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SISTEMÁTICA

**REVISIÓN SISTEMÁTICA DEL GÉNERO *HEMIRRHAGUS* SIMON 1903**

**(ARANEAE: THERAPHOSIDAE, THERAPHOSINAE)**

# **TESIS**

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*Presente*

Me permito informar a usted que en la reunión del Subcomité por Campo de Conocimiento Biología Evolutiva y Sistemática del Posgrado en Ciencias Biológicas, celebrada el día 7 de octubre de 2013, se aprobó el siguiente jurado para el examen de grado de **MAESTRO EN CIENCIAS BIOLÓGICAS** del alumno **MENDOZA MARROQUÍN JORGE IVÁN** con número de cuenta **99192390** con la tesis titulada "**Revisión sistemática del género *Hemirrhagus* Simon, 1903 (Araneae, Theraphosidae, Theraphosinae)**", realizada bajo la dirección del **DR. OSCAR FEDERICO FRANCKE BALLVÉ**:

Presidente: DR. JUAN JOSÉ MORRONE LUPI  
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Sin otro particular, me es grato enviarle un cordial saludo.

**ATENTAMENTE**  
"POR MI RAZA HABLARA EL ESPIRITU"  
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c.c.p. Expediente del (la) interesado (a).

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### **Nota Aclaratoria**

De acuerdo con el artículo 8 del código internacional de nomenclatura zoológica (CINZ) acerca de lo que constituye una obra no publicada. Es que declaro de manifiesto con lo estipulado por los incisos 8.2 y 8.3 del CINZ, que esta obra no ha sido editada para constituir un registro científico público y permanente o para fines de nomenclatura zoológica. Por lo que de igual manera los nombres o actos nomenclaturales contenidos en esta obra, no tienen una finalidad nomenclatural, por lo que estos nombres y actos no se hallan disponibles para su utilización.

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## Resumen

El género terafósino *Hemirrhagus* Simon 1903 es revisado con base en la revisión de las especies tipo y material adicional recolectado en México. Ocho especies fueron redescritas e ilustradas. Los machos de *H. ocellatus*, *H. papalotl* y *H. stygius*, anteriormente desconocidos, son descritos por vez primera. Cinco nuevas especies fueron reconocidas y son descritas e ilustradas. *Hemirrhagus* comprende 21 especies, todas endémicas de México. Se realizó la clave de identificación para machos y hembras de todas las especies, así como sus mapas de distribución. Nuevas características taxonómicas son incluidas en las descripciones y diferentes tipos de órganos estridulatorios son descritos por primera vez para el género. Se reporta por vez primera que *Hemirrhagus* es el único género conocido de Theraphosinae que fabrica ovisacos fijos tipo hamaca. *H. embolulatus* sp. nov. es descrita como la única especie conocida dentro del género que posee otras quillas adicionales del émbolo presentes en otros géneros de Theraphosinae. Información acerca del hábitat de las especies y datos sobre su reproducción son mencionados.

## Abstract

The theraphosine genus *Hemirrhagus* Simon 1903 is revised based on the examination of the type specimens and additional material collected in Mexico. Eight species were redescribed and illustrated. The males of *H. ocellatus*, *H. papalotl* and *H. stygius*, formerly unknown, are described for the first time. Five new species were recognized and are newly described and illustrated. Hence, *Hemirrhagus* comprises 21 species, all endemic to Mexico. All species are keyed and mapped. New taxonomic features are included in the descriptions and different types of stridulatory organs are described for the first time for the genus. It is reported for the first time that *Hemirrhagus* is the only known Theraphosinae which lay fixed eggsacs. *H. embolulatus* sp. nov. is described as the only known *Hemirrhagus* which possesses embolus keels also present in other Theraphosinae genera. Information on species habitat and reproduction are included.

## Introducción

Las tarántulas son un grupo de arañas que pertenecen a la familia Theraphosidae Thorell, 1869. Dentro del infraorden Mygalomorphae, es el grupo más diverso y con mayor distribución en el planeta (Locht, 2008). Actualmente, se reconocen 118 géneros y 933 especies dentro de la familia Theraphosidae distribuidas a nivel mundial (Platnick, 2013). En América se encuentran 51 géneros con más de 270 especies, siendo la familia más rica y diversa en el continente americano que en los demás. En México se conocen hasta hoy 13 géneros y 73 especies, siendo el 93% endémicas, ocupando así el segundo lugar del mundo en cuanto a diversidad de Theraphosidae, sólo después de Brasil (Platnick, 2013).

Según el análisis filogenético realizado por Raven (1985), la familia Theraphosidae está formada por 12 subfamilias (4 subfamilias en América). Tres de ellas (Aviculariinae, Theraphosinae, e Ichnocolineae en parte), y la subfamilia Selenocosminae sólo representada por el género *Psalmopoeus*, se encuentran en México (Locht, 2008). Sin embargo, un análisis cladístico más reciente realizado por West *et al.* (2008) mostró que la subfamilia Aviculariinae es un grupo monofilético y que dentro de este grupo se incluye al género *Psalmopoeus*. Por lo tanto las subfamilias de Theraphosidae en América quedan reducidas a tres, siendo México el único país que posee representantes de las tres subfamilias (Locht, 2008).

La subfamilia Theraphosinae es la mejor representada en nuestro país y dentro de ésta se incluye el género *Hemirrhagus* Simon, 1903 conformado por tarántulas de tamaño medio, entre 5 y 10cm; con coloración usualmente negra, ocho ocelos que presentan pigmentación periocular y uno o dos parches de sedas urticantes de coloración cobriza u oscura en el opistosoma (Smith, 1995; Pérez-Miles y Loch, 2003). Dentro de Theraphosidae, este género parcialmente se diagnostica por: 1) extensión retrolateral-ventral de las coxas y 2) presencia de sedas urticantes tipo VI en la mayoría de las especies (Pérez-Miles, 1998). Adicionalmente, difiere de otros géneros de Theraphosinae en la morfología del bulbo pedipalpal, con un subtegulum extendido y una sola quilla desarrollada retrolateralmente (Pérez-Miles y Loch, 2003; García-Villafuerte y Loch, 2010). Actualmente, el género *Hemirrhagus* está

conformado por 16 especies formalmente descritas, de las cuales *H. stygius* (Gertsch, 1971), *H. puebla* (Gertsch, 1982), *H. reddelli* (Gertsch, 1973), *H. grieta* (Gertsch, 1982) y *H. mitchelli* (Gertsch, 1982) conforman un grupo único en el mundo, por sus adaptaciones a la vida en cavernas. La ausencia de sedas urticantes, falta de pigmentación y reducción ocular, son interpretadas como reversiones relacionadas con sus hábitos troglobios (Pérez-Miles y Locht, 2003).

## **Métodos**

### *Revisión bibliográfica.*

Se revisaron las diagnósicos y descripciones originales de cada una de las especies del género *Hemirrhagus* correspondientes a las siguientes referencias bibliográficas: Ausserer 1875, Simon 1891, Gertsch 1971, 1973 y 1982, Pérez-Miles y Locht 2003 y García-Villafuerte y Locht 2010. Así como trabajos relacionados con cambios taxonómicos: Smith, 1995, Schmidt, 1997, Pérez-Miles, 1998 y Pérez-Miles y Locht, 2003.

Complementariamente, se revisaron diagnósicos y descripciones de otros géneros y especies de la subfamilia Theraphosinae. Se obtuvo mayor información de caracteres utilizados en revisiones de géneros y su codificación. Se llevó a cabo la revisión del trabajo de Pérez-Miles *et al.* (1996) acerca de la revisión sistemática y el análisis cladístico de la subfamilia Theraphosinae. Se evaluaron los caracteres utilizados en su estudio para incluir al género *Hemirrhagus* en la matriz de datos. Posteriormente se revisó el trabajo de Pérez-Miles (2000) donde complementa el análisis cladístico de la subfamilia Theraphosinae e incluye al género *Hemirrhagus*; sin embargo, los datos son incompletos debido a que sólo tomó en cuenta a *H. cervinus*, especie de la que se desconoce el macho.

Dos trabajos respecto a la revisión del género fueron encontrados: (1) Smith (1995) hace una redescrición de las especies descritas por Gertsch, aunque son parciales y les falta información e ilustraciones; (2) Pérez-Miles y Locht (2003) revisan el género y transfieren las 5 especies de *Spelopelma* (Gertsch, 1982) a *Hemirrhagus*;

hacen la descripción de 5 especies nuevas para el género y transfieren la especie *Cyrtopholis pernix* (Ausserer, 1875) a *Hemirrhagus*. Sin embargo no realizan redescrípción de las especies ya descritas y sólo mencionan algunas características para diferenciarlas de las nuevas especies que describieron. Realizaron un análisis cladístico del género con información incompleta por no contar con ejemplares de ambos sexos para la mayoría de las especies.

#### *Material biológico.*

Se revisaron los ejemplares de *Hemirrhagus* depositados en la Colección Nacional de Arácnidos (CNAN), del Instituto de Biología de la UNAM (IBUNAM), donde se encuentra el holotipo de *H. perezmilesi* García-Villafuerte y Locht, 2011. El material de muestreos de años anteriores fue clasificado, etiquetado y adicionado en la base de datos de la colección.

Se revisaron los holotipos depositados en el American Museum of Natural History (AMNH) y en el Laboratorio de Acarología Anita Hoffmann (LAAH). El material adicional encontrado en el AMNH fue identificado y etiquetado. El Dr. Stuart Longhorn, post doctorado de la National University of Ireland (NUIM), Maynooth, Irlanda, ayudó en la recopilación de datos morfológicos y fotográficos del holotipo de *H. pernix*, depositado en el British Museum of Natural History (BMNH). Se realizaron numerosos esfuerzos por contactar con la Dr. Christine Rollard, responsable de la colección de arácnidos, Museum National d'histoire Naturelle (MNHNP), Paris, para poder obtener acceso al holotipo de *H. cervinus*, pero nunca se recibió una respuesta satisfactoria de su parte, a pesar de que la solicitud de préstamo fue aprobada por el MNHNP. El Biól. Kaleb Zárate Gálvez de la colección de arácnidos, Facultad de Ciencias Biológicas, Universidad de Ciencias y Artes de Chiapas, envió para su revisión el material depositado de tarántulas procedentes de cuevas en Chiapas.



### *Trabajo de campo.*

Se realizaron recolectas en diversas localidades registradas en la literatura para las diferentes especies de *Hemirrhagus* y en las localidades adicionales donde se han colectado probables nuevas especies a fin de obtener material adicional tanto de especies descritas como no descritas.

Durante 2011 se realizaron salidas a Oaxaca, Chiapas, Estado de México, Querétaro, Morelos, Distrito Federal e Hidalgo; en 2012 a Guerrero, Veracruz, Distrito Federal, Morelos, Estado de México, Oaxaca y San Luis Potosí; y en 2013 a Querétaro y Oaxaca.

La recolecta de ejemplares se llevó a cabo manualmente, depositando los ejemplares en frascos con alcohol etílico al 80% con sus datos correspondientes de localidad. Posteriormente fueron debidamente etiquetados y capturados en la base de datos de la CNAN.

