sclerotized but not pigmented, and not very conspicuous. Pedicellus projection flat, blade-like, extending par-

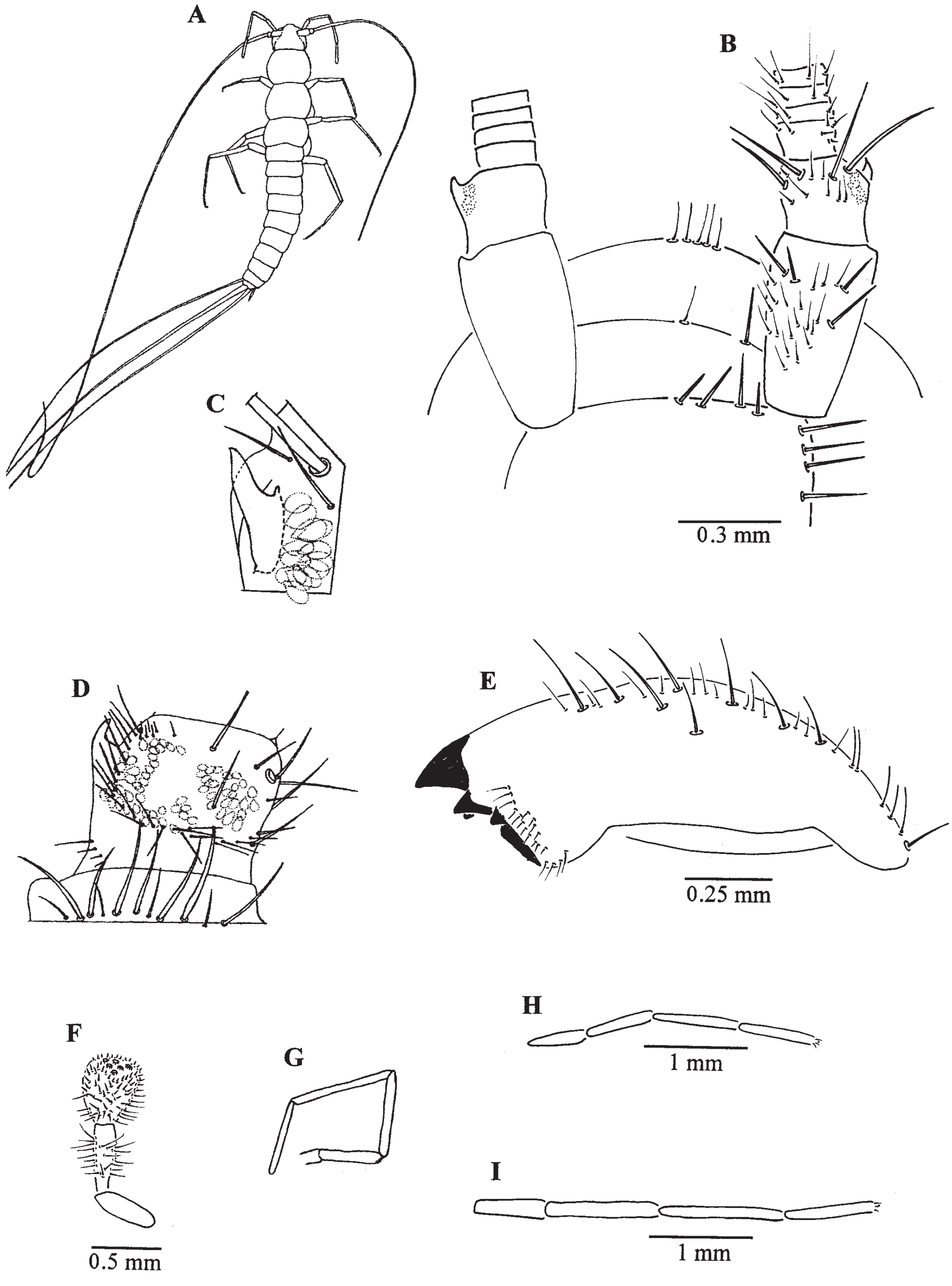


Fig. 4.—*Texoreddellia texensis* (E-H) and *Texoreddellia texensis* species complex (A-D, I). Microchaetae partially shown. A, body; B, head and antennae, male; C, hook-shaped appendage of pedicellus; D, pedicellus; E, mandible; F, labial palp; G-I, maxillary palp. A, Boehm's Cave, Medina County; B and I, Sky High Cave, Edwards County; C-D; Inner Space Cavern, Williamsons County; E, Accident Sink, Bexar County; F, Hoskin's Hole, Hays County; G-H, Ezell's Cave, Hays County (*T. texensis* type locality). Figures A, C, D and G from Wygodzinsky (1973), from which no scale was available.

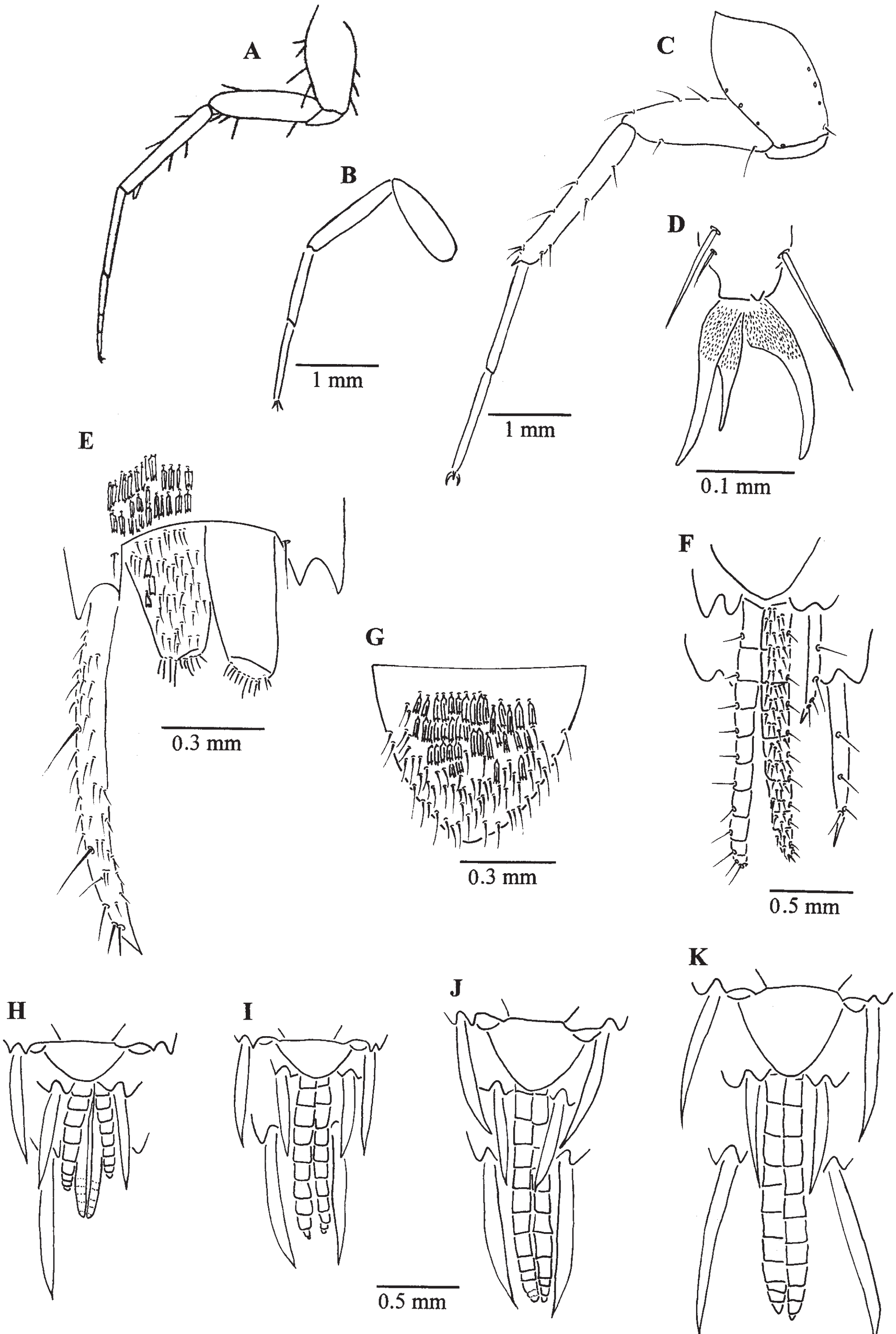


Fig. 5.—*Texoreddellia texensis* (A-B, E-G) and *Texoreddellia texensis* species complex (C-D, H-K). Microchaetae partially shown. A-C, hind legs; D, claws; E, urosternum IX and parameres; F, ovipositor; G, subgenital plate, note abundance of setae; H-K, female postembryonic development (equal scale). A-B, Ezell's Cave, Hays County (*T. texensis* type locality); C-D; Sky High Cave, Edwards, County; E, Hoskin's Hole, Hays County; F-G, Accident Sink, Bexar County; H-K, MARS Shaft, Bexar County. Figure A from Wygodzinsky (1973) from which no scale was available.

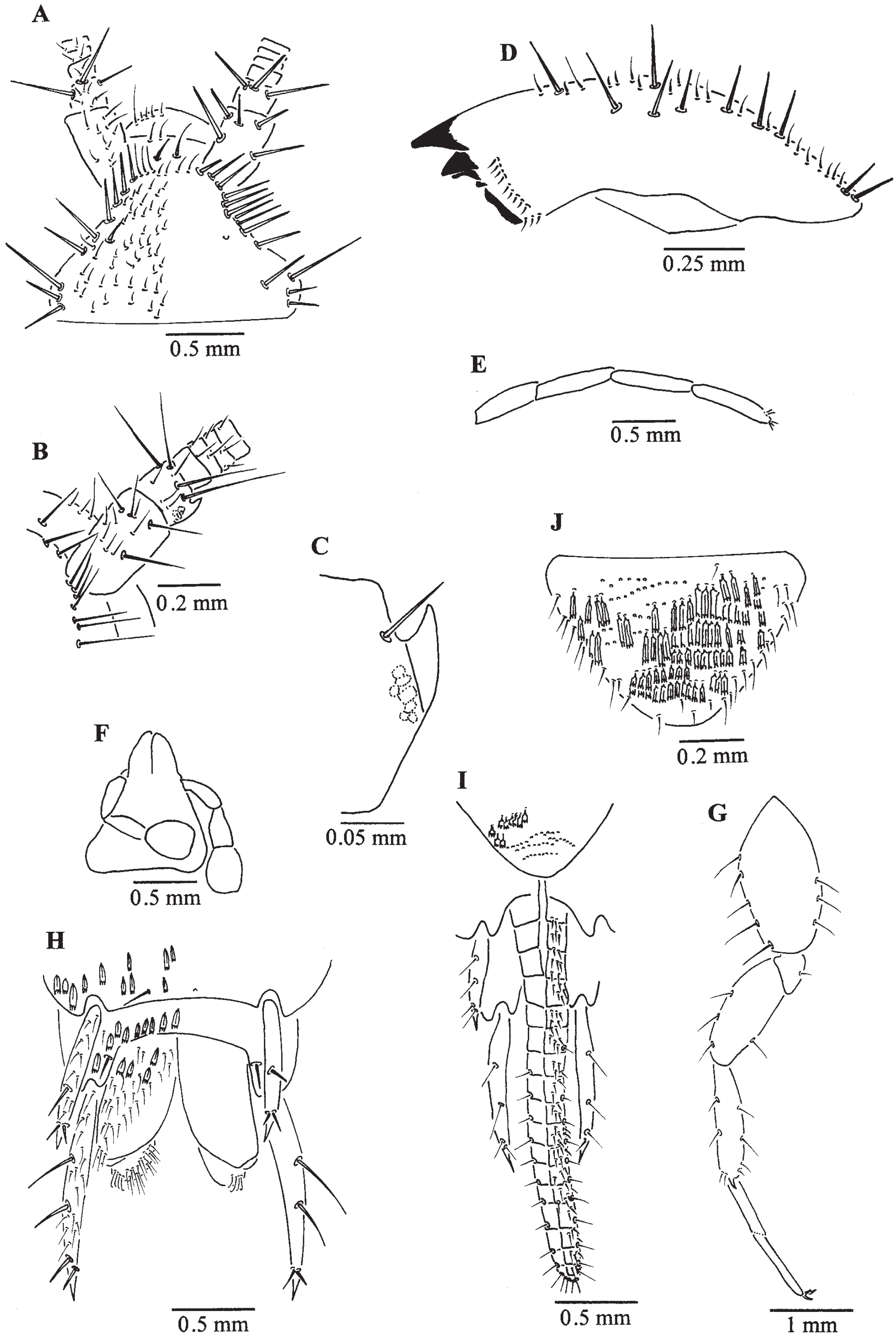


Fig. 6.—*Texoreddellia aquilonalis,* n.sp. Microchaetae partially shown. A, head and antennae, female; B, antennae, male; C, hook-shaped appendage of pedicellus; D, mandible; E, maxillary palp; F, labium and labial palp; G, hind leg; H, urosternum VIII-IX and parameres; I, ovipositor; J, subgenital plate. Note scarcity of setae. A-J, Seven Mile Mountain Cave, Bell County.

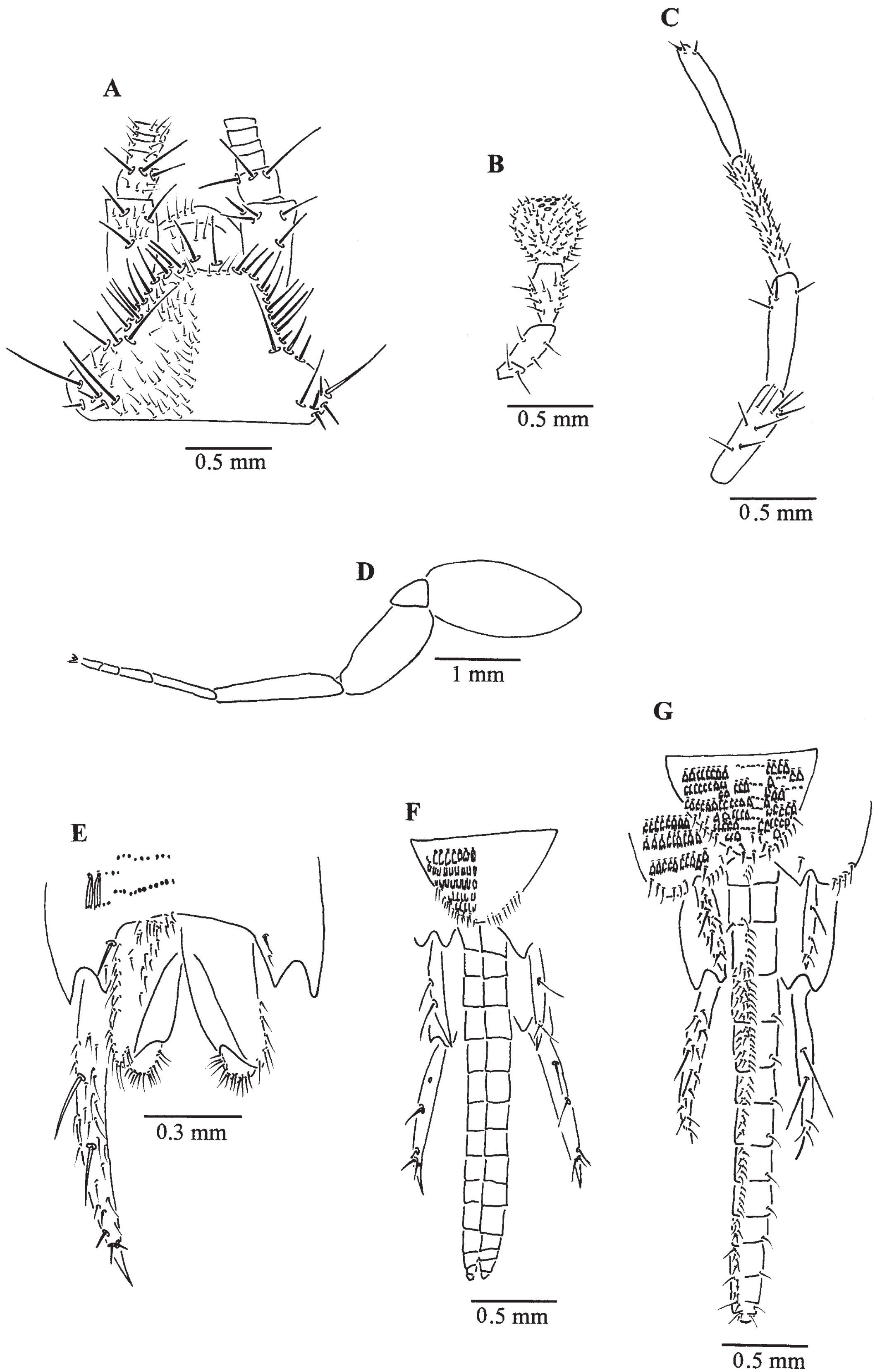


Fig. 7.—*Texoreddellia media,* n.sp. Microchaetae partially shown. A, head and antennae, female; B, labial palp; C, maxillary palp; D, hind leg; E, urosternum IX and parameres; F-G, ovipositor. A-D, F, Flach's Cave, Bexar County; E, G, Robber Baron Cave, Bexar County.

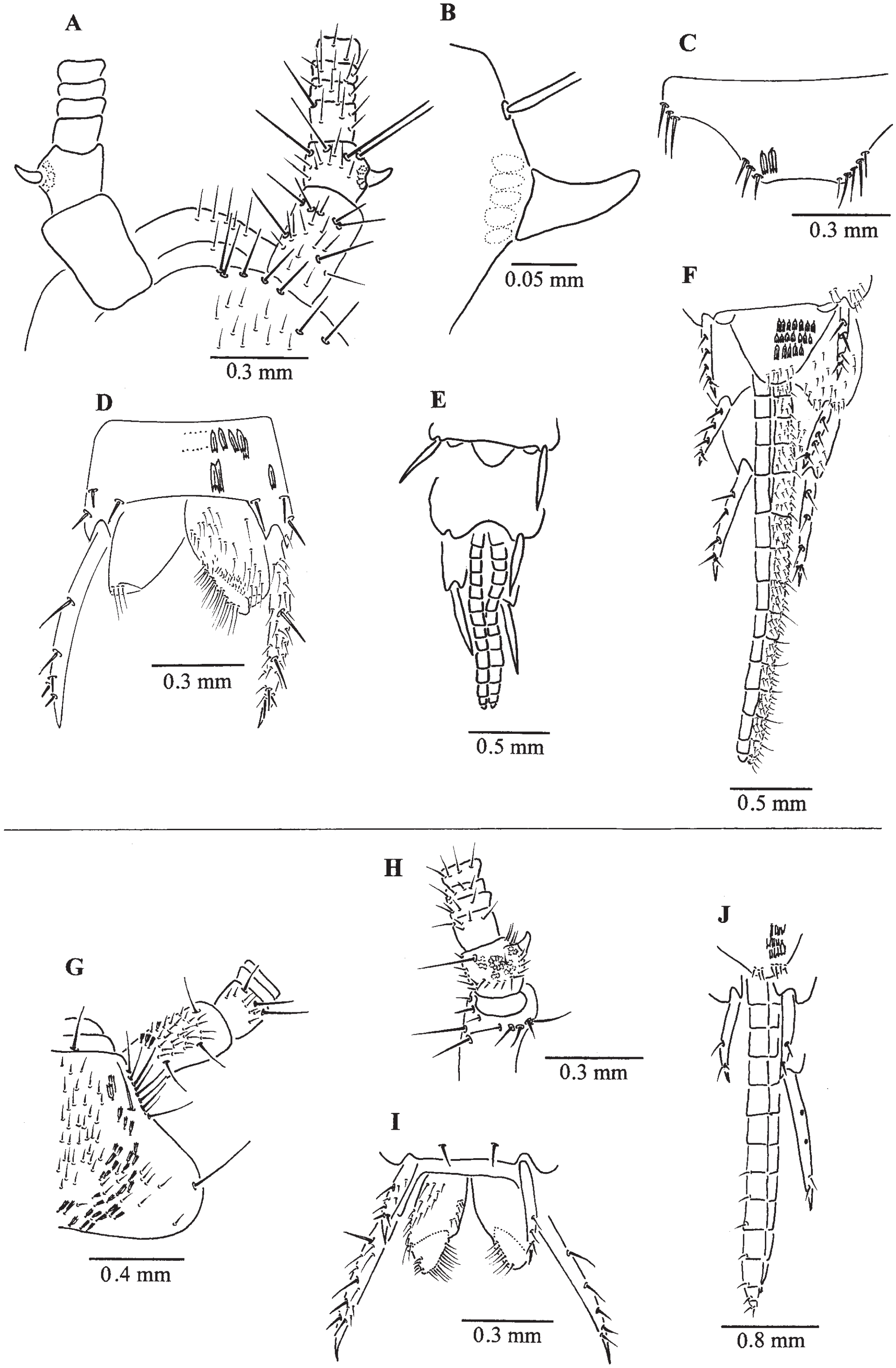


Fig. 8.—*Texoreddellia occasus,* n.sp. (A-F, above line) and *T. capitesquameo,* n.sp. (G-J, below line). Microchaetae partially shown. A, head and antennae, male; B, hook-shaped appendage of pedicellus; C, urotergite X; D, urosternum IX and parameres; E-F, female postembryonic development of ovipositors; G, head and antennae, female; H, hook-shaped appendage of pedicellus; I, urosternum IX and parameres; J,

allel to the antennae. Its length is no more than 1/3rd the length of the pedicellus.

Mouthparts relatively short and robust. Terminal article of maxillary palp approximately equal to penultimate article (Fig. 6E). Labial palp as in Fig. 6F, terminal article slightly longer than wide and slightly longer than penultimate article. Penultimate article about two times longer than wide. Legs relatively short as shown in Fig. 6G. Hind tibia approximately 4.5 times longer than wide and approximately 4/5 length of tarsus.

Parameres as shown in Fig. 6H, with some scales. Parameres attaining slightly less than half of stylets IX length in largest specimen examined with unbroken stylets IX (Seven Mile Mountain Cave; 8 mm). Subgenital plate of female parabolic and with few setae (Fig. 6J). Ovipositor in largest female examined (Polaris Cave; 17 mm) surpassing tip of stylets IX by about 3/4 their length. Gonapophysis with about 18 annuli (Fig. 6I).

Postembryonic development of male as in table 4a: In the smallest specimen available (6 mm), parameres barely attain 1/4th of stylets IX, but there are no unicellular glands or projections on its pedicellus. In individuals 8 mm long, projections on pedicellus are present and parameres attain slightly less than half of stylets IX. In the largest specimen (11 mm), projections on pedicellus were present, but stylets IX were broken, so a comparison with parameres could not be made.

Postembryonic development of females as in table 4b: In the smallest specimen (8.5 mm) the ovipositor barely surpasses the base of stylets IX and it has at least 15 annuli. On the next three females (14, 15 and 17 mm) ovipositor surpasses the tip of stylets IX by about 3/4 their length and gonapophysis with about 18 annuli. The largest female (20 mm) has a broken ovipositor.

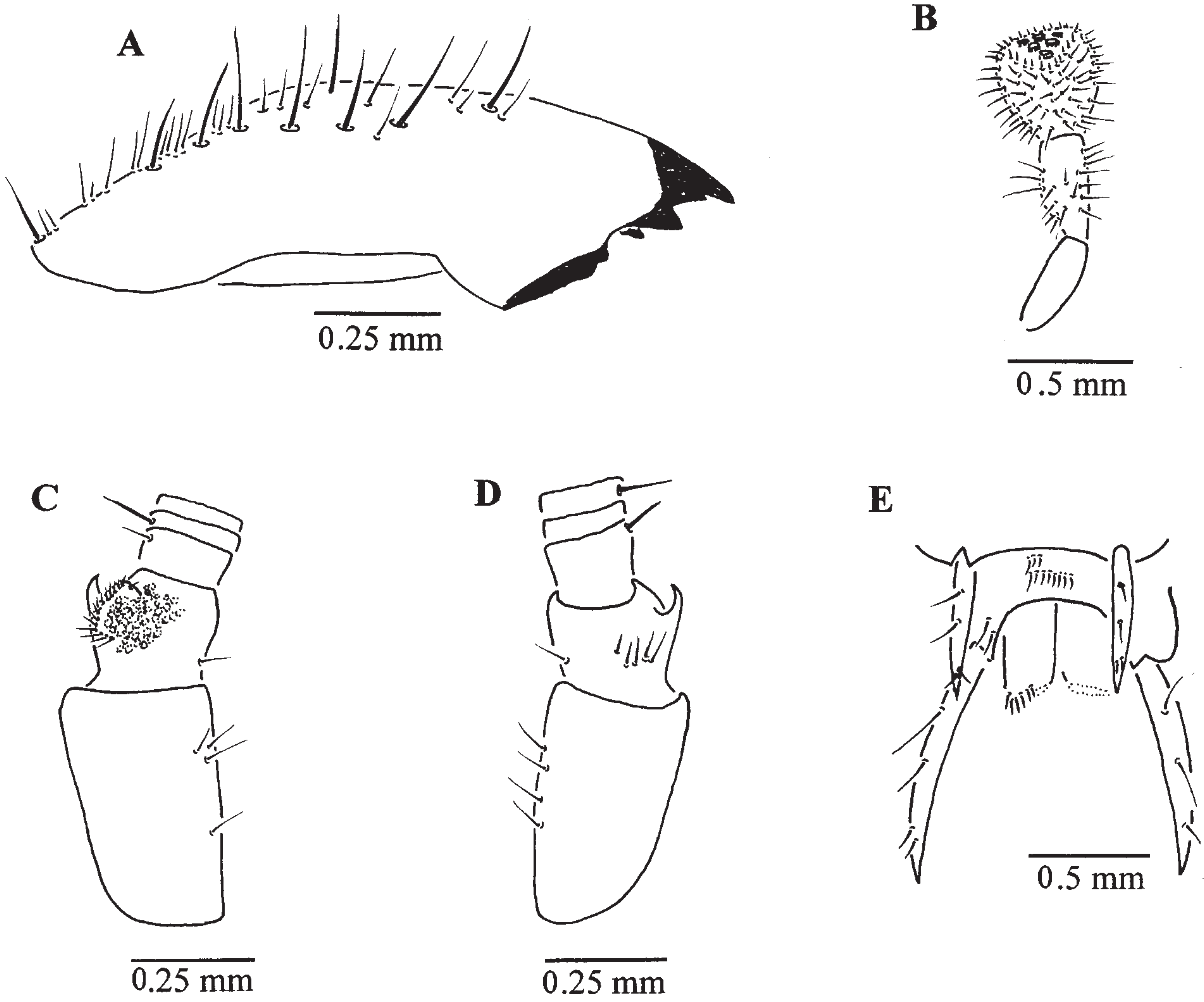


Fig. 9.—*Texoreddellia coahuilensis,* n.sp. Microchaetae partially shown. A, mandible; B, labial palp; C-D, antennae and hook-shaped appendage of pedicellus, male; E, urostena VIII-IX and parameres. A-B, E, Cueva de Casa Blanca, Coahuila, Mexico. C-D, Sótano de Amezcua, Coahuila, Mexico.

Distribution.—Individuals from this species were found in three caves: Seven Mile Mountain Cave (Fort Hood, Bell County), Cobb Cavern (Williamson County), and Polaris Cave (Williamson County). The cave from Bell County is separated from the caves in Williamson County by about 30 km. Although separated by non-cavernicolous rock (Reddell, pers. com.), no 16S rRNA sequence differences were found between two individuals from Fort Hood and one individual from Cobb Cavern. No other specimens with the diagnostic 18 annuli gonapophysis were found among the extensive collection sites available for this study. It is likely that this species is restricted to the northeastern-most karst region of Texas in Bell and Williamson Counties.

Etymology.—The name *aquilonalis* (in nominative, singular feminine) derives from Latin for "northerly" and alludes to this species inhabiting caves within the northern-most range for *Texoreddellia*.

Texoreddellia media Espinasa and Giribet,
new species
Fig. 7A-G

Type-data.—Flach's Cave, Camp Bullis, Bexar County, UTM NAD27 14 543867 3287196: Female holotype, 5 Dec. 2005 (A. Gluesenkamp) (AMNH); Accident Sink, Camp Bullis, Bexar County: Three female paratypes 9 May 2005 (J. Reddell, M. Reyes) (TMMC #38,098); Robber Barton Cave, San Antonio, Bexar County: One male and one female paratypes, 9 Dec. 1983 (collector?) (TMMC #24,559); 0-9 Well, Crockett County: Two female paratypes, 15 Aug. 1992 (C. Savvas) (TMMC #24,730).

Description.—Maximum body length 15 mm (0-9 Well). Individuals from which molecular data are available (Flach's Cave and Accident Sink) belongs to a second distal branch within Clade 1. Head with setae only (Fig. 7A). Antennal pedicellus projection identical to Wygodzinsky's original description (Fig. 4B-D); hook-shaped, heavily sclerotized but not pigmented, and not very conspicuous. Pedicellus projection flat, blade-like, extending parallel to the antenna; its length less than 1/3rd the length of the pedicellus. Mouthparts relatively short and robust. Terminal article of maxillary palp approximately equal to penultimate article (Fig. 7C). Labial palp as in Fig. 7B, apical article almost as wide as long, and longer than penultimate article. Penultimate article about two times longer than wide. Legs relatively short as in Fig. 7D. Hind tibia approximately 4.5 times longer than wide and approximately 4/5th the length of tarsus.

Parameres as in Fig. 7E, with some scales. Parameres reaching about 1/3rd of stylets IX in the single male specimen available (Robber Baron Cave; 13 mm). Subgenital plate of female parabolic and typically with few setae (Fig. 7F-G), although some specimens may have more. Largest ovipositor in females examined (Accident Sink; 15 mm) surpassing tip of stylets IX by about half their length (Fig. 7G). Gonapophysis with about 14 annuli (Fig. 7F-G).

Postembryonic development of male unknown because a single male specimen was available (Table 4a). In this comparatively large specimen (13 mm), parameres attain about 1/3rd of stylets IX. When compared with the other species, parameres are thinner and most of their inner surface appears with a larger area with distinct small setae. It is unknown if this character is distinctive for the species or if it only represents a further stage of postembryonic development since available males of other species examined were of smaller size.

Postembryonic development of females unclear (Table 4b). In all specimens of Flach's Cave (12 mm) and Accident Sink (14, 15, 15 mm) the ovipositor surpasses the tip of stylets IX by about half their length and gonapophyses have ca. 14 annuli. The specimen from Robber Baron Cave, although smaller in length (13 mm), has an ovipositor that surpasses the tip of stylets IX by about once their total length. The two specimens of 0-9 Well (12 and 15 mm) have an ovipositor that surpasses the tip of stylets IX by only 1/3rd their total length. Regardless of the variability, in all localities the ovipositor in adult females is long, surpassing stylets IX by 1/3rd their length or more and with 14 annuli. The specimens for which 16S rRNA sequence data were obtained are one from Flach's Cave and two from Accident Sink, so it is not known whether the difference in development of this character is due to significant genetic distance or to a random difference in the development of samples collected in the different localities.

Distribution.—Individuals from this species were collected in four caves: Flach's Cave, Accident Sink, Robber Baron Cave and 0-9 Well. The first three are in Bexar County and the latter one in Crockett County. The distribution of *Texoreddellia media,* n.sp., overlaps with some populations of the *T. texensis* species complex. Collections from Accident Sink and Robber Baron Cave have specimens with short appendages and large ovipositors with 14 annuli, distinctive of *T. media*, and specimens with long appendages and small ovipositors with 12 annuli, distinctive of the *T. texensis* species complex. This variability cannot simply be the result of specimens at different stages on a progressive postembryonary development because in some cases, the longer ovipositors are in significantly smaller individuals than those with short ovipositors. Furthermore, there is a perfect correlation between the type of appendages, the respective ovipositor, and the 16S rRNA haplotype in the specimens examined. In Accident Sink, the female with 12 gonapophyses sequenced had a Clade 2 haplotype (with a three nucleotide deletion on bp 158-160, when aligned as in ClustalW2, among other sequence characters) while the two females with 14 gonapophyses sequenced had a Clade 1 haplotype (without the three nucleotide deletion on bp 158-160, when aligned as in ClustalW2, among other sequence characters). These last two females only had 1-2 bp differences when compared with the Flach's Cave specimen. Based on the above, it is our opinion that these caves are inhabited by at least two sympatric species, as evidenced by the collection in Robber Baron Cave on 9 December 1983, where both species were collected on the same date. This implies that both species can cohabitate the same cave at least for some periods of time.

Etymology.—The name *media* (in nominative, singular, feminine) derived from Latin for "situated in the center or in the middle," neuter of *medius*, and alludes to this species inhabiting caves within the central range for the genus *Texoreddellia*.

Texoreddellia occasus Espinasa and Giribet, new species
Fig. 8A-F

Type-data.—Rattlesnake Cave, Ward County, Texas: Male holotype (AMNH), 2 male paratypes and 3 female paratypes (TMMC #24,635), 5 Dec. 1986 (J. Reddell, M. Reyes, A. R. Smith) (TMMC #24,635).

Description.—Maximum body length 11.2 mm. No molecular data were obtained. Head with setae only (Fig. 8A). Antennal pedicellus projection very conspicuous (Fig. 8A-B). Pedicellus projection spine-like, not pigmented, extending perpendicular to the antennae. Distal portion of pedicellus projection slightly hooked. Projection length about half the length of the pedicellus.

Mouthparts of intermediate length when compared with the long and slim or short and robust mouthparts of other species. Terminal article of maxillary palp subequal to penultimate article. Labial palp terminal article longer than wide and equal to penultimate article. Penultimate article about twice as long as wide. Legs relatively short. Hind tibia approximately 4.5 times longer than wide and approximately 4/5th the length of tarsus.

Parameres as in Fig. 8D, with no scales. Parameres reaching slightly less than half the length of stylets IX in the largest specimen available (9.5 mm). Subgenital plate of female parabolic and typically with few setae (Fig. 8F). Ovipositor surpassing tip of stylets IX by about 1.5 their length in largest female examined (11.5 mm) (Fig. 8F). Gonapophysis with about 15 annuli (Fig. 8F).

Postembryonic development of male (Table 4a) largely unknown because only two males were available and they were of similar length (8 and 9.5 mm). In the smallest specimen parameres reach about 1/3rd of stylets IX and there is a large projection on their pedicellus. In the largest specimen parameres reach slightly less than half the length of stylets IX and also have a large projec-

Table 4.—Postembryonic development. In males (a), fractions indicate relative length of parameres with respect to stylets IX. In females (b), fractions indicate relative length of ovipositors with respect to stylets IX. Zero values indicate that they reach the base of stylets IX, A "1" value indicates that they reach the tip of stylets IX, a "2" value indicates that they surpass the tip of stylets IX by the whole length of the stylets, etc.

a) males	**Body length (mm)**									
	4	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
T. texensis	0		1/4					1/3		
T. aquilonalis			1/4		1/2					
T. media										1/3
T. occasus					1/3	1/2				
T. capitesquameo				1/2						
T. coahuilensis				1/4	1/4		1/4			

b) females	**Body length (mm)**					
	5-6	**8-9**	**10-11**	**12-13**	**14-15**	**16-17**
T. texensis	0	9/10	1+1/10			
T. aquilonalis		0			1+3/4	1+3/4
T. media				1+1/3 - 2	1+1/3 - 2	
T. occasus		1+1/2	2+1/3 - 2+1/2			
T. capitesquameo			1+2/3			
T. coahuilensis				1+1/10		

tion on their pedicellus. In both specimens the projection of the pedicellus is distinctly larger than in *T. capitesquameo*, n.sp., but since in that species the specimen is smaller (7 mm) it might be that the difference is from normal postembryonary development instead of a species difference.

Postembryonic development of females as in table 4b: In the smallest specimen (9.5 mm) the ovipositor surpasses the tip of stylets IX by half their length and at least 14 annuli can be counted (Fig. 8E). In the next females (11 mm) the ovipositor surpasses the tip of stylets IX by about 4/3rd their length and the gonapophysis has ca. 15 annuli. In the largest female (11.2 mm) the ovipositor surpasses the tip of stylets IX by about 3/2 their length and the gonapophysis has about 15 annuli (Fig. 8F).

Distribution.—Known only from the type locality.

Etymology.—The name *occasus* (in genitive, singular) derives from Latin for "the region or quarter where the sun sets, "the west." and alludes to the western range of the distribution of *Texoreddellia*, where this species is found.

Texoreddellia capitesquameo Espinasa and Giribet, new species
Fig. 8G-J

Material examined.—Phantom Lake Spring Cave, Reeves County: Male holotype (AMNH), female paratype (TMMC #24,535), July 1977 (Bill Tucker).

Description.—Based on two specimens. Body length of male 7 mm and of female 11 mm. No molecular data were obtained. Head with setae and scales (Fig. 8G). Antennal pedicellus projection very conspicuous (Fig. 8H). Projection spine-like, not pigmented, extending perpendicular to the antennae. Distal portion of pedicellus projection slightly hooked; its length about half the length of the pedicellus.

Relative length of mouthparts unclear. In the small male holotype the mouthparts are relatively short and robust (terminal article of maxillary palp approximately equal to penultimate article, labial palp apical article almost as wide as long and longer than penultimate article; penultimate article about twice longer than wide), but in the larger female paratype the mouthparts appear longer and slimmer, although they are poorly preserved. Legs relatively short. Hind tibia approximately 5 times longer than wide and approximately 4/5th the length of tarsus.

Parameres as in Fig. 8I, with some scales. Parameres reaching slightly less than half the length of stylets IX in the specimen available (7 mm). Subgenital plate of female parabolic and with few setae (Fig. 8J). Ovipositor in female paratype (11 mm) surpassing the tip of stylets IX by about 2/3 their length (Fig. 8J). Gonapophysis with about 14 annuli (Fig. 8J).

Postembryonic development unknown.

Distribution.—Known only from the type locality.

