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This special number is dedicated to México, and is an effort by the authors to update the knowledge of the Mexican cave fauna which has greatly increased in recent years, thanks to many people dedicated to this unique environment. This number is a special joint contribution of the International Society for Subterranean Biology and the Unión Mexicana de Agrupaciones Espeleológicas, A. C. It corresponds to a special volume of the Encyclopaedia Biospeologica and to numbers 25-26 of *Mundos Subterráneos*.

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Cover: Picture taken by Rodrigo Lopes at Juxtlahuaca caves, Guerrero State. Bat *Natalus* (Natalidae) being eaten by one nymph of the cockroach *Blaberus craniifer* (Blaberidae) and snails (Gasteropoda: Subulinidae).



MEXICO

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I. History

I. 1. Pre-Columbian Period

The knowledge of Mexican caves is anterior to the European discovery of the Americas. Aztecs named the caves "oztotl" in Nahuatl idiom.

Native Americans utilized caves in all parts of México. Petroglyphs and pictographs were painted in caves, especially in northern México and Baja California, but also in the Sierra de El Abra, San Luis Potosí and Tamaulipas. Elaborate paintings, including a jaguar, were found in the Olmec cave, Grutas de Juxtlahuaca, Guerrero. Burials and caches of pottery and other artifacts have been found in caves throughout México. Naturally mummified remains have been found in dry caves in Chihuahua, Coahuila, and Nuevo León.

The best-documented use of caves is that of the Mayas (STONE, 1997; BRADY, 1999, 2012; RISSOLO, 2003). They explored caves with wooden torches and never used oil lamps. Most caves explored by the ancient Mayas are small, their record for penetration is 3 km in Actún Chek. Usually the greatest concentration of artifacts is found in the twilight zone.

Evidence for cave utilization prior to 1200 BC is limited; cave rituals became more frequent during the late Classic Period (600-900 AD) and continued in northern Yucatán and the Maya highlands until 900-1550 AD.

In the absence of surface water in the Yucatán Península, caves were an essential source of water and pits more than 20 meters in depth and long, torturous crawlways were entered in search of water. This practice continued throughout the Península until the recent construction of drilled wells in most towns. Cenotes are still the primary water source for the Maya in rural areas.

They used caves as burials, and deployed various types of construction within the cave: stone walls with low doorways, pavements, stairs, and dams in caves with seasonal flooding.

Human sacrifices were an important part of Mayan religious ritual. This included throwing victims into cenotes, most notably at the Cenote de Sacrificio in archaeological site Chichen Itza.

About sixty decorated caves are known, making this one of the most important cave art areas in the world. Art work includes negative and positive handprints, footprints, geometric drawings, and in Yucatán engraved petroglyphs and modified speleothems showing frontal faces which may represent spirits.

In their cosmology, the first appearance of humans on the earth is from caves. Caves are the house of ancestors and supernatural beings.

In non karstic areas, artificial caverns were excavated by Mayans.

I. 2. Modern period

The first biological investigation of a cave in México was conducted in 1866 by the Austrian Reverend **Dominik Bilimek**, who accompanied in México the Maximilian Imperator, when he visited Grutas de Cacahuamilpa (Guerrero). He reported 11 species with one troglobite, *Anelpistina* (ex *Lepisma*) *anophthalma* (BILIMEK, 1867). The next important contribution was that of the Mexican **D. A. L Herrera** (1891, 1893) on fauna in the Grutas de Cacahuamilpa and also from a

well in Monterrey where he collected a stygobitic cirrolanid (*Conilera stygia*), described by *A. S. Packard* in 1900. These are the only studies of cave fauna prior to 1932.

In 1932 *E. P. Creaser*, *F. G. Hall* and *A. S. Pearse* investigated 35 cenotes and caves in Yucatán (PEARSE, 1936). The volume, published in 1936, emphasized the description and list of fauna (70 species with only four stygobitic crustaceans), the chemical and physical nature of karst waters, and ecology of cenotes and caves. CREASER (1936) described new species of Isopoda (*Cirolana anops*), Mysidacea (*Antromysis cenotensis*) and Decapoda (*Typhlatya pearsei* and *Palaemon morleyi*).



Fig. 1 – Location of caves with biggest biodiversity in México (in parenthesis number of species). 1 = Cueva de las Sardinas, Tabasco (169); 2 = Actún Xpukil, Yucatán (134); 3 = Sistema Purificación, Tamaulipas (103); 4 = Grutas de Juxtlahuaca, Guerrero (93); 5 = Cenote Xtolok, Chichén-Itzá, Yucatán (86); 6 = Cueva Aerolito de Paraiso, Quintana Roo (71); 7 = Cueva de la Mina, Tamaulipas (60); 8 = Cueva de Balaam Canché, Chichén Itzá, Yucatán (59); 9 = Cueva de Sambulhá, Motul, Yucatán (53); 10 = Sistema Huautla, Oaxaca (48); 11 = Cueva de Los Sabinos, San Luis Potosí (48); 12 = Sótano del Arroyo, San Luis Potosí (43); 13 = Grutas del Palmito, Nuevo León (43); 14 = Cueva Chica, San Luis Potosí (41); 15 = Grutas de Acuitlapán, Guerrero (40); 16 = Grutas de Cacahuamilpa, Guerrero (30); 17 = Cueva del Nacimiento del Río San Antonio, Oaxaca (30).

In 1936 *A. S. Pearse* explored 27 caves in Yucatán and the results were published in 1938 by the Carnegie Institution of Washington (PEARSE, 1938a); a total of 306 species were identified of which eight troglobites and two stygobites were added to the cave fauna of México: two Araneae (CHAMBERLIN & IVIE, 1938b), three Collembola (MILLS, 1938), one Orthoptera (HUBBELL, 1938) and two Pisces (HUBBS, 1938).

The same year *Salvador Coronado* discovered in Cueva Chica (San Luis Potosí) the first Mexican eyeless Characidae, described by *Hubbs* and *Innes* (1938) as *Anoptichthys jordani*. *ÁLVAREZ* (1946) described a second species, *A. antrobius*, from Cueva El Pachón, and the following year a third species, *A. hubbsi* from Cueva de Los Sabinos (*ÁLVAREZ*, 1947). In the following years it was demonstrated the complete interfertility of the cave forms among themselves and with epigeal *Astyanax mexicanus*, so they were considered as cave populations of *Astyanax mexicanus*. Their presence in vast number, the ease with which they could be raised in the laboratory, and their ability to interbreed between cave and epigeal populations, has led to its study by numerous American and European researchers. They may also be purchased in aquarium shops

throughout the world. Early work was conducted by **C. M. Breder** and colleagues. Later, the team of Hamburg (**C. Kosswig**, **J. Parzefall**, and **H. Wilkens**) studied the biology, behavior, and genetics of the species.

In 1938, two Spanish biospeleologists, **Federico Bonet** and **Cándido Bolívar y Pieltain**, immigrated to México and began an intensive study of cave fauna during the next 20 years. They began with a visit to Grutas de Cacahuamilpa in 1939 (BOLÍVAR Y PIELTAIN, 1940), then in 1941 the Olmec cave, Grutas de Juxtaluaca (Guerrero), and Grutas de Atoyac (Veracruz) with discovery of several troglobites. In 1942 with other Mexican zoologists, they visited Cueva Chica and Cueva de Los Sabinos and discovered new troglobitic species of Ricinulei (BOLÍVAR Y PIELTAIN, 1946), Isopoda (BOLÍVAR Y PIELTAIN, 1950), Opiliones (GOODNIGHT & GOODNIGHT, 1942) and Pisces (ÁLVAREZ, 1947). These trips resulted in one of the more significant publications on the aquatic fauna of Mexican caves (OSORIO TAFALL, 1942, 1943).

In the same period in 1940, **Ivan T. Sanderson** (1941) collected a large series of Ricinulei in Actún Kaua (Yucatán), and **Harry Hoogstraal** in the Cueva de la Boca (Nuevo León) the first troglobitic centiped (CHAMBERLIN, 1941).

Further, in 1942-1945, **F. Bonet**, **C. Bolívar y Pieltain**, and other members of the Escuela Nacional de Ciencias Biológicas de México visited caves in Nuevo León, Cueva de El Pachón and other caves in Tamaulipas, Cueva de los Sabinos and other caves in San Luis Potosí; in 1950 caves in the Xilitla region and prepared detailed maps and descriptions of the caves (BONET 1953 b); in 1954 cavernicolous fauna of Oaxaca; and in 1962 Grutas de Acuitlapán (Guerrero). From 1951 to 1963 **Bonet** published several articles on his excursions in caves, and finally in 1971 a book on the speleology of the Cacahuamilpa region.

In 1943 **B. F. Osorio-Tafall** collected two species of pseudoscorpions representative of the new family Vachoniidae in Actún Sabacá and Grutas de Balankanché, Yucatán (CHAMBERLIN, 1947) and in 1947 with **Cardenas Figueroa** he discovered the blind fish *Typhliasina pearsei* in Cenote del Pochote, Yucatán.

A. Villalobos conducted explorations in Cueva del Ojo de Agua Grande (Veracruz) in 1947, in Cenote de Sambulá de Motul (Yucatán) in 1953, and in Grutas de Coconá (Tabasco) in 1960. These studies led to descriptions of new Isopoda (RIOJA, 1953a, b, c, d, 1958), and Decapoda (VILLALOBOS, 1951, 1953, 1954, 1958).

With the organization in 1962 of the Speleological Survey of México in Austin, Texas, (now called Association for Mexican Cave Studies) a new period in the study of the cave fauna of México was initiated. Because of the interest of the initial collection (1962) of cave animals in caves of San Luis Potosi by **T. R. Evans**, **T. W. Raines**, **J. R. Reddell** and **W. H. Russell** an important program of study of the cave fauna of México was initiated. In 1964 caves and their fauna in karst areas of Tequila, Veracruz; Sierra de Guatemala, Tamaulipas; and Xilitla, San Luis Potosí, were investigated. Among the cave fauna described from these collections were a new troglobitic carabid beetle (BARR, 1965), gryllids (HUBBELL, 1972), millipeds (CAUSEY, 1963, 1964a,b, 1969, 1971a,b) pseudoscorpions (MUCHMORE, 1969, 1972a,b), earthworm (GATES, 1968), spiders (GERTSCH, 1971a) and Ricinulei (GERTSCH, 1971b). Lists of species were provided for several areas: Sierra de El Abra, San Luis Potosí and Tamaulipas (REDDELL & MITCHELL, 1971a; REDDELL & ELLIOTT, 1973a); Sierra de Guatemala, Tamaulipas (REDDELL & MITCHELL, 1971a; REDDELL & ELLIOTT, 1973a); Valle de los Fantomas region, San Luis Potosí (ELLIOTT & REDDELL, 1973); southern México (REDDELL, 1971b); northern México (REDDELL, 1982).

In 1971b **J. R. Reddell** published the first checklist of the cave fauna of México, and in 1981 the most significant book on the history of explorations and the cave fauna of México, with distribution maps of species and a complete bibliography until 1980.

For details on the extraordinary biospeleological activity of North Americans through 1980, including expeditions, names of biologists, and discoveries, see "A review of the cavernicole fauna of México, Guatemala, and Belize". by **J. R. Reddell** (1981).

In 1969 the Accademia Nazionale dei Lincei of Italy sponsored the first Italian expedition to México, conducted by **Valerio Sbordoni**, **Roberto Argano**, and **Vittorio Parisi**. They visited 17 caves in the Sierra de Guatemala, Sierra de EL Abra, western Xilitla region, Cacahuamilpa region, and Veracruz. A second expedition was conducted in 1971 devoted to extreme southern México and Guatemala. A third expedition in 1973 investigated 45 caves in Chiapas and Huehuetenango, Guatemala. In 1975 a fourth expedition visited caves in Chiapas, and cenotes and caves in Campeche, Quintana Roo, and Yucatán. The descriptions of a large number of new troglobitic and stygobitic species were published in three large publications under the title "Subterranean Fauna of México," Part I (1971), II (1974) and III (1977) by Accademia Nazionale dei Lincei, Roma. Additional explorations were made in Chiapas by the Circolo Speleologico Romano in 1981, 1984, 1986, and 1987 (SBORDONI *et al.*, 1986, 1987).

In 1970 **J. Parzefall**, and **H. Wilkens** began their numerous trips to México to visit caves and collect *Astyanax* fishes in San Luis Potosí, *Poecilia mexicana* in Tabasco, and *Rhamdia guatemalensis* in Yucatán to study the biology, behavior, and genetics of these species in Hamburg (PARZEFALL, 1973, 1979, etc.; WILKENS, 1982, 2001, 2005, 210; WEBER *et al.* 1998). In 1995 **T. G. Langecker** and colleagues studied the sulfurous chemoautotrophic Cueva de las Sardinias, Tabasco, partly similar to the Movile Pester in Romania.

Since 1980, **José G. Palacios-Vargas** and colleagues have described numerous new species of Acari and Collembola and studied the biocenosis of many caves throughout México (PALACIOS-VARGAS, 1980a,b; 1981a,b; 1982a,b; 1983a,b,c,d; 1988a,b; 1989, 1991, 1993; MORALES-MALACARA, 1980, 1982; PALACIOS-VARGAS & NAJT, 1982; PALACIOS-VARGAS & THIBAUD, 1985; PALACIOS-VARGAS *et al.*, 1985b, 1997, 1998 a,b,c; 2006, PALACIOS-VARGAS & GRANADOS, 1990; MEJÍA-ORTÍZ *et al.*, 1997; FUENTES-SILVA & CUTZ POOL, 2004; PALACIOS-VARGAS & VARO DE LA ROSA, 2012).

With the development of subaquatic techniques of exploration of caves, many new species were collected above the halocline in cenotes and submerged passages in freshwater and below in saline water. These studies include the discovery of numerous new species of Crustacea, including the first Remipedia species in México and many new Copepoda, Ostracoda, Amphipoda, Mysidacea, Thermosbaenacea, and Isopoda (BOWMAN & ILIFFE, 1988; HOLSINGER, 1990, 1992; ILIFFE, 1993; FIERS *et al.*, 1996, 2000; KORNICKER & ILIFFE, 1989, 2000; ROCHA & ILIFFE, 1994; ROCHA *et al.*, 1998, 2000; BOTOSANEANU & ILIFFE, 1999; PESCE & ILIFFE, 2002).

Dean Hendrickson, Jean Krejca and Peter Sprouse of the University of Texas at Austin conducted extensive studies in the caves of northern México in the late 1990s, with special emphasis on the blind catfishes of the genus *Prietella* (HENDRICKSON *et al.*, 2001).

REDDELL (2001) published a list of the cave fauna of the Xilitla region, Querétaro and San Luis Potosí.

In 1992 began the exploration of lava tubes of the Succhioc Volcano in the Chichinautzin volcanic field. In total more than 28 km of passages have been mapped (ESPINASA-PEREÑA, 2006).

In 1994 **José Palacios-Vargas** published a review of the cave fauna of México in the *Encyclopaedia Biospeologica*. HOFFMANN *et al.* (2004) published a comprehensive review of the arthropod fauna of Mexican caves.

From 1996 to 2005 the chemoautotrophic cave, Cueva de las Sardinias (= Cueva de Villa Luz, Cueva del Azufre) and its fauna was studied (LANGECKER *et al.*, 1996; GAMBOA & KU, 1998; PALACIOS VARGAS *et al.*, 1998, 2001, 2011; HOSE & PISAROWICZ, 1999; HOSE *et al.*, 2000; HOSE, 2003b, PISAROWICZ, 2001; PALMER & HILL, 2005).

An overview of the cave fauna of Central America and the Caribbean Islands was provided by REDDELL (2003).

During the 2000s and early 2010s **Peter Sprouse** conducted extensive biological investigations of caves in northern and northwestern México.

CASTAÑO-MENESES *et al.* (2005) studied the impact of tourism on Grutas de Juxtlahuaca, Guerrero. They discovered a significantly reduced biodiversity in the cave from earlier studies.

In recent years **Oscar F. Francke**, curator of Arachnida at the Universidad Nacional Autónoma de México, has supervised the study of students, resulting in the description of many new species of cave-dwelling arachnids (VALDEZ-MONDRAGÓN, 2007a,b,c, 2010, 2013; VALDEZ-MONDRAGÓN & FRANCKE, 2007, 2009, 2013).

In 2007 the robotic deep phreatic thermal explorer (DEPTHX) was used to map and collect biological and other samples from Sistema Zacatón, Tamaulipas, the world's second deepest water-filled sinkhole (-335 m).

PALACIOS-VARGAS & REDDELL (2013) published an updated list of stygobites, troglobites, and other species known only from caves in México.

II – Karst and caves

II. 1 Karstic areas

Caves occur in all parts of México but the best studied areas are the Sierra Madre Oriental, the Sierra Madre del Sur, the Chiapas Highlands, and the Yucatán Peninsula. There have been few studies in the remaining provinces, but they will certainly contain biologically significant caves. See REDDELL (1981) for detailed discussions of karst regions within each physiographic province that had been biologically investigated up to 1980.

1 – Sierra Madre Occidental. Most of the Sierra Madre Occidental consists of Tertiary volcanics but a few isolated outcrops of Cretaceous limestone have been exposed by erosion. Few caves have been studied and to date no troglobites or stygobites are known.

2 – Northern Coahuila. This area is geologically and physiographically related to the Edwards Plateau across the Rio Grande to the north. The area consists of a narrow band of Cretaceous limestone extending from Ciudad Acuña northwest to the Serranias del Burro. One large cave, Sótano de Amezcuca, has been studied. The fauna of the region is closely related to that of Texas immediately across the Rio Grande. The troglobitic millipede *Cambala speobia* is found in both regions. Stygobites common to both regions include the amphipod *Paraholsingerius smaragdinus*, the asellid isopod *Lirceolus cocytus*, and the cirolanid isopod *Cirolanides texensis*.

3 – Basins and Ranges. This area consists of an area of folded and faulted mountain ranges separated by wide valleys and basins. It extends in México from the United States border into northern Durango and southern Coahuila. The western ranges are largely igneous, but to the east they tend to be composed of folded Cretaceous sediments. It is bounded on the west by the Sierra Madre Occidental, on the east by the Sierra Madre Oriental, and on the south by the Cross Ranges of the Sierra Madre Oriental. Two notable basins are the Bolsón de Mapimí and the Bolsón de Cuatro Ciénegas de Carranza. Elevations of the basins are about 1,200 meters with the mountains rising several thousand meters above the valleys. The area has been poorly investigated, with the exception of the Bolsón de Cuatro Ciénegas. The area contains a significant stygobitic fauna, especially in the Cuatro Ciénegas area, where snails, crustaceans, and the blind fish *Prietella phreatophila* have been found. Terrestrial troglobites include the ricinuleids *Pseudocellus mitchelli* and *P. reddelli*; one pholcid spider is a probable troglobite. Italian explorers have investigated both the aquatic habitats and dry caves in the Cuatro Ciénegas area (BADINO, *et al.*, 2004)

4 – Sierra Madre Oriental. This is a series of folded ranges extending NE-SW from the Big Bend region of Texas southeast to Monterrey, then south to Tamazunchale where it turns more to the east to terminate in the Neovolcanic Plateau near Jalapa, Veracruz. Although some igneous rocks occur in the northern portion, the principal rocks are Cretaceous limestone. Jurassic gypsum occurs in valleys between Monterrey and Ciudad Valles. Isolated mountain ranges in the northern

extent of the Sierra contain several large, biologically significant caves such as Grutas del Palmito, Grutas de Villa de García, and Cueva del Carrizal. These caves all contain endemic species and in many cases represent the northern extent of troglotic genera.

The principal part of the Sierra Madre Oriental has been the subject of extensive studies by Mexican, North American, and Italian biospeleologists, where they described a very rich endemic subterranean fauna. Four regions have received special attention: the Purificación Region west of the town of El Barretal, the Sierra de El Abra, the Sierra de Guatemala, and the Xilitla Region. The Sierra de El Abra lies approximately 150 kilometers from the Gulf of México coast and extends for some 125 kilometers. Elevations range from 450 to 650 meters. Its eastern face is a steep escarpment rising above the coastal plain. The Sierra de El Abra and the two other ranges of mountains in the west, the Sierra Nicolas Pérez and the Sierra de Colmena form to the north the Sierra de Guatemala with elevations in excess of 2,200 meters and to the south in the vicinity of Xilitla peaks of over 3000 m (map in RUSSELL, 1972; MITCHELL *et al.*, 1977). RUSSELL (1972) provides an analytical and geographical list of the caves of the Sierra de El Abra.

The Purificación Region with elevations ranging from 1,100 to 2,200 meters contains numerous caves and sótanos (HOSE, 2004). Two large cave systems are especially notable: Cueva del Tecolote, the seventh longest cave in México at 40,475 meters and the Sistema Purificación, the longest cave not filled with water at 94,899 meters and 11th deepest at 957 meters (HOSE, 1996, 2000). The cave fauna is remarkably diverse with different species of the same genera occurring at different elevations. The Sistema Purificación contains 93 species.

The Sierra de Guatemala is among the first areas to be seriously studied by North American biospeleologists and contains a remarkably diverse fauna. Most caves are small and with few exceptions shallow. Caves located near the base of the Sierra reach streams containing blind populations of the characin *Astyanax jordani* and interesting stygobitic crustaceans.

The Sierra de El Abra has been intensively studied both geologically and biologically. It was the subject of a pioneering study by *F. Bonet* (1953b). It is especially remarkable for containing large arroyos emptying into extensive cave systems, such as Sótano del Arroyo with 7,200 m of passage, Sótano del Tigre, and Sótano de la Tinaja. Cueva Chica was the first cave in which blind *A. jordani* was found. The fauna includes numerous stygobites and troglotites. The karst hydrogeology is discussed in FISH (2004).

The Xilitla Region was the subject of the earliest systematic study of caves and cave fauna in México (BONET, 1953a). This study revealed the biological potential and provided considerable information on the geology and speleogenesis of the caves of the area. Many of the caves are small, but the area also includes several large, deep caves such as Sótano de Tlamaya with a depth of about 400 meters and Sótano de Huitzmolilitla with more than three kilometers of passage. To the north of the Xilitla Region proper, studies in the mountains above Aquismón have revealed the existence of enormous vertical shafts such as Sótano de las Golondrinas (-376 meters) and Hoya de las Guaguas (202 m entrance and -478 m total depth) (HOSE, 2003a; SPROUSE & FANT, 2002).

The Cuetzalan Region is located near the southern edge of the Sierra Madre Oriental and is remarkable for containing enormous sinking streams (sumideros) that extend for many kilometers before emerging from large cave entrances. The Sistema Cuetzalan contains several entrances with 37,676 meters of surveyed and much additional unsurveyed passage. The area has been little studied biologically but does contain a significant troglotic fauna.

5 – Sierra Madre del Sur. This region includes all of the area between the Neovolcanic Plateau and the Isthmus of Tehuantepec. The area has been subdivided into three areas of considerable speleological interest. The Balsas-Mezcala Basin is a structurally complex region largely drained by the Tepalcatepec, Balsas, and Mezcala rivers. Rivers flow at elevations of 300 to 600 meters, while to the south the land rises to 2,000 to 3,000 meters. Part of the area is covered by Tertiary volcanics, but erosion has exposed Cretaceous limestone in many places. Cerro Grande in Colima and Jalisco contains numerous caves but has been little studied biologically (LAZCANO SAHAGÚN, 1988). Many extensive caves have been surveyed and biologically studied in this area. The most notable are Grutas de Cacahuamilpa (BONET, 1971), Grutas de Juxtlahuaca, Gruta de Acuitlapán, and Gruta de Aguacachil.

The Oaxaca Upland is plateau-like, much dissected, and in the center lies the Valley of Oaxaca. Cretaceous limestone crops out particularly in the southern part and has been comparatively little studied speleologically. The most notable cave in the area is Grutas de San Sebastián de las Grutas.

The Northeast Folded Ranges is a disjunct part of the Sierra Madre Oriental, separated by the main part of the Sierra by the Neovolcanic Plateau. This consists largely of Cretaceous limestone, but volcanic deposits cover the limestone in some areas. This is among the most speleologically important areas in México. Heavy rainfall, high relief, and massive limestone deposits have contributed to the development of some of the more significant caves in México. Large stream caves occur in the Acatlán region of Oaxaca. Among the more significant of these are Cueva del Nacimiento del Río San Antonio with four stygobitic crustaceans and the stygobitic catfish *Rhamdia reddelli*. Extensive karst development south of Orizaba, Veracruz, and in the Huautla de Jiménez region of Oaxaca has resulted in nearly complete internal drainage. Deep, vertical systems have been studied. Of special note is the Sistema Huautla in the Sierra Mazateca with a horizontal extent of 55,953 meters and depth of 1,475 meters (STEELE, 1995; STEELE & SMITH, 2005). The Sistema Cheve is the second deepest cave in North America, attaining a depth of 1,484 meters and a length of 26,194 meters. Springs at a depth of 2,450 meters below the cave entrance have been dye-traced to prove a hydrological connection (HOSE, 2000). Other major caves in these ranges are Kihaje Xontjoa, Oaxaca (1,223 meters deep, 31,373 meters long) and Akemati, in the San Pablo Zoquitlán region, Puebla (1,226 meters deep). The biology of the highland caves remains poorly studied but includes numerous troglotites and stygobites.

6 – Chiapas Highlands. This area extends from the coastal plain in Tabasco on the north at an elevation of about 40 meters and rises to about 2,300 meters in Chiapas. Significant caves in the lowlands of Tabasco include Grutas del Coconá and other lengthy caves near Teapa and the remarkable chemoautotrophic Cueva de las Sardinas (= Cueva del Azufre, Cueva Villa Luz) near Tapijulapa. The karst of Chiapas has been extensively studied by several Italian expeditions with the result that this is one of the best known areas in México. Numerous troglobites and stygobites have been described. The Sistema de la Lucha near Malpaso is an especially important cave. The caves and cave fauna of the Río La Venta have been extensively studied by Italian explorers (BADINO *et al.*, 1999; BERNABEI *et al.*, 2012).

7 – Yucatán Península. The Yucatán Península, between the Caribbean Sea and the Gulf of México, 150,000 km², the major part in México, the south-eastern part in Belize, is a platform of low altitude from the coastal plain of Mérida in the north (5-30 m) to the interior plateau to the south (100-400 m in elevation) (CORBEL, 1959; WEIDIE, 1985; HERAUD-PIÑA, 1995, 1996; BACK, 1989; BEDDOWS, 2003a,b; THOMAS, 1999, 2005, 2010).

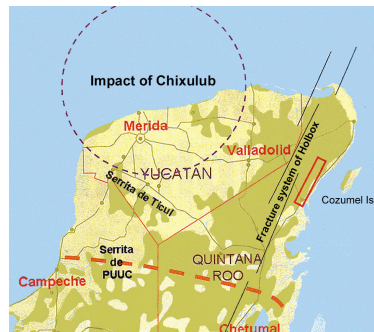


Fig. 2 - Map of Yucatán showing the Chixulub meteorite impact, the Holbox fault, the area of the longest flooded subterranean systems of the world along the coast of the Caribbean sea. The red southern dashed line corresponds to the limit of the freshwater lens (from Thomas, 2005, modified).

Its basement, around -3000 m, consists of shales, granites and rhyolites (LÓPEZ-RAMOS, 1973), overlain by Triassic and Jurassic sands and silts, and over by Cretaceous limestones.

Several regions can be distinguished: the Eocene and Miocene northern karst with hundreds of cenotes, of low altitude, from 15 m to the NW and 25-30 m to the E; the central karst which consists of mogotes 50 to 100 m high, isolated by uvalas and poljes; the southern fluvio-karst with mogotes and poljes, for more than 100 km from the coast; mogotes looking down from 50 to 60 m upon a system of dry or temporary active valleys and large dry or flooded poljes.

The southern part of the Península consists of two low ranges, the Sierra de Ticul rising out of the lowland areas to the north and the Sierra de Bolchen in Campeche. These areas are characterized by large dry cave systems with a distinctive fauna. Notable caves in the Sierra de Ticul include Actún Xpukil with more than 100 species recorded, Actún Sabacá, and the archeologically important Actún Loltún with more than 1 kilometer of passage. In a few caves in the Sierra de Ticul, passages descend to water containing stygobites. Some caves in the Sierra de Bolonchén such as Grutas de Xtacumbilxunaan and Grutas de San Antonio are entered at the end of arroyos that drain into huge entrances and descend through a series of vertical shafts to eventually reach groundwater containing a rich stygobitic fauna.

Hydrogeology of cenotes and underwater cave systems (Figs. 3, 4).

A lens of fresh water (Dupuit-Ghyben-Herzberg lens) approximately -20 m deep, is underlain by saline marine water in Yucatán cenotes. The characteristic stratification of anchialine waters is the result of the great differences in water density correlated with level of salinity. The depth of the freshwater lens increases during the seasonal rainy period.

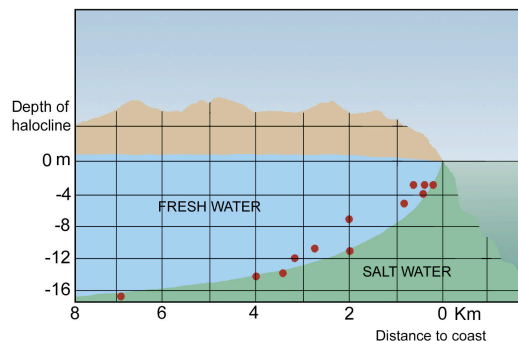


Fig. 3 – Depth of the freshwater lens and the halocline in 12 cenotes related to distance from the ocean (from Thomas 2005, modified).

Cenotes may be large-diameter drowned pits which can exceptionally be 100 m deep, open shafts where freshwater is generally between -5 to -20 m or cenotes that open via a cave with a partially open roof or connected to dry lateral passages. Blue holes are marine cenotes, located near the Yucatán coast, Bahamas, Belize, etc.

To the north, several hundred cenotes form a half ring, centered 17 km north of Mérida (Fig. 4). According to POPE (1991) and PERRY *et al.* (1995) this ring-shaped concentration of cenotes overlies the deeply buried Chicxulub Cretaceous/Tertiary meteoritic impact crater.



Fig. 4 – Location of an arc of cenotes around Mérida related to the impact of the Chicxulub meteorite, in grey. Cretaceous/Tertiary limit (after Pope, 1991).

Several caves with significant horizontal extent occur between Chichén Itzá and Valladolid. Grutas de Balankanché, a major archeological site, is a lengthy horizontal passage and is now open to the public. Actún Kaua is an incredibly complex maze cave, still only partially explored, with 10,360 meters of surveyed passage.

Near and along the Caribbean coast more than 90 horizontally submerged cave systems connected to cenotes have been listed and explored (GERRARD, 2000; PHILLIPS, 2001). These include the longest flooded caves in the world: Sistema Ox Bel Ha (Three Paths of Water) (Fig. 5) with 256.9 km of inter-linked channel networks, with 140 cenotes, average depth -15 m, and four springs near the coast of the Caribbean Sea (Fig. 5) Sistema Sac Actún with 230.7 km of development, 101 m depth, and about 170 cenotes; Sistema Dos Ojos with 82.4 km development, 119 m depth and 28 cenotes; Sistema K'ooch Baal with 74.3 km length, 26 m depth, and 44 cenotes; Sistema Toh Ha, with 32 km length and 17 cenotes; and Sistema Sand Crack with a length of 26.7 km, depth of 12.8 m, and 8 cenotes; Sistema Xunaan Ha with 52.2 km length and 27 m depth; Sistema Nohoch Pek with 23.9 km length, 18.6 m depth, and 7 cenotes; and Sistema Ponderosa with 15 km length, 20.4 m depth, and 19 cenotes.

Numerous cenotes contain anchialine habitats; above the halocline the water is fresh, up to 1.5-2 mg/ CINA, and below the halocline the water is between 30 and 35 mg/l (Cenote Mayan Blue); part of the fauna of stygobitic Crustacea occurs within freshwater and another part below the halocline where the water is saline, for example in Cenote Mayan Blue, one fish and six species of Crustacea were in freshwater and four species of Crustacea were in saline water below the halocline (ILIFFE, 1992, 1993; POHLMAN *et al.*, 1997; KORNICKER & ILIFFE, 2000; THOMAS, 2010; PAKES, 2013). A synthesis of the fauna of the anchialine caves of Yucatán has been published by ÁLVAREZ & RODRIGUEZ ALMARAZ in 2008.

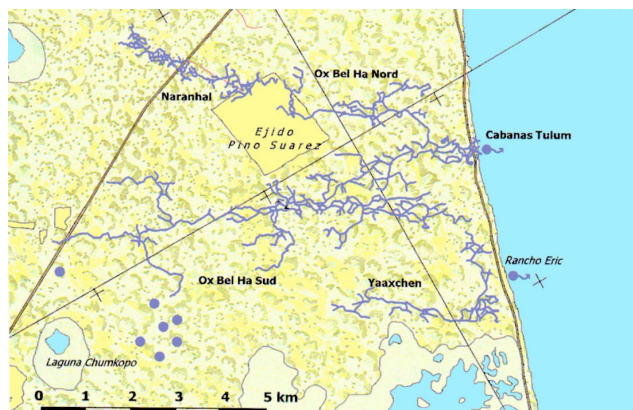


Fig. 5 – Sistema Ox Bel Ha the longest flooded system (256.9 km) along the eastern coast of the Yucatán Península, Quintana Roo (from Thomas, 2005, modified).

The limestone possesses a high level of porosity so a freshwater lens, recharged by rapid infiltration of rainfall, lies over the halocline interface, a layer of saline water that enters from the coastal margins to distances of several kilometers; in the northwest of the peninsula the hydraulic gradient is very flat.

The karstification began during the Tertiary, from the end of Eocene to the end of Pliocene in relation to the uplift of the platform. Speleogenesis has been intense and related to the halocline, a mixing corrosion zone between saltwater and freshwater. It is also related to the fluctuation of sea level and caves formed before the present high sea level has a great abundance of drowned vadose speleothems. Many cave passages contain Mayan pottery, fire pits, engraved walls, and human remains below the water table.

8 – Isla Cozumel. Eighteen cenotes have been recorded on *Isla Cozumel* (Fig. 2) near the northeastern Yucatán coast (MEJÍA-ORTÍZ *et al.*, 2006, 2007; YÁÑEZ-MENDOZA *et al.*, 2007). Cueva Quebrada and Cueva Aerolito de Paraiso, anchialine caves connected with the sea, contain a rich stygobitic crustacean fauna, with several species known only from these caves.

II. 2. Particular caves

Sistema Huautla. The Sistema Huautla in the Sierra Mazateca of the Sierra Madre Oriental del Sur, Oaxaca, is the deepest cave in México and in the Western Hemisphere (-1545 m). The system is a complex network of cave streams with 17 entrances and 66.9 km of passages. The separate streams descend vertically to the base level and converge to give one large stream discharging out of a spring entrance. The Huautla system area, located at an altitude of 2,100 m, receives 2.5 m of annual rainfall.

The cave life is diverse and rich in cave-adapted invertebrates. Forty-eight species have been recorded, including: the scorpion *Alacran tartarus* found in deep parts near and in the water; the troglitic theraphosid spider *Hemirrhagus grieta*, also found in deep parts, an unnamed pholcid spider, "*Pholocophora*" sp.; the amblypigid, *Paraphrynus grubbsi*, with very reduced eyes; an undescribed schizomid of the genus *Stenochrus*; two cave-adapted diplopods, the cleidogonid *Cleidogona baroqua* and the cambalid *Mexicambala fishi*; one Collembola, *Pseudosinella bonita*; the carabid beetle *Mexisphodrus urquijoi*; and the nicoletiid silverfish *Anelpistina specusprofundi*. Also known are undescribed species of spiders of the genera *Coryssocnemis*, *Ctenus*, *Maymena*, *Metagonia*, and *Modismus*; opilionids of the genera *Hoplobunus* and *Karos*, and the diplopods *Sphaeriodesmus grubbsi* and *S. iglesia*.

Chemoautotrophic cave. Cueva de las Sardinas (= Cueva del Azufre, Cueva de Villa Luz), located 3 km south of the village of Tapijulapa, Tabasco, in the semi-tropical jungle and in Cretaceous limestone, was first described by **Gordon & Rosen** in 1962. Within the cave, approximately 250 m length, a dozen small subterranean springs, at 28°C, supply a subterranean stream that emerges from the cave to form the head of the surface stream "Rio Azufre" (Fig. 6). Within the cave, the inlet springs release two types of water: anoxic and turbid water high in H₂S that release abundant hydrogen sulfide and carbon dioxide gases into the cave atmosphere, and clear oxygenated water with no detectable H₂S. The cave atmosphere is highly toxic, and at times a high level of CO₂ is measured and the H₂S level exceeds 200 ppm. These gases mix with water vapor in the cave, in air and on walls, and release sulfuric and carbonic acid.

On walls and on the ceiling sulfuro-oxidative bacteria (*Thiobacillus*, *Beggiatoa*) oxidate the hydrogen sulfide, and use the chemical energy, 798kJ mole⁻¹, to develop in areas with a high level of CO₂ and H₂S white deposits ("snottites") that resemble filamentous, gelatinous, elastic stalactites drip sulfuric acid at their extremities and grow quickly, up to a centimeter in length a day (HOSE *et al.*, 2000; HOSE, 2003b; PALMER & HILL, 2005; ROSALES LAGARDE, 2013). Sulfur-oxidizing bacteria, abundant in the water, on the walls, ceiling and mucous stalactites are the primary producers in the Cueva de las Sardinas system.

Numerous small invertebrates live within the mats and filamentous stalactites (Acari, Nematoda, undetermined Isopoda, larvae of Diptera, etc.) some of them very abundant (PALACIOS-VARGAS *et al.*, 2011).

The adults of the chironomid dipteran *Goeldichironomus fulvipilus* are the most conspicuous inhabitant of the cave; they occur in tremendous densities in all parts of the cave and in some areas they fill the passages in buzzing clouds; the larvae are found in considerable numbers, primarily in the innermost chambers, usually attached to the rocks, preferentially on slopes with a rapid movement of water. They attain their highest densities within the bacterial mats which suggest that they graze on the bacteria (LANGECKER *et al.*, 1996).

A large population of several species of spider occurs that capture dipterans in their webs. Several species of bat inhabit the cave and the guano teems with Acari and argasid ticks. At least 169 species have been identified from the cave (PALACIOS-VARGAS *et al.*, 1998, 2001, 2011).

An exceptionally large population of the cave fish *Poecilia mexicana* inhabits the cave. The dominance of individuals of small size, 2 cm to 3 cm, very few above 5 cm, is probably related to the annual capture of fishes in April for ritual ceremonies. The diet of the fishes, studied by stomach content analysis, consisted of bacteria, sediments and large quantities of chironomid larvae and imagoes. Further food items sporadically found could be identified as nematodes, ostracods and mites, but none of those occurred in large quantities (LANGECKER, *et al.*, 1996).

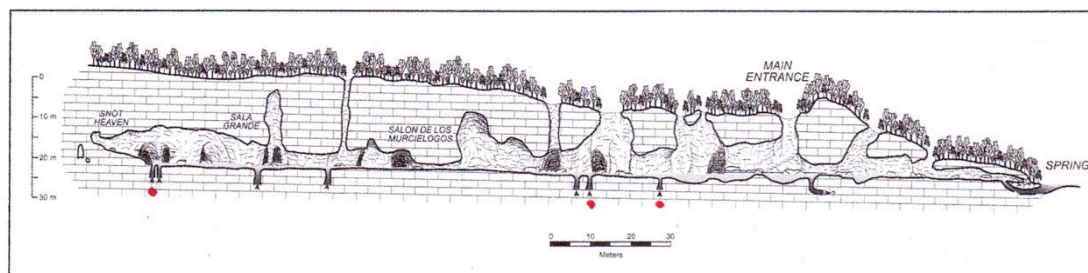


Fig. 6 – Profile of Cueva de las Sardinias with spring of Río Azul. Red points = inlet springs with H₂S (from Richards and Hose, modified).

Sistema Zacatón. The Sistema Zacatón, Tamaulipas, is the world's second deepest phreatic sinkhole (-335 m). Volcanism provided elevated levels of dissolved CO₂ and H₂S to increase solution (GARY, 2010). The only biota recorded from the cave is a broad spectrum of Archaea and Bacteria (SAHL *et al.*, 2010).

Volcanic caves. Lava caves are known from an isolated area in Tamaulipas, but have not been studied. Most of the caves occur in the Trans-Volcanic belt extending from Veracruz in the east to the Pacific Ocean on the west and extending through México City. Several small caves were studied in the Ruins of Teotihuacan but were dry and lacked troglobites; larger lava tubes are reported but have not been studied. A small cave on the eastern edge of México City, Cueva de la Estrella, contained a possibly troglotic thysanuran. Cueva del Volcancillo on a spur of Cofre de Perote, near Las Vigas, Veracruz, is an extensive cave with more than 1,000 meters of passage. It contained a rich troglotic fauna that included trechine beetles, nicoletiid thysanurans, millipedes, and spiders. Cueva de Ocotitlán, Morelos, is a recent volcanic cave; its fauna was studied by HOFFMANN *et al.* (1980, 1986).

Thermal springs. Several hot springs with a rich hypogean fauna are known, such as the Pozos de la Becerra in Bolsón de Cuatro Ciénegas, Coahuila, temperature 29 to 34°C; its stygobitic fauna consists of gastropods, amphipods, and cirriand and stenaseiid isopods (COLE & MINCKLEY, 1966, 1970; BOTOSANEANU, 1998). Other hot springs in central Chihuahua at 29°C and 32°C are inhabited by endemic species of the sphaeromatid isopod genus *Thermosphaeroma* (BOWMAN, 1981, 1985). These, however, show no sign of adaptation to a subterranean existence.

Anchialine habitat in Isla Cozumel

The Aerolito de Paraiso on Isla Cozumel is a unique anchialine system characterized and inhabited by 22 species of echinoderms. The Ophiuroidea are the best represented class with 11 species.

The first cave echinoderm was described in 2010, *Copidastes cavernicola* Solís-Marín & Laguarda-Figuera (Echinodermata: Asteroidea), probably endemic to this cave system.

Others cave species known from the anchialine caves in the Cozumel Island are: numerous polychaete annelids, the copepod Ridgewayiidae *Exumella* sp. Suárez-Morales *et al.* 2006, a family with amphi-Atlantic distribution in anchialine caves, the copepod calanoid *Balinella yucatanensis*, known from different sinkholes, the decapods *Barbouria yanezi* Mejía-Ortíz *et al.* (Barbouriidae), *Agostocaris bozanici* (Agostocarididae), *Yagerocaris cozumel* (Alpheidae), *Janicea antiguensis* (Hippolytidae), and *Somersiella sterri* (Hippolytidae) (MEJÍA-ORTÍZ *et al.*, 2007b, 2008b).

A synthesis of the biodiversity of Isla Cozumel was published by MEJÍA-ORTÍZ (2008). Other significant publications include: CALDERÓN-GUTIÉRREZ & SÁNCHEZ-ORTIZ, 2012; CALDERÓN-GUTIÉRREZ *et al.*, 2012; ILIFFE, 1992, 2002; ILIFFE & KORNICKER, 2009; KORNICKER & ILIFFE, 1989, 2000; MEJÍA-ORTÍZ, 2008; MEJÍA-ORTÍZ *et al.*, 2005, 2006, 2008; SOLÍS-MARÍN *et al.*, 2010; SOLÍS-MARÍN & LAGUARDA-FIGUERA, 2010; SUÁREZ-MORALES & ILIFFE, 2005a; SUÁREZ-MORALES & RIVERA-ARRIAGA, 1998, 2000; SUÁREZ-MORALES *et al.*, 2006; TORRES-TALAMANTE *et al.*, 2011, 2012).

III. Subterranean Fauna

Caves with a high biodiversity include the following:

1. Cueva de las Sardinias (Tabasco) (169 species)
2. Actún Xpukil (Yucatán) (134 species)
3. Sistema Purificación (Tamaulipas) (103 species)
4. Grutas de Juxtlahuaca (Guerrero) (93 species)
5. Cenote Xtolok, Chichén-Itzá (Yucatán) (86 species)
6. Cueva Aerolito de Paraiso (Quintana Roo) (71 species)
7. Cueva de la Mina (Tamaulipas) (60 species)
8. Cueva de Balaam Canché, Chichén-Itzá (Yucatán) (59 species)
9. Cueva de Sambulhá, Motul (Yucatán) (53 species)

10. Sistema Huautla (Oaxaca) (48 species)
11. Cueva de los Sabinos, Valles (San Luis Potosí) (48 species)
12. Sótano del Arroyo (San Luis Potosí) (43 species)
13. Grutas del Palmito (Nuevo León) (43 species)
14. Cueva Chica (San Luis Potosí) (41 species)
15. Gruta de Acuitlapán (Guerrero) (40 species)
16. Grutas de Cacahuamilpa (Guerrero) (30 species)
17. Cueva del Nacimiento del Río San Antonio (Oaxaca) (30 species)

III. 1. Aquatic subterranean fauna

PHYLUM ECHINODERMATA

Twenty-six species of echinoderms have been identified from Cueva Aerolito de Paraíso, Isla Cozumel, Quintana Roo (MEJÍA-ORTÍZ *et al.*, 2007; SOLÍS-MARÍN & LAGUARDA-FIGUERAS, 2008, 2010; BRIBIESCA-CONTRERAS, *et al.*, 2013).