### *Morfología.*

Para realizar la identificación de las especies en el laboratorio, se emplearon las descripciones de las especies realizadas por Smith (1995) y Pérez-Miles y Locht (2003). La confirmación de la correcta identificación se realizó mediante la comparación de los ejemplares tipo de cada una de las especies descritas. La manipulación de los ejemplares se hizo con pinzas y agujas de disección, haciendo las observaciones en un microscopio estereoscópico Nikon SMZ645. La observación de estructuras reproductivas tanto masculina como femenina se llevó a cabo mediante una disección empleando agujas entomológicas y tijeras de cirugía. Estas estructuras fueron observadas en una pequeña caja petri y posteriormente fueron guardadas en un microvial junto al ejemplar de origen con sus respectivos datos.

### *Análisis Filogenético.*

#### Grupo Externo.

Se utilizó el criterio de comparación con el grupo externo, que asume que si uno de los estados de carácter presente en alguno de los taxones en estudio (grupo interno) también se encuentra en el o los taxones que no son parte del grupo de estudio (grupo externo), entonces es el estado plesiomórfico. Cuando un estado de carácter se restringe al grupo interno, es considerado apomórfico (Kitching, 1992; Kitching *et al.*, 1998; Wiley, 1987; Wiley, 2011). Los grupos externos fueron seleccionados con base en el análisis cladístico de la subfamilia Theraphosinae hecho por Pérez-Miles *et al.* (1996) y Pérez-Miles (2000), incluyendo dentro del análisis al género *Hemirrhagus* y completando toda la información faltante en la matriz de datos. Adicionalmente se incluyeron otros géneros mexicanos en el análisis. El total de grupos externos que se utilizó fue de seis, pertenecientes a los siguientes taxones: *Holothele incei* (F.O.P. Cambridge 1898), *Hapalopus formosus* (Ausserer 1875), *Cyriocosmus perezmilesi* (Kaderka 2007), *Cardiopelma mascatum* (Vol 1999), *Aphonopelma anitahoffmannae* (Locht *et al.* 2005) y *Brachypelma smithi* (F.O.P. Cambridge 1897).

#### Elección y codificación de caracteres.

Sereno (2007) menciona que los caracteres son simples características expresadas como variables independientes y que los estados de carácter son las condiciones mutuamente exclusivas de un carácter. Juntos, los caracteres y estados de carácter componen los enunciados de carácter; estos enunciados de carácter son formados de cuatro componentes funcionales identificados como localizador, variable, calificador de variable y estado de carácter, estos componentes existen únicamente en dos patrones, neomorfo y transformacional. Basado en esta definición se llevó a cabo la codificación de caracteres tomando como punto de partida trabajos filogenéticos realizados con otros géneros de la familia así como con *Hemirrhagus* (Bertani, 2001; Fukushima *et al.*, 2005; Pérez-Miles, 2000; Pérez-Miles y Locht, 2003; West y Nunn, 2010).

Se analizó la variación intraespecífica revisando hasta 20 ejemplares de cada sexo, planteando de esta manera las hipótesis de homología. Los caracteres analizados tanto internos como externos, fueron solamente en ejemplares adultos (machos y hembras). Sólo los adultos presentan los caracteres diagnósticos, y el desarrollo total de caracteres morfológicos que permiten plantear hipótesis de homología. La información fue volcada en una matriz de datos.

#### Métodos de análisis.

Se analizó una matriz de datos de 27 terminales y 100 caracteres, de los cuales 4 fueron no informativos. Los caracteres no informativos permanecen en la matriz debido a su posible utilidad diagnóstica o filogenética tras la inclusión de más terminales, pero se excluyeron de todos los análisis, por lo que no contribuyen en los índices y medidas de soporte. Los caracteres multiestado se optimizaron de manera no aditiva (Fitch, 1971), al no existir evidencia que soportara el ordenamiento en los caracteres de múltiples estados. Se realizaron dos diferentes análisis filogenéticos usando el principio de parsimonia con el criterio de comparación con el grupo externo (Watrous y Wheeler, 1981). Un primer análisis que incluyó todos los caracteres informativos y un segundo en el que se excluyeron los caracteres determinados como troglomorfismos. Wiens *et al.* (2003) mencionan que los caracteres morfológicos relacionados al hábitat cavernícola son susceptibles de convergencia por lo que estos troglomorfismos podrían agrupar a las especies que los presentan, pudiendo mostrar un arreglo filogenético engañoso derivado de la semejanza entre organismos que no es resultado directo de una historia filogenética común. Sino de una convergencia morfológica asociada a una adaptación a hábitats con presiones de selección muy similares entre sí.

Dado que la cantidad de datos en este análisis imposibilita el uso de estrategias de búsqueda exactas, se emplearon estrategias heurísticas para hallar las hipótesis más parsimoniosas para el conjunto de datos contenidos en la matriz. Se usó el programa TNT versión 1.1 (Goloboff *et al.*, 2000) en una computadora de sistema operativo Windows 8. Para el análisis se aplicó el método de búsqueda de New

Tecnology Search (Goloboff *et al.*, 2008) usando Sectorial Search, Ratchet (10000 iteraciones y 2,000 substituciones), Drift (100 ciclos) y Tree Fusing (5 rondas); memoria con un máximo de 10,000 árboles retenidos. El análisis se realizó con pesos iguales y posteriormente con pesos implicados (Goloboff, 1993).

Acorde con el criterio de pesos implicados un árbol que es más corto bajo los pesos que implica es un árbol que resuelve los conflictos de carácter en favor de los caracteres que, en el árbol en sí, tienen menos homoplasia, y por lo tanto es un árbol auto-consistente. Si el árbol no es más corto bajo los pesos que implica, el árbol es contradictorio a sí mismo: es decir, que resuelve los conflictos de carácter en favor de aquellos caracteres en los que el mismo árbol indica no confiar (Goloboff, 1993).

Para cada uno de los análisis se reportan la longitud (L) del o los árboles óptimos, los índices de consistencia (Ci) y retención (Ri). Se reporta además el valor de ajuste (f) para los árboles obtenidos durante el uso de pesos implicados. La optimización de caracteres ambiguos se llevó a cabo utilizando transformación acelerada ACCTTRAN (Accelerated Transformation), con la finalidad de d esfavorecer paralelismos y favorecer las regresiones. De acuerdo con Agnarson y Miller (2008), no existen argumentos para preferir algún algoritmo para resolver las optimizaciones ambiguas. Por lo que el empleo de ACCTTRAN es un tanto arbitrario y sólo se utiliza con el único propósito de presentar una hipótesis sobre una resolución de dichas ambigüedades.

Como medida de soporte de los clados se usó la técnica de Jackknife usando remuestreo simétrico en TNT usando 10,000 replicas, con un 50% de probabilidad de cambio. Los cladogramas obtenidos por TNT fueron exportados en formato de imagen Tree Metafile, los cuales fueron posteriormente editados con los programas FigTree ver. 1.3.1 y Adobe Illustrator CS5.

### *Biogeografía Cladística.*

Como parte de la discusión sobre las implicaciones biogeográficas de las hipótesis filogenéticas obtenidas, se emplearon herramientas de la biogeografía cladística, la cual utiliza información sobre relaciones filogenéticas entre organismos y su distribución geográfica para proponer hipótesis sobre relaciones entre áreas de endemismos (Morrone, 2013).

Se realizó un cladograma taxonómico de áreas a partir del cladograma taxonómico que prescindía de los caracteres troglomorfo. Se utilizó el Análisis de Parsimonia de Brooks (BPA por sus siglas en inglés) construyendo una matriz de datos a partir del cladograma taxonómico de áreas. Se obtuvo una matriz de 20 caracteres y 5 terminales representadas por las provincias biogeográficas donde se distribuyen las especies. El análisis de esta matriz de datos se hizo con el Programa TNT utilizando una búsqueda exacta (implicit enumeration) para poder obtener el cladograma más parsimonioso.

La regionalización de provincias biogeográficas de México que se empleó fue la de CONABIO (1997) y Morrone (2005). Se estableció que el género *Hemirrhagus* se distribuye en cinco provincias biogeográficas: Sierra Madre Oriental, Oaxaca Norte, Sierra de Chiapas (Soconusco), Eje Volcánico Transmexicano y Sierra Madre del Sur.

## TAXONOMIA

Zoological Journal of the Linnean Society



**Taxonomic revision of Hemirrhagus Simon 1903 (Araneae: Theraphosidae, Theraphosinae), with description of five new species from Mexico.**

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**Taxonomic revision of *Hemirrhagus* Simon 1903 (Araneae: Theraphosidae, Therphosinae), with description of five new species from Mexico.**

**Revision of *Hemirrhagus***

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**Abstract**

The theraphosine genus *Hemirrhagus* Simon 1903 is revised based on the examination of the type specimens and additional material collected in Mexico. Eight species are redescribed and illustrated. The males of *H. ocellatus*, *H. papaloti* and *H. stygius*, formerly unknown, are described for the first time. Five new species are recognized and are newly described and illustrated. Hence, *Hemirrhagus* comprises 21 valid species, all endemic to Mexico. All species are keyed and mapped. New taxonomic features are included in the descriptions and different types of stridulatory organs are described by first time for the genus. It is reported for the first time that *Hemirrhagus* is the only known Theraphosinae which lays fixed eggsacs. *H. embolulatus* sp. nov. is described as the only known *Hemirrhagus* which possesses embolus keels present in other Theraphosinae genera. Information on species habitat and reproduction are mentioned.

**Key Words:** Tarantula, taxonomy, morphology, stridulating organs, troglobitic species.

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### Introduction

The genus *Hemirrhagus* Simon, 1903 of the subfamily Theraphosinae Thorell 1870 is endemic to Mexico. In 1891, Simon described *Cratorrhagus cervinus* without specific locality other than Mexico. In 1903, Simon described *Hemirrhagus* to accommodate that species. One hundred years later, Pérez-Miles & Locht (2003) revised *Hemirrhagus* and established the synonymy with the genus *Spelopelma* Gertsch 1982. They included also *Cyrtopholis pernix* (Ausserer 1875) in *Hemirrhagus*, described six new species and made a cladistic analysis of the genus. Garcia-Villafuerte reports in 2008 the first fossil *Hemirrhagus* species in Miocene amber from Chiapas, Mexico. Later, Garcia-Villafuerte & Locht (2010) described *H. perezmilesi* which is the only known species that lacks tibial apophyses and is the first recent species registered from Chiapas.

This genus is made up of medium-sized tarantulas 5 to 12cm long, usually black in color, the urticating setae on the opisthosoma are arranged in one dorsomedian patch, two dorsal paramedian patches or two lateral patches. It is unique amongst all other theraphosine genera with the following character combination: (a) retrolateral coxal heels, (b) the presence of type VI urticating setae in most of the species and (c) the shape of the male palpal bulb (Pérez-Miles, 1998; Pérez-Miles & Locht, 2003; Garcia-Villafuerte & Locht, 2010).