Etymology.—The name *capitesquameo* (in ablative, neutral, singular) is derived from the Latin "capite+squameo" for head+scaly, as this is the only described species of *Texoreddellia* with scales on its head.

Texoreddellia coahuilensis Espinasa and Giribet, new species
Fig. 9A-E

Type-data.—Cueva de Casa Blanca, Municipio de Ciudad Acuña, Coahuila, Mexico. NAD 27 14R 302246 3251311, 19 Feb. 2005 (Rob Myers): Male holotype (AMNH); Sótano de Amezcua, 35 mi W and 8 miles N of Ciudad Acuña. Coahuila, Mexico: Male paratype, 4 Dec. 1992, (M. Warton, W. Elliot, D. Hubbard, J. Krejca) (TMMC #23,584); male paratype and two female paratypes, 26 June 1994 (M. Warton, W. Elliot, D. Hubbard, J. Krejca) (TMMC #23,585, 23,586); and one male paratype, 15 June 1998 (M. Warton, W. Elliot, D. Hubbard, J. Krejca) (TMMC #23,583).

Description.—Maximum body length 13 mm. Holotype from which molecular data are available belongs to the basal branch of Clade 1. Head with setae only. Antennal pedicellus projection slightly different from Wygodzinsky's description of *T. texensis* and the new species described above. The projection starts on a somewhat enlarged and bulging portion of the pedicellus with numerous unicellular glands (Fig. 9C). Otherwise the projection is flat, blade-like and it extends parallel to the antennae (Fig. 9D), as in all the other species. Its length is less than 1/3rd the length of the pedicellus.

Mouthparts relatively short and robust. Terminal article of maxillary palp approximately equal to penultimate article. Labial palp as in Fig. 9B, terminal article equal or slightly longer than wide and slightly longer than penultimate article. Penultimate article about twice as long as wide. Legs relatively short. Hind tibia approximately 4.5 times longer than wide and approximately 3/4 to 4/5 the length of tarsus.

Parameres as in Fig. 9E, with no scales. Parameres reaching 1/4th of stylets IX in largest specimen examined (10.5 mm). Subgenital plate of female parabolic and with few setae. Ovipositor surpassing tip of stylets IX by about 1/10th their length in largest female examined (13 mm). Gonapophysis with about 12 annuli.

Postembryonic development of male as in table 4a: In the smallest specimen (7 mm) parameres barely reach 1/4th the length of stylets IX, without unicellular glands or projections on its pedicellus. At 8 mm long, projections on pedicellus are present and parameres attain 1/

4th the length of stylets IX. In the largest specimen (10.5 mm), projections on pedicellus are present, but parameres still only reach 1/4th the length of stylets IX.

Postembryonic development of females largely unknown as all females had a length of about 13 mm (Table 4b). In all specimens ovipositor surpassing tip of stylets IX by about 1/10th their length; gonapophysis with about 12 annuli.

Distribution.—Individuals were examined from Cueva de Casa Blanca and Sótano de Amezcua, both caves near Ciudad Acuña, Coahuila (Mexico), thus extending the range of *Texoreddellia* outside Texas. The localities are south of the Río Grande, a major barrier for cave-adapted organisms. The species is most probably restricted to caves in Northern Mexico.

Etymology.—The name *coahuilensis* (in genitive singular) refers to the region where the species inhabits, the caves in the state of Coahuila, Mexico.

CONCLUSIONS

The troglobitic insects of the genus *Texoreddellia* are amongst the most important and common representatives of the cave-adapted fauna of Texas (Reddell, 1994) and Coahuila (northern Mexico). In this study it was found that enough genetic and morphologic differences exist to subdivide into several distinct species the *Texoreddellia* populations found throughout the caves in this area. The evolutionary origin of the group appears to be somewhere near the border of Texas and Mexico. From this center, several lineages dispersed, differentiated morphologically and speciated.

From the 13 populations examined, seven had non-private haplotypes with respect to individuals from other caves, implying that some species of *Texoreddellia* as defined here have a wide distribution. Among the specimens studied, those from Formation Cave (Fort Hood, Coryell County) and Hoskin's Hole (Hays County) are the farthest apart (about 200 km) with no 16S rRNA sequence divergence. These two cave populations are not only separated by major barriers, such as the Colorado River, but they also lack a limestone connection; Fort Hood is a geologically and topographically isolated area separated from other karst regions by a gap of non-cavernicolous deposits (Reddell, pers. com.).

Of course, there is the possibility that 16S rRNA is not an appropriate marker to capture phylogeographic patterns in *Texoreddellia*. However, this seems implausible, as the marker is able to differentiate among putative cryptic species/lineages (this study). Variation of the same marker in other genera within the same subfamily Cubacubaninae shows a similar pattern and molecular clock, with species sharing identical or closely related haplotypes while divergences are much larger among species (authors' unpublished data). The 16S rRNA marker has also been used successfully for phylogeny/phylogeography in several other groups of terrestrial arthropods.

Our morphological studies show an interesting aspect of the group. Several caves appear to be inhabited by multiple species of *Texoreddellia*. In Accident Sink in Camp Bullis (Bexar County), females collected on 26 October 2004 and on 12 April 2005, had long appendages and short ovipositors with about 12 annuli. One of these specimen's 16S rRNA sequence corroborates that it belongs to *T. texensis*. However, a collection from the same cave at a later date (9 May 2005) yielded specimens with short appendages and long ovipositors with about 14 annuli whose 16S rRNA sequence corroborates that they belong to *T. media*. For the ovipositor, ontogenetic differences can be discarded as an explanation because in the populations examined, once females attain the proper subdivision of the ovipositor of 12, 14 or 18 annuli, this number remains constant thereafter regardless of the increase of body length (Fig. 5F, H-K).

Another cave in Bexar County, Robber Baron Cave, showed that two species could actually inhabit the same cave at the same time. Specimens collected on 11 December 1983 were composed of a mixture of individuals with long appendages and short ovipositors of about 12 annuli, and individuals with short appendages and long ovipositors of about 14 annuli. The differences could not be again assigned to variability within a single species at different postembryonic developmental stages because the number of annuli in the ovipositor was independent of the length of the females and it could be corroborated by their different length ratio of body/tarsus apparent of *T. texensis* vs. *T. media*. This cave was visited again in 25 June 1993 and a single individual with a short ovipositor of 12 annuli was collected.

Other caves have previously been reported with more than one species of nicoletiids of the subfamily Cubacubaninae. Some volcanic caves in the state of Morelos, Mexico, are inhabited by two closely related species of *Anelpistina* (Espinasa and Fisher, 2006) and Cuaxilotla Cave in Guerrero, Mexico is inhabited by *Prosthecina avita, Anelpistina cuaxilotla* and *Anelpistina mexicana* (Espinasa, 2000).

ACKNOWLEDGMENTS

We thank James R. Reddell for kindly offering the *Texoreddellia* material from the Texas Memorial Museum collection. Without his determination for amassing such an amazing collection of cave organisms, many collected by him, the present study could not have been carried out. We also thank all the cavers that collected specimens, especially those that under our request collected fresh samples for DNA analysis. Their names are mentioned under each species description. Christopher D. Mango, an undergraduate from Marist College, sketched and inked many of the illustrations. His attention to detail resulted in many of the beautiful figures in the article. The undergraduate students of the "Genetics 320, Spring 2007" course at Marist College also performed some of the DNA sequencing. Finally, we also thank Monika Baker, Marshal Hedin, Luis Mendes, Graeme Smith, and an anonymous reviewer for reviewing the manuscript, James Cokendolpher for editing the publication, and Dr. Michael Tannenbaum, Dean of School of Science, Marist College, for supporting a portion of the laboratory work and the publication of this article. Research on Fort Hood was funded by The Nature Conservancy through cooperative agreement DPW-ENV-02-A-001 between the Department of the Army and The Nature Conservancy. Information contained in this report does not necessarily reflect the position or the policy of the government and no official endorsement should be inferred.

LITERATURE CITED

De Laet, J. E. 2005. Parsimony and the problem of inapplicables in sequence data. Pp. 81-116 in: V. A. Albert, ed., Parsimony, phylogeny, and genomics. Oxford University Press, Oxford.

Edgecombe, G. D., G. Giribet, and W. C. Wheeler. 2002. Phylogeny of Henicopidae (Chilopoda: Lithobiomorpha): A combined analysis of morphology and five molecular loci. Systematic Entomology, 27:31-64.

Espinasa, L. 2000. A new species of the genus *Prosthecina* (Insecta: Zygentoma: Nicoletiidae). Pedobiologia, 101:1-13.

Espinasa, L., and E. C. Cappuccio. 2008. New genus allocation for the cavernicole Nicoletiids (Insecta: Zygentoma) of Aruba and description of their previously unknown males. Proceedings of the Entomological Society of Washington,. 110(2): 292–299.

Espinasa, L., and A. Fisher. 2006. Troglobites from the lava tubes in the Sierra de Chichinautzin, Mexico, challenge the competitive exclusion principle. XII International Symposium on Vulcanospeleology. 38.

Espinasa, L., C. Flick, and G. Giribet. 2007. Phylogeny of the American silverfish Cubacubaninae (Hexapoda: Zygentoma: Nicoletiidae): a combined approach using morphology and five molecular loci. Cladistics, 23:22–40.

Farris, J. S., 1997. The future of phylogeny reconstruction. Zoologica Scripta, 26:303-311.

Farris, J. S., .V. A. Albert, M. Källersjö, D. Lipscomb, and A. G. Kluge.1996. Parsimony jackknifing outperforms neighbor-joining. Cladistics, 12:99-124.

Giribet, G. 2001. Exploring the behavior of POY, a program for direct optimization of molecular data. Cladistics, 17:S60-S70.

Giribet, G. 2002. Relationships among metazoan phyla as inferred from 18S rRNA sequence data: a methodological approach. Pp. 85-101 in: R. DeSalle, G. Giribet and W. C. Wheeler, eds., Molecular Systematics and Evolution: Theory and Practice. Birkhäuser Verlag, Basel.

Linton, E. W. 2005. MacGDE: Genetic Data Environment for MacOS X. Ver. 2.0. Software available at www.msu.edu/~lintone/macgde/.

Mendes, L. F. 1986. Nouvelles données sur les Zygentoma (Insecta) de l'Amérique Centrale et du Mexique. Bulletin du Muséum national d'Histoire naturelle, Paris, (4) 8 (A):333-342.

Paclt, J. 1963. Thysanura. Family Nicoletiidae. Genera Insectorum, 216 (e):1-58.

Reddell, J. R. 1966. A checklist of the cave fauna of Texas II. Insecta. The Texas Journal of Science, 18:25-56.

Reddell, J. R. 1994. The Cave Fauna of Texas with special reference to the western Edwards Plateau. Pp. 31-49 in: W. R. Elliott and G. Veni, eds., The Caves and Karst of Texas, 1994 NSS Convention guidebook. National Speleological Society. Huntsville, Alabama.

Trajano, E. 2005: Evolution of lineages. Pp. 230-234 in: D. C. Culver and W. B. White, eds., Encyclopedia of Caves. Elsevier, Amsterdam etc.

Ulrich, C. J. 1902. A contribution to the subterranean fauna of Texas. Transactions of the American Microscopical Society, 23:83-101.

Wheeler, W. C. 1996. Optimization alignment: the end of multiple sequence alignment in phylogenetics? Cladistics, 12:1-9.

Wheeler, W. C. 2002. Optimization alignment: down, up, error, and improvements. Pp. 55-69 in: R. DeSalle, G. Giribet, and W. C. Wheeler, eds., Techniques in Molecular Systematics and Evolution. Birkhäuser, Basel.

Wheeler, W. C., L. Aagesen, C. P. Arango, J. Faivovich, T. Grant, C. D'Haese, D. Janies, W. L. Smith, A. Varon, and G. Giribet. 2006. Dynamic homology and phylogenetic systematics: a unified approach using POY. American Museum of Natural History, New York.

Wygodzinsky, P. 1973. Description of a new genus of cave Thysanura from Texas (Nicoletiidae, Thysanura, Insecta). American Museum Novitates, 2518:1-8.

Wygodzinsky, P., and A. M. Hollinger. 1977. A study of Nicoletiidae from Cuba (Thysanura). Resultats des Expéditions Bioespeologiques Cubano-roumaines á Cuba, 2:317-324.

Appendix 1.—DNA sequences of the16S rRNA fragment. **Clade 1**: 1) Cueva de Casa Blanca, Coahuila, Mexico. 2) Sky High Cave, Edwards County. 3) Red Arrow Cave, Real County. 4) Flach's Cave, Bexar County. 5-6) Accident Sink, Bexar County. b 7) Flint Ridge Cave, Travis County. 8) Cobb Cavern, Williamson County. 9-10) Seven Mile Mountain Cave, Bell County.). **Clade 2**: a) Accident Sink, Bexar County. b-c) Ezell's Cave, Hays County. and type locality of *Texoreddellia texensis*. d) Hoskin's Hole, Hays County. e) Airman's Cave, Travis County. f) Formation Cave, Coryell County. **Clade 3**:β) Root Canal Cave, Bexar County.

```
d e f           GGTTTTTTGGTTAGGTATTTAAAGTTTGACCTGCCCAATGATGAATTTAATGGCCGCGGT 60
b c             GGTTTTTTGGTTAGGTATTTAAAGTTTGACCTGCCCAATGATGAATTTAATGGCCGCGGT 60
a               GGTTTTTTGGTTAGGTATTTAAAGTTTGACCTGCCCAATGATGAATTTAATGGCCGCGGT 60
β               GGTTTTTTGGTTAAGTATTTAAAGTTTGACCTGCCCAATGATGAGTTTAATGGCCGCGGT 60
2 3             GGTTTTTTGGTTAGGAATTTAAAGTTTGACCTGCCCAATGATGAATTTAATGGCCGCGGT 60
8 9 10          GGTTTTTTGGTTAGGAATTTAAAGTTTGACCTGCCCAATGATGAATTTAATGGCCGCGGT 60
7               GGTTTTTTGGTCTGGAATTTAAAGTTTGACCTGCCCAATGATGAATTTAATGGCCGCGGT 60
4               GGTTTTTTGGTTTGGAATTTAAAGTTTGACCTGCCCAATGATGAATTTAATGGCCGCGGT 60
5               GGTTTTTTGGTTTGGAATTTAAAGTTTGACCTGCCCAATGATGAATTTAATGGCCGCGGT 60
6               GGTTTTTTGGTTTGGAATTTAAAGTTTGACCTGCCCAATGATGAATTTAATGGCCGCGGT 60
1               GGTTTTTTGGTTAGGAATTTAAGGTTTGACCTGCCCAATGATTAATTTAATGGCCGCGGT 60
                ***********   * ****** ******************* * ***************

d e             ATTGTGACCGTGCAAAGGTAGCATAATCATTAGTCTTTTAATTGAGGGCTTGTATGAATG 120
b c             ATTGTGACCGTGCAAAGGTAGCATAATCATTAGTCTTTTAATTGAGGGCTTGTATGAATG 120
a               ATTGTGACCGTGCAAAGGTAGCATAATCATTAGTCTTTTAATTGAGGGCTTGTATGAATG 120
β               ATTGTGACCGTGCAAAGGTAGCATAATCATTAGTCTTTTAATTAAGGGCTTGTATGAATG 120
2 3             ATTGTGACCGTGCAAAGGTAGCATAATCATTAGTCTTTTAATTGAGGGCTTGTATGAATG 120
8 9 10          ATTGTGACCGTGCAAAGGTAGCATAATCATTAGTCTTTTAATTGAGGGCTTGTATGAATG 120
7               ATTGTGACCGTGCAAAGGTAGCATAATCATTAGTCTTTTAATTGAGGGCTTGTATGAATG 120
4               ATTGTGACCGTGCAAAGGTAGCATAATCATTAGTCTTTTAATTGAGGGCTTGTATGAATG 120
5               ATTGTGACCGTGCAAAGGTAGCATAATCATTAGTCTTTTAATTGAGGGCTTGTATGAATG 120
6               ATTGTGACCGTGCAAAGGTAGCATAATCATTAGTCTTTTAATTGAGGGCTTGTATGAATG 120
1               ATTGTGACCGTGCAAAGGTAGCATAATCATTAGTCTTTTAATTGAGGGCTTGTATGAATG 120
                ******************************************* ****************

d e f           GTTGGACGAGGAGGGGACTGTCTTCAAATGAAGTTTT---ATTTGAATTTTACTTTTAAG 177
b c             GTTGGACGAGGAGGGGACTGTCTTCAAATGAAGTTTT---ATTTGAATTTTACTTTTAAG 177
a               GTTGGACGAGGAGGAGACTGTCTTCAAATGAAGTTTT---ATTTGAATTTTACTTTTGAG 177
β               GTTGGACGAGGAGGGGACTGTCTTCAAATGAAGTTTTGT-ATTTGAATTTTACTTTTAAG 179
2 3             GTCGGACGAGGAGGGGACTGTCTTCAAATGAAGTTTTGTTATTTGAATTTTACCTTTAAG 180
8 9 10          GTTGGACGAGGAGGGGACTGTCTTCAAATGAAGTTTT-TTATTTGAATTTTACCTTTAAG 179
7               GTTGGACGAGGAGGAGACTGTCTTCAAATGGAGTTTTGTTATTTGAATTTTACCTTTAAG 180
4               GTTGGACGAGGAGGGGACTGTCTTCAAATGAAGTTTTGTTATTTGAATTTTACCTTTAAG 180
5               GTTGGACGAGGAGGGGACTGTCTTCAAATGAAGTTTTGTTATTTGAATTTTACCTTTAAG 180
6               GTTGGACGAGGAGGGGACTGTCTTCAAATGAAGTTTTGTTATTTGAATTTTACCTTTAAG 180
1               GTTGGACGAGGAGGGGACTGTCTTCAAATGAAGTTTTGTTATTTGAATTTTACCTTTAAG 180
                ** *********** *************** ******   ************* *** **

d e f           TGAAAAGGCTTAAATGGTCTTGAGGGGCGATAAGACCCTATAGATCTTTACATTGTTGTT 237
b c             TGAAAAGGCTTAAATGGTCTTGAGGGGCGATAAGACCCTATAGATCTTTACATTGTTGTT 237
a               TGAAAAGGCTTAAATGGTCTTGAGGGGCGATAAGACCCTATAGATCTTTACATTGTTGTG 237
β               TGAAAAGGCTTAAATGGTCTTGGGGGGCGATAAGACCCTATAGATCTTTACATTGTTATG 239
2 3             TGAAAAGGCTTAAATGGTCTTGAGGGGCGATAAGACCCTATAGATCTTTACATTGTTGTA 240
8 9 10          TGAAAAGGCTTAAATGGTCTTGAGGGGCGATAAGACCCTATAGATCTTTACATTATAGCA 239
7               TGAAAAGGCTTAAATGGTCTTGAGGGGCGATAAGACCCTATAGATCTTTACATTATTGCA 240
4               TGAAAAGGCTTAAATGGTCTTGAGGGGCGATAAGACCCTATAGATCTTTACATT-TTGCA 239
5               TGAAAAGGCTTAAATGGTCTTGAGGGGCGATAAGACCCTATAGATCTTTACATT-TTGCA 239
6               TGAAAAGGCTTAAATGGTCTTGAGGGGCGATAAGACCCTATAGATCTTTACATT-TTGCA 239
1               TGAAAAGGCTTAAATGGTTTTGAGGGGCGATAAGACCCTATAGATCTTTACATTGTTGTC 240
                ***************** *** ******************************** *

d e f           TCATTGAAGTGTGATGGGCTATGATGTTAGGTTGGGGCGACAGGAAGATATAAATAACTT 297
b c             TCATTGAAGTGTGATGGGCCATGATGTTAGGTTGGGGCGACAGGAAGATATAAATAACTT 297
a               TCATTAAAGTGTGA-GGATCATGATGTTAGGTTGGGGCGACAGGAAGATATAAATAACTT 296
β               TTGTTAAGTTGTAATGATATACGGTGTTGGGTTGGGGCGACAGGAAGATAGGAATAACTT 299
2 3             GCATTAGGGTGTAATGGGGCATGGTGTTAGGTTGGGGCGACAGGAAGAAAAGCATAACTT 300
8 9 10          GCATTAGGGTGTAATGAGGTGTTATGTTAGGTTGGGGCGACAGGAAGAGAAGTATAACTT 299
7               GCATTAGGGTGTAATGAGGCGTTATGTTAGGTTGGGGCGACAGGAAGAAAAGTATAACTT 300
4               GCATTAGAGTGTAATGAGGTATTATGTTAGGTTGGGGCGACAGGAAGAAAAGTATAACTT 299
5               GCATTAGAGTGTAATGAGGTATTATGTTAGGTTGGGGCGACAGGAAGAAAAGTGTAACTT 299
6               GCATTAAGGTGTAATGAGGTATTATGTTAGGTTGGGGCGACAGGAAGAAAAGTATAACTT 299
1               ATGTTAAGGTGTAATAAGGTGCAATGTTAGGTTGGGGCGACAGGAAGAAAAGGATAACTT 300
                   **    *** *          **** ****************** *    ******

d e f           TTTGGTT-ATAAGGTTACTGTTTTGTATATTGGGGATCCACGGTTATAGTGATTATGAGA 356
b c             TTTGGTT-ATAAGGTTACTGTTTTGTATATTGGGGATCCACGGTTATAGTGATTATGAGA 356
a               TTTGGCT-ATAAGGTTACTGTTTTGTATGTTAAGGATCCACAGTTATAGTGATTATGAGA 355
β               TTTGGTTTATAAGGTTACTGTTTTGTATATTAAGGATCCACGGTTATAGTGATTATGAGA 359
```

Appendix 1.—continued

```
7              GCATTAGGGTGTAATGAGGCGTTATGTTAGGTTGGGGCGACAGGAAGAAAAGTATAACTT 300
4              GCATTAGAGTGTAATGAGGTATTATGTTAGGTTGGGGCGACAGGAAGAAAAGTATAACTT 299
5              GCATTAGAGTGTAATGAGGTATTATGTTAGGTTGGGGCGACAGGAAGAAAAGTGTAACTT 299
6              GCATTAAGGTGTAATGAGGTATTATGTTAGGTTGGGGCGACAGGAAGAAAAGTATAACTT 299
1              ATGTTAAGGTGTAATAAGGTGCAATGTTAGGTTGGGGCGACAGGAAGAAAAGGATAACTT 300
                  **    *** *          **** ******************* *    ******

d e f          TTTGGTT-ATAAGGTTACTGTTTTGTATATTGGGGATCCACGGTTATAGTGATTATGAGA 356
b c            TTTGGTT-ATAAGGTTACTGTTTTGTATATTGGGGATCCACGGTTATAGTGATTATGAGA 356
a              TTTGGCT-ATAAGGTTACTGTTTTGTATGTTAAGGATCCACAGTTATAGTGATTATGAGA 355
β              TTTGGTTTATAAGGTTACTGTTTTGTATATTAAGGATCCACGGTTATAGTGATTATGAGA 359
2 3            TTTAGGT-GTGGGATTACTGTTTTGTATGTTGAAGATCCACGATTATAGTGATTGTGAGA 359
8 9 10         TTTAGGT-GTAGGATTACTGTTTTGTATATTGAAGATCCACGATTATAGTGATTATGAGA 358
7              TTTGGGC-GTAGAGTTACTGTTTTGTATATTTGAGATCCACGATTATAGTGATTATGAGA 359
4              TTTAGGT-GTAGGATTACTGTTTTGTATATTGAAGATCCACGTTTATAGTGATTATGAGA 358
5              TTTAGGT-GTAGGATTACTGTTTTGTATATTGAAGATCCACGTTTATAGTGATTATGAGA 358
6              TTTAGGT-GTAGGATTACTGTTTTGTATATTGAAGATCCACGTTTATAGTGATTATGAGA 358
1              TTTGGGT-ATGGGGTTACTATTTTGTATATTGAAGATCCACGGTTATAGTGATTATGAGA 359
               *** *    *    ***** ******** **   *******  *********** *****

d e f          CTAAGTTACCTTAGGGATAACAGCGTAATCTTTTTTGAGAGTTCATATCGAGAGAAGGGA 416
b c            CTAAGTTACCTTAGGGATAACAGCGTAATCTTTTTTGAGAGTTCATATCGAGAGAAGGGA 416
a              CTAAGTTACCTTAGGGATAACAGCGTAATCTTTTTTGAGAGTTCATATCGAGAGAAGGGA 415
β              CTAAGTTACCTTAGGGATAACAGCGTAATCTTTTTTGAGAGTTCATATCGAGAGAAGGGA 419
2 3            CTAAGTTACCTTAGGGATAACAGCGTAATCTTTTTTGAGAGTTCATATCGAGAGAGGGGA 419
8 9 10         CTAAGTTACCTTAGGGATAACAGCGTAATCTTTTTTGAGAGTTCATATCGAGAGAAGGGA 418
7              CTAAGTTACCTTAGGGATAACAGCGTAATCTTTTTTGAGAGTTCATATCGAGAGAAGGGA 419
4              CTAAGTTACCTTAGGGATAACAGCGTAATCTTTTTTGAGAGTTCATATCGAGAGAAGGGA 418
5              CTAAGTTACCTTAGGGATAACAGCGTAATCTTTTTTGAGAGTTCATATCGAGAGAAGGGA 418
6              CTAAGTTACCTTAGGGATAACAGCGTAATCTTTTTTGAGAGTTCATATCGAGAGAAGGGA 418
1              CTAAGTTACCTTAGGGATAACAGCGTAATCTTTTTTGAGAGTTCATATCGAGAGAAGGGA 419
               ******************************************************* ****

d e f          TTGCGACCTCGATGTTGGATTAAGGTTTCCTTGGGGTGCAGAGGCTTCAGGGGAGGGTCT 476
b c            TTGCGACCTCGATGTTGGATTAAGGTTTCCTTGGGGTGCAGAGGCTTCAGGGGAGGGTCT 476
a              TTGCGACCTCGATGTTGGATTAAGGTTTCCTTGGGGTGCAGAGGCTTCAGGGGAGGGTCT 475
β              TTGCGACCTCGATGTTGGATTAAGGTTTCTTTGTGGTGTAGAAGCTACAAGGGAGGGTCT 479
2 3            TTGCGACCTCGATGTTGGATTAAGGTTTCCTTGTGGTGCAGGAGCTGCAGGGGAGGGTCT 479
8 9 10         TTGCGACCTCGATGTTGGATTAAGGTTTCCTTGTGGTGCAGAAGTTGCAAGGGAAGGTCT 478
7              TTGCGACCTCGATGTTGGATTAAGGTTTCCTTGTGGTGCAGAAGTTGCAGGGGAAGGTCT 479
4              TTGCGACCTCGATGTTGGATTAAGGTTTCCTTGCGGTGCAGAAGTTGCAGGGGAAGGTCT 478
5              TTGCGACCTCGATGTTGGATTAAGGTTTCCTTGCGGTGCAGAAGTTGCAGGGGAAGGTCT 478
6              TTGCGACCTCGATGTTGGATTAAGGTTTCCTTGCGGTGCAGAAGTTGCAGGGGAAGGTCT 478
1              TTGCGACCTCGATGTTGGATTAAGGTTTCCTTGTGGTGTAGAAGTTACAGGGGAGGGTCT 479
               ***************************** *** **** **  * * ** **** *****

d e f          GTTCGACCTTTAAATCCTTACA 498
b c            GTTCGACCTTTAAATCCTTACA 498
a              GTTCGACCTTTAAATCCTTACA 497
β              GTTCGACCTTTAAATCCTTACA 501
2 e            GTTCGACCTTTAAATCCTTACA 501
8 9 10         GTTCGACCTTTAAATCCTTACA 500
7              GTTCGACCTTTAAATCCTTACA 501
4              GTTCGACCTTTAAATCCTTACA 500
5              GTTCGACCTTTAAATCCTTACA 500
6              GTTCGACCTTTAAATCCTTACA 500
1              GTTCGACCTTTAAATCCTTACA 501
               **********************
```

Reddell, James R., and Nadine Dupérré, 2009. A new species of troglobitic *Rhadine* (Coleoptera: Carabidae) from Hays County, Texas [Nueva especie troglobia de *Rhadine* (Coleoptera: Carabidae) del condado Hays, Texas]. Texas Memorial Museum Speleological Monographs, 7. Studies on the cave and endogean fauna of North America, V. Pp. 111-114.

A NEW SPECIES OF TROGLOBITIC *RHADINE* (COLEOPTERA: CARABIDAE) FROM HAYS COUNTY, TEXAS

James R. Reddell

Texas Natural Science Center
The University of Texas at Austin, PRC 176, 10100 Burnet
Austin, Texas 78758 U.S.A.
Email: jreddell.caves@mail.utexas.edu

and

Nadine Dupérré

Division of Invertebrate Zoology
American Museum of Natural History
Central Park West at 79th Street
New York, New York 10024 U.S.A.
Email: nduperre@AMNH.org

ABSTRACT

Rhadine grubbsi, n.sp., is described from three caves in Hays County, Texas. It is a slender species belonging to the *subterranea* group.

RESUMEN

Se describe *Rhadine grubbsi*, n.sp., de tres cuevas en el condado Hays, Texas. Es una especie angosta que pertenece al grupo *subterranea*.

INTRODUCTION

The *subterranea* group of the genus *Rhadine* as revised by Barr (1974) included 11 species, all troglobitic, from caves in Texas. Barr (1982) added two additional troglobitic species from caves in northern Mexico. Reddell and Cokendolpher (2001) added one new species from Fort Hood, Bell and Coryell Counties; and Reddell and Cokendolpher (2004) added three new species from Camp Bullis, Bexar County. With the addition of the species described herein, the total species in the *subterranea* group numbers 18. Extensive collecting from Texas caves has resulted in the discovery of numerous new populations of troglobitic *Rhadine*. It is not clear yet if these represent new populations of known species or should be considered distinct species. The new species described herein from Hays County is a distinctive slender species.

Development in Hays County, as in other parts of Central Texas, has placed all caves and cave fauna in peril and it is desirable to describe the present species so that it can be considered for protection.

Rhadine grubbsi, new species

Figs. 1-4

Type-data.—Texas: *Hays County*: Lime Kiln Quarry Cave, 21 April 1993 (A. G. Grubbs, M. Tangestani, S. Wade), male holotype (AMNH), female allotype (AMNH); 3 July 1993 (A. G. Grubbs), 1 teneral male (TMMC), 1 male (TMMC), 1 female paratype (TMMC).

Other material examined (all TMMC).—Texas: *Hays County*: Ezell's Cave, San Marcos, 16 Dec. 2006 (A. Gluesenkamp, J. Krejca), 1 male; McCarty Cave, 1997 (A. G. Grubbs), 1 teneral female; 14 April 1998 (A. G. Grubbs), 1 male; 14 March 2000 (J. Kennedy, J. Jenkins, J. Fant), 1 female.

Etymology.—This species is named for Andrew G. Grubbs, who collected the type-series of this species, in recognition of his many contributions to the cave biology of Texas.

Diagnosis.—Form slender, integument rufo-testaceous, subglabrous; pronotum widest behind middle, about 0.3 as wide as long, with one pair marginal setae near center; eye rudiment small (about 0.08 x 0.10 mm). Distinguished from *R. exilis* (Barr and Lawrence) and *R. speca* (Barr) by absence of posterior pronotal setae and elytral striae virtually obsolescent. Distinguished from *R. insolita* Barr by more slender pronotum and narrower neck. Nothing evident in the genitalic structure could be used as a diagnostic character.

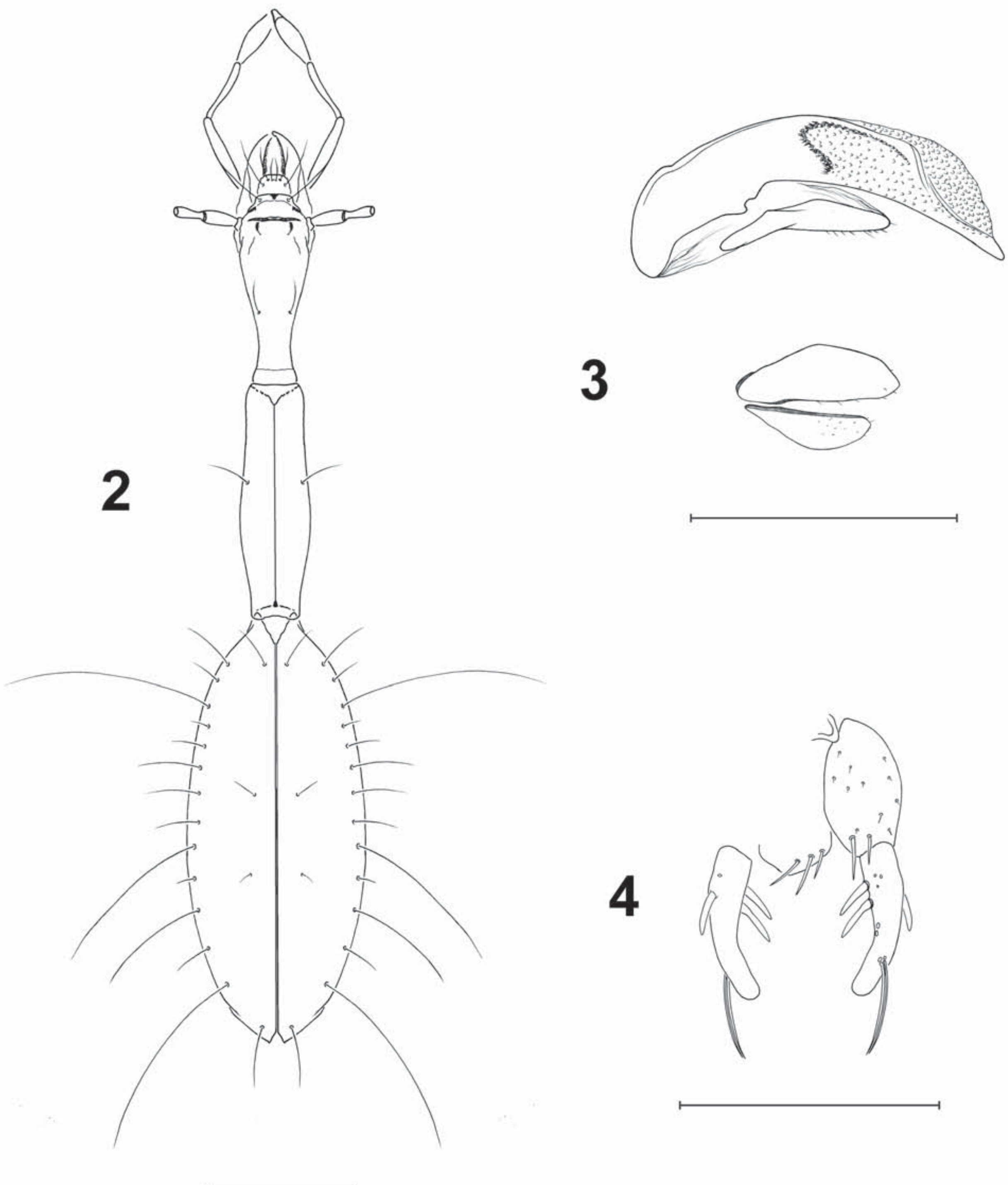
Description.—Length 7.48-8.44 mm. Form slender, convex (Figs. 1-2). Integument rufotestaceous, virtually glabrous, shining. Head 0.36-0.42 longer than wide, cervical constriction distinct; neck 0.40-0.47 narrower than greatest head width; labrum not emarginate; frontal grooves broad, shallow, extending to distal margin of eye; frontal and antennal ridges short, weak, associated wrinkles not reaching posterior supraorbital puncture; eye rudiment small, about 0.8 by 0.10 mm, ovate. Pronotum greatest width about 0.3 length, widest just behind middle; disc glabrous, shining, almost flat; posterior margin wider than anterior margin; posterior angles rounded; one pair lateral setae slightly nearer anterior margin. Elytra 0.41 to 0.53 as wide as long; disc glabrous, shining, subconvex except narrow, shallow concavity adjacent to lateral margins; apical sinus shallow, about 1/3 as long as scutellum, apices sharp to slightly rounded; longitudinal striae virtually obsolescent; one pair setae present on second interval at about level of first umbilicate puncture; one pair discal setae on third interval at about level of 7th umbilical puncture; one pair discal setae on third interval at about level of 10th umbilical puncture; row of 14 umbilicate punctures, setae longer in third, ninth, eleventh, and thirteenth positions. Palps sparsely pubescent, last segment wider than preceeding segments; apices pale, glabrous only at distal tip, distal tip slightly swollen. Antennae slender, reaching to beyond middle of elytra; segment III longest; segments I-III sparsely pubescent, others densely pubescent.

Aedeagus flattened, blade-like, about 0.8 mm long (Fig. 3); parameres as illustrated.

Stylus as in Fig. (4).

Distribution.—Known only from three caves in and near San Marcos, Hays County, Texas.

Fig. 1. Dorsolateral view of *Rhadine grubbsi*, n. sp. from Ezell's Cave (photograph by Jean Krejca).



Figs. 2-3. *Rhadine grubbsi,* n.sp., from Lime Kiln Quarry Cave: 2, dorsal view; 3, aedeagus, parameres in ventral view; 3, stylus, dorsal view on right; 4, stylus, ventral view on left. Scale lines: Fig. 2 = 1 mm; Figs. 3-4 = 0.5 mm.

Habitat.—The three caves containing this species are formed in the Edwards Limestone. The entrance to Lime Kiln Quarry Cave is in the wall of a quarry. McCarty Cave is a complex cave containing a large population of the bat *Myotis velifer incautus* Allen. Ezell's Cave is a historically important cave that reaches the Edwards Aquifer. It is remarkable that *Rhadine grubbsi* has only recently been found in Ezell's Cave. It is one of the most intensively studied caves in Texas.