CLASS ASTEROIDEA

Order Paxillosida

Family Astropectinidae

Specimens of *Astropecten* sp. cf. *duplicatus* Gray from Cueva Aerolito de Paraíso were genetically but not morphologically distinct from species from the ocean.

Order Spinulosida

Family Mithrodiidae

Mithrodia clavigera (Lamarck) was found in Cueva Aerolito de Paraíso.

Order Valvatida

Family Asterinidae

Depigmented specimens of *Asterinides* n. sp. were taken below the halocline 256 m from the entrance of Cueva Aerolito de Paraíso. *Asterinides* sp. cf. *pompom* A. M. Clark was found in Cueva Quebrada, Isla Cozumel.

Family Ophidiasteridae

Two species of *Copidaster* were found in Cueva Aerolito de Paraíso: *C. lymani* A. H. Clark, and *C. cavernicola* Solís-Marín. The latter species was described from marine water in the cave. It contains more numerous pointed tubercles than the related epigeal species, indicating that this may be an adaptation to the cave environment.

CLASS ECHINOIDEA

Order Camerodonta

Family Toxopneustidae

Lytechinus variegatus variegatus (Lamarck) was found in Cueva Aerolito de Paraíso.

Order Cidaroida

Family Cidaridae

Eucidaris tribuloides tribuloides (Lamarck) was collected above the halocline 60 m from the entrance of Cueva Aerolito de Paraíso.

Order Diadematoidea

Family Diademataidae

Diadema antillarum antillarum (Philippi) was found in Cueva Aerolito de Paraíso.

Order Spatangoida

Family Brissidae

Two species of this family were found in Cueva Aerolito de Paraíso: *Brissopsis* sp. cf. *atlantica* Mortensen and *Meoma* sp. cf. *ventricosa* (Lamarck).

CLASS HOLOTHUROIDEA

Order Apodida

Family Synaptidae

Euapta sp. cf. *lappa* (Müller) was found in Cueva Aerolito de Paraíso.

Order Aspidochirotida

Family Holothuriidae

Holothurida (Semperothuria) surinamensis Ludwig was found in Cueva Aerolito de Paraíso.

CLASS OPHIUROIDEA

Order Ophiurida**Family Amphiuridae**

Amphipholis sp. cf. *squamata* (Delle Chiaje) was found in Cueva Aerolito de Paraiso. Genetic data indicates that this may be an undescribed species endemic to the cave.

Family Ophiactidae

Ophiactis sp. cf. *algicola* H. L. Clark was found in Cueva Aerolito de Paraiso.

Family Ophiocomidae

Ophiocoma wendtii Müller & Troschel was found in Cueva Aerolito de Paraiso.

Family Ophiodermatidae

Ophioderma appressa Say and *O. ensifera* Hendler & Miller were found in Cueva Aerolito de Paraiso.

Family Ophiolepididae

Ophiolepis n. sp. and *O. impressa* Lütken were found in Cueva Aerolito de Paraiso.

Family Ophionereididae

Ophionereis n. sp. was found in marine water at 40 and 336 m from the entrance of Cueva Aerolito de Paraiso. This species has extremely long arms which may be an adaptation to the cavernicole habitat.

Family Ophiotrichidae

Four species of this family were found in Cueva Aerolito de Paraiso: *Ophiotrix (Acanthophiothrix) soensoni* Lütken, *O. (A.)* sp. 1 and 2 cf. *angulata* Say, and *O. (A.) oerstedii* Lütken.

Family Ophiuridae

Ophiura sp. cf. *ljungmani* (Lyman) was found in Cueva Aerolito de Paraiso.

PHYLUM PLATYHELMINTHES**CLASS TURBELLARIA****Order Tricladida****Family Dugesiidae**

This family is represented in México by four stygobites and one stygophile (MITCHELL & KAWAKATSU, 1973; KAWAKATSU & MITCHELL, 1981). The stygobites are: *Dugesia* n. sp. from Cueva del Nacimiento del Rancho Nuevo, Veracruz; *D. (Girardia) barbarae* Mitchell & Kawakatsu from Cueva de la Capilla, Tamaulipas; *D. (G.) mckenziei* Mitchell & Kawakatsu from Cueva de Los Llanos, Chiapas; and *D. (G.) typhlomexicana* Mitchell and Kawakatsu from Cueva de la Mina, Tamaulipas.

Dugesia (G.) guatemalensis Mitchell & Kawakatsu is a troglophile with two small eyes from two caves in the Sierra de Guatemala, Tamaulipas.

Family Opisthobursidae

This family belongs to a predominantly marine group and is known only from two species in Mexican caves (BENAZZI, 1972, 1976): *Opisthobursa josephinae* Benazzi from Pozza Casa Bell, Chiapas; and *O. mexicana* Benazzi from Grutas del Coconá, Tabasco.

PHYLUM ROTIFERA

OSORIO TAFALL (1943) reported six species of rotifers from Cueva Chica and Cueva de Los Sabinos in the Sierra de El Abra, San Luis Potosí.

CLASS BDELLOIDEA**Order Bdelloida****Family Philodinidae**

Philodina sp. was taken from Cueva de Aguacachil, Guerrero, and *P. roseola* Ehrenberg in Cueva de Los Sabinos.

CLASS MONOGONONTA**Order Ploima****Family Brachionidae**

Lepadella (Lepadella) patella (Müller) and *Platyias patulus* (Müller) were found in Cueva de Los Sabinos.

Family Lecanidae

Lecane closterocerca Schmarda occurred in Cueva de Los Sabinos and *L. quadridentata* Ehrenberg in Cueva Chica and Cueva de Los Sabinos.

Order Floculariacea**Family Flosculariidae**

Sinantherina socialis (Linnaeus) was found in Cueva Chica and Cueva de Los Sabinos.

PHYLUM NEMATODA

Knowledge of subterranean nematodes is poor, but species have been recorded from Mexican groundwater (ZULLINI, 1974, 1977).

CLASS ADENOPHOREA**Order Enoplida****Family Ironidae**

Two species of *Ironus* are known from Mexican caves and groundwater: *I. ignavus* Bastian from Cueva Chorreadero, Chiapas and from cenote at Yokdzonot, Yucatán; and *I. longicaudatus* de Man from Sima del Ojito, Chiapas and from Cenote Xtojil, Yucatan, Yucatán.

Family Tripylidae

Two species of *Trischistoma* were found: *T. arenicola* (de Man) from Cenote Xtojil, Yucatán; and *T. monhystera* (de Man) from Cueva del Panteón, Chiapas.

Order Mononchida**Family Mononchidae**

Four species were recovered from caves and groundwater: *Mononchus longicaudatus* Cobb from Cueva del Panteón, Chiapas; *Mylonychus lacustris* (Cobb) from a well at Tamhek, Yucatán; *M. signaturellus* Mulvey from Cenote Xtojil, Yucatán; and *M. signaturus* Cobb from Grutas de Zapaluta, Chiapas.

Order Dorylaimida**Family Alaimidae**

Alaimus primitivus de Man was collected from mold in Cueva Chorreadero, Chiapas. *Amphidelus* sp. was taken from Grutas de Zapaluta, Chiapas.

Family Dorylaimidae

This family is well-represented in Mexican groundwater habitats: *Aprocelaimellus* sp. from Grutas de Zapaluta, Chiapas; *A. obscurus* (Thorne & Swanger), from a well in Tabasco; *Discolaimus* sp. prob. *paramajor* Coomans from a well in Tabasco; *Eudorylaimus* sp. from Cenote Xtojil, Yucatán; *E.* sp. cf. *granuliferus* (Cobb) from a well at Tamhek, Yucatán; *E. diadematus* (Cobb) from a well in Tabasco; *E. granuliferus* (Cobb) from Cueva Luchil, Yucatán; *Idiodorylaimus annulatus* (Daday) from Cenote Xtojil, Yucatán; *Mesodorylaimus* sp. from Chiapas and Yucatán; and *M. bastiani* (Bütschli) from Cueva del Panteón, Chiapas.

Family Longidoridae

Xiphenema basiri Siddiqi was found in wells in Yucatán.

Order Monhysterida**Family Monhysteridae**

Monhystera paludicola de Man was collected from Cueva Chorreadero, Chiapas; and *Plectus cirratus* Bastian from Cueva del Panteon and Grutas del Rancho Nuevo, in Chiapas.

Order Chromadorida**Family Cyatholaimidae**

Prodesmodora circulata (Micoletzky) was found in Cueva Chorreadero, Chiapas.

CLASS SECERNENTEA**Order Ascaridida****Family Toxocaridae**

An encapsulated larva of *Porrocaecum* sp. was taken from the blind fish *Typhliasina pearsei* from Sistema Nohoch, Quintana Roo (MORAVEC *et al.*, (1999).

ORDER SPIRURIDA**Family Rhabdochonidae**

Rhabdochona kidderi kidderi Pearse is a parasite of the blind fish *Typhliasina pearsei* in Sistema Nohoch, Quintana Roo (MORAVEC *et al.*, 1999).

PHYLUM NEMATOMORPHA**CLASS GORDIOIDA**

Five species of gordian worms have been recorded from Mexican caves (SCHMIDT-RHAESA & MENZEL, 2005). All are also known from epigeal habitats. The hosts for the cavernicoles are unknown. The genus *Gordius* (Gordiidae) has been collected at Juxtlahuaca caves and probably are parasites of the cockroaches *Blaberus craniifer* (Blaberidae) which are very abundant in this cave.

Order Chordeodea**Family Chordodidae**

Three species of *Pseudochordodes* have been found in Mexican caves: *P. bulbargolatus* Schmidt-Rhaesa & Menzel from Sumidero de Tlatenango, Veracruz; *P. manteri* Carvalho from Cueva de Xometta, Veracruz; and *P. meridionalis* Carvalho & Feio from Sótano de San Marcos, Tamaulipas

Neochordodes occidentalis (Montgomery) is known from caves in San Luis Potosí and Veracruz.

Family Paragordidae

Paragordius varius Leidy is known from caves in the Sierra de El Abra, San Luis Potosí, and Sierra de Guatemala, Tamaulipas.

PHYLUM ANNELIDA

CLASS CLITELLATA

Order Haplotaxida

Family Acanthodrilidae

Two stygobitic species of this family have been taken from the bottom of pools in caves (GATES, 1968, 1970): *Eodrilus albidus* Gates in Cueva de la Capilla and Cueva de las Perlas in the Sierra de Guatemala, Tamaulipas; and *E. mexicanus* Gates from three caves in the vicinity of Xilitla, San Luis Potosí.

Order Branchiobdellida

Family Cambarincolidae

Five species of branchiobdellids have been taken from stygobitic cirrolanid isopods and stygophilic crayfish in México (HOLT & OPELL, 1993).

Two species are presumably stygobitic: *Cambarincola acudentata* Holt from the stygobitic isopods *Speocirolana bolivari* and *S. pelaezi* in Grutas de Quintero, Tamaulipas; and *C. speocirolanae* Holt from *S. pelaezi* in Sótano del Arroyo, San Luis Potosí.

Probable stygophiles include: *C. susanae* Holt from the stygophilic crayfish *Procambarus acutus cuevachicae* in Cueva Chica, San Luis Potosí; *Oedipodrilus cuetzalanae* Holt from the stygophilic crayfish *P. cuetzalanae* in Sima de Zoquiapan, Puebla; and *Sathodrilus villalobosi* Holt from the stygophilic crayfish *P. cuetzalanae* in Cueva de Guayateno, Puebla.

CLASS HIRUDINEA

Order Pharyngobdellida

Family Diestecostomidae

Diestecostoma magna Moore was found in Cueva del Lencho Virgen, Oaxaca; and Cueva de California, Tamaulipas.

Family Erpobdellidae

Dina? lineata (Müller) was found in Grutas de San José, Campeche.

Order Rhynchobdellida

Family Glossiphoniidae

Helobdella elongata (Castle), *H. stagnalis* (Linnaeus), and *H. triserialis* (E. Blanchard) were found in Cueva de Sala de Agua, Veracruz.

CLASS POLYCHAETA

FONTANA-URIBE & SOLÍS-WEISS (2011) report the presence of 11 species in five families from Cueva Aerolito de Paraiso, Isla Cozumel, Quintana Roo. With one exception these were taken from below the entrance to the cave and are not further discussed. GONZÁLEZ *et al.* (2012) report the presence of two possible stygobitic polychaetes in Cueva Aerolito de Paraiso.

Order Aciculata

Family Amphinomidae

Hermodice carunculata (Pallas) is a marine polychaete found in Cueva Aerolito de Paraiso.

Family Nereididae

The only troglomorphic polychaete known from Mexican caves is the eyeless species *Nemanereis cavernicola* Espinasa from Resumidero del Isote, at an elevation of 1,650 m, Guerrero. It has also been recorded from subterranean waters in Cuba, Hispaniola, and St. Vincent (ESPINASA, 1989; SOLÍS-WEISS & ESPINASA, 1991; GLASBY, 1999).

Order Canalipalpata

An undescribed genus and species of this family is a possible stygobite in Cenote Aerolito de Paraiso, Isla Cozumel, Quintana Roo (GONZÁLEZ *et al.*, 2012). It was found at a depth of 19 m more than 300 m from the entrance.

Family Teribellidae

An undescribed species of *Macrochaeta* is a possible stygobite in Cenote Aerolito de Paraiso, Isla Cozumel, Quintana Roo (GONZÁLEZ *et al.*, 2012). It was found at a depth of 19 m more than 300 m from the entrance.

PHYLUM MOLLUSCA

CLASS GASTROPODA

Clade Caenogastropoda

Family Amnicolidae

Two stygobitic species were found: *Emmericiella longa* (Pilsbry) from Nacimiento del Río Choy, San Luis Potosí; and *E. novimundi* (Pilsbry) from Nacimiento del Río Choy and Cueva del Nacimiento del Santa Clara, Tamaulipas.

Family Hydrobiidae

Four stygobitic species of Hydrobiidae have been described from the Bolsón de Cuatro Ciénegas, Coahuila (HERSHLER, 1985): *Coahuilix hubbsi* Taylor, *C. landyei* Hershler, and *Paludiscala caramba* Taylor. All were taken from the outflow of springs. An undescribed species tentatively placed in the genus *Orygoceras* has also been taken from springheads at Cuatro Ciénegas.

Another species associated with the subterranean habitat is *Pyrgophorus coronatus* (Pfeiffer) from several caves in Yucatán.

Family Lithoglyphidae

Shells of three stygobitic species were described from San Luis Potosí (PILSBRY, 1909): *Pterides pterostoma* Pilsbry and *P. rhabdus* Pilsbry from Nacimiento del Río Choy; and *P. bisinulabris* Pilsbry from Río Gannina, 3 km SW of San Dieguito. Live specimens obtained by divers have demonstrated that these are true stygobites.

Clade Heterobranchia

Family Physidae

Stenophysa sp. is a significant stygophile in two caves in Campeche.

PHYLUM ARTHROPODA SUBPHYLUM CRUSTACEA

CLASS REMIPEDIA

Order Nectiopoda

Family Speleonectidae

Speleonectes tulumensis Yager was described from Cenote Carwash, near Tulum, Quintana Roo (YAGER, 1987). It was collected below the halocline in marine water in a zone with a very low level of oxygen (Fig. 2a, p. 89, Encyclopaedia Remipedia, Tome I). It inhabits a number of cenotes near its type-locality, such as the northern-most cave systems Cenote Ponderosa and Cenote Chac Mool.

Speleonectes fuchscockburni Neiber, Hansen, Iliffe, González & Koenemann is known only from Cenote Crustacea, Quintana Roo, Yucatán. A large population occurs in the cave in the same section as do enormous numbers of the atyid *Typhlatia pearsei* upon which the remiped prey (NEIBER *et al.*, 2012).

CLASS MAXILLOPODA

SUBCLASS COPEPODA

Order Calanoida

Family Diaptomidae

The only stygobitic species is *Microdiaptomus cokeri* Osorio-Tafall which is abundant in caves of the Sierra de El Abra, San Luis Potosí (OSORIO-TAFALL, 1942; ELÍAS-GUTIÉRREZ & SUÁREZ-MORALES, 1998).

Family Epacteriscidae

Balinella yucatanensis Suárez-Morales, Ferrari & Iliffe was described from three karstic sinkholes of the Yucatán Peninsula. This second species of the genus *Balinella* extends the range of *Balinella* from anchialine caves of the Bahamas to subterranean waters of the Yucatán Peninsula (SUÁREZ-MORALES *et al.*, 2006).

Family Ridgewayiidae

The only species of this family from México is the stygobitic *Exumella tsonot* Suárez-Morales & Iliffe from Cenote Edén (Sistema Ponderosa), Quintana Roo (SUÁREZ-MORALES & ILIFFE, 2005a).

Order Cyclopoida

Family Cyclopidae

Subfamily Cyclopinae.

Numerous species of stygobitic and stygophilic cyclopid copepods have been reported from subterranean waters in México, with special emphasis on the Yucatán Peninsula (OSORIO-TAFALL, 1943; FIERS *et al.*, 1996, 2000; ROCHA *et al.*, 1998, 2000; CRUZ-HERNÁNDEZ *et al.*, 2002; MEJÍA-ORTÍZ, 2005). SUÁREZ-MORALES *et al.*, (2004), discuss the historical biogeography and distribution of the subfamily Cyclopinae in the Yucatán Peninsula.

Acanthocyclops robustus (Sars) has been found in caves in the Sierra de El Abra, San Luis Potosí.

Four species of *Diacyclops* have been described from underground waters of the Yucatán Peninsula: *D. chakan* Fiers & Reid from cenotes and wells in Quintana Roo and Yucatán; *D. ecabensis* Fiers & Ghene from a well at Punto Allen, Quintana Roo; *D. pilosus* Fiers & Ghene from a well south of Tulum, Quintana Roo; and *D. puuc* Fiers from a well south of

Tulum, Quintana Roo, and a well in Chan-Lah and Muchulux-Cahand Hubicu Cenote, Yucatán. *Diacyclops* sp. has been found in 12 pools in Cueva Gabriel, Oaxaca.

Two species of *Eucyclops* have been found in Mexican caves: *E. conrowae* Reid from Cenote Cristal and a well south of Tulum, Quintana Roo, and *E. serrulatus* (Fischer) from San Luis Potosí and Yucatán;

Halicyclops cenoticola Rocha was described from several cenotes in Yucatán and Quintana Roo and has been found with *Prehendicyclops* species. A second species, *H. caneki* Fiers, was found in Celestún Lagoon, Campeche.

Macrocyclus albidus (Jurine) is known from caves and cenotes in Campeche, Guerrero, Quintana Roo, San Luis Potosí, and Yucatán;

Three species of *Mesocyclops* have been found only in underground waters in México: *M. chaci* Fiers from a cenote near Chiquila, Quintana Roo and from wells and Grutas de Tzab-Nah, Yucatán; *M. pescei* Petkovski from a well in San Eusebio pueblo, Quintana Roo; and *M. yutsil* Reid from Grutas de Tzab-Nah and cenotes in Yucatán, and water-filled cenotes in Quintana Roo. These species are sympatric with species of Halicyclopinae. Records of *M. ellipticus* Kiefer and *M. leuckarti* (Claus) are believed erroneously recorded from Yucatán and probably belong to other species.

Microcyclus dubitabilis Kiefer was found in Cenote Dzaptun, Yucatán.

Paracyclops chiltoni (Thompson) is known from caves and cenotes in Campeche, Quintana Roo, and Yucatán;

A new genus, *Prehendocyclops*, was described for three species from cenotes in Yucatán: *P. abbreviatus* Rocha from Cenote Chan-Hoch, collected with *Antromysis cenotensis* and *Typhlatya* sp.; *P. boxshalli* Rocha from two caves and one cenote in Yucatán, taken with the mysidacean *Antromysis cenotensis*, the amphipod *Mayaweckelia cenoticola*, the atyids *T. mitchelli* and *T. pearsei*, the palaemonid *Creaseria morleyi*, the fishes *Ophisternon infernale* and *Typhliasina pearsei*, the isopods *Creaseriella anops* and *Haptolana bowmani*, and several other cyclopids such as *Halicyclops cenoticola*; and *Prehendocyclops monchenkoi* Rocha (Fig. 7) from two caves and two cenotes in Quintana Roo.

The genus *Prehendocyclops* has affinities to the genera *Smirnoviella* and *Colpocyclops* from estuaries of the Caspian Sea and Black Sea, related to the ancient Tethys.

Two species of *Thermocyclops* have been found in Mexican caves and cenotes: *T. inversus* (Kiefer) from a cenote near Chiquila, Quintana Roo, and a cave in the Sierra de El Abra, San Luis Potosí, and *T. tenuis* (Marsh) from Campeche and Yucatán;

Tropocyclops prasinus (Fischer) has been found in caves and cenotes in San Luis Potosí and Yucatán.

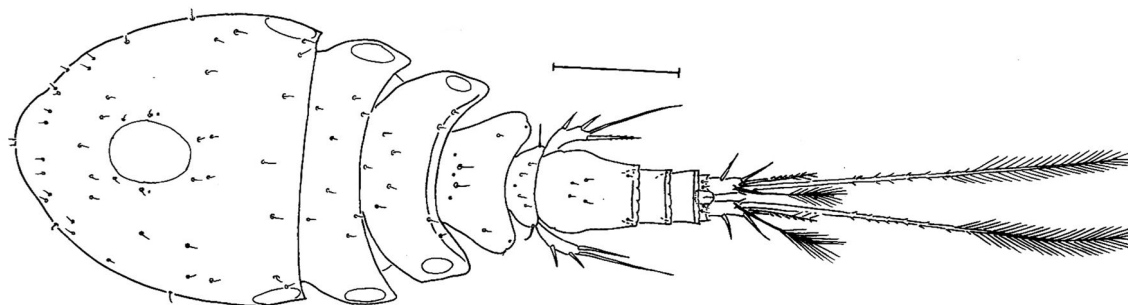


Fig. 7 – Copepoda Cyclopidae, Halicyclopinae, *Prehendocyclops monchenkoi* Rocha et al., 2000, from Gruta de Santa María, Yucatán.

Order Harpacticoida

Family Ameiridae

PEARSE & WILSON (1938) reported *Nitocrella subterranea* Chappuis from Grutas de Balankanché, Yucatán. This record is now believed to be referable to *Parapseudoleptomesochra botosaneanui* (Petkovski), a species also known from caves in Cuba (SUÁREZ-MORALES & REID, 2003).

Stygonoitocrella (*Eustyganitocrella*) *mexicana* Suárez-Morales & Iliffe is a stygobite from Guayalejo Spring near Jaumave, Tamaulipas (SUÁREZ-MORALES & ILIFFE, 2005b). This is the only species of the genus in México.

Family Canthocamptidae

Atthyella (*Marazekiella*) sp. cf. *pilosa* Chappuis was recorded from two caves in the Sierra de El Abra, San Luis Potosí (OSORIO TAFALL, 1943).

Order Misophrioida

Family Speleophriidae

Mexicophria cenoticola Boxshall et al. was described from Cenote Carwash, Quintana Roo (BOXSHALL et al., 2014). It is the only species of the order Misophrioida from México. It was found at or below the halocline at depths of 19-23 meters.

CLASS OSTRACODA**Order Halocyprida****Family Deevyiidae**

Spelaeoecia mayan Kornicker & Iliffe is a stygobite from Cenote Maya Blue and Cenote 27 Steps near Tulum, Yucatán (KORNICKER & ILIFFE, 1998, 2000).

Family Polycopidae

Pseudopolycope (Pseudopolycope) helix Kornicker, Iliffe, & Harrison-Nelson is known from Cueva Aerolito de Paraiso, Isla Cozumel, Quintana Roo, México. It is also known from Double Drop Blue Hole, San Andros, Great Bahamas Bank (KORNICKER *et al.*, 2007).

Family Thaumatoocyprididae

Danielopolina mexicana Kornicker & Iliffe was described from below the halocline in Cenote Maya Blue, Cenote Ponderosa (a 15.5 km long cave), Cenote 27 Steps near Tulum, and Temple of Doom Cenote, Quintana Roo (KORNICKER & ILIFFE, 1989, 1998, 2000). The genus contains nine species from anchialine habitats, and one species collected in the South Atlantic at a depth of 3,459 m.

Order Podocopida**Family Cyprididae**

Two species of *Neocypridopsis* have been taken from caves and cenotes in Yucatán (FURTOS, 1936, 1938): *N. mexicana* Furtos from Cenote Yunchen; and *N. yucatanensis* Furtos from four cenotes and one cave.

Family Darwinulidae

Darwinula stevensoni (Brady & Robertson) was found in Cenote Xlaká, Yucatán (FURTOS, 1936).

Family Entocytheridae

Thirteen species are commensals of ciroland isopods and crayfish in México (RIOJA, 1951a; HOBBS, 1971; HOBBS & HOBBS, 1973; MEJÍA-ORTÍZ, 2005).

The only stygobites are two species of *Hobbsiella*: *H. cirolanae* (Rioja) from *Speocirolana bolivari* and *S. pelaezi* in many caves of the Sierra de El Abra, San Luis Potosí and Tamaulipas, and from *S. guerrai* in Cueva la Chorrera, Nuevo León; and *H. coahuilteca* (Hobbs and Hobbs) from an unknown host (probably *Mexilana saluposi*) in Cueva del Huisache, San Luis Potosí.

The remaining species are commensals of crayfish: *Ankylocythere bidentata* (Rioja) from Chiapas, Oaxaca, and Veracruz; *A. maya* Hobbs from the Valle Nacional region, Oaxaca; *A. sinuosa* (Rioja) from Cueva Chica, San Luis Potosí; *A. tolteca* Hobbs from Hidalgo and San Luis Potosí; *A. villalobosi* Hobbs from Grutas de Zapaluta, Chiapas; *Entocythere claytonhoffi* (Rioja) from Chiapas, Hidalgo, Oaxaca, and San Luis Potosí; *E. mexicana* Rioja from the Cuetzalan region, Puebla; *Uncinocythere bicuspidata* (Rioja), *U. cuadricuspidata* (Rioja), and *U. dobbinae* (Rioja) from the Cuetzalan region, Puebla; and *U. tolteca* Hobbs from Cueva de El Tenango, Hidalgo.

Family Limnocytheridae

Cytheridella tilosvayi Dayad was found in Aktun Ha, Quintana Roo (VAN HENGSTUM *et al.*, 2009).

CLASS MALACOSTRACA**Order Thermosbaenacea****Family Halosbaenidae**

Tulumella unidens Bowman & Iliffe is an unpigmented stygobiont with small eyestalks lacking visual elements from six anchialine cenotes in Quintana Roo (BOWMAN & ILIFFE, 1988). In Cenote Najarón, about 8 km inland from the Caribbean Sea on the eastern coast, in the vicinity of the ancient Mayan city of Tulum it was collected from -10 to -18 m, mostly in oligohaline water just above the halocline; salinity just above the halocline at -14 m was 1.5 mg/l, just below at -15 m, 32.5 m/l and at the bottom, -20 m, 35 mg/l; water temperature was 24°C.

Order Mysidacea**Family Lepidomysidae**

The genus *Spelaeomysis* includes three species from Mexican caves (VILLALOBOS, 1951; BOWMAN, 1973; GARCÍA-GARZA *et al.*, 1996; PESCE & ILIFFE, 2002; MEJÍA-ORTÍZ, 2005): *S. olivae* Bowman, eyestalks without ommatidia, from Cueva Gabriel and Cueva del Nacimiento del Río San Antonio, Oaxaca; *S. quinterensis* (Villalobos) from Grutas de Quintero and a spring on the Río Guayalejo, Tamaulipas, where it has been collected with the cirolanid *Speocirolana disparicornis* and an amphipod of the genus *Seborgia*; and *S. villalobosi* García-Garza, Rodríguez-Almaraz, & Bowman from a well, spring, and cave in Nuevo León. The genus is otherwise known from seven other species from southern Italy, Zanzibar, Cuba, Colombia, and India.

Family Stygiomysidae

Two species of *Antromysis* are known from Mexican subterranean waters (CREASER, 1936, 1938; BOWMAN, 1977; PÉREZ-ARANDA, 1985; PESCE & ILIFFE, 2002; MEJÍA-ORTÍZ, 2005): *A. cenotensis* Creaser, with pigmentless eyes, abundant in caves throughout the Yucatán Peninsula; and *A. reddelli* Bowman from Cueva de las Maravillas, Oaxaca. An undetermined species has been found in Cueva Gabriel, Oaxaca.

Two species of *Stygiomysis* have been found in the Yucatán Peninsula (KALLMEYER & CARPENTER, 1996).

Stygiomysis cokei Kallmeyer & Carpenter is known from Actún-Ko near Tulum, and from Cenote Pabakal, Cenote San Eduardo, Cenote Kankirixche, and Cenote Dzonot-ila 200 km farther west, between 40 and 50 km SW of Mérida. It was captured between -15 m and -50 m in salt water. The Cenote Pabakal is also inhabited by the cirrolanid *Yucatalana robustispina*.

Stygiomysis holtuisi (Gordon) is known from two cenotes in Quintana Roo and one in Yucatán. It was described from Devil's Hole in Saint-Martin Island, and found again in Anguilla, Bahamas, and Puerto Rico. In the Cenote Mayan Blue, 5 km from the coast and 3 km south of Tulum it was found near the halocline. Water has 2 mg/l of salt above the halocline and below the halocline at -18 m, 35mg/l. A diversified fauna was found that included *Typhalatyia*, *Creaseria morleyi*, *Speleonectes tulumensis*, *Danielopolina mexicana*, *Tulumella unidens*, *Spelaeoecia mayan*, *Antromysis cenotensis*, *Tuluweckelia cernua*, *Bahalana mayana*, *Craeseriella anops*, and *Typhliasina pearsei*.

Order Amphipoda

Family Bogidiellidae

Ten stygobitic species of Bogidiellidae are recorded from México (VILLALOBOS, 1960; RUFFO & VIGNA-TAGLIANTI, 1974, 1977; KARAMAN, 1981, 1982; KOENEMANN & HOLSINGER, 1999; MEJÍA-ORTÍZ, 2005).

Arganogidiella includes two species: *A. arganoi* (Ruffo & Vigna-Taglianti) from a well at Paraje Nuevo, Veracruz; and *A. arganoides* (Karaman) from a well at Etna, Oaxaca.

Bogidiella includes three species described from México: *B. michaelae* Ruffo & Vigna-Taglianti and *B. niphargoides* Ruffo & Vigna-Taglianti from a well at Etna, Oaxaca (Fig. 8); and *B. vomeroi* Ruffo & Vigna Taglianti from Cueva de Chanchanptic, Chiapas.

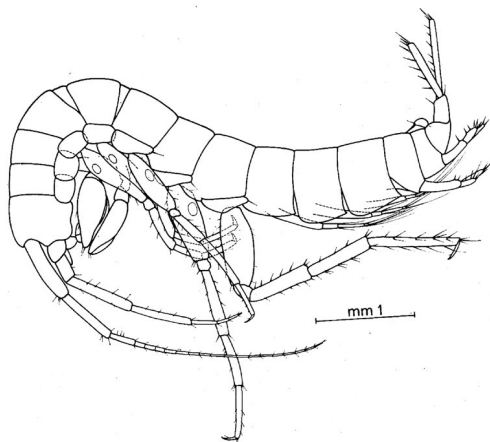


Fig. 8 – Amphipoda: Bogidiellidae: *Bogidiella niphargoides* Ruffo & Vigna-Taglianti 1977 from a well at Etna, Oaxaca.

Mexigidiella includes four species from México: *M. chitalensis* (Karaman) from Cueva de Chital no. 2 and Grutas de Rancho Nuevo, Chiapas; *M. mexicana* (Karaman) from Cueva de los Chivos and Resurgencia de la Planta no. 3, Chiapas; *M. sbordonii* (Ruffo & Vigna-Taglianti) from Cueva de Cerro Brujo, Chiapas; and *M. tabascensis* (Villalobos) from Grutas de Coconá, Tabasco. One interstitial species of the genus occurs in Haiti.

Orchestigidiella contains only *O. orchestipes* (Ruffo & Vigna-Taglianti) (Fig. 9) from Pozo Casa Bell, San Cristóbal de las Casas, Chiapas

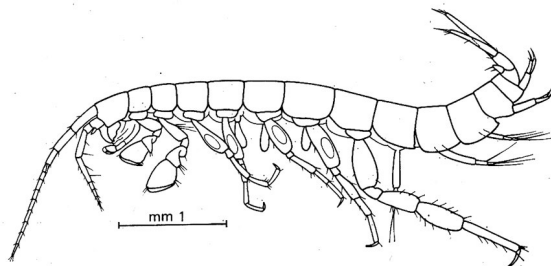


Fig. 9 – Amphipoda: Bogidiellidae: *Orchestigidiella orchestipes* Ruffo et Vigna Taglianti, 1977, Pozo Casa Bell, San Cristóbal de las Casas, Chiapas (from the authors).

Family Hadziidae

The family Hadziidae contains eleven stygobitic species from Mexican subterranean habitats (HOLSINGER & MINCKLEY, 1971; HOLSINGER, 1973, 1977, 1982, 1990, 1992; MEJÍA-ORTÍZ, 2005; SAWICKI & HOLSINGER, 2005)

Two species of *Bahadzia* have been found in Mexican caves. Other species in the genus occur in the Bahamas, Turks & Caicos Islands, and Haiti. *Bahadzia bozanici* Holsinger is known from Cenote Carwash near Tulum and Cueva Quebrada and Cueva Aerolito de Paraiso on Isla Cozumel, Quintana Roo. It was collected in Cenote Carwash below the halocline in euhaline water with 19 ppt salinity at a depth of -21-23 m. A female with 2 embryos and another with 3 were observed. *Bahadzia setodactylus* Holsinger is known only from Cenote Xcan-ha on Isla Cozumel, Quintana Roo. It was collected below the halocline which occurs at a depth of -12 m. Salinity was measured at 34 ppt.

Mayaweckelia includes two species: *M. cenoticola* Holsinger from freshwater or slightly salt water from cenotes in Yucatán and Quintana Roo and caves in Campeche; and *M. yucatanensis* Holsinger, known only from a bat guano-floored freshwater pool in Grutas de Xtacumbilxunam, Sierra de Bolonchen, Campeche.

Two species of *Mexiweckelia* without eyes and unpigmented have been found in México: *M. colei* Holsinger & Minckley is a tiny interstitial species found in springs with a temperature of 30° to 33° C at Cuatro Ciénegas, Coahuila; and *M. mitchelli* Holsinger from a deep pool at 24.5° C in Cueva de Siguerita, 45 km NW of Mapimí, Durango.

Paraholsingerius contains two species: *P. mexicanus* Sawicki & Holsinger from Grutas de Carrizal, Coahuila; and *P. smaragdinus* (Holsinger), described from caves in the Edwards Plateau of Texas, from Sótano de Amezcua, Coahuila.

Two species of *Paramexiweckelia* are known from México: *P. particeps* (Holsinger) from springs at Cuatro Ciénegas, Coahuila; and *P. ruffoi* Holsinger from springs in the Edwards Plateau of Texas and from a mine above El Socavón no. 2, Melchor Múzquiz, Coahuila.

Tamaweckelia contains only *T. apalpa* Sawicki & Holsinger from Manantial de San Rafael de los Castros, a deep artesian spring in Tamaulipas. The artesian spring also contains the cirrolanid isopod *Sphaerolana interstitialis*, mexistenasellid isopods, the atyid shrimp *Troglomexicanus huastecae*, and the ictalurid catfish *Prietella lundbergi*.

Tuluweckelia cernua Holsinger is known in freshwater or slightly saline water from six cenotes near Tulum in the northeastern coastal region of Quintana Roo.

Family Hyaellidae

Two species of *Hyaella* have been found in Mexican caves and cenotes: *Hyaella azteca* Saussure is a widespread stygophile known from caves and cenotes in Campeche, Coahuila, Michoacán, San Luis Potosí, Tamaulipas, Veracruz, and Yucatán. The only stygobitic species in México is *H. cenotensis* Marrón-Becerra, Hermoso-Salazar & Solís-Weiss from Cenote Carwash (=Cenote Aktun-Ha), Quintana Roo (MARRÓN-BECERRA *et al.*, 2014).

Family Hyalidae

Parhyale hawaiiensis Dana was found in Cueva Aerolito de Paraiso on Isla Cozumel, Quintana Roo (TRUJILLO PISANTY *et al.*, 2010).

Family Ingolfiellidae

An undescribed species of this family was found in a spring in Nuevo León. The only other North American species in this genus is a second undescribed species from a spring in Texas (U.S.A.).

Family Melitidae

Three species of Melitidae have been found in caves and cenotes in Quintana Roo (HOLSINGER, 1977; TRUJILLO PISANTY *et al.*, 2010): *Melita longisetosa* Sheridan and *M. planaterga* Kunkel in Cueva Aerolito de Paraiso on Isla Cozumel; and *Quadrivisio lutzii* (Shoemaker) in Cueva de Tanchah and Cenote de Tulum, Quintana Roo (HOLSINGER, 1977). The latter species is also known from Aruba, Bonaire, and Barbados.

Order Tanaidacea

Family Leptocheiliidae

Hargeria rapax Harger was found in Cueva Aerolito de Paraiso on Isla Cozumel, Quintana Roo (TRUJILLO PISANTY *et al.*, 2010).

Order Isopoda

Forty-three described species of stygobitic isopods have been found in Mexican subterranean waters (ROCHA-RAMÍREZ *et al.*, 2009). Additional species await description.

Family Anthuridae

The group consists primarily of marine species, but several forms have colonized freshwater in the Caribbean Islands, Venezuela, México, Isla La Reunión, New Caledonia, New-Zealand and Papouasia-New Guinea, and Sarawak.

Three species from Mexican caves are known: *Stygocyathura* sp. from Cueva Gabriel, Oaxaca; *S. sbordonii* (Argano) from three caves in Veracruz and *S. mexidos* Botosaneanu from Cueva del Huisache, San Luis Potosí (ARGANO, 1971; MEJÍA-ORTÍZ, 2005; BOTOSANEANU, 2008).

Family Asellidae

Four species of *Caecidotea* have been described from Mexican caves (ARGANO, 1972, 1977; BOWMAN, 1976): *C. chiapas* Bowman from four caves and a well in Chiapas; *C. pasquini* Argano from a well in the pueblo of San Juan de la Punta, Veracruz, a fairly recent stygobit, related to the widespread species *C. communis* (Say); *C. vomeroi* Argano from

Cueva de Chital no. 2, Chiapas, taken in association with *Bogidiella tabascensis*; and *C. zullinii* Argano (Fig. 10) from Cueva de Chachaniptic, Chiapas, taken in association with *B. vomeroi*. An undescribed species is known from Sistema Purificación, Tamaulipas.

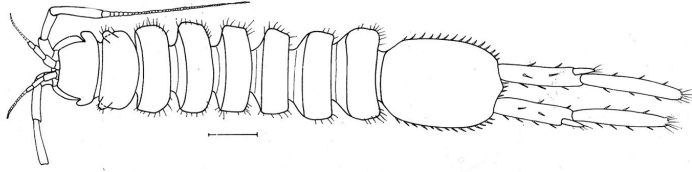


Fig. 10 – Isopoda: Asellidae: *Cecidotea zullinii* Argano, 1977, Cueva de Chachaniptic, Chiapas (from the author).

Caecidotea puebla (Cole and Minckley) is a stygophile in Cueva de El Salto, Hidalgo, and a well in Paraje Nuevo, Veracruz.

Lirceolus cocytus Lewis, described from underground waters in Texas (U.S.A.), has been found in Sótano de Amezcua, Coahuila (LEWIS, 2001).

Family Cirolanidae

Twenty-four species (one unrecognizable) of cirolanids have been described from México. All are of marine origin.

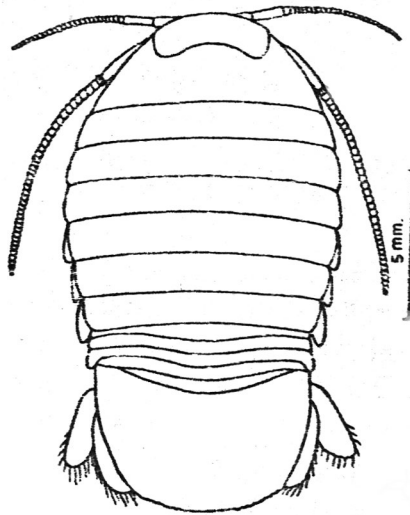


Fig.11 – Isopoda: Cirolanidae: *Creaseriella anops* (Creaser, 1936) from several caves in Yucatán (from the author).

Anopsilana yucatanana (Botosaneanu & Iliffe) is known only from Dzonotila, a deep cenote at Mucuyche, Yucatán (BOTOSANEANU & ILIFFE, 2000).

Cirolanides texensis Benedict, a stygobite, well known in caves and phreatic waters of the Edwards Plateau, Texas, was collected in three Mexican caves: Cueva de El Tule and Cueva de la Espantosa, Nuevo León, and Sótano de Amezcua, Coahuila. It was described as subspecies *C. t. mexicensis* Botosaneanu & Iliffe (BOTOSANEANU *et al.*, 1998; BOTOSANEANU & ILIFFE, 1999, 2002a).

“*Conilera*” *stygia* Packard was described from a well at Monterrey, Nuevo León (PACKARD, 1900). The description is too poor for identification and it may be one of the known species from northern México.

Creaseriella anops (Creaser) (Fig. 11) is known from many cenotes and caves in Yucatán, Quintana Roo and a well in Campeche (CREASER, 1936; 1938; PÉREZ-ARANDA, 1984b; BOTOSANEANU & ILIFFE, 2000).

Two species of *Haptolana* occur in Yucatán (BOTOSANEANU & ILIFFE, 1997, 2000): *H. bowmani* Botosaneanu & Iliffe from one cave and possibly three cenotes; and *H. yunca* Botosaneanu & Iliffe from Cenote Sabacha, Yuncu, Yucatán.

Metacirolana mayana (Bowman) has been collected from cenotes in Quintana Roo (BOWMAN, 1987). It was found at -18 m (salinity 14%) in anchialine Temple of Doom Cenote near Tulum in Quintana Roo and from the Cueva Quebrada on Isla Cozumel where they were collected 800 m from the entrance, at -5 m, with salinities of 21%.

Mexilana saluposi Bowman is known only from Cueva del Huizache, San Luis Potosí (BOWMAN, 1975).

Twelve species of *Speocirolana* are known (BOLÍVAR Y PIELTAIN, 1950; RIOJA, 1953d; BOWMAN, 1975, 1982a, 1987; COLE & MINCKLEY, 1966; CONTRERAS-BALDERAS & PURATA-VELARDE, 1982; BOTOSANEANU *et al.*, 1998; BOTOSANEANU & ILIFFE, 1999; SCHOTTE, 2002; MEJÍA-ORTÍZ, 2005; ÁLVAREZ & VILLALOBOS, 2007): *Speocirolana* sp. from Cueva de Gabriel, Oaxaca; *S. bolivari* (Rioja) from two caves in the Sierra de El Abra and Sierra de Guatemala, Tamaulipas, and from a spring at La Laja San Luis Potosí; it is abundant in Grutas de Quintero where it cohabits with *S. pelaezi*; *S. disparicornis* Botosaneanu & Iliffe from Guayalejo Spring near Jaumave, Tamaulipas; *S. endeca* Bowman from Sótano de las Calenturas and Cueva del Tecolote, Tamaulipas; *S. fustiura* Botosaneanu & Iliffe from Sima Chupacable, Nuevo León; *S. guerrai* Contreras-Balderas & Purata-Velarde from Cueva de la Chorrera, Nuevo León; *S. lapenita* Botosaneanu & Iliffe from Manantial La Penita, Tamaulipas; *S. pelaezi* (Bolívar y Pieltain), the most widespread species, known from caves in Puebla, San Luis Potosí and Tamaulipas; *S. prima* Schotte from Nacimiento del Río Mante, Tamaulipas; *S. pubens* Bowman from Cueva de la Bonita, San Luis Potosí, and Cueva del Ojo de Agua de Manantiales, Tamaulipas; *S. thermydronis* Cole & Minckley from Posos de la Becerra and an unnamed natural well in the Cuatro Ciénegas basin, Coahuila; *S. xilitla* Álvarez & Villalobos from Cueva de las Carinas in the environs of the town of Xilitla, San Luis Potosí; and *S. zumbadora* Botosaneanu, Iliffe, and Hendrickson from La Zumbadora, Coahuila.

Three stygobitic species of *Sphaerolana* have been described from Mexican caves; they are characterized by their ability to roll into a ball (COLE & MINCKLEY, 1970; RODRÍGUEZ-ALMARAZ & BOWMAN, 1995): *Sphaerolana affinis* Cole & Minckley from spring-fed wells near Cuatro Ciénegas de Carranza, Coahuila, Nuevo León; *S. interstitialis* Cole & Minckley from a small spring and natural wells near Cuatro Ciénegas de Carranza, Coahuila, and Manantial de San Rafael de los Castros, Tamaulipas; and *S. karenae* Rodríguez-Almaraz & Bowman from a spring adjacent to the Río Pilón and on wood in a mine below Cueva de la Boca, Nuevo León.

Yucatalana robustispina Botosaneanu & Iliffe is a very small (3-4 mm long) enigmatic species known only from cenotes in Yucatán (BOTOSANEANU & ILIFFE, 1999).