Currently *Hemirrhagus* has 16 described species (Platnick, 2013), including *H. stygius*, *H. puebla*, *H. reddelli*, *H. grieta* and *H. mitchelli* which are the only known troglobite theraphosine spiders. The absence of urticating setae, lack of eye pigmentation and ocular reduction in those five species, are interpreted as evolutionary reversals related to their troglobitic habits (Pérez-Miles & Locht, 2003).

Examining the spider collections of the CNAN and AMNH, undescribed material of *Hemirrhagus* was found. Five new species were recognized from this material and are newly described. The generic diagnosis is emended to include newly discovered taxonomic features. Different types of stridulatory setae are described for the first time in the genus. Eight species are redescribed and illustrated. The males of *H. ocellatus*, *H. papalotl* and *H. stygius*, formerly unknown, are described for the first time. An identification key and distribution maps for all the species are presented.

### Material and Methods

The general descriptive format follows Pérez-Miles & Locht (2003) and Raven (2005) with some modifications. All measurements are in millimeters and were taken using an ocular micrometer on a Nikon SMZ645 stereomicroscope and with a digital caliper with an error of 0.1mm. Leg and palp measurements were taken along the dorsal central axis of the left side. Abbreviations: AME= anterior median eyes; ALE= anterior lateral eyes; PME= posterior median eyes; PLE= posterior lateral eyes; d= dorsal; p= prolateral; r= retrolateral; v= ventral; Rap= retrolateral tibial apophysis; Pap= prolateral tibial apophysis; SA= subapical keel; PI= Prolateral inferior keel; PS= Prolateral superior keel; R= Retrolateral keel; PMS= Posterior median spinneret; PLS= Posterior lateral spinneret; RP= Retrolateral projection of the coxa; LSC= Lateral scopular setae; PL= Plumose setae; SP= Spiniform setae; CLP= Claviform parallel setae; FHS= Femur hard setae; VG= Ventral groove. Spination description follows Pérez-Miles & Locht (2003); that of tarsal scopulae from

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Pérez-Miles (1994) and Guadanucci (2005); that of urticating hairs from Pérez-Miles (1998) and Pérez-Miles & Locht (2003) with modifications in the urticating setae patches terminology, according to their position on the opistosoma as follows: a) one dorsomedian patch, b) two dorsal paramedian patches and c) two lateral patches. Male palpal bulb keel terminology follows Bertani (2000). The diagnosis for all described species are emended. For species whose original description is adequate, only new features that were not included in the original description are described. The photographs of figures (3–25, 28–47) were taken with a digital camera coupled to a stereomicroscope. Photographs of figures (1–2) were taken with a digital camera in laboratory and field. Photographs and most of the data of the type specimen of *Hemirrhagus permix* were provided by Stuart Longhorn (Figures 26 and 27). The following photographs were provided as follows: (Fig 1B, F, L; Fig 2B, E, I, K) by Emmanuel Goyer, (Fig 1J; Fig 2G, H) by Jesus A. Cruz López, (Fig 2A) by Martin Gamache and (Fig 2C) by Leopoldo Vazquez. Distribution maps were made using gvSIG 1.2. Types of new species are deposited in the CNAN and AMNH.

Material from the following institutions was examined: AMNH= American Museum of Natural History, United States. LAAH= Laboratorio de Acarología Anita Hoffman, UNAM, México. LAE= Laboratorio de Acarología, Instituto de Ecología, Univ. Autónoma, México. CNAN= Colección Nacional de Arácnidos, UNAM, México.

Material examined for comparisons: *Hemirrhagus chilango* Pérez-Miles & Locht 2003, MEXICO: holotype ♂ LAAH, Pedregal de San Ángel, México DF 15-XI-1977, Col. A. Zaldivar; 1 juvenile LAE, Pedregal de San Ángel, México DF 13-IX-1985, no col. name; 1 ♂ CNAN 3470, Ciudad Universitaria, México DF X-2002, no col. name; 1 ♂ CNAN 3485, Pedregal de San Ángel, México DF 27-VII-2002, no col. name; 1 ♂ CNAN 4253, Bosque del Ajusco, México DF 20-VIII-2012, Col. F. Torres; 1 ♂ CNAN 4252, Instituto de Biología, UNAM Ciudad Universitaria, México DF 13-IX-2012, Col. J. Cruz. *Hemirrhagus coztic* Pérez-Miles & Locht 2003, MEXICO: holotype ♀ LAAH, Km 92.5 FFCC México-Cuernavaca, Tepoztlán, Morelos 26-XI-1978, Col. G. Lopez; 1 ♀ and 1 juvenile LAAH, Cueva de San Juan, Tepoztlán, Morelos 26-XI-1978, Col. R. Castellanos. *Hemirrhagus eros* Pérez-Miles & Locht 2003, MEXICO: holotype ♂ AMNH, El Punto, Oaxaca 28-VI-1967, Col. M. R. Bogert; paratype ♀, AMNH, El Punto, Oaxaca 5-IX-1962, Col. M. R. Bogert; 1 ♀ AMNH, El Punto, Oaxaca 5-IX-1962, Col. M. R. Bogert; 1 ♂ AMNH, El Punto, Oaxaca 19-VIII-1961, Col. C.M. & R. M. Bogert; 1 juvenile AMNH, El Punto, Oaxaca 5-IX-1962, Col. C. M. Bogert; 1 juvenile AMNH, El Punto, Oaxaca 28-VI-1967, Col. M. R. Bogert; 1 ♂ and 1 juvenile CNAN 3493, 3km al Sur de El Punto, Oaxaca 24-XI-2010, Col. G. Montiel; 1 ♂, 1 ♀ and 2 juveniles CNAN 3572, El Punto, Oaxaca 12-XII-2011, Col. J. Mendoza, G. Contreras, E. Hijmensen, E. Goyer. *Hemirrhagus gertschi* Pérez-Miles & Locht 2003, MEXICO: holotype ♂ and paratype ♀ LAAH, Resumidero, Guerrero 27-III-1976, Col. L. Rendon; 1 ♂ LAAH, Resumidero, Guerrero, without further information. *Hemirrhagus ocellatus* Pérez-Miles & Locht 2003, MEXICO: holotype ♀ LAAH, Cueva Peña Blanca, Valle de Bravo, Estado de México 6-XI-1976, Col. S. Ibarra; 3 ♂ CNAN 4457, Cueva de la Peña Blanca, Valle de Bravo, Estado de México 27-VIII-2011, Col. J. Mendoza, A. Valdez, D. Barrales, R. Monjaraz, E. Miranda. *Hemirrhagus papalotl* Pérez-Miles & Locht 2003, MEXICO: Holotype ♀ LAAH, Gruta de Aguacachil, Taxco, Guerrero 29-XI-1980, Col. I. Cascalera; 1 ♀ LAAH, Aguacachil, Guerrero 3-VIII-1980,

Col. J. Palacios; 2 juveniles LAAH, Aguacachil, Guerrero 23-I-1982, Col. I. Cascalera; 1 ♀ CNAN 4458, Cueva de Zacatecolotla, Mpio. Taxco de Alarcón, Guerrero 3-II-2012, Col. R. Monjaraz; 5 ♂ and 10 ♀ CNAN 4459, CNAN 4460, CNAN4461, Gruta de Zacatecolotla-Aguacachil, Mpio. Taxco de Alarcón, Guerrero 21-IV-2012, Col. J. Mendoza, G. Contreras, R. Monjaraz, D. Ortiz. *Hemirrhagus perezmilei* García-Villafuerte & Locht 2010, MEXICO: 1 holotype ♂ CNAN T-0395 and paratype ♀ CNAN T-0396, Cerro Tres Picos, Mpio. Villa Corzo, Chiapas XI-2007 to VI-2008, Col. K. Zárate-Gálvez, C. Pérez-Bonifaz, G. Salinas, M. A. Rabasa.

*Note:* Pérez-Miles & Locht 2003 reported that the holotype ♀ *Hemirrhagus coztic* was collected in Cueva del Diablo, Tepoztlán, Morelos by E. López. However the label with the holotype simply indicates "Km 92.5 of Mexican Railroad México-Cuernavaca 26-XI-1978 col. G. López"; this locality actually refers to Cueva de San Juan, which is located exactly along the old railroad, as is reported by Hoffmann *et al.* 1986 (incidentally, this work includes the expedition to Cueva de San Juan in 1978, in which G. López and R. Castellanos were members of the expedition team; collectors of the holotype and other examined material of *H. coztic*, respectively).

*Note:* García-Villafuerte & Locht 2010 in their publication mentioned only 1 ♂ holotype and 1 ♀ paratype of *Hemirrhagus perezmilei*, however there are three additional males labeled and deposited as paratypes: 2 ♂ CNAN T-0397 and CNAN T-0398, Cerro Tres Picos, Mpio. Villa Corzo, Chiapas XI-2007 to VI-2008, Col. K. Zárate-Gálvez, C. Pérez-Bonifaz, G. Salinas, M. A. Rabasa; 1 ♂ AMNH, same data as previous. Because they did not mention these specimens in the original description as types, but simply as other material examined, they must not be considered as part of the type series.

#### Taxonomy

##### Theraphosinae Thorell 1870

##### *Hemirrhagus* Simon, 1903

(Figs 1–49)

*Hemirrhagus* Simon, 1903: 926; Strand, 1907: 16; 1912: 175; Petrunkevitch, 1911: 71; 1928: 78; Roewer, 1942: 231; Raven, 1985: 116; Schmidt, 1993: 59; Smith, 1995: 185; Pérez-Miles, 1998: 121; Pérez-Miles & Locht, 2003: 366.  
*Spelopelma* Gertsch, 1982: 87; Smith, 1995: 32; Schmidt, 1997: 2. Junior Synonymy.

**Emended Diagnosis:** *Hemirrhagus* differs from all other theraphosine genera by retrolateral projections (heels) on ventral face of coxae on all legs. Also differs by possessing type VI urticating setae (Pérez-Miles, 1998) arranged in one dorsomedian patch, two dorsal paramedian patches or two lateral patches on most of species, with the exception of trogllobites (*H. grieta*, *H. mitchelli*, *H. puebla*, *H. reddelli* and *H. stygius*) which lacks urticating setae. Urticating setae are yellowish-orange, platinum, black or brown in color depending on the species. Differs from most theraphosine genera in the male palpal bulb with a slender embolus (except *H. embolulatus* sp. nov.). The SA is large and extending posteriorly on retrolateral face of embolus. The posterior curvature of SA occurs at embolus



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base (except *H. stygius*). The transition of tegulum to embolus forms a ventral groove. The embolus is curved retrolaterally (best seen in dorsal view). Spermathecae paired, unilobular, which can be completely separated (most of the troglobitic species) or fused at its base (epigean species).