Comments.—*Rhadine grubbsi* belongs to the slender subgroup of the *Rhadine subterranea* group and it appears most closely related to *R. exilis* and *R. speca.* The absence of the posterior lateral setae on the pronotum is shared only by *R. insolita* from southwestern Hays and adjacent Comal Counties. The only other species of troglobitic *Rhadine* in Hays County are populations in extreme northern Hays County, tentatively identified as *R. austinica*. These populations show some differences from typical *R. austinica* and may represent a distinct taxon.

ACKNOWLEDGMENTS

We are especially grateful to Andrew G. Grubbs for the opportunity to study his many collections of *Rhadine* from Texas caves. We also thank the following cave explorers for providing us with specimens: Jerry Fant, Andrew Gluesenkamp, Julie Jenkins, Jim Kennedy, and Jean Krejca. Jean Krejca is thanked for providing the photograph of *R. grubbsi,* n.sp., from Ezell's Cave. We thank Pierre Paquin and Thomas C. Barr, Jr., for their careful reviews of the manuscript.

Specimens are deposited in the American Museum of Natural History (AMNH) and the Texas Memorial Museum, The University of Texas at Austin (TMMC).

LITERATURE CITED

Barr, T. C., Jr. 1974. Revision of *Rhadine* LeConte (Coleoptera, Carabidae) I. The *subterranea* group. American Museum Novitates, no. 2539. 30 pp.

Barr, T. C., Jr. 1982. The cavernicolous anchomenine beetles of México (Coleoptera: Carabidae: Agonini). Association for Mexican Cave Studies Bulletin, 8:161-192/Texas Memorial Museum Bulletin, 28:161-192.

Reddell, J. R., and J. C. Cokendolpher. 2001. A new species of troglobitic *Rhadine* (Coleoptera: Carabidae) from Texas. Texas Memorial Museum Speleological Monographs, 5. Studies on the cave and endogean fauna of North America, III. Pp. 109-114.

Reddell, J. R., and J. C. Cokendolpher. 2004. New species and records of cavernicole *Rhadine* (Coleoptera: Carabidae) from Camp Bullis, Texas. Texas Memorial Museum Speleological Monographs, 6. Studies on the cave and endogean fauna of North America, IV. Pp.153-162.

Paquin, Pierre, and Robert S. Anderson. 2009. First troglobitic weevil (Coleoptera: Curculionidae) in North America? Description of a new eyeless species of *Lymantes* Schoenherr from Central Texas caves. [¿Primer gorgojo troglobio (Coleoptera: Curculionidae) en Norteamérica? Descripción de una nueva especie ciega de *Lymantes* Schoenherr de cuevas del centro de Texas]. Texas Memorial Museum Speleological Monographs, 7. Studies on the cave and endogean fauna of North America, V. Pp. 115-123.

FIRST TROGLOBITIC WEEVIL (COLEOPTERA: CURCULIONIDAE) IN NORTH AMERICA? DESCRIPTION OF A NEW EYELESS SPECIES OF *LYMANTES* SCHOENHERR FROM CENTRAL TEXAS CAVES

Pierre Paquin

Cave and Endangered Invertebrate Research Laboratory
SWCA Environmental Consultants
4407 Monterey Oaks Boulevard, Building 1, Suite 110
Austin, Texas, 78749, U.S.A.
Email: ppaquin@swca.com

and

Robert S. Anderson

Research Division, Canadian Museum of Nature
P.O. Box 3443, Station D
Ottawa, Ontario, K1P 6P4, Canada
Email: randerson@mus-nature.ca

ABSTRACT

Recent bio-inventories carried out in Texas caves have led to the discovery of an eyeless weevil *Lymantes nadineae* Anderson, new species (type locality: Texas: Williamson County, Electro-Mag Cave). The species is known only from three specimens from three caves despite intense sampling efforts carried out in a geographic region characterized by narrow endemism of troglobitic animals. *Lymantes nadineae* clearly shows troglobitic adaptations such as complete loss of eyes, reduced pigmentation, and increased length of appendages. The lack of collections on the surface does not exclude the possibility that it is an edaphobite species, but more likely, *L. nadineae* is the first North American troglobitic weevil. Probable evolutionary scenarios hypothesize that *L. nadineae* is a troglobite that has been isolated from its surface ancestor and that survives on roots found on ceilings of shallow caves. The closest known relative appears to be *L. scrobicollis,* a surface species occasionally found in the entrances of caves occurring on the eastern side of the continent, rather than an undescribed species that has recently been collected in leaf litter and at least one cave entrance in Central Texas. *Lymantes nadineae* is likely one of the rarest beetles of North America.

RESUMEN

Los inventarios biológicos recientes realizados en las cuevas de Texas han conducido al descubrimiento de un gorgojo ciego *Lymantes nadineae* Anderson, especie nueva (localidad tipo: Texas: Condado Williamson, Cueva Electro-Mag). La especie se conoce solamente de tres especimenes provenientes de tres cuevas a pesar de los intensos esfuerzos de muestreo realizados en una región geográfica caracterizada por el endemismo de animales troglobios. *Lymantes nadineae* demuestra troglomorfismos tales como pérdida completa de ojos, pigmentación reducida, y alargamiento de los apéndices. La falta de colecciones en la superficie no excluye la posibilidad que sea una especie edáfica, pero lo más probable es que *L. nadineae* sea el primer gorgojo troglobio de América del Norte. El probable escenario evolutivo hipotetiza que *L. nadineae* es una especie troglobia que se ha aislado de su ancestro en la superficie y que sobrevive en las raíces encontradas en los techonadineae de las cuevas bajas. El pariente más cercano parece ser *L. scrobicollis*, una especie de la superficie encontrada ocasionalmente en las entradas de cuevas en la región oriental del continente, y no una especie sin describir del centro de Texas que se ha colectado recientemente en hojarasca y por lo menos una entrada de cueva. Los *Lymantes nadineae* son probablemente uno del escarabajo más raro de América del Norte.

INTRODUCTION

Central Texas caves have been the object of bio-inventories for about 40 years, and are now known to harbor one of the richest and most distinctive cave faunas in North America and in the world (Culver, et al., 2003, 2006). More than a thousand cavernicolous taxa have been recorded from the state (Reddell, 1994), including 160 obligatory cave-inhabiting species known in 2008 (J. Reddell, pers. comm.). Such troglobitic species are found in many taxonomic groups, but impressive radiations are well-known for arachnids and Coleoptera, particularly Carabidae (*Rhadine* of the *R. subterranea* group, see Barr, 1974; Reddell and Cokendolpher, 2001, 2004) and Staphylinidae: Pselaphinae (*Batrisodes,* see Chandler, 1992; Chandler and Reddell, 2001; Chandler, et al., 2009). In the last 10 years, the caves of certain areas have been intensely monitored because of conservation issues involving endangered troglobitic species threatened by urban development (see Longacre, 2000; Paquin and Hedin, 2004). Despite important sampling efforts, several of these species are known only from a few specimens or have not been seen since their original collection. Such rarity and/or sampling difficulties result in obvious management problems because of incomplete distributional data, but also demonstrate that knowledge of the diversity is still fragmentary. The distribution and biology of most troglobites remain to be better understood and discoveries of new entities are still likely.

Eyeless weevils are scarce but reported from every continent, except Antarctica (Osella, 1979; Kuschel, 1990). In North America, they are known only from the states of California and Oregon on the west coast and the extreme south of Florida (Osella, 1979; Morrone, et al., 2001). Most eyeless weevil species are associated with deep soil and leaf litter (Gilbert, 1956; Howden, 1992; Osella, 1977, 1989), and are usually collected by sifting and washing deep humus or soil (Morrone, et al., 2001). None of the North American eyeless weevils are cave obligates although leaf litter inhabiting species with reduced eyes are sometimes collected in cave entrances. The present paper describes a new eyeless weevil known from three Texas caves, hypothesized to be a troglobite rather than an edaphobite. The tenuous distinction between troglophiles and troglobites is addressed, particularly for Texas Coleoptera, and evolutionary scenarios concerning the existence of what appears to be the first troglobitic weevil in North America are briefly explored.

METHODS

Specimens were collected in cave bio-inventories and preserved in 80% ethanol. These were air dried and mounted on a point for morphological examination and description. They were examined with a WILD M5 stereoscope at magnifications of up to 200X. Dissections were made by gently boiling the specimens in water with subsequent separation of the abdomen and placement of the latter in hot 5-10% KOH solution to clear away musculature. Habitus photographs were taken using Automontage™. For other illustrative purposes, specimens were examined under a SMZ-U Nikon dissection microscope. A Nikon Coolpix 950 digital camera attached to the microscope was used to take photographs of the different structures to be illustrated. The digital photo was then used to trace proportions, and the illustration was detailed and shaded by referring back to the

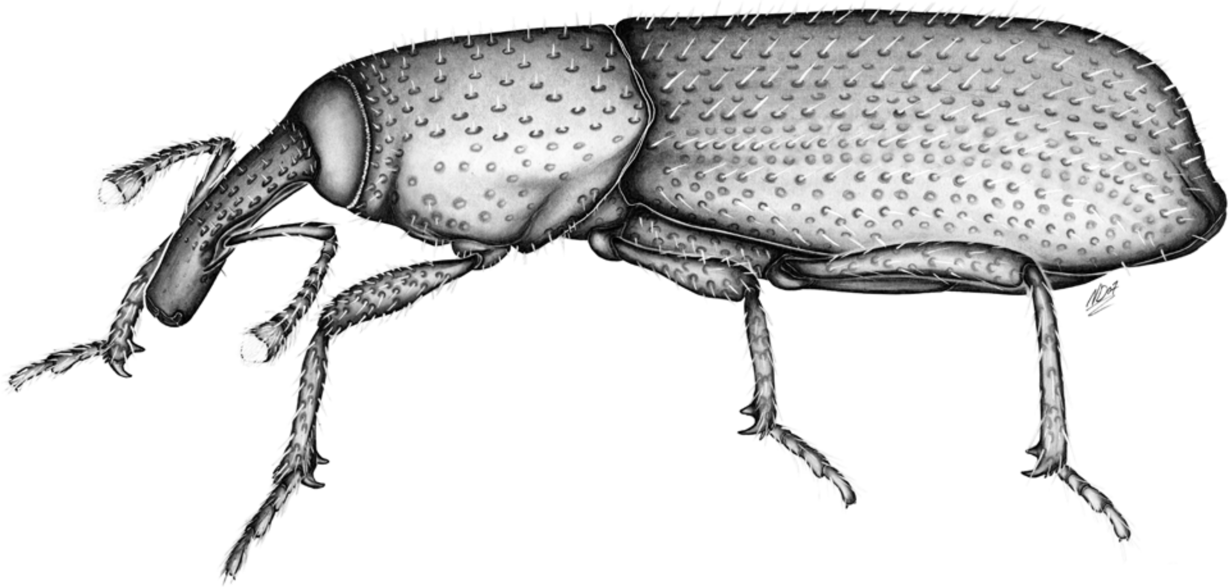


Fig. 1.-Female allotype *Lymantes nadineae*, n.sp., habitus.

specimen under the microscope. Genitalia were photographed and illustrated under an AmScope XSG Series T-500 compound microscope as explained above. Specimens are deposited in the Canadian Museum of Nature (CMNC), Ottawa, Canada, and the Texas Memorial Museum, The Universitty of Texas at Austin (TMMC).

TAXONOMY

Family Curculionidae

Lymantes Schoenherr

***Lymantes nadineae* Anderson**, new species

Figs. 1-6

Diagnosis.—Eyes fully lacking, with no external trace of eye facets or ocular swelling (Fig. 1). Punctures of body generally small, widely spaced, those of pronotal disc shallow, small, widely spaced, the distance between punctures much greater than diameter of a puncture (Figs. 2-4). Punctures of striae of elytral disc small, shallow, and linearly arranged, intervals distinct, much wider than width of a strial puncture, disc with more or less 30 punctures along each complete strial length. Dorsal vestiture short and very fine, each seta about as long as basal puncture. Legs long and spindly, hind femora about 6X as long as wide, apex reaching slightly beyond suture between ventrites 2 and 3. Aedeagus as in Fig. 5.

Type-data.—Holotype male (CMNC), Texas: Williamson County, Electro-Mag Cave, 27 Dec. 2006 (P. Paquin, C. Crawford, K. White), found dead on a flowstone. Allotype female (CMNC), Texas: Travis County, Tooth Cave, 19 May 1965 (T. C. Barr). Paratype female (TMMC), Texas: Williamson County, Phraetica Cave, 20 June 2002 (M. Warton).

Etymology.—This species is named after Nadine Dupérré for her outstanding contributions to systematics in providing many taxonomists with beautiful illustrations to describe and document arthropod diversity.

Description.—Male, length 3.5 mm, width 1.1 mm. Color pale orange brown throughout. Head globose, minutely finely punctuate. Eyes fully lacking, ocular swelling not evident. Rostrum with antennae inserted slightly beyond apical third of length, slightly wider in dorsal view beyond antennae insertion, scrobes narrowly visible at point of antennal insertion in dorsal view. Rostrum about 0.7X length of pronotum, slightly arcuate in lateral view, dorsally moderately deeply, moderately densely punctuate, punctures separated by about their own diameter, row of punctures above scrobe coalescent, forming shallow groove. Ventrally irregularly punctulate, most punctures coalescent, with median posterior extension represented by narrowly separated lateral cariniform ridges, extended to base of rostrum. Antennae with scape almost reaching base of rostrum, funicle with articles 1 and 2 elongate, subequal in length, articles 3-6 monilliform, article 7 longer and wide and wider towards apex. Pronotum with width about 0.7X length, lateral margins slightly arcuate, widest at about midlength, subapical constriction not evident dorsally, distinctly impressed laterally, bordered posteriorly by 2-3 crenulae, disc with punctures shallow, small, widely spaced, distance between punctures much greater than diameter of a puncture, each puncture with small, fine erect seta. Elytra about twice as long as wide, lateral margins subparallel from behind humeri to apical fourth, humeri not pronounced, disc with striae with small, shallow and linearly arranged punctures numbering about 30 per complete discal stria, intervals impunctate, shining, much wider than width of a strial puncture, punctures each with fine, very short erect seta. Striae 1-6 complete to base, 7 and 8 fused opposite metacoxae, not continuous to base, stria 10 terminated opposite metacoxa. Venter uniformly shallowly, sparsely, regularly punctuate, punctures well-spaced, except punctures larger, deeper and more closely spaced on ventrite 5. Abdominal ventrites 1 and 2 very long, each about as long as ventrites 3-5 combined, ventrites 3 and 4 very short, subequal in length, ventrite 5 about twice as long as 3 and 4 combined. Legs sparsely shallowly punctuate, punctures well-spaced, long and slender, femora extended slightly beyond suture between ventrites 2 and 3, about 6X as long as wide, tibiae straight, slender, about 3/4 as long at femora. Tarsi slender, ventrally with a few scattered setae, tarsal claws absent (broken?). Aedeagus with body short, very slightly longer than wide; internal sac present with extensive internal sclerotization in form of a pair of basal arciform sclerites one (darker) situated more dorsally, distally with pair of laterally situated helical (twisted) band-like sclerites surrounding an irregularly shaped median apical complex; struts long, about 3X length of aedeagal body.

Female differing from male as follows. Female, length 3.8-4.2 mm, width 1.25-1.30 mm. Rostrum with antennae inserted slightly proximad of apical third of length. Pronotum more elongate, width about 0.6X length, individual punctures less evident, particularly on disc. Elytral striae not as deeply impressed. Tarsi with claws. Female not dissected.

Distribution.**—**Known only from two caves in Williamson County, and one in Travis County, Texas (Fig. 6).

Comments.—Sleeper (1965) and Howden (1992) were the last authors to treat *Lymantes*. Sleeper redescribed *L. scrobicollis* Gyllenhal and *L. puteolatum* (Dury), and described two new species and one subspecies. Howden's review consisted of a condensation of Sleeper's treatment, with some new distributional data. No dissections of genitalia were made by these authors.

In addition to *L. nadineae* described herein, two undescribed species are also known: one from the Edwards Plateau (and surrounding regions) of Central Texas, and one from the Davis and Guadalupe Mountains of West Texas. Additional specimens recently collected throughout the southeastern United States need to be assigned to species. The treatment of Sleeper (1965) needs reconsideration using additional morphological characters as well as characters of genitalia. A preliminary assessment suggests that all eastern specimens may be members of a single, widely distributed species, which would go under the name *L. scrobicollis* Gyllenhal. The genus is currently under revision by R.S.A.

The three known specimens of *L. nadineae* collected in different but proximal caves, are here considered conspecific, being the only known *Lymantes* that fully lack any external traces of eye facets and an ocular swelling as well as sharing the unique feature of smaller, shallower and more widely spaced body punctation and longer dorsal vestiture. Among other *Lymantes*, only *Lymantes scrobicollis* Gyllenhal (known from "Am. Borealis") is noted as lacking eye facets although a distinct ocular swelling was noted (Sleeper, 1965; Howden,

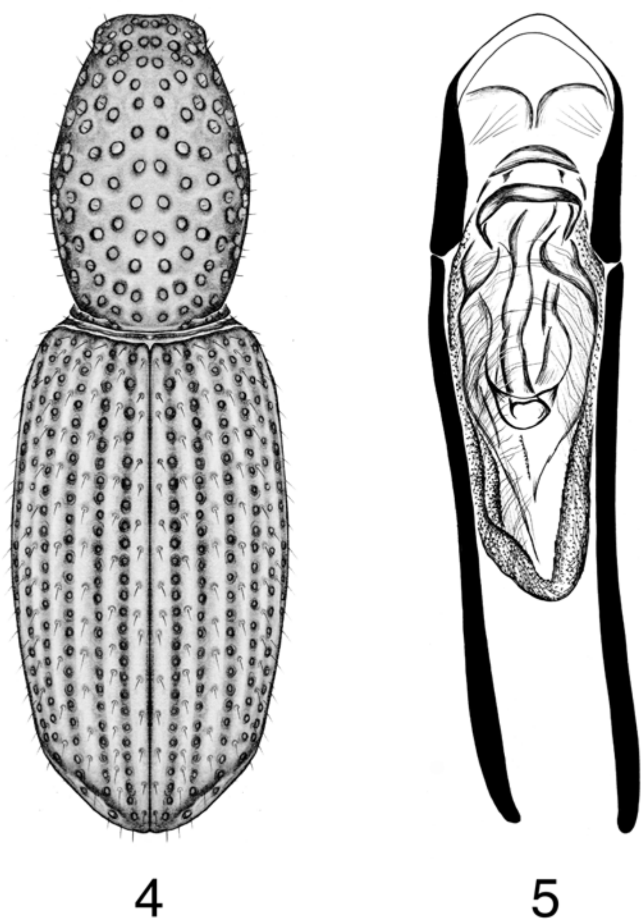
Figs. 2, 3.- Male holotype *Lymantes nadineae*, n.sp. 2, dorsal view; 3, lateral view.

1992). One of us (R.S.A.) has examined the holotype of *L. scrobicollis* (on loan from the Naturhistorika riksmuseet, Stockholm, Sweden), and both an ocular swelling and 4-6 linearly arranged eye facets are present. As for punctation, all other *Lymantes* possess large, deep, closely spaced (generally subcontiguous) dorsal and ventral punctures. For example, *L. nadineae* has more or less 30 punctures along the complete length of any elytral stria, whereas in other *Lymantes* the number of punctures does not exceed 20 and is generally less than 20. Tarsal claws are apparently lacking in the male which was collected already dead. They may have been broken but the undamaged nature of all other parts of all legs, including the apical tarsomere, suggests they may be truly absent. The other specimens of *L. nadineae* also show the characteristic cave adaptations to subterranean life of reduced pigmentation, more so than in most other *Lymantes*, and have longer, more slender legs (hind tibia l/w = 5.73, N=3 compared with l/w = 4.19, N=5 for *L. scrobicollis*).

Lymantes nadineae appears to be closely related to the widespread eastern species *L. scrobicollis,* which is sometimes found in leaf litter at cave entrances, and not to an additional undescribed species from Central Texas. The latter species has been collected in leaf litter and at least one cave entrance and has obvious eye facets at the base of the rostrum. With *L. scrobicollis*, *L. nadineae* shares the character states of longer dorsal vestiture and a very similar structure of the internal sac of the aedeagus.

DISCUSSION

Some beetles associated with Texas caves are well-known troglophiles. For example, the widespread species *Ptomaphagus cavernicola* Schwartz (Leiodidae) does not display morphological adaptations for cave life despite clear behavioral affinities for this habitat (Peck, 1973). Thanks to sound taxonomy and adequate sampling, the species is also known from surface habitats (Peck, 1982), leaving no doubts of its ecological status as a troglophile. However, the distinction between a troglophile (affinities for living in a cave) and a troglobite (obligate inhabitant of caves) could be difficult to delineate because morphological adaptations such as eye reduction, lost of pigmentation and leg elongation are also observed for species associated with other types of habi-



Figs. 4, 5.- Male holotype *Lymantes nadineae*, n.sp. 4, details of punctation on pronotum and elytra; 5, aedeagus, ventral view.

tats - such as deep litter and soil. Aalbu (2005) reported tenebrionid species [*Schizillus nunenmacheri* Blaisdell and *Asbolus mexicanus* (Champion)] from West Texas and Mexican caves that display morphological adaptations for cave habitats – morphological elongation and reduction in the number of eggs – but these species are also known from surface records and are better categorized as troglophiles. For these species, caves may simply constitute a refuge from extreme environmental conditions (Aalbu, 2005).

In other cases, the assignment as a troglobite or a troglophile is very tenuous because of incomplete knowledge. For instance, three eyeless species of Anillina (Carabidae) are known from Central Texas [*Micranillodes depressus* Jeannel, *Anillodes debilis* LeConte and *Anillodes minutus* Jeannel]. The labels of the only published records (the three female holotypes) do not provide any details about habitat of collection, but all subsequent collections of eyeless Anillina in Texas (about 70 specimens known, Paquin and Bousquet, in prep.) are from caves. The lack of surface sampling in Central Texas does not exclude the possibility that these species could survive outside of the cave environment despite their total lack of eyes. Affinities of Anillina for surface soil (non-cave) habitats and deep litter has been recently documented by Sokolov, et al. (2004, 2007) for Appalachian species, but none of these display eye reduction comparable to the Texas species. Due to the few data available, in addition to taxonomic problems that hamper species-level identification, the ecological status of Texas anillines remains undetermined.

The recognition of dependence on cave habitats and the discrimination of this trait from a lack of sampling in other surface habitats – such as deep litter, soil, or talus slopes that could also harbor eyeless species – are particularly difficult for species that are known only from a few specimens. While high numbers of specimens and morphological adaptations support the troglobitic status of the members of *subterranea* group of *Rhadine* or *Batrisodes* spp., the three known specimens of *L. nadineae* do not allow any level of certainty about their ecological status. Because no troglobitic weevils are known yet from North America, it does not mean that *L. nadineae* is an edaphobite. Coincidently, in a review of Staphylinidae associated with caves (exclusive of Pselaphinae and Aleocharinae), Peck and Thayer (2003) concluded that there are no troglobitic Staphylinidae in North America. However, they did not account for *Cylindropsis* sp. an eyeless rove-beetle known only from one specimen collected from Tooth Cave in Travis County (Central Texas), because the species has never been described due to its poor condition (S. B. Peck, pers. comm.). Nonetheless, it has been considered for listing as an endangered species (see Chambers, 1988), but the procedure was aborted due to the lack of a formal species identity. It is remarkable that two eyeless species, *L. nadineae* and *Cylindropsis* sp., which may both constitute the only troglobitic members of their families (excluding Pselaphinae for Staphylinidae) in North America, are known only from the same area in Central Texas. While it could be a coincidence, it may also suggest that evolutionary pressure that resulted in the unique and well-known area of narrow endemism for cave life in Central Texas (Culver, et al., 2006), may have affected some taxa in a unique manner in this particular region.

It is generally admitted that evolutionary processes behind cave adaptations may be a reaction to adverse conditions (glaciations, extreme temperatures, etc.) (Barr, 1968; Culver, et al., 2007). However, the discovery of a troglobitic fauna in the relatively young lava-tube caves of Hawaii (Howarth, 1972) challenged these hypotheses. Howarth (1986) suggested that cave adaptations could also be the result of adaptative shifts towards empty ecological niches (Howarth, 1980, 1993). This alternative hypothesis supports well the interpretation of the radiation of Cixiidae (Hemiptera) that are feeding on plant roots in Hawaiian caves (Hoch, 1999; Wessel and Hoch, 1999). In a world review of eyeless weevils, Osella (1979) stated that specimens of eyeless weevils collected in caves are not true cave-dwellers as they likely came into caves following the roots of trees, and could not survive, let alone breed, in this environment. This interpretation is arguable as roots found on cave ceilings are a part of the cave ecosystem, as are other food sources on which much cave life depends (cave guano, cricket droppings, etc.). However, affinities for moist and cool conditions, as well as food source availability (roots), might be a driving force behind the evolution of an edaphobite weevil towards troglobitism, echoing the principles proposed by Barr (1968) and Howarth (1986). Curiously however, although we know nothing of *Lymantes* biology, the genus belongs in Molytinae, a subfamily apparently saproxylic (feeding on dead wood) rather than rhizophagous (feeding on roots) (Osella, 1979). In the case of *L. nadineae*, we know nothing about food habits, but feeding on woody roots found on cave ceilings is perhaps the best available hypothesis. Its ecological status as a troglobite is possible under both the scenarios of Barr (1968) and Howarth (1986) and its association with caves may well represent an invasion of an empty niche, or that adverse conditions isolated the species from its surface ancestor long enough to allow development of morphological modifications to cave life. A combination of both scenarios is also possible. Given that the only known specimens were not found in entrances but in true cave conditions (total darkness along with other troglobitic spiders, millipedes, and beetles), and that survival and evolution is possible as a root feeder in a cave context, this species is proposed as the first North American troglobitic weevil. Additional data will hopefully confirm this hypothesis or suggest an alternative evolutionary scenario.

The known distribution of *L. nadineae* is comparable to that of other troglobitic species: *Texella reyesi* Ubick and Briggs (Opiliones, Phalangodidae, see Ubick and Briggs, 2004), *Anapistula* sp. (Araneae: Symphytognathidae, Paquin, et al., in prep.), *Speodesmus bicornourus* Causey (Diplopoda, Polydesmidae, see Elliott, 2004), *Batrisodes* spp. (Coleoptera: Staphylinidae: Pselaphinae, see Chandler, 1992; Chandler and Reddell, 2001; Chandler, et al., 2009), and *Rhadine* spp. (Coleoptera: Carabidae, see Barr, 1974) that are known exclusively from Travis and Williamson Counties. Such narrow distributions raise important evolutionary/ecological questions, for which we still do not have any firm answers: are these distributions the result of an initial cave invasion and subsequent subterranean dispersion through the mesocavern; or are these distributions the result of independent vicariant events leading to complex population structure and/or speciation

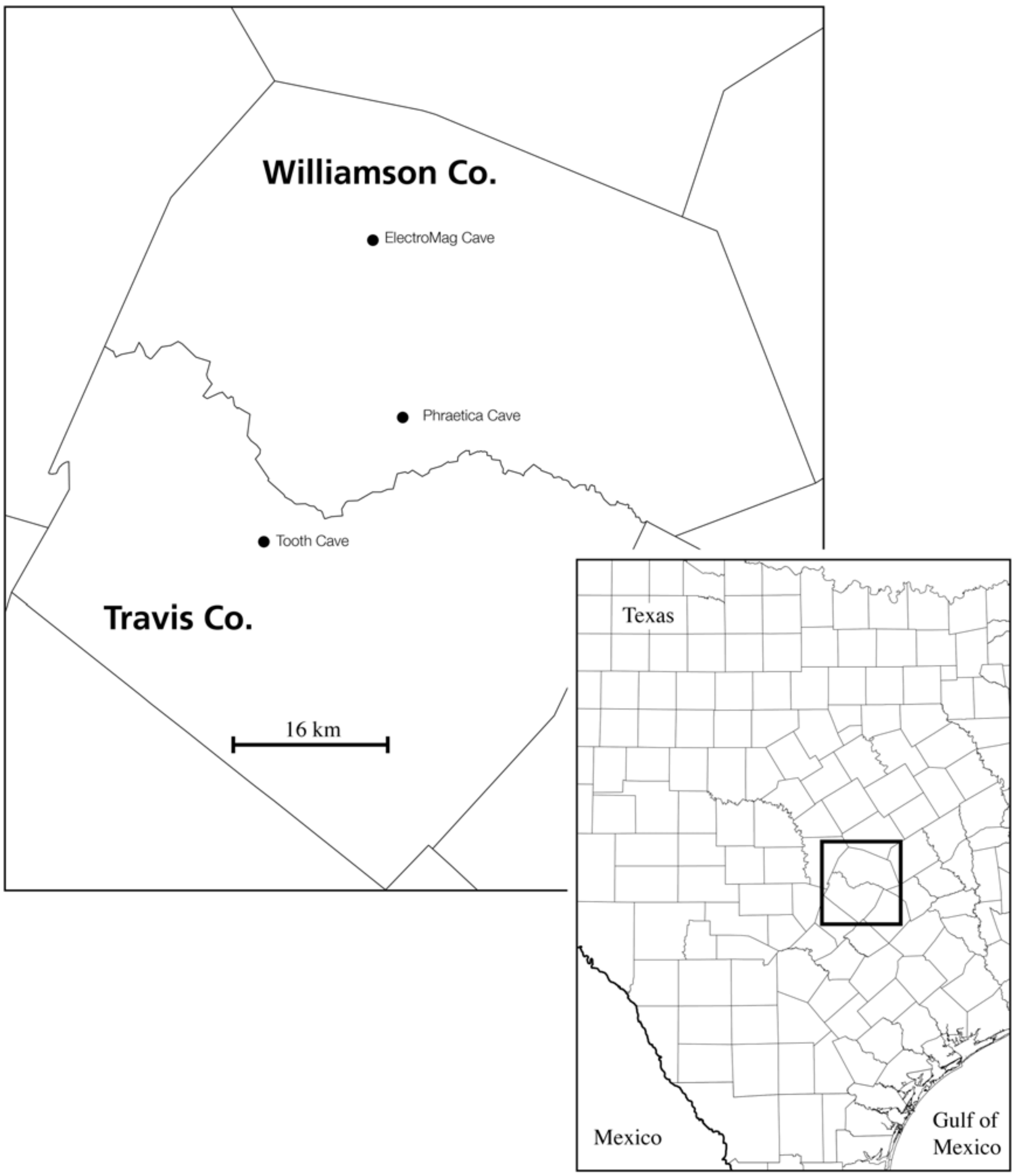


Fig. 6.-Distribution map of *Lymantes nadineae*, n.sp. known only from Travis and Williamson Counties, Central Texas.

patterns; or something else? Recent genetic data on *Cicurina* (Araneae: Dictynidae) show a high level of connection between caves of this area (Paquin and Hedin, 2007). However, this does not allow one to discriminate between evolutionary scenarios that are linked into a complex geological history which resulted in a cave network that evolved since its formation about 10 million years ago to its present condition. Hedin (1997a, b) concluded that vicariance has been a driving force behind the diversification of Appalachian *Nesticus* (Araneae: Nesticidae), but in Texas, the apparently higher degree of connection between caves and the complexity of the subterranean network related to the aquifer evolution may have driven the diversification of life differently.

It is remarkable that the closest relative of *L. nadineae* is not an undescribed *Lymantes* species found in leaf litter and at least one cave entrance in Central Texas, but rather *L. scrobicollis* a species found in leaf litter and cave entrances in the eastern U.S.A., east of Texas. Comparable relationships are observed for some *Batrisodes* and *Cicurina* species, which suggests an isolation of the Texas troglobites from their related species that shifted towards the east. In these cases, other congeneric surface species are found in Texas caves and these are not the closest known relatives (*Cicurina varians*, *Batrisodes uncicornis, Lymantes* sp.), suggesting broader affinities for cave habitats in each genus.

One of the three known localities, Phraetica Cave, has unfortunately been altered by urban development and the entrance is presently sealed by concrete. Given the proximity of the known locations and the suspected connectivity between caves of Central Texas (see Paquin and Hedin, 2007), it is likely that *L. nadineae* also inhabits other caves of this area. However, intensive monitoring by J. Reddell and his collaborators have yet failed to yield additional specimens, but eyeless weevils are typically rare, even for litter species. Collecting efforts in caves are rarely oriented towards ceilings where roots are found, and a careful examination of this microhabitat may increase chances of future collections. Given the monitoring intensity of the caves in the distribution area and that only three specimens have been found in more than 40 years of collection, *L. nadineae* is likely one of the rarest beetles in North America.

ACKOWLDGMENTS

This is publication no. 13 of the Karst Biosciences and Environmental Geophysics Research Laboratories, SWCA Environmental Consultants. We would first like to thank Nadine Dupérré for the illustrations; Craig Crawford and Kemble White for help in the field; Mike Warton provided much appreciated information on Phraetica Cave. The reviews of Stewart B. Peck and Donald S. Chandler are also appreciated. Finally, we address our sincere appreciation to James Reddell for the loan of material, sharing data and his discussions on this topic.

LITERATURE CITED

Aalbu, R. L. 2005. The Pimeliine tribe Cryptoglossini: classification, biology and inferred phylogeny (Coleoptera: Tenebrionidae). Annales Zoologici (Warszawa), 55:677-756.

Barr, T. C. 1968. The evolution of troglobites. Evolutionary Biology, 2:35-105.

Barr, T. C. 1974. Revision of *Rhadine* LeConte (Coleoptera, Carabidae). I. The *subterranea* group. American Museum Novitates, no. 2539, 30 pp.

Chambers, S. M. 1988. Department of the Interior, Fish and Wildlife Service, 50 CFR part 17. Endangered and threatened wildlife and plants; proposal to determine five Texas cave invertebrates to be endangered species. Federal Register, 53(75):12787-12790.

Chandler, D. S. 1992. The Pselaphidae of Texas caves (Coleoptera). Texas Memorial Museum, Speleological Monographs, 3:241-253.

Chandler, D. S., and J. R. Reddell. 2001. A review of the ant-like litter beetles found in Texas caves (Coleoptera: Staphylinidae: Pselaphinae). Texas Memorial Museum, Speleological Monographs, 5:115-128.

Chandler, D. S., J. R. Reddell, and P. Paquin. 2009. New cave Pselaphinae and records from Texas, with a discussion of the relationships and distributions of the Texas troglobitic Pselaphinae (Coleoptera: Staphylinidae: Pselaphinae). Texas Memorial Museum Speleological Monographs, 7. Studies on the cave and endogean fauna of North America, V. Pp. 125-140.

Culver, D. C., M. Christman, W. Elliott, H. Hobbs III, and J. Reddell. 2003. The North American obligate cave fauna: regional patterns. Biodiversity and Conservation, 12:441-468.

Culver, D. C., T. Pipan, and K. Schneider. 2007. Vicariance, dispersal and scale in the aquatic subterranean fauna of karst regions. In: J. Gibert and D. C. Culver, eds., Assessing and conserving groundwater biodiversity. Freshwater Biology, Special Issue. doi:10.1111/j.1365-2427 (2007.01856.x.

Culver, D. C., L. Deharveng, A. Bedos, J. J. Lewis, M. Madden, J. R. Reddell, B. Sket, P. Trontelj, and D. White. 2006. The mid-latitude biodiversity ridge in terrestrial cave fauna. Ecography, 29:120-128.

Elliott, W. R. 2004. *Speodesmus* cave millipedes. Four new species from Central Texas (Diplopoda: Polydesmida: Polydesmidae). Texas Memorial Museum Speleological Monographs, 6. Studies on the cave and endogean fauna of North America IV: pp. 163-174.

Gilbert, E. E. 1956. The raymondionymine weevils of California, with a description of a new genus, and several new species (Coleoptera: Curculionidae). The Pan-Pacific Entomologist, 32:55-72.

Hedin, M. C. 1997a. Molecular phylogenetics at the population/species interface in cave spiders of the southern Appalachians (Araneae: Nesticidae: *Nesticus*). Molecular Biology and Evolution, 14:309-324.

Hedin, M. C. 1997b. Speciational history in a diverse clade of habitat-specialized spiders (Araneae: Nesticidae: *Nesticus*): inferences from geographic-based sampling. Evolution, 51:1929-1945.

Hoch, H. 1999. The Hawaiian cave planthoppers (Homoptera: Fulguroidea: Cixiidae) – A model for rapid subterranean speciation? International Journal of Speleology, 26(1/2):21-31.

Howarth, F. G. 1972. Cavernicoles in lava tubes on the island of Hawaii. Science, 175:325-326.

Howarth, F. G. 1980. The zoogeography of specialized cave animals: a bioclimatic model. Evolution, 34(2):394-406.

Howarth, F. G. 1986. The tropical cave environment and the evolution of troglobites. Proceedings of the 9th International Congress of Speleology, Barcelona, Spain. Pp. 153-155.

Howarth, F. G. 1993. High-stress subterranean habitats and evolutionary change in cave-inhabiting arthropods. The American Naturalist, 142, supplement: S65-S77.

Howden, A. T. 1992. Review of the New World eyeless weevils with uncinate tibiae (Coleoptera, Curculionidae; Molytinae, Cryptorhynchinae, Cossoninae). Memoirs of the Entomological Society of Canada, no. 162, 76 pp.

Kuschel, G. 1990. Beetles in a suburban environment: a New Zealand case study. DSIR Plant Protection Report No. 3, 118 pp.

Longacre, C. 2000. Department of the Interior, Fish and Wildlife Service, 50 CFR part 17, RIN 1018-AF33. Endangered and threatened wildlife and plants; Final rule to list nine Bexar County, Texas Invertebrate species as endangered. Federal Register 65(248):81419–81433.

Morrone, J. J., G. Osella, and A. M. Zuppa. 2001. Distributional patterns of the relictual subfamily Raymondionyminae (Coleoptera: Erirhinidae): a track analysis. Folia Entomologica Mexicana, 40:381-388.

Osella, G. 1977. Revisione della sottofamiglia Raymondionyminae (Coleoptera, Curculionidae). Memorie del Museo Civico di Storia Naturale di Verona (II serie), Sezione Sciencia de la Vita, 1:1-162.