Family Microcerberidae

Two stygobitic species are known from Mexican caves (SCHULTZ, 1974): *Mexicerberus troglodytes* Schultz from Cueva de la Mina, Sierra de Guatemala, Tamaulipas; and *Microcerberus* n. sp. from Cueva Pinta, Sierra de El Abra, San Luis Potosí. These are the only species in this suborder from freshwater in the New World. Most species are found in the marine interstitial.

Family Sphaeromatidae

Six species of *Thermosphaeroma* have been described from hot springs in México but these are all eyed and not a part of the subterranean fauna (BOWMAN, 1981, 1985).

Family Stenasellidae

Seven species of stenasellids have been described from Mexican caves and springs (COLE & MINCKLEY, 1972; MAGNIEZ, 1972; VANDEL, 1973; ARGANO, 1974, 1977; BOWMAN, 1982b).

Etlastenasellus includes two eyeless, unpigmented stygobites: *E. confinis* Bowman from Cueva del Guayabo, Oaxaca; and *E. mixtecus* Argano from a well at Etlá, Oaxaca, taken in association with three bogidiellid species.

Mexistenasellus includes six eyeless species from Mexican underground waters: *M. coahuila* Cole & Minckley from several springs in the Cuatro Ciénegas region; *M. colei* Bowman from Sistema Purificación, Tamaulipas; *M. magniezi* Argano from a well at Paraje Nuevo, Veracruz; *M. nulemex* Bowman (Fig. 12) from a mine below Cueva de la Boca, Nuevo León; and *M. parzefalli* Magniez and *M. wilkensi* Magniez from the bottom of a pool over which bats roosted in Cueva del Huizache, San Luis Potosí. *Mexistenasellus colei* has red pigmentation; it has also been found in waters of the Edwards Aquifer, Texas (U.S.A.), others are unpigmented.

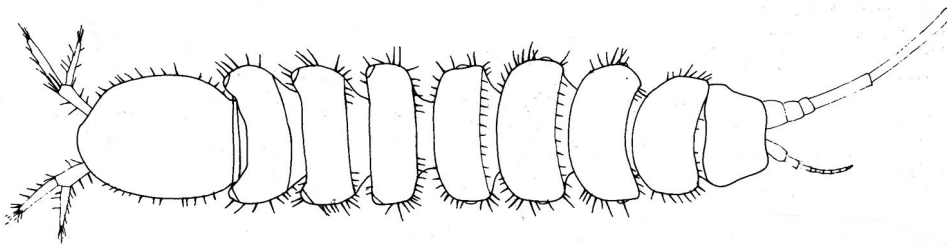


Fig. 12 - Isopoda Stenasellidae, *Mexistenasellus nulemex* Bowman, 1982, mine below Cueva de la Boca, Nuevo León.

Family Trichoniscidae

Three species of the terrestrial isopod suborder Oniscoidea either entirely or partially aquatic are known from México (RIOJA, 1953c, 1956; SCHULTZ, 1964, 1995; BOWMAN, 1965). The aquatic life of these species is a secondary return to an ancestral type of life (TABACARU, 1999).

Brachenriridgia bridgesi (Van Name) is known from caves in the Sierra de El Abra, San Luis Potosí and Tamaulipas and the Sierra de Guatemala, Tamaulipas. Individuals have been seen to walk through pools several centimeters deep and even to be seen remaining under water for long periods of time. The population, estimated by mark-recapture method in Cueva Chica, is about 500 individuals (JOHNSON & HEATH, 1976).

Mexiconiscus laevis (Rioja) is known from several caves near Xilitla and Aquismón, San Luis Potosí. Young are terrestrial but adults are aquatic.

Typhlotricholigioides aquaticus Rioja, aquatic in all developmental stages, is known from Cueva del Ojo de Agua Grande, near Córdoba, and Cueva del Oztoc, Sierra de Zongolica, Veracruz.

Order Decapoda

Suborder Caridea

Family Agostocarididae

Agostocaris bozanici Kensley, unpigmented, known only from two caves on Isla Cozumel, Quintana Roo (KENSLEY, 1988). Specimens were taken from -18.3 m to -41.15 m deep in water with 34% salinity.

Family Alpheidae

Three species of the predominantly marine family Alpheidae have been recorded from caves in México (HOBBS, 1973b; KENSLEY, 1988; MEJÍA-ORTÍZ, 2005; ANKER, 2008; ÁLVAREZ *et al.*, 2012):

Potamalphaeops stygicola Hobbs, with reduced eyes, was abundant in the main passage from 300 to 1000 m from the entrance of Cueva del Nacimiento del Río San Antonio, and in Cueva Gabriel, Oaxaca.

Triacanthoneus akumalensis Álvarez, Iliffe, González, & Villalobos, is known only from Cenote Aak Kimin, an anchialine cave near Akumal, Quintana Roo.

Yagerocaris cozumel Kensley, is only known from Cueva Aerolito de Paraiso and Cueva de Quebrada on Isla Cozumel, Quintana Roo (Fig. 13).

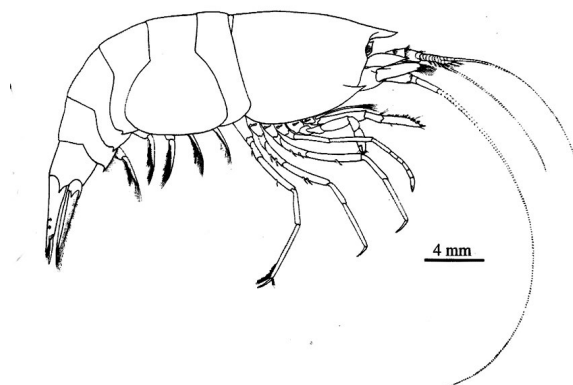


Fig. 13 - Decapoda: Agostocarididae: *Yagerocaris cozumel* Kensley, 1988, from caves on the island of Cozumel (from Anker, 2008).

Family Atyidae

Four species of stygobitic atyid shrimp of the genus *Typhlatya* have been found in caves and cenotes in the Yucatán Peninsula (HOBBS & HOBBS, 1976; HOBBS, 1979; PÉREZ-ARANDA, 1983a, 1984a; ÁLVAREZ *et al.*, 2005; MEJÍA-ORTÍZ, 2005): *T. campecheae* Hobbs & Hobbs (Fig. 14), translucent or white, eyes without pigment, from two caves in Campeche; *T. dzilamensis* Álvarez, Iliffe, & Villalobos, eyes reduced, without pigment, from three cenotes in northern Yucatán; *T. mitchelli* Hobbs and Hobbs, translucent, white or some individuals with grey pigment, eyes without corneae and pigment, found in numerous cenotes and caves in Yucatán and Quintana Roo, in pools from 0.3 to 2 m deep, with guano, organic matter and rocks on the bottom; and *T. pearsei* Creaser, white, eyes without corneae and pigment, from numerous cenotes and caves in Campeche, Quintana Roo and Yucatán, in pools or lakes with bat guano on bottom.

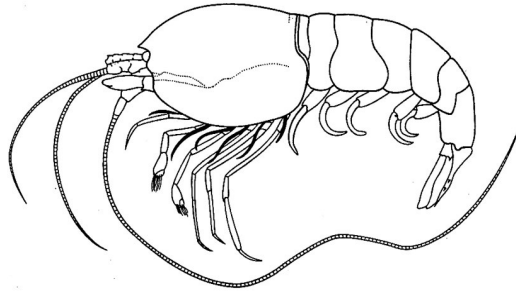


Fig. 14 – Decapoda: Atyidae: *Typhlatya campecheae* Hobbs & Hobbs, 1976, from two caves in Campeche.

Family Barbouriidae

Barbouria yanezi Mejía, Zarza, & López, with orange pigment and pigmented eyes, is known only from Cenote Tres Potrillos, Isla Cozumel, Quintana Roo (MEJÍA-ORTÍZ *et al.*, 2008). The only other species in the genus is *Barbouria cubensis* (Von Martens) from Cuba, Turks and Caicos Islands, Bermuda, Cayman Brac, and the Bahamas.

Family Hippolytidae

Four species of this family have been taken from water-filled caves in Quintana Roo (KENSLEY, 1988; ESCOBAR-BRIONES *et al.*, 1997).

Calliasmata nohochi Escobar-Briones, Camacho & Alcocer has been taken from three anchialine caves in Quintana Roo.

Janicera antiguensis (Chase) and *Somersiella sterreri* Hart & Manning, two large shrimps, with red body and black eyes, are known only from Cueva Quebrada on Isla Cozumel, Quintana Roo. They were taken from a depth of -12 m with a salt level of 21%. The first is known from anchialine caves on Bermuda and the Bahamas; the second in Bermuda. The female of *S. sterreri* carries a high number of embryos, around 2000; this suggests that young are pelagic and explains their large geographical range (ILLIFE, 1993).

Family Palaemonidae

Nine species of this family are stygobitic in México (CREASER, 1936, 1938; HOBBS, 1973a, 1973b, 1979; HOLTHUIS, 1974, 1977; VILLALOBOS, 1974; PÉREZ-ARANDA, 1983a; VILLALOBOS *et al.*, 1999; MEJÍA-ORTÍZ, 2005; MEJÍA-ORTÍZ *et al.*, 2008a; BALDARI *et al.*, 2010; BOTELLO & ÁLVAREZ, 2010).

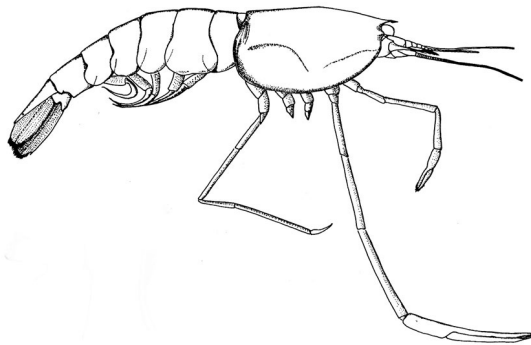


Fig. 15 – Decapoda: Palaemonidae: *Troglomexicanus tamaulipasensis* Villalobos, 1999, from Cueva del Nacimiento del Río Frío, Sierra de Guatemala.

Creaseria morleyi (Creaser) is translucent or white, with unpigmented eyes. It is known from more than 30 cenotes and caves in Campeche, Quintana Roo, and Yucatán (PÉREZ-ARANDA, 1983b), and its genetic variation was studied by BOTELLO & ÁLVAREZ (2010). It is an aggressive predator found in freshwater, walking on the bottom with bat guano, organic matter, and rocks.

Three species of *Cryphiops* (*Bithynops*) have been recorded from caves in Chiapas, *C. (B.) luscus* (Holthuis), a probable stygobite with eyes reduced but probably functional, from the stream in the Grutas de l'Arco, Chiapas, swimming and walking on the bottom; *C. (B.) perspicax* (Holthuis), an apparent stygophile with large eyes from Cenote la Cueva, Chiapas; and *C. (B.) sbordonii* Baldari, Mejía, & López-Mejía, a stygobite without pigment and with reduced eyes, from Cueva Chamorro, Chiapas.

Macrobrachium includes three stygobitic and two stygophilic species from caves in México: *M. acherontinum* Holthuis from Grutas del Coconá and Resumidero del Coconá, Tabasco, where it rests quietly or walks on the silt floor; *M. sbordonii* Mejía-Ortíz, Baldari, & López-Mejía from Cueva de la Lucha, Chiapas, near the border with Oaxaca, water 19° C, eyes reduced with a small apical black point; and *M. villalobosi* Hobbs (Fig. 5, p. 899, Tome II) from two caves near Acatlán, Oaxaca, where it was taken in association with *Spelaemyia olivae*, *Potamalpheops stygicola*, etc. *M. cationium* Hobbs and Hobbs is a stygobite in Belize.

Stygophilic species are: *Macrobrachium acanthurus* (Wiegmann) from Cueva de Abispas, Quintana Roo; and *M. carcinus* (Linnaeus) from Cueva de Los Sabinos, San Luis Potosí.

Neopalaemon nahualtus Hobbs is a stygobite described from a guano-floored stream in Cueva del Guano, Valle Nacional, Oaxaca.

Three species of *Troglomexicanus* are stygobitic in México: *T. huastecae* Villalobos, Álvarez & Iliffe from Cueva Manantial de San Rafael de los Castros where it was found with the fish *Prietella*, cirrolanid and stenassellid isopods, and amphipods; *T. perezfarfanteae* Villalobos from Sótano de la Tinaja, San Luis Potosí, and Nacimiento del Río Mante, Tamaulipas; and *T. tamaulipasensis* Villalobos, Álvarez & Iliffe (Fig.15) from Cueva del Nacimiento del Río Frío, Tamaulipas, with *Prietella lundbergi*, Mysidacea, Gastropoda, and Oligochaeta. The genus is related to *Troglocubanus* from Cuba.

Family Procarididae

The only species of this family from Mexican caves is *Procaris mexicana* von Sternberg & Schotte from anchialine caves on Isla Cozumel, Quintana Roo (STERNBERG & SCHOTTE, 2004). Other stygobites in the genus are known from Ascension Island, Bermuda, and Hawaii.

Suborder Astacida

Family Cambaridae

The genus *Procambarus* includes four stygobitic (one with two subspecies) and seven stygophilic species in México (RIOJA, 1953a; VILLALOBOS, 1953, 1954, 1958; HOBBS, 1941, 1943, 1973a, 1975, 1977, 1982, 1987; HOBBS & GRUBBS, 1982; SBORDONI *et al.*, 1988; MEJÍA-ORTÍZ *et al.*, 2003; MEJÍA-ORTÍZ, 2005).

The stygobites are: *P. (Austrocambarus) cavernicola* Mejía-Ortíz, Hartnoll, & Viccon-Pale from Cueva Gabriel, Oaxaca; *P. (A.) oaxacae oaxacae* Hobbs, eyes greatly reduced, with a large population from Cueva del Guano, Oaxaca; *P. (A.) oaxacae reddelli* Hobbs from Cueva del Nacimiento del Río San Antonio, Oaxaca, where it was extremely abundant and congregated about small areas of guano; they are used for food by local inhabitants; *P. (A.) rodriguezii* Villalobos from caves in Veracruz; and *P. (Ortmannicus) xilitlae* Hobbs & Grubbs from Hoya de las Guaguas, in the Aquismón region, San Luis Potosí.

The stygophiles are: *Procambarus (Austrocambarus) sbordonii* Hobbs from Cueva del Nacimiento del Río Santo Domingo, Chiapas; *P. (Ortmannicus) acutus cuevachicae* (Hobbs), a widely distributed epigean form, found in abundance in Cueva Chica, San Luis Potosí; *P. (O.) tolteca* Hobbs from caves in Hidalgo and San Luis Potosí; *P. (O.) villalobosi* Hobbs from lotic habitats and from Cueva del Agua and Pozita de Ojo de Agua, San Luis Potosí; *P. (Paracambarus) ortmanni* (Villalobos) from Grutas de Olivares, Puebla; and *P. (Villalobosus) cuetzalanae* Hobbs and *P. (V.) xochitlanae* Hobbs from caves in the Cuetzalan region, Puebla.

Two undescribed species, one dark with large eyes and one depigmented and microphthalmic have been studied from Cueva de Los Camarones, Chiapas (SBORDONI *et al.*, 1988; ALLEGRUCCI *et al.*, 1992).

Suborder Brachyura

Family Pseudothelphusidae

Four stygobitic and six probable stygophilic species in this family are known from Mexican caves: RIOJA, 1953b; RODRÍGUEZ & SMALLEY, 1969; DELAMARE DEBOUTTEVILLE, 1977; ÁLVAREZ-NOGUERA, 1987;; RODRÍGUEZ & HOBBS, 1989; ÁLVAREZ & VILLALOBOS, 1991,1998; VILLALOBOS HIRIART & ÁLVAREZ, 2008, 2013).

Sylvathelphusa cavernicola Villalobos & Álvarez is a stygobite known only from Cueva de las Arañas, Chiapas.

The Neotropical genus *Typhlopseudothelphusa* consists of five species all exclusively stygobitic, two in México, two in Guatemala, and one in Belize. The Mexican species are: *T. hyba* Rodríguez & Hobbs from Cueva de los Llanos and Cueva de los Murciélagos, Chiapas; and *T. mocinoi* Rioja from Cueva del Tío Ticho, Chiapas. Females of the latter species were found with 57 and 75 young.

Villalobosus lopezformenti (Álvarez & Villalobos) is known only from Cueva del Brujo, Municipio de Valle Nacional, Oaxaca. It retains eyes but reduced pigment and elongated appendages indicates that it is a stygobite.

Possible stygophiles are: *Odontothelphusa monodontis* Rodríguez & Hobbs from Grutas del Coconá, Tabasco; *Phrygiopilus montebelloensis* Álvarez & Villalobos, described from Gruta del Arco, Chiapas; *P. yoshibensis* Álvarez & Villalobos, described from Sumidero Yochib, Chiapas; *Pseudothelphusa mexicana* Álvarez-Noguera from Resumidero La Joya San Gregorio, Guerrero; *P. sonora* Rodríguez & Smalley from within Mina La Aduana, Sonora; *Tehuana complanata* (Rathbun) from Cueva del Ojo de Agua Grande, Veracruz; and *Villalobosus leptomelus* (Rodríguez & Hobbs) from Cueva del Túnel, Zongolica, Veracruz.

Family Trichodactylidae

One stygobite and two probable stygophiles are known from Mexican caves (RODRÍGUEZ & HOBBS, 1989; RODRÍGUEZ, 1992; MEGALHAES & TÜRKAY, 2012).

Two species of *Avotrichodactylus* are known from Mexican caves: *A. constrictus* (Pearse), a stygophile with black eyes from Cueva de las Sardinas, Tabasco, a predator on the blind cave fish *Poecilia mexicana* (KLAUS & PLATH, 2011); and *S. oaxacensis* Rodríguez from Cueva de Juan Sánchez, Oaxaca.

Rodriguezia mensabak (Cottarelli & Argano) (PL. I, 3), blind and unpigmented, is known only from Cueva de Nicolás Bravo, Chiapas.

CLASS INSECTA

Order Hemiptera

Family Belostomatidae

Three species of *Abedus* have been found in Mexican caves: *A. breviceps* Stal from Guerrero; *A. immensus* Menke from San Luis Potosí; and *A. signoreti* Mayr from Tamaulipas.

An undetermined species of *Belostoma* is an important predator of the cave fish *Poecilia mexicana* in Cueva de la Villa Luz, Tabasco (TOBLER *et al.*, 2007; PLATH *et al.*, 2011). Two other species of *Belostoma* have been taken from Mexican caves: *B. flumineum* Say from Grutas de Tolantongo, Hidalgo; and *B. subspinosum* Beauvois from Sótano de Lienzo, San Luis Potosí.

Family Veliidae

Undetermined *Microvelia* has been taken from caves in Guerrero, Oaxaca, Puebla, San Luis Potosí, Tamaulipas, and Yucatán. Undetermined *Rhagovelia* has been found in caves in Puebla, San Luis Potosí, and Tamaulipas. *Rhagovelia varipes* Champion was collected from caves in Hidalgo and San Luis Potosí.

Order Coleoptera

Family Dytiscidae

Possibly stygophilic dytiscids from Mexican caves include: *Agabus americanus* Aubé from Cueva de la Cascada, Veracruz; *Hydroporus belfragei* Sharp from Sótano de la Golondrina, San Luis Potosí; and *Neoclypeodytes decoratus* Fall from caves in San Luis Potosí.

The only stygobitic dytiscid beetle from México is *Sanfilippodytes sbordonii* Franciscolo from Cueva de la Capilla, Tamaulipas (FRANCISCOLO, 1979).

PHYLUM CHORDATA

CLASS ACTINOPTERYGII

Order Anguilliformes

Family Anguillidae

The American eel *Anguilla rostrata* (Lesueur) has been taken from cenotes in Quintana Roo (NAVARRO-MENDOZA & VALDÉS-CASILLAS, 1990).

CLASS PISCES

México with 10 species, with Brazil and USA, is the country which has the highest number of stygobitic fishes in the Nearctic zone (WEBER *et al.*, 1998; ROMERO & PAULSON, 2001; WILKENS, 2005).

Order Cypriniformes

Family Characidae

The taxonomy of the Mexican populations of *Astyanax* is not completely resolved with several alternative hypotheses regarding the status of both surface and cave-dwelling populations. Earlier studies utilized the genetics of hybrid crosses between epigeal and stygobitic populations. Recently, molecular data have been used to determine the status, origin, and phylogeography of the various populations. The molecular studies, however, have resulted in several contradictory conclusions (ESPINASA, 1997; ESPINASA & BOROWSKY, 2001; STRECKER *et al.*, 2003, 2004; PANARAM & BOROWSKY, 2005; PROTAS *et al.*, 2007, 2008; JEFFERY, 2008, 2009; ORNELAS-GARCÍA *et al.*, 2008; WILKENS, 2010; HAUSDORF *et al.*, 2011; BRADIC *et al.*, 2012; GROSS, 2012). The most recent interpretation is by STRECKER *et al.* (2012) who consider the correct name for the troglomorphic populations to be *Astyanax jordani* (Hubbs & Innes).

Astyanax jordani is known from twenty-seven caves in the Sierra de El Abra, San Luis Potosí and Tamaulipas, Sierra de Guatemala, Tamaulipas, and Micos region, San Luis Potosí (MITCHELL *et al.*, 1977). The ability of the various populations to interbreed both among themselves and with epigeal populations has led to it's being the best-studied cave fish in the world. It is easily available in commercial aquarium stores and many studies have been based on specimens acquired from these sources. See the bibliography in REDDELL (1981) for early publications. Recent work has included extensive studies by *Jacob Parzefall, Ulrike Strecker, Horst Wilkens*, and colleagues of Hamburg and by *Richard Borowsky, Luis Espinasa, William Jeffery*, and colleagues.

A troglomorphic population of *A. aeneus* (Günther) has been found in Gruta de las Granadas, Guerrero (ESPINASA *et al.*, 2001). Both troglomorphic and non-troglomorphic fish were found in the cave. Non-troglomorphic populations of the species have been recorded from caves in Chiapas, Guerrero, Quintana Roo, Tabasco, and Yucatán.

A population of *A. mexicanus* (De Filippi) without troglomorphic adaptations was found in Gruta de Carrizal, Nuevo León. Some authors consider the cave populations of *Astyanax mexicanus* as a species complex.

Order Siluriformes

Family Heptapteridae

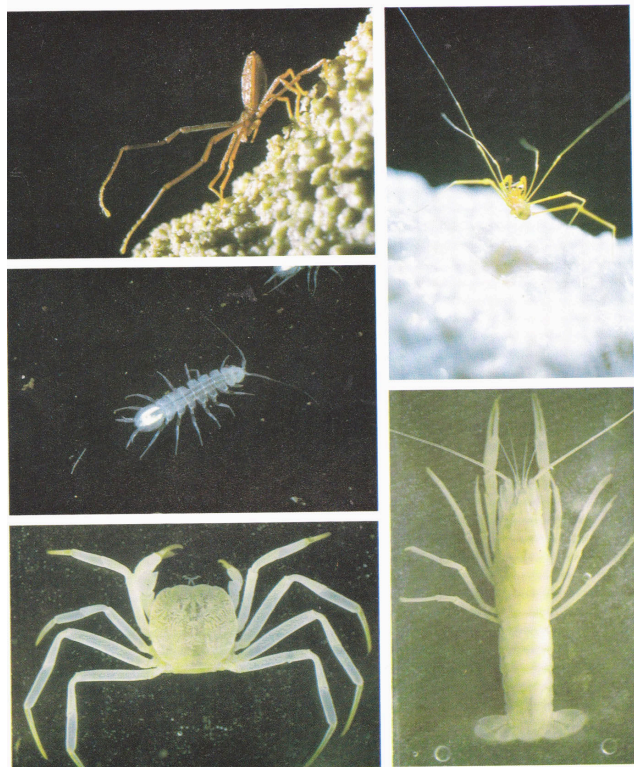
The *Rhamdia* cave populations in México have been placed in two species groups, the *laticauda* group with six species, of which two are epigeal and four stygobitic; and the *guatemalensis* group, found in caves and cenotes in Yucatán (WEBER, 1996).

Four stygobitic species with a variable reduction of eyes and no body pigmentation (MILLER, 1984; WILKENS, 1993, 2001; WEBER & WILKENS, 1998; WEBER *et al.*, 2003) were placed in the *laticauda* group: *R. laluchensis* Weber, Allegrucci, & Sbordoni from Sistema de la Lucha, Ocozocoautla, Chiapas; *R. macuspanensis* Weber & Wilkens from Grutas de Agua Blanca, Macuspana, Tabasco; *R. reddelli* Miller from Cueva del Nacimiento del Río San Antonio and Cueva de Las Maravillas, Acatlán region, Oaxaca; and *R. zongolicensis* Wilkens from Cueva del Oztoc, Sierra de Zongolica, Veracruz. WILKENS (2001) has studied the genetics of this group. SILFVERGRIP (1996) synonymized *R. reddelli* and *R. zongolicensis* with *R. laticauda*. This synonymy was rejected by later students of the stygobitic species. He also synonymized the black Yucatán cenote fish *R. guatemalensis sacrificii* Barbour & Cole with *R. laticauda*.

HUBBS (1936, 1938) described three subspecies of *R. guatemalensis* (Günther) from caves and cenotes in Yucatán: *R. g. decolor* Hubbs, with reduced pigmentation; *R. g. depressa* Barbour & Cole, with a somewhat flattened head; and *R. g. stygaea* Hubbs, with reduced eyes and pigmentation, and a comparatively long, flat snout, and found exclusively on the floor of dark caves. SILFVERGRIP (1996) considered the Yucatán populations to belong to *R. quelen* (Quoy & Gaimard) and did not recognize any of the subspecies. This species is present in numerous caves and cenotes throughout the Yucatán Peninsula (HUBBS, 1936, 1938; WILKENS, 1982).

Family Ictaluridae

The genus *Prietella* includes two stygobitic species in México (CARRANZA, 1954, WALSH & GILBERT, 1995; HENDRICKSON *et al.*, 2001, WILCOX *et al.* 2004): *P. lundbergi* Walsh & Gilbert from Nacimiento de San Rafael de los Castros and Cueva del Nacimiento del Río Frio, Tamaulipas; and *P. phreatophila* Carranza from 12 wells and caves in Coahuila. The biology of the species has been extensively studied by **Dean Hendrickson** at the University of Texas at Austin.



PL. 1 – México: troglobitic and stygobitic species. 1 (above left) - Ricinulei: *Pseudocellus sbordonii* Brignoli, 1974. 2 (middle left) - Isopoda Asellidae: *Caecidotea* sp. 3 (below left) - Decapoda Brachyura: *Rodriguezia mensabak* Cottarelli & Argano, 1977. 4 (above right) - Opiliones: Stygnopsidae: *Troglostygnopsis anophthalma* Silhavy, 1973. 5 (below right) - Decapoda Astacidae: *Procambarus* sp. Photos by V. Sbordoni.

Order Ophidiformes

Family Bythitidae

Lucifuga sp., eyeless and depigmented, has been collected from Cenote Catedrales and seen in Cenote Cristal, Quintana Roo (NAVARRO-MENDOZA & VALDÉS-CASILLAS, 1990). The genus is otherwise known only from caves in Cuba and the Bahamas and deep water of the coast of the Galapagos Islands.

Typhliasina pearsei (Hubbs) (Fig. 16) is eyeless and white with pink posterior margins, well developed cavities, and sensory papillae on the head; length is up to 9 cm. It is found in freshwater in about 20 caves in Quintana Roo and Yucatán (HUBBS, 1938; CHUMBA SEGURA, 1983a; MEDINA-GONZÁLEZ *et al.*, 2001; PROUDLOVE *et al.*, 2001; MØLLER *et al.*, 2004). Because of its rarity and secretiveness it probably will be found in many more localities. It is specialized in capturing planctonic and nectonic species, detected by mechanosensitive organs. It is viviparous with 2 to 11 young, depending on female size; parturition is from December to February. It is derived from marine ancestors.

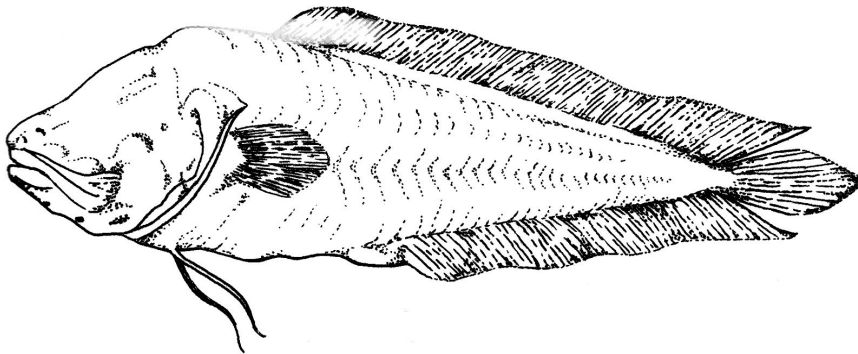


Fig. 16 – Pisces: Bythitidae: *Typhliasina pearsei* (Hubbs), 1938 from cenotes and groundwater in Yucatán.

Family Poeciliidae

Two morphologically distinct stygobitic populations of *Poecilia mexicana* are present in hydrogen sulfide cave Cueva de las Sardinias (= Cueva de Villa Luz and Cueva del Azufre) and the nearby freshwater Cueva Luna Azufre, Tabasco (TOBLER *et al.*, 2008). As part of a religious ceremony of local Zoque residents each year catch this fish from Cueva de las Sardinias.

Individuals possess small eyes and reduced pigmentation. The population in Cueva de las Sardinias was initially recorded in 1962 (GORDON & ROSEN, 1962). They were subsequently studied by a team of scientists from the Zoologisches Institut und Zoologisches Museum der Universität Hamburg (PARZEFALL, 1973, 1979, 1983, 1985, 2001; PETERS, 1973). More recently the species has been studied by *M. Plath, I. Schlupp, M. Tobler* and others (TOBLER *et al.*, 2006; ENGEL, 2007; PLATH *et al.*, 2007; TOBLER *et al.*, 2008).

Order Perciformes

Family Cichlidae

This family is abundant in cenotes in the Yucatán Peninsula (HUBBS, 1936, 1938; GAMBOA-PEREZ, 1992). None show signs of adaptation to the cave environment. Twelve species have been found: *Amphilophus robertsoni* (Regan) from Quintana Roo; *Cichlasoma conchitae* Hubbs from Yucatán; *C. ericymba* Hubbs from Yucatán; *C. mayorum* Hubbs from Yucatán; *C. salvini* (Günther) from Quintana Roo; *C. urophthalmus* (Günther) from Quintana Roo and Yucatán; *C. zebra* Hubbs from Yucatán; *Paraneetroplus synspilus* (Hubbs) from Quintana Roo; *Rocio octofasciata* (Regan) from Quintana Roo; *Thorichthys friedrichsthalii* (Heckel) from Quintana Roo; and *T. meeki* Brind from Quintana Roo and Yucatán.

In addition, *Herichthys cyanoguttatus* (Baird & Girard) was found in Gruta de Carrizal, Nuevo León.

Order Synbranchiformes

Family Synbranchidae

Ophisternon infernale (Hubbs) has been found in ten caves and cenotes in Quintana Roo and Yucatán (CHUMBA SEGURA, 1984b; WILKENS *et al.*, 1989); temperatures range from 22° to 27°C. It is sympatric with *Typhliasina pearsei* and *Rhamdia quelen* in some areas. A maximum of two specimens have been observed at any one locality. It has been observed under stones in muddy bottoms in shallow parts of caves and cenotes, where it builds mucus-lined burrows in organically rich sediments within the freshwater part of the aquifer (NAVARRO-MENDOZA, 1988), or swimming along the silt floor of pools. It feeds on the stygobitic shrimps *Creaseria morleyi* and other cave fauna, detected by mechanosensitive organs, tolerates low oxygen levels, and when the oxygen level is below 1.3 mg/l its head emerges above the water and it is able to breathe atmospheric oxygen (MEDINA-GONZÁLEZ *et al.*, 2001). One troglobitic adaptation is an enhancement of number of taste buds on the head surface and outer jaws. According to WILKENS (1982) *O. infernale* is located near the ancient limit of the coast during the Pliocene. It is reported to be oviparous.

Synbranchus marmoratus (Bloch) has been reported from cenotes near the Caribbean coast in Quintana Roo. (GAMBOA-PEREZ, 1992)

III. 2. Terrestrial cave fauna

PHYLUM PLATYHELMINTHES

CLASS TURBELLARIA

Order Tricladida

Terrestrial triclads belonging to three families have been taken from Mexican caves (HYMAN, 1938).

Family Bipaliidae

Bipalium sp. cf. *kewensis* Moseley was found in Sótano de Huitzmolotitla, San Luis Potosí.

Family Geoplanidae

Geoplana (*Geoplana*) *multipunctata* Fuhrmann was recorded from Actún Loltún, Yucatán

Family Rhynchodemidae

Diporodemus yucatani Hyman was described from Actún Sabacá, Yucatán. Specimens tentatively assigned to the genus *Rhynchodemus* have been collected from caves in Oaxaca and San Luis Potosí.

PHYLUM NEMATODA

ZULLINI (1974) has recorded several species of terrestrial nematodes from caves in México.

CLASS ADENOPHOREA

Order Anoplida

Family Tripylidae

Tripyla tenuis Brzeski was taken from sediment in Cueva Chorreadero, Chiapas.

Order Mononchida

Mononchidae

Clarkus venezolanus (Loof) was taken from slime in Sima del Ojito, Chiapas.

Order Dorylaimida

Family Alaimidae

Alaimus primitivus de Man was taken from mould in Cueva Chorreadero, Chiapas.

Family Dorylaimidae

Axonchium sbordonii Zullini is known only from mud in Sima del Ojito, Chiapas.

Family Longidoridae

Xphinema index Thorne & Allen was taken from cave mud in Sima del Ojito, Chiapas.

Order Araeolimida

Family Cyatholaimidae

Prodesmodera circulata (Micoletzky) was taken from cave mud in Cueva Chorreadero, Chiapas.

CLASS CHROMADOREA

Order Rhabditida

Mesorhabditis acidophila Borgonie, Dierick, Houthoofd, Willems, Jacobs & Bert was described from Cueva de las Sardinias, Tabasco (BORGONIE *et al.*, 2010). It was only found in the "snottites" hanging from the ceiling. These mucous tubes are inhabited by large numbers of bacteria and nematode-eating mites. Fluid drops from the snottites had pH values of 0-3. Attempts to keep the nematodes alive were unsuccessful once the snottites disintegrated, implying that the nematodes are restricted to this extreme environment.

PHYLUM ANNELIDA

CLASS OLIGOCHAETA

Order Haplotaxida

Thirteen species of earthworms have been recorded from Mexican caves (PICKFORD, 1938; GATES, 1971, 1973).

Family Acanthodrilidae

Two species are troglophiles in Yucatán: *Balantiodrilus pearsei* Pickford and *Notiodrilus oxkutzcabensis* Pickford. Undetermined species of *Diplocardia* are known from caves in San Luis Potosí and Tamaulipas.

Family Lumbricidae

Three exotic species have been taken from caves: *Dendrobaena rubida* (Savigny) and *Eisenea rosea* (Savigny) in Tamaulipas; and *Octolasion tyrtaeum* (Savigny) in Querétaro and San Luis Potosí.

Family Megascolecidae

Two species of *Pheretima* have been found in caves in México: *P. diffrenzens* (Baird) is frequent in mud and beneath rotting wood in caves in Oaxaca, Puebla, San Luis Potosi, and Veracruz; and *P. hawayana* (Rosa) has been found in wet mud under rotting wood in Sumidero de Cuetzeltémanes, Puebla.

Family Ocnodrilidae

Eukerria saltensis (Beddard) was abundant in moist, insectivorous bat guano about 500 m from the entrance of Cueva de la Florida, Tamaulipas.

Family Octochaetidae

Two species of *Dichogaster* are troglophiles in Yucatán: *D. affinis* (Michaelsen) and *D. bolau* (Michaelsen). The latter species has also been found in Grutas del Coconá, Tabasco.

The genus *Trigaster* is represented by three endemic troglophiles extremely abundant in deep mud: *T. albida* Gates from Sótano del Anticlino, Nuevo León; and *T. reddelli* Gates and *T. vallesensis* Gates from Sótano de Yerbaniz, San Luis Potosí.

PHYLUM MOLLUSCA
CLASS GASTROPODA

A large number of snails have been recorded from Mexican caves, but most records are based on empty shells of accidental species washed into caves or deposited in cave sediments.

Clade Neritimorpha

Family Proserpinellidae

Ceres nelsoni Dall has been found in caves in San Luis Potosí.

Clade Caenogastropoda

Family Cyclophoridae

Neocyclotus dysoni berendti (Pfeiffer) has been found in numerous caves in Yucatán.

Family Pomatiidae

Choanopoma largillierti (Pfeiffer) is frequently found in caves in Yucatán.

Clade Stylommatophora

Family Achatinidae

Troglophiles in Mexican caves include: *Lamellaxis gracilis* (Hutton) from Oaxaca, San Luis Potosí, and Yucatán; *L. micra* (d'Orbigny), and *Opeas yucatanense* Pilsbry in Yucatán; *Leptinaria mexicana* (Pfeiffer) from Puebla and San Luis Potosí; *Opeas pyrgula* (Schmacker & Boettger) and *Subulina porrecta* von Martens from Guerrero.

Family Orthalicidae

Bulimulus unicolor (Sowerby) has been found in several caves in Yucatán.

Family Spiraxidae

This is the most important family of troglophilic snails from Mexican caves. Common species are: *Euglandina cylindracea* (Phillips) and *Streptostyla ventricosula* (Morelet) from Yucatán; *S. meridana meridana* (Morelet) from Campeche and Yucatán; *S. jililana* Dall from high elevation caves in Querétaro and San Luis Potosí. Eggs, young, and adults of *S. bartschi* (Dall) have been found in the inner rooms of Cueva de la Mina, Tamaulipas.

Family Urocoptidae

Brachypodella dubia (Morelet) is a troglophile in the caves of Quintana Roo and Yucatán.

Family Subulinidae. Unidentified specimens of this family have been found in Juxtlahuaca caves, Guerrero, eating death bats or in small ponds. They are able to survive outside the cave if they have enough humidity (Fig. 17)



Fig. 17 – Gasteropods feeding on bats from Grutas de Juxtlahuaca, Guerrero (pic. R. Lopes).

PHYLUM ARTHROPODA**CLASS MAXILLIPODA****Order Isopoda****Suborder Oniscoidea**

The terrestrial isopod fauna of Mexican caves remains poorly known with many species awaiting description. The ecological status of some species is uncertain, but eight species are definitely troglobitic and another six are either troglobitic or endogean forms (RIOJA, 1950, 1951b, 1951c, 1954, 1955a, 1955b, 1958; MULAİK, 1960; VANDEL, 1965; SCHULTZ, 1970, 1977).

Family Armadilliidae

Nine species of this family are troglaphiles in Mexican caves.

Cubaris mirandai Rioja is known only from Cueva del Ojo de Agua Grande, Veracruz.

The genus *Venezillo* includes seven species from caves in México: *V. articulatus* (Mulaik) and *V. boneti* (Mulaik) from Grutas de Juxtlahuaca, Guerrero; *V. cacahuamilpensis* (Bilimek) from caves in Guerrero; *V. chiapensis* (Rioja) from Grutas de Zapaluta, Chiapas; *V. llamasi* (Rioja) from Cueva de Patla, Puebla; *V. osorioi* (Mulaik) from Grutas de Acuitlapán, Guerrero, and Grutas del Palmito, Nuevo León; *V. pleogoniophorus* (Rioja) from Cueva de Los Sabinos, San Luis Potosí; and *V. tanneri* (Mulaik & Mulaik) from Grutas del Palmito, Nuevo León.

Family Oniscidae

Hoctunus vespertilio Mulaik is known only from Cenote de Hoctun, Yucatán. It lacks pigment and has very small ocelli, so it may be a troglobite.

Family Philosciidae

Troglophiloscia laevis Schultz is a troglobite known only from Actún Xpukil, Yucatán. Other species of the genus are troglobitic in Guatemala, Belize, and Venezuela.

Family Sphaeroniscidae

Spherarmadillo schwarzi Richardson was originally considered a troglobite, but it is apparently an endogean form; it has been found in caves in Quintana Roo, San Luis Potosí, and Tamaulipas.

Family Squamiferidae

Trichorhina includes four troglobites or endogean species from México known only from caves: *T. atoyacensis* Mulaik from Grutas de Atoyac, Veracruz; *T. boneti* Rioja from Cueva de Ahuate no. 2, Xilitla region, San Luis Potosí; *T. pearsei* (Creaser) from seven caves in Yucatán; and *T. vandeli* Rioja from Cueva Cerro Hueco, Chiapas. A fifth species is known only from a cave in Belize.

Family Trichoniscidae

Four species of *Brackenridgia* are troglobitic in México: *B. acostai* (Rioja) from two caves in Chiapas; *B. bridgesi* (Van Name), a semi-aquatic species, from caves in the Sierra de El Abra, San Luis Potosí and Tamaulipas, and Sierra de Guatemala, Tamaulipas; *B. palmitensis* (Mulaik) from Grutas del Palmito, Nuevo León; and *B. villalobosi* (Rioja) in Veracruz. Other species of *Brackenridgia* occur in caves in the U.S.A.

Cylindroniscus includes three small troglobitic species in México: *C. cavicolus* (Mulaik) from Grutas del Palmito, Nuevo León; *C. maya* Rioja from caves in Yucatán; and *C. vallesensis* Schultz from Cueva Pinta, Sierra de El Abra, San Luis Potosí.

Trichoniscus hoctuni Mulaik is a fragile unpigmented species with small ocelli known only from Cenote de Hoctun, Yucatán. It is probably an endogean form.

CLASS ARACHNIDA**Order Scorpiones**

Among the 17 troglobitic scorpions in the world, 15 are endemic to México and usually known by very few specimens. SISSOM & REDDELL (2009) reviewed the cave scorpions of México.

Family Buthidae

Three species of *Centruroides*, all probably accidental, have been found in Mexican caves (CHAMBERLIN & IVIE, 1938a; WAGNER, 1977): *C. gracilis* (Latreille) from Quintana Roo, San Luis Potosí, Tamaulipas, and Yucatán; *C. ochraceus* Pocock from Yucatán; and *C. vittatus* (Say) from Tamaulipas.

Family Diplocentridae

Six species of *Diplocentrus* were found in caves in southern México (FRANCKE, 1977; 1978; BEUTELSPACHER & LÓPEZ-FORMENT, 1991; ARMAS & PALACIOS-VARGAS, 2002).

Four species are probably troglobitic: *Diplocentrus actun* Armas & Palacios-Vargas from Actún Xpukil, Yucatán; *D. anophthalmus* Francke from Actún Chukum, Yucatán; *D. cueva* Francke from Cueva Desapareciendo, Oaxaca; and *D. mitchelli*, Francke from Actún Halmensura, Campeche.

Two species are troglaphilic: *Diplocentrus magnus* Beutelspacher B. & López-Forment from a cave and surface localities near Puerto Marqués, Guerrero; and *D. reddelli* Francke from Actún Xpukil, Yucatán.

Family Euscorpiidae

Megacormus gertschi Díaz Najera is known from a cave in Hidalgo. Additional undescribed species of the genus have been found in caves in Puebla, Querétaro, and San Luis Potosí.

The genus *Troglocormus* includes only two troglobitic species, both found in the Sierra Madre Oriental of México (FRANCKE, 1981): *Troglocormus ciego* Francke from Cueva de Elías, San Luis Potosí; and *T. willis* Francke from eight caves in the Purificación region of Tamaulipas.

Family Typhlochactidae

This family includes six troglobites in México (MITCHELL, 1968, 1971; MITCHELL & PECK, 1977; FRANCKE, 1982, 1986; SISSOM, 1988; SISSOM & COKENDOLPHER, 1998; FRANCKE, 2009b; PRENDINI *et al*, 2010). All species are eyeless.

Two highly troglomorphic species of *Alacran* have been described from Mexican caves: *A. chamuco* Francke, known only from Te Cimutaa (cave) in the Municipio de Valle Nacional, Oaxaca and *Alacran tartarus* Francke from Sistema Huautla, Oaxaca. The latter species has been taken more than 1,000 m below the surface in the Sótano de San Agustín section.

Sotanochactas ellioti (Mitchell) (Fig. 18) with a nearly transparent body is known only from Sótano de Yerbaniz, Sierra de El Abra, San Luis Potosí.

The genus *Typhlochactas* is known only by four troglobites and three eyeless endogean species: *T. cavicola* Francke from Cueva del Vandalismo in the Purificación region, Tamaulipas; *T. granulatus* Sissom & Cokendolpher from Sótano de Poncho, Tlaquilpa, Veracruz; *T. reddelli* Mitchell from Cueva del Ojo de Agua de Tlilapan, Orizaba, Veracruz; and *T. rhodesi* Mitchell from Cueva de la Mina in the Sierra de Guatemala, Tamaulipas. The endogean species are: *T. mitchelli* Sissom from Oaxaca; *T. sissomi* Francke, Vignoli, & Prendini from Querétaro and *T. sylvestris* Mitchell & Peck from Oaxaca.