**Type species:** *Cratorrhagus cervinus* Simon, 1891 by original designation.

**Species Included:** *Hemirrhagus benzaa* sp. nov., *Hemirrhagus cervinus* (Simon, 1891), *Hemirrhagus chilango* Pérez-Miles & Locht, 2003, *Hemirrhagus coztic* Pérez-Miles & Locht, 2003, *Hemirrhagus elliotti* (Gertsch, 1973), *Hemirrhagus embolulatus* sp. nov., *Hemirrhagus eros* Pérez-Miles & Locht, 2003, *Hemirrhagus franckei* sp. nov., *Hemirrhagus gertschi* Pérez-Miles & Locht, 2003, *Hemirrhagus grieta* (Gertsch, 1982), *Hemirrhagus guichi* sp. nov., *Hemirrhagus mitchelli* (Gertsch, 1982), *Hemirrhagus nahuanus* (Gertsch, 1982), *Hemirrhagus ocellatus* Pérez-Miles & Locht, 2003, *Hemirrhagus papalotl* Pérez-Miles & Locht, 2003, *Hemirrhagus perezmilesi* García-Vilafuerte & Locht, 2010, *Hemirrhagus pernix* (Ausserer, 1875), *Hemirrhagus puebla* (Gertsch, 1982), *Hemirrhagus reddelli* (Gertsch, 1973), *Hemirrhagus stygius* (Gertsch, 1971), *Hemirrhagus valdezi* sp. nov.

**Distribution:** The genus is endemic to Mexico and it is mostly distributed from Tamaulipas in the north to Chiapas in the south, primarily in the mountainous regions of Sierra Madre Oriental, Eje Volcánico Transversal, Sierra Norte de Oaxaca, Sierra Madre Sur and Sierra Madre de Chiapas. The troglobitic species are found primarily in the cave systems of Xilitla in San Luis Potosí, Cuetzalan in Puebla, Cacahuamilpa in Guerrero, Huautla and Acatlán in Oaxaca.

**Natural History:** The genus *Hemirrhagus* has a natural distribution in cold climate zones, can be found mainly in pine, oak or pine-oak forest (Fig 2E, F, G, I, K). Some species as *Hemirrhagus embolulatus* sp. nov. were collected in tropical forest-pine forest ecotone (Fig 2J). Most of the species (epigean) are located between 1500–3100 mamsl, although most of the troglobitic species are found in cave systems between 100–1900 mamsl. The troglobitic species inhabits inside the caves between 50–600m below the entrance (Fig 2D, H).

The *Hemirrhagus* species collected during fieldwork were found among fallen logs or under rocks, they does not make burrows as other theraphosid spiders, but lives on superficial canals without spiderweb. No species has been seen throwing their urticating hairs as a defense mechanism, but when disturbed their first reaction is to run away very quickly. In karstic and pseudokarstic formations these tarantulas are found inside the caves, walking on walls or hiding among the rocks and cracks. Because some species are specially adapted to life in caves, are considered as troglobitic species, but some others only present conspicuous troglomorphic adaptaptions, so they are considered as troglophiles.

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**Identification key for species of *Hemirrhagus* Simon, 1903**

**Adult males**

1. Type VI urticating setae present (Figs 5C, 9B, 25B)..... 2  
 Type VI urticating setae absent (Fig 31A)..... *H. stygius*
- 2 (1). Tibial apophyses present (Figs 3G, 7F, 9G)..... 3  
 Tibial apophyses absent (Fig 23D, E)..... *H. perezmilei*
- 3 (2). Retrolateral face of palp trochanter with spiniform setae (Figs 15G, 26G, 39K)..... 4  
 Retrolateral face of palp trochanter without spiniform setae..... 6
- 4 (3). Metatarsus I curved (Fig 26J, 39J)..... 5  
 Metatarsus I straight (Figs 15K)..... *H. nahuanus*
- 5 (4). Metatarsus I slightly curved (Fig 39J); VG shallow (Fig 40B); SA slightly curved posteriorly (Fig 40A)..... *H. franckei* sp. nov.  
 Metatarsus I strongly curved (Fig 26J); VG deep (Fig 27A); SA strongly curved posteriorly (Fig 27B)..... *H. pernix*
- 6 (3). Embolus slender and with only subapical keel retrolaterally extended present (Figs 4A, 8B, 11A)..... 7  
 Embolus wide and with prolateral superior keel, prolateral inferior keel, retrolateral keel and subapical keel retrolaterally extended present (Fig 37A–E)..... *H. embolulatus* sp. nov.
- 7 (6). Periocular pigmentation complete or at least strongly marked in anterior eye row (Figs 3D, 20D); urticating setae not arranged in two dorsal paramedian patches as bands (Fig 3C, 6C, 17C)..... 8  
 Periocular pigmentation strongly marked only around anterior median eyes, ocular tubercle reduced (Fig 10E); urticating setae arranged in two dorsal paramedian patches as bands (Fig 10C)..... *H. gertschi*
- 8 (7). With two dorsal paramedian or two lateral patches of urticating setae (Figs 3C, 17C, 45E)..... 9  
 With one dorsomedian patch of urticating setae (Figs 20C, 33E)..... 11
- 9 (8). With two lateral patches black in color; with more than 15 labial cuspules (Fig 3E, 45D)..... 10  
 With two dorsal paramedian patches yellowish-orange in color (Fig 17C); with fewer than 15 labial cuspules (Fig 17F)..... *H. ocellatus*
- 10 (9). Oval patches of urticating setae with well-defined margins (Fig 3F); subapical keel retrolaterally extended ends at embolus base (Fig 4A, D); metatarsus I almost straight (Fig 3H)..... *H. chilango*  
 Patches of urticating setae not oval in shape or margins poorly defined (Fig 45I); subapical keel retrolaterally extended ends at retrolateral face of the embolus (Fig 46A,

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9	D); metatarsus I curved (Fig 45H)..... <i>H. valdezi</i> sp. nov.
10	11 (8). Ocular tubercle normally developed and periocular pigmentation complete (Fig 42C); with spinose setae on patellae I to IV; SA weakly curved posteriorly (Fig 8B, 43B)..... 12
11	□ Ocular tubercle reduced, periocular pigmentation only strongly marked in anterior eye row (Fig 20D); without spinose setae on patellae I to IV; SA strongly curved posteriorly (Fig 21C)..... <i>H. papaloti</i>
12	12 (11). Subapical keel retrolaterally extended ends at retrolateral face of the embolus (Figs 34B, D; 43B, C); more than 5 spinose setae on patellae II, III, and IV; dorsomedian patch of urticating setae not heart shaped (Figs 34E, 42E)..... 13
13	□ Subapical keel retrolaterally extended ends at embolus base (Fig 8B, D); fewer than 5 spinose setae on patellae II, III and IV; dorsomedian patch of urticating setae heart shaped (Fig 7C)..... <i>H. eros</i>
14	13 (12). Dorsomedian patch of urticating setae with posterior margin notched medially, sides convex (Fig 33E); fewer than 5 spinose setae on each patellae I to IV; fewer than 10 spinose setae on femur IV; embolus longer than tegulum (Fig 34A, B)..... <i>H. benzaa</i> sp. nov.
15	□ Dorsomedian patch of urticating setae with posterior margin notched medially, sides straight (Fig 42E); more than 5 spinose setae on patellae I and II; more than 10 spinose setae on femur IV; embolus as long as tegulum (Fig 43A, B)..... <i>H. guichi</i> sp. nov.
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31	<b>Adult females</b>
32	1. Type VI urticating setae present (Fig 9B, 19B)..... 6
33	□ Type VI urticating setae absent (Fig 13B, 28E)..... 2
34	2 (1). Spermathecae completely separated or slightly fused at the base (Figs 29J, K; 30H).....3
35	□ Spermathecae close together and strongly fused at its base (Fig 28F)..... <i>H. puebla</i>
36	3 (2). Anterior median eyes present (Figs 14C, 29C, 30C).....4
37	□ Anterior median eyes absent (Fig 13D)..... <i>H. grieta</i>
38	4 (3). Periocular pigmentation strongly marked around anterior median eyes (Figs 14C, 29C).....5
39	□ Periocular pigmentation absent (Fig 30C)..... <i>H. stygius</i>
40	5 (4). Spermathecae fused at their base (Fig 14F); more than 15 labial cuspules (Fig 14D); retrolateral face of femur I without a group of hard setae proximally..... <i>H. mitchelli</i>
41	□ Spermathecae separated at their base (Fig 29J, K); fewer than 15 labial cuspules; retrolateral face of femur I with a group of hard setae proximally (Fig 29F, H)..... <i>H. reddelli</i>
42	6 (1). Urticating setae arranged in two dorsal paramedian or two lateral patches (Figs 19B, 47C).....7
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- Urticating setae arranged in one dorsomedian patch (Figs 5C, 29B, 41C)..... 10  
 7 (6). Retrolateral face of palp trochanter without claviform setae..... 8  
 Retrolateral face of palp trochanter with large parallel claviform setae (Fig 25C)..... *H. perezmilesi*  
 8 (7). Urticating setae in two dorsal paramedian patches (Fig 12C, 19B); tibiae I and II with more than 10 spinose setae; fewer than 20 labial cuspules..... 9  
 Urticating setae in two lateral patches; tibiae I and II with less than 10 spinose setae; more than 20 labial cuspules (Fig 47C)..... *H. valdezi* sp. nov.  
 9 (8). Dorsal paramedian patches of urticating setae rounded, yellowish-orange in color (Fig 19B); spermathecae longer than wide (Fig 19D); periorcular pigmentation complete (Fig 19C); more than 30 spinose setae on metatarsus IV ..... *H. ocellatus*  
 Dorsal paramedian patches of urticating setae as bands, brown in color (Fig 12C); spermathecae as long as wide (Fig 12F); periorcular pigmentation strongly marked only around anterior median eyes (Fig 12E); fewer than 30 spinose setae on metatarsus IV ..... *H. gertschi*  
 10 (6). Retrolateral face of palp trochanter without spiniform setae..... 11  
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 11 (10). Periorcular pigmentation present (complete, in anterior eye row or at least strongly marked in anterior median eyes) (Figs 5E, 6E, 38C); not all tarsal scopulae divided..... 12  
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 12 (11). Ocular tubercle poorly developed or slightly reduced (Fig 5E)..... 13  
 Ocular tubercle normally developed (Fig 38C)..... 15  
 13 (12). Labial cuspules arranged in one group (as normal) (Fig 44E)..... 14  
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 14 (13). Spermathecae bent laterally, broad at base, tapering distally (Fig 6G, H); prolateral face of coxae II and trochanter II without scopular setae; anterior and posterior margins of urticating setae patch straight (Fig 6C)..... *H. elliotti*  
 Spermathecae straight or nearly so, uniform in width (Fig 22C, D); prolateral face of coxa II and trochanter II with scopular setae; anterior and posterior margins of urticating setae patch notched, sides rounded (butterfly-shaped) (Fig 22B)..... *H. papaloti*  
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 16 (15). Prolateral face of palp femur without scopular setae; spermathecae very short and close at their base, almost as long as wide, parallel..... 17  
 Prolateral face of palp femur with scopular setae; spermathecae almost twice longer than wide, receptacles widely separated at their base, slightly bent laterally (Fig 9D, E)..... *H. eros*



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- 17 (16). Tibia IV with more than 15 spinose setae; femora III and IV with more than 4 spinose setae; dorsomedian patch of urticating setae with posterior margin notched medially, sides convex (Fig 35C).....*H. benzaa* sp. nov.  
□ Tibia IV with less than 15 spinose setae; femora III and IV with less than 4 spinose setae; dorsomedian patch of urticating setae with posterior margin notched medially, sides straight (Fig 44C).....*H. guichi* sp. nov.