Osella, G. 1979. Soil Curculionidae. Bolletino di Zoologia, 46:299-318.

Osella, G. 1989. Due nuovi curculionidi endogei (Coleoptera) (XXXIV. Contributo alla conoscenza della curculionidofauna endogea). Revue suisse de Zoologie, 96:451-458.

Paquin, P., and M. Hedin 2004. The power and perils of 'molecular taxonomy': a case study of eyeless and endangered *Cicurina* (Araneae: Dictynidae) from Texas caves. Molecular Ecology, 13:3239-3255.

Paquin, P., and M. Hedin. 2007. Genetic and morphological analysis of species limits in *Cicurina* spiders (Araneae, Dictynidae) from southern Travis and northern Hays Counties (Texas), with emphasis on *Cicurina cueva* Gertsch and relatives. Report to United States Fish & Wildlife Services, Austin, Texas, 40 pp.

Peck, S. B. 1973. A systematic revision and the evolutionary biology of the *Ptomaphagus* (*Adelops*) beetles of North America (Coleoptera; Leiodidae, Catopinae), with emphasis on cave-inhabiting species. Bulletin of the Museum of Comparative Zoology, 145:29-162.

Peck, S. B. 1982. Occurrence of *Ptomaphagus cavernicola* in forests in Florida and Georgia (Coleoptera; Leiodidae; Cholevinae). The Florida Entomologist, 65(3):378-379.

Peck, S. B., and M. K. Thayer. 2003. The cave-inhabiting rove beetles of the United States (Coleoptera; Staphylinidae; excluding Aleocharinae and Pselaphinae): diversity and distributions. Journal of Cave and Karst Studies, 65(1):3-8.

Reddell, J. R. 1994. The cave fauna of Texas with special reference to the western Edwards Plateau. Pp. 31-50 *In:* W. R. Elliott and G. Veni (eds.). The Caves and Karst of Texas. National Speleological Society. Huntsville, Alabama.

Reddell, J. R., and J. C. Cokendolpher. 2001. A new species of troglobitic *Rhadine* (Coleoptera: Carabidae) from Texas. Texas Memorial Museum Speleological Monographs, 5. Studies on the cave and endogean fauna of North America III: pp. 109-114.

Reddell, J. R., and J. C. Cokendolpher. 2004. New species and records of cavernicole *Rhadine* (Coleoptera: Carabidae) from Camp Bullis, Texas. Texas Memorial Museum Speleological Monographs, 6. Studies on the cave and endogean fauna of North America IV: pp. 153-162.

Sleeper, E. L. 1965. On *Lymantes* Schoenherr (Coleoptera, Curculionidae). Bulletin of the Southern California Academy of Sciences, 64:144-152.

Sokolov, I. M., C. Carlton, and J. F. Cornell. 2004. Review of *Anillinus*, with descriptions of 17 new species and a key to soil and litter species (Coleoptera: Carabidae: Trechinae: Bembidiini). The Coleopterists Bulletin, 58:185-233.

Sokolov, I. M., Y.Y. Sokolova, and C. Carlton. 2007. New species of *Anillinus* Casey (Carabidae: Trechinae: Bembidiini) from Great Smoky Mountains National Park, U.S.A. and phylogeography of the *A. langdoni* species group. Zootaxa, 1542:1-20.

Ubick, D., and T. S. Briggs. 2004. The harvestman family Phalangodidae. 5. New records and species of *Texella* Goodnight and Goodnight (Opiliones: Laniatores). Texas Memorial Museum Speleological Monographs, 6. Studies on the cave and endogean fauna of North America IV: pp. 101-142.

Wessel, A., and H. Hoch. 1999. Remane's statistic species criterion applied to Hawaiian cave planthoppers (Hemiptera: Auchenorrhyncha: Fulguromorpha: Cixiidae). Reichen-bachia, 33(3):27-35.

Chandler, Donald S., James R. Reddell, and Pierre Paquin, 2009. New cave Pselaphinae and records from Texas with a discussion of the relationships and distributions of the Texas troglobitic Pselaphinae (Coleoptera: Staphylinidae: Pselaphinae). [Nuevos Pselaphinae de cuevas y registros de Texas, con una discusión de las relaciones y distribuciones de Pselaphinae troglobios de Texas (Coleoptera: Staphylinidae: Pselaphinae)]. Texas Memorial Museum Speleological Monographs, 7. Studies on the cave and endogean fauna of North America, V. Pp. 125-140.

NEW CAVE PSELAPHINAE AND RECORDS FROM TEXAS, WITH A DISCUSSION OF THE RELATIONSHIPS AND DISTRIBUTIONS OF THE TEXAS TROGLOBITIC PSELAPHINAE (COLEOPTERA: STAPHYLINIDAE: PSELAPHINAE)

Donald S. Chandler

Department of Biological Sciences
University of New Hampshire
Durham, New Hampshire 03824 U.S.A.
Email: dsc1@cisunix.unh.edu

James R. Reddell

Texas Natural Science Center
The University of Texas at Austin, PRC 176, 10100 Burnet
Austin, Texas 78758 U.S.A.
Email: jreddell.caves@mail.utexas.edu

and

Pierre Paquin

Cave and Endangered Invertebrate Research Laboratory,
SWCA Environmental Consultants,
4407 Monterey Oaks Boulevard, Building 1, Suite 110,
Austin, Texas 78749 U.S.A.
Email: ppaquin@swca.com

ABSTRACT

Continuing cave surveys at Fort Hood in central Texas have produced four undescribed members of Pselaphinae, family Staphylinidae. All are members of the genus *Batrisodes*: *B.* (*Babnormodes*) *dentifrons*, *B.* (*Babnormodes*) *incisipes*, *B.* (*Babnormodes*) *fanti*, *B.* (*Babnormodes*) *pekinsi*. A fifth undescribed species was taken at Camp Bullis, Texas: *B.* (*Excavodes*) *shadeae*. Two other morphospecies from Fort Hood are represented by females (probable members of *Babnormodes*), and another from southern Texas in the subgenus *Declivodes* represents another morphospecies. An unplaced member of *Thesium* was also taken. New collection records are given for twelve species previously recorded from Texas caves. All species taken from Texas caves are treated in a revised key, and the relationships and distributions of the Texas troglobitic species are discussed for the first time.

RESUMEN

Los continuos muestreos en cuevas en Fort Hood, centro de Texas, han generado cuatro nuevas especies de Pselaphinae, familia Staphylinidae. Todas pertenecen al género *Batrisodes*: *B.* (*Babnormodes*) *dentifrons*, *B.* (*Babnormodes*) *incisipes*, *B.* (*Babnormodes*) *fanti*, y *B.* (*Babnormodes*) *pekinsi*. Una quinta nueva especie fue colectada en Camp Bullis, Texas: *B.* (*Excavodes*) *shadeae.* Dos otras morfoespecies de Fort Hood son representadas

por hembras (miembros probables de *Babnormodes*), y otra del sur de Texas en el subgénero *Declivodes* representa otra morfoespecie. Se colectó una especie de *Thesium* no identificada. Se dan nuevos registros de doce especies registradas previamente de cuevas de Texas. Se presenta una clave dicotómica de todas las especies colectadas de cuevas de Texas, y las relaciones y distribuciones de las especies troglobias de Texas se discuten por primera vez.

INTRODUCTION

The cave-associated Pselaphinae fauna continues to grow since the treatments by Chandler (1992, 12 species), and Chandler and Reddell (2001, 19 species). Continuing inventory work in the caves along the eastern perimeter of the Edwards Plateau has focused on two military reservations, Fort Hood in central Texas to the west of Temple, and Camp Bullis to the south near San Antonio, and also in Williamson County where the ranges of two federally listed threatened and endangered species occur. Twelve species of Pselaphinae have been taken during the surveys of military reservations, with five of these species being described as new in this paper. The total fauna of described Pselaphinae known from Texas caves now totals 25 species, with 14 of these being troglobites. These troglobites are characterized by the eyes being reduced to a few granulate facets, and often have abnormally long legs, maxillary palpi, and antennae. Two additional troglobitic morphospecies were taken that are represented solely by females: *Batrisodes* (subgenus *Babnormodes*) sp. A and sp. B, and a third morpho-species, represented by a single female, is a probable myrmecophile or troglophile in the subgenus *Declivodes* Park. These morphospecies are not described, but are treated in the following discussion. Six additional species were taken from other cave areas in Texas, and these records are included here. Particularly important were specimens taken by Pierre Paquin and colleagues in their search for specimens of *Batrisodes cryptotexanus* Chandler and Reddell and *Batrisodes texanus* Chandler in order to compare these close species using molecular techniques.

The 14 species of trogobitic Pselaphinae from Texas are all members of the tribe Batrisini (13 *Batrisodes* species and *Texamaurops reddelli* Barr and Steeves, 1963). Two other species of *Batrisodes* taken from caves have reduced eyes: *B. clypeonotus* (Brendel, 1893) and *B.* (*Declivodes*) sp. These are known or presumed to be associated with ants (all described *Declivodes* are associated with ants). The Fort Hood fauna is surprisingly rich in troglobites: seven troglobitic members of the genus *Batrisodes* are now known and are endemic to this area, plus the two undescribed species that are represented solely by females.

The genus *Batrisodes* now holds 119 described species, with 83 species known from North America and 36 Palaearctic species known from Europe to Japan. The North American total is definitely low, since there are also about 30 additional undescribed species from the eastern United States, with the area of major diversity being the southern Appalachian Mountains and their adjacent karst areas. This large Holarctic genus is currently divided into eight subgenera, with seven of these created by Park for the North American fauna (Park, 1951, 1953). Two of Park's subgenera are now applied to species from the Far East of Eurasia and Japan: *Excavodes* Park and *Pubimodes* Park (Löbl and Besuchet, 2004), with the nominotypical subgenus *Batrisodes* restricted to the Palaearctic region. None of the European species are noted to occur in or around caves. In North America, 23 of the 32 species in the subgenus *Babnormodes* Park are known only from cave entrances or within caves, as are 7 of the 19 species of *Excavodes* Park. Most of the undescribed North American species are members of these two subgenera, and many of these have been collected only in or near caves. The other subgenera lack cave-associated members.

While many of the eastern U.S.A. *Batrisodes* species are collected in and around caves, they have somewhat reduced but apparently functional eyes, and none are troglobites. The few troglobites formerly housed in *Batrisodes* have been placed with some free-living species in *Batriasymmodes* Park. The most complex subgenus is *Babnormodes*, where based on male features of the head and antennae it appears that there are several species groups, each with a mixture of species that are free-living or that prefer the areas around cave entrances (Chandler and Carlton, revision in progress). The basic configuration of male features typical for each species group is suggestive in terms of relationships to the Texas cave species, but not certain. The relationships of the Texas cave species to their eastern counterparts are yet to be determined for either subgenus, but some observations are noted here:

subgenus *Excavodes*:

a) *B. reyesi* Chandler, *B. texanus*, and *B. cryptotexanus* form a group united by the sharp and prominent vertexal carinae, which are not shared with any of the eastern U.S.A. species. These three species appear to form a monophyletic group.

b) *B. grubbsi* Chandler shares the broadly subtruncate frontal apex with *B. venyivi* Chandler, and a number of eastern species centered on *B. clypeonotus* and *B. lineaticollis* (Aubé).

c) *B. shadeae*, n.sp., has a frontal morphology that is not strongly suggestive of any of the known species.

subgenus *Babnormodes*:

a) *B. fanti,* n.sp., *B. pekinsi,* n.sp., and *B. feminiclypeus* Chandler and Reddell have a smooth, concave front merging into the clypeus that is suggestive of some species such as *B. henroti* Park, from Kentucky.

b) *B. gravesi* Chandler and Reddell and *B. incisipes,* n.sp., have the front angularly protruding above the clypeus, that is shared with a number of other species near *B. uncicornis* (Casey).

c) *B. dentifrons,* n.sp., and *B. wartoni* Chandler and Reddell, 2001 have a subtruncate frontal apex that is shared with several Midwestern species

Interestingly the species found from the southern portion of the karst areas (San Antonio to Georgetown) are members of the subgenus *Excavodes*, while those from the northern area at Fort Hood are members of *Babnormodes* (see Fig. 30). However, the variation in male frontal forms suggests that there was not one introduction and subsequent radiation of a single ancestral species for each of the two subgenera. The most likely scenario supports concurrent or perhaps sequential introductions of members from various species groups during more hospitable times. Eastern species are typically found in moist, thick leaf litter or in rotten wood (in/near caves or from the forest floor), conditions uncharacteristic of the Texas Hill Country today.

DISTRIBUTION OF TEXAS TROGLOBITIC PSELAPHINAE

Figure 31 is based on all records of troglobitic Pselaphinae known from Texas published by Chandler (1992), Chandler and Reddell (2001), and in the present paper. Each location is represented by a dot, and locations harboring the same species are used to roughly outline a distributional range. To date, 14 species are known from Texas and four undescribed trogloblitic morphospecies are also reported (species A to D). These taxa are known from female specimens only and males are needed in order to provide reliable taxonomic characters for species descriptions and diagnoses, though based on subtle features the two morphospecies from Fort Hood (species A and B) are probable members of the subgenus *Babnormodes*, and the two from Sutton (*Batrisodes* sp. C) and Edwards Counties (*Batrisodes* sp. D) are probable members of *Excavodes*. While some species are only known from a single cave and a single specimen, it seems likely that additional collecting in adjacent localities will yield additional specimens and locations, at least in the areas that have not been surveyed well. However, it is surprising that in areas that have been intensely monitored, such as Fort Hood in Bell and Coryell Counties, there are still several species represented by a single specimen or are known from a single location.

Most species have well-defined distributions that do not overlap with others. For instance, *B. cryptotexanus*, *B. texanus* and *B. reyesi* show an impressive geographic cohesion in their distribution. Similarly, all the localities known for *T. reddelli* are found on the Jollyville plateau, a geological isolate in Travis County. Surprisingly, no records of eyeless Pselaphinae are known between the ranges of *T. reddelli* and *B. cryptotexanus* / *texanus*, despite numerous caves and suitable habitat occupied by many other troglobitic species in an area that has been thoroughly surveyed. The absence of troglobitic Pselaphinae from large areas, such as the southern portion of Travis County, could be due to sampling bias, but that seems unlikely given the intensity of monitoring. Their absence from particular areas may be real. However, the recent discovery of *B. shadeae* on Camp Bullis, an intensively studied area, indicates that new species may be found in other well-studied areas.

The geographic cohesion observed for most species highly contrasts with the situation observed on Fort Hood, where the range of *B. gravesi* overlaps with several other species. Remarkably, only Buchanan Cave harbors two troglobitic species: *B. pekinsi* and *B. gravesi*. The co-occurrence of two species in the same cave, and the overlapping ranges of that particular area may be the result of different invasions of the same cave system by different surface ancestors. The best evolutionary scenario for these two species is: *B. pekinsi* and *B. gravesi* belong to different species groups that are likely derived from different surface ancestors. The relationships within the genus are still poorly known, but several species appear related to surface members occurring on the surface east of Texas.

This is also known for other Texas troglobites such as *Cicurina* (subgenus *Cicurella*) spiders (Gertsch, 1992), and the eyeless weevil *Lymantes nadineae* Anderson (Paquin and Anderson, 2009). There are *Rhadine* beetles (Carabidae) for which pairs of species (one highly troglobitic and the other one less troglobitic) have been reported in the same cave at several localities (Barr, 1974). There are some indications of such a pairing with the more elongate and slender antennae found in *B. gravesi* when compared with cohabitant *B.*

pekinsi, suggesting that they may occupy different ecological niches, but nonetheless, they may also represent different speciation/invasion events as hypothesized for *Rhadine.* Finally, *B. feminiclypeus* Chandler and Reddell is the first species for which a disjunct distribution is documented, with one record from a cave that is not adjacent to the other known locations, leaving a distribution gap filled by other species, particularly *B. gravesi,* the most widely-distributed troglobitic pselaphine of the Fort Hood area.

DISPOSITION OF THE SPECIMENS

Holotypes of the species described here will be placed in the Field Museum of Natural History, Chicago, Illinois. The paratypes and other specimens are split between the Texas Memorial Museum, Austin, Texas (TMMC) and the collection of the senior author (DSC), with most specimens of the non-troglobitic species held in the TMMC.

KEY TO SPECIES

As the numbers of species in cave inhabiting *Batrisodes* have grown, it has become impossible to construct a simple key that includes the females due to lack of strong characters, and lack of associated females for several species. For this reason only males are keyed starting at couplet 16. Males of subgenus *Excavodes* may be recognized by the presence of sulci and tubercles on the head between the antennal insertions, simple protibiae and mesotarsi, while for male *Babnormodes* the protibiae are flattened and twisted in the apical half, the second tarsomeres are notched near the base, and the head may have the area between the antennal insertions sulcate or tuberculate. Males have the last sternite medially impressed in both subgenera. Females have this sternite broadly rounded or nearly flat, and they lack all the modifications of the head and legs.

---

1. Abdominal segments II-IV with acute lateral margins 2

Abdominal segments II-IV lacking lateral margins, abdomen round in cross section (Fig. 10) (Batrisitae, Batrisini) 9

2. (1) Last segment of maxillary palpi laterally angulate, previous two segments with spine on outer face (Fig. 2) (Pselaphitae, Tmesiphorini) ....*Tmesiphorus costalis*

Last segment of maxillary palpi lacking lateral angulations or spines on previous segments (Figs. 1, 3-8) 3

3. (2) Last segment of maxillary palpi elongate, penultimate segment angulate on mesal margin (Fig. 1) (Goniaceritae, Tychini) ....*Cylindrarctus bicornis*

Last segment of maxillary palpi enlarged, penultimate segment much smaller (Figs. 3-8) 4

4. (3) Last segment of maxillary palpi enlarged, nearly half as long as head, with longitudinal membraneous sulcus on mesal margin (Fig. 3); tarsi with two equal claws (Pselaphitae, Tyrini) ......*Hamotus electrae*

Last segment of maxillary palpi smaller, no more than one-third head length, smoothly sclerotized on mesal margin (Figs. 4-8); tarsi with only one claw visible (Euplectitae) 5

5. (4) Pronotum with apical lobe formed by strong constriction; first antennomeres elongate, one-third antennal length, antennae geniculate (Fig. 4) (Trogastrini) ....*Rhexius stephani*

Pronotum broadly rounded at apex (Figs. 5-7); first antennomeres short, no more than twice length of second antennomeres 6

6. (5) Pronotum abruptly constricted near base (Fig. 5); head venter with prominent Y-shaped carina Jubini) ....*Sebaga ocampi*

Pronotum slightly and smoothly constricted near base, or margins nearly straight to near base (Figs. 6-7); head venter with faint median longitudinal carina (Trichonychini) 7

7. (6) Antennal club formed by large last antenno-mere (Fig. 8); pronotum with lateral margins smoothly but distinctly constricted adjacent to lateral foveae ....*Trimioarcus musamator*

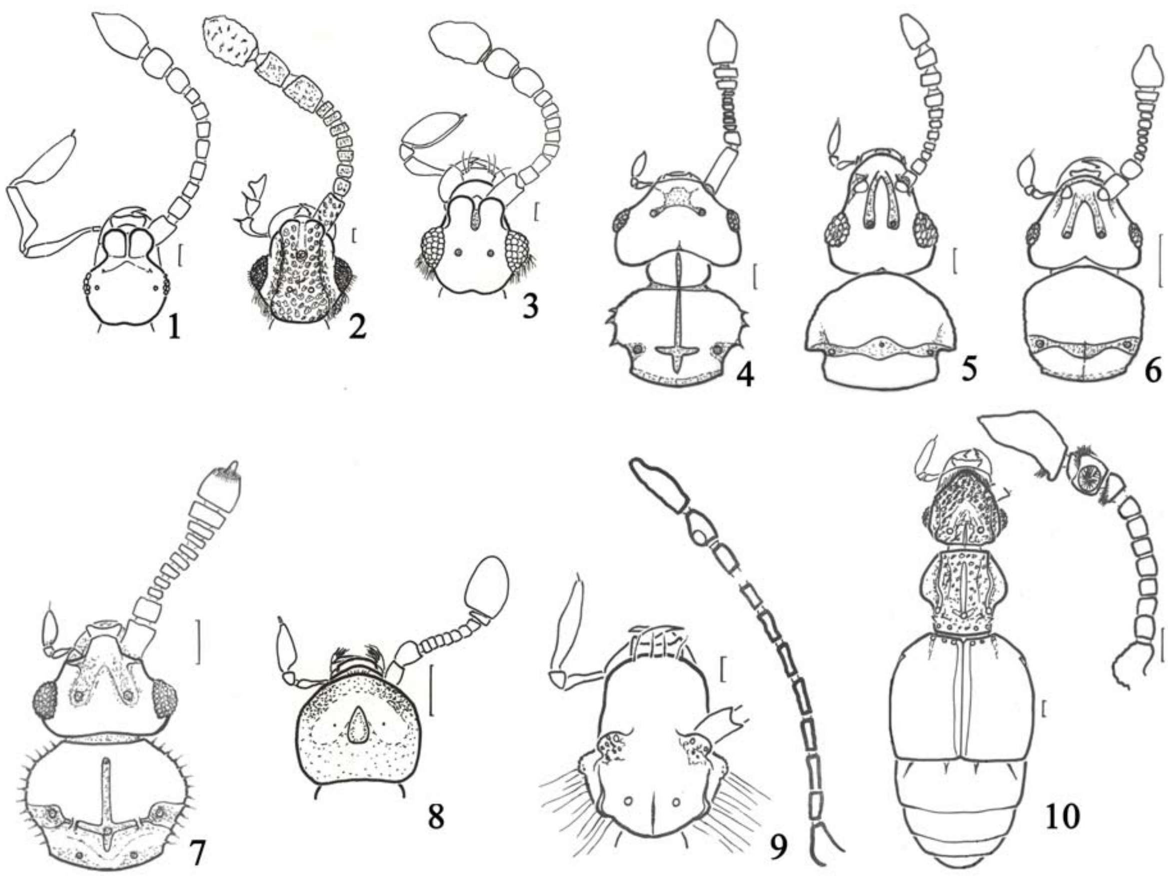
Antennal club smaller, formed by last 2-3 antennomeres (Figs. 6-7); pronotum with lateral margins nearly straight through most of length, or smoothly rounded to base 8

8. (7) Pronotum with lateral margins smooth to granular, never distinctly denticulate; three antennomeres forming antennal club, 10th to 9th thin, progressively narrower (Fig. 6) ....*Bibloplectus comanche*

Pronotum with lateral margins clearly denticulate, with small spaced teeth; two antennomeres forming antennal club, 10th antennomere trapezoidal and large, nearly as wide or as wide as apical antennomere (Fig. 7) ....*Thesium* sp.

9. (1) Ocular area bluntly protruding, lacking distinct eyes (Fig. 9); apex of metatibiae lacking elongate pencil of appressed setae; Travis County ....*Texamaurops reddelli*

Ocular area with eyes distinct (Figs. 10-11) or lacking, if with eyes lacking or very reduced then ocular area not bluntly protruding (Figs. 12-14); apex of metatibiae with elongate pencil of appressed setae (*Batrisodes*) 10



Figs. 1-10.—1, *Cylindrarctus bicornis*, head; 2, *Tmesiphorus costalis*, head; 3, *Hamotus electrae*, head; 4, *Rhexius stephani*, head and pronotum; 5, *Sebaga ocampi*, head and pronotum; 6, *Bibloplectus cherokee*, head and pronotum; 7, *Thesium* sp., head and pronotum; 8, *Trimioarcus musamator*, head; 9, *Texamaurops reddelli*, head and antenna; 10, *Batrisodes uncicornis*, body and antenna. Line equals 0.1 mm. Antennal figures in lateral view, with apical three-four antennomeres rotated into ventral view.

10. (9) Pronotal disc with sharply defined median sulcus to near apex (Fig. 10); eyes distinct, with 10 to 50 facets grouped together, or may be small and somewhat protruding in *B. clypeonotus* (Fig. 12) 11

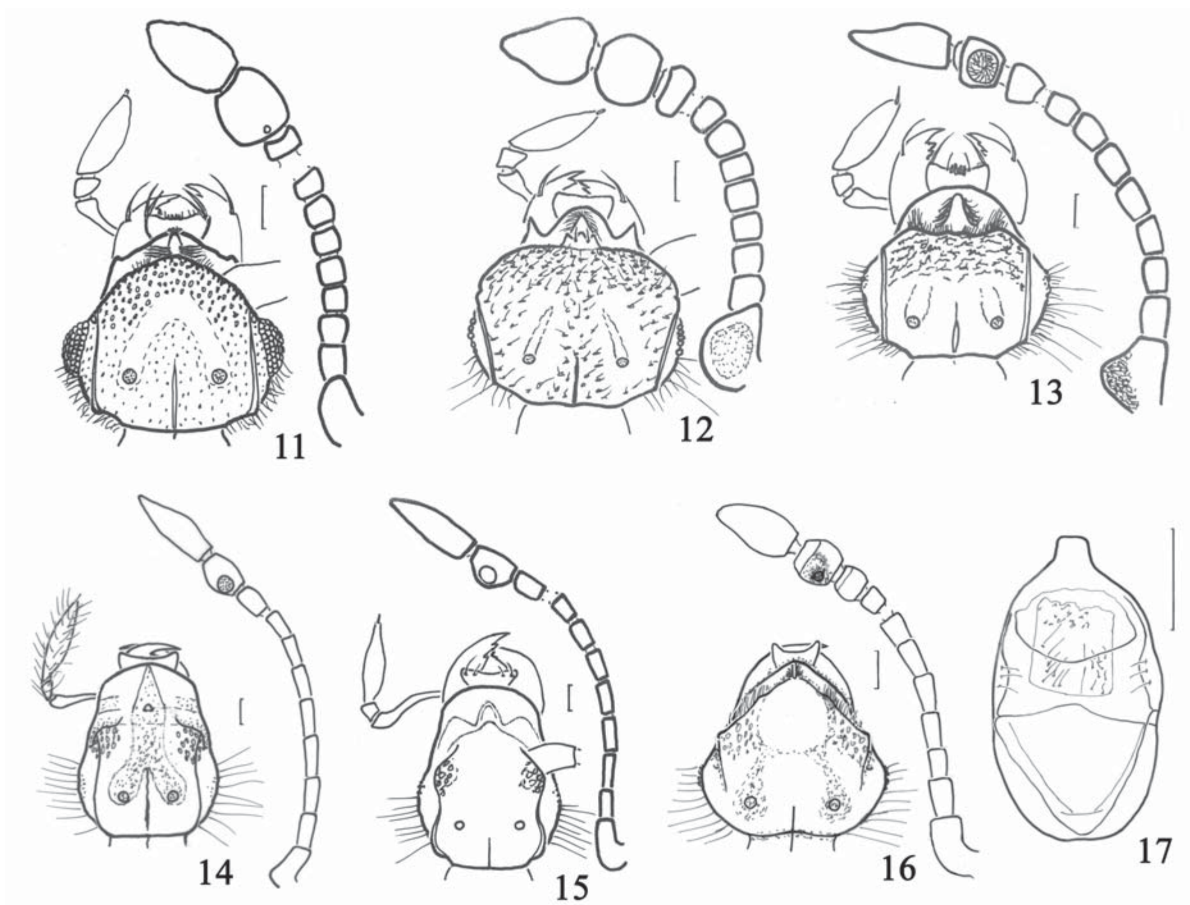
Pronotal disc convex or with faint median impression to middle; eyes apparently absent, possibly up to 10 disassociated pale granules in area where eyes should be, ocular area broadly to narrowly rounded (Figs. 13-16) 13

11. (10) Head dorsum and anterior portion of pronotum coarsely punctate; males with anterior margin of frons angulate (Fig. 10); common, wide-spread ....*Batrisodes* (*Babnormodes*) *uncicornis*

Head posterior to vertexal foveae and anterior portion of pronotum smoother, not coarsely punctate; males with anterior margin of frons subtruncate to broadly rounded (Figs. 1-12); females with frons at most coarsely punctate on antennal tubercles, area between vertexal foveae smooth or sparsely granulate; rarely taken 12

12. (11) Males with anterior margin of frons broadly rounded, penultimate antennomere with small fovea at base (Fig. 11); females with large eyes of more than 40 facets.......... ....*Batrisodes* (*Excavodes*) *lineaticollis* (formerly *B. globosus*)

Males with anterior margin of frons broadly subtruncate, penultimate antennomere lacking basal fovea (Fig. 12); females with small eyes of approximately 15 facets, ocular area angularly protruding ....*Batrisodes* (*Excavodes*) *clypeonotus*



Figs. 11-17.—11, *Batrisodes lineaticollis*, head and antenna; 12, *Batrisodes clypeonotus*, head and antenna; 13, *Batrisodes reyesi*, head and antenna; 14, *Batrisodes texanus*, head and antenna; 15, *Batrisodes cryptotexanus*, head and antenna; 16, *Batrisodes shadeae*, head and antenna; 17, *Batrisodes shadeae*, male genitalia. Line equals 0.1 mm. Antennal figures in lateral view, with apical three-four antennomeres rotated into ventral view; male genitalia in dorsal view.

13.(10) Head with prominent lateral and median vertexal carinae, area between carinae deeply and smoothly concave (Figs. 13-15); lateral vertexal carinae sloping anterodorsally to form carinate outer margins of prominent antennal tubercles, best seen in lateral view 14

Head with lateral and median vertexal carinae low, one or both often weakly defined or lacking (Figs. 16, 18-19), area between vertexal foveae convex with small median vertexal carina at summit; in lateral view antennal tubercles only weakly projecting above plane of vertex, lateral carinae never strongly forming outer margin (key to males only from this point) 16
......

14. (13) Antennomeres III-VII only slightly longer than wide; male with first antennomere (scape) broadly projecting ventrally, frons prominent at apex, with deep setose transverse sulcus below apex (Fig. 13); Burnet, Travis, and Williamson Counties ....*Batrisodes* (*Excavodes*) *reyesi*

Antennomeres III-VII twice as long as wide; males with frons declining to clypeus, transverse sulcus weakly indicated, not setose (Figs. 14-15) 15

15.(14) Apical tergite with projection about as long as wide; males with lateral ridges of sternite VI acutely projecting; Williamson County ....*Batrisodes* (*Excavodes*) *cryptotexanus*
Apical tergite with projection about half as long as wide; males with lateral ridges of sternite VI slightly raised; Williamson County ....*Batrisodes* (*Excavodes*) *texanus*

16.(13) Mesotarsomeres all linear; protibiae and mesotibiae lacking difications; Penultimate antennomere (10^{th}) with large, ventral, setose fovea (Figs. 16, 18) (subgenus *Excavodes*) 17

Second mesotarsomere with ventral notch at base, often arcuate or sinuate (Fig. 29 for extreme example); protibiae flattened and twisted in at least apical half; mesotibiae with setose preapical angulation on inner margin; penultimate antennomere lacking ventral setose fovea (Fig. 20) in all but *B. fanti* (Fig. 21) (subgenus *Babnormodes*) 19

17. (16) Frons smoothly declining between antennal insertions to prominent clypeal tubercle that projects well above frontal apex (Fig. 16); Bexar County ....*Batrisodes* (*Excavodes*) *shadeae,* n.sp.

Frons level to broadly subtruncate apex, apex sharply defined ventrally by setose transverse sulcus; clypeal tubercle clearly ventral to frontal apex (Figs. 18-19) 18

18. (17) Frontal apex broadly rounded, slightly emarginate at middle; frons smooth, punc-tation indistinct (Fig. 18); Bexar County ....*Batrisodes* (*Excavodes*) *venyivi*

Frontal apex more subtruncate, lacking emargination at middle; frons coarsely punctate (Fig. 19); Hays County ....*Batrisodes* (*Excavodes*) *grubbsi*

19. (18) Clypeus smoothly concave from antennal insertions to apex, frons smoothly merging with clypeus (Figs. 20-21) 20

Clypeus with setose transverse sulcus or impression at base near antennal insertions, often with frons apex strongly projecting (Figs. 25, 27) 22

20. (19) Penultimate antennomere (10^{th}) symmetrical, about half size of apical antennomere, lacking angular margin and ventral fovea (Fig. 20); Bell County ....*Batrisodes* (*Babnormodes*) *feminiclypeus*
Penultimate antennomere (10^{th}) asymmetrical, nearly as large as apical antennomere, angularly produced on mesal margin (Figs. 21, 23) 21

21. (20) Penultimate antennomere (10^{th}) with large setose fovea covering mesal half of ventral margin (Fig. 21); Bell County ....*Batrisodes* (*Babnormodes*) *fanti,* n.sp.

Penultimate antennomere (10th) lacking fovea on ventral margin (Fig. 23); Bell County...*Batrisodes* (*Babnormodes*) *pekinsi,* n.sp.

22. (19) Frontal apex broadly subtruncate, apex shallowly emarginate (Figs. 25, 27) 23

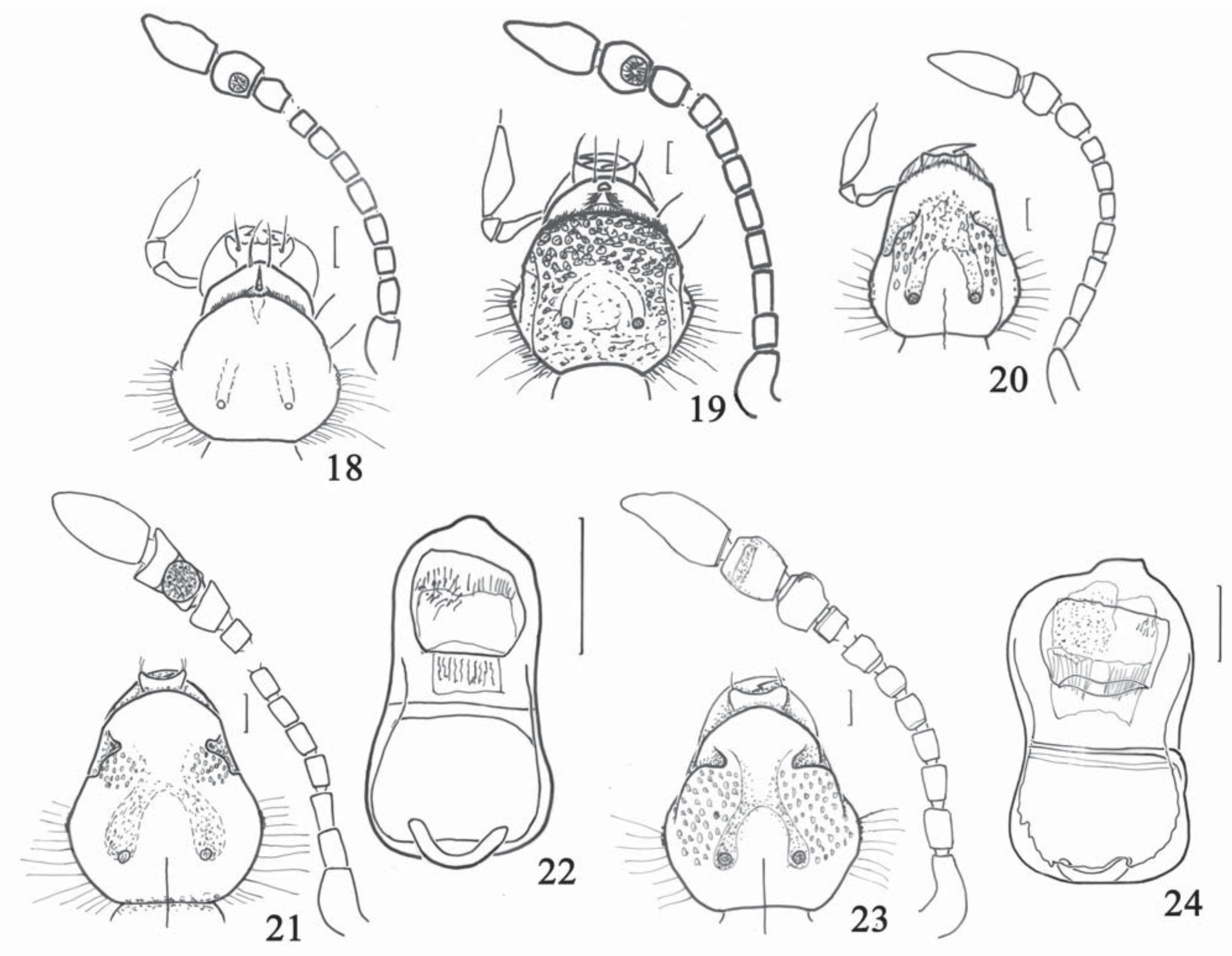
Frontal apex narrowing to rounded point (Figs. 28-29) 24

23. (22) Frontal apex with two small teeth at middle; first antennomere (scape) broadly bulging ventrally (Fig. 25); Bell County ....*Batrisodes* (*Babnormodes*) *dentifrons,* n.sp.

Frontal apex truncate, appearing slightly emarginate in dorsal view due to depression at middle; first antennomere (scape) gently convex on ventral margin (Fig. 27); Coryell County...*Batrisodes* (*Babnormodes*) *wartoni*

24. (22) Antennomere VIII 1.5-2 times as long as wide, antennomeres IV-VII twice as long as wide; frontal apex acutely pointed (Fig. 28); Bell and Coryell Counties ....*Batrisodes* (*Babnormodes*) *gravesi*

Antennomere VIII about as long as wide, antennomeres IV-VII never more than 1.5 times as long as wide; frontal apex roundly pointed (Fig. 29); Bell County ....*Batrisodes* (*Babnormodes*) *incisipes,* n.sp.



Figs. 18-24.—18, *Batrisodes venyivi*, head and antenna; 19, *Batrisodes grubbsi*, head and antenna; 20, *Batrisodes feminiclypeus*, head and antenna; 21. *Batrisodes fanti*, head and antenna; 22, *Batrisdoes fanti*, male genitalia; 23, *Batrisodes pekinsi*, head and antenna; 24, *Batrisodes pekinsi*, male genitalia. Line equals 0.1 mm. Antennal figures in lateral view, with apical three-four antennomeres rotated into ventral view; male genitalia in dorsal view.