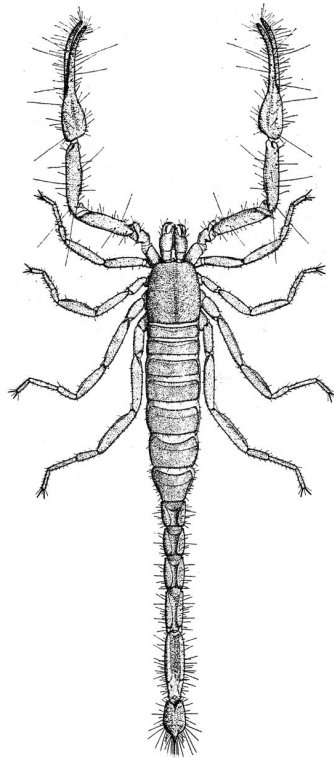


Fig. 18 - Scorpiones: Typhlochactidae: *Sotanochactas ellioti* (Mitchell, 1971) from Sótano de Yerbaniz, Sierra del Abra, San Luis Potosí.

Family Vaejovidae

Three probable troglobites and eleven possible trogliphiles have been found in Mexican caves (WILLIAMS, 1968; GERTSCH & SOLEGLAD, 1972; SISSOM, 1986, 1989, 1991; GONZÁLEZ-SANTILLÁN *et al.*, 2004; SISSOM & GONZÁLEZ-SANTILLÁN, 2004; SOLEGLAD & FET, 2005; FRANCKE & SAVARY, 2006; FRANCKE, 2009b).

The genus *Pseudouroctonus* includes three species from Mexican caves: *P. savvasi* Francke, a troglophile from two caves in Coahuila; *P. reddelli* (Gertsch and Soleglad), a widespread trogliphile in Texas (U.S.A.) caves, from Cueva de Cuchillo, Nuevo León; and *S. sprousei* Francke & Savary, a probable troglobite from Cueva de El Abra, Coahuila.

Two troglobitic species of *Vaejovis* are known: *V. davidi* Soleglad & Fet from Cueva de la Barranca and Grutas de Jonotla, Cuetzalan region, Puebla; and *V. gracilis* Gertsch & Soleglad, a pale, slender species with reduced eyes, from five caves in the Atoyac region of Veracruz. Specimens originally identified as *V. gracilis* but subsequently lost from Cueva del Lencho Virgen, Oaxaca; and Cueva del Volcancillo, Veracruz, probably represent undescribed species of troglobite.

Possible troglaphiles are: *Vaejovis mexicanus* (C. L. Koch) from Cueva del Diablo, Morelos; *V. minckleyi* Williams, described from a cave near Cuatro Ciénegas de Carranza, Coahuila; *V. mitchelli* Sissom from Cueva de Cristián, San Luis Potosí; *V. nigrescens* Pocock from Cueva de las Rusias, San Luis Potosí; *V. norteno* Sissom & González-Santillán from Coahuila and Nuevo León; *V. ocotensis* Zárate-Gálvez & Francke from Cueva del Metate, Chiapas; *V. rossmani* Sissom from the Purificación region, Tamaulipas; *V. rubrimanus* Sissom, described from Gruta Sur de San Bartolo, Nuevo León; and *V. sprousei* Sissom from Nuevo León.

Order Palpigradi

Family Eukoeneiidae

Palpigradida have only been recorded from three caves in México, all belonging to the genus *Eukoenia*: an undescribed troglóbite from Grutas de San Sebastián de las Grutas, Oaxaca; an undetermined specimen from Cueva del Precipicio, Nuevo León; and specimens identified as *E. hanseni* (Silvestri) from Sótano de la Tinaja, San Luis Potosí. The identity of the latter record requires verification.

Order Pseudoscorpiones

Family Bochicidae

The family is represented in México by 18 troglóbitic species in five genera (MUCHMORE, 1977, 1998). *Paravachonium*, *Troglohya*, and *Vachonium* contain only troglóbitic species; *Leucohya* and *Mexobisium* contain both troglóbitic and epigeal representatives.

Two species of *Leucohya* are troglóbitic: *L. heteropoda* Chamberlin from Grutas del Palmito, Nuevo León; and *L. magnifica* Muchmore from Cueva del Carrizal, Nuevo León. *L. texana* Muchmore is a troglóbite in Texas.

Mexobisium includes two troglóbites: *M. maya* Muchmore from Grutas del Coconá, Tabasco; and *M. paradoxum* Muchmore from Cueva del Ojo de Agua de Tlilapan, Veracruz. Troglóbites are also known from Belize and Guatemala.

Paravachonium includes only five Mexican troglóbites: *P. bolivari* Beier from Grutas de Quintero, Tamaulipas; *P. delanoi* Muchmore from Sistema Purificación, Tamaulipas; *P. insolitum* Muchmore from Sótano de la Tinaja, San Luis Potosí; *P. sprousei* Muchmore from Cueva de la Culebra, Oaxaca; and *P. superbum* Muchmore from Sótano de Gómez Farías, Tamaulipas.

Troglohya includes only two Mexican troglóbites: *T. carranzai* Beier from Grutas de Monteflor, Oaxaca; and *T. mitchelli* Muchmore from Grutas de Zapaluta, Chiapas.

Vachonium includes seven troglóbites from Yucatán: *V. boneti* Chamberlin from Actún Sabacá, *V. chukum* Muchmore and *V. robustum* Muchmore from Actún Chukum; *V. cryptum* Muchmore from Actún Xkyc; *V. kauae* Muchmore from Actún Kaua; *V. lolturn* Muchmore from Actún Lolturn; and *V. maya* Chamberlin from Grutas de Balankanché.

Family Cheliferidae

Mexichelifer reddelli is a possible troglóphile known only from Cueva de Carnicerías, Valle de los Fantasmas, San Luis Potosí (MUCHMORE, 1973).

Family Chernetidae

Four species have been described from caves in the Yucatán Península, but only one is probably a troglóbite (CHAMBERLIN, 1938a; MUCHMORE, 1990).

Coprochernes (?) *quintanarooensis* Muchmore is a troglóphile in two caves in Quintana Roo.

Lustrochernes minor Chamberlin is a troglóphile known only from two caves in Yucatán and possible one in Tabasco.

Parachernes attenuatus Muchmore with elongate pedipalps and reduced eyes is probably a troglóbite from caves in Quintana Roo and Yucatán.

Parazoana cavicola Chamberlin is a troglóphile from two caves in Yucatán.

Undetermined species of *Cordylochernes*, *Hesperochernes*, *Neallochernes*, and *Semeiochernes* are frequently found in caves throughout México.

Family Chthoniidae

Five species of *Aphrastochthonius* are troglóbitic in México (MUCHMORE, 1972b, 1973, 1986): *A. major* Muchmore from Cueva de la Capilla, Tamaulipas; *A. palmitensis* Muchmore from Grutas del Palmito, Nuevo León; *A. parvus* Muchmore from Cueva de la Florida, Tamaulipas; *A. patei* Muchmore from Sistema Purificación, Tamaulipas; and *A. russelli* Muchmore from Cueva Pinta, San Luis Potosí. This genus is largely restricted to caves, with cavernicolous species in Guatemala, U.S.A., and Cuba.

Lechythia cavicola Muchmore is a probable troglóphile from Grutas de Cacahuamilpa, Guerrero (MUCHMORE, 1973).

Mundochthonius mexicanus Muchmore is a litter-dwelling species also known from caves in Nuevo León and Tamaulipas (MUCHMORE, 1973).

Pseudochthonius troglobius is a troglóbite known only from Cueva del Cenote Xtlok, Yucatán (MUCHMORE, 1986).

Tyrannochthonius includes six troglóbites in México (MUCHMORE, 1969, 1973, 1986): *T. intermedius* Muchmore from Sótano de San Rafael de los Castros, Tamaulipas; *T. pallidus* Muchmore from Cueva de El Jobo, San Luis Potosí; *T. tlilapanensis* Muchmore from Cueva Macinga, Veracruz; *T. troglobius* Muchmore and *T. vampirorum* Muchmore from caves in the Sierra de Guatemala, Tamaulipas; and *T. volcancillo* Muchmore from Cueva del Volcancillo, a lava tube on Cofre de Perote, Veracruz. Undescribed troglóphiles are known from caves in Oaxaca, San Luis Potosí, Tamaulipas, and Veracruz. Troglóbitic species of *Tyrannochthonius* are also known from Guatemala, Jamaica, and U.S.A.

Family Ideoroncidae

This family includes five troglobites and two probable troglaphiles in México (BEIER, 1963; MUCHMORE, 1982, 1986; VILLEGAS-GUZMÁN & FRANCKE, 2009; HARVEY *et al.*, 2007; HARVEY & MUCHMORE, 2013).

Albiorix includes one troglobite and one troglaphile from México: *A. mirabilis* Muchmore, with two eyes, elongated pedipalps and reduced pigmentation is a probable troglobite known only from Cueva de las Maravillas, Oaxaca; *A. bolivari* Beier, described from Gruta de Acuitlapán, Guerrero, has since been synonymized with the widespread surface species *A. retrodentatus* Hoff.

Pseudalbiorix reddelli (Muchmore) was described from Grutas de Monteflor, Oaxaca, but has since been found to be widespread on the surface.

Typhloroncus includes four troglobites in México: *T. attenuatus* Muchmore from Sistema Purificación, Tamaulipas; *T. diabolus* Muchmore from Cueva del Diablo, Veracruz; *T. troglobius* Muchmore from Grutas de Atepolihuit, Cuetzalan region, Puebla; and *T. xilitlensis* Muchmore from Sótano de Huitzmolotitla, Xilitla region, San Luis Potosí.

Family Syarinidae

Three eyeless species of *Ideoblothrus* are known from caves in México (CHAMBERLIN, 1938a; MUCHMORE, 1972a): *I. grandis* (Muchmore), a probable troglobite from Cueva del Tío Ticho, Chiapas; *I. maya* (Chamberlin), a probable troglaphile from Cueva Primera Camino a San Roque, Yucatán; and *I. vampirorum* (Muchmore), only slightly modified for cavernicolous existence, from Cueva de los Vampiros, Sierra de Guatemala, Tamaulipas.

Family Tridenchthoniidae

Tridenchthonius juxtlahuaca Chamberlin & Chamberlin is a probable troglaphile taken from bat guano in Grutas de Juxtlahuaca, Guerrero (CHAMBERLIN & CHAMBERLIN, 1945).

Order Uropygi

Family Thelyphonidae

Mastigoproctus giganteus Lucas is a troglaxene found near entrances of caves in Coahuila, Hidalgo, Nuevo León, San Luis Potosí, and Tamaulipas and it was recently found very far from the main entrance of Grutas de Juxtlahuaca, Guerrero.

Order Schizomida

The schizomid fauna of México includes 27 described and several undescribed species recorded from caves (REDDELL & COKENDOLPHER, 1995; MONJARAZ-RUEDAS, 2012, 1913).

Family Hubbardiidae

Twelve described species of this family show troglomorphic adaptations (loss or reduction of eyespots, reduced pigmentation, and elongate appendages) and are considered troglabitic, and additional six species are troglaphiles.

Two species of the genus *Pacal* are troglaphiles in México: *Pacal stewarti* (Rowland) from Cueva del Guayabo, Valle Nacional, Oaxaca; and *P. trilobatus* (Rowland) from Grutas del Coconá, Tabasco.

“*Schizomus*” *arganoi* Brignoli is a poorly known species from Cueva de la Golondrina, Bochil, Chiapas. This species does not belong in *Schizomus*.

The genus *Sotanostenochrus* includes only two troglabitic species: *S. cookei* (Rowland) from two caves north of Valles, Sierra de El Abra, San Luis Potosí; and *S. mitchelli* (Rowland) from three caves in the northern Sierra de El Abra, Tamaulipas.

The genus *Stenochrus* is abundant in caves in México, Central América, and the West Indies. Troglabites from México are: *S. bartolo* (Rowland) from Grutas de San Bartolo, Nuevo León; *S. firstmani* (Rowland) from Grutas de Atoyac, Veracruz; and tentatively caves near Acatlán, Oaxaca; *S. lukensi* (Rowland) from two caves in the Sierra de Tamaulipas, Tamaulipas; *S. palaciosi* (Reddell & Cokendolpher) from Grutas de Acuitlapán, Guerrero; *S. pallidus* (Rowland) from Cueva Macinga, Veracruz; *S. pecki* (Rowland) from Grutas de Coconá and Resumidero de Coconá, Tabasco; *S. reddelli* (Rowland) from caves in the Sierra de Guatemala, Tamaulipas; *S. sbordonii* (Brignoli) from Grutas de Atoyac and Cueva de Ojo de Agua Grande, Veracruz; and *S. valdezi* (Monjaraz-Ruedas) from Cueva de San Francisco, Chiapas.

Troglaphilic *Stenochrus* are: *S. lanceolatus* (Rowland) from Cueva del Diablo, Orizaba, Veracruz; *S. mexicanus* (Rowland) from caves and epigeal habitats in the Sierra de El Abra, San Luis Potosí and Tamaulipas and the Sierra de Guatemala, Tamaulipas; *S. moisisii* (Rowland) from Grutas de Monteflor, near Valle Nacional, Oaxaca; and *S. portoricensis* Chamberlin, a facultatively parthenogenetic species, from caves in southern México and from both epigeal and cave habitats in Central América, and the West Indies.

Family Protoschizomidae

The family Protoschizomidae is known only from México and Texas (U.S.A.) (COKENDOLPHER & REDDELL, 1992; MONTAÑO-MORENO & FRANCKE, 2009; MONJARAZ-RUEDAS, 2013). All species are eyeless.

The genus *Agastochizomus* includes only five described troglabites: *A. huitzmolotitlensis* Rowland from Sótano de Huitzmolotitla, near Xilitla, San Luis Potosí; *A. juxtlahuacaensis* Montaña-Moreno & Francke from Grutas de Juxtlahuaca, Guerrero (Fig. 19) which presence was first recorded by ARMAS & PALACIOS-VARGAS, 2006; *A. lucifer* Rowland from three caves in the Sierra de El Abra, San Luis Potosí; *A. patei* Cokendolpher & Reddell from Cueva de la Llorona, Purificación region, Tamaulipas; and *A. stygius* from Sótano Hondo de Pinalito, Hidalgo. An undescribed species is known from a cave in Tamaulipas.



Fig. 19 – Schizomida: Protoschizomidae: *Agastoschizomus juxtlahuacaensis* Montaña-Moreno & Francke, 2009 from Grutas de Juxtlahuaca, Guerrero.

The genus *Protoschizomus* includes three epigeal and six troglobitic species. The troglobites are: *P. franckei* Monjaraz-Ruedas from Cueva de Boca del Diablo, Guerrero; *P. gertschi* Cokendolpher and Reddell from Sótano de Riachuelo, Miqihuana, Tamaulipas, and three species from the Purificación region, Tamaulipas: *P. purificacion* Cokendolpher and Reddell from Cueva X, *P. sprousei* Cokendolpher and Reddell from Cueva del Tecolote, and *P. treaceyae* Cokendolpher and Reddell from Cueva del Borrego. An undescribed troglobitic species is known from one cave in Texas (U.S.A.).

Order Amblypygi

Family Phrynidae

Three genera of this family are known from Mexican caves (ROWLAND, 1973; MULLINEX, 1975, 1979; COKENDOLPHER & SISSOM, 2001).

Acanthophrynus coronatus (Koch) is a large species known from a cave at Ixtlahuacán, Colima, and a fissure in Guerrero.

The genus *Paraphrynus* includes five described troglobites in México: *P. baeops* Mullinex from the Sierra de El Abra, Tamaulipas; *P. chacmool* (Rowland) from Quintana Roo and Yucatán; *P. chiztun* (Rowland) from Grutas de Coconá, Tabasco; *P. grubbsi* Cokendolpher & Sissom from three caves in the Huautla region, Oaxaca; *P. reddelli* Mullinex from Actún Loltún, Yucatán; and *P. velmae* Mullinex from three caves in the Xilitla region, San Luis Potosí. Several undescribed species are also known from caves in México.

Troglophilic species of *Paraphrynus* are: *P. azteca* (Pocock) from Chiapas, Oaxaca, Puebla, and Veracruz; *P. mexicanus* (Bilimek) from Guerrero (Fig. 20), Morelos, and Oaxaca; *P. pococki* Mullinex from San Luis Potosí and Tamaulipas; and *P. williamsi* Mullinex from Grutas de Zapaluta, Chiapas. Records of the Guatemalan *P. raptator* (Pocock) from the Yucatán Peninsula actually represent an undescribed species (**J. Ballesteros**, pers. com.).

Phrynus whitei Gervais has been recorded from caves in Chiapas and Guerrero.



Fig. 20 – Amblypygi: Phrynidae: *Paraphrynus mexicanus* (Bilimek 1867) from caves in Guerrero, Morelos and Oaxaca.

Order Araneae

Suborder Mygalomorphae

Twelve possibly troglobitic species are recorded from Mexican caves (GERTSCH, 1982b).

Family Barychelidae

Thalerommata meridana (Chamberlin & Ivie) was described from Cueva de San Isidro, Yucatán, but it is probably an accidental. Undetermined *Thalerommata* are known from caves in San Luis Potosí and Tamaulipas.

Family Ctenizidae

Cyclocosmia loricata (C.L. Koch) has been found in two caves in Tamaulipas.

Undetermined species of *Eucteniza* have been found in caves in Oaxaca and San Luis Potosí.

Family Dipluridae

The genus *Euagrus* includes three pale, eyeless troglobites in México (COYLE, 1988): *E. anops* Gertsch, known only from a single female from Cueva de la Porra, San Luis Potosí; *E. cavernicola* Gertsch, known from three caves in the Sierra de Guatemala, Tamaulipas; and *E. troglodyta* Gertsch from one cave each in Querétaro and San Luis Potosí.

Apparent troglaphiles include: *Euagrus carlos* Coyle from the surface and one cave in Chiapas and another in Guatemala; *E. gus* Coyle from the surface and caves in Guerrero and Morelos; *E. luteus* Gertsch, known only from caves in Querétaro; *E. lynceus* Brignoli from both cave and epigeal habitats in Chiapas, Oaxaca, Tabasco, and Veracruz; *E. mexicanus* Ausserer from the surface and one cave in Morelos; and *E. pristinus* Pickard-Cambridge from the surface in eastern México, has been found in caves in Hidalgo and Oaxaca.

Family Theraphosidae

Large dark tarantulas are frequently found near cave entrances but are troglaxenes. The conclusion that some species are cave-adapted is based on features such as paler coloration, reduction and loss of eye tubercle and eyes, and absence from epigeal collections. The absence of urticating hairs in some species may be related to the rarity of large predators in the caves.

Nine possible troglobites and one troglaphile of *Hemirrhagus* are known from México (PÉREZ-MILES & LOCHT, 2003): *H. elliotti* (Gertsch), eye tubercle and eyes of medium development, pallid; known only from Cueva de la Laguna, San Luis Potosí; *H. gertschi* Pérez-Milles & Locht, possible troglobite with reduced ocular tubercle and eye pigmentation; known only from Resumidero, Guerrero; *H. grieta* (Gertsch), eyeless; known only from Cueva de la Grieta, Oaxaca; *H. mitchelli* (Gertsch), small eyes, pallid, long-legged, from Entrada del Viento Alta, Tamaulipas; *H. ocellatus* Pérez-Milles & Locht, possible troglobite with reduced ocular tubercle; known only from Cueva Peña Blanca, México; *H. papalotl* Pérez-Milles & Locht, possible troglobite with ocular tubercle and eye pigmentation reduced; known only from Gruta de Aguacachil, Guerrero; *H. puebla* (Gertsch), small evanescent eyes, pallid; known from Cueva de Tasalolpan and Cueva de la Barranca, Puebla; *H. reddelli* (Gertsch), pale with greatly reduced eyes, long-legged, lacks urticating hairs; known from two caves near Acatlán, Oaxaca; and *H. stygius* (Gertsch), pale species with reduced eyes, lacks urticating hairs; known from four caves near Ahuacatlán, San Luis Potosí.

One species, *H. coztic* Pérez-Milles & Locht, from Cueva del Diablo and Cueva de San Juan, Morelos, is probably a troglaphile.

Suborder Araneomorphae

Eight families of araneomorph spiders contain troglobites. This fauna has been studied by BILIMEK, 1867; CHAMBERLIN & IVIE, 1938b; ROTH, 1968; GERTSCH, 1971a, 1973, 1974, 1977, 1982a, 1984, 1986, 1992; GERTSCH & ENNIK, 1983; BRIGNOLI, 1972, 1974b; SHEAR, 1978; MILLIDGE, 1984; HUBER, 2000, PLATNICK & UBICK, 2007; VALDEZ-MONDRAGÓN, 2007a, 2007b, 2007c, 2010, 2013; PAQUIN & DUPÉRRÉ, 2009; PLATNICK (2009); VALDEZ-MONDRAGÓN & FRANCKE, 2009; LEDFORD & GRISWOLD, 2010; LEDFORD *et al.*, 2011; PLATNICK & DUPÉRRÉ, 2012; PLATNICK *et al.* 2012, 2013; PLATNICK & BERNIKER, 2014; CANDIA-RAMÍREZ & VALDEZ-MONDRAGÓN, 2014.

Family Agelenidae

The genus *Tegenaria* includes two probable troglobites: *T. blanda* Gertsch, a pale-orange, long-legged, species with reduced eyes known only from Cueva de la Capilla, Tamaulipas; and *T. caverna* Gertsch, a pale, orange-brown species with greatly reduced eyes, from three caves in Querétaro.

Seven troglaphiles are known: *Tegenaria decora* Gertsch from Cueva de Potrerillos, San Luis Potosí; *T. florea* Brignoli from Chiapas; *T. gertschi* Roth from Coahuila and Nuevo León; *T. mexicana* Roth from Morelos, Michoacán, and Guerrero; *T. rothi* Gertsch from two caves in Hidalgo; *T. selva* Roth from San Luis Potosí and Tamaulipas; and *T. tlaxcala* Roth, from underground water tunnels in Tlaxcala and tentatively from volcanic caves near Jalapa, Veracruz.

Family Clubionidae

Tixcocoba maya Gertsch is a troglaphile from caves in Yucatán.

Family Corinnidae

Abapega saga (Pickard-Cambridge) is a troglaphile in Yucatán.

Two species of *Creugas* are troglaphiles in Grutas de Juxtahuaaca, Guerrero: *C. bicuspis* (P. O. P.-Cambridge), on walls, stalactites and stalagmites around the guano area, Guerrero; and *C. gulosus* Thorell, a cosmopolitan species.

Undetermined species of *Phonotimpus* and *Phrurotimpus* have been taken from numerous caves in México.

Family Ctenidae

The family is an abundant troglomorphic element of the cave fauna of México.

Ctenus includes numerous species from throughout México, but only *C. mitchelli* Gertsch from caves in Hidalgo, San Luis Potosí, and Tamaulipas has been described.

Undetermined specimens of *Cupiennus* have been taken from caves in Campeche, Quintana Roo, and San Luis Potosí.

Family Dictynidae

Cicurina includes four eyeless troglobites from caves in México: *C. (Cicurella) coahuila* Gertsch from Cueva de los Lagos, Coahuila, now covered by the waters of the Amistad Reservoir; *C. (C.) leona* Gertsch from Cueva de Cuchillo, Nuevo León; *C. (C.) maya* Gertsch from Actún Tucil, Yucatán; and *C. (Cicurusta) mina* Gertsch from two caves in the Sierra de Guatemala, Tamaulipas. An undescribed eyeless species of *C. (Cicurella)* is known from caves in Coahuila.

Cicurina (Cicurusta) iviei Gertsch is a six-eyed troglophile from Harrison Sinkhole in the Sierra de Guatemala, Tamaulipas. *C. (Cicurusta) varians* Gertsch & Mulaik, an extremely abundant troglophile in Texas (U.S.A.), has been found in Grutas de Casa Blanca, Nuevo León.

Family Filistatidae

An undescribed species of *Filistatoides* is a troglophile in caves in Coahuila and Nuevo León.

Family Gnaphosidae

Three species of this family were described from caves but none show traits of adaptation to the cave environment: *Drassodes pallidipalpis* (Bilimek) from Grutas de Cacahuamilpa; *Drassyllus tinus* Platnick and Shadab from Sótano de la Tinaja, San Luis Potosí; and *Zelotes mayanus* from Actún Sabacá, Yucatán. *Urozelotes rusticus* (L. Koch) has been collected in Cueva del León, Coahuila, and Cueva de la Finca, Colima.

Family Hahniidae

Undescribed eyeless species of *Hahnia* are known from Grutas del Palmito, Nuevo León and Cueva de Borrego, Purificación region, Tamaulipas.

Neoantistea unifistula Opell and Beatty was described from Sótano de Botella Chica, Veracruz, but shows no signs of adaptation for cavernicolous existence.

Family Leptonetidae

The family consists of six troglobitic and five trogliphiles species in México.

Chisoneta includes one troglobite and two trogliphiles in México: *C. isolata* (Gertsch), a pale, eyeless species from caves in Nuevo León and Tamaulipas; *C. modica* (Gertsch), known from the surface and one cave in Nuevo León; and *C. pecki* (Gertsch), an eyed species from Grutas de San Bartolo, Nuevo León.

Darkoneta includes one troglobite and two trogliphiles in México: *D. arganoi* (Brignoli), a troglophile from Cueva Grande de San Agustín, Chiapas; *D. obscura* (Gertsch), a troglophile from Cueva del Tío Ticho, Chiapas; and *D. reddelli* Ledford & Griswold, an eyeless species known only from Cueva de Tasalolpan, Cuetzalan area, Puebla.

Neoleptoneta includes five probable troglobites from Mexican caves: *N. capilla* (Gertsch), a pale, eyeless species with long legs, from three caves in the Sierra de Guatemala, Tamaulipas; *N. delicata* (Gertsch), a pale species with reduced eyes, from a mined-out cave near Pinal de Amoles, Querétaro; *N. limpida* (Gertsch), a pale, long-legged species with reduced eyes, from Cueva de los Riscos near Mapimí, Durango; and *N. reclusa* (Gertsch), a pale species with reduced eyes, from Cueva de Chorros de Agua, Nuevo León.

Two species are known only from caves but are probably trogliphiles: *Neoleptoneta bonita* (Gertsch) from Cueva Bonita, Tamaulipas; and *N. rainsi* (Gertsch) from caves in the Sierra de El Abra, San Luis Potosí.

Family Linyphiidae

No troglobites belonging to this family are known from México, but several trogliphiles are known.

Two species of *Erigone* are known: *E. monterreyensis* Gertsch from caves in Guerrero, San Luis Potosí, and Tamaulipas; and *E. tamazunchalensis* Gertsch & Davis from caves in Puebla and San Luis Potosí.

Undetermined *Mermessus* are known from many caves. Two trogliphiles are: *M. agressus* (Gertsch & Davis) from Sótano de la Escuela, Querétaro; and *M. tlaxcalanus* (Gertsch & Davis) from Sótano de Vásquez, Tamaulipas.

Tunagyna antricola Millidge, a troglophile, was described from a cave near Jacala, Hidalgo.

Family Mysmenidae

Seven species of *Maymena* recorded from Mexican caves are probably trogliphiles: *M. cascada* Gertsch from caves in Oaxaca and Veracruz; *M. chica* Gertsch from caves in Nuevo León, San Luis Potosí, and Tamaulipas; *M. delicata* Gertsch from caves in Oaxaca and Veracruz; *M. grisea* Gertsch from Cueva de la Capilla, Sierra de Guatemala, Tamaulipas; *M. mayana* (Chamberlin & Ivie) from caves in Campeche, Chiapas, Oaxaca, Quintana Roo, Veracruz, Yucatán, Belize, and Guatemala with some specimens from caves having reduced eyes; *M. misteca* Gertsch from caves in Guerrero and Oaxaca; and *M. sbordonii* Brignoli from Cueva del Cerro Brujo, Chiapas. Several new species are known from other areas.

Family Nesticidae

The family Nesticidae is represented by the genera *Eidmannella*, *Gaucelmus*, and *Nesticus*, and represents one of the more important elements in Mexican caves.

Eidmannella includes two trogliphiles: *E. pallida* (Emerton), an abundant species in caves throughout the United States and México; and *E. pachona* Gertsch, known only from Cueva de El Pachón, Tamaulipas.

Two species of *Gaucelmus* are trogliphiles in México: *G. augustinus* Keyserling ranges from the southern United States into Panama and is known from caves in Chiapas, Nuevo León, Oaxaca, Puebla, Querétaro, San Luis Potosí,

Tamaulipas, and Veracruz; and *G. calidus* Gertsch from caves in Chiapas, Guerrero, Hidalgo, Oaxaca, Puebla, San Luis Potosí, Tabasco, and Veracruz.

Nesticus contains ten species from caves in México. Three species are probably troglobitic: *N. arganoi* Brignoli, eyeless, from Cueva Macinga, Orizaba region, Veracruz; *N. caverna* Gertsch, eyeless, from Cueva de las Ranas, Zoquitlán, Puebla; and *N. reddelli* Gertsch, without anterior median eyes, from Cueva de Apoala, Oaxaca.

The remaining species are known only from caves but are probably troglaphiles: *Nesticus campus* Gertsch from Cueva de Campamento, Querétaro; *N. hoffmanni* Gertsch from Cueva El Ocote, Hidalgo; *N. jamesoni* Gertsch from caves in Querétaro; *N. nahuanus* Gertsch from caves in Nuevo León; *N. rainesi* Gertsch from caves in the Purificación region of Tamaulipas; *N. sedatus* Gertsch from caves in the Xilitla region, San Luis Potosí; and *N. vazquezae* Gertsch from caves in the Pinal de Amoles region, Querétaro.

Family Ochyroceratidae

Two troglaphilic species of *Ochyrocera* are recorded: *Ochyrocera fagei* Brignoli from Cueva del Panteón, Chiapas; and *O. n. sp.* from Grutas de Balankanché, Yucatán.

Two troglobitic *Theotima* occur in México: *T. martha* Gertsch, pale-yellow with long legs and reduced eyes, from Cueva Sodzil, Yucatán; and *T. pura* Gertsch, known by a single eyeless female from Cueva de los Vampiros, Sierra de Guatemala, Tamaulipas.

Family Oonopidae

This family includes two troglobites and five troglaphiles from México: *Reductoonops jabin* Platnick & Berniker, an eyeless species known only from Cenote Jabin, Yucatán (PLANICK & BERNIKER, 2013); and *Wanops coecus* Chamberlin & Ivie, an eyeless, pale whitish species from caves in Campeche, Quintana Roo, and Yucatán.

Troglaphiles are: *Costarina plena* (O.P. Cambridge) from caves in Chiapas; *Oonopoides mitchelli* (Gertsch) from caves in Yucatán; *Oonops chickeringi* Brignoli from Cueva del Panteón, Chiapas; "*O.*" *mckenziei* Gertsch from Grutas del Coconá, Tabasco; "*O.*" *reddelli* Gertsch from caves in Yucatán; and *Triaeris stenaspis* Simon, a pantropical species known from caves in Campeche, Guerrero, Oaxaca, Quintana Roo, San Luis Potosí, Tabasco, Veracruz, and Guatemala.

Family Pholcidae

The family Pholcidae contains the largest number of species associated with caves. It is represented in México by nine genera and 107 species with 24 troglobites, 19 of which are highly troglomorphic.

The genus *Anopsicus* is a highly successful group inhabiting Mexican caves, with twenty species known only from caves. Ten species are probable troglobites: *A. exiguus* (Gertsch) from Cueva de los Riscos, Durango; *A. gruta* (Gertsch) from Grutas de Juxtahuaca, Guerrero; *A. lucidus* Gertsch from two caves near Cuetzalan, Puebla; *A. mckenziei* Gertsch from two caves near Cuetzalan, Puebla; *A. mirabilis* Gertsch from Cueva de las Maravillas, Acatlán, Oaxaca; *A. niveus* Gertsch from Sótano de San Agustín, Oaxaca; *A. pearsei* Chamberlin & Ivie from caves in Quintana Roo and Yucatán; *A. reddelli* Gertsch from Actún Halmensura, Campeche; *A. soileauae* Gertsch from Cueva de Juan Sánchez, Acatlán, Oaxaca; and *A. vinnulus* Gertsch from Cueva de la Finca, Acatlán, Oaxaca.

The troglaphiles are: *Anopsicus bispinosus* (Gertsch) from three caves in Chiapas; *A. bolivari* (Gertsch) from Cueva de los Cuarteles, Tamaulipas; *A. elliotti* (Gertsch) from two caves in the Sierra de El Abra, San Luis Potosí; *A. evansi* (Gertsch) from Grutas de Zapaluta, Chiapas; *A. grubbsi* Gertsch from Cueva Desapareciendo, Acatlán, Oaxaca; *A. mitchelli* (Gertsch) from Cueva de la Virgen de Guadalupe, Tamaulipas; *A. ocote* Gertsch from Cueva El Ocote, Hidalgo; *A. speophila* (Chamberlin & Ivie) from caves in Campeche and Yucatán; *A. troglodyta* (Gertsch) from Grutas de Atoyac, Veracruz; and *A. wileyae* Gertsch from Actún Loltún, Yucatán.

Seven troglaphiles were originally described in *Coryssocnemis*, but none belong there. Specimens are usually found hanging in webs in the vicinity of the cave entrance. Three species are too poorly known to place in the proper genus: "*C.*" *clara* Gertsch from Cueva del Nacimiento del Río Frío, Sierra de Guatemala, Tamaulipas; "*C.*" *faceta* Gertsch from Cueva del Camino, Chiapas; and "*C.*" *iviei* Gertsch from Hidalgo, Querétaro, and San Luis Potosí. The remaining four species have been removed to the genus *Ixchela*.

Ixchela includes four troglaphiles: *I. abernathyi* (Gertsch) from caves in Nuevo León, Oaxaca, Puebla, San Luis Potosí and Tamaulipas; *I. franckei* Valdez-Mondragón from Guerrero; *I. huasteca* Valdez-Mondragón from Hidalgo, Querétaro, and San Luis Potosí; *I. mixe* Valdez-Mondragón; from Oaxaca; *I. pecki* (Gertsch) from Chiapas; *I. placida* (Gertsch) from Puebla and Veracruz; *I. santibanezi* Valdez-Mondragón from Chiapas; *I. simoni* (O. Pickard-Cambridge) from Guerrero, Hidalgo, Nuevo León, Oaxaca, and Querétaro; *I. taxco* Valdez-Mondragón from Guerrero; and *I. tzotzil* Valdez-Mondragón from Chiapas.

Metagonia is the best represented genus in Mexican caves with 12 troglobites known: *M. atoyacae* Gertsch, pale, eyeless species from three caves in Veracruz; *M. chiquita* Gertsch, eyeless species collected beneath a rock on bat guano in Cenote Chen Mul, Yucatán; *M. joya* Gertsch, eyeless species from Sótano de la Joya de Salas, Sierra de Guatemala, Tamaulipas; *M. lepida* Gertsch, eyeless species from Cueva del Ojo de Agua de Manantiales, Sierra de Guatemala, Tamaulipas; *M. luisa* Gertsch, eyeless species from Sótano de Huitzmolotitla, Xilitla region, San Luis Potosí; *M. martha* Gertsch, pale with rudimentary eyes from Cueva del Nacimiento del Río San Antonio, Oaxaca; *M. oxtalja* Gertsch, eyeless species from Cueva de Oxtalja, San Luis Potosí; *M. pachona* Gertsch, pale, small-eyed species from Cueva de El Pachón, Tamaulipas; *M. puebla* Gertsch, essentially eyeless species from Grutas de Atepolihuit, Cuetzalan, Puebla; *M. pura* Gertsch, pale, eyeless species from Cueva de la Capilla, Sierra de Guatemala, Tamaulipas; *M. tlamaya* Gertsch, pale, eyeless species from Sótano de Tlamaya, San Luis Potosí; and *M. torete* Gertsch, species with evanescent eyes and long legs from caves in the Yucatán Peninsula.

The troglaphiles are: *Metagonia amica* Gertsch from Cueva de El Jobo, Xilitla region, San Luis Potosí; *M. candela* Gertsch from two caves in Nuevo León; *M. capilla* Gertsch from Cueva de la Capilla, Sierra de Guatemala, Tamaulipas; *M. coahuila* Gertsch from caves in Coahuila and Nuevo León; *M. cuate* Gertsch from Cueva de los Cuates, Sierra de El Abra, San Luis Potosí; *M. faceta* Gertsch from Cueva Pajaritos, Nuevo León; *M. guagua* Gertsch from Hoya de las Guaguas, Aquismón, San Luis Potosí; *M. mcNatti* Gertsch from two caves in Chiapas; *M. maximiliani* Brignoli from Cueva del Madroño, Querétaro; *M. iviei* Gertsch from caves in Campeche, Quintana Roo, and Yucatán; *M. maya* Gertsch from caves in Campeche, Quintana Roo, and Yucatán; *M. modesta* Gertsch from Cueva del Ahuate no. 2, Xilitla region, San Luis Potosí; *M. placida* Gertsch from Cueva de la Boca, Nuevo León; *M. punctata* Gertsch from the Valle de los Fantasmas region, San Luis Potosí; *M. secreta* Gertsch from Cueva del Nacimiento del Río Frío, Sierra de Guatemala, Tamaulipas; *M. serena* Gertsch from Grutas de Villa de García, Nuevo León; *M. suzanne* Gertsch from Sótano de El Jineo, Sierra de Guatemala, Tamaulipas; *M. tinaja* Gertsch from the Sierra de El Abra, San Luis Potosí and Tamaulipas; and *M. yucatanana* Chamberlin & Ivie from caves in Campeche and Yucatán.

Modisimus includes 12 probable troglaphiles from Mexican caves; they are found in all parts of caves, where they hang in webs along the walls or among speleothems: *M. beneficus* Gertsch from Sótano de Botella Chica, Veracruz; *M. boneti* Gertsch from the Sierra de El Abra, San Luis Potosí and Tamaulipas; *M. deltoroi* Valdez-Mondragón & Francke from Cueva Ch'en-bajlám (Cueva del Tigre) and Cueva Kolem-Ch'en (Cueva Grande), Chiapas; *M. iviei* Gertsch from Quintana Roo, Tabasco, and Yucatán; *M. mckenziei* Gertsch from Tamaulipas; *M. mitchelli* Gertsch from the Purificación region and Sierra de Guatemala, Tamaulipas; *M. propinquus* O. Pickard-Cambridge from Chiapas; *M. pusillus* Gertsch from Nuevo León; *M. rainesi* Gertsch from Nuevo León and Tamaulipas; *M. reddelli* Gertsch from Hidalgo and Tamaulipas. *M. texanus* Banks from San Luis Potosí and Tamaulipas; and *M. tzotzile* Brignoli from Sima del Ojito, Chiapas.

Twelve species were originally placed in the genus *Pholcophora*, but the only species from Mexican caves now placed in the genus is *P. texana* Gertsch from Cueva de la Boca, Nuevo León. "*Pholcophora*" *maria* Gertsch is a troglaphile from Actún Xpukil, Yucatán; it probably belongs elsewhere. An undescribed species of "*Pholcophora*" was found in Sistema Huautla, Oaxaca.

Individuals of *Physocyclus* are usually found hanging from webs near the cave entrance. Fifteen troglaphilic species are reported from México: *P. bicornis* Gertsch from Grutas de Juxtlahuaca, Guerrero; *P. darwini* Valdez-Mondragón from Cueva Oxtotitlan, Guerrero; *P. dugesi* Simon from México, Morelos, Oaxaca, and Puebla; *P. enaulus* Crosby from Chihuahua, Coahuila, and Tamaulipas; *P. globosus* (Taczanowski) from Chiapas, Quintana Roo, San Luis Potosí, Veracruz, and Yucatán; *P. hoogstraali* Gertsch & Davis from Coahuila and Nuevo León; *P. lautus* Gertsch from Colima; *P. merus* Gertsch from Coahuila, Puebla, and San Luis Potosí; *P. modestus* Gertsch from Guerrero and Oaxaca; *P. pedregosus* Gertsch from Pedregoso Circle Cave, Coahuila; *P. reddelli* Gertsch from Hidalgo, Querétaro, San Luis Potosí, and Tamaulipas, *P. sarae* Valdez-Mondragón from Michoacán; *P. sprousei* Valdez-Mondragón from Chihuahua and Durango; *P. tanneri* Chamberlin from Sonora; and *P. validus* Gertsch from Colima and Puebla. *Physocyclus bicornis* was the most abundant species in Grutas de Juxtlahuaca with a total of 1380 specimens recorded.

Psilochorus includes two troglaphites and seven troglaphiles in México. The two probable troglaphites are: *P. delicatus* Gertsch, pale with reduced eyes, found near the end of Cueva de los Riscos, Durango; and *P. diablo* Gertsch, pale with reduced eyes, known only from Cueva del Diablo, Chihuahua.

Troglaphilic species are: *Psilochorus concinnus* Gertsch from Cueva de Cinquenta y Ocho, San Luis Potosí; *P. conjunctus* Gertsch & Davis from Morelos; *P. cordatus* (Bilimek) from Grutas de Cacahuamilpa, Guerrero; *P. fishi* Gertsch from Grutas de Xoxafí, Hidalgo; *P. murphyi* Gertsch from Cueva de Apoala, Oaxaca; *P. russelli* Gertsch from Coahuila; and *P. tellezi* Gertsch from Resumidero del Río San Gerónimo, Guerrero. Undescribed species are known from caves in Chihuahua, Coahuila, México, Nuevo León, and Veracruz.

Family Scytodidae

Four species of *Scytodes* are troglaphiles in México: *S. fusca* Walckenaer from San Luis Potosí, Veracruz, and Yucatán; *S. intricata* Banks from Campeche, Guerrero, Quintana Roo, and Yucatán; *S. itzana* Chamberlin and Ivie from Yucatán; and *S. longipes* Lucas from Chiapas, Distrito Federal, and Veracruz.

Family Selenopidae

Two species of *Selenops* are probably troglaphiles in Mexican caves: *S. juxtlahuaca* Valdez-Mondragón from Grutas de Juxtlahuaca, Guerrero; and *S. mexicanus* Keyserling from Grutas de Palmito, Nuevo León.

Family Sicariidae

These spiders are usually found in dry areas of the cave and are frequently present in large numbers. Seventeen species of *Loxosceles* are considered troglaphiles in México: *L. apachea* Gertsch & Ennik from Chihuahua; *L. areana* Gertsch from Querétaro; *L. aurea* Gertsch from Durango; *L. belli* Gertsch from Coahuila; *L. boneti* Gertsch from Guerrero; *L. candela* Gertsch from Nuevo León; *L. chinateca* Gertsch & Ennik from Oaxaca and Veracruz; *L. colima* Gertsch from Colima; *L. deserta* Gertsch from Baja California Norte; *L. devia* Gertsch & Mulaik from Nuevo León and Tamaulipas; *L. luteola* Gertsch from Nuevo León; *L. misteca* Gertsch from Guerrero; *L. tehuana* Gertsch from Chiapas; *L. tenango* Gertsch from Hidalgo; *L. valdosa* Gertsch from San Luis Potosí and Tamaulipas; *L. yucatanana* Chamberlin & Ivie from the Yucatán Peninsula and Guatemala; and *L. zapoteca* Gertsch from a mine near Iguala, Guerrero.

Family Tengellidae

Two species of *Tengella* have been reported from Mexican caves: *T. thaleri* Platnick, a troglophile known only from Cueva de la Selva, Xilitla, San Luis Potosí, and *T. kalebi* Candia-Ramírez & Valdez-Mondragón, a troglobite with elongate legs and reduced eyes and pigment, from two caves in Chiapas.

Family Tetrablemmidae

Two species are known from caves in México. *Caraimatta sbordonii* (Brignoli) has epigeal populations and a subterranean population which consists of eyeless specimens from Cueva del Ojo de Agua de Tlilapan. *Matta mckenziei* Gertsch is an eyeless species known from two caves in Campeche.

Family Tetragnathidae

Two described trogliphiles are known from México: *Azilia affinis* O. Pickard-Cambridge from Chiapas, Tamaulipas, and Veracruz and *Leucauge venusta* (Walckenaer) from San Luis Potosí, Tamaulipas, Veracruz, and Yucatán.

Family Theridiidae

Two species of *Ameridion* are possible trogliphiles: *A. bridgesi* (Levi) from Hidalgo, Puebla, and Veracruz; and *A. cobanum* (Levi) from Veracruz.

Four species of *Cryptachaea* are presumed trogliphiles: *C. canionis* (Chamberlin & Gertsch) from Chihuahua, Nuevo León, and San Luis Potosí; *C. catapetraea* (Gertsch & Archer) from San Luis Potosí, *C. manzanillo* (Levi) from Grutas de Juxtlahuaca, Guerrero; and *C. porteri* (Banks) from Querétaro and San Luis Potosí. The latter species is an abundant trogliphile in the caves of Texas (U.S.A.).

Nesticodes rufipes (Lucas) is a possible trogliphile in Campeche and Yucatán.

Three species of *Thymoites* are probable trogliphiles: *T. sp. nr. maderae* (Gertsch and Archer) from Puebla; *T. confraternus* (Banks) from San Luis Potosí; and *T. spukilum* Chamberlin & Ivie from Campeche, Puebla, Veracruz, and Yucatán.

Two species of *Tidarren* are possible trogliphiles: *T. mixtum* (Pickard-Cambridge) from Chiapas and *T. sisypoides* (Walckenaer) from Chiapas, Tabasco, Veracruz, and Yucatán. The latter species is also known from numerous caves in Texas (U.S.A.).

Family Titanocidae

Goeldia tizamina Chamberlin & Ivie is a trogliphile in caves in Campeche and Yucatán. An undetermined species of *Goeldia* is a trogliphile in the caves of the Cuetzalan region, Puebla.