***Hemirrhagus cervinus* (Simon, 1891)**

*Cratorrhagus cervinus* Simon, 1891: 330 (D♀); F.O.P.-Cambridge, 1899: 41, pl. 2, fig. 1.  
*Hemirrhagus cervinus* Simon, 1903: 926, fig. 1077; Strand, 1907: 16; 1912: 175;  
Petrunkevich, 1911: 71; 1928: 78; Roewer, 1942: 231; Raven, 1985: 116; Smith, 1995:  
185, figs. 1032-1033; Pérez-Miles, 1998: 121, figs. 1-6; Pérez-Miles & Locht, 2003: 367.

**Type material:** holotype ♀ MNHP #756, MEXICO: Without further information, not examined. Male unknown.

**Diagnosis:** The following character combination, modified from Pérez-Miles 1998; Pérez-Miles & Locht 2003, is diagnostic for *H. cervinus*. Theraphosine spider with an ocular tubercle and eyes normally developed. Periocular pigmentation absent. Tarsi I-IV scopulate, all divided. With rounded dorsomedian patch of urticating setae, grey-brown in color. Spermathecae paired, slightly fused, broad at base, tapering distally, strongly bent laterally from their base. *H. cervinus* differs from all other species of *Hemirrhagus* by the ocular tubercle and eyes normally developed but lacking periocular pigmentation. It also differs by having all tarsal scopula divided and the strong curvature of the spermathecae.

**Distribution and natural history:** Mexico, without locality, known only from the holotype.

**Note:** Despite multiple efforts to obtain the type specimen, the author received no response to loan the type by MNHP curator Dr. C. Rollard. Thus, all diagnostic features and comparisons were made based on the characteristics mentioned in Pérez-Miles 1998 and Pérez-Miles & Locht 2003.

***Hemirrhagus chilango* Pérez-Miles & Locht, 2003**  
(Figs 1A; 2F; 3A-I; 4A-D; 48)

*Hemirrhagus chilango* Pérez-Miles & Locht, 2003: 367, figs. 1-6 (D♂).

**Type material:** holotype ♂ LAAH, MEXICO: Pedregal de San Ángel, México DF 15-XI-1977, Col. A. Zaldivar. Examined. Female unknown.

**Additional material examined:** 1 juvenile LAE, MEXICO: Pedregal de San Ángel, México DF 13-IX-1985, no col. name; 1 ♂ CNAN 3470, MEXICO: Ciudad Universitaria, México DF X-2002, no col. name; 1 ♂ CNAN 3485, MEXICO: Pedregal de San Ángel, México DF 27-VII-2002, no col. name; 1 ♂ CNAN 4253, MEXICO: Bosque del Ajusco, México DF

20-VIII-2012, Col. F. Torres; 1 ♂ CNAN 4252, MEXICO: IBUNAM Ciudad Universitaria, México DF 13-IX-2012, Col. J. Cruz.

**Emended diagnosis:** The following character combination is diagnostic for *H. chilango*. Male palpal bulb with slender embolus similar in length to tegulum, SA ends at embolus base (Fig 4A, D); VG deep (Fig 4B). Embolus strongly curved retrolaterally on distal half (Fig 4C, D). The Pap is reduced with one slender spinose seta ventrally which does not exceed the apex of Pap; the Rap is narrow with one large spinose seta on dorsal face, the spinose seta exceeds the apex of Rap (Fig 3G, I). Metatarsus I almost straight (Fig 3H). Ocular tubercle and eyes normally developed, periocular pigmentation complete (Fig. 3A, D). Labial cuspules are highly variable, ranging from 16-38 (Fig. 3B, E). Urticating setae arranged in two lateral, oval patches, black in color, with well-defined margins (Figs 3C, F).

*H. chilango* differs from most *Hemirrhagus* species in having the urticating setae arranged in two lateral patches. From *H. perezmilei* by tibial apophyses well developed. Differs from *H. valdezi* sp. nov. by oval patches of urticating setae with well-defined margins rather than diffuse, and metatarsus I straight rather than curved.

**Distribution and natural history:** Known only from Mexico City (Fig 48), inhabits in shrubland and pine forest (Fig 2F).

*Hemirrhagus coztic* Pérez-Miles & Loch, 2003  
(Fig 5A–G; 48)

*Hemirrhagus coztic* Pérez-Miles & Loch, 2003: 368, figs. 7-10 (D♀).

**Type material:** holotype ♀ LAAH, MEXICO: Cueva de San Juan, Km 92.5 FFCC México-Cuernavaca, Tepoztlán, Morelos 26-XI-1978, Col G. López. Examined. Male unknown.

**Additional material examined:** 1 ♀ y 1 juvenile LAAH, MEXICO: Cueva de San Juan, Tepoztlán, Morelos 26-XI-1978, Col. R. Castellanos.

**Emended diagnosis:** The following character combination is diagnostic for *H. coztic*. Ocular tubercle reduced, all eyes normally developed; periocular pigmentation strongly marked on anterior eye row (Fig 5A, E). Labial cuspules arranged in two groups (Fig 5B, F). Urticating setae arranged in one dorsomedian patch, yellowish-orange in color, without well-defined margins, the patch is slightly extended laterally (Fig 5C). Spermathecae paired, fused at the base, each lobe widely separated at the base almost by one length, broad at base; slightly bent laterally (Fig 5G).

*H. coztic* differs from all other *Hemirrhagus* species in the labial cuspules arranged in two groups.

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**Distribution and natural history:** Known only from Cueva de San Juan, Tepoztlan, Morelos, inhabits inside the cave (Fig 48).

***Hemirrhagus ellioti* (Gertsch, 1973)**  
(Fig 2G; 6A–H; 48)

*Schizopelma ellioti* Gertsch, 1973: 144, fig. 2c (D♀)

*Spelopelma ellioti* Gertsch, 1982: 91, fig. 14; Schmidt, 1993: 68, fig. 130; Smith, 1995: 32, figs. 12-20; Schmidt, 2003: 117, fig. 65.

*Hemirrhagus ellioti* Pérez-Miles & Loch, 2003: 372-373.

**Type material:** holotype ♀ AMNH, MEXICO: San Luis Potosí, Mpio. Zaragoza, 5km al N del Valle de los Fantasma, Cueva de La Laguna, 20-V-1972, Col. W. Elliott, P. Lynn, R. M. McEachern. Examined. Male unknown

**Additional material examined:** 1 ♀ AMNH, MEXICO: San Luis Potosí, Mpio. Zaragoza, 40km E San Luis Potosí, 5km al N del Valle de los Fantasma, Cueva de La Laguna, 20-V-1972, Col. W. Elliott, P. Lynn, R. M. McEachern.

**Emended diagnosis:** The following character combination is diagnostic for *H. ellioti*.

Ocular tubercle reduced, PLE slightly integumentary and periocular pigmentation strongly marked on AME (Fig 6A, E). Urticating setae arranged in one dorsomedian patch, yellowish-orange in color, with anterior and posterior margins straight (Fig 6C). Spermathecae bent laterally, broad at base, tapering distally (Fig 6G, H). Prolateral face of coxa II and trochanter II without LSC.

*H. ellioti* differs from most *Hemirrhagus* species in the reduced ocular tubercle with periocular pigmentation strongly marked only on AME. From *H. gertschi* by urticating hairs arranged in only one dorsomedian patch and the spermathecae bent laterally. From *H. papalotl* by lacking LSC on prolateral face of coxa II and trochanter II and the patch of urticating hairs with anterior and posterior margins straight.

**Redescription.** Holotype female: body length (not including chelicerae and spinnerets): 20.31, carapace: 8.98 long, 8.37 wide. Caput not markedly elevated; fovea recurved, width 1.87. Carapace with brown setae (Fig 6A).  
Eyes: anterior eye row procurved, posterior eye row recurved. Periocular pigmentation only present in anterior eye row and strongly marked on AME. PME reduced and PLE slightly integumentary. Eye sizes and interocular distances: AME 0.28; ALE 0.345; PME 0.21; PLE 0.333; AME-AME 0.222; AME-ALE 0.148; PME-PME 0.83; PME-PLP 0.12; ALE-PLP 0.111. Ocular tubercle reduced, width 1.85; length 0.9; clypeus lacking (Fig 6E). Labium: length 1.1; width 1.9; with 11 cuspules. Maxilla inner corner with approximately 95 cuspules (Fig 6F). Cheliceral promargin with 9 teeth (proximal to distal: 1 medium, 2-3 large, 4-5 medium, 6-8 large, 9 small). Sternum length 4.0. Sigillae semicircular, third and fourth pairs hardly visible; fourth pair once its length from the margin (Fig 6B). Leg formula: IV, I, II, III. Length of legs and palpal segments (femur, patella, tibia, metatarsus, tarsus, total): I: 9.60, 4.63, 7.78, 7.78, 6.15, 35.94. II: 8.45, 4.49, 7.31, 7.64, 5.64, 33.53. III: 8.54, 3.87, 6.82, 8.32, 5.74, 33.29. IV: 10.51, 4.22, 9.05, 12.04, 7.03,

42.85. Palp: 7.17, 3.77, 5.63, -, 5.28, 21.85. Spinnerets: PMS, 0.7 long, 1.0 apart; PLS, 2.5 basal, 2.0 middle, 2.3 distal.

Scopulae: tarsi I-IV densely scopulate, III and IV divided by strong band of setae. Metatarsi I and II densely scopulate; III scopulate on distal  $\frac{2}{4}$  and IV scopulate on distal  $\frac{1}{3}$ .

Stridulatory setae: Lacking

Legs and palpi LSC in: palp trochanter prolateral and retrolateral faces, femur prolateral and retrolateral faces; leg I trochanter prolateral face, femur prolateral face.

Chaetotaxy (left side): femora I 1p; II 2p; III 1p, 3r; IV 2p, 3r; palp 2p; patellae none; tibiae I 2p, 9v; II 2p, 11v; III 2p, 9v, 3r; IV 3p, 10v, 4r; palp 1p, 11v; metatarsi I 2v; II 4v; III 3p, 9v, 3r; IV 5p, 12v, 4r.

Genitalia: Spermathecae paired, slightly fused, broad at base. Receptacles without neck defined by anterior or exterior margin; bent laterally and tapering distally (Fig 6G).

Genitalia variation: The general shape of the spermathecae is similar, but not strongly bent laterally (Fig 6H).

Urticating setae: Type VI arranged in one dorsomedian patch on the abdomen, yellowish-orange in color. All margins of the patch well defined, anterior and posterior margins evenly smooth, straight (Fig 6C).

Color pattern: Live specimens have not been observed. In ethanol the color is yellowish-brown with the abdomen darker in color.

**Distribution and natural history:** Known only from Cueva de la Laguna in San Luis Potosí, México (Fig 48). The specimens were collected in a shallow cave, less than 50m deep; there is nothing known about its life cycle. The cave is located in an oak forest area (Fig 2G).

***Hemirrhagus eros* Pérez-Miles & Locht, 2003**  
(Figs 1B, C, 2K; 7A–G; 8A–D; 9A–D; 48)

*Hemirrhagus eros* Pérez-Miles & Locht, 2003: 369, figs. 11–20 (D♂, ♀).