DESCRIPTIONS OF NEW SPECIES

Batrisodes* (*Babnormodes*) *dentifrons
Chandler and Reddell, n.sp.
Figs. 25-26

Description.– Length 2.08-2.28. Male head with frons flat, projecting to point anterior to antennal insertions, apical margin broad, shallowly concave in dorsal view, with several short setae projecting along lateral margins of apex, two sharp teeth arising at ventral margin of apex over deep transverse frontal sulcus, coarsely punctate anterior to vertexal foveae; clypeus with carinate median ridge extending from apex to frontal sulcus, ridge densely setose beneath projecting frons; lateral vertexal carinae faintly present near base, median vertexal carina distinct to between vertexal foveae; ocular area with about 10 small granules; postgenal area with about 8 long erect setae visible in dorsal view. Antennae with scape length about one-fourth of head length, broadened dorsoventally, width about two-thirds length, slightly concave on anterior face, antennomere III about twice as long as wide, IV-VII slightly decreasing in length toward apex, club formed by apical 3 antennomeres, IX and X smoothly rounded ventrally, unmodified.

Pronotum with disc convex, lateral longitudinal sulci shallow but distinct, lacking median antebasal fovea, basolateral tubercles short but distinct. Elytron with three small basal foveae, moderately densely and shallowly punctate, lacking subhumeral fovea, epipleural stria present in apical half. Second mesotarsomere notched at base, slightly sinuate; mesotibiae slightly widening apically to point at about two-thirds length, broadly angulate on inner margin, this area densely setose to apex. Protibiae flattened in apical half; metatibiae vaguely and broadly constricted in apical third.

Abdomen with second through fifth visible sternites broadly convex; sixth visible sternite shallowly concave in basal two-thirds.

Male holotype: antennae 1.20; metafemora 0.68; metatibiae 0.68; metatarsi 0.36.

Specimens examined.—3. Holotype male: TEXAS: *Bell County*: Canyon Floor Cave, Fort Hood, 21 Oct. 2003, J. Reddell, M. Reyes (FMNH). PARATYPES: 1 male, eutopotypical (DSC); 1 male, same locality, 27 March 2004, J. Fant , M. Reyes (TMMC).

Etymology.—The specific name refers to the two teeth at the apex of the frontal projection.

Comments.—The form of the male front is very distinctive, and not shared with other members of *Babnormodes*. The specimens were taken from the underside of a rock.

Batrisodes* (*Babnormodes*) *fanti
Chandler and Reddell, n.sp.
Figs. 21-22

Description.– Length 2.32-2.52. Male head lacking modifications of the frons and clypeus, frontal area smoothly declining between antennal bases to near clypeal apex, clypeus smoothly convex, glabrous; area medial to weak antennal tubercles distinctly punctate, punctate area sometimes extending posteriorly to near vertexal foveae; vertexal sulcus V-shaped, indistinct apically; ocular area with about 8 granules; postgenal area with about 16 long erect setae visible in dorsal view; cervix with thin median vertexal carina extending onto head base to point between vertexal foveae, lacking lateral vertexal carinae. Antennae with scape length about one-fourth head length, scape with margins parallel in lateral view; club formed by apical three antennomeres, IX trapezoidal, widest at apex, apex abruptly truncate, flattened ventrally; X elongate, subrectangular, ventral margin angulate near base, anterior face broadly and shallowly concave, venter with large fovea occupying basal half, slanting from base to protruding carinate rim at middle of ventral side.

Pronotum with faint median longitudinal sulcus that extends anteriorly across most of disc, originating from shallow median antebasal fovea; lateral antebasal tubercles small and pointed; lateral longitudinal sulci faint. Elytra with three small basal foveae, moderately and shallowly punctate, lacking subhumeral fovea, epipleural stria present in apical three-fourths. Protibiae sinuate and slightly twisted, flattened in apical half; mesotibiae gradually widening to point about two-thirds of length, inner margin broadly angulate at this point, densely setose to tibial apex from angulation. Second mesotarsomeres slightly sinuate, notched at base.

Abdomen with second through fifth visible sternites flattened medially, sixth shallowly concave near base, becoming flattened apically at middle.

Female with antennomeres IX and X elongate, X slightly dorsoventrally flattened. Abdomen with sternites slightly flattened at middle; tibiae cylindrical.

Male holotype: antennae 1.16; metafemora 0.88; metatibiae 0.87; metatarsi 0.36.

Specimens examined.— Holotype male: TEXAS: *Bell County*: Blue Green Hole, Fort Hood, 5 April 2007 (J. Fant) (FMNH). PARATYPES: *Bell County*: Blue Green Hole, Fort Hood, 3 May 2005 (J. Fant, J. Reddell), 6 females (DSC, TMMC); Cross Crack Cave, Fort Hood, 3 May 2005 (M. Reyes), 1 female; Hackberry Cave, Fort Hood, 12 June 2004 (M. Reyes, M. Warton)

(DSC), 1 male, 1 female; Slotsky Cave, 19 Sept. 2004 (J. Fant, M. Reyes) (DSC); Plethodon Cave, Fort Hood, 25 Aug. 2004 (J. Fant, M. Reyes) (TMMC).

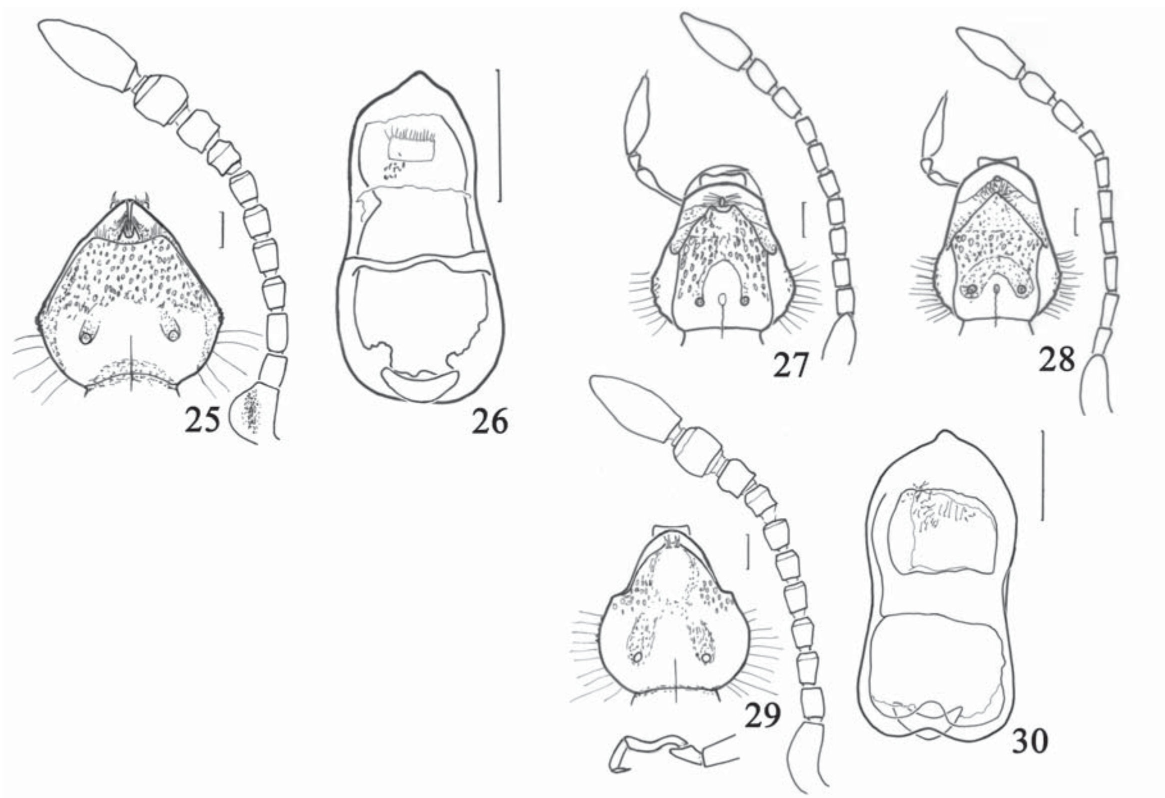
Etymology.—The species is named for Jerry Fant, who collected the holotype and one of the paratypes.

Comments.—The simple front of the male is similar to that of *Batrisodes feminiclypeus* and *B. pekinsi*, both known from caves in Bell County, but the antennae of the first species are unmodified. The male antennal club of *B. fanti* is very strongly modified, and generally similar in form to that of *B. pekinsi*, but possesses a large setose ventral fovea on antennomere X which *B. pekinsi* lacks, and the antennae of *B. pekinsi* are not so strongly angulate in a lateral view. This species was taken from the underside of rocks in both dim twilight and complete darkness.

Batrisodes* (*Babnormodes*) *incisipes
Chandler and Reddell, n.sp.
Figs. 29-30

Description.—Length 2.24. Male head triangular, lacking antennal tubercles, anterior portion of frons deflexed ventrally between antennal bases, center shallowly concave, lateral margins of deflexed portion slightly sinuate at middle, converging to narrowly truncate apex projecting over narrow transverse frontal excavation, with pair of short forked setae at apex; area medial to antennal insertions coarsely punctate, punctures minute and faint on deflexed area, faint V-shaped vertexal sulcus extending anteriorly from vertexal foveae; vertexal foveae small; lacking lateral vertexal carinae, median vertexal carina on cervix extending anteriorly onto head between vertexal foveae; ocular area with about 6 small granules, postgenal area with about 10 short to long setae visible in dorsal view; clypeus narrowly rounded at middle, with small median tuft deep in frontal excavation. Antennae with scape relatively long, about two-fifths of head length, in lateral view ventral margin broadly convex; antennomeres IV-VII same length, apical three antennomeres forming club, antennomeres IX and X unmodified, smoothly rounded on venter, X lacking a fovea.

Pronotum with disc convex, median antebasal fovea faint, median longitudinal sulcus faintly present in basal half, lateral longitudinal sulci shallow but distinct. Elytron with three small basal foveae, lackiing subhumeral fovea, epipleural stria present in apical three-fourths; elytra moderately and shallowly punctate. Second mesotarsomeres strongly sinuate (Fig. 29).



Figs. 25-30.—25, *Batrisodes dentifrons*, head and antenna; 26, *Batrisodes dentifrons*, male genitalia; 27, *Batrisodes wartoni*, head and antenna; 28, *Batrisodes gravesi*, head and antenna; 29, *Batrisodes incisipes*, head and antenna, posterior view left mesotarsus; 30, *Batrisodes incisipes*, male genitalia. Line equals 0.1 mm. Antennal figures in lateral view, with apical three-four antennomeres rotated into ventral view; male genitalia in dorsal view.

Protibiae flattened in apical two-thirds, sides parallel; mesotibiae gradually widening to point at about two-thirds length, broadly angulate on inner margin, densely setose from angulate area to apex; metatibiae slightly and broadly constricted in apical half.

Abdomen with second through sixth visible sternites slightly flattened at middle.

Female unknown.

Male holotype: antennae 1.26; metafemora 0.72, metatibiae 0.70; metatarsi 0.36.

Specimen examined.—Holotype male: TEXAS: *Bell County*: Talking Crows Cave, Fort Hood, 6 June 2000 (J. Reddell, M. Reyes) (FMNH).

Etymology.—The specific name refers to the very deep notch of the second tarsomere for the males of this species.

Comments.—The general structure of the modified male vertex is close to that of *B. gravesi* (also from Bell County), but all parts of the body are generally more compact, with the antennomeres being much shorter. The specimen was collected from the underside of a rock deeply buried in soil near the end of the cave in dim twilight. This biotically rich cave also contains the troglobitic spiders *Cicurina* (*Cicurella*) *hoodensis* Cokendolpher and Reddell and *Neoleptoneta* sp. cf. *paraconcinna* Cokendolpher and Reddell, the troglobitic pseudoscorpion *Tartarocreagris hoodensis* Muchmore, a troglobitic lithobiomorph centipede, and a blind ground beetle of the tribe Anillini.

Batrisodes* (*Babnormodes*) *pekinsi
Chandler and Reddell, n.sp.
Figs. 23-24

Description.—Length 2.48. Male head lacking modifications of the frons and clypeus, frontal area smoothly declining between antennal bases to near clypeal apex, clypeus smoothly convex, glabrous; coarsely punctate from weak antennal tubercles to near vertexal foveae, area between vertexal foveae roughened; vertexal sulcus V-shaped, indistinct apically; ocular area with about 5 granules; postgenal area with about 8 long erect setae on each side visible in dorsal view; cervix with thin median vertexal carina extending onto head base to point between vertexal foveae, lacking lateral vertexal carinae. Antennae with scape length about one-fourth head length, scape with margins nearly parallel in lateral view; club formed by apical three antennomeres, their surface roughly punctured, in lateral view IX widest near middle, X elongate, subrectangular, broadly projecting and smoothly curved on ventral margin, in ventral view portion apical to angulation with slight transverse, broad sulcus, lacking fovea.

Pronotum with faint median longitudinal sulcus that extends anteriorly to middle of disc, originating from shallow median antebasal fovea; lateral antebasal tubercles small and pointed; lateral longitudinal sulci faint. Elytra with three small basal foveae, moderately and shallowly punctate, lacking subhumeral fovea, epipleural stria present in apical three-fourths. Protibiae sinuate and slightly twisted, flattened in apical half; mesotibiae gradually widening to point about two-thirds of length, inner margin broadly angulate at this point, densely setose to tibial apex from angulation. Second mesotarsomeres slightly sinuate, notched at base.

Abdomen with second through fifth visible sternites flattened medially, sixth shallowly concave near middle, becoming flattened apically.

Female: unknown.

Male holotype: antennae 1.20; metafemora 0.72; metatibiae 0.72; metatarsi 0.36.

Specimen examined.—Holotype male: TEXAS: *Bell County*: Buchanan Cave, lower level, Fort Hood, 2 June 2005 (J. Fant, C. Pekins) (FMNH).

Etymology.—The species is named for Charles Pekins, one of the collectors of the holotype.

Comments.—The general form of the modifications of the antennal club is similar to that of *B. fanti*. However, males of that species have a large setose fovea on the ventral surface of antennomere X, while in *B. pekinsi* this antennomere lacks fovea. The simple male front is shared with *B. fanti* and *B. feminiclypeus*, while this last species lacks modified male antennae. The specimen was taken from under a small rock buried in clay in the deepest part of the cave in total darkness.

Batrisodes* (*Excavodes*) *shadeae
Chandler and Reddell, n.sp.
Figs. 16-17

Description.—Length 1.96 mm. Male head with apical portion of frons deflexed between antennal tubercles, concavely impressed through most of width, apex angled upwards to merge with prominent clypeal tubercle, concave area glabrous, with row of short stiff setae along lateral margins of declivity, carina extending from clypeal tubercle to clypeus apex, tubercle setose at apex, punctures most distinct on antennal tubercles, shallow sulci extending anteriorly and convergently from vertexal foveae to base of declivity, postgenal area with about 10 long setae visible in dorsal view, ocular area with about 8 small granules; with faint median vertexal carina that extends from cervix anteriorly to point even with vertexal foveae on head, lacking lateral vertexal carinae. Antennae with scape length about one-fifth head length, club formed by antennomeres IX-XI, X globose, venter with large subtriangular impression covering over half of surface, small setose fovea present near mesal margin.

Pronotum with disc convex, median antebasal fovea punctiform, antebasal tubercles low and blunt, lateral longitudinal sulci indistinct. Elytra with three basal foveae, disc faintly punctate only near base, most of disc smooth; lacking subhumeral fovea, epipleural stria distinct in apical three-fourths. Second mesotarsomeres linear. All tibiae thin and cylindrical.

Abdomen with second through sixth visible sternites flattened medially.

Male holotype: antennae 1.16; metafemora 0.88; metatibiae 0.88; metatarsi 0.48.

Specimen examined.—Holotype male: TEXAS: *Bexar County*: Darling's Pumpkin Hole, Camp Bullis, 7 Jan. 2005 (J. Fant, B. Shade) (FMNH).

Etymology.—The specific name is in recognition of the participation by Bev Shade in collecting this specimen.

Comments.—The front between the antennal insertions declines to a smooth, concave impression, with the apex smoothly merging with the base of a prominent, acute clypeal tubercle. This frontal morphology is not suggestive of any of the previously described species.

NEW RECORDS

Batrisodes (*Babnormodes*) *feminiclypeus*
Chandler and Reddell, 2001

Records.—*Bell County*: Hope Well Sink, Fort Hood, 2 April 2006 (J. Fant, M. Reyes), 1 female; Skeeter Cave, 25 Aug. 2003 (C. Pekins, J. Reddell), 1 female; Afternoon Cave, Fort Hood, 9-10 Oct. 2004 (J. Fant, C. Murray, M. Reyes, M. Warton), 1 male.

Batrisodes (*Babnormodes*) *gravesi*
Chandler and Reddell, 2001

Records.—*Bell County*: Buchanan Cave, Fort Hood, 8 Nov. 1995 (D. Allen), 1; Buchanan Cave, Fort Hood, 13 June 2000 (J. Krejca, P. Sprouse), lower level, 2 females; Buchanan Cave, Fort Hood, 14 Dec. 2001 (J. Reddell, M. Reyes), 1; Buchanan Cave, upper level, Fort Hood, 2 June 2005 (J. Reddell, M. Reyes), 2 males,

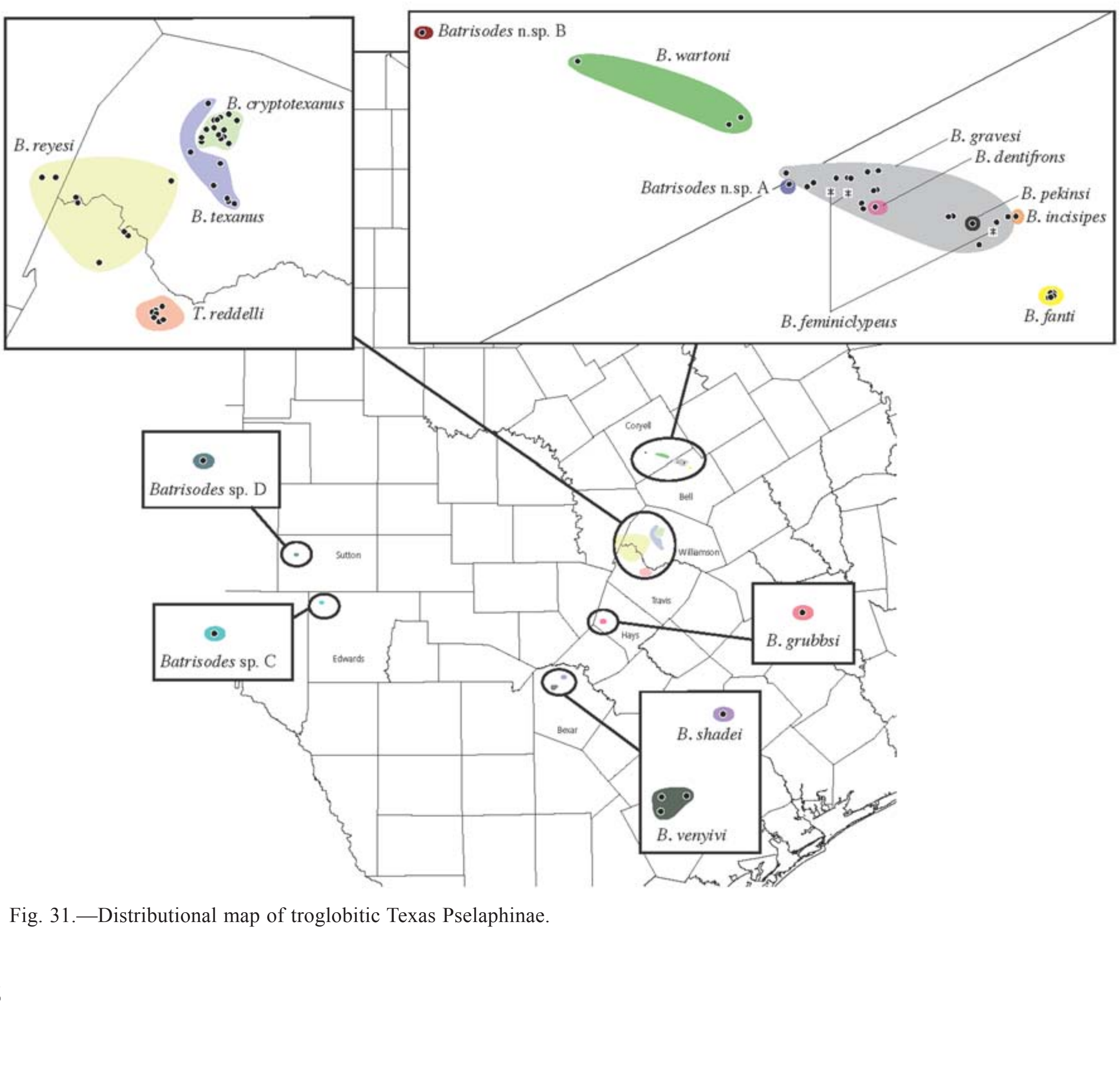


Fig. 31.—Distributional map of troglobitic Texas Pselaphinae.

1 female; Buchanan Cave, lower level, Fort Hood, 2 June 2005 (J. Fant, C. Pekins), 1 male, 1 female; Buchanan Cave, Fort Hood, 19 Oct. 2007 (J. Reddell, M. Reyes), 1 male, 2 females; Dual Sinks, Fort Hood, 22 Nov. 2005 (J. Fant, M. Reyes), 1 female; Endless Pit Cave, Fort Hood, 15 Oct. 2004 (J. Fant, C. Pekins, J. Reddell, M. Reyes), 1 male; Falling Turtle Cave, Fort Hood, 20 March 2004 (J. Fant, R. Ralph, J. Reddell, M. Reyes, M. Warton), 1; Fire Break Cave, Fort Hood, 17 Jan. 2008 (J. Fant, M. Reyes), 8 males, 3 females; Legless Visitor Cave, Fort Hood, 17 Oct. 2007 (J. Reddell, M. Reyes), 1 female; Molly Hatchet Cave, Fort Hood, 8-9 Oct. 2005 (J. Fant, M. Reyes), 1 male; Molly Hatchet Cave, Fort Hood, 19 May 2007 (J. Fant, J. Reddell, M. Reyes), 4 females; Price Pit Cave, Fort Hood, 18 Oct. 2007 (J. Reddell, M. Reyes), 1 male; Sanford Pit Cave, Fort Hood, 2 June 2005 (J. Fant, C. Pekins), 1; Streak Cave, Fort Hood, 18 Oct. 2007 (J. Reddell, M. Reyes), 1 male; Tres Dedos Cave, Fort Hood, 28 Nov. 2007 (M. Reyes), 1 male. *Coryell County*: Big Red Cave, Fort Hood, 3 Feb. 2003 (J. Krejca), ex: bedrock and clay wall at cave end, 1.

Comments.— This species has distinctive variation in relative lengths of the antennomeres which seem to be associated with groups of caves. Of the specimens on hand, individuals from Price Pit, Fire Break, Streak, Keyhole, Legless Visitor, and Tres Dedos Caves have the antennomeres relatively short, with antennomere VIII being no more than twice as long as wide, and sometimes a bit shorter, and antennomeres IV-VII being about twice as long as wide. Specimens from Buchanan, Molly Hatchet, and Bumelia Caves have the antennomeres longer and appearing much thinner, with VIII being clearly more than twice as long as wide, and antennomeres IV-VII about three times as long as wide. A specimen from Triple J Cave is intermediate in these features. The male head characters and the genitalia are identical for both long- and short-antennal forms.

Batrisodes (*Babnormodes*) *uncicornis* (Casey, 1897)

Records.—*Bexar County*: 40mm Cave, Camp Bullis, 25 Oct. 2003 (J. Reddell, M. Reyes), 1; 50 Bucket Cave, Camp Bullis. 6 March 2008 (P. Sprouse, K. McDermid), 1 female; 50 Bucket Cave, Camp Bullis, 8 May 2008 (P. Sprouse, K. McDermid), 1 male, 1 female; Accident Sink, Camp Bullis, 26 Oct. 2004 (C. Thibodaux, C. Murray), 1; 9 May 2005 (J. Reddell, M. Reyes), 1; B-52 Cave, Camp Bullis, 26 Oct. 2005 (J. Krejca, R. Myers), 1; Canyon Ranch Shelf Cave. 9 Aug. 2002 (C. Collins, K. White), 1; Cowbell Cave, no date (A. Grubbs), 6; Cross the Creek Cave, Camp Bullis. 1 Nov. 2001 (J. Reddell, M. Reyes), 2; Darling's Pumpkin Hole, Camp Bullis, 7 Jan. 2005 (J. Fant, B. Shade), 2; 9 May 2005 (J. Reddell, M. Reyes), 1; Elm Springs Cave. no date (A. G. Grubbs), 1; Hectors Hole, Camp Bullis. 15 April 2002 (J. Reddell, M. Reyes, G. Veni), 10; Hectors Hole, Camp Bullis, 11 April 2006 (J. Fant, A. Gluesenkamp), 1; Hold Me Back Cave, Camp Bullis, 20 May 2004 (J. Krejca, P. Sprouse), 1; Hold Me Back Cave, Camp Bullis. 2 Oct. 2007 (K. McDermid), 1 male, 1 female; Hold Me Back Cave, Camp Bullis. 8 May 2008 (P. Sprouse, K. McDermid), 1 female; Persimmon Pit. no date (A. G. Grubbs), 5; Platypus Pit, Camp Bullis. 8 May 2008 (K. McDermid), 1 female; Porcupine Pit, 24 Feb. 2000 (A. G. Grubbs, P. Pearse), 1; Root Toupee Cave, Camp Bullis, 16 June 2006 (J. Krejca), 1; Stahl Cave, Camp Bullis. 1 Nov. 2001 (J. Reddell, M. Reyes), 1; Strange Little Cave, Camp Bullis, 31 July 2005 (R. Myers), 1; Toad Cave. no date (A. G. Grubbs), 2; Wedge Cave, Camp Bullis, no date, (P. Sprouse), 1; Wedge Cave, Camp Bullis, 15 Nov. 2006 (P. Sprouse), 1. *Hays County*: Academy Cave, Texas State Campus, San Marcos. 26 Aug. 2005 (P. Sprouse), 1 male; Snake Cave, San Marcos. 20 Nov. 2001 (J. Reddell, M. Reyes), 2. *Kendall County*: Charley's Downclimb Cave, Sattler/Hoffman Ranch, 4 March 2005 (J. Krejca, V. Loftin), 1; Charley's Downclimb Cave, Sattler/Hoffman Ranch, 4 Mar. 2006 (J. Krejca, V. Loftin), 1; Hoffman Ranch Windmill Cave, 4 March 2005 (A. Gluesenkamp), 2. *Travis County*: Airman's Cave, 12 Jan. 2005 (P. Paquin), 1; Get Down Cave, 7 Jan. 2005 (P. Paquin, M. Sanders), 80% darkness inside cave, 1; Lost Oasis Cave, 22 May 2005 (P. Sprouse), 1; Maple Run Cave, 8 Nov. 2004 (M. Sanders), 1. *Williamson County*: Ballroom Cave no. 2, 27 Oct. 2008 (P. Paquin, B. Parker), 1; Beck Rattlesnake Cave, 10 Nov. 2000 (J. Reddell, M. Reyes), 3; Blessed Virgin Cave, 2.2 mi. W Round Rock, 14 Nov. 2002 (J. Fant, A. Grubbs), 2; Brown's Cave, 4 Mar. 2005 (P. Paquin), 100% darkness inside cave, 1; Cat Hollow No. 1 Cave, 10 Mar. 2005 (P. Paquin), inside cave, 2; Critchfield Bat Cave, 13 Mar. 2008 (C. Crawford), 1; Fossil Garden Cave, 11 Mar. 2005 (P. Paquin), 100% darkness inside cave, 4; Gullet Cave, 20 Nov. 2002 (J. Reddell, M. Reyes) 1; LakeLine Cave, 6 July 2003 (J. Krejca, P. Sprouse), 1; LakeLine Cave, 3 Mar. 2005 (P. Paquin), 100% darkness inside cave, 1; Lizard's Lounge Cave, 3.3 mi. W Georgetown, 14 July 2003 (J. Fant, A. Grubbs), 1; Mongo Cave, 14 Mar. 2005 (P. Paquin), inside cave, 1; Pencil Cactus Cave, 4.6 mi. SW Round Rock, 15 Oct. 1993 (A. G. Grubbs), 1; Poison Ivy Cave, 9 June 2005 (J. Reddell, M. Reyes), 1; Raccoon Lounge Cave, 2.2 mi. W Round Rock, 15 Jan. 2003 (J. Fant, A. Grubbs), 6; Rock Ridge Cave, 14 Mar. 2005 (P. Paquin), 100% darkness inside cave, 1; Three Mile Cave, 30 Oct.

2008 (P. Paquin, C. Crawford, B. Parker), 1; Waterfall Canyon Cave, 30 July 2008 (P. Paquin, C. Crawford, B. Parker), under rocks, clayish soil, 4; Waterfall Canyon Cave, 31 Oct. 2008 (P. Paquin, C. Crawford, B. Parker), under rocks, clayish soil, 1 female.

Batrisodes (*Babnormodes*) spp.

Records.—*Bell County*: Born Again Cave, Fort Hood, 3 March 2005 (J. Fant), 1 female; Endless Pit Cave, Fort Hood, 9 March 2005 (J. Fant), 1 female; Hammer Crack Cave, 11 Jan. 2005 (J. Fant, M. Reyes), 1 female; Plethodon Pit Cave, Fort Hood, 24 Mar. 2004 (J. Fant, C. Pekins, J. Reddell, M. Reyes), 1 female.

Comment.—These specimens cannot be placed to species without examination of associated males.

Batrisodes (*Babnormodes*) sp. A

Records.—*Coryell County*: Lucky Day Cave, Fort Hood, 12 March 2004 (J. Fant, M. Reyes), 1 female; 4 June 2003 (J. Reddell, M. Reyes), 3 females; 4 April 2007 (J. Fant, J. Reddell, M. Reyes), 1 female.

Comment.—This appears to be an undescribed species but cannot be described without a male.

Batrisodes (*Babnormodes*) sp. B

Records.—*Coryell County*: Sperry Cave, Fort Hood, 5 June 2006 (C. Pekins, J. Reddell, M. Reyes), 2 females; 12 May 2007 (J. Fant, J. Reddell, M. Reyes), 1 female.; 5 June 2006 (C. Pekins, J. Reddell, M. Reyes), 2 females.

Comment.—This appears to be an undescribed species but cannot be described without a male.

Batrisodes (*Declivodes*) sp.

Record.—*Travis County*: Midnight Cave, Austin. 29 Jan. 2004, M. Sanders, 1 female.

Comments.—This individual has about 12 lightly colored eye facets to each side, and is not conspecific with any of the described species. The somewhat broad head and robust form, small eyes, and densely punctate frons and clypeus indicate placement in the subgenus *Declivodes*. The described North American species in this subgenus are typically associated with ants. Published ant associations are for members of *Formica exsectoides* and *F. subsericea*, with one record for the ant *Lasius claviger* (Chandler, 1997).

Batrisodes (*Excavodes*) *cryptotexanus*
Chandler and Reddell, 2001

Records.— *Williamson County*: Blow Hole Cave, 2 Apr. 2007 (P. Paquin, C. Thibodaux, B. Larsen), 2 females; Corn Cobbs Cave, 15 Oct. 2008 (P. Paquin, B. Parker, L. Baird), under rocks, clayish soil, 1 female; Dragonfly Cave, Sun City, 29 May 2001 (M. Reyes), 3; Electro-Mag Cave, 27 Dec. 2006 (P. Paquin, K. White, C. Crawford), hand collecting, 1 female; Hourglass Cave, 5 June 2001 (L. J. Graves, M. Reyes), 1 female; Rattlesnake Inn Cave, 1 June 2001 (L. J. Graves, J. Reddell, M. Reyes), 2 females;-Rattlesnake Inn Cave, 27 Dec. 2006 (P. Paquin, C. Crawford), hand collect, 1 male, 1 female; Shaman Cave, Sun City, 12 Dec. 2006 (J. Reddell, M. Reyes), hand collect, 1 male; Ventilator Cave, 28 April 2002 (J. Reddell, M. Reyes), 2 females.

Batrisodes (*Excavodes*) *texanus* Chandler, 1992

Records.—*Williamson County*: Cobb Cavern, 3 Feb. 2003 (J. Reddell, M. Reyes), 1 female; Cobb Cavern, 30 March 2004 (M. Warton), 1 male; Cobb Cavern, 24 Nov. 2004 (P. Paquin), 1 male; Inner Space Cavern, 1 Mar. 2007 (P. Paquin, C. Collins, K. White, C. Crawford), 1 male, 1 female; Sunless City Cave, 28 Feb. 2007 (P. Paquin, et al.), 1 female; Sunless City Cave, 8 Jan. 2008 (K. White), 1; Waterfall Canyon Cave, 31 Oct. 2008 (P. Paquin, B. Parker), under rocks, clayish soil, 1 male, 1 female.

Comments.—*Batrisodes texanus* is included on the federal list of endangered species (U.S.F.W.S., 1993). However, the common name used for this species is the Coffin Cave mold beetle, which is incorrect. The species found in Coffin Cave (Williamson County) is *Batrisodes cryptotexanus* (see Chandler and Reddell, 2001). To correct this situation, we propose the common name "Inner Space Cavern mold beetle" for *B. texanus*, based on the type locality of that species.

Batrisodes (*Excavodes*) sp. C

Two female specimens from Edwards County were placed as *B. reyesi* in Chandler and Reddell (2001). Since this record represented a surprisingly distant range extension for an otherwise very local species (see figure 31), the specimens were re-examined and found to be representatives of an undescribed species, with their lateral vertexal carinae much less prominent than in *B. reyesi*. This species is probably a member of the subgenus *Excavodes*. The single female *Batrisodes* from Caverns of Sonora, Sutton County (Chandler and Reddell, 2001) is another probable member of the subgenus *Excavodes*, and is treated for the purposes of the map as *Batrisodes* (*Excavodes*) sp. D.

Record.—*Edwards County*: Wyatt Cave, 21 Sept. 1963 (J. Reddell, D. McKenzie), 2 females.

Hamotus (*Hamotoides*) *electrae* Park, 1942

Records.—*Bexar County*: Canyon Ranch Shelf Cave. 9 Aug. 2002 (C. Collins, K. White), 1. *Hays County*: Taylor Bat Cave, 7 Mar. 2005 (P. Paquin), 100% darkness inside cave, 2 males; *Mason County*: James Bat Cave. 6 July 2003, 1 male; *Sutton County*: Felton Cave. 27 Feb. 2008 (J. Krejca), 4 females; *Val Verde County*: Judge's Chamber Cave, just upriver from confluence of Devil's River and Dry Devil's River, 15 Oct. 2005 (M. Sanders), 1 male.

Rhexius stephani Chandler, 1990

Record.—*Bexar County*: Camp Bullis, surface above Headquarters Cave, 28 May 2007 (Zara Environmental staff), berlese leaf litter, quadrat HZ 38, 1 female.

Sebaga ocampi Park, 1945

Record.—*Bexar County*: Up the Creek Cave, Camp Bullis, 11 May 2005 (J. Reddell, M. Reyes), 1.

Comment.—This species was taken on the underside of a rock in total darkness.

Texamaurops reddelli Barr and Steeves, 1963

Records.— *Travis County*: Gallifer Cave, 7 Jan. 2005 (P. Paquin), under rocks, hand collect, 1 female; Kretschmarr Cave, 3 Apr. 2007 (P. Paquin, K. O'Connor), 2 females; Tardus Hole, 6 Apr. 2007 (P. Paquin, K. O'Connor), 2 males.

Tmesiphorus costalis LeConte, 1849

Records.—*Bell County*: Chupacabra Pit Cave, Fort Hood, 3 May 2005 (J. Fant, M. Reyes), 1; Loma Bonita Sink, Fort Hood, 1 April 2006 (J. Fant, M. Reyes), 1; Lost Chasm Cave, Fort Hood, 4 May 2005 (J. Fant, J. Reddell, M. Reyes), 1; Nolan Creek Cave, Fort Hood, 20 May 2007 (J. Fant, J. Reddell, M. Reyes), 1; Plethodon Cave, Fort Hood, 3 May 2005 (J. Fant, J. Reddell, M. Reyes), 1; Pump House Cave, Fort Hood, 28 Aug. 2004 (J. Fant, M. Reyes), 2; Talking Crows Cave, Fort Hood, 18 Aug. 2003 (C. Pekins, J. Reddell, M. Reyes), 2; Talking Crows Cave, Fort Hood. 21 July 2008 (J. Reddell, M. Reyes), 1; Thumbs Up Cave, Fort Hood, 12 Nov. 2005 (M. Reyes), 1; Tres Dedos Cave, Fort Hood, 10 June 2005 (J. Fant), 1. *Hays County*: Taylor Bat Cave, 7 Mar. 2005 (P. Paquin), 100% darkness, inside cave, hand collecting, 1 male. *Travis County*: Gallifer Cave, 10 Apr. 2007 (P. Paquin, M. Sanders, K. O'Connor), 1 male. *Williamson County*: Karst Feature F-5, The Sanctuary, 3.3 mi. W Georgetown, 3 Nov. 2003 (A. G. Grubbs), 1; Poison Ivy Cave, 9 June 2005 (J. Reddell, M. Reyes), 1; Salt Lick Cave, 3.3 mi. W Georgetown, 2003 (A. G. Grubbs), 1.

Comment.—This probable troglophile has been found on the underside of rocks in both the twilight zone and total darkness.

Thesium sp.

Record.—*Williamson County*: Ventilator Cave, 28 April 2002 (J. Reddell, M. Reyes), 1.

Comments.—*Thesium* is a large Neotropical group, with only a single species known from the United States. The single specimen taken from Ventilator Cave is not the widespread eastern *Thesium cavifrons* LeConte, and very likely is one of the described but poorly known Neotropical species. Species placement cannot be resolved at this time.