Family Uloboridae

Four species of *Philoponella* are probable trogliphiles: *P. oweni* Chamberlin in Chihuahua; *P. semiplumosa* (Simon) in Tamaulipas and Veracruz; *P. signatella* (Roewer) in Oaxaca, Puebla, Tabasco, and Yucatán; and *P. vicina* (O. Pickard-Cambridge) in Tabasco and Veracruz.

Family Zorocratidae

Three species of *Zorocrates* have been reported from Mexican caves: *Z. gnaphosoides* (O. Pickard-Cambridge) from Chiapas; *Z. terrell* Platnick & Ubick from Tamaulipas, and *Z. potosi* Platnick & Ubick, described from Cueva de los Viet Cong, San Luis Potosí.

Order Opiliones

Suborder Cyphophthalmi

Family Neogoveidae

Shearogovia mexasca (Shear) is the only troglobitic species in the family (SHEAR, 1977b, 1980; GIRIBET, 2011). It is pale red, eyeless, and with elongate appendages. It was found on bat guano 2 km from the entrance in Cueva del Nacimiento del Río San Antonio, Oaxaca, and 1 km from the entrance in Cueva Finca, Oaxaca. The placement of the species in the Neogoveidae is uncertain.

Suborder Eupnoi

Family Sclerosomatidae

This family is frequently found in the entrance area of caves, but most species have not been identified. All are probably troglonexes. Three commonly encountered species are: *Geaya yucatanana* Goodnight & Goodnight from caves in the Yucatán Peninsula; *Leiobunum metallicum* Roewer from Querétaro and San Luis Potosí; and *L. viridorsum* Goodnight & Goodnight from Hidalgo, Nuevo León, Querétaro, San Luis Potosí, and Tamaulipas.

Suborder Dyspnoi

Family Nemastomatidae

Subfamily Ortholasmatinae

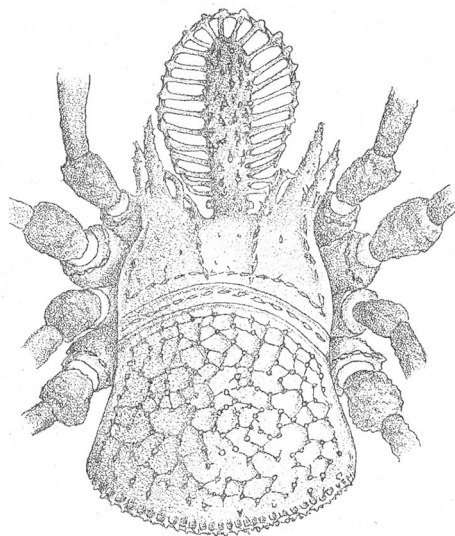


Fig. 21 - Opiliones: Troglulidae: *Trilasma sbordonii* Silhavý, 1973, from Cueva de la Perra, Tamaulipas (from the author).

The species of the subfamily are characterized as bearing a hood overhanging the chelicerae and palpi, formed from an extension of the eye tubercule. The body is covered by a layer of earth glued together by a dermal secretion.

The only troglotic species of this family known from Mexican caves is *Trilasma sbordonii* Silhavý (Fig.21) from Cueva de la Mina and Cueva de la Perra in the Sierra de Guatemala, Tamaulipas (SILHAVÝ, 1974, 1977; SHEAR & GRUBER, 1983). The species has reduced and unpigmented eyes, attenuated appendages, and a pale body. Two troglophilic species of *Trilasma* have been recently described from caves in México (SHEAR, 2010): *T. petersprousei* Shear from Hoya de las Guaguas, San Luis Potosí; and *T. tempestado* Shear from three caves in Nuevo León.

Suborder Laniatores

Family Cosmetidae

This family is well represented in Mexican caves (GOODNIGHT & GOODNIGHT, 1973, 1977).

Cynorta includes three troglophiles known from Mexican caves: *Cynorta formosa* (Goodnight & Goodnight) from Cueva de Tenango, Hidalgo; *C. guadalupensis* Goodnight & Goodnight, known only from Pozo de Guadalupe, San Luis Potosí; and *C. jamesoni* Goodnight & Goodnight, known only from caves in San Luis Potosí and Tamaulipas.

Erginulus contains three troglophiles in Mexican caves: *E. bimaculata* Goodnight & Goodnight, known only from caves in Campeche and Yucatán; *E. clavotibialis* (Pickard-Cambridge) from Cenote Bolchen, Campeche; and *E. roeweri* (Goodnight & Goodnight) from Actún Xpukil, Yucatán.

Family Phalangodidae

This large family, well represented in European and U.S caves, is known from México by three troglotic and six possibly troglophile species (GOODNIGHT & GOODNIGHT, 1945, 1971, 1973; ŠILHAVÝ, 1974, 1977; VÁZQUEZ & COKENDOLPHER, 1997).

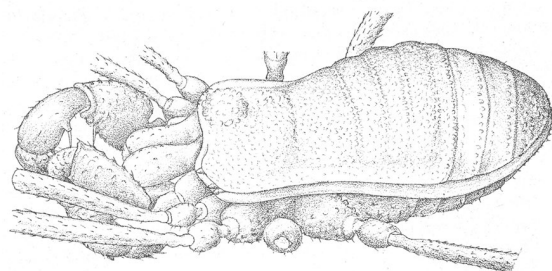


Fig. 22 – Opiliones: Phalangodidae: *Guerrobunus arganoi* Silhavý, 1973, Cueva de Coatepec, Chiapas.

Akdalima vomeroi Šilhavý is known only from Cueva del Sabín, Chiapas.

Arganotus macrochelis (Goodnight & Goodnight) is a troglophile from Cueva del Sabín, Chiapas.

Guerrobunus contains two troglobitic species: *G. arganoi* (Šilhavý) (Fig. 22), an eyeless species from Cueva de Coatepec, 2100 m in altitude, Chiapas; and *G. vallensis* Vázquez & Cokendolpher, with unpigmented eyes from Cueva del Diablo, México State.

Guerrobunus minutus Goodnight & Goodnight is an eyed species known only from Resumidero de San Jerónimo, Guerrero, and is presumably a troglophile.

The genus *Karos* includes six possible troglobites known only from caves and with small eyes and reduced ocular tubercles: *K. brignolii* Šilhavý, eyemount low, body yellowish brown, from Cueva de Tlilapan, Veracruz; *K. depressus* Goodnight & Goodnight from Cueva del Llano del Conejo, Xilitla, San Luis Potosí; *K. gratiosus* Goodnight & Goodnight from caves in the Xilitla region, San Luis Potosí, and the Huautla region, Oaxaca; *K. parvus* Goodnight & Goodnight from caves in the Sierra de El Abra, Tamaulipas, and the Micos and Valle de los Fantasmas regions, San Luis Potosí; *K. projectus* Goodnight & Goodnight from two caves in the Xilitla region, San Luis Potosí; and *K. rugosus* Goodnight & Goodnight from two caves in the vicinity of Córdoba and Orizaba, Veracruz.

Two species are troglophiles: *Karos dybasi* (Goodnight & Goodnight) from Cueva de El Jobo, Xilitla region, San Luis Potosí and *K. unispinosus* (Goodnight & Goodnight) from Nuevo León and Tamaulipas.

Mexotroglinus sbordonii Šilhavý; the only species in the genus, is eyeless and unpigmented; it is known only from Cueva del Pedro de Agua, Chiapas.

Paramitraceras. Three species of *Paramitraceras* are probably troglophiles in México: *P. femoralis* Goodnight & Goodnight from Sótano de Malpaso, Chiapas; *P. granulatus* Cambridge from Cueva del Guayabo, Oaxaca; and *P. hispidulus* Pickard-Cambridge from Cueva de la Golondrina, and Cueva del Río Hondo, Chiapas.

Sbordonia armigera Šilhavý is a troglophile in Sótano de Malpaso, Chiapas.

Family Stygnommatidae

Two species of *Stygnomma* are troglophiles in Mexican caves: *S. spinifera tancahensis* Goodnight and Goodnight from Cueva de Abispa, Quintana Roo; and *S. tuberculata* Goodnight & Goodnight, known only from Cueva de los Cuarteles, Tamaulipas.

Family Stygnopsidae

This largely tropical family includes eleven troglobites and five troglophiles from México (GOODNIGHT & GOODNIGHT, 1971, 1973; ŠILHAVÝ, 1974; COKENDOLPHER, 2004). Many species of troglobites and troglophiles await description.

Chiniquellobunus contains six described species known only from caves in Texas (U.S.A.) and México. *C. madlae* (Goodnight & Goodnight) is an eyeless species known from Sótano de Amezcua, Coahuila, and many caves in Texas. Two eyed species may be troglobites isolated in the cave environment by the surrounding desert: *C. mexicanus* Cokendolpher from three caves in Nuevo León, and *C. osorioi* Goodnight & Goodnight from Cueva del Carrizal and Grutas de Villa de García, Nuevo León. The only other species in the genus is the troglobitic *C. russelli* (Goodnight & Goodnight) from one cave in Texas. Several undescribed species are known from caves in northern México. *C. coahuilensis* Cokendolpher is a probable troglophile known only from Sumidero de Alicante, Coahuila.

Hoplobunus contains six troglobites known from Mexican caves: *H. apoalensis* Goodnight & Goodnight, with small eyes, from walls and silt banks in a moist room above the stream in Cueva de Apoala, Oaxaca; *H. boneti* (Goodnight & Goodnight), with small eyes, from caves in the Sierra de El Abra, San Luis Potosí and Tamaulipas, and the Xilitla region, San Luis Potosí; *H. oaxacensis* Goodnight & Goodnight, with small eyes, from Grutas del Llano Grande and Sótano de los Árboles, Chiapas; *H. planus* Goodnight & Goodnight, eyeless, from caves in the Xilitla region, San Luis Potosí; *H. queretarius* Šilhavý, eyeless, from Cueva del Madroño and El Socavón, Querétaro; and *H. zullinii* Šilhavý from Grutas de Llano Grande and Sumidero de Cañada, Chiapas.

The troglophiles are: *Hoplobunus barretti* Banks from Sistema Purificación, Tamaulipas; *H. mexicanus* (Roewer) from caves in Oaxaca and Tamaulipas; and *H. spinooculorum* Goodnight & Goodnight, known only from Cueva del Guayabo, Valle Nacional region, Oaxaca.

Stygnopsis robusta (Goodnight & Goodnight) is a large troglophile known only from caves in the Tequila and Zoquitlán regions of Veracruz.

Troglostygnopsis is represented by two troglobites in México: *T. anophthalma* Šilhavý (Fig. 23 and Pl I, 4), eyeless and unpigmented, known from Cueva de la Golondrina, Cueva del Nacimiento del Río Santo Domingo, and Grutas de Rancho Nuevo in central Chiapas; and *T. inops* (Goodnight & Goodnight), with small eyes, known from six caves in the Sierra de Guatemala, Tamaulipas. An undescribed species is known from Cueva del Nacimiento del Río San Antonio, Oaxaca.

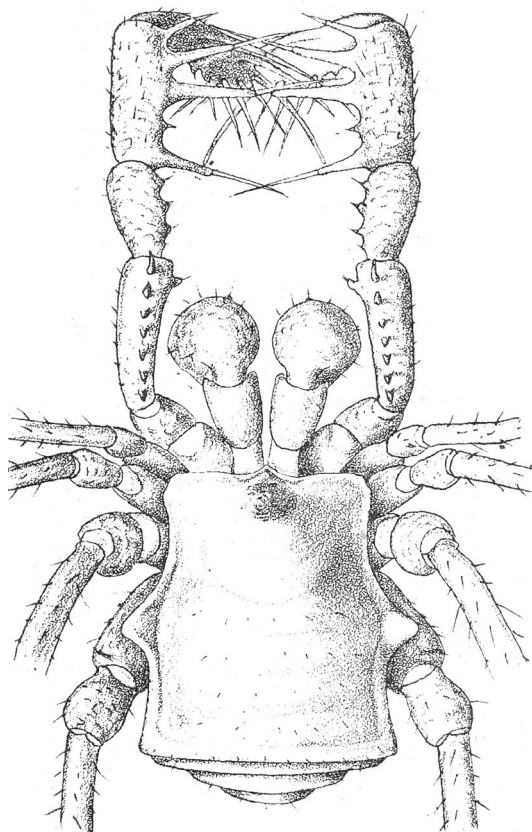


Fig. 23 – Opiliones: Stygnopsidae: *Troglstygnopsis anophthalma* Silhavy, 1973.

Order Ricinulei

Family Ricinoididae

The order Ricinulei consists of 73 described species in three genera: *Pseudocellus* from southern Texas (USA) and México, *Cryptocellus* from Honduras to Brazil, South America, and *Ricinoides* in Africa. They occur in tropical and subtropical endogenous habitats (leaf litter, soil, and under rocks and logs) and caves.

Thirteen troglotic or presumably troglotic species of *Pseudocellus*, all blind, are endemic to caves in México. One new species is undescribed (CHAMBERLIN & IVIE, 1938b; BOLÍVAR Y PIELTAIN, 1941, 1946; CORONADO-GUTIÉRREZ, 1970; BRIGNOLI, 1974a; GERTSCH, 1971b, 1977; JUBERTHIE, 1994; COKENDOLPHER & ENRIQUEZ, 2004; VALDES-MONDRAGÓN & FRANCKE, 2011, 2013). Several species inhabit caves at mid-elevation, to the limit of tropical/temperate forests; for instance, the Cueva del Tío Ticho, Chiapas, at 1350 m in altitude.

The troglotic species are: *Pseudocellus bolivari* (Gertsch), with slender, elongate legs, from Sumidero del Camino and Cueva del Tío Ticho, Chiapas; *P. boneti* (Bolívar y Pieltain), presumably troglotic, from four caves in Guerrero. *P. mitchelli* (Gertsch), presumably troglotic, abundant on bat guano in Cueva del Guano, Durango; *P. monjarazi* Valdez-Mondragón & Francke, a highly evolved troglote from Cueva de San Francisco and Grutas de Zapaluta, Chiapas; *P. osorioi* (Bolívar y Pieltain) from several caves in the Sierra de El Abra, San Luis Potosí and Tamaulipas; in Sótano del Tigre it was living on guano in an extremely warm, humid passage several meters long; the size of the population has been estimated at several thousand individuals (MITCHELL, 1970); *P. oztotl* Valdez-Mondragón & Francke, troglomorphic species known only from Cueva de las Tres Quimeras in the Sierra Negra, Puebla; *P. pearsei* (Chamberlin & Ivie) from many caves in Quintana Roo and Yucatán; *Pseudocellus platnicki* Valdez-Mondragón & Francke, a highly adapted troglote with slender and elongate appendages known only from Cueva Sasaparilla, 130 km WSW Ciudad Acuña, Coahuila, the most northern species in the order; *P. reddelli* (Gertsch) with elongate legs, from Cueva de los Riscos, Durango; and *P. sbordonii* (Brignoli), prosoma bright red, opisthosoma dark red, from Cuevas de las Canicas, Rancho del Cielito, and possibly Cueva de Cerro Brujo, Chiapas. An undescribed species of highly evolved troglote is known from Resumidero de La Joya San Gregorio, Guerrero.

Two species are troglophiles: *Pseudocellus chankin* Valdez-Mondragón & Francke, found deep inside Cueva Kolemchen (Cueva Grande) in Chiapas, surface habitats in Chiapas and Tabasco, and caves in Guatemala; and *P. pelaezi* (Coronado Gutiérrez) (Fig. 24) from caves and epigeal localities in the Sierra de El Abra, San Luis Potosí and Tamaulipas. It is the best-studied of all ricinuleids due to the work of MITCHELL (1970). It was found living on the guano of two frugivorous bats in

Cueva de la Florida, Tamaulipas. Population was estimated at 8000 + or - 1,200 individuals, with the total number in the cave perhaps 11,000. The age structure was inverted with 72.8% adults, 1.9 % larvae, 2.5% first nymphs, 9.5% second nymphs, and 13.4% third nymphs (sub-adults). This unbalance probably results from a low rate of natural increase with females producing only a single egg at a time and from reduced predation on adults.

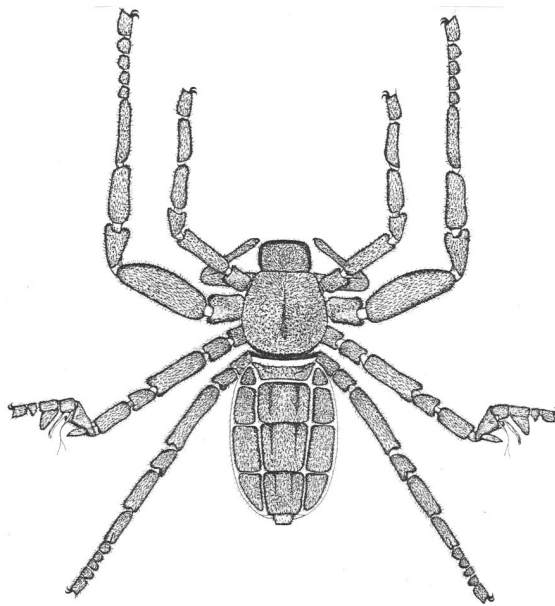


Fig. 24 – Ricinulei: Ricinoididae: *Pseudocellus pelaezi* (Gertsch, 1971), Cueva de la Florida (from Pittard & Mitchell).

CLASS ACARI

Acari are commonly found in Mexican caves and more than 120 species are recorded belonging to 28 families. Only four species are definitely troglotic, most are trogliphiles, and numerous troglonexic. They have been systematically studied in Yucatán caves (WHARTON, 1938; MAHUNKA, 1982; MAHUNKA & PALACIOS-VARGAS, 1996; PALACIOS-VARGAS, 1993). It is often difficult to say whether a species found in a cave is truly troglotic, trogliphile, or accidental.

Order Metastigmata (Ixodida)

Family Argasidae

Larvae are parasitic while adults are free-living. Eleven species are recorded from Mexican caves (MAZZOTTI, 1940, 1941; HOFFMANN, 1944, 1962; KEIRANS & CLIFFORD, 1975; KEIRANS *et al.*, 1977; GUZMÁN-CORNEJO *et al.*, 2012; LABRUNA *et al.*, 2012).

Three species of *Antricola* have been found; the adults of some are present in vast numbers in bat guano: *A. coprophilus* (McIntosh) from Chiapas, Colima, Guerrero, Jalisco, San Luis Potosí, Tamaulipas, Veracruz, and Yucatán; *A. marginatus* (Banks) from Campeche, Veracruz, and Yucatán; and *A. mexicanus* Hoffmann from Campeche, Chihuahua, Guerrero, San Luis Potosí, Tabasco, Tamaulipas, and Veracruz.

Nothoaspis reddelli Keirans & Clifford is known from bat caves in Campeche, Tabasco, and Yucatán.

Orthithodoros includes seven species from Mexican caves: *O. (Alectorobius) azteci* Matheson from bats in Morelos; *O. (A.) brodyi* Matheson from Chihuahua, Guerrero, Quintana Roo, and Tamaulipas; *O. (A.) concanensis* Cooley & Kohls from Grutas de Loltún, Yucatán; *O. (A.) dyeri* Cooley & Kohls from bats in Chiapas, Colima, Hidalgo, Nuevo León, Puebla, San Luis Potosí, Veracruz, and Yucatán; *O. (A.) talaje* (Guérin-Méneville) from Guerrero and Yucatán; *O. (A.) yumatensis* Cooley & Kohls from bats in Chiapas, Guerrero, Michoacán, Tamaulipas, and Yucatán; and *O. (Pavlovskyella) nicollee* Mooser from soil and walls of Cueva de Huajintlán, Morelos.

Family Ixodidae

Ixodes coneptati Cooley & Kohls was found in three caves in Coahuila (GUZMÁN-CORNEJO *et al.*, 2007). This species is known from many caves in Texas (U.S.A.). It is a parasite of small mammals.

Order Mesostigmata (Gamasida) (Fig. 26A)

Family Dermanyssidae

Lipponysoides sanguineus (Hirst) was taken from *Neotoma torquata* in Gruta de la Estrella, México (HOFFMANN *et al.*, 1974).

Family Macronyssidae

Nine species of this family are parasitic on bats from caves in México (RADOVSKY *et al.*, 1971; PALACIOS-VARGAS & MORALES-MALACARA, 1980, 1983; HOFFMANN *et al.*, 1980, 1986; MORALES-MALACARA & LÓPEZ, 1990).

Chirotonyssus robustipes (Ewing) is known from Nuevo León.

Macronyssoides kochi (Fonseca) is known from Cueva del Salitre, Morelos.

Three species of *Macronyssus* have been taken from caves and an abandoned tunnel in Tlaxcala: *M. crosbyi* (Ewing & Stover) from Cueva del Salitre, Morelos; and *M. longisetosus* (Furman) and *M. unidens* Radovsky from an abandoned tunnel in Tlaxcala.

Parichoronyssus sclerus Radovsky is known from Guerrero and Morelos.

Three species of *Radfordiella* have been found in Mexican caves: *R. anourae* Radovsky, Jones, & Phillips from Cueva de San Juan, Morelos; *R. desmodi* Radovsky from Morelos; and *R. oricola* Radovsky, Jones, & Phillips from Guerrero, Morelos, and Nuevo León.

Family Pterygosomidae

Hirstiella trombidiformes (Berlese) was taken from Cueva del Carrizal, Nuevo León (CUNLIFFE, 1952).

Family Spelaorhynchidae

Spelaorhynchus praecursor Neumann is a parasite of bats from caves in San Luis Potosí and Tabasco (HOFFMANN & DE BARRERA, 1970).

Family Spinturnicidae

Ten species of this family are parasitic on bats from caves and a tunnel in México (RUDNICK, 1960; MORALES-MALACARA & LÓPEZ, 1998).

Cameroneta elongatus (Furman) was taken from Guerrero and Morelos.

Six species of *Periglyphis* have been recorded from Mexican caves: *P. herrerae* Machado-Allison from Guerrero and Morelos; *C. strandmanni* Tibbetts, *P. caligus* Kolinati; *P. iheringi* Oudemans from Guerrero, San Luis Potosí, and Yucatán; *P. natali* Furman from Guerrero; and *P. vargasi* Hoffmann from Baja California Sur, Chiapas, Guerrero, Morelos, and Tabasco.

Three species of *Spinturnix* are known from caves and one from a tunnel: *S. americanus* (Banks) from Cueva del Salitre, Morelos; *S. carloshoffmanni* Hoffmann from Cueva de los Cuarteles, Tamaulipas; and *S. traubi* Morales-Malacara & López. from an abandoned tunnel in Tabasco

Family Ascidae

Species recorded from Mexican caves include *Melichares* sp. from Hoyo de Don Nicho, Chiapas; *Protogamasellus* sp., from caves in Guerrero; *Gamasellodes* sp., numerous specimens on bat guano in Cueva de las Sardinas, Tabasco; and undetermined species of *Artroseius*, *Iphidozercon*, and *Zercoseius* from bat guano in Yucatán.

Family Macrochelidae

Three species have been recorded from Mexican caves: *Macrocheles coprophila* Womersley from Cueva de la Hoya, San Luis Potosí; *M. austroamericanus* Evans & Hyatt from Actún Xpukil, Yucatán; and *Glyptolaspis* sp., numerous specimens on bat guano in Cueva de las Sardinas.

Family Laelapidae

The majority of species are parasites of rodents or insectivores but some are free living. From Mexican caves was reported: *Haemolaelaps glasgowi* (Ewing) from the carcass of a paca in Grutas de Balankanché and from guano in Actún Xpukil, Yucatán. Undetermined specimens of *Androlaelaps*, *Cosmolaelaps*, *Geolaelaps*, and *Holostaspis* have been taken from caves in Yucatán.

Family Metagnuridae

Metagnynella sp. was taken from bat guano in Cueva de las Sardinas, Tabasco.

Family Pachylaelapidae

Pachyseius sp. and *Zygoeius* sp. were found in caves in Yucatán.

Family Parasitidae

This family contains many species abundant on bat guano. *Parasitus* sp. was taken from caves in Morelos where it is necrophagous or a predator. *Pergamasus* sp. was found in Gruta de Aguacachil, Guerrero.

Family Podocinidae

Species of this family usually inhabit soil and litter. Two species of free-living *Podocinum* are known from Mexican caves (PALACIOS-VARGAS & OJEDA CARRASCO, 1982): *P. jamaicensis* Evans & Hyatt from Grutas de Atoyac, Veracruz; and *P. pacificum* (Berlese) from caves in Guerrero and Querétaro.

Family Polyaspididae

Most species inhabit soil and litter. From México were reported: *Diploaspis* sp. from caves in the Xilitla region, San Luis Potosí; and *Trachytes* sp. from Actún Siete Aguas, Yucatán.

Family Rhodacaridae

Rhodacarus sp. was taken from Gruta de Aguacachil, Guerrero, and *R. minimus* (Karg) from Cueva de las Sardinas, Tabasco. These are predators of small insects.

Family Sejidae

Sejus sp. was taken from bat guano and soil under chemoautotrophic bacteria in Cueva de las Sardinas, Tabasco, and surface soil.

Family Trematuridae

Treichouropoda sp. was found in bat guano in Cueva de las Sardinas, Tabasco.

Family Uropodidae

This family is an important element of the cave fauna of México, with at least seven species known: *Metagnynella* sp., *Urodiaspis* sp., *Uroobovelia* sp., *Uropolyaspis* sp., *Uroseius* sp. from caves in Yucatán; *Nenteria* sp. from caves in Campeche and Yucatán; *Uropoda pearsei* Wharton described from bat guano in Cenote de Sambulha, Motul, Yucatán; and *Uropoda (Phaulodimychus)* sp. from litter and bat guano in Cueva de las Sardinas, Tabasco.

Order PROSTIGMATA (Trombidiformes) (Fig. 26 B)

Family Bdellidae

Two species of *Spinibdella* are possible troglaphiles in Mexican caves: *S. bifurcata* Atyeo from Cueva del Rancho Sambula, Yucatán; and *S. depressa* (Ewing) from Grutas de Nevada, Nuevo León.

Family Cheyletidae

More than four species of these predatory mites are known in Mexican caves, with several more undescribed.

Two species of *Cheyletus* are known: *C. cacahuamilpensis* Baker from Grutas de Cacahuamilpa, Guerrero, Morelos and Yucatán; and *C. malaccensis* Oudemans from Tamaulipas and Veracruz.

Family Cunaxidae

At least fourteen species of Cunaxidae have been found in Mexican caves (FUENTES *et al.*, 2002, 2007; ESTRADA & MEJÍA-RECAMIER, 2005).

Two species of *Coleoscirus* were found in Cueva de las Sardinas, Tabasco: *C. sp. breslauensis* Den Heyer in litter and soil under chemoautotrophic bacteria; and *C. sp. cf. simplex* (Ewing) in litter.

Cunaxa sp. is known from Querétaro and Yucatán.

At least two species of *Cunaxoides* have been found in Mexican caves: *Cunaxoides* sp., abundant in litter and bat guano in Cueva de las Sardinas, Tabasco; *C. sp. ca. nicobarensis* Gupta & Ghosh from litter in Cueva de las Sardinas, Tabasco, and *C. pectinatus* Ewing from Cueva del Salitre, Morelos.

Two undetermined species of *Dactyloscirus* have been found in Cueva de las Sardinas, Tabasco.

At least two species of *Neoscirula* have been found in Cueva de las Sardinas, Tabasco: *N. sp. ca. delareyi* Den Heyer and *N. sp. ca. luxtoni* Smiley.

Pseudobonzia sp. was taken from litter and soil under bacteria colonies in Cueva de las Sardinas, Tabasco.

Pulaeus sp. cf. *pectinatus* (Ewing) and two undetermined species of *Pulaeus* have been found in Cueva de las Sardinas, Tabasco. An undetermined species of the genus is known from Cueva del Salitre, Morelos.

Family Ereynetidae

Ereynetes sabinensis Baker is a free-living species described from guano in Cueva de los Sabinos, San Luis Potosí (BAKER, 1945).

Family Erythraeidae

Erythraxus bisetosus (Wharton) is a predatory species from Cueva de San Isidro, Yucatán (WHARTON, 1938).

Family Eupodidae

Two mycophagous species are reported from Mexican caves: *Eupodes* sp. from Gruta de Aguacachil, Guerrero; and *Linopodes* sp. in Cueva de San Juan, Morelos.

Family Pachygnathidae

Pachygnathus sp. is recorded from Grutas de Juxtlaahuaca, Guerrero.

Family Proterorhagiidae

Proterorhagia oztotoica Lindquist & Palacios-Vargas is unpigmented, not sclerified, without lateral eyes, and with elongated appendages and long and fine thricobothria. It is known only from a cave in Colima (LINDQUIST & PALACIOS-VARGAS, 1991).

Family Rhagidiidae

Two species are probably troglitic (ELLIOTT & STRANDTMANN, 1971; ZACHARDA & ELLIOTT, 1985): *Foveacheles* sp., eyes and pigment reduced, and with elongated sensilla, from Grutas de Juxtlaahuaca, Guerrero; and *Robustocheles infernalis* Zacharda & Elliott from Cueva de Diablo, 1310 m in altitude, Veracruz.

Six species are probably trogliphiles: *Foveacheles* n. sp. from Grutas de Juxtlaahuaca, Guerrero; *Poecilophysis pratensis* (C. L. Koch) from Gruta de Aguachil, Guerrero; *Poecilophysis (Dentocheles) weyerensis* (Packard), a widespread species in the United States with one population in Sótano de la Tinaja, San Luis Potosí, where it was found on damp leaves and humus carried by flood water which covers mud slopes 100 to 400 m from the entrance; *Rhagidia trisetata* Elliott & Strandtman, a poorly known species represented only by a female from El Sótano de la Tinaja, San Luis Potosí; *Robustocheles hilli* (Strandtmann) from Gruta de Aguacachil, Guerrero; and *Robustocheles mucronata* (Willmann) from Grutas de Xtacumbilxunam, Campeche, and Gruta de Aguacachil, Guerrero.

Undetermined species of *Coccorhagidia* and *Rhagidia* have been reported from Actún Chen, Quintana Roo (PALACIOS-VARGAS *et al.*, 1998).

Family Scutacaridae

Imparipes (Imparipes) tocatlphilus Ebermann & Palacios-Vargas, ranges widely in neotropical soil (Brazil) and is known from Grutas de Acuitlapán and Grutas de Juxtlaahuaca, México. In Grutas de Acuitlapán it was phoretic on the ricinuleid *Pseudocellus boneti* (EBERMANN & PALACIOS-VARGAS, 1988).

Family Leeuwenhoekiiidae

Two species of *Hannemania* have been recorded from anurans in México caves: *H. hylae* (Ewing) from *Eleutherodactylus longipes* in Cueva de los Riscos, Querétaro, and *H. monticola* Welbourn & Loomis from Anura in Cueva de Potrerillos, San Luis Potosí (ESPINO DEL CASTILLO *et al.*, 2011).

Three species are parasitic on bats: *Tarsalacarus bakeri* (Hoffmann) from Gruta de la Estrella, México; *Whartonia* (*Asolentria*) *glenni* Brennan from a cave in Morelos, one mine in Sonora, and a tunnel in Tlaxcala; *W. (A.) guerrensis* (Hoffmann) from Grutas de Cacahuamilpa, Guerrero; and *W. (Whartonia) nudosetosa* (Wharton) from Yucatán.

Family Myobiidae

Six species of this family have been found on bats in Mexican caves and two from a tunnel (VOMERO, 1972; PALACIOS-VARGAS & MORALES-MALACARA, 1983; MORALES-MALACARA, 1994, *et al.*, 2002; GUZMÁN-CORNEJO *et al.*, 2003a, 2004): *Acanthopthirus* (*A.*) *lopezi* Morales-Malacara from an abandoned tunnel in Tlaxcala; *Dusbabekia choeronycteris* Guzmán-Cornejo, Morales-Malacara, & López-Ortega in Cueva de las Cochinas, San Luis Potosí; *Eudusbabeka arganoi* (Vomero) from Morelos and San Luis Potosí; *M. provirilia* Morales-Malacara *et al.* from Cueva del Diablo, Morelos; *Ewingana* (*Doreyana*) *inaequalis* (Ewing) and *E. (Mormoobia) longa* (Ewing) from Cueva de la Boca, Nuevo León; *Pteracarus elegans* Dusbábek & Wilson from El Tunel, Tlaxcala; and *Ugandobia* sp. from Cueva 8 de Julio, Morelos.

Family Neotrombidiidae

Ceuthothrombium cavaticum Robaux, Webb, & Campbell was taken from Rhabdiphoridae in Cueva de Ojo de Agua, Nuevo León (ROBAUX *et al.*, 1977).

Family Trombiculidae

Trombiculid mites are parasitic on vertebrates in the larval stage but free-living as adults (HOFFMANN, 1949, 1960, 1990).

The following species are parasites of bats: *Crypticula merrihewi* (Loomis & Lipovsky) from caves in Baja California Sur and Chiapas and mines in Sonora; *Eutrombicula acuitlapanensis* Hoffmann from bat guano in Grutas de Acuitlapán, Guerrero; *Hoffmanniella beltrani* (Hoffmann) from Grutas de Quintero, Tamaulipas; *Hooperella alvarezi* (Loomis) from Grutas de Balankanché, Yucatán; *H. vesperuginis* (Brennan & Jones) from bats in caves in Guerrero and Morelos; *Leptotrombidium mexicana* (Ewing) from Cueva de la Boca, Nuevo León; *Loomisia desmodus* (Brennan & Dalmat) and *Perissopalla lipoglana* Loomis from Grutas de Balankanché, Yucatán; *Microtrombicula boneti* (Hoffmann) from Guerrero, Morelos, and Tamaulipas; *Nycterinastes secundus* Brennan & Reed from Cueva del Diablo, Morelos; *Perates anophthalma* (Hoffmann) from México and Yucatán; *Speleocola davisii* Webb & Loomis and *S. tadaridae* Lipovsky from mines in Sonora; and *Tecomatlana sandovali* Hoffmann in Morelos and Puebla.

Two species reported by WHARTON (1938) from Yucatán, *Trombicula camilla* Wharton and *T. myops* (Vitzhun) cannot be placed in a current genus.

Family Trombidiidae (Fig. 26B).

The larvae of this family are parasitic on arthropods and the adults free-living. Two species are known from Mexican caves (WHARTON, 1938). *Monunguis streblida* Wharton from streblid flies in Yucatán; and *Platyseta yucatanicus* Wharton from Yucatán.

Family Smarididae

Fessonnia sp. was taken from cave swallow guano in Cueva del Salitre, Chihuahua. Larvae are parasitic on insects, adults are predaceous.

Order Cryptostigmata (Oribatei) (Fig. 26C)**Family Cosmochthoniidae**

Cosmochthonius desaussurei Mahunka was described from Sima del Borrego, Guerrero.

Family Sphaerochthoniidae

Sphaerochthonius sp. has been taken from guano, soil and litter in Cueva Oxtotitlán, Guerrero; and from guano in Cueva del Rancho Sambulá, Yucatán.

Family Euphthiracaridae

Rhysotritia sp. is known from Grutas de Nevada, Nuevo León, and *R. ardua* (C. L. Koch) from Grutas de Aguacachil and Grutas de Juxtlahuaca, Guerrero.

Family Lohmanniidae

Javacarus (*Euryacarus*) *pilosus* (Mahunka) was found in litter in Cueva de las Sardinias, Tabasco.

Family Malaconothridae

At least three species of *Malaconothrus* have been found in Mexican caves: *Malaconothrus* sp. is known from Grutas de Juxtlahuaca, Guerrero; and *Malaconothrus* sp., *M. (Christonothrus)* sp. ca. *granulosus*; *M. (C.) peruensis* Hammer; and *M. (M.)* sp. ca. *angulatus* Hammer from Cueva de las Sardinias, Tabasco (PALACIOS-VARGAS *et al.* 2011). *Malaconothrus calcehtokensis* Palacios-Vargas & Iglesias (Fig. 25), was taken from guano of hematophagous bats in Actún Xpukil (= Gruta de Calcehtok), Yucatán (PALACIOS-VARGAS & IGLESIAS, 1997).

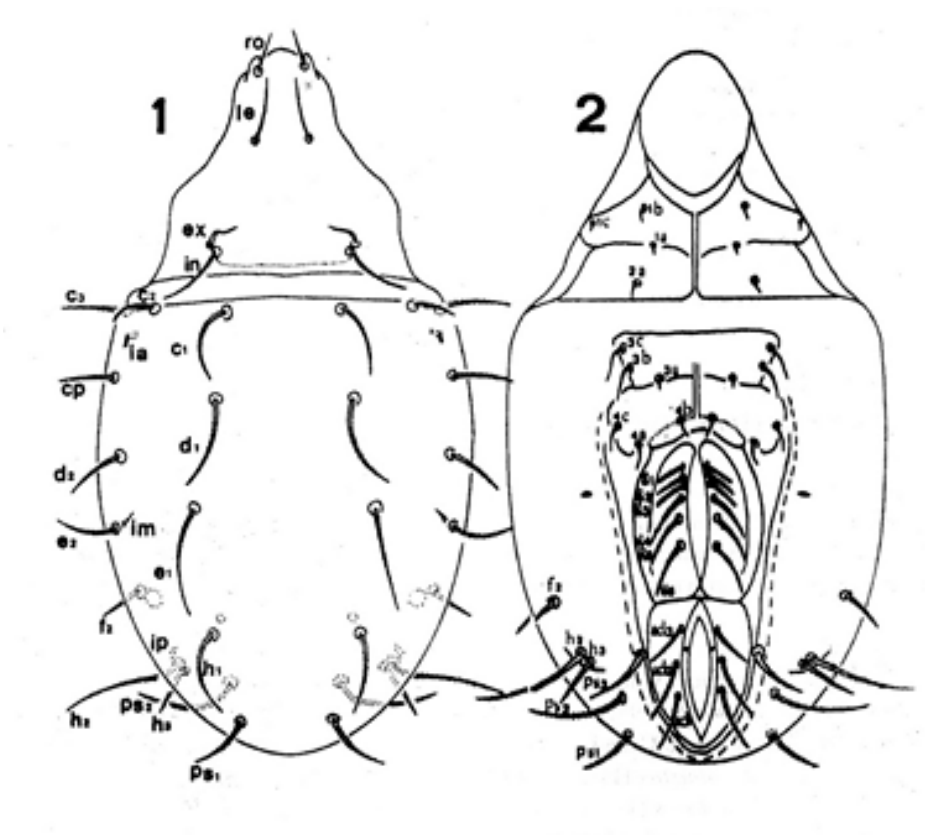


Fig. 25 - *Malacothrus calcehtokensis* Palacios-Vargas & Iglesias, 1997 Actún Xpukil, Yucatán.

Family Damaeidae

Epidamaeus palaciosi Iglesias & Guzmán was described from Resumidero de Zacatecolotla, Guerrero (IGLESIAS & GUZMÁN, 2012).

Family Microzetidae

Acaroceras hamifer Balogh and Mahunka is a troglophile living on detritus from *Atta* ants in Actún Xmahit, Yucatán, and on guano in Grutas de Xtacumbilxunam, Campeche, where several hundred individuals were collected (MAHUNKA & PALACIOS-VARGAS, 1996).

Family Basilobelbidae

Basilobelba insularis Mahunka was found in guano in Cueva del Rancho, Sambulá, Yucatán.

Family Carabodidae

Cubabodes sp. ca. *radiatus* Balogh & Mahunka was found in litter in Cueva de las Sardinias, Tabasco.

Family Oppiidae

This family is frequently found in detritus and soil in Mexican caves, with eight genera represented.

Aeroppia nasalis Mahunka was taken from litter in Cueva de las Sardinias, Tabasco (ESTRADA & IGLESIAS, 2003).

Ameroppia sp. was found in Gruta de Aguacachil, Guerrero, and *A. similis* Covarrubias in litter in Cueva de las Sardinias, Tabasco.

Intermedioppia sp. ca. *alvarezi* (Pérez-Iñigo) was collected in litter, in soil under chemoautotrophic bacteria in Cueva de las Sardinias, Tabasco, and in surface soil.

Oppia sp. was found in caves in Guerrero, Morelos, and Querétaro;

Oxyoppia sp. was found in several caves in Yucatán. ? *Oxyoppia genavensium* Mahunka was described from Cueva del Borrego, Guerrero.

Ramusella sp. was taken from guano and soil in Cueva de Oxtotitlán, Guerrero.

Similoppia (Reductoppia) sp. was found in bat guano in Cueva de las Sardinias, Tabasco.

Taiwanoppia (Vietoppia) sp. was found in litter in Cueva de las Sardinias, Tabasco.

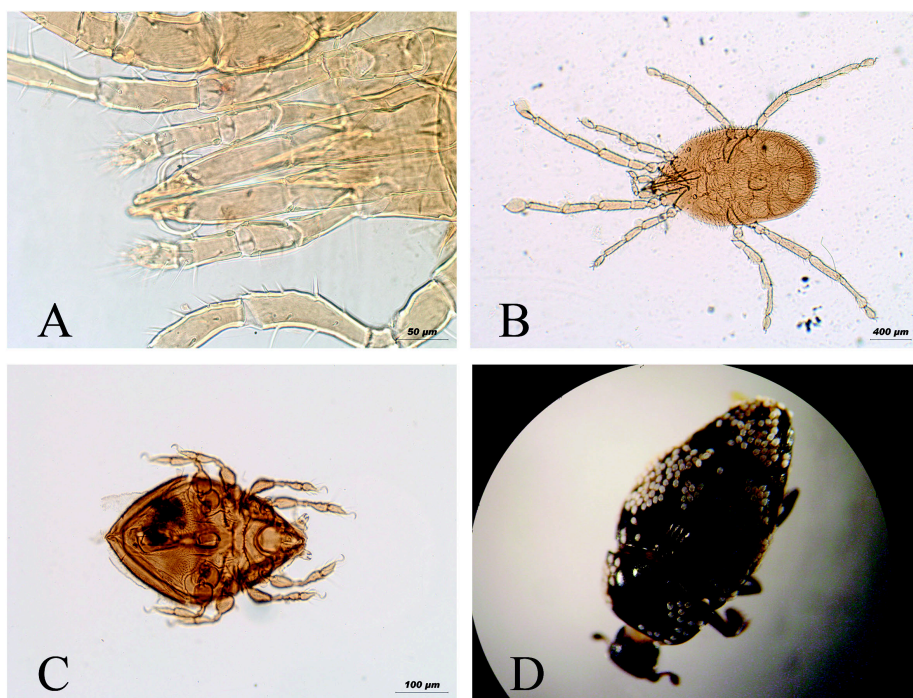


Fig. 26 – Frequent mites in Mexican caves: A, Order Mesostigmata (Gamasida); B, Order PROSTIGMATA (Trombidiformes); C, Order Cryptostigmata (Oribatei); D, Order Astigmata (phoretic on beetles) (pics Ana Isabel Bieler).

Family Haplozetidae

Trachyoribates (Rostrozetes) foveolatus (Sellnick) was abundant in litter and bat guano in Cueva de las Sardinas, Tabasco. *Tuxenia* sp. and *Xylobates* sp. have been found in caves in Yucatán.

Family Scheloribatidae

At least three species of this family have been recorded from Mexican caves: *Monoscheloribates* sp. in Cueva del Ídolo, Morelos; *Scheloribates* sp. in caves in Guerrero, Morelos, and Cueva de las Sardinas, Tabasco; *S. elegans* Hammer from Cueva de las Sardinas, Tabasco; and *S. luchili* Wharton, described from Cueva Luchil, Yucatán.

Family Oribatellidae

Undetermined specimens of this family are frequent in caves in Guerrero and San Luis Potosí.

Lamellobates sp. was found in Cueva del Ídolo, Morelos.

Oribatella monospicus Wharton was described from Cenote de Sambulá, Yucatán.

Family Galumnidae

At least two species of *Galumna* have been found in Mexican caves: *G. hamifer* Mahunka from Cueva de las Sardinas, Tabasco; and *G. jacoti* Wharton, described from Cenote de Sambulá, Mérida, Yucatán.

Pergalumna sp. is known from Gruta de Aguacachil, Guerrero.

Order Astigmata (Fig. 26D)

Family Acaridae

Species of this family feed on decaying insects, or are fungivorous. Many hypopi (detonyphs) are phoretic on different arthropods. More than twelve species are known from caves.

Acarus sp. is known from Cueva de la Hoya, San Luis Potosí.

Acotyledon sp. is known from two caves in Yucatán.

The genus *Caloglyphus* includes three species from Mexican caves: *C. armipes longisetosus* Nesbitt from Cueva de la Calera, Michoacán; *C. longipilus* Nesbitt from Grutas de Juxtlahuaca, Guerrero, and Cueva de Carrizal, Nuevo León; and *C. paranomalus* Nesbitt from Michoacán, Nuevo León, and Veracruz.

Lacherbaueria sp. is known from Cueva del Rancho Sambulá, Yucatán.

Rhizoglyphus sp. ca. *callae* Oudemans and *R.* sp. ca. *robini* Claparède were taken from litter and bat guano in Cueva de las Sardinas, Tabasco.