**Type material:** holotype ♂ AMNH, MEXICO: El Punto, Oaxaca 28-VI-1967, Col. M. R. Bogert; paratype ♀ AMNH, MEXICO: El Punto, Oaxaca 5-IX-1962, Col. M. R. Bogert. Examined.

**Additional material examined:** 1 ♀ AMNH, El Punto, Oaxaca 5-IX-1962, Col. M. R. Bogert; 1 ♂ AMNH, El Punto, Oaxaca 19-VIII-1961, Col. C.M. & R. M. Bogert; 1 juvenile AMNH, El Punto, Oaxaca 5-IX-1962, Col. C. M. Bogert; 1 juvenile AMNH, El Punto, Oaxaca 28-VI-1967, Col. M. R. Bogert; 1 ♂ and 1 juvenile CNAN 3493, 3km al Sur de El Punto, Oaxaca 24-XI-2010, Col. G. Montiel; 1 ♂, 1 ♀ and 2 juveniles CNAN 3572, El Punto, Oaxaca 12-XII-2011, Col. J. Mendoza, G. Contreras, E. Hijmensen, E. Goyer.

**Emended diagnosis:** The following character combination is diagnostic for *H. eros*. Male palpal bulb with slender embolus similar in length to tegulum, SA ends at embolus base; VG shallow (Fig 8A–D). Metatarsus I curved (Fig 7E). The Rap is normally developed with one large spinose seta on ventral face, the spinose seta exceeds the apex of Rap (Fig 7F, G). Males with spinose setae on patellae I to IV, which are absent on females. Ocular tubercle and eyes normally developed and periorcular pigmentation complete (Figs 7A; 9A,



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C). Urticating setae arranged in one dorsomedian patch, yellowish-orange in color; with well-defined margins, posterior margin slightly notched, forming a furrow (Figs 7C, 9B). Spermathecae paired, slightly fused; receptacles broad at base; slightly bent laterally (Fig 9D, E).

*H. eros* differs from most *Hemirrhagus* species in the male with spinose setae on patellae I to IV. From *H. benzaa* and *H. guichi* in the spermathecae with the receptacles widely separated at the base by nearly one length, slightly bent laterally and in SA which ends at embolus base.

**Distribution and habitat:** Known only from El Punto, Oaxaca (Fig 48), inhabits in pine forest (2K).

***Hemirrhagus gertschi* Pérez-Miles & Locht, 2003**  
(Figs 10A–H; 11A–D; 12A–F; 49)

*Hemirrhagus gertschi* Pérez-Miles & Locht, 2003: 370, figs. 21–30. (D ♂, ♀)

**Type material:** holotype ♂ and paratype ♀ LAAH, MEXICO: Resumidero, Guerrero 27-III-1976, Col. L. Rendon. Examined.

**Additional material examined:** 1 ♂ LAAH, MÉXICO: Resumidero, Guerrero, without further information.

**Emended diagnosis:** The following character combination is diagnostic for *H. gertschi*. Male palpal bulb with slender embolus similar in length to tegulum (Fig 11A, B), SA ends at retrolateral face of embolus; VG deep. The posterior curvature of SA occurs in the base of the embolus and forms an angle of 90° (Fig 11A–D). Metatarsus I curved (Fig 10D). The Rap and Pap are slightly reduced (Fig 10G, H). Ocular tubercle reduced, all eyes normally developed; periocular pigmentation strongly marked on AME (Figs 10A, E; 12A, E). Urticating setae arranged in two dorsal paramedian patches as bands along the opisthosoma, brown in color, without well-defined margins (Fig 10C, 12C). Spermathecae paired, slightly fused at the base; receptacles strongly sclerotized apically, broad at base and slightly bent laterally (Fig 12F).

*H. gertschi* differs from most *Hemirrhagus* species in the posterior curvature of SA which forms an angle of 90°. From *H. papaloti* and *H. valdezi* sp. nov. in having the urticating setae arranged in two dorsal paramedian patches as bands along the opisthosoma.

**Distribution and natural history:** Known only from Resumidero, Guerrero; inhabits inside the cave (Fig 49).

***Hemirrhagus grieta* (Gertsch, 1982)**  
(Fig 13A–F; 48)

*Spelopelma grieta* Gertsch, 1982: 93, fig. 17 (D♀); Schmidt, 1993: 68, fig. 133; Smith, 1995: 33, figs. 21–29; Schmidt, 2003: 117, fig. 65.

*Hemirrhagus grieta* Pérez-Miles & Locht, 2003: 373.

**Type material:** holotype ♀ AMNH, MEXICO: Oaxaca, Mpio. Huautla de Jiménez, Cueva de la Grieta, 8-VI-1978, Col. J. Jancewics, D. Lowney and S. Zeaman. Examined. Male unknown.

**Additional material examined:** 1 juvenile AMNH, MEXICO: Oaxaca, Mpio. Huautla de Jiménez, Sótano Li Nita, 1-III-1981, Col. A. Grubbs; 1 juvenile AMNH, MEXICO: Oaxaca, Mpio. Huautla de Jiménez, Nita Nanta, 6-IV-1983, Col. M. Minton.

**Emended diagnosis:** The following character combination is diagnostic for *H. grieta*. Ocular tubercle undeveloped, AME and PME completely absent, not even integumentary. ALE and PLE reduced, only integumentary spots; periocular pigmentation absent (Fig 13A, D). Lacking urticating setae on abdomen (Fig 13B). Labium with one cuspule (Fig 13E). Tarsus I to III scopulae divided by strong bands of setae, IV almost replaced by strong band of setae. Metatarsus IV lacking scopula. Spermathecae paired, separated at base; receptacles straight and slender throughout their length (Fig 13F).

*H. grieta* differs from all other *Hemirrhagus* in the absence of eyes, with only ALE and PLE as integumentary spots.

**Redescription.** Holotype female: body length (not including chelicerae and spinnerets): 17.48, carapace 7.35 long, 5.90 wide. Caput not elevated; fovea recurved, width 1.20 (Fig 13A).

Eyes: anterior eye row straight, posterior eye row straight. Periocular pigmentation absent. The eyes are not developed; there is only presence of subintegumental ALE and PLE light spots. Eye sizes and interocular distances: ALE 0.225; PLE 0.113; ALE-PLE 0.075. Ocular tubercle undeveloped, width 1.50; length 0.40; clypeus lacking (Fig 13D). Labium: length 0.8, width 1.1; with 1 cuspule. Maxilla inner corner with approximately 102 cuspules (Fig 13E). Cheliceral promargin with 14 teeth (proximal to distal: 1-2 medium, 3-5 large, 6-10 medium, 11-14 large). Sternum length 3.1. Sigillae circular, second, third and fourth pairs hardly visible; fourth pair one and a half times its length from the margin (Fig 13C). Leg formula: IV, I, II, III. Length of legs and palpal segments (femur, patella, tibia, metatarsus, tarsus, total): I: 6.96, 4.13, 6.94, 5.33, 4.60, 27.96. II: 6.97, 3.41, 6.24, 5.77, 4.24, 26.63. III: 5.49, 3.07, 6.01, 6.61, 4.76, 25.94. IV: 7.47, 3.43, 7.99, 9.90, 5.95, 34.74. Palp: 5.64, 3.11, 4.94, -, 4.25, 17.94. Spinnerets: PMS, 0.5 long, 0.8 apart; PLS, 1.2 basal, 0.8 middle, 1.0 distal.

Scopulae: tarsi I-III densely scopulate, IV almost absent; I to III divided by strong band of setae, IV almost replaced by strong band of setae. Metatarsi I and II densely scopulate; III scopulate on distal ¼, and IV without scopulae.

Stridulatory setae: Lacking.

Legs and palpi LSC in: palp trochanter retrolateral face; leg I coxa retrolateral face, trochanter prolateral face and femur prolateral face; leg II trochanter prolateral face.

Chaetotaxy (left side): femora I 1p; II 1p; III 1p, 2r; IV 1p, 2r; palp 1p; patellae none; tibiae: I 4v; II 1p, 5v; III 2p, 8v, 2r; IV 2p, 7v, 2r; palp 1p, 9v; metatarsi I 4v; II 4v; III 3p, 8v, 2r; IV 3p, 8v, 3r.

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Genitalia: Spermathecae paired, separated at base; receptacles longer than wide, straight and slender throughout their length; with neck defined by interior and exterior margins (Fig 13F).

Urticating setae: Lacking (Fig 13B).

Color pattern: Live specimens have not been observed. In ethanol the color is yellowish.

**Distribution and natural history:** Known from Cueva de la Grieta, Nita Nanta and Sótano Li Nita in Oaxaca, México (Fig 48). The species was collected in one of the deepest cave systems in Mexico, although the actual depth at which the holotype was collected is unknown.

**Note:** The specimens collected in Nita Nanta and Sótano Li Nita are spiderlings and may not belong to the same species as *H. grieta*, which cannot be confirmed until adult specimens are collected.

***Hemirrhagus mitchelli* (Gertsch, 1982)**

(Fig 14A–F; 49)

*Spelopelma mitchelli* Gertsch, 1982: 89, fig. 12 (D♀); Schmidt, 1993: 68, fig. 128; Smith, 1995: 34, figs. 30–40; Schmidt, 2003: 118, fig. 67.

*Hemirrhagus mitchelli* Pérez-Miles & Loch, 2003: 373.

**Type material:** holotype ♀ AMNH, MEXICO: Tamaulipas, Entrada del Viento Alto, VII-1978, Col. P. Keys and R. Anderson. Examined. Male unknown.

**Emended diagnosis:** The following character combination is diagnostic for *H. mitchelli*.

Ocular tubercle very reduced, AME and PLE reduced, PME as integumentary spots; pericocular pigmentation slightly present only in posterior eye row (Fig 14E). Lacking urticating setae on abdomen. Tarsal scopula II divided by narrow band of setae, III and IV divided by strong band of setae. Spermathecae paired, slightly fused at base; receptacles straight and with well-defined neck (Fig 14F).

*H. mitchelli* differs from all other *Hemirrhagus* in the pericocular pigmentation faintly present only in posterior eye row, the presence of PME as only integumentary spots and the spermathecae slightly fused at base but the receptacles are not bent laterally.