Trimioarcus musamator Chandler, 1992

Records.—*Bell County*: Cuchilla Cave, Fort Hood. 11 Dec. 2002 (M. Reyes), Berlese of leaf litter, 33. *Coryell County*: Porter Cave, Fort Hood, 31 March 2004, C. Pekins, J. Reddell), Berlese of leaf litter, 1. *Williamson County*: Prospectors Cave, Brushy Creek Reserve, 11 Feb. 2002 (M. Reyes, M. Warton), 1. Rock Ridge Cave, 21 Dec. 2006 (P. Paquin, K. White, C. Crawford), 1.

Comment.—This Texan species has always been taken from leaf litter in or at the mouths of caves. There are now a number of records from leaf litter samples that were not taken near caves.

ACKNOWLEDGMENTS

This is Scientific Contribution Number 2372 from the New Hampshire Agricultural Experiment Station. This is publication no. 17 of the Karst Biosciences and Environmental Geophysics Research Laboratories, SWCA Environmental Consultants.

We are especially grateful to Jerry Fant, Charles Pekins, Marcelino Reyes, and Mike Warton for their assistance in the field on Fort Hood. We also thank Andy Grubbs, Jean Krejca, Mark Sanders, Bev Shade, Peter Sprouse, and Kemble White for assistance in the field or providing specimens for this study. Research on Fort

Hood was funded by The Nature Conservancy through cooperative agreement DPW-ENV-02-A-001 between the Department of the Army and The Nature Conservancy. Information contained in this report does not necessarily reflect the position or the policy of the government and no official endorsement should be inferred.

We would like to thank Chris Carlton (Louisiana State University) for reviewing the manuscript.

LITERATURE CITED

Barr, T. C. 1974. Revision of *Rhadine* LeConte (Coleopetera, Carabidae). I. The subterranea group. American Museum Novitates, No 2539:1-30.

Chandler, D. S. 1992. The Pselaphidae (Coleoptera) of Texas caves. Texas Memorial Museum Speleological Mono-graphs, 3:241-253.

Chandler, D. S. 1997. Coleoptera: Pselaphidae. In A Catalog of the Coleoptera of America North of Mexico. U.S.D.A., Agriculture Handbook Number 31. 118 pp.

Chandler, D. S., and J. R. Reddell. 2001. A review of the ant-like litter beetles found in Texas caves (Coleoptera: Staphylinidae: Pselaphinae). Texas Memorial Museum Speleological Monographs, 5:115-128.

Gertsch, W. J. 1992. Distribution patterns and speciation in North American cave spiders with a list of the troglobites and revision of the cicurinas of the subgenus *Cicurella.* Texas Memorial Museum Speleological Monographs, 3:75-122.

Löbl, I.., and C. Besuchet. 2004. Subfamily Pselaphinae Latreille, 1802, pp. 272-329. In: Löbl, I., and A. Smetana (editors). Catalogue of Palaearctic Coleoptera. Volume 2. Hydrophiloidea - Histeroidea - Staphylinoidea. Apollo Books, Stenstrup. 942 pp.

Paquin, P., and R. Anderson. 2009. The first troglobitic weevil (Coleoptera: Curculionidae) in North America? Description of a new eyeless species of *Lymantes* Schoenherr from Central Texas caves. Texas Memorial Museum Speleo-logical Monographs, 7. Studies on the cave and endogean fauna of North America, V. Pp. 115-123.

Park, O. 1951. Cavernicolous pselaphid beetles of Alabama and Tennessee, with observations on the taxonomy of the family. Geological Survey of Alabama, Museum Paper, 31:1-107.

Park, O. 1953. New or little known pselaphid beetles of the United States, with observations on taxonomy and evolution of the family Pselaphidae. Bulletin of the Chicago Academy of Sciences, 9 249-283.

U.S. Fish and Wildlife Service. 1993. Endangered and threatened wildlife and plants: Coffin Cave mold beetle (*Batrisodes texanus*) and the Bone Cave harvestman (*Texella reyesi*) determined to be endangered. Federal Register, 58 43818–43820.

Holsinger, John R. and James R. Reddell. 2009. Amphipoda from caves and springs on Fort Hood, Bell and Coryell Counties, Texas [Amphipoda de cuevas y manantiales en los condados de Bell y Coryell, Texas]. Texas Memorial Museum Speleological Monographs, 7. Studies on the cave and endogean fauna of North America,V. Pp. 141-146.

AMPHIPODA FROM CAVES AND SPRINGS ON FORT HOOD, BELL AND CORYELL COUNTIES, TEXAS

John R. Holsinger

Department of Biological Sciences
Old Dominion University
Norfolk, Virginia 23529-0266 U.S.A.
Email: jholsing@odu.edu

and

James R. Reddell

Texas Natural Science Center
The University of Texas at Austin, PRC 176, 10100 Burnet
Austin, Texas 78758 U.S.A.
Email: jreddell.caves@mail.utexas.edu

ABSTRACT

Three species of Amphipoda are recorded from caves and springs on Fort Hood. The epigean species *Hyaella* sp. nr. *azteca* Saussure is recorded from one spring. New records of the stygobitic species *Stygobromus bifurcatus* (Holsinger) and *S. russelli* (Holsinger) are recorded from caves and springs. Descriptions of habitat and a distribution map are included.

RESUMEN

Se registran tres especies de Amphip da de cuevas y manantiales en Fort Hood. La especie epigea *Hyaella* sp. nr. *azteca* Saussure se registra de un manantial. Nuevos hallazgos de las especies estigobiontes *Stygobromus bifurcatus* (Holsinger) y *Stygobromus russelli* (Holsinger) de cuevas y manantiales se incluyen. Se presentan descripciones del hábitat y mapas de distribución.

INTRODUCTION

Fort Hood is a 217,000 acre military reservation located in Bell and Coryell Counties, Texas. Physiographically it is located in the Lampasas Cut Plains, an area of hills and mesas dissected by creeks and rivers. Two large (Owl Creek and Cowhouse Creek) and numerous smaller creeks occur on the reservation. These all drain eventually into the Leon River, with a large dam forming Belton Lake along the eastern edge of Fort Hood.

The only cavernous unit on Fort Hood is the Edwards Limestone. This is underlain by the softer but non-cavernous Comanche Peak Limestone. Fort Hood is highly dissected by creeks and deep canyons. Water entering the Edwards Limestone through sinkholes and caves emerges from numerous seeps and springs at the base of the Edwards Limestone. With few exceptions these seeps and springs flow only after heavy rains. The only major subterranean stream flows through the 2,000 m+ long Rocket River Cave System. Water sinks into large sinkholes on the southern edge of a plateau, flows underground, and emerges from talus to form Cave Springs and from the Flowstone Spring Cave entrance. The stream in Briar Cave to the west of the Rocket River Cave System probably emerges from Wagontop Spring. The small stream in Tippit Cave presumably emerges from talus in a deep canyon immediately west of the cave. The only other cave streams that are clearly associated with springs are Nolan Creek Cave and Geocache Cave south of Nolan Creek in southern Fort Hood. Both emerge from springs in less than 100 m from the cave streams and flow north into North Nolan Creek which has dissected the cavernous limestone. The origin of the water in these caves is doubtless from a limited area of Edwards Limestone upslope from the caves. The only other significant cave stream is in Fire Break Cave. The source of the water is presumably from numerous sinkholes to the south of the cave. It probably emerges from one or more springs in deep canyons north of the cave. Water from Asellid Spring, Ostracod Spring, and Tres Dedos Cave apparently drains south into the drainage of Cowhouse Creek. Water from Bumelia Well Cave, Endless Pit Cave, and Fire Break Cave presumably drains north into canyons that flow east into Belton Lake. The water in Hidden Pool Cave probably is derived from a narrow upland area west of the cave and emerges from talus in a deep canyon below the cave entrance.

Most collections from caves were made by hand. The only concerted effort to obtain aquatic fauna was in 2007 when aquifer levels were extremely high. Three caves and seven springs were sampled by placing mopheads in cave streams and pools and in or immediately below spring openings. Amphipods were found in two caves and three springs. By contrast asellid isopods were recovered from one cave and seven springs.

Fig. 1-2.—*Stygobromus russelli* female, from Zesch Ranch Cave, from Mason County, Texas; images by Robert W. Mitchell. 1 (top), lateral aspect; 2 (bottom), ventral view with eggs.

The aquatic fauna of Fort Hood remains poorly known with only three stygobites, the asellid isopod *Caecidotea reddelli* (Steeves) and the amphipods *Stygobromus bifurcatus* (Holsinger) and *S. russelli* (Holsinger). *Caecidotea reddelli* is an incredibly abundant species found in springs, seeps, and caves. When aquifer levels are high it may be found in the smallest seeps and be present in the thousands in springs. Specimens may be found in spring runs up to 20 m from the spring opening with dead and dying individuals present in larger numbers as distance increases from the opening. The only occurrence of amphipods in springs is following heavy rains when they are presumably washed from the openings. They are never found more than a few meters from the opening and never in large numbers. Additional information on *S. bifurcatus* and *S. russelli* can be found in Holsinger (1967).

RECORDS

Hyalella sp. nr. *azteca* (Saussure)

Record.—*Bell County*: Geocache Spring, 30 July 2007 (C. Pekins, J. Reddell, M. Reyes), 1 specimen.

Stygobromus bifurcatus (Holsinger)

Records.—*Bell County*: Fire Break Cave, 16 Feb. 2005 (J. Fant, M. Reyes), 1 specimen; Ostracod Spring, 30 July 2007 (C. Pekins, J. Reddell, M. Reyes), ex mophead, 1 female. *Coryell County*: Briar Cave, 20 March 2004 (J. Krejca, V. Loftin), 3 females; Tippit Cave.

Comments.—This species is also known from springs in other parts of Bell County, from a spring in Hays County, from caves and springs in Travis County, and from caves in Kendall, Lampasas, San Saba, and Williamson Counties. It occurs with *S. russelli* in a number of localities.

Stygobromus russelli (Holsinger)

Records.—*Bell County*: Asellid Spring, 25 July 2007 (J. Reddell, M. Reyes), 2 females; 30 July 2007 (C. Pekins, J. Reddell, M. Reyes), ex mophead, 1 female; Bumelia Well Cave, 24 Oct. 1994 (D. Allen, D. Love), 1 female; 5 Nov. 1998 (J. Cokendolpher, J. Krejca), 17 females; Endless Pit Cave, 9 March 2005 (J. Fant), 1 female; Fire Break Cave, 16 Feb. 2005 (J. Fant, M. Reyes), 6 females; 20 Feb. 2006 (M. Reyes), 1 female; Geocache Cave, 18 May 2004 (J. Fant, J. Reddell, M. Reyes), 3 small specimens; 11 June 2005 (J. Fant, M. Reyes), 3 small specimens, 30 July 2007 (C. Pekins, J. Reddell, M. Reyes), ex mophead, 1 juvenile; Nolan Creek Cave; Tres Dedos Cave, 24 March 1999 (J. Reddell, M. Reyes), 8 females; 10 June 2005 (J. Fant), 4 females. *Coryell County*: Hidden Pool Cave, 13 Oct. 2005 (J. Fant, J. Reddell, M. Reyes), 2 females, 1 juvenile; 27 Oct. 2007 (J. Reddell, M. Reyes), ex mophead, 1 female; Rocket River Cave, 16 July 1993 (J. Reddell, M. Reyes) 1 small specimen; Tippit Cave (type-locality), 8 April 1999 (L. J. Graves, M. Reyes), 1 female.

Fig. 3.—Group of *Stygobromus russelli* in Bumelia Well Cave, Fort Hood; image by James C. Cokendolpher.

Comments.—This common, widespread species is also known from springs in other parts of Bell County, from caves and springs in Bexar and Travis Counties, from a spring and artesian well in Hays County, from caves and the hyporheic zone in Medina County, from a cave, spring and hyporeic zone in Kendall County, and from caves in Burnet, Comal, Mason, San Saba, and Williamson Counties. It exhibits considerable variation across its range and may be a complex of cryptic species. It also occurs with *S. bifurcatus* in a number of localities as noted above.

HABITAT
Bell County

Asellid Spring: This spring emerges from below the base of the Edwards Limestone at the head of a shallow blind canyon. Asellid isopods (probably *Caecidotea reddelli*) were present by the thousands in the spring run. Aquatic fauna recovered from a mophead placed in the spring opening included eyed flatworms, snails, ostracods, asellid isopods, amphipods (*Stytobromus russelli*), mites, and Trichoptera larvae.

Bumelia Well Cave: The entrance is a 0.9 m diameter, 6.4 m deep drop. At the bottom of the drop a narrow crevice leads to a short climb up to "The Window." This overlooks Bumelia Well, a 9.27 m pit. At the bottom of this, an offset leads to Hammerfall Pit, a 9.3 m drop. At the bottom of this pit, a passage containing pools of water extends as a tight crawlway for 12.2 m before becoming too narrow. The only aquatic fauna obtained were amphipods (*Stygobromus russelli*) and asellid isopods (*Caecidotea reddelli*).

Endless Pit Cave: The entrance is an elongate opening up to 1 m wide and 3 m long. It drops 3 m to a ledge and then an additional 9 m to the floor. A passage about 0.4 m wide and 4 m high extends about 5 m where it enlarges to 2 m wide and up to 8 m high. The passage ends in a solid wall of red clay fill. A cross passage just before the end is too small upstream but can be squeezed into for about 2 m. It continues too small but with running water. The only aquatic fauna obtained were amphipods (*Stygobromus russelli*).

Fire Break Cave: The entrance is a solid walled pit about 1 m in diameter that drops at a steep angle to the northwest for 2.5 m at which point the shaft drops vertically for an additional 2.3 m to a floor of dark gray clay. The floor slopes beneath an undercut wall for 0.5 m to a crawlway that extends to the east for 3 m to a 1.5 m drop. This opens directly into a room and joint-guided passage that extends in two directions. To the northwest the passage opens into a room directly beneath the entrance shaft. To the southeast the floor descends along a narrow winding joint with highly sculpted walls. The lowest part of the passage is about 10 m beneath the surface. This crevice was enlarged to gain access to a

Fig. 4.—Distribution of Amphipoda on Fort Hood: triangles = *Stygobromus bifurcatus*; open squares = *S. bifurcatus* and *S. russelli*; circles = *S. russelli*; closed square = *Hyalella* sp. nr. *azteca.*

stream passage with several constrictions. The last constriction led to the top of a 2 m drop, followed immediately by a 10 m deep pit with a waterfall dropping into it. This opens into a room with two passages extending from the bottom. One is an upstream infeeder too small to follow, but the other continues too small for human entry. Pools at the bottom of the waterfall drop contained amphipods (*Stygobromus bifurcatus* and *Stygobromus russelli*) and undetermined asellid isopods (probably *Caecidotea reddelli*).

Geocache Cave: The entrance is a 6 m wide, 2 m high opening at the head of a shallow canyon draining into North Nolan Creek. Large boulders in front of the entrance channel water into the cave and the floor of the front section is of recent sediment. The passage enlarges to 7 to 8 m for about 5 m, where the ceiling height drops to about 1.8 m. About 9 m from the entrance the passage abruptly narrows to about 5 m and the cave gradually lowers. This passage was opened large enough to allow entry for an additional 4 m before becoming impassable. Near the back a small running stream emerges from the floor but sinks after a few meters. The stream dries periodically. A mophead placed in the stream contained snails, copepods, ostracods, amphipods (*Stygobromus russelli*), asellid isopods (probably *Caecidotea reddelli*), mites, Collembola Symphypleona, and Diptera larvae.

Geocache Spring: Geocache Spring emerges from talus below the entrance of Geocache Cave. The water presumably originates in the cave. A pool has been formed by rocks placed below the spring opening. Water flows north into North Nolan Creek. Aquatic fauna recovered from a mophead placed in the spring outlet included eyed flatworms, snails, copepods, ostracods, amphipods (*Hyalella* sp. nr. *azteca*), asellid isopods (probably *Caecidotea reddelli*), Odonata nymphs, Coleoptera larvae, and Diptera larvae.

Nolan Creek Cave: The cave is entered through a crevice-like 2.1 m deep sink. This leads to a 22.9 m long, 3 to 4.5 m wide passage. The ceiling height does not exceed 1 m. From the southwest end of the passage a low 4.5 m wide bedding-plane crawl contains about 0.1 m of slow-moving water. The stream sinks into a narrow crevice. Upstream the passage was explored for about 12 m to a gradual lowering of the ceiling. The cave stream emerges as a spring situated at the foot of the bluff about 12 m below and 60 m west of the cave entrance. The spring flows into a large pool that then drains into North Nolan Creek. The stream contains ostracods (*Ankylocythere sinuosa*) taken from the crayfish *Procambarus* (*Girardiella*) *simulans simulans*, amphipods (*Stygobromus russelli*), and asellid isopods (*Caedidotea reddelli*). The crayfish doubtless entered the cave from the spring.

Ostracod Spring: The spring emerges from a small hole in solid rock on a slope leading down to a shallow drainage way. Other small seeps and springs emerge from the bottom of the drainage. Aquatic fauna recovered from a mophead placed in a small pool immediately below the spring opening included snails, copepods, ostracods, amphipods (*Stygobromus bifurcatus*), mites, Coleoptera larvae, Trichoptera larvae, and Diptera larvae. Ostracods were extremely abundant.

Tres Dedos Cave: Three vertical entrances drop from a surface sink about 3.7 m wide by 15 m long and 1.4 m deep. The principal entrance is a 12.95 m deep vertical shaft. Part of the way down this drop a narrow passage extends back to connect to the other two entrances. At the bottom of the entrance shaft the passage continues down two short drops before becoming level. A high, very tight fissure passage extends for about 20 m. It is necessary to squeeze or crawl along the bottom of the passage. At the end of the explored area small holes in the floor lead a few centimeters down to water. The cave passage here becomes too narrow to follow but can be seen to enlarge after about one meter. The cave has strong airflow. The only aquatic fauna found in the cave were amphipods (*Stygobromus russelli*).

Coryell County

Briar Cave: The entrance is a rock-filled sinkhole about 4.6 m in diameter and originally overgrown with briars. On one side a slope leads down to a bedding-plane chamber about 3 m wide and 6 m long. A narrow crevice in the floor was enlarged by excavation to reveal a 0.9 m wide, 1.2 m long, 6.1 m deep pit. .At the bottom a small passage extends a short distance to intersect an enlarged joint-guided passage almost large enough to stand in. To the right, this passage pinches off completely after about 3 m. To the left, the passage extends about 4.6 m to a 0.8 m drop in the floor. The joint-guided passage also ends just beyond the drop. At the bottom of the drop, a crawlway extends in two directions. The passage to the left extends about 18 m before water covers the floor. The passage is 0.6 to 1.2 m high and 1.2 m wide, with one area up to 4.3 m high. One side passage about 27 m from the entrance extends to the left but is too small to enter, but appears to be an infeeder since a sediment bar has formed in the main passage. A short distance beyond this, the passage becomes very tight. This is 57 m from the intersection. This continues for an estimated 33 m before the passage height is only about 0.1 m with 0.12 m of water covering the floor. One open joint perpendicular to this passage is up to 2.7 m high but is impassable at both ends. The right-hand passage from below the drop extends about 104 m before water is encountered. An additional 60 m was explored beyond this point and continues. A side passage connects to Plateau Cave No. 2 as proven by smoke, but is too small for human entry. Aquatic fauna collected were amphipods (*Stygobromus bifurcatus*), and undetermined asellid isopoda (probably *Caecidotea reddelli*). Eyed crayfish were observed.

Hidden Pool Cave: The entrance to the cave is an opening about 1 m wide and 0.8 m high at the base of a limestone outcrop above a steep talus slope. The passage extends into a passage about 5 m wide and up to 1.5 m high. It is divided by collapse for about 3 m. After 5 m the ceiling drops and a passage about 0.8 m high extends for about 3 m before becoming 1.5 m high. The passage narrows to about 2 m, then enlarges again to about 4 m wide. Two small drains on the left wall are too small to follow. Near the end of the passage a series of rimstone dams extend up to end at a shallow pool. The cave ends in a small water-floored passage too small to follow. Water flows from the passage at times and disappears down a small hole. The pool periodically dries. The only aquatic fauna obtained were undetermined oligochaete worms and amphipods (*Stygobromus russelli*).

Rocket River Cave System (Rocket River Cave): The entrance to Rocket River Cave is at the junction of three shallow draws draining an extensive area. A crawlway extends about 3 m to the top of a climbable 3.7 m deep drop. A squeezeway from the bottom of this water-floored pit shortly intersects a wide gravel-floored crawlway. This extends back to the west to eventually connect to B.R.'s Secret Cave. To the east the crawlway opens up after about 30 m into stream conduit passage ranging in height from 1.2 to 3.4 m and in width up to 3 m. Several natural bridges and flowstone dams occur in this stretch of the cave. About 518 m from the beginning of the stream passage the Overflow Passage extends to the left. Straight ahead the cave continues for about 180 m where it intersects the passage from Cave Springs Cave on the right. Straight ahead a narrow 0.8 m high passage extends for about 60 m where it is blocked by the talus collapse at Cave Springs. The Overflow Passage extends to the left for about 76 m where a 1.4 m drop opens into a wider ponded passage, the Copperhead Lagoon. This lake ends in a 1.8 m long sump. Beyond the sump, the passage continues as a narrow, winding passage for 91 m where it intersects the Plateau Borehole. Upstream the passage is blocked by clay fill, but downstream it continues for about 30 m to a collapse zone that required excavation to pass. Beyond the collapse the passage continues for about 107 m to Flowstone Falls, a 2.1 m drop. About 49 m beyond this the collapse material from Double Tree Cave is encountered. Beyond this collapse, the cave passage continues to end at the Flowstone Spring Cave entrance. Aquatic fauna collected were undetermined copepods, ostracods (*Ankylocythere sinuosa* taken from the crayfish *Procambarus* (*Girardiella*) *simulans simulans,* amphipods (*Stygobromus russelli*) and asellid isopods (*Caecidotea reddelli*).

Tippit Cave: The entrance is a sinkhole about 0.9 m in diameter. About one meter below the surface two passages slope down. One to the east extends about 3 m before ending. The second slopes steeply down for about 6 m to the lip of a crevice-like pit in the floor. Ledges along the sides allow access to the continuation of the passage. On the far side of the pit a slope leads up and ends after about 6 m. It is possible to climb down to a large breakdown pile about 1.2 m at the shallowest point. To the west this leads down into a 3 m high, 3 m wide passage that extends about 9 m to where a 0.9 m wide, 0.3 m high crawlway extends for a short distance before becoming too small. The floor and walls throughout this part of the cave are covered in red clay. A slope down over breakdown to the east leads into the main passage of the cave. This extends back under the entrance as a 3 to 6 m wide, 2.4 to 3 m high passage for about 12 m to a funnel-shaped depression that leads down to a narrow pit. This drops about 3 m to a lower level passage that contains a small flowing stream. The passage is too small to follow in either direction. Beyond this pit on the upper level, the passage continues for about 11 m where the ceiling lowers to a crawlway. This extends for about 9 m before the ceiling rises to 3.7 m. The passage widens somewhat and extends about 12 m where massive breakdown blocks further passage. This breakdown probably correlates with the side of a canyon. The stream contained amphipods (*Stygobromus bifurcatus* and *Stygobromus russelli*), and asellid isopods (*Caecidotea reddelli*).

ACKNOWLEDGEMENTS

Special thanks go to Jerry Fant, Charles Pekins, and Marcelino Reyes for their assistance in the field. We also thank Doug Allen, James Cokendolpher, Jean Krejca, Vivian Loftin, and Dan Love for providing additional specimens. Research on Fort Hood was funded by The Nature Conservancy through cooperative agreement DPW-ENV-02-A-001 between the Department of the Army and The Nature Conservancy. Information contained in this report does not necessarily reflect the position or the policy of the government and no official endorsement should be inferred.

LITERATURE CITED

Holsinger, J. R. 1967. Systematics, speciation, and distribution of the subterranean amphipod genus *Stygonectes* (Gammar-idae). United States National Museum, Bulletin 259:1-176.

Elliott, William R., and James R. Reddell. 2009. New records of *Speodesmus* (Diplopoda: Polydesmida: Polydesmidae) from Fort Hood, Bell and Coryell Counties, Texas [Nuevos registros de *Speodesmus* (Diplopoda: Polydesmida: Polydesmidae) de los condados Fort Hood, Bell y Coryell, Texas]. Texas Memorial Museum Speleological Monographs, 7. Studies on the cave and endogean fauna of North America, V. Pp. 147-150.

NEW RECORDS OF *SPEODESMUS* (DIPLOPODA: POLYDESMIDA: POLYDESMIDAE) FROM FORT HOOD, BELL AND CORYELL COUNTIES, TEXAS

William R. Elliott

Missouri Department of Conservation
Resource Science Division
Cave Lab, Runge Conservation Nature Center, P.O. Box 180
Jefferson City, Missouri 65102-0180, U.S.A.
Email: Bill.Elliott@mdc.mo.gov

and

James R. Reddell

Texas Natural Science Center
The University of Texas at Austin, PRC 176, 10100 Burnet
Austin, Texas 78758 U.S.A.
Email: jreddell.caves@mail.utexas.edu

ABSTRACT

New records are provided for the troglobitic millipede *Speodesmus castellanus* in caves on Fort Hood, Bell and Coryell Counties, Texas. Additional records for the genus are also provided for female and immature specimens not identifiable to species but probably belonging to *S. castellanus*.

RESUMEN

Se proporcionan nuevos registros para el milpiés troglobio *Speodesmus castellanus* en cuevas en los condados de Fort Hood, Bell y Coryell, Texas. Se proporcionan registros adicionales de especimenes hembras e inmaduros para el género, no identificables a especie pero que probablemente pertenezcan a *S. castellanus*.

INTRODUCTION

The genus *Speodesmus* Loomis, 1939, is an important element of the cavernicole fauna of Texas, with six described and several undescribed species. *Speodesmus tuganbius* (Chamberlin) from western Texas also occurs in New Mexico and another species is known only from a cave in Colorado (Loomis, 1939; Chamberlin, 1952; Causey, 1959; Shear, 1984; Elliott, 2004). All species are troglobitic.

The only species known from Fort Hood is *S. castellanus* Elliott, described from adults in six caves. Females and immatures were tentatively identified as this species from eleven additional caves. The present report includes records of adult males from an additional 18 caves and females or immatures from an additional 10 caves.

Specimens of *S. castellanus* have been taken from clay banks in total darkness, but they have also been found (sometimes abundant) in soil in the twilight zone of sinkhole entrances to caves.

METHODS

Specimens were preserved in 80% ethanol and stored in patent lipped vials within museum jars. Specimens were examined up to 80X on a stereoscope. Gonopods of all adult males were examined, and all were *Speodesmus castellanus*.

RESULTS

A total of 148 specimens was examined, of which 55 were adult males, 51 were adult females, and 42 were immature.

The species is widely distributed across northern Fort Hood (Fig. 1). The only specimens of the genus from southern Fort Hood are two juveniles from Nolan Creek Cave. This cave is physiographically isolated from caves in northern Fort Hood and it will be interesting to determine if it contains *S. castellanus* or an undescribed species.

There was little variation except in body size, from 7 to about 11 mm for adults. There was no significant difference from across Fort Hood or from specimens taken in different habitats. In some vials adult males were larger, in some females were larger. Some sexual dimorphism was noted: males usually have longer, thicker legs, as in other species, but males had no obvious leg bumps. A few females had swollen cyphophores on segment 3. The overall sex ratio was about equal. Immatures were about 29% of the 148 total specimens. All preanal scales that were examined (most adults) had two setae, as in the species description. Many smaller specimens were fragmented, as were some adults, but the collections were good for determination.

Figure 2 shows an annual cycle in the ratio of immatures to adults. Data were grouped into four seasons and the percentage of immatures was graphed in the total for each season. Immatures are at a low in summer (11%), then peak in the fall at 39% and decline through the winter to spring as they mature into adults. From this it appears that the species has an annual cycle and lays eggs mostly in the summer. A more systematic census is required to verify this, especially since there is a collecting bias for larger specimens. Another potential problem is that in dry summer months specimens are generally rare and there have been fewer collections made during these months than at other times of the year.

Speodesmus sp.

Records.—*Bell County*: Buchanan Cave; Figure 8 Cave; Sanford Pit Cave; Streak Cave; Triple J Cave. *Coryell County*: Big Red Cave; Copperhead Cave; Cornelius Cave; Ingram Cave; Mixmaster Cave; Tippit Cave.

New records.—*Bell County*: Buchanan Cave, 2 June 2005 (J. Fant, C. Pekins), lower level, 1 female; Chupacabra Pit Cave, 3 May 2006 (J. Fant, M. Reyes), 1 female; Cross Crack Cave, 5 April 2007 (J. Reddell), 1 female, 2 immature males; Estes Cave, 27 Sept. 2005 (J. Krejca, C. Phillips), 1 female; Green Carpet Cave, 10 Oct. 2004 (J. Fant, C. Murray, M. Reyes, M. Warton), 1 immature female; Molly Hatchet Cave, 8-9 Oct. 2005

Fig. 1.—Distribution of *Speodesmus castellanus* on Fort Hood.

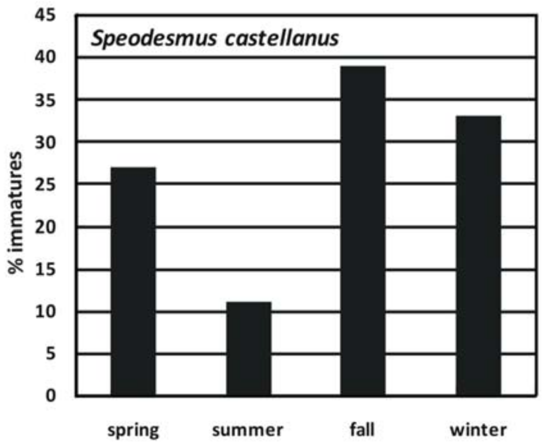


Fig. 2.—Annual cycle in the ratio of immatures to adults of *Speodesmus castellanus.*

(J. Fant, M. Reyes), 2 immature females; Nolan Creek Cave, 27 April 2007 (J. Fant, J. Reddell), 1 immature female; 20 May 2007 (J. Fant, J. Reddell, M. Reyes), 1 immature male; Ruggers Rift Cave, 17 March 2005 (C. Pekins), 1 immature male; Streak Cave, 18 Oct. 2007 (J. Reddell, M. Reyes), 1 immature female; Triple J Cave, 15 June 2007 (C. Pekins, J. Reddell, M. Reyes), 1 female; Wire Basket Cave, 2 May 2005 (J. Fant), 1 immature male; Woods Edge Cave, 7 Nov. 2005 (M. Reyes, M. Warton), 1 immature male. *Coryell County*: Lucky Day Cave, 4 April 2007 (J. Fant, J. Reddell, M. Reyes), 1 immature male.

Speodesmus castellanus Elliott

Records.—*Bell County*: Bumelia Well Cave; Fellers Cave; Lucky Rock Cave; Price Pit Cave. *Coryell County*: Keyhole Cave; Rocket River Cave (type-locality).

New records.—*Bell County*: Afternoon Cave, 18 March 2005 (M. Reyes), 2 females; 4 May 2005 (M. Reyes), 1 male; 4 April 2007 (M. Reyes), 3 males, 1 female; Blue Green Hole Cave, 3 May 2005 (J. Fant, J. Reddell), 1 female; 31 May 2005 (J. Fant, M. Reyes), 1 female; 5 April 2007 (J. Fant), 2 males, 2 females, 2 immature males; Cicurina Cave, 6 April 2007 (C. Pekins, J. Reddell, M. Reyes), 1 male; Copperdead Cave, 20 Aug. 2004 (J. Fant, J. Reddell), 1 male; 20 Feb. 2005 (J. Fant, M. Reyes), 2 females; 2 May 2005 (J. Fant, M. Reyes), 1 immature female; Cowbell Cave, 19 May 2004 (C. Pekins, J. Reddell, M. Reyes), 1 male; Dos Caminos Cave, 4 May 2005 (J. Fant, J. Reddell), 5 males, 6 females, 1 immature female; 23 Oct. 2005 (M. Reyes), 1 male, 1 female; Dual Sinks Cave, 22 Nov. 2005 (J. Fant, M. Reyes), 3 males, 2 females; Endless Pit Cave, 15 Oct. 2004 (J. Fant, C. Pekins, J. Reddell, M. Reyes), 3 males, 3 immature males, 2 immature females; 9 March 2005 (J. Fant), 2 males, 2 females; Falling Turtle Cave, 20 March 2004 (J. Fant, R. Ralph, J. Reddell, M. Reyes, M. Warton), 4 males, 1 female, 1 immature male, 1 immature female; Fellers Cave, 13 May 2007 (J. Fant, J. Reddell), 1 male, 1 female, 1 immature male; Fire Break Cave, 7 March 2004 (M. Reyes, M. Warton), 1 male, 1 female; 2 Oct. 2004 (J. Fant, C. Murray, M. Warton), 1 male; 25 Oct. 2004 (J. Fant, C. Pekins, J. Reddell, M. Reyes), 2 females; Hackberry Cave, 12 June 2004 (M. Reyes, M. Warton), 1 male; 18 Sept. 2004 (J. Fant, M. Reyes), 1 male, 2 females; Hidden Fern Pit Cave, 26 Aug. 2004 (J. Fant, M. Reyes), 1 male, 1 female, 1 immature female; 2 May 2005 (M. Reyes), 1 male; Hidden Pit Cave, 7 Aug. 2003 (J. Reddell, M. Reyes), 1 female; 21 March 2004 (J. Fant, J. Reddell, M. Reyes), 1 male; Lost Chasm Cave, 4 May 2004 (J. Fant, J. Reddell, M. Reyes), 1 male, 1 female, 1 immature male, 1 immature female; 20 Jan. 2005 (M. Reyes), 1 immature female; 18 Oct. 2007 (J. Reddell, M. Reyes), 1 immature female; Mouse Hole Pit, 7 March 2004 (M. Reyes), 1 male; Plethodon Pit Cave, 24 March 2004 (J. Fant, C. Pekins, J. Reddell, M. Reyes), 1 immature male; 2 May 2005 (J. Fant, M. Reyes), 1 male, 1 immature male, 3 immature females; Rainy Day Cave, 14 Aug. 2003 (J. Reddell, M. Reyes), 1 male; 19 May 2004 (M. Reyes), 2 males, 2 females, 1 immature female; Slotsky Pit Cave, 19 Sept. 2004 (J. Fant, M. Reyes), 1 male. *Coryell County*: Sperry Cave, 2 April 2007 (J. Fant, J. Reddell, M. Reyes), 13 males, 9 females, 1 immature male, 6 immature females; 12 May 2007 (J. Fant, J. Reddell, M. Reyes), 1 female, 1 immature male.

ACKNOWLEDGMENTS

We express our special thanks to Charles Pekins of the Fort Hood Natural Resources Management Branch for his field assistance and logistical support. We also thank Jerry Fant, Chris Murray, Marcelino Reyes, and Mike Warton for assistance in the field and to Jean Krejca and Chris Phillips for providing specimens obtained during their research on the salamander *Plethodon albagula* Grobman. Research on Fort Hood was funded by The Nature Conservancy through cooperative agreement DPW-ENV-02-A-001 between the Department of the Army and The Nature Conservancy. Information contained in this report does not necessarily reflect the position or the policy of the government and no official endorsement should be inferred.

LITERATURE CITED

Causey, N. B. 1959. Two new troglodytic millipeds from Texas. Proceedings of the Biological Society of Washington, 72:69-74.

Chamberlin, R. V. 1952. Three cave-dwelling millipeds. Entomological News, 63:10-12.

Elliott, W. R. 2004. *Speodesmus* cave millipedes. Four new species from Central Texas (Diplopoda: Polydesmida: Polydesmidae). Texas Memorial Museum Speleological Monographs, 6. Studies on the cave and endogean fauna of North America, IV. Pp. 163-174.

Loomis, H. F. 1939. The millipeds collected in Appalachian caves by Mr. Kenneth Dearolf. Bulletin of the Museum of Comparative Zoology, 86:165-193.

Shear, W. A. 1984. Cave millipeds of the United States. III. Two new species from the western states. (Diplopoda: Polydesmida, Chordeumatida). Myriapodologica, 1(14):95-104.

Cokendolpher, James C., James R. Reddell, Steven J. Taylor, Jean K. Krejca, Andrew V. Suarez, and Charles E. Pekins. 2009. Further ants (Hymenoptera: Formicidae) from caves of Texas [Hormigas (Hymenoptera: Formicdae) adicionales de cuevas de Texas]. Texas Memorial Museum Speleological Monographs, 7. Studies on the cave and endogean fauna of North America, V. Pp. 151-168.

FURTHER ANTS (HYMENOPTERA: FORMICIDAE) FROM CAVES OF TEXAS

James C. Cokendolpher

Invertebrate Zoology, Natural Science Research Laboratory
Museum of Texas Tech University, 3301 4th Street
Lubbock, Texas 79409 U.S.A.
Email: james.cokendolpher@ttu.edu

James R. Reddell

Texas Natural Science Center
The University of Texas at Austin, PRC 176, 10100 Burnet
Austin, Texas 78758 U.S.A.
Email: jreddell.caves@mail.utexas.edu

Steven J. Taylor

Division of Biodiversity and Ecological Entomology
Illinois Natural History Survey, 1816 S. Oak Street
Champaign, Illinois 61820-6953 U.S.A.
Email: sjtaylor@illinois.edu

Jean K. Krejca

Zara Environmental LLC
118 West Goforth Road,
Buda, Texas 78610 U.S.A.
Email: jean@zaraenvironmental.com

Andrew V. Suarez

Departments of Animal Biology and Entomology
University of Illinois, 515 Morrill Hall, 505 S. Goodwin Ave.
Urbana, Illinois 61801 U.S.A.
Email: avsuarez@life.uiuc.edu

Charles E. Pekins

Directorate of Public Works-Environmental
Natural Resources Management Branch
4219 77th Street (Fort Hood), Texas 76544-5028 U.S.A.
Email: charles.pekins@us.army.mil

ABSTRACT

An annotated list of the 41 species of ants recorded from caves in Texas is provided. Previously published records are given just by cave name and county; whereas new collections are recorded by cave name, date, and collectors. More detailed information about *Labidus coecus* and *Solenopsis invicta* is provided because these are the two main ant species found in caves of central and southern Texas (the area of largest limestone karst in the state).