Sancassania sp. is known from caves in Guerrero, Morelos, and Nuevo León; *Sancassania* sp. ca. *mycophaga* (Mégnin) is abundant in litter, bat guano, and soil under chemoautotrophic bacteria in Cueva de las Sardinias, Tabasco, and in surface soil. *Sancassania* sp. ca. *sphaerogaster* (Zachvatkin) was the most abundant arthropod in bat guano in Cueva de la Boca, Nuevo Leon where it appears to feed on *Histoplasma capsulatum* (ESTRADA-BARCENAS *et al.*, 2010)

Schwiebea sp. has been taken from litter, bat guano, and soil under chemoautotrophic bacteria in Cueva de las Sardinias, Tabasco, and in surface soil.

Suidassia sp. is known from two caves in Yucatán.

Thyreophagus sp. has been taken from Cueva Siete Aguas, Yucatán.

Undetermined species of *Tyreophagus* have been taken in Morelos and from guano in Cueva de Oxtotitlán, Guerrero. *Tyreophagus* sp. ca. *neiswanderi* Johnston & Bruce and *T.* sp. ca. *similis* Volgin were taken from Cueva de las Sardinias, Tabasco.

Family Chirodiscidae

Six species of these bat parasites have been found in caves: *Alabidocarpus furmani* Pinichpongse and *Paralabidocarpus* n. sp. from Gruta de Aguacachil, Guerrero; *Dentocarpus macrotrichus* Dusbabek & Cruz and *Olabidocarpus nyctinomys* Fain from Cueva de la Boca, Nuevo León; and *Lawrenceocarpus* n. sp. and *L. planirostris* Fain from Grutas de Juxtahuaca, Guerrero.

Family Chirorhynchobiidae

This family of mites contains species parasitic on bats in Panamá, Venezuela, and México.

Chirorhynchobia matsoni Yunker with a large egg in the abdomen was found on *Anoura geoffroyi lasiopyga* in Cueva de San Juan Tepoztlán, Morelos (PALACIOS-VARGAS, 1980b).

Olabidocarpus nyctinomus Fain has been taken from Cueva de la Boca, Nuevo León (GUZMÁN-CORNEJO *et al.*, 2003a).

Family Rosensteiniidae

Nycteriglyphus sp. was taken in litter and bat guano in Cueva de las Sardinias, Tabasco; and *N. bifolium* Strandtmann from Cueva de la Boca, Nuevo León (GUZMÁN-CORNEJO *et al.*, 2003).

Undetermined species of *Nycteriglyphus* were found on bat guano from caves in Morelos, San Luis Potosí, and Tamaulipas.

Family Sarcoptidae

Two species of *Notoedres* have been recorded as bat parasites in Mexican caves: *N. (Bakeracarus) lasionycteris* (Boyd & Bernstein) from Cueva de la Boca, Nuevo León, and *N. (Notoedres) myotis* (Hedeén) from Cueva del Salitre, Morelos.

Family Histiotomatidae

At least seven species of *Histiotoma* are known from Mexican caves: Seven species were found in Cueva de las Sardinias, Tabasco: *Histiotoma* sp. 1 collected in great numbers in litter, bat guano, and soil under chemoautotrophic bacteria, and in surface soil; *H.* spp. 2-4 from litter; *H.* sp. ca. *bakeri* Hughes & Jackson in litter; *H.* sp. ca. *pilosea* Hughes & Jackson from bat guano; and *H.* sp. ca. *sextoni* Hughes & Jackson in litter. *Histiotoma* sp. was found in Campeche and Yucatán.

Family Glycyphagidae

Glycyphagus domesticus (De Geer) was found in Grutas de Cacahuamilpa, Guerrero (HOFFMANN *et al.*, 1974).

Family Guanolichidae

Neoguanolichus sp. was collected in litter, and in great numbers in bat guano and in soil under chemoautotrophic bacteria in Cueva de las Sardinias, Tabasco.

CLASS CHILOPODA

The centipede fauna of Mexican caves is very poorly known and includes less than one hundred species.

Order Scutigermorpha

Family Psellioididae

Pselliodes guildingii (Newport) is a troglophile in Cueva de Los Sabinos, Sierra de El Abra, San Luis Potosí (CHAMBERLIN, 1942).

Family Scutigerae

Scutigera includes two or three species of troglophile from México (HERRERA, 1891; CHAMBERLIN, 1942): *S. cacahuamilpensis* Herrera from Grutas de Cacahuamilpa, Guerrero, may be a synonym of *S. linceci* (Wood); *S. carrizala* from Grutas de Carrizal, Nuevo León; and *S. linceci* (Wood) from caves in Guerrero and Veracruz. Specimens of *Scutigera* are very common in many caves in México but they have not been studied.

Order Lithobiomorpha

Family Lithobiidae

Two species are troglobitic in México (CHAMBERLIN, 1941, 1942): *Garcibius osorioi* Chamberlin, with rudimentary ocelli and pale body, from Grutas de Villa de García, Nuevo León; and *Nuevobius cavicolens* Chamberlin, pale species with long, slender legs and antennae, from Cueva de la Boca, Nuevo León.

Family Watoibiidae

Cruzobius atoyacus Chamberlin is a troglophile in Grutas de Atoyac, Veracruz (CHAMBERLIN, 1942).

Order Scolopendromorpha**Family Scolopendridae**

Scolopendra sumichrasti Saussure is a large species found in caves (sometimes in darkness) in San Luis Potosí, Tamaulipas, and Yucatán.

Family Scolopocryptopidae

Five species of *Newportia* have been found in Mexican caves (CHAGAS & SHELLEY, 2003): *N. troglobia* Chagas & Shelley, a troglobite with extremely long appendages from caves in the Purificación region of Tamaulipas; *N. pelaezi* Chamberlin, a probable troglobite known only from a juvenile from Grutas del Palmito, Nuevo León.

Three species of *Newportia* are troglaphiles: *N. atoyaca* Chamberlin from caves in Tamaulipas and Veracruz but is also abundant on the surface; *N. morela* Chamberlin, an epigeal species that is apparently a troglaphile in caves in the Sierra de Guatemala, Tamaulipas; and *N. sabina* Chamberlin, known only from two caves in the Sierra de El Abra, San Luis Potosí.

Order Geophilomorpha**Family Geophilidae**

Pachymerium ferrugineum (C.L. Koch) is a probable troglaphile in two caves in Veracruz.

CLASS DIPLOPODA

Although 46 troglobites and about 90 troglaphiles are reported, every cave with moisture can be expected to contain at least one and usually several species. The fauna has been extensively studied by CHAMBERLIN (1938a, 1942); CAUSEY (1963, 1964a, 1964b, 1969, 1971a, 1971b, 1973, 1975, 1977); and SHEAR (1972, 1974, 1977a, 1980, 1982, 1986), but the fauna remains poorly known with many species awaiting description

Order Glomeridesmida**Family Glomeridesmidae**

Glomeridesmus sbordonii Shear is a troglobite taken in large numbers from rotten wood near the end of Grutas de Coconá, Tabasco, and tentatively identified from Cueva de la Golondrina, Chiapas.

Order Glomerida**Family Glomeridae**

Six troglaphitic species of *Glomeroides* were found in Mexican caves: *G. additius* Causey, eyeless species found on mud in Cueva Ungurria, Veracruz; *G. caecus* Causey, eyeless species found in three caves in the Xilitla region, San Luis Potosí; *G. grubbsi* Shear, eyeless species from caves in the Cuetzalan region, Puebla; *G. patei* Shear, pale with reduced ocelli, from caves in the Purificación region, Nuevo León and Tamaulipas; *G. pellucidus* Shear, with cuticular remnants of ocelli, from Cueva del Ojo de Agua Grande, Veracruz; *G. promiscus* Causey, with a few ocelli, from caves in the Sierra de Guatemala, Tamaulipas. The troglaphitic species of *Glomeroides* form a series of increasing adaptation to the cave habitat running through *G. promiscus* and *G. pellucidus* to *G. caecus* and *G. grubbsi*.

Troglaphiles are: *Glomeroides comitan* Shear from Cueva de las Florecillas, Chiapas; and *G. sabinus* Shear from Cueva del Sabin, Chiapas. *G. chiapensis* Shear, *G. cooki* Shear, and *G. pecki* Shear, epigeal species, have been erroneously listed as troglobites.

Order Spirobolida**Family Rhinocricidae**

Two species were described from caves in Yucatán, but they are probably accidentals: *Anadenobolus motulensis* (Chamberlin) from Cenote de Sambulá, Motul; and *Yucatabolus spukilensis* Chamberlin from Actún Xpukil.

Family Typhlobolellidae

Reddellobus troglobius Causey is eyeless, with reduced pigmentation, slender body, and attenuate appendages. It was collected on organic debris and bat guano in several caves in the Cuetzalan region of Puebla.

Order Spirostrepsida**Family Cambalidae**

The family is represented in México only by troglaphitic species.

Cambala speobia (Chamberlin), an abundant species in the caves of Texas, U.S.A., has been found in Cueva de los Lagos, Coahuila, México. The cave is now under the waters of the Amistad Reservoir.

The genus *Mexicambala* is composed of three troglaphitic species: *M. fishi* Causey from caves in the Huautla area, Oaxaca; *M. inopis* Causey from caves in the Sierra de Guatemala, Tamaulipas; and *M. russelli* Causey from caves in the Xilitla region, San Luis Potosí, and Purificación region, Tamaulipas.

Family Spirostreptidae

Orthoporus is the only genus of this order known from caves in México. It is represented by two troglobites from Yucatán: *O. spelaeus* Causey, with unpigmented ocelli and body, from Cenote de Catzín; and *O. zizicolens* (Chamberlin), with unpigmented ocelli, weakly sclerotized body wall, and elongated appendages, found on mud and guano slopes in several caves.

Four species are possible troglaphiles: *Orthoporus fraternus* (Saussure) from Chiapas; *O. guerreronus* (Chamberlin), described from Grutas de Juxtaluaca, Guerrero; *O. mimus* Chamberlin from caves in the Sierra de El Abra, San Luis Potosí and Tamaulipas; and *O. solicolens* Chamberlin, abundant in caves in Campeche and Yucatán

Order Siphonophorida

Family Siphonophoridae

Yukatanium sabachana (Chamberlin) was described from Actún Sabacá, Yucatán. Undetermined specimens of Siphonophoridae have been taken in other Yucatán caves.

Order Chordeumatida

Family Cleidogonidae

Six species of *Cleidogona* are considered as probable troglobites: *C. arco* Shear, with unpigmented body and ocelli, from Sótano del Arco, Zongolica, Veracruz; *C. baroqua* Shear, unpigmented with reduced ocelli, from caves in the Huautla de Jiménez region, Oaxaca; *C. crucis* (Chamberlin), unpigmented and ocelli reduced to 10, known only from three caves near Córdoba, Veracruz; *C. felipiana* Shear, unpigmented and fewer ocelli, from Cueva del Rayo de San Felipe, Chiapas; *C. hunapu* Shear, unpigmented with reduced ocelli, from Cueva del Burro, Chiapas; and *C. pecki* Shear, unpigmented with ocelli reduced to 16-20, from three caves in the Sierra de Guatemala, Tamaulipas. *C. chac* Shear and *C. revilla* Shear, epigeal species, have been erroneously listed as troglobites.

The troglaphiles are: *Cleidogona chiapas* Shear from Cueva de la Cañada no. 2, Chiapas; *C. coatlicue* Shear from Pozo del Arrecife, Purificación region, Tamaulipas; *C. crystallina* Shear from caves in the Sierra de Guatemala, Tamaulipas; *C. jamesoni* Shear from Cueva del Volcancillo, a lava tube on Cofre de Perote, Veracruz; *C. mayapec* Shear from Cueva del Judío, Querétaro; *C. pochteca* Shear from Sótano de la Torre, Purificación region, Tamaulipas; *C. totonaca* Shear from caves in Querétaro and Tamaulipas; *C. treaceyae* Shear from Cueva de los Viet Cong, Xilitla region, San Luis Potosí; and *C. yerbabuena* Shear from caves in the Purificación region, Nuevo León and Tamaulipas.

Family Trichopetalidae

This family is represented in México only by troglobites in the genus *Mexiterpes*: *M. calenturas* Shear from caves in the Purificación region, Tamaulipas; *M. egeo* (Causey), with reduced eyes, from caves in the San Francisco region, San Luis Potosí; *M. fishi* (Causey), number of ocelli reduced, from caves in the Aquismón region, San Luis Potosí; *M. metallicus* Shear, with only four ocelli, from caves in the Pinal de Amoles region, Querétaro; *M. nogal* Shear from Sótano de Nogal, Querétaro; *M. sabinus* Causey, the most highly evolved troglobite in the genus, from four caves in the Sierra de El Abra, San Luis Potosí; and *M. sangregorio* Shear from two caves in Guerrero.

Order Polydesmida

Family Bonetesmidae

The family reaches its northern limit in Veracruz where they are represented by three troglobitic species: *Bonetesmus ojo* Shear, transparent body, from Cueva del Ojo de Agua de Tlilapan, Veracruz; *B. soileauae* Shear from two caves near Acatlán, Oaxaca; and *B. verus* Chamberlin from five caves near Córdoba, Veracruz.

Family Chelodesmidae

Chondrodesmus sabachanus Chamberlin is a troglaphile in the caves of Yucatán.

Family Fuhrmannodesmidae

This family includes 11 species of small, delicate troglobites in México: undescribed species are known from Campeche and Yucatán.

Caramba contains three troglobitic species: *C. delburro* Shear from Cueva del Burro, Chiapas; *C. embecausius* Shear from caves in Oaxaca, Puebla, and Veracruz; and *C. grandeza* Shear from Grutas de Llano Grande, Chiapas.

Pozodesmus poco Shear, the only species in the genus, is a troglobite known only from Sótano de Tres Pozos, Hidalgo.

Salvadoria mexicana Shear is a troglobite known only from Sótano de Cancuc, Chiapas. Other species of the genus are epigeal in El Salvador and Belize.

Sumidero contains three troglobitic species: *S. pecki* (Shear) from caves in the Sierra de El Abra, Tamaulipas; *S. sprousei* Shear from Sótano de La Silleta, Xilitla region, San Luis Potosí; and *S. sumidero* Shear from Sumidero de Coahuatichan, Cuetzalan region, Puebla.

Tylogoneus contains four troglobites: *T. delnegro* (Shear) from Cueva del Negro, Chiapas; *T. minus* Causey from Cueva del Ojo de Agua Manantiales, Sierra de Guatemala, Tamaulipas; *T. oyamel* Shear from Sistema Purificación, Tamaulipas; and *T. rainsi* Causey from Cueva de San José, Hidalgo, and Cueva del Ahuate no. 2, Xilitla region, San Luis Potosí.

Family Haplodesmidae

Prosopodesmus jacobsoni Silvestri is a tropicopolitan species found in caves in Campeche and Yucatán.

Family Paradoxomatidae

Two introduced species are troglaphiles in México: *Orthomorpha coarctata* (Saussure) from caves in Oaxaca and Yucatán; and *Oxidus gracilis* (Koch) from caves in Guerrero, Hidalgo, México, Nuevo León, Puebla, Querétaro, San Luis Potosí, and Veracruz. These species are usually found in caves in or near towns and may be present in very large numbers.

Family Platyrhacidae

The only Mexican troglobite is *Polylepiscus vomeroi* Shear, unpigmented and weakly sclerotized, from Gruta II Finca Santa Anita, Chiapas.

Undetermined species of *Amplinus* are possible troglaphiles in Chiapas, Oaxaca, San Luis Potosí, and Veracruz.

Family Pyrgodesmidae

Five genera of this family have been found in Mexican caves. Some unpigmented species may be troglobitic, but it is not possible without further study to determine their ecological status. It is presumed that all are troglaphiles.

Caymmodesmus includes five species from Yucatán: *C. alienus* (Chamberlin) and *C. hoctunanus* Causey from Cenote de Hoctun; *C. isidricus* (Chamberlin) from Cueva de San Isidro; *C. muruztunicus* (Chamberlin) from Cueva Muruztun; and *C. viabilis* (Chamberlin) from five caves.

Cryptyma cocona Shear is known only from Grutas de Coconá. One other species occurs in caves in Guatemala.

Lophodesmus is known by four Mexican cave species: *L. italolegatus* Shear from three caves in Chiapas and four in Yucatán; *L. rodriguezii* Shear from Hoyo de Don Nicho, Chiapas, *L. tioticho* Shear from two caves in Chiapas; and *L. zullinii* Shear from Grutas del Rancho Grande, Chiapas.

Myrmecodesmus contains 16 cavernicolous species in México: *M. aconus* Shear from caves in Guerrero and State of México; *M. amarus* (Causey) from Sótano de Tlamaya, Xilitla region, San Luis Potosí; *M. amplus* (Causey) from caves in the Valle Nacional region, Oaxaca; *M. clarus* (Chamberlin) from caves near Córdoba, Veracruz; *M. colotlipa* (Chamberlin) from Grutas de Juxtlahuaca, Guerrero; *M. cornutus* (Shear) from Cueva del Nacimiento del Río Frío, Sierra de Guatemala, Tamaulipas; *M. egenus* (Causey) from two caves at high elevations in the Sierra de Guatemala, Tamaulipas; *M. errabundus* (Shear) from one cave each in the Sierra de El Abra and Sierra de Guatemala, Tamaulipas; *M. fissus* (Causey) from Sumidero del Camino, Chiapas; *M. fuscus* (Causey) from caves in the Atoyac region, Veracruz; *M. gelidus* (Causey) from low elevation caves in the Sierra de Guatemala, Tamaulipas; *M. ilymoides* (Shear) from Grutas de San Bartolo, Nuevo Leon; *M. inornatus* Shear from Grutas de Llano Grande, Chiapas; *M. monasticus* (Causey) from Cueva de Llanura, Micos region, San Luis Potosí; *M. potosinus* (Shear) from Cueva de la Porra, Xilitla region, San Luis Potosí; and *M. sabinus* (Chamberlin) from caves in the Sierra de El Abra, San Luis Potosí.

The genus *Psochodesmus* includes undetermined material from Grutas de Xtacumbilxunam, Campeche, and Grutas de Coconá, Tabasco.

Family Rhacodesmidae

This is among the more important elements of the Mexican cave fauna with 10 genera represented by troglobites and troglaphiles. The taxonomy of the family is poorly understood. Many species remain undescribed.

Three species of *Aceratophallus* are known from caves in Yucatán: *A. calcehtokanus* Chamberlin, a pale yellow species from caves in the northwestern Sierra de Ticul; *A. hoctunanus* Chamberlin, a unpigmented probable troglobite from Cenote de Hoctun; and *A. oxkutzcabus* Chamberlin, a bright orange species from three caves in the southeastern Sierra de Ticul. *Aceratophallus scutigeroides* is a troglobite described from caves in Guatemala and tentatively identified from Cueva del Sumidero de San Juan del Arco, Chiapas.

Acutangulus alius Causey is a troglobite found on silt and breakdown along the edges of a bat room in Cueva del Ojo de Agua de Tlilapan, Veracruz.

Ceuthauxus contains two troglobitic species: *C. constans* Causey, found in large numbers on silt banks in Grutas de El Mogote, Guerrero and maybe other caves as Juxtlahuaca (Fig. 27); and *C. palmitonus* Chamberlin, apparently a relict species now restricted to Grutas del Palmito, Nuevo León, by the surrounding desert.

Mexidesmus harrisoni (Causey) is a slightly adapted troglobite from caves in the Sierra de Guatemala, Tamaulipas.

Neoleptodesmus sp. is a troglaphile or troglobite in caves of the Cuetzalan region, Puebla.

Pararhachistes amblyus Chamberlin is a troglobite from Grutas de Juxtlahuaca, Guerrero.

Rhachodesmus digitatus Causey is a troglaphile in caves of the Huautla de Jiménez region, Oaxaca.

Strongylodesmus conspicuus Causey is a blue species frequently found in caves of the Sierra de El Abra and Xilitla region, San Luis Potosí. Undescribed species of the genus are possible troglaphiles in Querétaro and the Purificación region.

Tiphallus frivolus Causey is known only from Cuevacita de Nopales, San Luis Potosí but is probably an accidental.

Unculabes contains four troglobitic species: *U. arganoi* Shear from Cueva del Madroño, Querétaro; *U. causeyae* Shear from two caves in the Sierra de Guatemala, Tamaulipas; *U. crispus* Causey, a very delicate species present in vast numbers in Sótano de Huitzmolotitla, from caves in the Xilitla, Ahuacatlán and Aquismón regions, Querétaro and San Luis Potosí; and *U. porrensis* Shear from Cueva de la Porra, San Luis Potosí.

Unculabes columbinus Causey is a troglaphile known only from caves in the Aquismón and Xilitla regions, San Luis Potosí.

Family Sphaeriodesmidae

Cylionus kauanus Chamberlin is a probable troglaphile from Actún Kaua, Yucatán; it was erroneously listed as a troglobite by NICHOLAS (1962)

Sphaeriodesmus includes fourteen species from caves in México; some with translucent cuticles may be troglobitic but further study is needed to determine the ecological status of all cavernicolous species in the genus: *S. cotzalostoc* Shear and *S. robertsoni* Shear from Sumidero de Cotzalostoc, Zongolica, Veracruz; *S. cruzbelem* Shear from caves in Chiapas; *S. golondrinensis* Shear from Cueva de la Golondrina, Chiapas; *S. grubbsi* Shear and *S. iglesia* Shear from Sótano del Río Iglesia, Huautla de Jiménez region, Oaxaca; *S. neglectus* Carl, an epigeal form found in Centipede Cave, Huautla de Jiménez region, Oaxaca; *S. nortoni* Shear from Cueva Chica de la Perra, Sierra de Guatemala, Tamaulipas; *S. redondo* Shear from Cueva de Puente, Chiapas; *S. sanjose* Shear from Cueva de San José, Hidalgo; *S. sprousei* Shear from caves in the Purificación region, Tamaulipas; *S. tortus* Shear from Actún Loltún, Yucatán; *S. trullatus* Shear from Grutas de Llano Grande, Chiapas; and *S. zontehuitz* Shear from Cueva de Arcotete, Chiapas.

Family Xystodesmidae

Many undetermined species of *Rhysodesmus* have been found in caves in México but most are probably accidentals.



Fig. 27- Polydesmidae: Rhacodesmidae: *Ceuthauxus canstans* Causey from Grutas de Juxtlahuaca.

CLASS SYMPHYLA

No symphylans are troglobitic in México. The few species recorded from caves are probably endogean (SCHELLER, 1986).

Family Scutigereidae

Two species of *Hanseniella* are known from caves: *H. orientalis* (Hansen) from Campeche and Yucatán; and *H. appendicofera* Scheller from Cenote Hunto Chac (Cueva Mamey), Yucatán.

Scutigereella includes: *S. mexicana* Hirschberger from Cueva de los Cuarteles, Tamaulipas; *S. acicularis* Scheller from Cueva de la Mina, Tamaulipas; *S. aduncus* Scheller known only from Cueva de la Finca, Oaxaca, and Cueva de Tres Manantiales, Tamaulipas; and *S. silvestrii* Michelbacher from Sima Esteban, Puebla.

CLASS COLLEMBOLA

Collembolans are represented in every Mexican caves, and numerous troglobitic and trogliphilic species are listed. First, **F. Bonet** described several cavernicolous species in the families Oncopoduridae (1943), Hypogastruridae (1945, 1946) and Onychiuridae (1944). CHRISTIANSEN & REDDELL (1986) summarized all records up to 1986. PALACIOS-VARGAS (1981b, 1982a, 1983a, 1989, 2012), ZEPPELINI-FILHO & CASTAÑO-MENESES (1995), and CUTZ-POOL *et al.* (2007, 2009) include reviews of the fauna, with many new records, and Palacios-Vargas and his collaborators have described many new species.

Order Poduromorpha

Family Brachystomellidae

Three species of *Brachystomella* are possible trogliphiles in México (BONET, 1953a; PALACIOS-VARGAS & NAJT, 1982): *B. contorta* Denis from Morelos and Quintana Roo; *B. parvula* (Schäffer) from Colima, Querétaro, and San Luis Potosí; and *B. taxcoana* Palacios-Vargas & Najt, described from Gruta de Aguacachil, Guerrero, is also known from Hoya de las Guaguas, San Luis Potosí.

Family Hypogastruridae

The family is well-represented in Mexican caves with both troglobites or presumed troglobites and trogliphiles known (MILLS, 1938; BONET, 1945, 1946; PALACIOS-VARGAS & THIBAUD, 1985, 1997; CHRISTIANSEN & REDDELL, 1986).

Four species of *Acherontides* are known from Mexican caves: *A. atoyacensis* Bonet, eyeless and pigmentless, from Guerrero, Querétaro, Morelos and Veracruz; *A. juxtlahuacaensis* Palacios-Vargas & Gómez-Anaya from Grutas de Juxtlahuaca, Guerrero; *A. potosinus* Bonet, eyeless and pigmentless, from caves in Oaxaca, Puebla, San Luis Potosí, and Veracruz; and *A. spinus* (Christiansen & Reddell) from Cueva del Llano Grande, Oaxaca.

Acherontiella colotlipana Palacios-Vargas & Thibaud, an eyeless, white, troglobite without postantennal organ, is known only from guano in Grutas de Juxtlahuaca, Guerrero.

Acherontellina sabina Bonet has been found in caves in Colima, Nuevo León, Oaxaca, San Luis Potosí, Tamaulipas, and Veracruz. It has also been found in the fur of rodents and should probably be considered a trogliphile.

Three species of *Schafferia* are known from Mexican caves: *S. emucronata* (Absolon) from Sótano de Agua, Puebla, and from cave and epigeal habitats in Europe; *S. guerrerensis* (Bonet) from caves in Guerrero and Morelos; and *S. oaxacana* Palacios-Vargas & Thibaud, eyeless, white troglobite from Cueva de la Finca, Acatlán region, Oaxaca.

Two species of *Typhlogastrura* are known from Mexican caves: *T. veracruzana* Palacios-Vargas & Thibaud, usually eyeless but 10 % of individuals with 1+0 cornea, from Cueva del Volcancillo, a lava tube near Las Vigas, Veracruz; and *T. elzarzola* Palacios-Vargas & Thibaud from a cave in Nuevo León.

Willemia bulbosa Bonet is a probable troglophile from Cueva de los Sabinos, San Luis Potosí.

Three species of *Xenylla* are known from Mexican caves: *X. humicola* (Fabricius) from bat guano in Cueva de las Sardinias, Tabasco; *X. grisea* Axelson from San Luis Potosí; and *X. yucatanana* Mills, a troglophile in the caves of Yucatán and many others other states in México from caves and also soil and litter.

Family Neanuridae

Most species of this family are probably accidentals, but some species are troglobitic and probable trogliphiles (CASSAGNAU & PALACIOS-VARGAS, 1983; PALACIOS-VARGAS & GÓMEZ-ANAYA, 1995; PALACIOS-VARGAS et al., 1998, 2009).

Americanura nova Christiansen & Reddell is an eyeless troglobite from Sistema Purificación, Tamaulipas. Four other species of the genus are probable trogliphiles: *A. mcgregori* Cassagnau & Palacios-Vargas from Cueva de San Juan, Morelos; *A. mexicana* Cassagnau & Palacios-Vargas from Sótano del Buque, Querétaro; *A. sardiniasensis* Palacios-Vargas, Simón Benito, and Paniagua Nucamendi from Cueva de las Sardinias, Tabasco; and *A. sotanofila* Cassagnau & Palacios-Vargas from Sótano de Otates, Querétaro.

Hylaeonura nohbecana Vázquez, Cutz-Pool & Palacios-Vargas has been found in Actún Chen, Quintana Roo.

Paleonura colimana Palacios-Vargas & Gómez-Anaya, with 2+2 eyes, is probably a trogliphile from Cueva Pozo de la Escondida, Colima.

An eyeless species of *Paranura* is known only from Grutas del Mogote, Guerrero.

Pseudachorutes simplex Maynard has been found in Actún Chen, Quintana Roo, and Hoya de las Guaguas, San Luis Potosí.

Family Onychiuridae

The ecological status of most onychiurids is unknown, but some are probably trogliphiles. Five genera have been identified from Mexican caves (PALACIOS-VARGAS & DEHARVENG, 1982; PALACIOS-VARGAS, 1983b; PALACIOS-VARGAS & DIAZ, 1995).

Agraphorura acuitlapanensis (Palacios-Vargas & Deharveng) is known only from Gruta de Acuitlapán, Guerrero.

Deuterophorura sp. ca. *antheuili* (Denis) was found in Cueva del Diablo, Morelos, and *D. fimetaria* (Linnaeus) in Resumidero de Pablillo, Nuevo León.

Orthonychiurus folsomi (Schäffer) has been found in two caves in Guerrero.

One species of *Protaphorura* have been found in Mexican caves: *P. armata* (Tullberg) from two caves in Morelos.

Thallasaphorura encarpata (Denis) is known from caves in Guerrero, Querétaro, and San Luis Potosí; *T. hera* (Christiansen & Bellinger) from Chiapas and Guerrero; and *T. parvicornis* (Mills) from Guerrero, Morelos, and Veracruz.

Family Tullbergiidae

Eight species from Mexican caves of this family possibly are trogliphiles (PALACIOS-VARGAS & DÍAZ, 1995): *Tullbergia* sp. ca. *collis* (Bacon) from Grutas de Xtacumbilxunam, Campeche; *Mesaphorura foveata* Bonet from Cueva Chica, San Luis Potosí; *M. granulata* (Mills) from Gruta de Aguacachil, Guerrero; *M. hades* Christiansen & Bellinger from Gruta de Acuitlapán, Guerrero; *M. iowensis* (Mills) from Colima, Guerrero, and Nuevo León; *M. krausbaueri* (Börner) from Guerrero, Morelos, and San Luis Potosí; *M. macrochaeta* Rusek from Colima, Guerrero, San Luis Potosí, and Veracruz; and *M. yosii* (Rusek) from Colima, Guerrero, Morelos, Nuevo León, San Luis Potosí, Tabasco, and Veracruz.

Order Entomobryomorpha

Family Cyphoderidae

Cyphoderus innominatus Mills is a white, eyeless trogliphile known from caves in Campeche and Yucatán (MILLS, 1938) but also from litter and probably associated also with ants as many member of the genus. An undescribed species of *Cyphoderus* has been reported from Grutas de Juxtahuaca, Guerrero; but a revision of this genus is needed as it shows a very wide distribution in the Neotropical region.

Family Entomobryidae

Dicranorchesella fina Mari Mutt is a trogliphile known only from Cueva X, Purificación region, Tamaulipas.

Most species of *Lepidocyrtus* are probably troglonexes or accidentals, with the probable exception of *L. (Lanocyrtus) pearsei* Mills from caves in Yucatán (MILLS, 1938).

Metasinella (Sulcuncus) falcifera (Mills) is a white, eyeless troglobite from caves in Quintana Roo and Yucatán (MILLS, 1938, PALACIOS-VARGAS et al., 1998).

Two species of *Neorchesella* are probably troglobites in caves of the Purificación region, Tamaulipas (MARI MUTT, 1981): *N. boneti* Mari Mutt from Sistema Purificación; and *N. mexicana* Mari Mutt from Sótano de las Calenturas.

Pseudosinella is abundant in the caves of México, with 18 species recorded. Many species are highly troglomorphic. However several species remain undescribed (CHRISTIANSEN, 1973, 1982; CHRISTIANSEN & REDDELL, 1986, PALACIOS-VARGAS & MEJÍA RECAMIER, 2011).

Among species known only from caves, several are eyeless and unpigmented: *Pseudosinella bonita* Christiansen and *P. huautla* Christiansen from caves in the Huautla de Jiménez region, Oaxaca; *P. cava* Christiansen & Reddell from caves in Hidalgo, Querétaro, and San Luis Potosí; *P. crypta* Christiansen & Reddell from Cueva Sin Nombre, Potrero Redondo, Nuevo León; *P. leoni* Christiansen from several caves in Coahuila and Nuevo León; *P. petrustrinatii* Christiansen from Grutas de Juxtlahuaca, Guerrero, the Sierra de Guatemala, Tamaulipas, the Sierra de El Abra, San Luis Potosí and Tamaulipas, and the Sierra del Pino, Tamaulipas; *P. rochezi* Palacios-Vargas & Mejía-Recamier from a small cave close to Tepepan Zaragoza, Puebla; and *P. volca* Christiansen from caves in Veracruz.

Species with a varying number of ocelli known only from caves are: *Pseudosinella finca* Christiansen, eyeless and unpigmented or with 2-4 eyes per side and pigment; from several caves in Guatemala and in Morelos, Oaxaca, Puebla, Querétaro, San Luis Potosí, and Veracruz; *Pseudosinella palaciosi* Christiansen & Reddell, with 2+2 eyes, from Gruta de Acuitlapán, Guerrero; *P. voylesi* Christiansen, eyes 1+1 to 2+2 on diffuse patches of dark blue pigment, from caves near Cuetzalan, Puebla; and *P. yuca* Christiansen, eyes range from 2+2 to 4+4 on irregular eye patches, known only from Actún Xpukil, Yucatán.

Troglophilic *Pseudosinella* include: *P. collina* Wray on guano in Cueva Oxtotitlán, Guerrero; *P. reddelli* Christiansen, with eyes ranging from 2+2 to 4+4 per side, from one epigeal collection and caves in Coahuila, Nuevo León, Querétaro, San Luis Potosí, and Tamaulipas; *P. strinatii* Christiansen from San Luis Potosí and Tamaulipas; *P. vera* Christiansen, eyes 0-1, rarely 3, known from leaf litter and from many caves in Puebla, San Luis Potosí, Tamaulipas, and Veracruz; and *Pseudosinella violenta* (Folsom), abundant on the surface (soil and litter) and in caves of the U.S.A., in México known from soil and in caves in Coahuila, Durango, Hidalgo, Nuevo León, Michoacán, San Luis Potosí, and Tamaulipas.

Family Isotomidae

Cryptopygus contains at least two species known from caves: *C. sp.* from guano in Cueva de Oxtotitlán, Guerrero and Cueva de Puente Piedra, Veracruz; *C. sp. nr. benhami* Christiansen & Bellinger from Gruta de Acuitlapán, Guerrero.

Two species of *Folsomia* have been found in Mexican caves: *F. candida* Willem is a troglophile from caves in Guerrero, Hidalgo, Morelos, Nuevo León, Oaxaca, San Luis Potosí, and Tamaulipas; and *F. stella* Christiansen & Tucker from Gruta de Aguacachil, Guerrero.

Three species of *Folsomides* are known from Mexican caves (KOVÁČ & PALACIOS-VARGAS, 1996): *F. angularis* (Axelson) from Gruta de Aguacachil, Guerrero; *F. centralis* Denis from Guerrero, Hidalgo, San Luis Potosí, Veracruz, and Yucatán; and *F. parvulus* Stach from Guerrero, Querétaro, and San Luis Potosí, all of them are troglophiles.

Folsomina onychiurina Denis has been found in caves in Guerrero, Nuevo León, Querétaro, Quintana Roo, San Luis Potosí, Tabasco, Veracruz, and Yucatán but is very common in soils and has a very wide distribution in Mexico and other countries.

Hemisotoma thermophila (Axelson) is known from Sótano de Tilaco, Querétaro, but it is very common in soils in many states in México as Guerrero, Querétaro, Tabasco, and possibly Durango and other countries.

Isotomiella minor (Schäffer) is known from caves in Guerrero, Morelos, Querétaro, Quintana Roo, San Luis Potosí, Tabasco, Veracruz, and Yucatán as well from litter and soil.

Proisotoma includes two described species from caves in México (PALACIOS-VARGAS & ARBEA, 2009): *P. minuta* (Tullberg) from Guerrero and *P. santosorum* Palacios-Vargas & Arbea from Grutas del Palmito, Nuevo León. An undetermined species is known from Sótano de Yerbaniz, San Luis Potosí.

Family Oncopoduridae

Four troglobites *Oncopodura* have been described from Mexican caves (BONET, 1943; CHRISTIANSEN & REDDELL, 1986): *O. atoyacense* Bonet from Cueva de Atoyac, Veracruz; *O. dura* Christiansen & Reddell from Sistema Purificación, Tamaulipas; *O. prietoi* Bonet from four caves in Nuevo León; and *O. susanae* Christiansen & Reddell from caves in the Sierra de El Abra, Sierra de Guatemala, and Purificación region, Tamaulipas, but more undescribed taxa live in the north of the country.

Family Paronellidae

Dicranocentrua carpenteri (Denis), described from Guiana and also known from Costa Rica and Cueva del Guácharo, Venezuela, has been reported from Resumidero de Xocomanatlán, Guerrero.

Trogolaphysa includes ten species in Mexican caves, with varying levels of adaptation to the cave environment (MILLS, 1938; OJEDA & PALACIOS-VARGAS, 1984; PALACIOS-VARGAS *et al.*, 1985a; YOSHII, 1988).

Eyeless, unpigmented troglobites are: *Trogolaphysa marimutti* (Palacios-Vargas, Ojeda, & Christiansen) from Grutas de Atoyac, Veracruz; *T. maya* Mills from Campeche and Yucatán; *T. oztollicus* (Ojeda & Palacios-Vargas) from Grutas de Juxtlahuaca, Guerrero; and *T. xtolokensis* (Palacios-Vargas, Ojeda, & Christiansen) (Fig. 28) from Cueva del Cenote Xtolok, Yucatán.

Troglophilic known only from caves are: *Trogolaphysa nacionalica* (Palacios-Vargas, Ojeda, & Christiansen), 6+6 eyes and traces of pigment on body, from Grutas de Monteflor, Valle Nacional, Oaxaca; *T. relicta* (Palacios-Vargas, Ojeda, & Christiansen), 6+6 eyes and light grey-blue pigment on body, from Gruta de Acuitlapán, Guerrero; *T. strinatii* Yoshii from two caves in Guerrero; *T. toroi* (Palacios-Vargas, Ojeda, & Christiansen) from Cueva Encantada, Chiapas; *T. variabilis* (Palacios-Vargas, Ojeda, & Christiansen), 6+6 eyes and pigment around eyes, from Cueva de Ungurria, Veracruz; *T. yoshiia* (Palacios-Vargas, Ojeda, & Christiansen), eyes and pigment around eyes, from Cueva del Guayabo, Oaxaca.

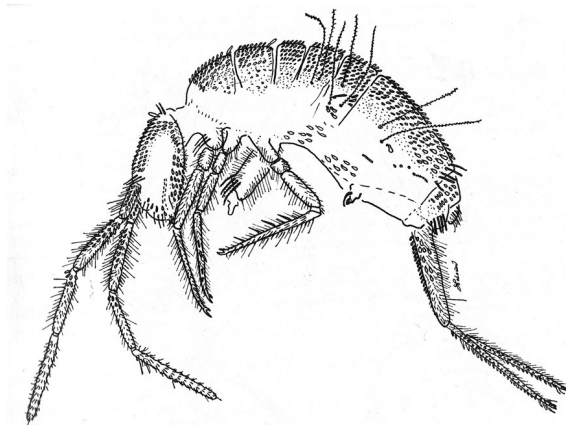


Fig. 28 – Collembola: Paronellidae: *Trogolaphysa xtolokensis* (Palacios-Vargas, Ojeda, & Christiansen, 1985), from Cueva del Cenote Xtolok, Yucatán.

Family Tomoceridae

Pogonognathellus flavescens (Tullberg) is a widespread species frequently found in cave entrance areas. It was found in caves in Nuevo León and San Luis Potosí.

Order Neelipleona

Family Neelidae

Four species of *Megalothorax* are known from caves but are probably troglophiles (PALACIOS-VARGAS & SÁNCHEZ, 1999): *M. minimus* Willem from Guerrero, Nuevo León, Tabasco, and Yucatán; *M. rapoportii* Salmon from Actún Chen, Quintana Roo; *M. spinotricosus* Palacios-Vargas & Sánchez from Grutas de Xtacumbilxunam and Actún Guachapil, Campeche; and *M. tonoius* Palacios-Vargas & Sánchez from Grutas de Acuitlapán, Guerrero.

Order Symphyleona

Family Arrhopalitidae

At least four species of *Arrhopalites* are known from Mexican caves (PALACIOS-VARGAS & ZEPPELINI, 1995): *A.* sp., troglophile, from Cueva del Sótano La Escondida, Colima, and Cueva de las Sardinas, Tabasco; *A.* sp. nr. *benitus* Folsom, troglophile, from Cueva del Tecolote, Tamaulipas; *A.* sp. cf. *pygmaeus* (Wankel), troglophile from Grutas de Acuitlapán, Guerrero; and *A. vazquezae* Palacios-Vargas & Zeppelini, with 1+1 eyes, from Cueva de la Culebra, Oaxaca. An undescribed species lives in the lava tubes (from Xitle Volcano) in México City, Distrito Federal.

Family Dicyrtomidae

Ptenothrix marmorata (Packard) was taken from litter in Cueva de las Sardinas, Tabasco but might be accidental.

Family Sminthuridae

Pararrhopalites anops Bonet & Tellez is known from Grutas del Palmito, Nuevo León (BONET & TELLEZ, 1947). *P. christianseni* (Palacios-Vargas & Zeplini) was described from caves of Actún Toh and Sambulá, Yucatán and *P. hennihi* (Palacios-Vargas & Zeplini) from Cueva Papagayo, Guerrero. Other cave species in this continent are known only from Brazil.

CLASS DIPLURA

Order Rhabdura

Family Campodeidae

Campodeids may be found in almost every moist Mexican caves, but only five species have been described (WYGODZINSKY, 1944): *Campodea chica* Wygodzinsky from Cueva Chica, San Luis Potosí; *Juxtlacampa juxtlahuacensis* Wygodzinsky from Grutas de Juxtlahuaca (Fig. 29); *Paratachycampa boneti* Wygodzinsky and *Parallocampa cavernicola* Wygodzinsky from Grutas de Villa de García, Nuevo León; and *Plusiocampa (Litocampa) atoyacensis* Wygodzinsky from Cueva de Atoyac, Veracruz. This is probably the family with more troglobite species in Mexico, six new taxa are under press by SERNA *et al.* and there are many waiting to be described.

Dicampa sp. and *Mexicampa* sp. have been recorded from Sótano del Barro, Querétaro.

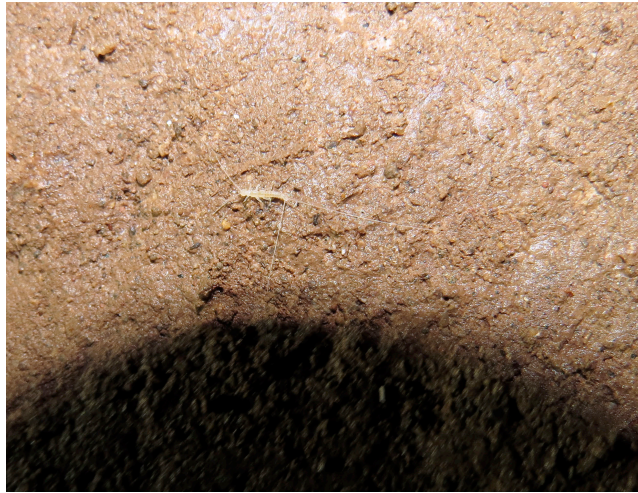


Fig. 29 - Diplura: Campodeidae: *Juxtacampa juxtlahuacaensis* wygodzinsky, 1944 from Grutas de Juxtlahuaca, Gro.

Order Dicellurata

Family Japygidae

This family is abundant in Mexican caves as troglaphiles but few specimens have been identified. *Allojapyx allodontus* (Silvestri) has been found in Sótano de la Tinaja, San Luis Potosí. Undetermined species of *Metajapyx* and *Mixojapyx* have been found in caves in the Sierra de El Abra, San Luis Potosí.

Family Parajapygidae

Parajapyx (Grassjapyx) mexicanus Silvestri is known from Cueva de Carroza, Yucatán.

CLASS INSECTA

Order Zygentoma

Family Nicoletiidae

Fourteen species of nicoletiids in three genera have been recorded from Mexican caves, but many undescribed species await study (BILIMEK, 1867; WYGODZINSKY, 1946; PACLT 1971; ESPINASA, 1991, 1999a, 1999b, 2000; ESPINASA & BURNHAM, 2004; ESPINASA & RISHMAWI, 2005; ESPINASA & FISHER, 2006; ESPINASA *et al.*, 2007; ESPINASA & VUONG, 2008a, 2008b; ESPINASA & GIRIBET, 2009).

Eleven species of *Anelpistina* have been described from Mexican caves *A. acanthocrus* Espinasa & Fisher, a troglobite from Grutas de San Sebastián, Oaxaca; *A. anophthalma* (Bilimek), a troglobite from Grutas de Cacahuamilpa, Guerrero; *A. asymmetrica* (Espinasa), a troglobite from Cueva de Gabriel, Oaxaca, TP4-13 Cave and Xaltégoxtl Cave, Puebla; *A. boneti* (Wygodzinsky), a troglaphile from Grutas de Juxtlahuaca, Guerrero, and Iglesia-Mina Superior, Morelos; *A. cuaxilotla* Espinasa, a troglaphile from Cueva Cuaxilotla, Guerrero; and Sistema Ferrocarril-Mina Inferior, Morelos; *A. inappendicata* Espinasa, a possible troglobite from Cueva de Agua Brava, Guerrero; *A. luticola* Espinasa & Vuong, a troglobite from Cueva de Yextla, Guerrero; *A. mexicana* (Espinasa) from Gruta de El Hoyito, Guerrero; *A. parkerae* (Espinasa & Rishmawi), a troglobite from Sótano Hondo del Pinalito, Hidalgo; *A. quinterensis* (Paclt), a troglobite from three caves in the Sierra de El Abra, Tamaulipas; and *A. specusprofundi* Espinasa & Vuong, a troglobite from Cueva Nita Ka and Sistema Huautla, Oaxaca.,

The genus *Squamigera* includes two troglobitic species: *S. latebricola* Espinasa from Cueva de las Pozas Azules, Guerrero; and *S. cumcalcaris* Espinasa from Gruta I Finca S. Anita, Chiapas.