**Redescription.** Holotype female: body length (not including chelicerae and spinnerets): 16.96, carapace: 6.83 long, 6.30 wide. Caput not elevated; fovea straight, width 1.87. Carapace with yellowish setae (Fig 14A). Eyes: anterior eye row recurved, posterior eye row straight. Pericocular pigmentation only faintly present in posterior eye row. AME and PLE reduced, PME as integumentary spots. Eye sizes and interocular distances: AME 0.115; ALE 0.244; PLE 0.129; AME-AME 0.115; AME-ALE 0.20; ALE-PLP 0.058. Ocular tubercle very reduced, width 1.15; length 0.4; clypeus lacking (Fig 14C). Labium: length 0.79; width 1.29; with 24 cuspules. Maxilla inner corner with approximately 102 cuspules (Fig 14D). Cheliceral promargin with 10 teeth (proximal to distal: 1–3 large, 4–5 medium, 6–10 large). Sternum length 3.037. Sigillae

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9 circular, second, third and fourth pairs hardly visible; fourth pair once its length from the  
margin (Fig 14B, E).  
10 Leg formula: IV, I, II, III. Length of legs and palpal segments (femur, patella, tibia,  
11 metatarsus, tarsus, total): I: 7.29, 3.53, 6.18, 5.38, 4.30, 26.68. II: 5.78, 3.11, 5.90, 5.09,  
12 4.24, 24.12. III: 6.02, 3.04, 5.68, 6.14, 4.18, 25.06. IV: 7.87, 3.02, 6.97, 9.06, 4.86, 31.78.  
13 Palp: 5.03, 2.76, 4.67, -, 4.09, 16.55. **Spinnerets: PMS, 0.3 long, 0.55 apart; PLS, 0.8 basal,**  
14 **0.5 middle, 0.65 distal.**  
15 Scopulae: tarsi I-IV densely scopulate, II divided by narrow band of setae, III and IV  
16 divided by strong band of setae. Metatarsi I and II densely scopulate; III scopulate on distal  
17  $\frac{1}{2}$  and IV scopulate on distal  $\frac{1}{4}$ .  
18 Stridulatory setae: Lacking.  
19 Legs and palpi LSC in: palp trochanter retrolateral face, femur prolateral and retrolateral  
20 faces; leg I trochanter prolateral face, femur prolateral face.  
21 Chaetotaxy (left side): femora I 1p; II 1p; III 2p, 2r; IV 2p, 3r; palp 1p; patellae none; tibiae  
22 I 2p, 4v; II 2p, 5v; III 3p, 8v, 3r; IV 3p, 10v, 3r; palp 1p, 9v; metatarsi I 2v; II 3v; III 2p, 8v,  
23 3r; IV 4p, 9v, 4r.  
24 Genitalia: Spermathecae paired, slightly fused at base; receptacles straight and slender not  
25 bent laterally; with neck defined by interior and exterior margins (Fig 14F).  
26 Urticating setae: Lacking.  
27 Color pattern: Live specimens have not been observed. In ethanol the color is yellowish  
28 overall.

29 **Distribution and natural history:** Known only from Entrada del Viento Alto in  
30 Tamaulipas; inhabits inside the cave (Fig 49).

31 ***Hemirrhagus nahuanus* (Gertsch, 1982)**  
32 (Fig 15A–K; 16A–B; 39)

33 *Spelopelma nahuanum* Gertsch, 1982: 93, fig. 10–11 (D♂); Schmidt, 1993: 68, fig. 126–  
34 127; Smith, 1995: 35, figs. 41–43; Schmidt, 2003: 118, fig. 68–69.  
35 *Hemirrhagus nahuanus* Pérez-Miles & Loch, 2003: 373.

36 **Type material:** holotype ♂ AMNH, MEXICO: Puebla, Mpio. Zoquitlan, Zoquitlan  
37 Surface, 30-XII-1978, Col. A. G. Grubs. Examined. Female unknown.  
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39 **Emended diagnosis:** The following character combination is diagnostic for *H. nahuanus*.  
40 Male palpal bulb with slender embolus similar in length to tegulum, SA ends at embolus  
41 retrolateral face (Fig 16B); VG deep (Fig 16A). Embolus strongly curved retrolaterally on  
42 distal half. Metatarsus I straight (Fig 15K). With Pap between two large spinose setae (Fig  
43 15J). Ocular tubercle slightly reduced and eyes normally developed. Periocular  
44 pigmentation only in anterior eye row, strongly marked in AME (Fig 15C). With  
45 stridulatory setae conformed by SP on retrolateral face of palp trochanter and PL on  
46 prolateral face of trochanter I (Fig 15F, G, I). Urticating setae arranged in one dorsomedian  
47 patch, platinum in color (Fig 15E).  
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49 *H. nahuanus* differs from most *Hemirrhagus* species in the stridulatory setae on palp  
50 trochanter and trochanter I conformed by SP and PL. From *H. pernix* in metatarsus I  
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straight. From *H. franckei* sp. nov. in Pap between two large spinose setae, the ocular tubercle slightly reduced and pericocular pigmentation only in anterior eye row.

**Notes:** The tip of the embolus is broken, but as in other *Hemirrhagus* species it is presumed this apex is curved retrolaterally.

Gertsch (1982) indicated the presence of a dorsomedian patch of urticating setae in this species, which was also pointed out by Smith (1995) indicating this patch as grey (platinum) in color. Pérez-Miles & Loch (2003) did not find urticating setae in the holotype, they presumed urticating setae have been lost as a result of preservation conditions and manipulation in previous studies. The holotype actually does not have urticating setae, although it is possible to observe the marks on the opisthosoma where urticating setae were attached, and definitely the arrangement conforms to the original description, this species has urticating setae arranged in one dorsomedian patch.

**Redescription:** Holotype male: body length (not including chelicerae and spinnerets) 17.79, carapace: 9.53 long, 8.05 wide. Caput not markedly elevated; fovea recurved, 1.8 wide (Fig 15A).

Eyes: anterior eye row procurved, posterior eye row recurved. Pericocular pigmentation only present in anterior eye row, strongly marked in AME. All eyes well developed. Eyes sizes and interocular distances: AME 0.226; ALE 0.21; PME 0.134; PLE 0.21; AME-AME 0.041; AME-ALE 0.023; PME-PME 0.456; PME-PLP 0.051; ALE-PLP 0.113. Ocular tubercle slightly reduced, width 1.10; length 0.9; clypeus lacking (Fig 15C). Labium: length 0.90; width 1.20; with 32 cuspules. Maxilla inner corner with approximately 81 cuspules (Fig 15D). Cheliceral promargin with 11 teeth (proximal to distal: 1 medium, 2-4 large, 5-7 medium, 8-11 large) (Fig 15H). Sternum length 4.20. Sigillae oval, second, third and fourth pairs hardly visible; fourth pair one and a half times its length from the margin (Fig 15B).

Leg formula: IV, III, I, II. Length of legs and palpal segments (femur, patella, tibia, metatarsus, tarsus, total): I: 10.02, 4.30, 8.24, 8.10, 6.36, 37.02. II: 9.05, 4.60, 7.69, 8.31, 6.35, 36.0. III: 9.22, 4.06, 7.72, 10.52, 6.29, 37.81. IV: 11.06, 3.99, 10.51, 12.95, 7.02, 45.53. Palp: 6.47, 3.46, 5.98, -, 2.60, 18.51. **Spinnerets are damaged.**

Scopulae: tarsi I-IV densely scopulate, III and IV divided by strong band of setae. Metatarsi I-II densely scopulate; III scopulate on distal  $\frac{2}{3}$ , and IV scopulate on distal  $\frac{1}{3}$ .

Tibia I with two apophyses which do not originate from a common base, the Pap is reduced and is located between two large spinose setae more than twice its length; the Rap is narrow with one large spinose seta on dorsal face, the spinose seta exceeds the apex of Rap (Fig 15J). Metatarsus I straight (Fig 15K).

Stridulatory setae: On palpal trochanter retrolateral face proximally, with ca. 14 SP setae of different sizes, disorganized (Fig 15G). Trochanter I with PL setae on prolateral face (Fig 15F).

Legs and palpi LSC in: palp femur prolateral and retrolateral faces; leg I coxa retrolateral face, trochanter retrolateral face, femur prolateral face (Fig 15I); leg II trochanter prolateral face and femur prolateral face.

Chaetotaxy (left side): femora I 2p; II 3p; III 2p, 2r; IV 2p, 2r; palp 1p; patellae none; tibiae I 2p, 5v; II 2p, 6v; III 2p, 10v, 3r; IV 3p, 10v, 3r; palp 1p, 7v; metatarsi I 2v; II 2v; III 1d, 3p, 8v, 2r; IV 3p, 9v, 3r.

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Palp. Embolus slender, similar in length to tegulum, SA ends at embolus retrolateral face; VG deep (Figs 16A, B). Embolus strongly curved retrolaterally on distal half. Urticating setae: Type VI arranged in one dorsomedian patch, platinum in color. Color pattern: In ethanol specimens color is maroon. Smith (1995) indicated a uniform pale brown color, with dusky setae on the abdomen.

**Distribution and natural history:** Known only from Zoquitlan in Puebla (Fig 48). Smith (1995) presumed the species could inhabit caves. However, the original label of the specimen indicates that it was collected on the surface.

***Hemirrhagus ocellatus* Pérez-Miles & Loch, 2003**  
(Figs 1D, E; 17A–J, 18A–D; 19A–D; 49)

*Hemirrhagus ocellatus* Pérez-Miles & Loch, 2003: 371, figs. 31–34 (D♀).

**Type material:** holotype ♀ LAAH, MEXICO: Cueva Peña Blanca, Valle de Bravo, Estado de México 6-XI-1976, Col. S. Ibarra. Examined.

**Additional material examined:** 3 ♂ CNAN 4457, Cueva de la Peña Blanca, Valle de Bravo, Estado de México 27-VIII-2011, Col. J. Mendoza, A. Valdez, D. Barrales, R. Monjaraz, E. Miranda.

**Emended diagnosis:** The following character combination is diagnostic for *H. ocellatus*. Male palpal bulb with slender embolus similar in length to tegulum, SA ends at embolus retrolateral face (Fig 18A, D); VG shallow (Fig 18B). Embolus strongly curved retrolaterally on distal half (Fig 18C, D). Metatarsus I straight (Fig 17H). Ocular tubercle slightly reduced and eyes normally developed; periocular pigmentation complete (Figs 17E, 19C). Tarsi II–IV with scopulae divided. With 6 to 10 labial cuspules (Fig 17F). Males with rounded sternum (Fig 17B, G). Urticating setae arranged in two dorsal paramedian patches, oval-shaped, yellowish-orange in color and well-defined margins (Figs 17C, 19B). Spermathecae paired, slightly fused; receptacles slender throughout their length; strongly curved outwards from the middle (Fig 19D).

*H. ocellatus* differs from most *Hemirrhagus* species in the urticating setae arranged in two dorsal paramedian patches. From *H. gertschi* in the periocular pigmentation complete.

**Description:** Male: body length (not including chelicerae and spinnerets) 16.70, carapace: 6.58 long, 5.59 wide. Caput not markedly elevated; fovea recurved, 0.88 wide (Fig 17A). Eyes: anterior eye row procurved, posterior eye row recurved. Periocular pigmentation complete. All eyes normally developed. Eyes sizes and interocular distances: AME 0.28; ALE 0.30; PME 0.15; PLE 0.25; AME-AME 0.020; AME-ALE 0.025; PME-PME 0.48; PME-PLP 0.038; ALE-PLP 0.10. Ocular tubercle slightly reduced, width 1.15; length 0.73; clypeus lacking (Fig 17E). Labium: length 0.83; width 1.33; with 10 cuspules. Maxilla inner corner with approximately 82 cuspules (Fig 17F). Cheliceral promargin with 11 teeth (proximal to distal: 1 small, 2–3 large, 4 small, 5–6 medium, 7–9 large, 10 medium, 11 small). Sternum length 2.97. Sigillae semicircular, second, third and fourth pairs hardly visible; fourth pair once its length from the margin (Figs 17B, G).