At least 36 species of ants were recorded from Texas caves by Reddell and Cokendolpher (2001). Here, we further list an additional five species; one being an uncommon endogean species (*Discothryrea testacea* Roger), which is the first record from the state of Texas and the furthest west for the species. A *Leptogenys* sp. is recorded for the first time from the U.S.A. Illustrations of this ant are provided; it has not been identified to species and may be undescribed. Photographs and records are provided showing ants preying on a variety of foods within caves, and a troglobitic spider eating an ant.

RESUMEN

Se presenta una lista de las 41 especies de hormigas registradas en cuevas en Texas. En reportes previos sólo es dado el nombre de la cueva y el condado; mientras que las nuevas colectas se registran con el nombre de la cueva, fecha, y colectores. Se proporciona más información detallada sobre *Labidus coecus* y *Solenopsis invicta* debido a que estas son las principales especies que se encuentran en las cuevas del centro y sur de Texas (la zona kárstica más grande del estado).

Al menos 36 especies de hormigas fueron registradas de cuevas de Texas por Reddell y Cokendolpher (2001). Aquí, reportamos cinco especies adicionales; una es una especie endogea poco común (*Discothryrea testacea* Roger), que es el primer registro del estado de Texas y el limite occidental para la especie. Se registra *Leptogenys* sp. por primera vez de los E.U. Se proporcionan ilustraciones de esta hormiga, que no ha sido identificada a especie, y podría ser una especie aún no descrita. Incluimos fotografías y registros de hormigas consumiendo una variedad de alimentos adentro de las cuevas, y una araña troglobia comiendo una hormiga.

INTRODUCTION

With few exceptions (e.g., Roncin, et al., 2001; Roncin and Deharveng, 2003) ants reported from caves (Decu, et al., 1998; Reddell and Cokendolpher, 2001; Tinaut and Lopez, 2001; Wilson, 1962) are likely incidental or accidental, having little or no particular affinity for the cavernous habitat. Some ants use a cave entrance as a temporary place where it is cooler and moister. A few Ponerinae ants are food specialists eating terrestrial isopods, Collembola, spiders' eggs, etc., and therefore may find moist cave entrances filled with leaf litter as an ideal habitat. Only the Red Imported Fire Ant (*Solenopsis invicta* Buren) and the Subterranean Army Ant (*Labidus coecus* Latreille) appear to go deep inside caves to search for moisture and prey. The fire ant is such an efficient predator in caves that it has been cited as a threat and part of the reason some troglobitic arachnids were listed as endangered species (Longacre, 2000).

At least 36 species of ants were recorded from Texas caves by Reddell and Cokendolpher (2001). An additional five species found associated with caves are recorded. A *Leptogenys* species is recorded for the first time from the U.S.A. Illustrations of this ant are provided; it has not been identified to species. Photographs and records are provided showing ants preying on a variety of foods within caves, and a troglobitic spider eating an ant. Most of the species recorded only to genus by Reddell and Cokendolpher (2001) are identified to species in this article.

MATERIALS AND METHODS

Vouchers for observations and records have been deposited in the Texas Natural History Collection (Austin), Museum of Texas Tech University (Lubbock), and Illinois Natural History Survey (Urbana). Field samples were fixed/preserved in 70-80% ethanol. In the laboratory, some specimens were dabbed on tissue paper to dry the surface and then air-dried slightly more to see surface sculpture better.

The specimens for study with the electron microscope were air dried and attached to a temporary SEM stub coated with carbon tape. Both specimens were examined with a Hatachi S-4300SE/N. This scope is an environmental SEM and therefore the samples were not critical point dried or sputter coated. Both were examined while under 70 Pa of vacuum.

Notes on distribution of Texas ants follow information provided by O'Keefe, et al. (2000). We are following the arrangement of subfamilies used by Bolton (2003): Dolichoderinae, Formicinae, Ecitoninae, Ponerinae, Proceratiinae, and Myrmicinae

Subfamily Dolichoderinae

Forelius pruinosus (Roger)

New record.—*Bexar County*: Pain in the Glass Cave (Camp Bullis), 28 Oct. 2004 (J. Krejca, P. Sprouse).

Comment.—This is the first record of this species from a cave in Texas and the first record of the species for Bexar County. It is otherwise widespread across Texas.

Liometopum apiculatum Mayr

Previous Cave Record (Reddell and Cokendolpher, 2001)**.—***Brewster County*: O.T.L. Cave.

Comment.—The species is widespread and nests arboreally.

Subfamily Formicinae

Camponotus decipiens Emery

New Record: *Bell County*: Raining Rattler Cave (Fort Hood), 28 Nov. 2007 (M. Reyes).

Previous Cave Record (Reddell and Cokendolpher, 2001).—*Burnet County*: Simons Road Side Sink No. 1.

Comment.—This is the first record of the species in Bell County. It is reported from scattered counties across Texas.

Camponotus festinatus (Buckley)

New Record.—*Bexar County*: Eagles Nest Cave (Camp Bullis), 14 Dec. 2000 (J. Reddell, M. Reyes).

Previous Cave Record (Reddell and Cokendolpher, 2001).—*Sutton County*: Felton Cave.

Comment.—The species is a widespread soil nesting species in Texas.

Camponotus nearcticus Emery

New Records.—*Bell County*: Hackberry Cave (Fort Hood), 12 June 2004 (M. Reyes, M. Warton); Tweedledee Cave (Fort Hood), 5 June 2004 (M. Reyes, M. Warton). *Bexar County*: Bunny Hole (Camp Bullis), 12 Aug. 2004 (J. Reddell, M. Reyes); Root Canal Cave (Camp Bullis), 2 Aug. 2005 (J. Krejca). *Coryell County*: Sperry Cave (Fort Hood), 5 June 2006 (C. Pekins, J. Reddell, M. Reyes). *Kendall County*: Glen Rose Cave, 4 March 1999 (M. Reyes, M. Warton).

Previous Cave Records (Reddell and Cokendolpher, 2001).—*Bexar County*: Backhole Cave (Camp Bullis). *Kendall County*: Glen Rose Cave.

Comment.—The species was previously recorded from Kendall County as *Camponotus* sp. (Reddell and Cokendolpher, 2001). These are the first identified records for the species in Bell, Coryell, and Kendall Counties. The species is widespread across Texas.

Camponotus sansabeanus (Buckley)

Previous Cave Records (Reddell and Cokendolpher, 2001).—*Hays County*: Ezell's Cave. *Williamson County*: Elm Water Cave.

Camponotus semitestaceus Snelling

Previous Cave Record (Reddell and Cokendolpher, 2001).—*Williamson County*: Yearwood Gold Mine Cave.

Camponotus texanus Wheeler

New Records.—*Bell County*: Collapse Sink (Fort Hood), 27 Nov. 2007 (M. Reyes); Herbert Cave (Fort Hood), 10 Sept. 1997 (L. J. Graves, M. Reyes); Leopard Frog Cave (Fort Hood), 8 Feb. 2006 (J. Reddell, M. Reyes); Price Pit Cave (Fort Hood), 20 July 2008 (J. Reddell, M. Reyes); String Ball Sink (Fort Hood), 3 April 2007 (J. Reddell); Thumbs Up Cave (Fort Hood), 12 Nov. 2005 (M. Reyes). *Coryell County*: Chigouxs' Cave (Fort Hood), 21 Nov. 1995 (J. Reddell, M. Reyes); 10 Sept. 1997 (J. Reddell, M. Reyes); Copperhead Cave (Fort Hood), 9 March 2005 (J. Reddell, M. Reyes).

Previous Cave Records (Reddell and Cokendolpher, 2001).—*Bell County*: Nolan Creek Cave (Fort Hood), Herbert Cave (Fort Hood). *Bexar County*: Encino Park Cave (=Here Today, Gone Tomorrow Cave), Headquarters Cave (Camp Bullis). *Coryell County*: Chigouxs' Cave (Fort Hood).

Comment.—Some records of this species were earlier recorded as *Camponotus* sp. (Reddell and Cokendolpher, 2001). This is the first record of the species for Coryell County. The species is known from scattered localities across Texas.

Formica gnava Buckley

New Record.—*Sutton County*: Harrison Cave, 20 Nov. 2004 (J. Kennedy).

Previous Cave Record (Reddell and Cokendolpher, 2001).—*Hardeman County*: Campsey Cave.

Comment.—This is the first correctly identified record of the species from a cave in Texas. The species ranges from central to western Texas. Reddell and Cokendolpher, 2001) reported a *Formica* sp. (*fusca* group) which was identified by A.C. Cole, in 1964. That specimen is not currently available for restudy, but it is almost certainly *F. gnava* as this is the only *fusca* group member recorded from this region of Texas.

Paratrechina arenivaga (Wheeler)

New Records.—*Bexar County*: Canyon Ranch Shelf Cave, 9 Aug. 2002 (C. Collins, K. White). *Edwards County*: Deep Cave, 3 March 2005 (A. Gluesenkamp).

Comment.—This is the first record of the species from caves in Texas. These are the first records of the species in Bexar and Edwards Counties. The species is recorded from widely scattered localities across Texas.

Paratrechina terricola (Buckley)

New Records.—*Travis County*: Cortana Feature 4 and leaf litter, 9 Oct. 2007 (R. Myers, K. McDermid); Down Dip Sink, 5 April 2007 (P. Sprouse); Karst Feature F4, 26 Sept. 2006 (J. Krejca). *Val Verde County*: Stella's Cave, 28 April 2007 (J. Kennedy, M. Sisson).

Previous Cave Record (Reddell and Cokendolpher, 2001).—*Bexar County*: Droll Cave. *Sutton County*: Caverns of Sonora.

Comment.—The species is widespread in Texas.

Paratrechina vividula (Nylander)

New Record.—*Kinney County*: Baker's Crossing Cave, 30 April 1995 (A. Grubbs).

Previous Cave Records (Reddell and Cokendolpher, 2001 as *Paratrechina* spp.).—*Kinney County*: Baker's Crossing Cave. *Williamson County*: Beck Horse Cave, Priscilla's Cave.

Comment.—This is the first record of this species identified from caves in Texas and in Kinney and Williamson Counties. The species is widespread in Texas.

Subfamily Ecitoninae

Labidus coecus (Latreille)
Figs. 1-4

New Records.—*Bell County*: Dillo Sink (Fort Hood), 29 Oct. 2002 (M. Reyes, M. Warton); Endless Pit Cave (Fort Hood), 19 Jan. 2005 (M. Reyes); Legless Visitor Cave (Fort Hood), 22 Oct. 2005 (H. Johnson, M. Warton); Lost Chasm Cave (Fort Hood), 25 July 2007 (J. Reddell, M. Reyes); 20 July 2008 (J. Reddell, M. Reyes); Lunch Counter Cave (Fort Hood), 10 April 2002 (J. Reddell, M. Reyes); 31 January 2007 (S. J. Taylor, J. K. Krejca, C. Pekins, T. Marston, R. Myers); Missing Chasm Cave (Fort Hood), 4 Feb. 2005 (J. Fant); Squiggles Sink (Fort Hood), 30 Jan. 2005 (J. Fant, M. Reyes); Tres Dedos Cave (Fort Hood), 28 Nov. 2007 (M. Reyes). *Bexar County*: Accident Sink (Camp Bullis), 26 Oct. 2004 (C. Thibodaux, C. Murray); Bunny Hole (Camp Bullis), 31 March 1995 (J. Reddell, M. Reyes); Cannonball Cave (Camp Bullis), 15 April 2002 (J. Reddell, M. Reyes, G. Veni); Cross the Creek Cave (Camp Bullis), 21 Aug. 2005 (J. Reddell, M. Reyes); Darling's Pumpkin Hole (Camp Bullis), 9 May 2005 (J. Reddell, M. Reyes); Dos Viboras Cave (Camp Bullis), 27 May 2005 (A. Gluesenkamp, J. Krejca); Flach's Cave (Camp Bullis), 6 March 2008 (P. Sprouse, K. McDermid); Isocow Cave (Camp Bullis), 17 May 2005 (A. Gluesnkamp, J. Krejca); Porcupine Parlor Cave (Camp Bullis), 29 March 2001 (G. Veni); Power Line Karst Feature D-16 (Camp Bullis), 15 Jan. 2002 (L. J. Graves); Strange Little Cave (Camp Bullis), 31 July 2006 (J. Krejca); Up the Creek Cave (Camp Bullis), 25 Oct. 2005 (J. Reddell, M. Reyes). *Medina County*: Nisbet Cave, 4 March 2001 (G. Veni, R.M. Waters). *Travis County*: Karst Feature F-14, Ribelin Ranch, 22, 28 Nov. 2001 (M. Warton). *Williamson County*: Little Surprise Cave, 9 Jan. 2004 (J. Fant, J. Reddell, M. Reyes); Testudo Tube, 14 Jan. 2005 (J. Krejca, P. Sprouse); Shaman Cave, Sun City, 22 July 2007 (J. Reddell, M. Reyes).

Previous Cave Records (Reddell and Cokendolpher, 2001).—*Bell County*: Camp 6 Cave No. 1 (Fort Hood), Soldiers Cave (Fort Hood). *Bexar County*: Dirtwater Cave, Poor Boy Baculum Cave (Camp Bullis), Root Canal Cave (Camp Bullis), Stevens Ranch Trash Hole Cave; Strange Little Cave (Camp Bullis). *Burnet County*: Longhorn Caverns. *Coryell County*: Briar Cave (Fort Hood), Egypt Cave (Fort Hood), Frank's Cave, Rocket River Cave System (Fort Hood), Saltpeter Cave (Fort Hood). *Hays County*: Ezell's Cave. *Kendall County*: Pfeiffer's Water Cave. *Kerr County*: Seven Room Cave. *Medina County*: Lutz Cave. *Menard County*: Powell's Cave. *Sutton County*: Caverns of Sonora. *Travis County*: Contortionist Cave, Ireland's Cave, Weldon Cave. *Val Verde County*: Emerald Sink. *Williamson County*: Beck Crevice Cave, Beck Sewer Cave, Cricket Cave, Fern Bluff Cave, LakeLine Mall Well, Testudo Tube.

Comment.—The map of Endless Pit Cave (Fig. 5) shows the locations for *Labidus coecus* during a visit. The ants were coming from a crawlway and were attracted towards a rotting coachwhip snake [*Masticophis flagellum* (Shaw)] at the bottom of the dropdown pit. Ants were observed feeding on mermithid nematodes (Fig. 3), *Ceuthophilus secretus* Scudder crickets and a hothouse millipede [*Oxidus gracilis* (Koch)]. *Helicodiscus* snail, *Cambala* and *Siphonophora* millipedes were left alone, despite being in very close proximity. Ants were emerging from the clay bank near the stream passage in the very bottom of the cave. They were also traveling from the stream passage where it becomes too low to crawl.

In Shaman Cave, Sun City, Williamson County, Texas, the ants were present by the thousands. They were along a trail that terminated at the top of a small pit about 25 m from the entrance and 5 m below the ground surface. They were coming from the wall.

The subterranean army ant *L. coecus* is distributed widely across the Americas from Texas in the north, extending south through the tropics to Paraguay. Relatively little is known about the biology of this species. Perfecto (1992) provides one of the most detailed accounts, wherein raids by this species on other ants (*Dorymyrmex* sp., *Pheidole* sp., *Pheidole radoszkowskii* Mayr, *Solenopsis geminata* (Fabricius), and *Brachy-myrmex patagonicus* Mayr (reported as *B. musculus* Forel- see MacGown, et al., 2007) in Costa Rica are documented. Other than these limited observations, and occasional collections of this species from caves (Kempf, 1961; Lewis, 1974; Reddell and Cokendolpher, 2001), we remain largely ignorant of the biology of this species. For some ant taxa, pronounced vertical stratification of nests allows colonies to move brood vertically in the tunnels through soils in response to daily fluctuations in abiotic

Figs. 1-2.—*Labidus coecus* (Latreille) in Endless Pit Cave (Fort Hood), Bell County, Texas (images by C. E. Pekins). 1, Ant tunnel portals into the clay bank that is perched slightly above the stream passage (the bank with the coyote scratch marks). 2, Another trail was in the stream passage below the portal where it becomes too low to crawl.

Figs. 3-4.—*Labidus coecus* (Latreille) in Endless Pit Cave (Fort Hood), Bell County, Texas (images by C. E. Pekins). 3, Attacking/ carrying a mermithid nematode (likely emerged from *Ceuthophilus* cricket) to the colony for feeding. 4, Attacking/ carrying *Ceuthophilus* cricket to colony.

conditions, provides a range of conditions for the storage of resources, and provides the queen a safe refuge from predators (Hölldobler and Wilson, 1990; Cole, 1994).

Moisture is considered critical for ant colony success (Johnson, 2000, 2001) and deep nests in arid environments may also be an adaptation for harvesting condensation or channeling surface water. Higher levels of soil moisture occur in nests of some ants than at similar depths in surrounding soils (MacMahon, et al., 2000).

We have observed *L. coecus* in shallow and deep cave environments in central Texas. On 15 Feb. 2004, the manager (Bill Sawyer) of a show cave (Caverns of Sonora) in central Texas reported seeing ants deep within the cave Caverns of Sonora, Sutton County, Texas (20 Feb. 2004, 25m deep in a cave). Two of us (S. J. T., J. K. K.) visited the cave on 20 Feb. 2004 and found that there were large numbers (over 200 individuals) of *L. coecus* in the cave at a depth of 21 to 25 m below the surface. Depth was determined by examination of a detailed map of the cave. The ants were associated with moist speleothems and shallowly (1-3 mm) pooled water. The environment around Sonora, Texas, is arid, with annual average precipitation is 57 cm of rainfall per year (www.idcide.com/weather/tx/sonora.htm). Consequently, little surface moisture is available during much of the year. The ants were associated with a 6 cm diameter shaft drilled between 1957 and 1960 from the surface during development of the show cave to facilitate the transfer of concrete into the cave for tour trail construction. After construction, the shaft was sealed at the surface, but the conduit is still used to bring electrical wires for lighting into the cave. When the ants were first observed in the cave, several days before our visit, they appeared to be utilizing the shaft to move into and out of the cave. At the time of our visit, many of the ants were dead (cause unknown) and the drill hole no longer contained ants moving along a trail.

On 9 August 2001, we visited Big Red Cave (Fort Hood), Coryell County, Texas, where we observed a small aggregation of *L. coecus* feeding on a camel cricket, *Ceuthophilus secretus* Scudder (Fig. 4).

In the case of *L. coecus*, however, there are numerous reports of utilization of cave habitats (Reddell and Cokendolpher, 2001; Kempf, 1961). But our observation is particularly noteworthy in pointing to the capacity of these ants to move deep below the surface of the ground, perhaps in search of moisture. The access in this

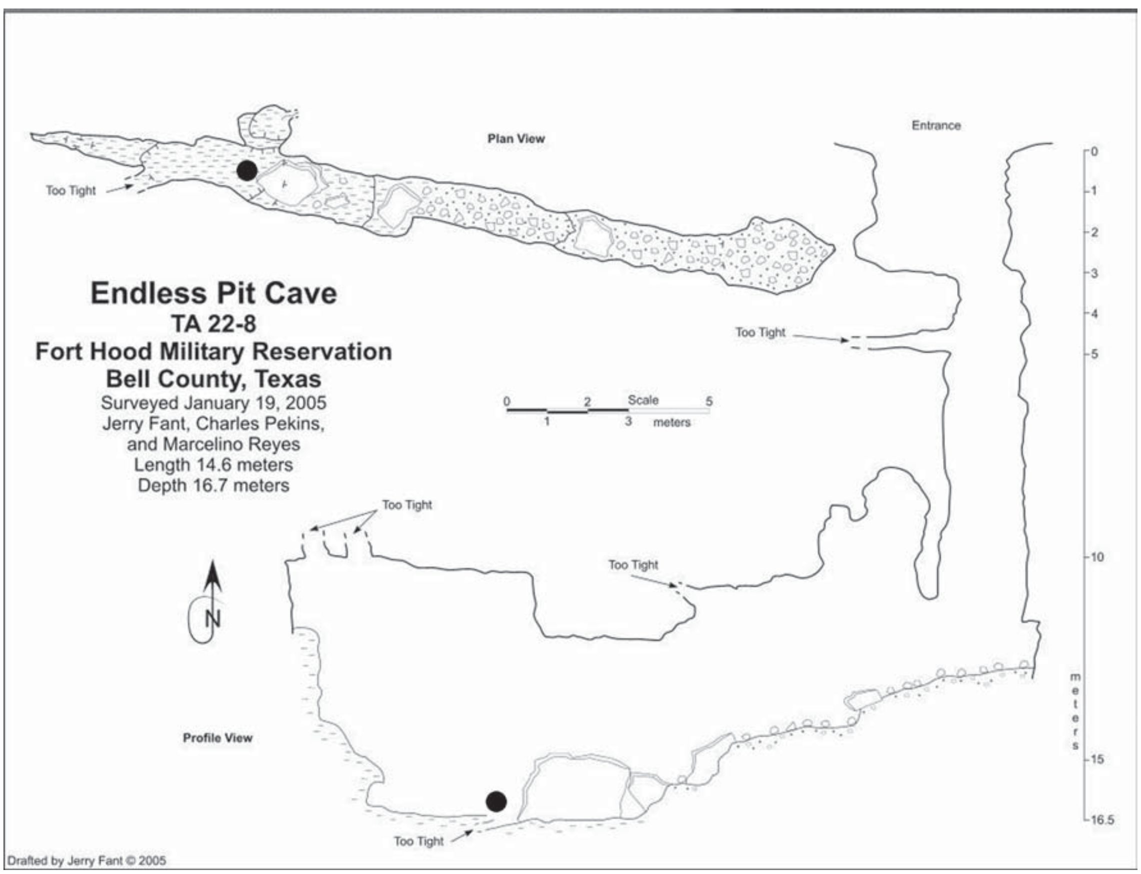


Fig. 5.—Map of Endless Pit Cave, Bell County, Texas, showing the collection site of *Labidus coecus* (Latreille) about 16 meters below the surface (map drafted by J. Fant).

case was via a man-made conduit, but in karstic terrane the subsurface is typically characterized by the presence of numerous fissures, joints and other mesocavernous spaces (Howarth 1983) in the "milieu souterrain superficial" (Juberthie, et al., 1980, 1981; Juberthie and Decu, 2004). Utilization of such fissures, commonly enlarged by the action of water (Klimchouk, et al., 2000), could allow access to moisture in an otherwise quite arid environment.

Our observations suggest that further investigation into the use of underground habitats by ants may be warranted. Future work measuring the productivity of colonies with and without access to moisture at depth may determine if this under-studied resource provides a benefit to ants in arid ecosystems.

Labidus coecus was collected in both 2002 and 2007 in Lunch Counter Cave (Taylor, et al., 2008), the second occurrence (2 specimens) as part of the stomach contents of a cave-inhabiting salamander, *Plethodon albagula* (Grobman).

Neivamyrmex fallax Borgmeier

Previous Cave Record (Reddell and Cokendolpher, 2001)**.—***Travis County*: Cotterell Cave.

Comment.—Presumably an accidental. The species occurs in the southcentral U.S.A. and south in Mexico and Guatemala.

Neivamyrmex opacithorax (Emery)

New Record.—*Bexar County*: 50 Bucket Cave, 6 March 2008 (P. Sprouse, K. McDermid).

Comment.—Presumably an accidental. This is the first record of this species from Bexar County and the first record for Texas caves.

Subfamily Ponerinae

Hypoponera inexorata (Wheeler)

New Record.—*Bexar County*: Hold Me Back Cave (Camp Bullis), 26 July 2006 (J. Krejca, R. Myers).

Previous Cave Record(Reddell and Cokendolpher, 2001)**.—***Williamson County*: Deliverance Cave No. 1.

Comment.—This is apparently the first record for the species in Bexar County. It is certainly an accidental and is reported to be widespread across Texas.

Hypoponera opaciceps (Mayr)

New Records.—*Bexar County*: Leon Hill Cave (Camp Bullis), 24 May 2003 (J. Reddell, M. Reyes), Berlese of leaf litter; Kamikazi Cricket Cave, no date (A.G. Grubbs).

Previous Cave Record (Reddell and Cokendolpher, 2001)**.—***Bexar County*: Stealth Cave.

Comment.—The species occurs throughout North America, often nesting in soil and rotten wood. This species is considered by some authorities to be introduced. Indeed, it seems to typically inhabit disturbed areas and is often found in conjunction with other introduced species.

Hypoponera opacior (Forel)

New Records.—*Bell County*: Snail Shell Sink (Fort Hood), 3 April 2007 (J. Fant, J. Reddell, M. Reyes). *Bexar County*: Genesis Cave, 2 Dec. 2004 (A. Gluesenkamp, P. Sprouse); Twin Cedar Cave, Government Canyon State Natural Area, 27 April 2003 (M. Miller). *Travis County*: 3-Holer Cave, 1 May 1992 (J. Reddell, M. Reyes). *Williamson County*: Lobo's Lair, 13 Sept. 1991 (J. Reddell, M. Reyes), Berlese of litter; Pussy Cat Cave, 6 June 1991 (D. Allen, W. Elliott).

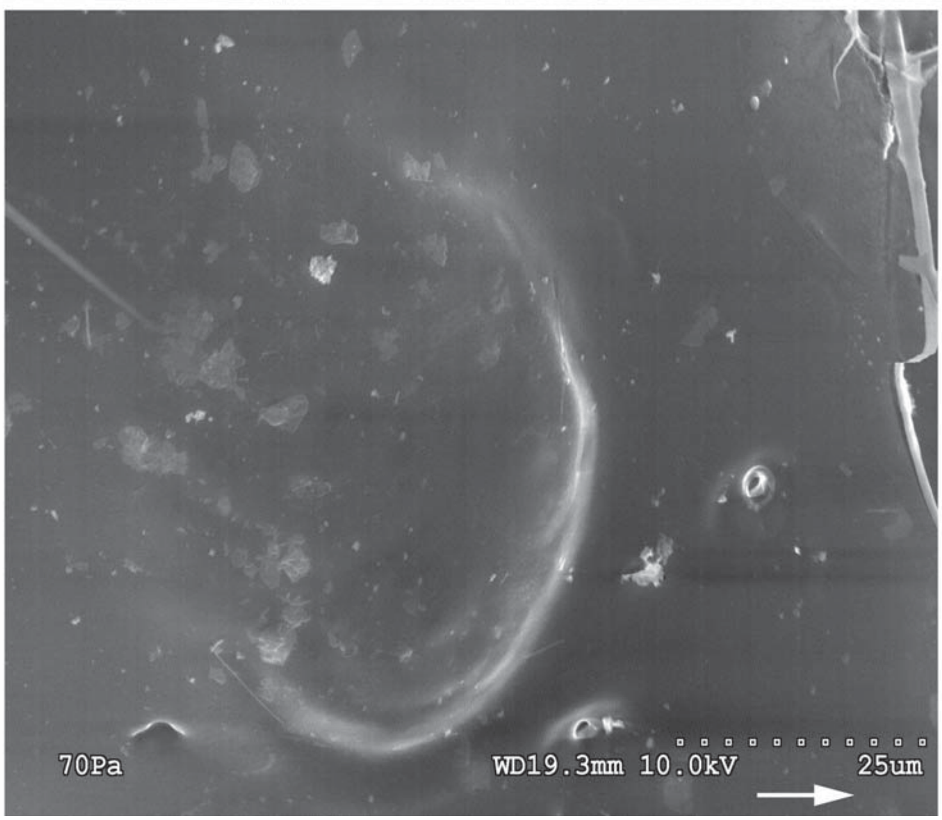
Previous Cave Records (Reddell and Cokendolpher, 2001)**.—***Bexar County*: Eagles Nest Cave, Strange Little Cave, Voight's Bat Cave. *Coryell County*: Porter Cave, (Fort Hood). *Uvalde County*: Indian Creek Cave.

Comment.—These are apparently the first records of the species from Williamson County. The species is widespread across Texas.

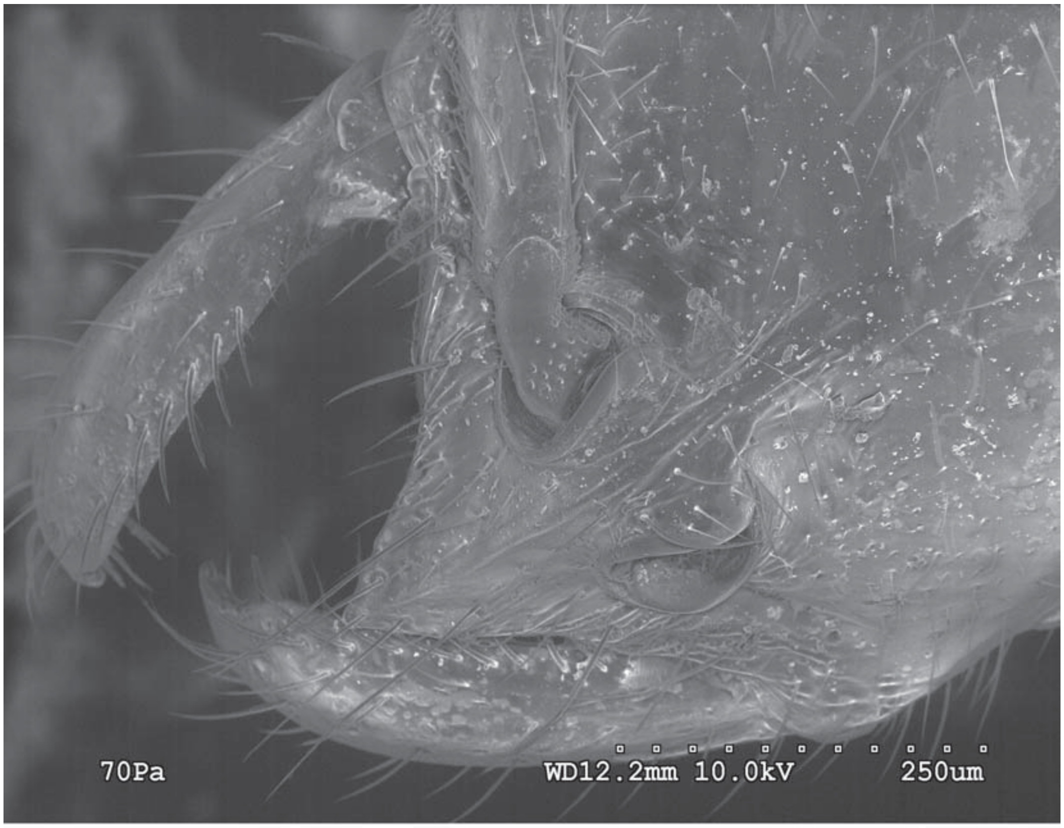
Leptogenys sp.
Figs. 6-9

New records.—*Val Verde County*: Judge's Chamber Cave, 15 Oct. 2005 (M. Sanders).

Comment.—Unlike all other members of this genus in North America, the worker of this species has a tiny eye without obvious facets. It is about half the size and lighter in color than *Leptogenys elongata* (which occurs in other Texas caves). It is not uncommon for other Ponerinae genera to have tiny/missing eyes. These ants are primarily found under covering objects (wood, rock, etc.) or in rotten wood or in the upper soil/litter layers. Because other members of this genus are known to feed upon terrestrial isopods, it is possible that this small species does the same. But, the mandibles are not dentate like *L. elongata* suggesting that they might not capture prey that is heavily armored. Roncin and Deharveng (2003) described what might be the first troglobitic ant from Laos. It is a very elongate and pale colored *Leptogenys*. The Texas species has the reduced eyes like a troglobite, but none of the other characters typical are present: female alate, size smaller, appendages not elongated, pigment dark.



Figs. 6-7.—Unknown *Leptogenys* sp. from Judge's Chamber Cave, Val Verde County, Texas. 6, lateral aspect. 7, closeup of eye rudiment, arrow points anteriorly (SEM micrographs by J. C. Cokendolpher).



Figs. 8-9.—Unknown *Leptogenys* sp. from Judge's Chamber Cave, Val Verde County, Texas; 8, anterior view of frons, base of antennae (left side detached), and mandibles. 9, lateral view of petiole (SEM micrographs by J. C. Cokendolpher).

Leptogenys elongata (Buckley)

New Records.—*Bell County*: Boulder Garden Cave (Fort Hood), 24 Sept. 2004 (J. Fant, M. Reyes, M. Warton); Pekins Cave (Fort Hood), 13 March 2004 (J. Fant, J. Reddell, M. Reyes); Pump House Cave (Fort Hood), 28 Aug. 2004 (J. Fant, M. Reyes); Rock Wall Sink (Fort Hood), 5 Dec. 2002 (M. Reyes, M. Warton); Southern Cross Cave (Fort Hood), 21 Aug. 2003 (C. Pekins, J. Reddell, M. Reyes). *Bexar County*: Low Priority Cave (Camp Bullis), 1 Nov. 2000 (J. Reddell, M. Reyes); Strange Little Cave, 13 July 2006 (J. Krejca); 31 July 2006 (J. Krejca); Up the Creek Cave, 25 Oct. 2005 (J. Reddell, M. Reyes). *Coryell County*: Formation Cave (Fort Hood), 29 Aug. 2005 (C. Pekins, J. Reddell, M. Reyes).

Previous Cave Records (Reddell and Cokendolpher, 2001)**.—***Bell County*: Big Ash Tree Sink (Fort Hood), Big Crevice (Fort Hood), Chimney Windows Cave (Fort Hood), Seven Mile Mountain Cave (Fort Hood). *Bexar County*: Backhole Cave (Camp Bullis), John Wilson Ranch Cave no. 3, Kamikazi Cricket Cave, Skull Cave. *Coryell County*: Brokeback Cave (Fort Hood), Cornelius Cave (Fort Hood). *Stonewall County*: Aspermont Bat Cave. *Travis County*: Tooth Cave. *Williamson County*: Forest Trail Pit.

Comment.—This widespread species occurs in the southeastern U.S.A. and Texas (http://www.cs.unc.edu/~hedlund/ants/). This ant species is locally abundant in southeastern Texas. Workers generally forage singly and feed largely, if not exclusively, on terrestrial isopods.

Odontomachus clarus Roger

New record.—*Bexar County*: Boneyard Pit (Camp Bullis), 1 Aug. 2005 (J. Krejca, P. Sprouse).

Previous Cave Record (Reddell and Cokendolpher, 2001)**.—***Bexar County*: Platypus Pit (Camp Bullis).

Comment.—The species is widespread in Texas and considered an accidental in caves.

Pachycondyla harpax (Fabricius)

New Records.—*Bexar County*: Voges Cave (Camp Bullis), 6 March 2001 (G. Veni). *Comal County*: Quantum Leap Cave, Kuhn Ranch, 2 Oct. 2005 (A. Gluesenkamp, N. Parker).

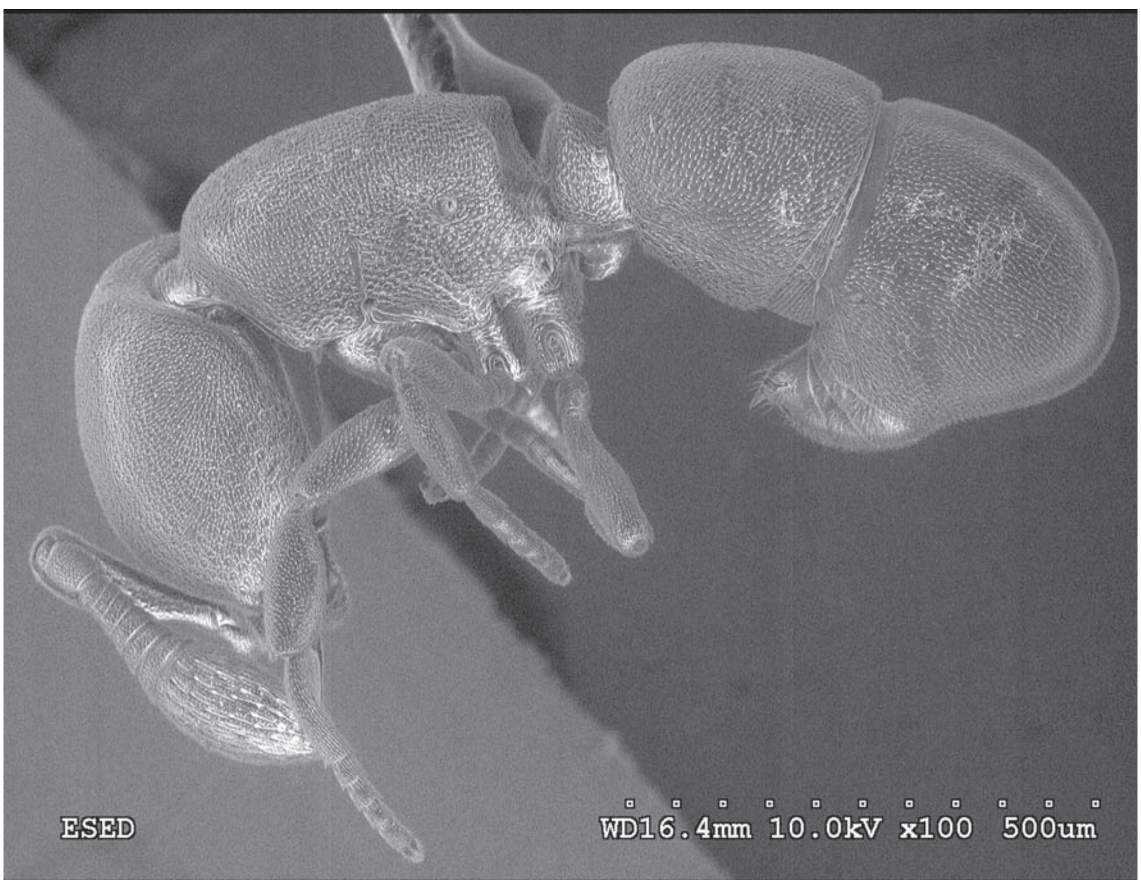


Fig. 10**.—***Discothyrea testacea* Roger from litter collected from the surface above Headquarters Cave, Bexar County, Texas; lateral aspect (SEM micrograph by J. C. Cokendolpher).