A third species, *S. jaureguii* Espinasa & Burnham, is known from the surface in Veracruz.

The genus *Texoreddellia* contains six troglobitic species from Texas (U.S.A.) and México. The only Mexican species is *T. coahuila* Espinasa & Giribet from Sótano de Amezcua, Coahuila.

Order Orthoptera

Family Phalangopsidae

According to DESUTTER-GRANDCOLAS (1998) Phalangopsidae have been recorded in tropical regions and Gryllidae in the Mediterranean region. Most crickets are found in caves in the daytime and feed outside during the night. However most cavernicolous crickets are slender, depigmented, with more or less reduced eyes, and acoustic tympana may or may not be present. In México 21 cavernicolous species are recorded. Four Mexican species are considered as true troglobites, others are troglaphiles.

DESUTTER-GRANDCOLAS (1993, 1995) classified nine species of *Longuripes*, three *Mayagrillus*, and two *Noctivox* as troglobites. These species are recorded only in caves but show only slight morphological modifications to cave life,

apterous and with reduced eyes. Without knowledge of their alimentary diet outside or not during the night it is better to consider them as troglonites.

Ten species of *Longuripes* are found in caves in Chiapas and Oaxaca and are partly distributed according to altitude of caves: *L. evanesca* Desutter-Grandcolas from Chiapas, *L. pseudogigas* Desutter-Grandcolas from Cueva del Guayabo, Oaxaca, *L. sbordonii* Desutter-Grandcolas & Hubbell (Fig.4, p. 995, Tome II) from Chiapas and *L. stenopsita* Desutter-Grandcolas from Grutas de Monteflor and Cueva del Zopilote, Oaxaca occur under 600 m; *L. altaminor* Desutter-Grandcolas and *L. minor* Desutter-Grandcolas from Chiapas occur from 600 to 1500 m; *L. stenops* Desutter-Grandcolas & Hubbell from caves in the Huautla region, Oaxaca occur above 1500 m; *L. arganoi* Desutter-Grandcolas & Hubbell, *L. intermedia* Desutter-Grandcolas, and *L. surchiapaneca* Desutter-Grandcolas from Chiapas occur from 1500 to 2300 m.

Two species of *Mayagrillus* with the same type of morphological modifications are known from caves in Chiapas: *M. tilaensis* Desutter-Grandcolas and *M. tumbalaensis* Desutter-Grandcolas. A third species, *M. yucatanus* (Hubbell) is found in deep caves, in cave entrances, and outside the caves in Yucatán; males have short elytrae.

Two species of *Noctivox* are recorded from caves: *N. bolivari* (Chopard) from Veracruz and *N. chopardi* Desutter-Grandcolas from Oaxaca and Veracruz.

Paracophus includes three troglitic and four troglitic species (CHOPARD, 1947; HUBBELL, 1972).

The troglitic species are: *P. caecus* Hubbell, the only eyeless species in the New World, known from many caves in the Sierra de Guatemala, Tamaulipas, under rocks, on cave walls and stalactites, and in association in a few caves with *P. apterus* or *P. reddelli*; *P. cladonotus* Hubbell, with small eyes and elongated appendages, from several caves in the Xilitla and Aquismón regions, San Luis Potosí and Hidalgo; *P. lippus* Hubbell, with very small eyes, reduced pigmentation, and elongated appendages, known only from Cueva de la Lagunita, San Luis Potosí.

The troglitic species are: *Paracophus apterus* Chopard from caves in the Sierra de El Abra, San Luis Potosí and Tamaulipas, and the Sierra de Guatemala, Tamaulipas; in Cueva Chica in the Sierra de El Abra the population of *P. apterus* was estimated by mark-recapture method to be 2,900 individuals with 95% confidence limit of 1,055-4,750 (JOHNSON & HEATH, 1976); *P. reddelli* Hubbell from caves in the Sierra de Guatemala, Tamaulipas; *P. sanctorum* Hubbell from Cueva de la Virgen, Tamaulipas; and *P. subapterus* Chopard from Coahuila and Nuevo León.

Tohila atelomma Hubbell, a small troglitic species with degenerated eyes, was found in several caves in Yucatán with the troglitic *Mayagrillus yucatanus* (HUBBELL, 1938).

Family Rhaphidophoridae

This family is widely distributed in caves throughout much of México, with most species undescribed. HUBBELL (1972, 1977) described four genera for some of the species known from southern México and the Sierra Madre Oriental. All species appear to be troglonites.

Anargyrtes includes one species known from caves, *A. annulata* (Bilimek) from Grutas de Cacahuamilpa and other caves in Guerrero and the state of México.

Exochodrilus includes two cavernicolous species from the Sierra de Guatemala, Tamaulipas: *E. caelestis* Hubbell and *E. forcipatus* Hubbell.

Leptargyrtes includes two species with very long, slender legs from caves at higher elevations in Querétaro: *L. boneti* Hubbell and *L. tejamanilae* Hubbell.

Hypsobadistes includes three slender, long-legged species from Guatemala and Chiapas, México. The only species recorded from Mexican caves is *H. tenuis* Hubbell from caves near Comitán, Chiapas.

Several undescribed genera and several undescribed species of *Ceuthophilus* have been collected from caves in northern and western México. Two species of *Ceuthophilus*, known from the United States, have been recorded from caves in northern México: *C. (C.) variegatus* Scudder in Chihuahua and Coahuila; and *C. (Geotettix) cunicularis* Hubbell from Cueva de los Lagos, Coahuila.

Order Dermaptera

Family Forficulidae

Mixocosmia cavernicola Brindle was described from Cueva de Carnicerías, San Luis Potosí but is probably an accidental (BRINDLE, 1980).

Order Blattaria

At least 23 species of cockroaches have been found in Mexican caves, but most are accidental (FISK, 1977; FISK & GURNEY, 1972; MARIÑO PEDRAZA, 1989)

Family Blaberidae

Three species of *Blaberus* are known from Mexican caves; some are very abundant in bat rooms: *B. atropos* (Stoll) from Actún Xmahit, Yucatán; *B. craniifer* Burmeister from Chiapas, Guerrero, and Yucatán; and *B. giganteus* (Linnaeus) from Cueva de San Rafael de los Castros, Tamaulipas. *Blaberus craniifer* (Burmeister, 1838) is very abundant in the caves of Juxtaluaca, Guerrero (Fig. 30)

Pycnoscelus surinamensis (Linnaeus) is known from caves in Chiapas and Tamaulipas.

Family Blatellidae

Aglaopteryx chiapas Fisk is known only from five caves in Chiapas from 1440 m to 2400 m in altitude.

Nelipophygus n. sp. is an eyeless species known only from a nymph in Cueva II de Chital, Chiapas.

Two species of *Nesomylacris* have been recorded from Mexican caves: *N. lateralis* Fisk, described from Cueva I de Chital, Chiapas; and *N. reddelli* Fisk & Gurney described from caves in Nuevo León and Tamaulipas.

Three species of *Pseudomops* are known from Mexican caves: *P. interceptus* (Burmeister) from Grutas de Tolantongo, Hidalgo; *P. nigrimaculis* Fisk known only from Cueva del Aguacero, Chiapas; and *P. septentrionalis* Hebard from Tamaulipas.

Family Blattidae

Periplaneta australasiae (Fabricius), an Old World species, was recorded for the first time in México when collected in Grutas de Juxtlahuaca, Guerrero.



Fig. 30 – Blataria: Blaberidae: *Blaberus craniifer* (Burmeister, 1838) Grutas de Juxtlahuaca, Gro.

Family Polyphagidae

Undetermined species of *Arenivaga* are frequently found in the dry entrance area of caves in Coahuila and Durango.

Two species of *Holocompsa* have been found in Mexican caves: *H. azteca* Saussure and *H. zapoteca* Saussure from dry caves in southern Yucatán.

Homoeogamia mexicana Burmeister has been found in caves in Guerrero, Hidalgo, Michoacán, San Luis Potosí, and Veracruz.

Order Psocida

Psocids are frequently found in Mexican caves, but few have been identified and most are probably accidentals.

Family Liposcelidae

Liposcelis bostrychopila Badonnel was found on bat guano in Cueva Oxtotitlán, Guerrero.

Family Psyllipsocidae

Two species of *Psyllipsocus* are troglophiles in México: *P. ramburii* Selys-Longchamps from caves in Chiapas, Chihuahua, Coahuila, Durango, Nuevo León, Puebla, San Luis Potosí, Tamaulipas, Veracruz, and Yucatán and *P. yucatan* Gurney, known only from Cueva del Cenote Xtolok, Yucatán (GURNEY, 1943).

Family Ptiloneuridae

Loneura leonilae García-Aldrete was described from Grutas de Balankanché, Yucatán (GARCÍA-ALDRETE, 1996).

Family Troctopsocidae

Protoctopsocus enigmaticus Mockford was described from small caves on Cuesta de Chipinque, Nuevo León (MOCKFORD, 1967).

Order Hemiptera

Family Cimicidae

Two species of *Cimex* have been found in Mexican caves (PEARSE, 1938b; HOFFMANN, 1972): *C. hemipterus* Fabricius from two caves in Yucatán and *Cimex pilosellus* (Horvath) from Cueva del Cerro del Xitle, Distrito Federal.

Primicimex cavernis Barber is a rare species parasitic on bats in Guatemala, México, and the U.S.A.. It is known from caves in Michoacán and Yucatán (USINGER, 1966).

Family Cydnidae

Species of this family are frequently found in Mexican caves, usually in bat guano. The more abundant troglophiles are: *Amnestus pusio* (Stål) from Oaxaca and Yucatán; *A. subferrugineus* (Westwood) from Oaxaca and San Luis Potosí; *Pangaeus (Pangaeus) aethiops* Fabricius from San Luis Potosí and Veracruz; *P. (P.) docilis* (Walker) from Campeche, Oaxaca, Quintana Roo, San Luis Potosí, Tamaulipas, Veracruz, and Yucatán; *P. (P.) piceatus* Stål from Chiapas, Oaxaca, San Luis Potosí, and Yucatán; and *Tominotus unisetosus* Froeschner from Guerrero and Yucatán.

Family Reduviidae

Several species of *Triatoma* have been collected from caves in México. Two species from the Yucatán Peninsula, *T. dimidiata* (Latreille) and *T. hegneri* Mazzotti are of special interest in that they have been found to be vectors of *Trypanosoma cruzi* Chagas, the protozoan responsible for Chagas disease. MAGALLÓN-CASTTELUM *et al.*, 2001 reported on infection rates of *T. cruzi* in *T. longipennis* (Usinger) and *T. picturata* (Usinger) from caves near Carrillo Puerto, Nayarit. *T. longipennis* is also very common in caves from Morelos state (PALACIOS-VARGAS & G. VARO DE LA ROSA, 2012).

The thread-legged bug *Ploiaria maya* Wygodzinsky is a small-eyed troglophile abundant in caves in the Yucatán Peninsula (WYGODZINSKY, 1966).

Order Homoptera**Family Cixiidae**

Two species of this family are troglotitic in Mexican caves (FENNAH, 1973; HOCH, 1988): *Cixius actunus* Hoch from Cueva de Las Maravillas and possibly Cueva de Cayateno, near Acatlán, Oaxaca; and *C. orcus* Fennah from Cueva de Emilia, near Ahuacatlán, Querétaro.

Family Kinnaridae

Oeclidius hades Fennah is a troglotite known only from Cueva de Valdosa in the Sierra de El Abra, San Luis Potosí (FENNAH, 1973).

Order Neuroptera**Family Myrmeleontidae**

Eremeleon longior Banks is an abundant troglophile in the caves of the Yucatán Peninsula (BANKS, 1938).

Order Coleoptera**Family Carabidae****Subfamily Bembidiinae****Tribe Anillini**

Mexanillus sbordonii Vigna Taglianti (Fig. 31) is an eyeless troglotite found under stones on clay and mud in Cueva de Tío Ticho, Chiapas, at 1700 m

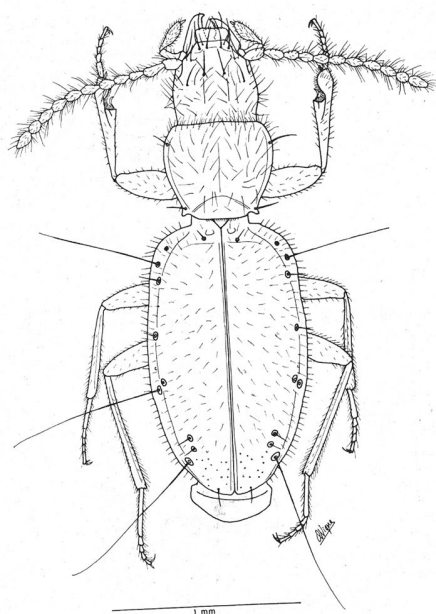


Fig. 31 – Carabidae: Bembidiinae: *Mexanillus sbordonii* Vigna Taglianti, 1974, Cueva de Tío Ticho, Chiapas

Tribe Bembidiini

Elaphropus unistriatus (Bilimek) was described from Grutas de Cacahuamilpa and since found in other caves in Guerrero (BOLÍVAR Y PIELTAIN & HENDRICHES, 1965).

Subfamily Paussinae

Tribe Ozaenini

Pachyteles urutiai Bolívar y Pieltain is a distinctive species abundant in caves of the Sierra de El Abra, San Luis Potosí and Tamaulipas (BOLÍVAR Y PIELTAIN, 1952).

Subfamily Scaritinae

Tribe Clivinini

Antroforceps bolivari Barr is a specialized troglobite, eyeless and with very long appendages, found only in Sótano de la Joya de Salas, Tamaulipas (BARR, 1967a).

Subfamily Trechinae

Eighteen species of Trechinae have been described from Mexican caves (BOLÍVAR Y PIELTAIN, 1942; BARR, 1967a, 1971, 1982b; VIGNA TAGLIANTI, 1977).

Chiapadytes bolivari Vigna Taglianti (Fig. 32), troglobite with elongated appendages and eyes reduced to pale areola, is known only from Cueva de la Planta 1 and 2, at 2,180 m altitude in the central highlands of Chiapas.

Mexaphaenops contains eight (one with three subspecies) troglotic species in caves of the Sierra Madre Oriental: *M. elegans* Barr from five caves near Pinal de Amoles, Querétaro; *M. febriculosus* Barr from Sótano de las Calenturas in the Purificación region, Tamaulipas; *M. fishi* Barr from two caves at 2,800 m in elevation in the Valle de los Fantasmas region, San Luis Potosí; *M. intermedius* Barr from moist flowstone and rotten wood in four caves in the Sierra de Guatemala, Tamaulipas; *M. jamesoni* Barr from three caves in the Purificación region, Tamaulipas; *M. mckenziei* Barr which includes three subspecies from the Purificación region, Nuevo León and Tamaulipas (*M. m. dulcinomis* Barr at 2,020 m; *M. m. gracilis* Barr at 1,900 m; and *M. m. mckenziei* Barr at 2,500-2,700 m); *M. prietoi* Bolívar y Pieltain, the rarest species, known only from Grutas del Palmito, Nuevo León; and *M. sulcifrons* Barr from three caves in the Purificación region, Nuevo León and Tamaulipas.

Three species of the primarily epigeal genus *Mexitrechus* are possible trogliphiles: *M. coarctatus* (Bates) from two caves in Oaxaca; *M. mogotensis* Barr, known only from Grutas del Mogote, Guerrero; and *M. tepoztlanensis* (Bolívar y Pieltain) from Cueva de Coatepec, México.

Four species of *Paratrechus* are recent trogliphiles: *P. contrarius* Barr from Cueva del Rincón, Querétaro; *P. laticeps* Barr from Sótano de Riachuelo, Tamaulipas; *P. pallescens* Barr from caves near Pinal de Amoles, Querétaro; and *P. reddelli* Barr from Cueva del Volcancillo, a lava tube on a spur of Cofre de Perote, Veracruz.

Two species are considered trogliphiles: *Paratrechus cataractae* Barr from Cueva de la Cascada, near Tequila, Veracruz; and *P. propior* Barr from Cueva del Cambio, Hidalgo.

Subfamily Harpalinae

Tribe Platynini

Mexisphodrus is represented by seven possibly troglotic species (BOLÍVAR Y PIELTAIN & HENDRICHES, 1964; HENDRICHES & BOLÍVAR Y PIELTAIN, 1966, 1973; BARR, 1965, 1966, 1982a): *M. cancu* Barr from Sótano de Cancu, Chiapas; *M. cuetzalan* Barr, with small eyes, from caves in the vicinity of Cuetzalan and zoquitlán, Puebla; *M. profundus* Barr, frequently found on guano and organic matter, from caves of the Sierra de Guatemala, Tamaulipas; *M. purgatus* Barr, with small eyes, from caves in the Purificación region, Nuevo León and Tamaulipas; *M. urquijoi* Hendrichs & Bolívar y Pieltain, with very small eye rudiments, from Sistema Huautla, Oaxaca; *M. veraecrucis* Barr, with small eyes and vestigial wings, from caves near Tequila and Soledad Atzompa, Veracruz; and *M. zoquitlan* Barr from two caves near San Pablo Zoquitlán, Puebla.

Four species, two with subspecies, are known only from caves but are probably trogliphiles: *M. boneti boneti* (Bolívar y Pieltain & Hendrichs) from Cueva de la Boca, Nuevo León; *M. b. monterreyensis* Barr from small caves on Chipinque Mesa, Nuevo León; *M. b. nortoni* Barr from caves near Montemorelos and Potrero Redondo, Nuevo León; *M. b. palmitensis* Barr from Grutas del Palmito, Nuevo León; *M. gertschi ahuacatlan* Barr from caves near Ahuacatlán, San Luis Potosí; *M. g. camposantos* Barr from caves in Hidalgo and Querétaro; *M. g. gertschi* Barr from Cueva de El Ocote, Hidalgo; *M. g. sprousei* Barr from Cueva del Agua, northwest of Xilitla, San Luis Potosí; and *M. spiritus* Barr from caves in the Valle de los Fantasmas region, San Luis Potosí. The genus is otherwise represented only by *M. valverdensis* Barr, a trogliphile from caves in Texas (U.S.A.).

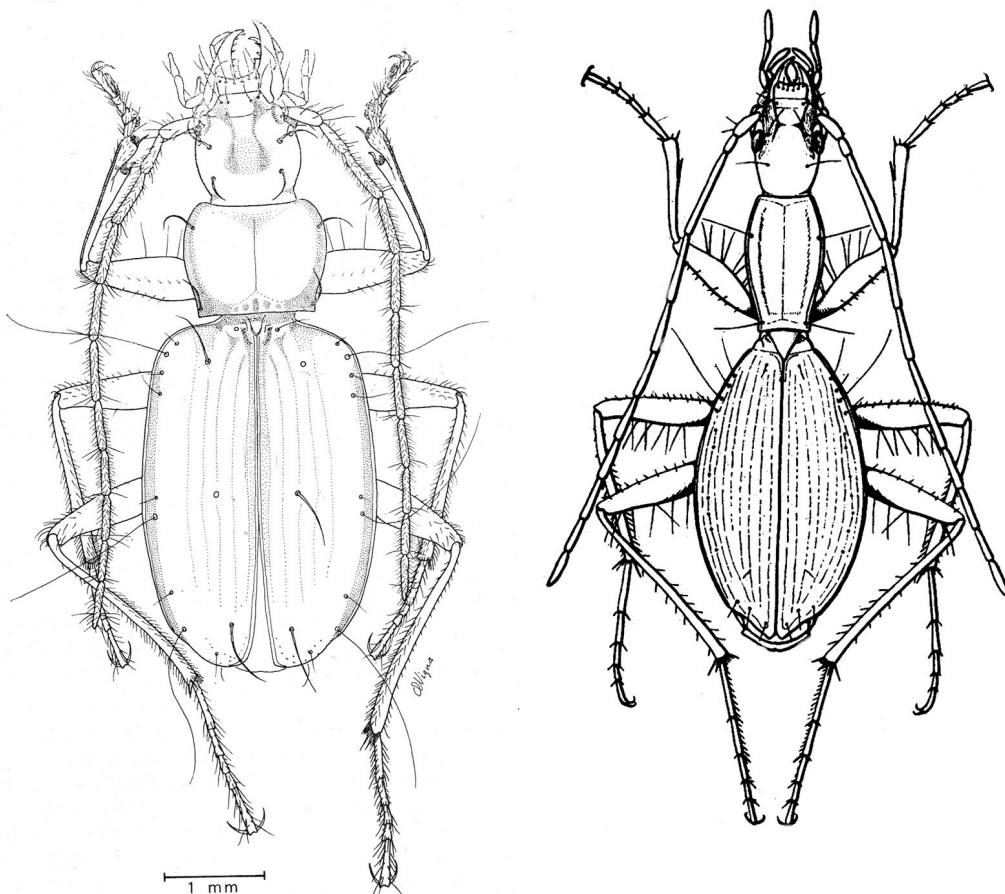


Fig. 32 – Coleoptera: Trechinae: Left: *Chiapadytes bolivari* Vigna Taglianti, 1977 from Cuevas de la Planta, Chiapas (from the author). Right: *Rhadine arazai* (Bolívar y Pieltain, 1944) from Grutas del Palmito, Nuevo Leon (from Bolívar y Pieltain).

Miquihuana rhadiniformis Barr, with small eyes, is known only from Sótano de Riachuelo, near Miquihuana, Tamaulipas (BARR, 1982a).

Platynus is frequently found in caves, but most species are probably accidentals (BOLÍVAR Y PIELTAIN & HENDRICH, 1964, 1965; BARR, 1966; BARR *et al.*, 1968). Four, however, are troglophiles: *P. colibor* Whitehead from Chiapas and Guerrero; *P. pelaezi* (Bolívar y Pieltain & Hendrichs) from Grutas de Villa de García, Nuevo León; *P. tlamayaensis* (Barr) from Querétaro, San Luis Potosí, and Veracruz; and *P. (Hemiplatynus) umbripennis* (Casey) from Guerrero.

Rhadine includes two troglobites and seven troglophiles from México (BOLÍVAR Y PIELTAIN, 1944; BOLÍVAR Y PIELTAIN & HENDRICH, 1964; BARR, 1982a). The troglobites are: *R. chipinque* Barr from an unnamed cave on Chipinque Mesa, Nuevo León; and *R. elliotti* Barr from Cueva Sin Nombre, Potrero Redondo, Nuevo León. These belong to the *subterranea* group which is otherwise known only by numerous troglobites in the caves of Texas (U.S.A.).

The troglophiles are: *Rhadine arazai* (Bolívar y Pieltain), known only from three caves in Nuevo León; *R. bolivari* Barr, known only from Cueva del Pedregoso, near Cuatro Ciénegas de Carranza, Coahuila; *R. hendrichsi* Barr, known only from Sumidero 552, south of Matehuala, San Luis Potosí; *R. medellini* (Bolívar y Pieltain & Hendrichs) from three caves near Matehuala, San Luis Potosí; *R. perlevis* Casey, an epigeal species, known from Grutas de Coyame, Chihuahua; *R. reddelli* Barr, known only from Cueva abajo de Carretera, southwest of Tula, Tamaulipas; and *R. rotgeri* Bolívar & Pieltain and Hendrichs, known only from Gruta de Cuevecillas, near Arteaga, Coahuila, and Grutas de Mapimí, Durango.

An undescribed troglotic species of *Speocolpodes* was found in Cueva de Santa Cruz, Chiapas (SBORDONI *et al.*, 1986). The only other species in the genus is the troglotic *S. franai* Barr from Guatemala.

Family Dermestidae

Two species of *Dermestes* have been found in Mexican caves: *D. carnivorus* (Fabricius), abundant on bat guano in caves in Coahuila, Durango, Guerrero, and San Luis Potosí; and *D. maculatus* De Geer from Pozo Melendes, Guerrero.

Family Histeridae

Troglobitic species belonging to the genus *Troglobacanius* inhabit only Mexican lowland tropical caves, from the Sierra Madre Oriental south to Tabasco. All are wingless, have reduced eyes, pale to dark reddish-brown body, and fused elytra (VOMERO, 1974). The four species are: *T. bolivari* Vomero from Sótano del Tigre, Sierra de El Abra, San Luis Potosí; *T. maya* Vomero from Grutas de Coconá, Tabasco; *T. reddelli* Vomero, with elongated appendages, from Grutas de El Puente and Cueva de los Vampiros, Sierra de Guatemala, Tamaulipas; and *T. sbordonii* Vomero, wingless, from Sótano de Gómez Fariás, Sierra de Guatemala, Tamaulipas (More details are in VOMERO 1998).

Other troglomorphic or troglonec species were frequently collected in Mexican caves, such as *Anapleus wenzeli* Vomero, abundant on fungal mycelia in Cueva de la Cañada no. 1, Chiapas, 2,270 m in altitude (VOMERO, 1977). Species of several genera are probable troglonecs: *Epeirus* in Oaxaca, San Luis Potosí, Tamaulipas, and Veracruz; *Euspilotus* in Nuevo León, Oaxaca, San Luis Potosí, Tamaulipas, and Yucatán; *Gnathoncus* in Yucatán, *Phelister* in Oaxaca, San Luis Potosí, and Yucatán; and *Platysoma*, *Plegaderus*, and *Saprinus* in Yucatán.

Family Leiodidae

This family is abundant in Mexican caves with endogean forms, troglonecs, and troglonecs present in all parts of the country (PECK, 1973, 1977, 1983; REDDELL, 1981; GIACHINO *et al.*, 1998).

Species are frequent in litter or are myrmecophilic worldwide. Three troglomorphic species of *Dissochaetus* without morphological adaptation to cave life, are recorded from México: *D. aztecus* Szymczakowski on vampire bat guano from caves in Nuevo León, San Luis Potosí, and Tamaulipas; *D. curtus* Portevin from Cueva Cerro Hueco, Chiapas; and *D. hetschkoi* Reitter from Campeche, Oaxaca, San Luis Potosí, Veracruz, and Yucatán.

Two species of *Proptomaphagus* are endogean forms found in Mexican caves: *P. microps* Peck from caves in the Xilitla region, San Luis Potosí; and *P. reddelli* Peck from Cueva de la Finca, Oaxaca.

Ptomaphagus (Adelops) is well represented in Mexican caves with two troglonecs known: *P. (A.) mckenziei* Peck, unpigmented, with reduced eyes and elongated appendages, from caves in the Purificación region, Tamaulipas; and *P. (A.) troglomexicanus* Peck, with greatly reduced eyes and elongated antennae, from four caves in the Sierra de Guatemala, Tamaulipas.

Several troglomorphic *Ptomaphagus (Adelops)* are recorded: *P. (A.) cavernicola aditus* Peck from Cueva de la Boca, Nuevo León; *P. (A.) cavernicola cavernicola* Schwarz, ranging in both cave and surface habitats in the U.S.A., known in México only from Grutas del Palmito, Nuevo León; *P. (A.) elabra* Peck, known only from many lowland caves in the Sierra de El Abra, San Luis Potosí and Tamaulipas, and the Sierra de Guatemala, Tamaulipas; *P. (A.) gypsum* Peck from the gypsum cave, Resumidero de Pablillo, Nuevo León and epigean localities; *P. (A.) leo* Peck from surface leaf litter and from caves in Nuevo León and Querétaro; *P. (A.) reddelli* Peck, known only from caves in the Valle Nacional region, Oaxaca; *P. (A.) spelaeus* (Bilimek) from caves in Guerrero and México, and epigean habitats in Guerrero, Jalisco and Oaxaca; and *P. (A.) tabascensis* Sbordoni from caves in Campeche, Tabasco, Quintana Roo, and Yucatán, and from forested habitats in Campeche.

Family Ptilodactylidae

Undetermined species of *Ptilodactylus* are probably troglomorphic in Guerrero, Oaxaca, Puebla, Querétaro, San Luis Potosí, Tamaulipas, and Veracruz. Both adults and larvae have been taken from caves.

Family Ptinidae

This family with saprophagous species is frequent in guano caves. One species, *Niptus absconditus* Spilman, with the smallest eyes in the genus, from Grutas de Xoxafi, Hidalgo, is considered as a possible troglonec by REDDELL (1981) and troglonec by GIACHINO *et al.* (1998). *Niptus abstrusus* Spilman is a troglonec taken from bat guano in caves in Texas (U.S.A.) and Coahuila and Durango, México.

Family Scarabaeidae

This family includes several apparent troglonecs from México (HOWDEN *et al.*, 1956; HOWDEN, 1973, 1980; ZUNINO & HALFFTER, 1988).

Aphodius sp. aff. *diminutus* (Bates) is known from Cueva de Tasalolpan, Cuetzalan region, Puebla.

Haplogeotrupes reddelli (Howden) is known only from two caves in the Cuetzalan region, Puebla.

Onthophagus contains seven troglomorphic species in México: *O. cuevensis* Howden from caves in San Luis Potosí and Tamaulipas; *O. incensus* Say from Sótano de Tlamaya, Xilitla region, San Luis Potosí; *O. landolti* Harold from Cueva del Ojo de Agua Grande, Veracruz; *O. mexicanus* Bates from Sótano de Peñuelas, Nuevo León; *O. moroni* Zunino & Halffter, known only from Cueva de Tasalolpan, Cuetzalan region, Puebla; *O. subtropicus* Howden & Cartwright from caves in the Cuetzalan region, Puebla; and *O. vespertilio* from two caves in Guerrero.

Family Staphylinidae

A preliminary list of six subfamilies of the Staphylinidae was given by NAVARRETE HEREDIA and MARQUEZ-LUNA (1993), but there are still many species to be studied.

Subfamily Aleocharinae

Numerous species of undetermined Aleocharinae have been taken in all parts of México.

Subfamily Paederinae

The subfamily has made a major contribution to the Mexican cave fauna, with at least 50 species, many known only by generic identification. Although most species are accidentals, others are troglonecs.

Two species of *Orus (Leucorus)* have been found in Mexican caves: *O. (L.) ferrugineus* (Casey) in Cueva Granjeno, Coahuila, and *O. (L.) guatemalensis* Sharp in Grutas de Zapaluta, Chiapas.

Stenopholea reddelli Herman from Cueva de la Mina, Sierra de Guatemala, Tamaulipas, was originally considered a troglobite but the discovery of other closely related species from leaf litter indicates that it is in fact an endogean form (HERMAN, 1969, 1981).

HERMAN (1970) recorded *Stilicolina condei* Jarrige from Mexican caves; this in fact represents one or more undescribed species of troglomorphic *Eustilicus* from caves in Coahuila, Michoacán, Nuevo León, Puebla, Querétaro, San Luis Potosí, and Tamaulipas.

Undetermined species of *Belonuchus*, *Homoaetarsus*, and *Orus* are known from many parts of México.

Subfamily Pselaphinae

Although many species of Pselaphinae are troglobites in the United States, no cave-adapted species have been found in México. Undetermined species of twelve genera have been found in Mexican caves: *Apharus* in Oaxaca; *Arthmius* in San Luis Potosí; *Batrybraxis* in Veracruz; *Circocerus* in Oaxaca; *Conoplectus*; *Euphalepsus* and *Hamotus* in Tamaulipas; *Oxarthrius* in Campeche, Tamaulipas, and Yucatán; *Phamisas* in Campeche and Yucatán; *Pselaphus* in Morelos; *Reichenbachia* in Chiapas; and *Sebaga* in Veracruz.

Subfamily Scydmaeninae

Two species have been described from caves (FRANZ, 1977): *Euconnus (Madagassconnus) arganoi* Franz from Cueva del Muju, Chiapas; and *Scydmaenus teapanus* Franz from Grutas de Coconá, Tabasco. Undetermined species of *Euconnus (Nepochus)* are known from caves in Campeche, Oaxaca, San Luis Potosí, and Veracruz; and undetermined *Scydmaenus* from caves in Oaxaca and Veracruz.

Subfamily Staphylininae

Undetermined species of *Philonthus* are known from caves in Coahuila, Guerrero, Oaxaca, Querétaro, San Luis Potosí, Tamaulipas, Veracruz, and Yucatán.

Family Tenebrionidae

Tenebrionids are widely distributed in Mexican caves, where they are usually found on bat guano or in drier parts (AALBU, 1985; TRIPLEHORN & REDDELL, 1991; PALACIOS-VARGAS *et al.*, 1998; TRIPLEHORN, 2007; AALBU *et al.*, 2012). Numerous species have been recorded, but many are at best troglonexes.

Possible troglophiles include: *Absolus mexicanus mexicanus* (Champion) from bat guano and dry silt in caves in Chihuahua, Coahuila, Durango, and Nuevo León; *Alphitobius diaperinus* (Panzer) from bat guano in Cueva de La Unión, Quintana Roo; *A. laevigatus* (Fabricius) from bat guano in Coahuila, San Luis Potosí, and Tamaulipas; *Eleodes exaratus* Champion from Cueva del Piña, Nuevo León; *E. (Eleodes) hispilabris* (Say) from Cueva de los Lagos, Coahuila; *E. (E.) rugosus* Perbosc from caves in the Sierra de El Abra, San Luis Potosí and Tamaulipas; *E. (Promus) knullorum* Triplehorn from Illusive Pit, Coahuila; *E. (P.) solieri* Champion in Sumidero de Fantasmas, San Luis Potosí; *E. (P.) spinolai* Solier from Grutas de Cacahuamilpa, Guerrero; *E. (Steneleodes) coarctatus* Champion from Pozo del Soyate Torcido, Tamaulipas; *E. (S.) distinctus* Solier from Hidalgo, Querétaro, San Luis Potosí, and Tamaulipas; *E. (S.) glabricollis* Champion from gypsum caves south of Galeana, Nuevo León; *E. (S.) sallaei* Champion in high elevation caves in San Luis Potosí; *Troglogeneion zapoteca* Aalbu from caves near Yagul, Oaxaca; and *Zophobas atratus* (Fabricius) from caves in the Sierra de El Abra, San Luis Potosí, and in Cuba.

Six species closely associated with caves are: *Eleodes (Caverneleodes) easterlai* Triplehorn, known only from Mt. Emory Cave, Texas (U.S.A.) and Cueva de San Vicente, Coahuila; *E. (C.) grutus* Aalbu, Smith, & Triplehorn, known only from Grutas de Villa de García, Nuevo León, *E. (C.) labialis* Triplehorn, known only from a fissure in Texas (U.S.A.) and Cueva del Plátano, Chihuahua; *E. (C.) reddelli* Triplehorn, known only from two caves in Nuevo León; *E. (C.) rugosifrons* Triplehorn & Reddell from Coahuila and Nuevo León, and *E. (C.) sprousei* Triplehorn & Reddell from the Purificación region, Nuevo Leon and Tamaulipas. Other species of the subgenus *Caverneleodes* are known from caves in Arizona, California, New México, Texas, and Utah (U.S.A.).

Order Hymenoptera

Family Apidae

Troglonex *Apis mellifera* Linnaeus is frequently found in hives on the walls of pits and caves entrances throughout México. Many of these populations have been replaced by Africanized populations and several cave explorers have been severely injured while attempting to enter the caves.

Family Formicidae

REDDELL & COKENDOLPHER (2000) reported 47 species of ants from the Yucatán Península and 36 species from other parts of México.

Although none are troglomorphic, *Brachymyrmex cavernicola* Wheeler, *Oligomyrmex urichi* (Wheeler), and *Paratrechina pearsei* (Wheeler) are troglophiles, with nests abundant in the darkness of caves in the Yucatán Península.

Troglonexes include *Labidus coecus* (Latreille) and *Solenopsis geminata* (Fabricius). The latter species was present in vast numbers in Sótano de Guadalupe, San Luis Potosí, where it was feeding on troglobites and other invertebrates.

Order Lepidoptera

Family Gracillariidae

Parornix impressipenella (Bilimek) was described from Grutas de Cacahuamilpa, Guerrero (BILIMEK, 1867).

Family Noctuidae

Latebraria amphipyroides Guénéé has been found in cave entrances, in caves in San Luis Potosí and Yucatán (BONET, 1953a; REDDELL, 1977).

Family Tineidae

Undetermined troglomorphic *Amydria* have been found in caves in Nuevo León, Puebla, San Luis Potosí, Tamaulipas, and Veracruz.

Order Diptera

More than 100 species of fly belonging to 14 families have been collected in Mexican caves. No species are troglomorphic but some are apparently troglomorphic and complete their life cycle in caves and others are sub-troglomorphic.

Family Chironomidae

Goeldichironomus fulvipilus (Rempel) is extraordinarily abundant in Cueva de las Sardinas, Tabasco (LAVOIE & EANS, 2002).

Family Milichiidae

Pholeomyia includes three troglomorphic in México (BILIMEK, 1867; SABROSKY, 1959): *P. dampfi* Sabrosky, described from a cave in Guatemala, and from Grutas de Coconá, Tabasco; *P. indecora* Loew from Cueva Chica, San Luis Potosí; and *P. leucozona* Bilimek from Grutas de Cacahuamilpa, Guerrero.

Family Phoridae

This family is abundant in Mexican caves. *Megaselia scalaris* Loew is a troglomorphic in caves in Yucatán (PEARSE, 1938b). Other species found in caves belong to the genera *Cornicera*, *Dohnniphora*, *Phora*, and *Pulicophora*.

Family Sphaeroceridae

Three troglomorphic have been identified from Mexican caves (STEYSKAL, 1973; MARSHALL, 1985): *Archiborborus (Procopromyza) mexicanus* Steyskal from Sótano de El Porvenir, Sierra de Guatemala, Tamaulipas; *Speleobia robinsoni* Marshall from caves in the Sierra de Guatemala, Tamaulipas, and Cueva del Volcancillo, Veracruz; and *S. sejuncta* Marshall from Sótano de San Francisco no. 2, San Luis Potosí.

Family Streblidae

This family of bat parasites includes 34 species in 12 genera recorded from caves and mines (HOFFMANN, 1953; MORALES-MALACARA & LÓPEZ., 1990; GUERRERO & MORALES-MALACARA, 1996; GUZMÁN-CORNEJO *et al.*, 2003b; DITTMAR *et al.*, 2009).

Anastrebla modestini Wenzel has been found in Cueva La Mina, México.

Aspidoptera delatorrei Wenzel is known from Cueva del Polvorín, Oaxaca.

Euctenodes mirabilis Waterhouse has been found in caves in Guerrero, San Luis Potosí, and Yucatán.

Exastinion clovisi (Pissoa & Guimeraes) has been found in caves in Guerrero, México, and Morelos.

Megistopoda araneae (Coquillett) has been found in caves in San Luis Potosí and Yucatán.

Metalasmus pseudopterus Coquillett is known from caves in Chiapas and San Luis Potosí.

Five species of *Nycterophila* are known from Mexican caves: *N. coxata* Ferris in Baja California Sur, Chiapas, Colima, Guerrero, Puebla, Tamaulipas, Veracruz, and Yucatán; *N. fairchildi* Wenzel in Veracruz; *N. moormopsis* Wenzel in Chiapas, Oaxaca, Puebla, Veracruz, and Yucatán; *N. natali* Wenzel in Tamaulipas and Veracruz; and *N. parnelli* Wenzel in Chiapas, Puebla, and Veracruz.

Pareuctonodes sp. has been found in Gruta de Acuitlapán, Guerrero.

Paratrachobius longicrus (Miranda & Ribeiro) is known from El Tunel, Tlaxcala.

Speiseria alvarezii Wenzel has been found in Cueva Yakmán, Yucatán.

Three species of *Strebla* have been found in Mexican caves: *S. alvarezii* Wenzel in Yucatán; *S. curvata* Wenzel in Chiapas; and *S. vespertilionis* (Fabricius) in Guerrero.

Seventeen species of *Trichobius* have been recorded from Mexican caves and mines: *T. adamsi* Augustson in Baja California Sur, Colima, and Guerrero; *T. caecus* Edwards in Guerrero, San Luis Potosí, Tamaulipas, and Yucatán; *T. corynorhini* Cockerell in Tamaulipas and Tlaxcala; *T. dugesii* Townsend in Chiapas and San Luis Potosí; *T. hirsutulus* Bequaert in Tamaulipas and Yucatán; *T. hoffmanni* Guerrero & Morales-Malacara in Chiapas and Veracruz; *T. intermedius* Peterson & Hurka in Chiapas, Veracruz, and Yucatán; *T. joblingi* Wenzel in Oaxaca and Yucatán; *T. johnsoni* Wenzel in Chiapas, Tabasco, and Veracruz; *T. leionotus* Wenzel in Nuevo León, Puebla, and Veracruz; *T. major* Coquillett in Nuevo León; *T. mixtus* Curran in San Luis Potosí; *T. parasiticus* Gervais in Chiapas, Guerrero, Morelos, San Luis Potosí, Tabasco, and Yucatán; *T. uniformis* Curran in Yucatán; and *T. yunkerii* Wenzel in Chiapas, Puebla, Veracruz, and Yucatán.

Order Siphonaptera

Only eight species of flea are known from Mexican caves (PEARSE, 1938b; BARRERA, 1951; MORALES-MALACARA & LÓPEZ W., 1990).

Family Hystrichopsyllidae

Anomiopsyllus traubi Barrera was described from a rodent nest in Cueva de Belén, Hidalgo.

Family Ischnopsyllidae

Four species of bat fleas have been collected from Mexican caves and a tunnel: *Myodopsylla collinsi* Kohls from an abandoned tunnel in Tlaxcala; *M. gentilis* Jordan & Rothschild from Chihuahua and San Luis Potosí; *M. globata* Holland from Tabasco and Tamaulipas; and *Sternopsylla distincta texana* (Fox), extremely abundant in guano in caves in Chihuahua and Nuevo León.

Family Pulicidae

Three species of this family are known from Mexican caves: *Pulex irritans* Linnaeus in San Luis Potosí and Yucatán; *P. porcinus* Jordan & Rothschild from caves in Campeche and Yucatán; and the plague flea *Xenopsylla cheopis* (Rothschild) from Grutas de Balankanché, Yucatán.

Family Tungidae

Hectopsylla sp. was found in Grutas de Xoxafi, Hidalgo.

PHYLUM CHORDATA**CLASS AMPHIBIA****Order Caudata**

Twelve species of salamander have been recorded from Mexican caves (DUNN, 1926; WOODALL, 1941; WALKER, 1955a; MARTIN, 1958; RABB, 1958, 1965; BOGERT, 1967; ELLIOTT & REDDELL, 1973; ELÍAS & WAKE, 1983).

Family Ambystomatidae

Ambystoma tigrinum (Green) has been found in caves near Valle de los Fantasma, San Luis Potosí.

Family Plethodontidae

Bolitoglossa yucatanica (Peters) is a rare species recorded from Actún Sabacá, Yucatán.

Five species of *Chiropterotriton* have been recorded from Mexican caves: *C. arboreus* (Taylor) in Hidalgo, Querétaro, and San Luis Potosí; *C. chondrostega* (Taylor) in Tamaulipas; *C. magnipes* Rabb in Querétaro and San Luis Potosí; *C. mosaueri* (Woodall) in Hidalgo; and *C. multidentatus* (Taylor) in Querétaro, San Luis Potosí, and Tamaulipas. *Chiropterotriton magnipes* is especially well-adapted for life in caves, with large sucker-like feet that allow it to easily climb cave walls.

Nyctanolis pernix Elias & Wake is known from a cave near Lagunas de Montebello, Chiapas.

Pseudoeurycea includes three species from caves in México: *P. anitae* Bogert in Oaxaca; *P. bellii* (Gray) in Tamaulipas; and *P. scandens* Walker in Tamaulipas.

Order Anura**Family Bufonidae**

Five species of bufonid toads have been found in Mexican caves (DUELLMAN, 1960; LAZCANO SAHAGÚN, 1986): *Anaxyrus debilis* (Girard) from San Luis Potosí; *A. punctatus* (Baird and Girard) from Nuevo León; *Incilius occidentalis* (Camerano) from Querétaro; *I. valliceps* (Wiegmann) from Yucatán; and *Rhinella marina* (Linnaeus) from Chiapas, Puebla, Tamaulipas, and Yucatán;

Family Craugastoridae

The following species of *Craugastor* have been recorded from caves in México (TAYLOR, 1949; SMITH & VAN GELDER, 1955; MARTIN, 1958; DUELLMAN, 1965; LYNCH, 1965, 1967, 1970a; FLORES VILLELA *et al.*, 1991): *C. alfredi* (Boulenger) in Veracruz; *C. augusti augusti* (Dugès) in Guerrero, San Luis Potosí, and Tamaulipas; *C. a. cactorum* (Taylor) in Guerrero, Morelos, and Puebla; *C. decoratus decoratus* (Taylor) in Hidalgo, Querétaro, San Luis Potosí, Tamaulipas, and Veracruz; *C. decoratus purpureus* (Lynch) in Oaxaca and Tamaulipas; *C. guerreroensis* (Lynch) in Guerrero; *C. pygmaeus* (Taylor) and *C. rhodopis* (Cope) in Puebla; *C. spatulatus* (Smith) in Oaxaca; *C. stuarti* (Lynch) in Chiapas; and *C. yucatanensis* (Lynch) in Quintana Roo.

Family Eleutherodactylidae

Six species of *Eleutherodactylus* (*Syrrhophus*) have been found in Mexican caves (MARTIN, 1958; LYNCH, 1970b): *E. (S.) cystignathoides* (Cope) and *E. (S.) dennisi* (Lynch) in Nuevo León, San Luis Potosí, and Tamaulipas; *E. (S.) guttilatus* (Cope) in San Luis Potosí; *E. (S.) longipes* (Baird) in Nuevo León, Querétaro, San Luis Potosí, and Tamaulipas; *E. (S.) nitidus* (Peters) in Guerrero and Morelos; and *E. (S.) verrucipes* Cope in Hidalgo and Puebla. ESPINO DEL CASTILLO *et al.* (2009) has studied the seasonal distribution and circadian activity of *E. (S.) longipes* in Cueva de los Riscos, Querétaro.

Family Leptodactylidae

Two species of *Leptodactylus* have been recorded from Mexican caves (FLORES VILLELA *et al.*, 1991): *L. melanonotus* (Hallowell) in Guerrero and Veracruz; and *L. mystacinus* (Burmeister) in Campeche and Yucatán

CLASS REPTILIA**Order Squamata****Family Boidae**

Boa constrictor imperator Daudin, was collected in Cueva Tezoapa, Guerrero, where it was presumably preying on bats (VILLA R. & LÓPEZ-FORMENT, 1966).

Family Colubridae

Five colubrid snakes have been identified from Mexican caves (GAIGE, 1938; MARTIN, 1958; DUELLMAN, 1965; VILLA R. & LÓPEZ-FORMENT, 1966; MYERS, 1974; SCOTT, 1984; BAYONA MIRAMONTES & SÁNCHEZ CHÁVEZ, 2007): *Elaphe flavirufa flavirufa* (Cope) in Cueva de la Sepultura, Tamaulipas; *E. f. phaescens* Dowling in Cueva de Kantemó, Quintana Roo and Cenote de Ake, Yucatán; *Rhadinaea gaigei* Bailey in San Luis Potosí and Tamaulipas; *Storeria dekayi* (Holbrook) in Sótano de Tlamaya, San Luis Potosí; and *Tropidodipsas sartorii sartorii* Cope in Quintana Roo and Yucatán.

Family Viperidae

The highly poisonous “nauyaca” o “cuatro narices” *Bothrops asper* (Garman) has been encountered in the entrance zone of caves in Chiapas, San Luis Potosí, Tamaulipas, Veracruz, and Yucatán.

Three species of rattlesnake have been recorded from cave entrance areas (DUELLMAN, 1961): *Crotalus atrox* Baird & Girard in northern México; *C. pusillus* Klauber in Michoacán; and *C. tzabcan* Klauber in Campeche and Yucatán;

Family Eublepharidae

Coleonyx elegans Gray has been found in caves in Yucatán (GAIGE, 1938).

Family Phyllodactylidae

Three species of this family have been found in Mexican caves (GAIGE, 1938; MAUTZ, 1982; BEUTELSPACHER & LÓPEZ-FORMENT, 1991; FLORES VILLELA *et al.*, 1991): *Phyllodactylus lanei* Smith and *P. tuberculosus tuberculosus* (Wiegmann) in Guerrero; and *Thecadactylus rapicaudus* (Houttuyn) in Yucatán.

Family Xanthusiidae

Six species of lizards of the genus *Lepidophyma* are frequently found in caves, occasionally in the dark zone (BEZY & CAMARILLO, 2002; GONZÁLEZ, 1995): *L. flavimaculatum* Duméril in Tabasco; *L. gaigeae* Mosauer in Hidalgo and Querétaro; *L. lipetzi* Smith and Álvarez del Toro in Chiapas; *L. micropholis* Walker in the Sierra de El Abra, Tamaulipas; *L. occulor* Smith in San Luis Potosí and Tabasco; *L. smithii* Bocourt in Guerrero; and *L. tarrascae* Bezy, Webb, & Álvarez in Cueva La Virgen, Michoacán.

CLASS AVES

Order Apodiformes

Family Apodidae

White-throated swifts *Streptoprocne zonaris mexicana* Ridgway roost in caves, frequently in large numbers. They have been recorded from caves in Chiapas, Guerrero, Nuevo León, Puebla, San Luis Potosí, and Veracruz. Their nesting habits in caves have been studied by WHITACRE & UKRAIN (1982).

Order Passeriformes

Family Hirundinidae

Cave swallows, *Petrochelidon fulva citata* Van Tyne, nest in caves in the Yucatán Peninsula, and *P. fulva pallida* (Nelson) in caves in Chihuahua.

Family Momotidae

The turquoise-browed motmot *Eumomota superciliosa* (Sandbach) is ubiquitous in the entrance of caves in the Yucatán Peninsula.

Two species of the genus *Momotus* have been recorded from Mexican caves: the russet-crowned motmot *M. mexicanus* Swainson in Chiapas and the blue-crowned motmot *M. momota coeruleiceps* (Gould) in Tamaulipas.

Family Psittacidae

The military macaw *Ara militaris* Linnaeus and the green parakeet *Aratinga holochlora* (Sclater) nest in large, deep open pits in Querétaro, San Luis Potosí, and Tamaulipas.

Order Strigiformes

Family Tytonidae

The barn owl *Tyto alba* (Scopoli) has been recorded roosting in caves in Baja California Norte, Guerrero, Oaxaca, Puebla, San Luis Potosí, Sonora, Tamaulipas, and Yucatán.

CLASS MAMMALIA

Order Chiroptera

Mexican bats have been well-studied because of the possibility of disease (histoplasmosis and rabies). MARTÍNEZ, 1939, 1941; MARTÍNEZ & VILLA, 1941a, 1941b performed the first studies, then R. B. VILLA & LÓPEZ-FORMENT (1966) published numerous articles and in 1966 the monograph "Los Murciélagos de México."

Close to 100 species and subspecies have been recorded from the caves and mines of México (VILLA, 1967; REDDELL, 1981; WILSON *et al.*, 1985; MEDELLÍN & LÓPEZ-FORMENT, 1986; MEDELLÍN *et al.*, 1983, 1987; REID, 1997; BRUNET & MEDELLÍN, 2001; HUTSON *et al.*, 2001; AVILA-FLORES & MEDELLÍN, 2004; TORRES-FLORES *et al.*, 2012; VARGAS-CONTRERAS *et al.*, 2012; AYALA-TÉLLEZ & DE LUNA ORNELAS, 2013) The Mexican caves contain insectivorous, nectarivorous, frugivorous, carnivorous, and hematophagous bats. The guano of each type of bat is inhabited by its own distinctive faunal assemblage.

Family Emballonuridae

Two species of *Balantiopteryx* have been recorded from Mexican caves: *B. io* Thomas from Chiapas, Oaxaca, Tabasco, and Veracruz may be present within the twilight zone as well as in total darkness, with colonies as large as 1000 individuals; and *B. plicata* Peters from caves in Colima, Guerrero, Jalisco, México, Michoacán, Morelos, Nayarit, Oaxaca, Puebla, San Luis Potosí, Sinaloa, Sonora, and Tabasco.

Two species of *Pteropteryx* are known from Mexican caves: *P. kappleri* Peters with few bats in small caves in Tabasco and Veracruz; and *P. macrotis* (Wagner) from Chiapas, Quintana Roo, Tabasco, Veracruz, and Yucatán.

Saccopteryx bilineata centralis Thomas from a few caves in Campeche, Jalisco, and Oaxaca, as well as in roosts in hollow trees.

Family Molossidae

Three species of *Nyctinomops* are recorded from Mexican caves and mines: *N. aurispinosus* (Peale) from San Luis Potosí and Tamaulipas; *N. femorosaccus* (Merriam) from a cave in Sinaloa and a mine in Sonora; *N. laticaudatus ferrugineus* Goodwin from Nayarit and Tamaulipas; and *N. l. yucatanicus* Miller from Campeche and Yucatán.

Tadarida brasiliensis mexicana (Saussure) is frequently present in caves in colonies ranging into the millions. The enormous guano deposits in caves in northern México have been mined. The species is of considerable economic importance because of the large numbers of harmful insects that it consumes. The species has been recorded from caves in Baja California Sur, Chiapas, Chihuahua, Coahuila, Distrito Federal, Durango, Hidalgo, Jalisco, Michoacán, Nuevo León, San Luis Potosí, Sinaloa, Sonora, and Tamaulipas.

Family Mormoopidae

Mormoops megalophylla megalophylla Peters is an insectivorous bat that may occur in colonies of up to several thousand in caves with high temperature and humidity. It has been recorded from caves in Baja California Sur, Campeche, Chiapas, Chihuahua, Coahuila, Colima, Durango, Hidalgo, Jalisco, Morelos, Nuevo León, Oaxaca, Puebla, San Luis Potosí, Sinaloa, Sonora, Tabasco, Tamaulipas, Veracruz, and Yucatán.

Four species of *Pteronotus* are recorded from Mexican caves and mines: *P. davyi fulvus* (Thomas), frequently present in large colonies, in Campeche, Chiapas, Colima, Guerrero, Jalisco, Morelos, Nuevo León, San Luis Potosí, Sinaloa, Sonora, Tabasco, Tamaulipas, Veracruz, and Yucatán; *P. gymnotus* Natterer in Campeche and Veracruz; *P. parnelli mesoamericanus* Smith in Campeche, Chiapas, Quintana Roo, Tabasco, and Yucatán; *P. p. mexicanus* (Miller) in Chihuahua, Guerrero, Colima, Jalisco, México, Morelos, Puebla, San Luis Potosí, Sinaloa, Sonora, Tamaulipas, and Veracruz; and *P. personatus psilotis* (Dobson), frequently in large colonies, in Campeche, Colima, Guerrero, Jalisco, Morelos, San Luis Potosí, Sinaloa, Sonora, Tabasco, and Veracruz.

Family Natalidae

The insectivorous funnel-eared bat *Natalus mexicanus* Miller has been found in caves and mines in Baja California Sur, Campeche, Chiapas, Chihuahua, Colima, Distrito Federal, Guerrero, Jalisco, Morelos, Nuevo León, Puebla, Quintana Roo, San Luis Potosí, Sinaloa, Sonora, Tabasco, Tamaulipas, Veracruz, and Yucatán.

Family Phyllostomidae

Anoura geoffroyi lasiopyga Gray is a primarily insectivorous species that has been recorded from caves in Chiapas, Guerrero, México, Morelos, Sinaloa, Sonora, and Tamaulipas.

Six species of fruit-eating bats of the genus *Artibeus* have been recorded from Mexican caves and mines: *A. aztecus aztecus* Andersen in Guerrero, México, Michoacán, Querétaro, San Luis Potosí, Sinaloa, and Tamaulipas; *A. aztecus minor* Davis in Chiapas; *A. hirsutus* Andersen in Chihuahua, Guerrero, Morelos, Nayarit, and Sinaloa; *A. jamicensis paulus* Davis in Chiapas; *A. j. richardsoni* J. A. Allen in Tabasco; *A. j. triomylus* Handley in Guerrero, Jalisco, México, Michoacán, and Morelos; *A. j. yucatanicus* J. A. Allen in Puebla, Quintana Roo, San Luis Potosí, Veracruz, and Yucatán; *A. lituratus* (Olfers) in Chiapas, Guerrero, Morelos, Puebla, San Luis Potosí, and Tamaulipas; *A. phaeotis phaeotis* Miller in Quintana Roo and Tabasco; and *A. toltecus toltecus* Saussure in Chiapas, Morelos, Nuevo León, and Veracruz.

Three species of *Carollia* have been found in Mexican caves: *C. perspicillata* (Linnaeus) in Chiapas, Puebla, Quintana Roo, Tabasco, Veracruz, and Yucatán; *C. sowelli* Baker, Solari, & Hoffmann in Chiapas, Puebla, Quintana Roo, San Luis Potosí, Tabasco, Tamaulipas, and Veracruz; and *C. subrufa* (Hahn) in Tabasco.

Choeronycteris mexicana Tschudi, a nectar-feeding species, is known from caves and mines in Baja California Norte, Chihuahua, Coahuila, Durango, Guerrero, Hidalgo, Jalisco, Michoacán, Morelos, San Luis Potosí, Sinaloa, Sonora, Tamaulipas, and Tlaxcala.

Chrotopterus auritus auritus (Peters) is primarily a carnivorous species. It has been recorded from caves in Chiapas, Oaxaca, Quintana Roo, Veracruz, and Yucatán.

The common vampire bat *Desmodus rotundus murinus* Wagner is the best-studied bat in México because of the incidence of rabies transmission by the species (WIMSATT, 1969; LÓPEZ-FORMENT, 1990). It roosts in small domes or crevices in the ceiling in clusters ranging from a few to more than one hundred individuals. Pools of black, tarry guano collect beneath the roosts that are inhabited by a distinctive invertebrate fauna, including Diptera, Histeridae, and Leiodidae. The species has been recorded from caves and mines in Campeche, Chiapas, Chihuahua, Colima, Guerrero, Hidalgo, Jalisco, México, Michoacán, Morelos, Nuevo León, Oaxaca, Puebla, Querétaro, Quintana Roo, San Luis Potosí, Sinaloa, Sonora, Tabasco, Tamaulipas, Veracruz, Yucatán, and Zacatecas.

The white-winged vampire bat *Diaemus youngi* (Jentink) is a rare species that feeds on mammals. The only cave record for México is Grutas de Coconá, Tabasco.

The hairy-legged vampire bat *Diphylla ecaudata centralis* Thomas feeds on avian blood. It leaves only dry, brown stains beneath its roosts. It has been recorded from caves in Chiapas, Hidalgo, Oaxaca, Puebla, Querétaro, Quintana Roo, San Luis Potosí, Tamaulipas, Veracruz, and Yucatán.

Four species of fruit-eating bats of the genus *Glossophaga* have been found in Mexican caves and mines: *G. commissarisii hespera* Webster & Jones from a mine in Jalisco and a cave in Sinaloa; *G. leechii* (Gray) in Guerrero, Michoacán, Morelos, Tlaxcala; *G. morenoi mexicana* Webster & Jones in Oaxaca; *G. m. morenoi* Martínez & Villa R. in Guerrero and Morelos; *G. soricina handleyi* Webster & Jones in Campeche, Chiapas, Guerrero, Jalisco, Puebla, Quintana Roo, San Luis Potosí, Tamaulipas, and Yucatán; and *G. S. mutica* Merriam, known only from the Islas Tres Marias, Nayarit, from caves on Isla Maria Madre. The genus has been the subject of considerable taxonomic confusion and many earlier

records can not be placed in a species without examination of the specimens. Doubtless some of the species will have been recorded from caves in other states than those listed above.

Glyphonycteris sylvestris Thomas has been found in caves in Colima, Jalisco, and Veracruz.

Hylonycteris underwoodi underwoodi Thomas is a rare frugivorous and nectarivorous species found in caves in Tabasco and Veracruz.

Lampronnycteris brachyotis (Dobson) has been found in caves in Veracruz.

Two species of nectarivorous long-nosed bats of the genus *Leptonycteris* have been taken from Mexican caves and mines: *L. nivalis* (Saussure) from Coahuila, Colima, Distrito Federal, Guerrero, Hidalgo, Jalisco, México, Morelos, Nuevo León, San Luis Potosí, and Tamaulipas; and *L. yerbabuena* Martínez & Villa R. from Chiapas, Chihuahua, Guerrero, Hidalgo, Jalisco, México, Morelos, Puebla, San Luis Potosí, Sinaloa, and Sonora.

Lonchorina aurita Tomes is a nectarivorous species that roosts in small clusters. It has been found in caves in Oaxaca, Quintana Roo, and Tabasco.

Macrophyllum macrophyllum Schinz is known only from a cave near Teapa, Tabasco.

Two species of leaf-nosed bats of the genus *Macrotus* have been found in Mexican caves: *M. californicus* Baird in Baja California Sur, Chihuahua, and Sonora; *M. waterhousii bulleri* H. Allen in Hidalgo, Jalisco, Nayarit, Nuevo León, Querétaro, Sinaloa, and Sonora; and *M. w. mexicanus* Saussure in Colima, Guerrero, México, Morelos, Oaxaca, Puebla, and Yucatán.

Macrotus waterhousii Gray was present in Cueva del Salitre, Colima.

Micronycteris meglotis mexicana Miller is known from caves in Guerrero, Jalisco, Morelos, San Luis Potosí, Tabasco, Tamaulipas, and Yucatán.

The spear-nosed bat *Mimon bennetti* (Gray) roosts in small numbers and feeds on fruit and insects. It has been found in caves in Chiapas, Oaxaca, Tabasco, Veracruz, and Yucatán.

Musonycteris harrisoni Schaldach and McLaughlin is a nectarivorous species found in caves in Guerrero.

Sturnira lilium parvidens Goldman has been taken from caves in Guerrero, Puebla, Quintana Roo, Tabasco, and Yucatán.

Trachops cirrhosus coffini Goldman, a carnivorous and insectivorous species with white droppings that resemble the feces of birds more than those of bats has been found in caves in Oaxaca and Veracruz.

Family Vespertilionidae

The primarily insectivorous pallid bat *Antrozous pallidus pallidus* (LeConte) has been found in caves in Chihuahua and Durango and a mine in Sonora.

Two insectivorous *Eptesicus* have been found in Mexican caves: *E. furinalis gaumeri* (J. A. Allen) in Morelos and Yucatán; *E. fuscus miradorensis* H. Allen in Michoacán, Oaxaca, Puebla, Tamaulipas, and Veracruz; and *E. fuscus pallidus* Young in Coahuila.

Two species of *Corynorhinus* are known from Mexican caves and mines: *C. mexicanus* G. M. Allen in Chihuahua, Jalisco, México, Michoacán, Morelos, Querétaro, San Luis Potosí, Tamaulipas, Tlaxcala, Yucatán, and Zacatecas; *C. townsendii australis* (Handley) in Aguascalientes, Chihuahua, Coahuila, Durango, Guerrero, Hidalgo, Jalisco, México, Michoacán, Nuevo León, Querétaro, and San Luis Potosí; and *C. t. pallescens* (Miller) in Baja California Norte, Baja California Sur, and Sonora.

Idionycteris phyllotis (Allen) is an insectivorous bat only known from one cave in Querétaro.

Eight species of insectivorous *Myotis* have been found in Mexican caves and mines: *M. auriculus apache* Hoffmeister and Krutzsch only from a mine in Sonora; *M. californicus californicus* (Audobon and Bachman) in a mine in Sonora; *M. c. mexicanus* (Saussure) from one cave each in Guerrero and Tlaxcala; *M. californicus stephensi* Dalquest from a mine in Baja California Norte; *M. ciliolabrum melanorhinus* Merriam in Chihuahua; *M. keaysi pilosatibialis* LaVal, frequently present in large numbers, in Campeche, Puebla, Quintana Roo, San Luis Potosí, Tamaulipas, Veracruz, and Yucatán; *M. nigricans nigricans* (Schinz) in Oaxaca, Puebla, Tamaulipas, and Veracruz; *M. peninsularis* Miller in Baja California Sur; *M. thysanodes aztecus* Miller in Chiapas, Guerrero, and Veracruz; *M. t. thysanodes* Miller in Baja California Norte, Chihuahua, Durango, and Nuevo León; *M. velifer incautus* J. A. Allen, present at times in colonies of thousands, in Coahuila, Nuevo León, and Tamaulipas; and *M. v. velifer* J. A. Allen, in Durango, Jalisco, Morelos, Puebla, Sinaloa, Sonora, Tlaxcala and Veracruz. The fish-eating bat *M. vivesi* Menegaux has been found in caves in Baja California Sur.

The canyon bat *Parastrellus hesperus* H. Allen is known from caves in Guerrero and Nuevo León and a mine in Sonora.

Perimyotis subflavus veraecrucis (Ward) is known only from caves in Veracruz.

Rhogeessa tumida major Goodwin is known from caves in Guerrero.

Order Rodentia

Family Cricetidae

Hodomys alleni (Merriam) has been found in caves in Jalisco and Morelos (DAVIS & RUSSELL, 1954; GENOWAYS & JONES, 1973).

The genus *Neotoma* includes two species recorded from Mexican caves (DALQUEST, 1953; HOOPER, 1953; HALL & DALQUEST, 1963): *N. angustapalata* Baker builds its nests in caves, in Tamaulipas; *N. mexicana griseoventer* Dalquest in San Luis Potosí and Veracruz; and *N. m. torquata* Ward in México, Morelos, and Veracruz.

Ototylomys phyllotis Merriam is known from caves in Yucatán (PEARSE & KELLOGG, 1938).

Two species of *Peromyscus* have been reported from Mexican caves (HALL & DALQUEST, 1963; DALQUEST & ROTH, 1970): *P. mexicanus* (Saussure) in Veracruz, and *P. pectoralis* Osgood in Cueva del Abra, Tamaulipas.

Family Erithizontidae

The Mexican porcupine, *Coendou mexicanus* (Kerr), has been reported from caves in Yucatán (PEARSE & KELLOGG, 1938).

III. 3 – Cave microbiota

The microbiota of Mexican caves is poorly known with the exception of numerous studies on the pathogenic fungus *Histoplasma capsulatum*. Studies on algae and protists include: OSORIO-TAFALL (1943) on caves in San Luis Potosí; HOFFMANN *et al.* (1986) on caves in Guerrero and Morelos, SÁNCHEZ *et al.*, (2002) on caves and cenotes in Quintana Roo; SCHMITTER-SOTO *et al.* (2002) on cenotes in Quintana Roo; and SIGALA-REGALADO *et al.* (2011) on caves in Guerrero.

ARCHAEA

The only study of Archaea in Mexican caves has been in five water-filled sinkholes in Tamaulipas (SAHL *et al.*, 2010, 2011). The group C2 Crenarchaeota dominated the archaeal diversity, with abundance increasing at depth. Other sequences grouped with the Methanomicrobia and anaerobic methane oxidizers (ANME-1).

KINGDOM BACTERIA

The bacterial fauna of Mexican caves has been little studied. ALCOCER *et al.* (1999); SÁNCHEZ *et al.* (2002), TORRES-TALAMANTE *et al.* (2011), and VAN HENGSTUM *et al.* (2009) have examined the bacteria of caves and cenotes in Quintana Roo; HOSE *et al.* (2000) has studied the bacteria of Cueva de las Sardinias, Tabasco; SAHL *et al.* (2010, 2011) have conducted a preliminary study of the bacteria of Cenote Azufrosa, Cenote Caracol, Cenote La Pilita, Sistema Zacatón, and Cenote Verde, deep water-filled sinkholes near Rancho La Azufrosa, Tamaulipas.

SAHL *et al.* (2010, 2011) identified two possible new phyla of bacteria from the caves of Rancho La Azufrosa, reported as Azufrosa Groups 1 and 4. Some were taken only from great depths.

PHYLUM ACIDOBACTERIA

Acidobacteria was present in small numbers throughout the water column in Sistema Zacatón.

PHYLUM ACTINOBACTERIA**CLASS ACTINOBACTERIA****Order Acidimicrobiales****Family Acidimicrobiaceae**

Bacteria similar to *Acidimicrobium ferrooxidans* Clark & Norris, a mineral-sulphide oxidizing species, was found in Cueva de las Sardinias, Tabasco.

PHYLUM BACTERIODETES

Bacterial sequences of this phylum from the water columns in Cenote Caracol, Cenote La Pilita, and Sistema Zacatón, Tamaulipas, were related to sequences from anoxic, freshwater lake sediment.

PHYLUM CHLOROBI**CLASS CHLOROBIA****Order Chlorobiales****Family Chlorobiaceae**

Sequences phylogenetically related to *Chlorobium phaeobacteroides* Pfennig were present in the water column in Cenote Caracol and Sistema Zacatón, Tamaulipas.

PHYLUM CHLOROFLEXI

Chloroflexi sequences were dominant in microbial mats in Cenote La Pilita and were also present in Cenote Caracol and Sistema Zacatón, Tamaulipas.

PHYLUM CYANOBACTERIA

Cyanobacteria was most abundant above 100 m in depth in Sistema Zacatón, Tamaulipas, and present throughout the water column in Cenote La Pilita.

CLASS CYANOPHYCEAE**Order Chroococcales****Family Spirulinaceae**

Spirulina sp. was found in the cave connected to Cenote Mayan Blue, Quintana Roo.

Order Oscillatoriales**Family Formidiaceae**

Phormidium sp. was found in Sistema Nohoch Hol, Quintana Roo; and *P. tenue* (Meneghini) Gomont was found in the cave connected to Cenote Mayan Blue, Quintana Roo.

Family Oscillatoriaceae

Lyngbya sp. was found in the caves connected to Cenote Cristal and Cenote Mayan Blue, Quintana Roo.

Oscillatoria agardhii Gomont was found in the cave connected to Cenote Mayan Blue, Quintana Roo.

Order Synechococcales

Family Merismopediaceae

Aphanocapsa sp. was found in the cave connected to Cenote Mayan Blue, Quintana Roo.

PHYLUM FIRMICUTES

The phylum Firmicutes was present in low densities throughout the water column in Sistema Zacatón, Tamaulipas.

PHYLUM NITROSPIRAE

CLASS NITROSPIRA

Order Nitrospirales

Family Nitrospiraceae

Sequences of the sulfate reducing genus *Thermodesulfovibrio* were obtained from deeper parts of Sistema Zacatón, Tamaulipas.

PHYLUM PLANCTOMYCETES

Sequences of Planctomycetes were obtained from deep microbial mat samples in Cenote La Pilita and Sistema Zacatón, Tamaulipas.

PHYLUM PROTEOBACTERIA

CLASS BETAPROTEOBACTERIA

Order Hydrogenophilales

Family Hydrogenophilaceae

Eighteen clones of *Thiobacillus*, a sulphur-oxidizing genus, were abundant in Cueva de las Sardinias, Tabasco.

Order Neisserales

Bacteria from the water column in Cenote La Pilita, Tamaulipas, are related to specimens obtained from a deep subsurface gold mine.

Order Rhodocyclales

A sample from the surface of Cenote La Pilita, Tamaulipas, groups with the order Rhodocyclales.

CLASS DELTAPROTEOBACTERIA

Sequences of 15 OTUs found in deep samples in Sistema Zacatón, Tamaulipas, were not closely related to known sequences.

Order Syntrophobacterales

Family Syntrophoaceae

Sequences related to *Desulfominile tiedjei* DeWeerd, Mandelco, Tanner, Woese, & Suflita were found in Sótano de Zacatón, Tamaulipas.

Family Syntrophobacteraceae

Sequences related to *Syntrophobacter pfennigii* Wallrabenstein, Hauschild, & Schink were found in Sótano de Zacatón, Tamaulipas.

CLASS EPSILONPROTEOBACTERIA

Order Campyloacterales

Family Campylobacteraceae

Actinobacter sp. was present in the water column of Sistema Zacatón, Tamaulipas.

Specimens from Sistema Zacatón, Tamaulipas, collected at -273 m were phylogenetically related to the sulfide-oxidizing species *Sulfuricurvum kujense* Kodama & Watanabe, originally collected from an underground crude oil storage facility.

CLASS GAMMAPROTEOBACTERIA

Sequences of this class from the water column in Sistema Zacatón, Tamaulipas, were closely related to sequences from deep subsurface mine fluids in South Africa. Samples from the surface in Cenote La Pilita, Tamaulipas, were distinct from samples in the deep zone

PHYLUM SPIROCHAETES

The phylum Spirochaetes was rare throughout the water column in Sistema Zacatón, Tamaulipas.

KINGDOM FUNGI

The best-studied fungus in Mexican caves is *Histoplasma capsulatum* Darling. Other studies include: WOLF (1938) on Yucatán, HOFFMANN *et al.* (1986) on Guerrero and Morelos; ROSSI & ROSSI (1977) on Laboulbeniales, and ULLOA *et al.* (2006) on bat guano in Guerrero.

PHYLUM ASCOMYCOTA

CLASS DOTHIDIOMYCETES

Order. Capnodiales

Family Davidiellaceae

Cladosporium sp. has been found in Cueva del Diablo, Morelos.

Order Pleosporales

Family Pleosporaceae

Alternaria sp. has been found in Cueva del Salitre (Emiliano Zapata), Morelos.

CLASS EUROTIDIOMYCETES

Order Eurotiales

Family Trichomaceae

Five species of *Aspergillus* have been found in Mexican caves: *A. clavatus* Desmazières in Grutas de Balankanché, Yucatán; *A. flavus* J.H.F. Link in Cueva del Diablo and Cueva del Salitre (Emiliano Zapata), Morelos; *A. flavofurcatus* Batista & Maia from bat guano in Cueva de Chichicastle, Guerrero; *A. terreus* Thom var. *aureus* Thom & Raper from bat guano in Grutas de Juxtlahuaca, Guerrero; and *A. versicolor* (Vuillemin) Tiraboschi from bat guano in Cueva de Chichicastle and Cueva del Diablo, Guerrero.

Penicillium sp. was found in caves in Guerrero and Yucatán and *P. chrysogenum* Thom in Cueva del Salitre (Emiliano Zapata, Morelos).

Order Onygenales

Family Gymnoascaceae

Gymnasella citrina (Masse & Salmon) Orr *et al.* was found on bat guano in Grutas de Juxtlahuaca, Guerrero.

Gymnoascus dankaliensis (Castell) Arx was found on bat guano in Grutas de Juxtlahuaca, Guerrero.

Family Myxoterichaceae

Malbranchea aurantiaca Sigler & J.W. Carmich is known from bat guano in Grutas de Juxtlahuaca, Guerrero.

Family Onygenaceae

Aphanoascus fulvescens (Cook) Apinis was taken from bat guano in Cueva del Diablo, Guerrero.

Histoplasma capsulatum Darlington, the fungus responsible for the invasive lung disease histoplasmosis, was discovered by **Darlington** in 1908. The fungus develops on bat guano in caves and the spores are disseminated in the air. Several caves mined for guano in northern México have been named "Cueva del Muerto," "Cueva del Diablo," and "Cueva Envenenada" because of the death of guano miners from the disease. The high mortality rate among guano miners is probably the result of inhaling massive numbers of spores, malnutrition, and failure to obtain medical treatment. A prior case of the disease appears to provide immunity, since cave explorers testing positive for the disease have entered caves known to harbor the fungus without becoming ill. Explorers from areas where the disease is not endemic frequently contract the disease.

Early studies of the fungus in Mexican caves include those by AGUIRRE PEQUEÑO (1959) and GONZÁLEZ-OCHOA (1963a, b). Recent studies have been conducted on the fungus recovered from bats captured in caves in Guerrero, Morelos, Oaxaca, and Puebla (TAYLOR *et al.*, 1996, 1999, 2000, 2005).

CLASS LABOULBENIOMYCETES

Order Laboulbeniales

Family Laboulbeniaceae

Two species of Laboulbeniaceae are parasitic on Mexican Trechinae: *Laboulbenia sbordonii* Rossi & Rossi on *Mexaphaenops intermedius* from Cueva de la Perra, Tamaulipas; and *Rhachomyces quetzalcoatl* Balazuc (Fig. 33) on *Paratrechus tepoztlanensis* from Cueva de Coatepec, Morelos.

CLASS SACCHAROMYCETES

Order Saccharomycetales

Family Endomycetaceae

Geotrichum sp. was found in Cueva del Diablo, Morelos.

Family Saccharomycetacea

Four species of yeast of the genus *Candida* have been found in Mexican caves: *C. catenulata* Diddens & Lodder in Grutas de Juxtlahuaca, Guerrero; *C. ciferrii* Kreger-van Rij in Cueva de Chiantzingo, Cueva de Copala, Cueva de la Mina,

and Grutas de Juxtlahuaca, Guerrero; *C. famta* (Harrison) var. *flareri* (Cifferri & Redaellii) in Grutas de Juxtlahuaca and Cueva de Zinacantla, Guerrero; *C. guilliermondii* (Castellani) in Cueva de Chiautzingo and Grutas de Juxtlahuaca, Guerrero.

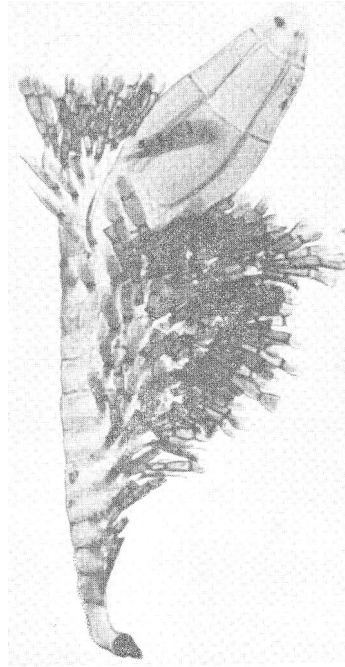


Fig. 33 – Laboulbeniales: Laboulbeniaceae: *Rhachomyces quetzalcoatl* Balazuc, 1975, on the beetle *Paratrechus tepoztlanensis* from Cueva de Coatepec, Morelos.

CLASS SORDARIOMYCETES

Order Hypocreales

Family Hypocreaceae

Acremonium sp. is a saprophile taken from bat guano in Grutas de Juxtlahuaca, Guerrero.

Order Sordariales

Family Chaetomiaceae

Chaetomium sp. was found in Cueva del Diablo, Morelos, and *C. fimeti* (Fuckel) Zopf in bat guano in Cueva del Diablo, Guerrero.

Guanomyces polythrix M. C. González, Hanlin, & Ulloa was described from bat guano in Cueva del Diablo, Morelos. (GONZÁLEZ *et al.*, 2000).

PHYLUM BASIDIOMYCOTA

CLASS AGARICOMYCETES

Order Agaricales

Family Agaricaceae

The mushroom *Coprinus* sp. has been found in Cueva del Diablo, Morelos.

CLASS UREDINIOMYCETES

Order Sporidiales

Family Sporidiolaceae

Rhodotorula sp. was taken from bat guano in Grutas de Juxtlahuaca, Guerrero.

PHYLUM ZYGOMYCOTA

CLASS ZYGOMYCETES

Order Mucorales

Family Mucoraceae

Actinomucor sp. was found in Cueva del Diablo and Cueva de San Juan, Morelos.

Mucor sp. was found in caves in Guerrero and Morelos.

Rhizopus sp. and *R. nigricans* Ehrenberg were found in caves in Guerrero and Morelos.

KINGDOM PLANTAE
PHYLUM CHAROPHYTA
CLASS CONJUGATOPHYCEAE

Order Zygnematales

Family Zygnemataceae

Spirogyra sp. was found in the cave connected to Cenote Cristal, Quintana Roo.

PHYLUM CHLOROPHYTA
CLASS CHLOROPHYCEAE

Chlorophyceae was present in Cenote La Pilita, Tamaulipas.

Order Chlamydomonales

Family Chlamydomonadaceae

Chlamydomonas sp. was found in Gruta de Aguacachil, Guerrero.

Family Volvocaceae

Volvox sp. was found in Gruta de Aguacachil, Guerrero.

Order Sphaeropleales

Family Scenedesmaceae

Scenedesmus sp. was found in the Sistema Nohoch Hol, Quintana Roo.

Family Selenastraceae

Monoraphidium sp. was found in the Sistema Nohoch Hol, Quintana Roo; and *M. minutum* (Nägeli) Komárková-Legnerová was found in the cave connected to Cenote Cristal, Quintana Roo.

CLASS TREBOUXIPHYCEAE

Order Chlorellales

Family Chlorellaceae

Chlorella sp. was found in the Sistema Nohoch Hol, Quintana Roo; and *C. vulgaris* Beyerinck was found in the cave connected to Cenote Mayan Blue, Quintana Roo.

KINGDOM CHROMISTA

PHYLUM CERCOZOA

CLASS FILOSA

Order Euglyphida

Family Euglyphitidae

Euglypha sp. has been found in Gruta de Aguacachil, Guerrero.

PHYLUM CILIOPHORA

CLASS COLPODEA

Order Colpodida

Family Colpodidae

Colpoda sp. was taken in Cueva de los Riscos, Querétaro, and five morphospecies of the genus were found in water, soil, and guano in Sistema Xalltégoxtlii, Puebla.

CLASS PROSTOMATEA

Order Prorodontida

Family Colepidae

Coleps sp. was found in Gruta de Aguacachil, Guerrero, and Cueva de los Riscos, Querétaro; and *C. sp. cf. hirtus* (Müller) in Cueva Chica, San Luis Potosí.

CLASS OLIGOHYMENOPHORA

Order Tetrahymenida

Family Glaucomidae

Glaucoma sp. was found in Gruta de Aguacachil, Guerrero.

Family Tetrahymenidae

Tetrahymena sp. was found in Gruta de Aguacachil and Grutas de Juxtlahuaca, Guerrero; and Cueva de los Riscos, Querétaro.

Family Turaniellidae

Colpidium sp. was found in Gruta de Aguacachil and Grutas de Juxtlahuaca, Guerrero.

Order Peniculida

Family Parameciidae

Paramecium sp. was found in Cueva de los Riscos, Querétaro; and *P. aurelia* Ehrenberg in Gruta de Aguacachil and Grutas de Juxtlahuaca, Guerrero.

Order Pleuronematida

Family Cyclidiidae

Cyclidium sp. was found in Gruta de Aguacachil and Grutas de Juxtlahuaca, Guerrero; and Cueva de los Riscos, Querétaro.

Order Sessilida

Family Vorticellidae

Vorticella sp. was taken in Gruta de Aguacachil, Guerrero, and Cueva de los Riscos, Querétaro; and *V.* sp. cf. *microstoma* Ehrenberg in Cueva Chica, San Luis Potosí.

CLASS ARMORPHOREA

Order Clevelandellida

Family Metopidae

Metopus sp. was found in Gruta de Aguacachil, Guerrero.

CLASS HETEROTRICHEA

Order Heterotrichida

Family Blepharismidae

Blepharisma sp. was found in Gruta de Aguacachil, Guerrero.

CLASS SPIROTRICHEA

Order Sporadotrichida

Family Halteriidae

Halteria sp. was found in Gruta de Aguacachil, Guerrero.

Family Oxytrichidae

Stylonychia sp. was found in Gruta de Aguacachil and Grutas de Juxtlahuaca, Guerrero.

Order Urostylida

Family Urostylidae

Uroleptus sp. was found in Gruta de Aguacachil and Grutas de Juxtlahuaca, Guerrero.

PHYLUM HETEROKONTOPHYTA

CLASS BACILLARIOPHYCEAE

Order Achnanthales

Family Achnanthaceae

Achnanthes brevipes C. Agardh var. *intermedia* (Kützing) Cleve and *A. minutissima* Kützing were found in the caves connected to Cenote Cristal and Cenote Mayan Blue, Quintana Roo; and *A. delicatula* (Kützing) Grunow var. *hauckiana* (Gronow) Lange-Bertalot & Ruppel was found in the cave connected to Cenote Mayan Blue.

Family Cocconeidaceae

Cocconeis placentula Ehrenberg var. *lineata* (Ehrenberg) Hustedt was found in the caves connected to Cenote Cristal and Cenote Mayan Blue, Quintana Roo.

Order Bacillariales

Family Bacillariaceae

Bacillaria paradoxa J. F. Gmelin was found in the cave connected to Cenote Mayan Blue, Quintana Roo.

Four species of *Nitzschia* have been found in caves in Quintana Roo: *N.* spp. in the Sistema Nohoch Hol; *N. amphibia* Grunow, *N. frustulum* (Kützing) Grunow, and *N. sigmoidea* (Nitzsch) W. Smith in the cave connected to Cenote Mayan Blue; and *N. amphibioides* Hustedt in the caves connected to Cenote Cristal and Cenote Mayan Blue.

Order Cymbellales

Family Cymbellaceae

Cymbella gracilis (Rabenhorst) Cleve, *C. microcephala* Grunow, and *C. muelleri* Hustedt have been found in the caves connected to Cenote Cristal and Cenote Mayan Blue, Quintana Roo.

Family Gomphonemataceae

Four species of *Gomphonema* have been found in caves in Quintana Roo: *Gomphonema gracile* Ehrenberg emend von Heurck in the caves connected to Cenote Cristal and Cenote Mayan Blue; *G.* sp. aff. *insigne* Gregory and *G. intricatum* Kützing var. *vibrio* (Ehrenberg) Cleve in the cave connected to Cenote Cristal; and *G. parvulum* (Kützing) Kützing in the cave connected to Cenote Mayan Blue.

Order Eunotiales**Family Eunotiaceae**

Eunotia monodon Ehrenberg and *E. pectinalis* (Kützing) Grunow were found in the caves connected to Cenote Cristal and Cenote Mayan Blue, Quintana Roo.

Order Naviculales**Family Amphipleuraceae**

Amphiprora gigantea Grunow was found in the cave connected to Cenote Cristal, Quintana Roo.

Family Naviculaceae

Four species of *Navicula* have been found in caves in Quintana Roo: *N.* spp. in the Sistema Nohoch Hol; *N. bicephala* Hustedt in the cave connected to Cenote Mayan Blue and *N. cryptotenella* Lange-Bertelot, *N. minuscula* Grunow, and *N. radiosa* Kützing in the caves connected to Cenote Cristal and Cenote Mayan Blue.

Family Neidiaceae

Neidium sp. was found in the caves connected to Cenote Cristal and Cenote Mayan Blue, Quintana Roo.

Family Pleurosigmataceae

Gyrosigma obscurum (W. Smith) J. W. Griffith & Henfrey was found in the caves connected to Cenote Cristal and Cenote Mayan Blue, Quintana Roo.

Order Thallasiophysales**Family Catenulaceae**

Amphora coffeaformis (C. Agardh) Kützing was found in the caves connected to Cenote Cristal and Cenote Mayan Blue, Quintana Roo.

CLASS COSCINODISCOPHYCEAE**Order Biddulphiales****Family Biddulphiaceae**

Terpsinoe musica Ehrenberg was found in the cave connected to Cenote Cristal and Cenote Mayan Blue, Quintana Roo.

Order Thalassiosirales**Family Stephanodiscaceae**

Cyclotella sp. was found in the Sistema Nohoch Hol, Quintana Roo; *C. meneghiniana* Kützing was found in caves connected to Cenote Cristal and Cenote Mayan Blue, Quintana Roo.

CLASS FRAGILARIOPHYCEAE**Order Fragilariales****Family Fragilariaceae**

Synedra acus Kützing, *S.* aff. *amphicephala* Kützing, and *S. ulna* (Nitzsch) Ehrenberg were found in the caves connected to Cenote Cristal and Cenote Mayan Blue, Quintana Roo.

Tabularia fasciculata (C. Argardh) D. M. Williams & Round was found in the caves connected to Cenote Cristal and Cenote Mayan Blue, Quintana Roo.

CLASS OOMYCOTA**Order Pythiales****Family Pythiaceae**

Pythium sp. was found in Cueva del Cinco de Mayo, Yucatán.

CLASS RAPIDOPHYCEAE**Order Actinophryida****Family Actinophryidae**

Actinophrys sp. is known from caves in Querétaro and San Luis Potosí.

PHYLUM PERCOLOZOA**CLASS HETEROLOBOSEA****Order Schizopyrenida****Family Vahlkampfiidae**

Vahlkampfia sp. was found in Gruta de Aguacachil, Guerrero, and Cueva de los Riscos, Querétaro.

KINGDOM PROTOZOA**PHYLUM AMOEBOZOA**

CLASS DISCOSEA**Order Dermamoebida****Family Mayorellidae**

Mayorella sp. was found in Gruta de Aguacachil, Guerrero, and in Sistema Xalltégoxtlii, Puebla.

CLASS TUBULINEA**CLASS ARCELLINIDA****Order Arcellinina****Family Arcellinidae**

Arcella sp. was found in caves in Guerrero and Puebla and *A. vulgaris* Ehrenberg in Aktun Ha, Quintana Roo; and Cueva de los Sabinos, San Luis Potosí.

Order Diffflugina**Family Centropyxidae**

Centropyxis aculeatus Ehrenberg was found in Aktun Ha, Quintana Roo, and Cueva Chica and Cueva de los Sabinos, San Luis Potosí.

Order Euamoebida**Family Amoebidae**

Amoeba sp. was found in Cueva Chica, San Luis Potosí.

PHYLUM EUGLENOZOA**CLASS APHAGEA****Order Astacida****Family Astaciaceae**

Astasia sp. was found in Gruta de Aguacachil, Guerrero.

CLASS EUGLENOIDEA**Order Euglenales****Family Euglenaceae**

Two species of this family are known from Mexican caves: *Euglena* sp. in Gruta de Aguacachil, Guerrero; and *Phacus* sp. in Sima de la Cruz Verde, Puebla.

Order Heteronematales**Family Paranemataceae**

Entosiphon sp. was found in Cueva de los Riscos, Querétaro, *Heteronema* sp. in Gruta de Aguacachil, Guerrero; and *Peranema* sp. in Gruta de Aguacachil, Guerrero, and Cueva de los Riscos, Querétaro.

Family Petalomaceae

Petalomonas sp. cf. *pusilla* Skuja was found in Cueva de Guayateno, Puebla.

CLASS KINETOPLASTIDA**Order Trypanosomatida****Family Trypanosomatidae**

Two species of *Trypanosoma* have been recovered from caves in México (MAZZOTTI, 1946; GONZÁLEZ-ANGULO & RYCKMAN, 1967).

Trypanosoma (Schizotrypanum) cruzi Chagas was taken from the reduviid bug *Triatoma dimidiata maculipennis* in a cave at Ticul, Yucatán; and *T. (S.) vespertilionis* Battaglia was taken from the bat *Pteronotus davi fulvus* from a cave near Tuxtla Gutiérrez, Chiapas, and an abandoned mine near Coquimatlán, Colima.

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