Previous Cave Record (Reddell and Cokendolpher, 2001)**.—***Medina County*: Weynand Cave.

Comment.—The species occurs throughout eastern and southern Texas. Elsewhere, it is found in Louisiana, south to Brazil, and the West Indies.

Subfamily Proceratiinae
Discothyrea testacea Roger
Fig. 10

New Record.—*Bexar County*: surface above Headquarters Cave (Camp Bullis): Berlese Funnel extraction of leaf litter, quadrat HQ36, 28 May 2007 (Zara Environmental).

Comment.—The discovery of this small ant in leaf litter is the first of this rarely collected ant encountered in the state of Texas. The western most record before our finding was: Zwolle N. Toledo Bend State Park, Sabine Parish, off LA 3229, 17 June 2003, sifting leaf litter (Dash 2005). The recorded distribution is from the southeastern U.S.A.: NC south to FL, west through GA, AL, MS, AR, LA, OK (Carter, 1962; Dash, 2005; Deyrup, 2003; General and Thompson, 2007; Ipser, et al., 2004; MacGown and Brown, 2006; MacGown and Forster, 2005; Smith and Wing, 1955; Smith, 1979). An illustration is provided (Fig. 10) so future researchers might more easily recognize this genus. It is likely to be more common than reported as it is tiny and easily missed without careful sorting or Berlese Funnel extractions.

Proceratium compitale Ward

Previous Cave Records (Reddell and Cokendolpher, 2001)**.—***Sutton* County: Caverns of Sonora. *Val Verde County*: Emerald Sink, Seminole Sink. *Terrell County*: Blackstone Cave. *Uvalde County*: Barn-Sized Fissure Cave.

Comment.—The species is a cryptic, likely subterranean predator that was only known from the type specimen at the time of Ward's 1988 revision.

Proceratium pergandei (Emery)

New records.—*Bexar County*: Cross the Creek Cave (Camp Bullis), 21 Oct. 2004 (J. Reddell, M. Reyes); Up the Creek Cave (Camp Bullis), 25 Oct. 2005 (J. Reddell, M. Reyes), queen.

Comment.—This is the first record for the species in Bexar County. It has not previously been recorded from any cave in Texas. The species is otherwise known only from Cameron, Houston, and San Jacinto Counties. This is a species thought to specialize by preying on spider eggs.

Subfamily Myrmicinae
Atta texana (Buckley)

Previous Cave Records (Reddell and Cokendolpher, 2001)**.—***Bandera County*: Fog Fissure. *Bexar County*: Jabba's Giant Sink (Camp Bullis).

Comment.—*Atta* are conspicuous above ground foraging ants that harvest leaves to grow fungus. The large subterranean nests of this species may result in their presence in caves.

Aphaenogaster texana Wheeler

New Records.—*Bandera County***:** Can Creek Cave No. 2, Lost Maples State Natural Area, 30 Oct. 2000 (J. Reddell, M. Reyes). *Bell County*: Boulder Garden Cave (Fort Hood), 24 Sept. 2004, (J. Fant, M. Reyes, M. Warton); Collapse Sink (Fort Hood), 16 July 2008 (J. Reddell, M. Reyes); Dumpty Cave (Fort Hood), 29 Aug. 2004 (M. Reyes, M. Warton); Falling Water Shelter Cave (Fort Hood), 15 Oct. 2003 (J. Reddell); Finger Mountain Cave (Fort Hood), 20 Oct. 2006 (J. Reddell, M. Reyes); Hope Well Sink (Fort Hood), 2 April 2006 (J. Fant, M. Reyes); Legless Visitor Cave (Fort Hood), 19 May 2007 (J. Fant, J. Reddell, M. Reyes); Loop Joint Cave (Fort Hood), 3 May 2000 (J. Reddell, M. Reyes); Price Pit Cave (Fort Hood), 25 Aug. 2003 (C. Pekins, J. Reddell); 20 July 2008 (J. Reddell, M. Reyes); Skeeter Cave (Fort Hood), 25 Aug. 2003 (C. Pekins, J. Reddell); Sleepy Hollow Cave (Fort Hood), 1 June 2005 (J. Reddell); Thumbs Up Cave (Fort Hood), 12 Nov. 2005 (M. Reyes). *Bexar County*: Hold Me Back Cave (Camp Bullis), 19 May 2005 (J. Krejca, R. Myers); 2 Oct. 2007 (K. McDermid). *Coryell County*: Dionne Cave (Fort Hood), 3 June 2003 (J. Reddell, M. Reyes); Loop-Around Cave, 16 July 1993 (J. Reddell, M. Reyes).

Previous Cave Records (Reddell and Cokendolpher, 2001)**.—***Bell County*: Bumelia Well Cave (Fort Hood), Creek Bed Sink (Fort Hood). *Brewster County*: O.T.L. Cave. *Coryell County*: Loop-Around Cave (Fort Hood).

Comment.—This species is here recorded for the first time from caves in Bandera, Bexar, and Coryell Counties. This is the first record of the species in Coryell County.

Crematogaster laeviuscula Mayr

New Records.—*Bell County*: Cedar Log Cave (Fort Hood), 4 June 2008 (J. Reddell, M. Reyes); Talking Crows Cave (Fort Hood), 21 July 2008 (J. Reddell, M. Reyes). *Bexar County*: Backhole Cave (Camp Bullis), 29 May 2006 (P. Sprouse); Boneyard Pit (Camp Bullis), 12 Oct 2004 (J. Krejca, P. Sprouse); 25 July 2006 (J.

Krejca, R. Myers); Headquarters Cave (Camp Bullis), 9 Aug. 2005 (J. Krejca, R. Myers); Hold Me Back Cave (Camp Bullis), 26 July 2006 (J. Krejca, R. Myers); MARS Pit (Camp Bullis), 4 Aug. 2005 (J. Krejca, R. Myers); Pain in the Glass Cave (Camp Bullis), 28 Oct. 2004 (J. Krejca, P. Sprouse); Phil's Line Cave, Iron Horse Canyon, 7 April 2005 (M. Warton). *Travis County*: Enfield Sinkhole, 18 June 1991 (W. Elliott, C. Ladd), founding queen. *Williamson County*: Priscilla's Cave, on gate, 6 June 1996 (W. Elliott); Holler Hole Cave, Sun City, 21 May 2008 (J. Reddell, M. Reyes).

Previous Cave Records (Reddell and Cokendolpher, 2001)**.—***Bell County*: Septum Pit Cave (Fort Hood). *Hardeman County*: Campsey Cave. *Edwards County*: Devil's Sinkhole. *Sutton County*: Felton Cave. *Edwards County*: Deep Cave, *Travis County*: Enfield Sinkhole, Wildflower Cave. *Williamson County*: Priscilla's Cave.

Comment.—Some records of this species were previously recorded as *Crematogaster* sp. and *Crematogaster* (*Crematogaster*) sp. prob. *laeviuscula* (Reddell and Cokendolpher, 2001).

Cyphomyrmex rimosus (Spinola)

New Record.—*Travis County*: Karst Feature F4, 26 Sept. 2006 (J. Krejca).

Previous Cave Record (Reddell and Cokendolpher, 2001)**.—***Bexar County*: Up the Creek Cave.

Comment.—This is the first record of the species from a cave in Travis County. The species ranges from eastern Texas to Uvalde County. This species feeds on fungus gardens, which it provisions with dead insects and plant material.

Monomorium sp. prob. *cyaneum* Wheeler

Previous Cave Record (Reddell and Cokendolpher, 2001)**.—***Bexar County*: Bullis Hole (Camp Bullis).

Monomorium minimum (Buckley)

Previous Cave Records (Reddell and Cokendolpher, 2001)**.—***San Saba County*: Gorman Cave. *Travis County*: Whirlpool Cave. *Williamson County*: Stonewall Ranch Cave.

Myrmecina americana Emery

New Records.—*Bell County*: Big Crevice (Fort Hood), 13 May 1999 (J. Reddell, M. Reyes), Berlese of leaf litter; Trapper Sink (Fort Hood), 28 Aug. 2004 (J. Fant, M. Reyes). *Bexar County*: Backhole Cave (Camp Bullis), 26 Oct. 2001 (J. Krejca, P. Sprouse), 31 July 2007 (J. Krejca). *Coryell County*: Porter Cave (Fort Hood), 31 March 2004 (C. Pekins, J. Reddell), Berlese of leaf litter.

Previous Cave Records (Reddell and Cokendolpher, 2001)**.—***Bell County*: Big Crevice (Fort Hood); Keilman Cave (Fort Hood). *Bexar County*: Charley's Hammer Hole (Camp Bullis). *Coryell County*: Copperhead Cave No. 2 (Fort Hood), Porter Cave (Fort Hood). *Travis County*: Trapjaw Sink; Wade Sink.

Comment.—The species ranges from eastern Texas to Brewster County in the West. It typically nests underneath logs or in areas with deep leaf litter.

Oligomyrmex longii (Wheeler)

Previous Cave Record (Reddell and Cokendolpher, 2001)**.—***Bell County*: Viper Den Cave (Fort Hood).

Pheidole spp.

New Records.—*Bell County*: Awesome Entrance Cave (Fort Hood), 24-25 Sept. 2004 (J. Fant, M. Reyes, M. Warton); Dumpty Cave (Fort Hood), 29 Aug. 2004 (M. Reyes, M. Warton); Falling Turtle Cave (Fort Hood), 3 Oct. 2004 (J. Fant, C. Murray, M. Warton); Green Carpet Cave (Fort Hood), 10 Oct. 2004 (J. Fant, C. Murray, M. Reyes, M. Warton); Ostracod Spring (mophead below spring outlet) (Fort Hood), 30 July 2007 (C. Pekins, J. Reddell, M. Reyes); Skeeter Cave (Fort Hood), 3 June 2001 (J. Reddell); 25 Aug. 2003 (C. Pekins, J. Reddell). *Bexar County*: B-52 Cave (Camp Bullis), 31 July 2008 (K. McDermid); Get a Rope Cave, 23 Sept. 2000 (G. Veni); Vera Cruz Shaft, 1 June 2007 (J. Krejca). *Terrell County*: The Crack, 23 Nov. 2001 (L. McNatt, C. Savvas).

Previous Cave Records (as *Pheidole* spp., Reddell and Cokendolpher, 2001)**.—***Bexar County*: Platypus Pit (Camp Bullis). *Burnet County*: Longhorn Caverns. *Edwards County*: Punkin Cave. *Travis County*: Dobie Shelter, Jester Estates Well Trap No. 9. *Val Verde County*: Diablo Cave.

Comment.—These records are based only on minor workers.

Pheidole dentata Mayr

Previous Cave Record (Reddell and Cokendolpher, 2001)**.—***Bexar County*: Cave of the Bearded Tree.

Pheidole hyatti Emery

New Record.—*Bell County*: Streak Cave, 15 July 2008 (J. Reddell, M. Reyes).

Previous Cave Record (as *Pheidole* sp., Reddell and Cokendolpher, 2001)**.—***Bell County*: Streak Cave.

Comment.—This is the first record of this species from a cave in Texas. The species is widespread in Texas.

Pheidole porcula Wheeler

New Record.—*Bexar County*: Vera Cruz Shaft, 1 June 2007 (J. Krejca).

Comment.—This is the first record of this species from a cave in Texas. This is apparently the first record of the species in Bexar County. It is largely restricted to western Texas.

Pogonomyrmex barbatus (F. Smith)

Previous Cave Records (Reddell and Cokendolpher, 2001)**.—***Edwards County*: Dunbar Cave. *Williamson County*: Shaman Cave.

Comment.—This is an accidental.

Pogonomyrmex comanche Wheeler

Previous Cave Record (Reddell and Cokendolpher, 2001)**.—***Travis County*: Fossil Cave.

Comment.—This is an accidental.

Solenopsis geminata (Fabricius)

New Record.—*Travis County*: Toucasia Cave, 5 June 2003 (M. Sanders, C. Abbruzzese).

Previous Cave Records (Reddell and Cokendolpher, 2001)**.—***Bexar County*: Kamikazi Cricket Cave. *Travis County*: Featherman's Cave. *Williamson County*: Squaw Cave.

Solenopsis invicta Buren
Figs. 11-12

New Records.—*Bandera County*: Can Creek Cave No. 3, Lost Maples State Natural Area, 20 July 2000 (J. Reddell, M. Reyes); Harvestman Annex Cave, Hill Country State Natural Area, 20 July 2000 (J. Reddell, M. Reyes). *Bell County*: Big Crevice (Fort Hood), 6 June 2000 (J. Reddell, M. Reyes), Berlese of leaf litter; Cinco de Mayo Cave (Fort Hood), 6 May 2004 (J. Reddell, M. Reyes); Collapse Sink (Fort Hood), 16 July 2008 (J. Reddell, M. Reyes); Diamondback Cave (Fort Hood), 25 Aug. 2004 (J. Reddell); Dumpty Cave (Fort Hood), 29 Aug. 2004 (M. Reyes, M. Warton); Falling Hammer Cave (Fort Hood), 4 May 2004 (M. Reyes); Hackberry Cave (Fort Hood), 18 Sept. 2004 (J. Fant, M. Reyes); Hidden Pit Cave (Fort Hood), 18 Aug. 2003 (C. Pekins, J. Reddell, M. Reyes); Hope Well Sink (Fort Hood), 16 May 2006 (J. Reddell); Newby Cave (Fort Hood), 31 January 2007 (S. J. Taylor, J. K. Krejca, C. Pekins, T. Marston, R. Myers); Plethodon Cave (Fort Hood), 25 May 2004 (J. Reddell, M. Reyes); Price Pit Cave (Fort Hood), 6 May 1999 (J. Reddell, M. Reyes), 20 July 2008 (J. Reddell, M. Reyes), 25 Aug. 2003 (C. Pekins, J. Reddell); Runoff Cave (Fort Hood), 26 May 2004 (J. Reddell, M. Reyes); Slotsky Pit Cave (Fort Hood), 6 June 2004 (M. Reyes, M. Warton); Talking Crows Cave (Fort Hood), 21 July 2008 (J. Reddell, M. Reyes); Trapper Sink (Fort Hood), 28 Aug. 2004 (J. Fant, M. Reyes); Vine Cave (Fort Hood), 18 June 2004 (J. Reddell, M. Reyes); Weep Hole Cave (Fort Hood), 14 Nov. 2002 (M. Reyes, M. Warton). *Bexar County*: Backhole Cave (Camp Bullis), 31 July 2007 (J. Krejca); Spring 4C-18 (middle) (Camp Bullis), 18 April 2001 (J. Reddell, M. Reyes), out of mophead; Spring 5D-1 (Camp Bullis), 31 May 2007 (P. Sprouse); Spring 7-49 (Camp Bullis), 14 April 2001 (J. Reddell, M. Reyes), out of mophead; Spring 9-161 (Camp Bullis), 31 May 2007 (J. Krejca); 40mm Cave (Camp Bullis), 21 July 2006 (J. Krejca); Accident Sink (Camp Bullis), 26 Oct. 2004 (C. Thibodaux, C. Murray); 9 May 2005 (J. Reddell, M. Reyes); Ailor Hill Cave (Camp Bullis), 26 May 2003 (B. Shade, G. Veni); B-52 Cave, Zone 1 (Camp Bullis), 8 Oct. 2003 (J. Krejca, P. Sprouse); Bone Pile Cave, Government Canyon State Natural Area, 12 Sept. 2001 (G. Veni); Bunny Hole (Camp Bullis), 10 Aug. 2006 (J. Reddell, M. Reyes); Cowbell Cave, no date (A.G. Grubbs); Crownridge Canyon Cave, 13 Nov. 2002 (G. Veni); 19 Nov. 2002 (J. Reddell, M. Reyes); Genesis Cave, 2 Dec. 2005 (A. Gluesenkamp, P. Sprouse); Mastodon Pit, 3 April 2002 (K. White); Obvious Little Cave, 14 June 2001 (J. Cokendolpher); Plethodon Pit, Stone Oak Karst Fauna Region, 12 Sept. 1999 (K. White); Power Pole 60 Feature (Camp Bullis), 20 April 2003 (J. Reddell, M. Reyes); 24 May 2003 (J. Reddell, M. Reyes); Power Line Karst Feature F-3, 16 Jan. 2002 (L. J. Graves); Root Toupee Cave (Camp Bullis), upper level, 14 Aug. 2007 (J. Reddell); Sewer Line Karst Feature F-3, 16 Jan. 2002 (L. J. Graves); Strange Little Cave (Camp Bullis), 31 Aug. 2006 (J. Krejca); Twin Cedar Cave, Government Canyon State Natural Area, 27 April 2003 (M. Miller). *Comal County*: Bufo Cave, Guadalupe River State Park, 14 May 2002 (J. Krejca, C. Lee, W. Russell). *Coryell County*: Big Red Cave (Fort Hood), 14 June 1999 (J. Krejca, P. Sprouse); Lucky Day Cave (Fort Hood), 12 March 2003 (J. Fant, M. Reyes); New Cave (Fort Hood), 20 June 2000 (J. Reddell, M. Reyes); Rocket River Cave System (B. R.'s Secret Cave) (Fort Hood), 31 March 2004 (J. Krejca); Sperry Cave (Fort Hood), 5 June 2006 (C. Pekins, J. Reddell, M. Reyes). *Llano*

Figs. 11-12.—*Solenopsis invicta* Buren from Big Red Cave (Fort Hood), Coryell County, Texas (images by J. Krejca and S. Taylor). 11, Eating a *Leiobunum townsendi* Weed: harvestman (10 August 2002). 12, Eating a *Ceuthophilus secretus* Scudder camel cricket (9 August 2001).

County: Riley Mountain Cave no. 1, 16 March 2006 (J. Krejca). *Sutton County*: Harrison Cave, 20 Nov. 2004 (J. Kennedy). *Travis County*: Cortana Cave, 3 Oct. 2007 (J. Krejca); Cortana Feature 2, 25 Sept. 2007 (P. Sprouse, K. McDermid); Cortana Feature 4, 25 Sept. 2007 (P. Sprouse, K. McDermid); Cortana Feature 4, leaf litter, 9 Oct. 2007 (R. Myers, K. McDermid); Cortana Feature 11, 25 Sept. 2007 (P. Sprouse, K. McDermid); Cortana Feature 12, 25 Sept. 2007 (P. Sprouse, K. McDermid); 9 Oct. 2007 (R. Myers, K. McDermid); Cortana Feature 12, leaf litter, 9 Oct. 2007 (R. Myers, K. McDermid); Cortana Feature 13, leaf litter, 9 Oct. 2007 (R. Myers, K. McDermid); Flint Ridge Cave, 29 Oct. 2004 (J. Krejca, M. Kirkpatrick, M. Sanders); Garden Hoe Cave, 22 May 2007 (J. Krejca); Karst Feature F4, 26 Sept. 2006 (J. Krejca); Karst Feature F10, 2 Oct. 2006 (A. Gluesenkamp); Karst Feature F10, 4 Oct. 2006 (J. Krejca); Rock Joint Sink, 4 Sept. 2002 (M. Reyes, M. Warton); Webb Root Cave, Webb Tract, 18 May 2005 (L. J. Graves, C. Thibodaux). *Williamson County*: Beck Crevice Cave, 3 June 1996 (J. Reddell, M. Reyes); Chigger Cave, 1 June 2001 (J. Reddell); Cobb Drain Cave, 1 June 2001 (L. J. Graves, J. Reddell, M. Reyes); Dead Dauber Cave, 20 May 2003 (J. Reddell, M. Reyes); Persimmon Sink, 3 Nov. 2005 (J. Reddell, M. Reyes).

Previous Cave Records (Reddell and Cokendolpher, 2001).—Bell County: Camp 6 Cave No. 1 (Fort Hood), Camp 6 Cave No. 2 (Fort Hood), Canyon Side Sink (Fort Hood), Coyote Den Cave (Fort Hood), Figure 8 Cave (Fort Hood), Flapjack Cave (Fort Hood), Hanging Stump Cave (Fort Hood), Herbert Cave (Fort Hood), Jagged Walls Cave (Fort Hood), Lunch Counter Cave (Fort Hood), Medusa Cave (Fort Hood), Monkey Walk Cave No. 2 (Fort Hood), Mystery Rock Sink (Fort Hood), Newby Cave (Fort Hood), Owl Mountain Cave (Fort Hood), Peep in the Deep Cave (Fort Hood), Price Pit Cave (Fort Hood), Rock Ring Sink (Fort Hood), Root Sink (Fort Hood), Talking Crows Cave (Fort Hood), Valentine Cave (Fort Hood), Violet Cave (Fort Hood). *Bexar County*: B. J. Pit, Backhole Cave (Camp Bullis), Bone Pile Cave (Government Canyon State Park), Bullis Hole (Camp Bullis), Zone 2, Buzzard Egg Cave (Camp Bullis), Caracol Creek Coon Cave, Cross the Creek Cave (Camp Bullis), Dangerfield Cave (Camp Bullis), Eagles Nest Cave (Camp Bullis), Elmore Cave, Flying Buzzworm Cave (Camp Bullis), Goat Cave (Government Canyon State Park), Government Canyon Bat Cave (Government Canyon State Park), Haz Mat Pit (Camp Bullis), Headquarters Cave (Camp Bullis), Isocow Cave (Camp Bullis), John Wagner Ranch Cave No. 3, Kamikazi Cricket Cave, Linda's First Cave Find, Logan's Cave, Lone Gunman Pit (Camp Bullis), Madla's Drop Cave, MARS Cave (Camp Bullis), MARS Pit (Camp Bullis), Mastodon Pit, Mattke Cave, Meusebach Flats Cave (Camp Bullis), NBC Cave (Camp Bullis), Poison Ivy Pit, Ponytail Pit (Camp Bullis), Poor Boy Ranch Cave, Pot-Bellied Stove Cave, Rattlesnake Cave, Record Fire 1 Pit (Camp Bullis), Robbers Cave, Root Toupee Cave (Camp Bullis), SARA Site 4 Cave (Camp Bullis), Scorpion Cave, Sink Hole, Stahl Cave (Camp Bullis), Stevens Ranch Cave No. 1, Stevens Ranch Trash Hole Cave, Strange Little Cave (Camp Bullis), Surprise Sink (Government Canyon State Park), Three Fingers Cave, Two Raccoon Cave, Vera Cruz Shaft (Camp Bullis), Winston's Cave (Camp Bullis), World News Cave, Wurzbach Bat Cave, Young Cave No. 1. *Comal County*: Camp Bullis Cave No. 1 (Camp Bullis), Ebert Cave, Fischer Pit. *Coryell County*: Cicurina Sink (Fort Hood), Egypt Cave (Fort Hood), Ingram Cave (Fort Hood), Mixmaster Cave (Fort Hood), Porter Cave (Fort Hood), Shults Cave (Fort Hood). *Hays County*: Antioch Cave, Autumn Woods Well. *Kendall County*: Covered Hole, Pfeiffer's Water Cave. *Travis County*: Balcones Sink, Bulldozer Cavern, Cave Z, Central Sink, Disbelievers Cave, District Park Cave, Driskill Cave, Enfield Sinkhole, Five Pocket Cave, Flint Ridge Cave, Fossil Garden Cave, Gallifer Cave, Geode Cave, Hawk Tract Well Trap No. 1, 3, 5, 7, Hole in the Road, Homestead Cave, Japygid Cave, Jest John Cave, Jollyville Jewel Cave, Kretschmarr Salamander Cave, Lamm Cave, M.W.A. Cave, Midden Sink, Moss Pit, Outhouse Hole Sink, Rock Top Cave, Singletary Cave, Spyglass Cave, Stoneworks Sink, Three-Holer Cave, Tight Pit Cave, Tooth Cave, Two Trunks Cave, Weldon Cave, Weldon Windmill Cave, Whirlpool Cave, Yaupon Ridge Cave. *Williamson County*: Agave Cave, Avery Avenue Cave, Bat Well, Beck Bat Cave, Beck Bridge Cave, Beck Cowcatcher Cave, Beck Creek Cave, Beck Pride Cave, Beck Rattlesnake Cave, Beck Salamander Cave, Beck Tex-2 Cave, Beck's Beside Road Cave, Big Oak Cave, Blue Wasp Cave, Bone Cave, Borgarigmie Cave, Broken Plate Cave, Buttercup Blow Hole Cave, Cannibal Lector Cave, Cat Cave, Cat Hollow Bat Cave, Chagas Cave, Circle Sink Cave, Coon Crawl Cave, Crescent Cave, Deliverance Cave No. 1, Dion Cave, Do Drop In Cave, Dragon Fly Cave, East Fork Fissure, Eclipse Cave, Electro-Mag Cave, Fence-Line Cave, Fern Cave, Fire Ant Cave, Flat Rock Cave, Flathead Cave, Flint Wash Cave, Floral Cave, Formation Forest Cave, Fortune 500 Cave, Gasch Cave, Godwin's Goat Grave Cave, Good Omen Spring, Hawk Tract Well Trap No. 2, Holler Hole Cave, Jackhammer Cave, Joker Cave, Knife Cave, Ku Klux Klan Cave, LakeLine Cave, LakeLine Mall Well Trap No. 2, 3, 6, Leaning Tree Cave, Lineament Cave, Lorfing's Unseen Rattler Cave, Man-With-A-Spear Cave, Medicine Man Cave, Mushroom Cave, Mustard Cave, Nostromos Cave, O'Connor Cave, Ominous Entrance Cave, On Campus Cave, Overlooked Cave, Paleospring Cave, Pow Wow

Cave, Priscilla's Cave, Pussy Cat Cave, Quinceñera Cave, Raccoon Cave, Red Crevice Cave,, Scoot Over Cave, Shaman Cave, Shawnee Pit Cave, Short Stack Cave, Sierra Vista Cave, Spiny Tortilla Cave, Sting Cave, Temples of Thor Cave, Testimony Cave, Testudo Tube, Texella Cave, The Chimney, Thin Roof Cave, Turner Goat Cave, Undercut Cave, Undertaker Cave, Ute Cave, Valley Cave, Varicose Cave, Villa de Indios Cave, Village Idiot Cave, Walsh Pasture Cave, Wigglewise Cave, Wild Card Cave, Williams Cave No. 1, Zee End Cave.

Comment.—These are the first records of the species from caves in Bandera and Sutton Counties. The record from Newby Cave (Bell County) is from the stomach of a salamander, *Plethodon albagula*. It is considered a trogloxene. The red inported fire ant, or *S. invicta*, is certainly the most important introduced pest ant in the U.S.A. Decades of research on fire ants have show them to be efficient predators of wildlife (Figs. 11-12). Whereas this can be useful in controlling certain plant pests, fire ants do not seem to serve any useful purpose in or around karst, except as an occasional meal for salamanders and spiders (Fig. 13). Numerous publications have been written on these ants and two nice books are provided by Taber (2000) and Tschinkel (2006).

Solenopsis texana Emery

Previous Cave Record (Reddell and Cokendolpher, 2001)**.—***Bell County*: Big Crevice (Fort Hood).

Solenopsis xyloni McCook

Previous Cave Records (Reddell and Cokendolpher, 2001)**.—***Bexar County*: Braken Bat Cave. *Val Verde County*: Seminole Sink. *Williamson County*: Hanging Branch Cave.

Temnothorax obturator (Wheeler)

New Record.—*Bell County*: Runoff Cave, 14 March 1992 (J. Reddell, M. Reyes), Berlese of leaf litter.

Previous Cave Record (Reddell and Cokendolpher, 2001)**.—***Bell County*: Runoff Cave.

Comment.—The specimens were previously recorded as *Leptothorax* sp. (Reddell and Cokendolpher, 2001).

ACKNOWLEDGMENTS

We thank Joe MacGown (Mississippi Entomological Museum, Mississippi State University), and William P. MacKay (University of Texas at El Paso) for their helpful reviews of the manuscript. We also thank Joe for his verification of the *Discothyrea*, and a guide to the literature, and distributional data for this interesting ant. Bill Sawyer (Sonora, Texas) arranged access and provided information about Caverns of Sonora. Access to the Hitachi S-4300SE/N was provided by the Texas Tech

Fig. 13.—*Eidmanella rostrata* Gertsch (Nesticidae) spider eating an ant, probably *Solenopsis invicta* Buren in a cave in northern Bexar County (August 2004, image by J. Krejca).

University Imaging Center, through NSF MRI 04-511. We are grateful to both institutions for making this equipment available for our study. Jerry Fant kindly allowed us use of his map of Endless Pit Cave. We are also very grateful to all of the collectors whose names are listed in the records sections of each species. Research on Fort Hood was funded by The Nature Conservancy through cooperative agreement DPW-ENV-02-A-001 between the Department of the Army and The Nature Conservancy. Information contained in this report does not necessarily reflect the position or the policy of the government and no official endorsement should be inferred.

LITERATURE CITED

Bolton, B. 2003. Synopsis and Classification of Formicidae. Memoirs of the American Entomological Institute, 71: 1-370.

Carter, W. G. 1962. Ant distribution in North Carolina. Journal of the Elisha Mitchell Science Society, 78:150-204.

Cole, B. J. 1994.Nest architecture in the western harvester ant, *Pogonomyrmex occidentalis* (Cresson). Insectes Sociaux, 41:401–410.

Dash, S. T. 2005. Species Diversity and Biogeography of Ants (Hymenoptera: Formicidae) in Louisiana, with Notes on their Ecology. M.S. Thesis, Louisiana State University, 290 pp.

Decu, V., A. Casale, P. L. Scaramozzino, F. López, and A. Tinaut. 1998. Hymenoptera. Pages 1015-1024 in: C. Juberthie, and V. Decu, eds., Encyclopaedia Biospeologica, Tome 2. Société Biospéologie, Moulis and Bucarest, 1,373 pp.

Deyrup, M. 2003. An updated list of Florida ants (Hymenoptera: Formicidae). Florida Entomologist, 86: 43-48.

General, D. M., and L. C. Thompson. 2007. Ants (Hymenoptera: Formicidae) of Arkansas Post National Memorial. Journal of the Arkansas Academy of Science, 61:59-64.

Hölldobler, B., and E. O. Wilson. 1990. The Ants. Cambridge, MA: Belknap Press, 732 pp.

Howarth, F. G. 1983. Ecology of cave arthropods. Annual Review of Entomology, 28:365-389.

Ipser, R. M., M. A. Brinkman, W. A. Gardner, and H. B. Peeler. 2004. A survey of the ground-dwelling ants (Hymenoptera: Formicidae) in Georgia. Florida Entomologist, 87:253-260.

Johnson, R. A. 2000. Habitat segregation based on soil texture and body size in the seed-harvester ants *Pogonomyrmex barbatus* and *P. rugosus*. Ecological Entomology, 2:403-412.

Johnson, R. A. 2001. Biogeography and community structure of North American seed-harvester ants. Annual Review of Entomology, 46:1-29.

Juberthie, C. and V. Decu. 2004. Interstitial habitats (terrestrial). Pp, 455-457 in J. Gunn, ed., Encyclopedia of Cave and Karst Science. Fitzroy Dearborn, New York, xviii + 902 pp.

Juberthie, C., B. Delay, and M. Bouilon. 1980. Extension du milieu souterrain en zone non calcaire: description d'un nouveau milieu et de son peuplement par les Coléoptères troglobies. Mémoires de Biospéologie, 7:19-52.

Juberthie, C., B. Delay, V. Decu, and G. Racovitza. 1981. Premières données sur la faune des microespaces du mileu souterrain suberficiel de Roumanie. Travaux de l'Institut de Spéologie Emile Racovitza, 20:103-111.

Kempf, W. W. 1961. *Labidus coecus* as a cave ant. Studia Entomologica, 4:551-552.

Klimchouk, A. B., D. C. Ford, A. N. Palmer and W. Dreybrodt, eds. 2000. Speleogenesis: Evolution of karst aquifers. National Speleological Society, Huntsville, Alabama, 527 pp.

Lewis, J. J. 1974. The invertebrate fauna of Mystery Cave, Perry County, Missouri. Missouri Speleology, 14(4):1-19.

Longacre, C. 2000. Department of the Interior, Fish and Wildlife Service, 50 CFR part 17, RIN 1018–AF33. Endangered and threatened wildlife and plants; final rule to list nine Bexar County, Texas Invertebrate species as endangered. Federal Register, 65(248):81419–81433.

MacGown, J. A., and R. L. Brown. 2006. Survey of Ants (Hymenoptera: Formicidae) of the Tombigbee National Forest in Mississippi. Journal of the Kansas Entomological Society, 79:325-340.

MacGown, J. A., J. G. Hill, and M. A. Deyrup. 2007. *Brachymyrmex patagonicus* (Hymenoptera: Formicidae), an emerging pest species in the southeastern United States. Florida Entomologist, 90(3):457-464.

MacGown, J. A., and J. A. Forster. 2005. A preliminary list of the ants (Hymenoptera: Formicidae) of Alabama. Entomological News, 116:61-74.

MacMahon, J. A., J. F. Mull, and T. O. Crist. 2000. Harvester ant (*Pogonomyrmex* spp.): their community and ecosystem influences. Annual Review of Ecology and Systematics, 31:265–291.

O'Keefe, S. T., J. L. Cook, T. Dudek, D. F. Wunneburger, M. D. Guzman, R. N. Coulson, and S. B. Vinson. 2000. The distribution of Texas ants. Southwestern Entomologist, Supplement, No. 22, 92 pp.

Perfecto, I. 1992. Observations of a *Labidus coecus* (Latreille) underground raid in the central highlands of Costa Rica. Psyche, 99:214-220.

Reddell, J. R., and J. C. Cokendolpher. 2001. Ants (Hymenoptera: Formicidae) from caves of Belize, Mexico, and California and Texas (U.S.A.). Texas Memorial Museum, Speleological Monographs, 5:129-154.

Roncin, E., and L. Deharveng. 2003. *Leptogenys khammouan-ensis* sp. nov. (Hymenoptera: Formicidae). A possible troglobitic species of Laos, with a discussion on cave ants. Zoological Science, 20:919-924.

Roncin, E., L. Deharveng, and A. Bedos. 2001. Cave ants in Southeast Asia. In "XV International Symposium of Biospeleology," Intervales, Sao Paulo (Brasil), 8-15 July 2001. Abstracts: 66-67.

Smith, D. R. 1979. Superfamily Formicoidea. Pp. 1323-1467 in: K. V. Krombein, P. D. Hurd, Jr., D. R. Smith, and B. D. Burks, eds., Catalog of Hymenoptera in America North of Mexico, Vol. 2: Apocrita (Aculeata). Smithsonian Institution Press, Washington, D. C., xvi + 1199-2209.

Smith, M. R., and M. W. Wing. 1955. Redescription of *Discothyrea testacea* Roger, a little-known North American ant, with notes on the genus (Hymenoptera: Formicidae). Journal of the New York Entomological Society, 62:105-112.

Taber, S. W. 2000. Fire Ants. Texas A&M University, College Station, 308 pp.

Taylor, S. J., A. P. Christopher, A. Phillips, and J. K. Krejca. 2008. Prey of cave and surface populations of *Plethodon albagula* (Plethodontidae) at Fort Hood, Texas. Illinois Natural History Survey Technical Report 2007 (48). Prepared for: U.S. Army Engineer Research and Development Center, ERDC-CTC, 2902 Newmark Drive, Champaign, IL 61822-1076.

Tinaut, A. and F. Lopez. 2001. Ants and caves: Sociability and ecological constraints (Hymenoptera, Formicidae). Sociobiology, 37(3):651-659.

Tschinkel, W. R. 2003. Subterranean ant nest: trace fossils past and future? Paleogeography, Paleoclimatology, Paleoecology, 192:321-333.

Tschinkel, W. R. 2006. The Fire Ants. Harvard University/Belknap Press, 744 pp.

Wilson, E. O. 1962. The Trinidad cave ant *Erebomyrma* (=*Spelaeomyrmex*) *urichi* (Wheeler), with a comment on cavernicolous ants in general. Psyche, 69:62-72.

LIST OF NEW TAXA

ARACHNIDA
SCORPIONES
Troglotayosicidae

Troglotayosicus humiculum Botero-Trujillo and Francke....3

Vaejovidae

Pseudouroctonus savvasi Francke 12

SCHIZOMIDA
Protoschizomidae

Agastoschizomus juxtlahuacensis Montaño Moreno and Francke 34

ARANEAE
Linyphiidae

Agyneta hedini Dupérré and Paquin 47

Pholcidae

Modisimus deltoroi Valdez-Mondragón and Francke 58

PSEUDOSCORPIONIDA
Chthoniidae

Tyrannochthonius muchmoreorum Cokendolpher 71

INSECTA
ZYGENTOMA
Nicoletiidae

Anelpistina multispinata Espinasa and Boyko 82
Texoreddellia aquilonalis Espinasa and Giribet 97
Texoreddellia media Espinasa and Giribet 104
Texoreddellia occasus Espinasa and Giribet 105
Texoreddellia capitesquameo Espinasa and Giribet 106
Texoreddellia coahuilensis Espinasa and Giribet 106

COLEOPTERA
Carabidae

Rhadine grubbsi Reddell and Dupérré 111

Curculionidae

Lymantes nadineae Anderson 117

Staphylinidae

Batrisodes (*Babnormodes*) *dentifrons* Chandler and Reddell 133
Batrisodes (*Babnormodes*) *fanti* Chandler and Reddell 133
Batrisodes (*Babnormodes*) *incisipes* Chandler and Reddell....134
Batrisodes (*Babnormodes*) *pekinsi* Chandler and Reddell....135
Batrisodes (*Excavodes*) *shadeae* Chandler and Reddell 135