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Leg formula: IV, I, III, II. Length of legs and palpal segments (femur, patella, tibia, metatarsus, tarsus, total): I: 6.41, 3.38, 5.50, 5.14, 4.05, 24.48. II: 5.53, 3.09, 4.99, 4.82, 3.91, 22.34. III: 5.70, 2.57, 4.61, 5.64, 3.98, 22.50. IV: 7.28, 3.01, 6.18, 7.68, 4.60, 28.75.

Palp: 4.65, 2.42, 3.66, -, 1.95, 12.68. Spinnerets: PMS, 0.7 long, 0.4 apart; PLS, 1.0 basal, 0.7 middle, 1.1 distal.

Scopulae: tarsi I-IV densely scopulate, II, divided by a row of soft setae, III and IV divided by a row of hard setae. Metatarsi I-II scopulate on distal  $\frac{2}{3}$ ; III scopulate on distal  $\frac{1}{3}$ , and IV scopulate on distal  $\frac{1}{4}$ .

Tibia I with two apophyses which do not originate from a common base, the Pap is reduced with one large spinose seta on ventral face, the spinose seta is bent apically and exceeds the apex of Pap; the Rap is narrow with one large spinose seta on dorsal face, the spinose seta exceeds the apex of Rap (Fig 17I, J). Metatarsus I straight (Fig 17H).

Stridulatory setae: Lacking.

Legs and palpi LSC in: palp trochanter retrolateral face, femur prolateral and retrolateral faces; leg I coxa retrolateral face, trochanter prolateral face, femur prolateral face; leg II trochanter prolateral face and femur prolateral face proximally.

Chaetotaxy (left side): femora I 1p; II 1p; III 2p, 2r; IV 1p, 2r, palp 1p; patellae none; tibiae I 2p, 7v, 3r; II 2p, 8v; III 2p, 12v, 2r; IV 2p, 12v, 6r; palp 1p, 7v; metatarsi I 6v; II 1p, 6v; III 4p, 14v, 3r; IV 1d, 5p, 16v, 5r.

Palp. Embolus slender, similar in length to tegulum, SA ends at embolus retrolateral face; ventral groove shallow. Embolus strongly curved retrolaterally on distal half. The apex of the embolus strongly curved ventrally (Fig 18A–D).

Urticating setae: Type VI arranged in two dorsolateral patches, oval-shaped, yellowish-orange in color and well-defined margins (Fig 17C).

Color pattern: In ethanol specimens color is yellowish. Live specimens are black, with urticating setae patches yellowish-orange.

**Distribution and natural history:** Known only from Cueva de la Peña Blanca, Valle de Bravo, Estado de México (Figs 2D, 49). The specimens were found under rocks and walking on the cave walls at a depth of 30 meters.

***Hemirrhagus papalotl* Pérez-Miles & Loch, 2003**

(Figs 1G–I, 20A–J, 21A–D, 22A–D, 48)

*Hemirrhagus papalotl* Pérez-Miles & Loch, 2003: 372, figs. 35–38 (D♀).

**Type material:** Holotype ♀ and paratype ♀ LAAH, MEXICO: Guerrero, Mpio. Taxco de Alarcón, Gruta de Aguacachil. 29-XI-1980, Col. I. Cascalera. Examined.

**Additional material examined:** 1 immature male LAAH, MEXICO: Guerrero, Mpio. Taxco de Alarcón, Gruta de Ahuacachil, 03-VIII-1980, Col. J. Palacios; 1 ♀ CNAN 4458, MEXICO: Guerrero, Mpio. Taxco de Alarcón, Gruta de Zacatecolotla, 03-II-2012, Col. R. Monjaraz; 11 ♀ and 5 ♂ CNAN4459, CNAN 4460, CNAN 4461, MEXICO: Guerrero, Mpio. Taxco de Alarcón, Gruta de Aguacachil, 21-IV-2012, Col. J. Mendoza, G. Contreras, R. Monjaraz, D. Ortiz.



**Emended diagnosis:** The following character combination is diagnostic for *H. papaloti*.

Male palpal bulb with slender embolus, longer than tegulum, SA ends at embolus retrolateral face (Fig 21A, C); VG deep (Fig 21 D). The posterior curvature of SA occurs at the base of the embolus and forms an angle of 90° (Fig 21 C). Embolus strongly curved retrolaterally on distal third (Fig 21A, B). Metatarsus I curved (Fig 20I). Ocular tubercle slightly reduced and PME slightly reduced; perioocular pigmentation only strongly marked on anterior eye row (Figs 20D, 22A). Urticating setae arranged in one dorsomedian patch, brown in color, with anterior and posterior margins notched medially, with rounded edges (butterfly-shaped) (Figs 20C, 22B). Spermathecae receptacles are straight or nearly so; the receptacles can vary from short and wide to large and thin (Fig 21 C, D).

*H. papaloti* differs from most *Hemirrhagus* species in the posterior curvature of SA which forms an angle of 90°. From *H. gertschi* and *H. valdezi* sp. nov. in the urticating setae arranged in one dorsomedian, butterfly-shaped patch.

**Description.** Male CNAN 4461: body length (not including chelicerae and spinnerets) 23.46, carapace: 10.16 long, 8.96 wide. Caput not elevated; fovea recurved, width 1.875 (Fig 20A).

Eyes: anterior eye row procurved, posterior eye row recurved. Perioocular pigmentation only strongly marked on anterior eye row. PLE slightly reduced. Eye sizes and interocular distances: AME 0.275; ALE 0.375; PME 0.15; PLE 0.175; AME-AME 0.15; AME-ALE 0.075; PME-PME 0.75; PME-PLE 0.075; ALE-PLE 0.1. Ocular tubercle reduced, width 1.525; length 0.875; clypeus lacking (Fig 20D). Labium: length 1.45; width 1.85; with 23 cuspsules. Maxilla inner corner with approximately 130 cuspsules (Fig 20E). Cheliceral promargin with 10 teeth (proximal to distal: 1-3 large, 4-5 medium, 6-8 large, 9-10 small) (Fig 20G). Sternum length 4.5. Sigillae circular, third and fourth pairs hardly visible; fourth pair once its length from margin (Fig 20B, F).

Leg formula: IV, I, II, III. Length of legs and palpal segments (femur, patella, tibia, metatarsus, tarsus, total): I: 12.20, 5.80, 11.29, 11.13, 8.07, 48.49. II: 11.87, 5.94, 10.74, 11.19, 7.72, 47.46. III: 11.64, 4.96, 10.05, 12.47, 8.00, 47.12. IV: 13.78, 5.25, 12.95, 17.39, 9.54, 58.91. Palp: 8.32, 4.25, 7.04, -, 3.47, 23.08. Spinnerets: PMS, 1.2 long, 1.1 apart, PLS, 2.4 basal, 1.8 middle, 2.7 distal.

Scopulae: tarsi I-IV densely scopulate, III and IV divided by strong band of setae. Metatarsi I-II densely scopulate; III scopulate on distal 1/2, IV scopulate on distal 1/4.

Tibia I with two apophyses which do not originate from a common base, the Pap is reduced with one large spinose seta on ventral face, the spinose seta is bent apically and exceeds the apex of Pap; the Rap is narrow with one large spinose seta on dorsal face, the spinose seta exceeds the apex of Rap (Fig 20H, J). Metatarsus I curved (Fig 20I).

Stridulatory setae: Lacking.

Legs and palpi LSC in: palp trochanter retrolateral face, femur prolateral and retrolateral faces; leg I coxa retrolateral face, trochanter prolateral face, femur prolateral face; leg II coxa prolateral face, trochanter prolateral face, femur prolateral face.

Chaetotaxy (left side): femora I 2p, 3r; II 4p, 3r; III 4p, 4r; IV 6p, 5r; palp 2p, 3r; patellae none; tibiae I 2p, 8v, 4r; II 3p, 9v, 4r; III 4p, 10v, 6r; IV 7p, 15v, 11r; palp 3p, 9v; metatarsi I 3v; II 1p, 6v, 1r; III 5p, 9v, 4r; IV 7p, 12v, 6r.

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Palp. Embolus slender, longer than tegulum. SA ends at embolus retrolateral face. The posterior curvature of SA occurs at the base of the embolus and forms an angle of 90°. VG deep (Fig 21A–D).

Urticating setae: Type VI arranged in one dorsomedian patch, brown in color, with anterior and posterior margins notched medially, with rounded edges (butterfly-shaped). The margins are clearly defined (Fig 20C).

Color pattern: In ethanol the color is brown, with the carapace, legs and palps darker. In live specimens the general color is very dark brown, with femora and carapace darker than rest of the body (Fig 1G).

**Distribution and natural history:** Known only from Gruta de Aguacachil/Zacatecolotla in Guerrero, México (Fig 48). The species inhabits only inside the cave; specimens were collected on walls at a depth of 20 meters from the entrance (Fig 1H). Females laid fixed hammock egg sacs in the cave wall; these were fixed between two protuberances on the wall (Fig 1I). The females with egg sacs were found in a common area, each protecting their egg sac. One of the egg sacs contained 63 eggs.

***Hemirrhagus perezmilesi* Garcia-Villafuerte & Loch, 2010**

(Figs 23A–G; 24A–D; 25A–F; 48)

*Hemirrhagus perezmilesi* Garcia-Villafuerte & Loch, 2010: 82, figs. 2–11. (♂, ♀)

**Type material:** holotype ♂ CNAN T-0395 and paratype ♀ CNAN T-0396, MEXICO: Cerro Tres Picos, Mpio. Villa Corzo, Chiapas XI-2007 to VI-2008, Col. K. Zárate-Gálvez, C. Pérez-Bonifaz, G. Salinas, M. A. Rabasa. Examined.

**Additional material examined:** 2 ♂ CNAN T-0397 and CNAN T-0398, Cerro Tres Picos, Mpio. Villa Corzo, Chiapas XI-2007 to VI-2008, Col. K. Zárate-Gálvez, C. Pérez-Bonifaz, G. Salinas, M. A. Rabasa; 1 ♂ AMNH, same data as previous.

**Emended diagnosis:** The following character combination is diagnostic for *H. perezmilesi*. Male palpal bulb with slender embolus, similar in length to tegulum, SA ends at retrolateral face of the embolus; VG shallow; embolus strongly curved retrolaterally on distal third (Fig 24A–D). Ocular tubercle slightly reduced, all eyes normally developed; periorcular pigmentation complete in males, in females only in anterior eye row and strongly marked in AME (Figs 23A, C; 25A, E). Metatarsus I straight (Fig 23D). Male tibia I lacks tibial apophyses (Fig 23E). Urticating setae arranged in two lateral round patches, yellowish-orange in color and with well-defined margins (Figs 23B, 25B). With stridulatory setae conformed by CLP on palpal trochanter retrolateral face and SP on trochanter I prolateral face (Figs 23F, G; 25C, D). Spermathecae paired, slightly fused at the base, receptacles finger-shaped and slightly bent laterally (Fig 25F).

*H. perezmilesi* differs from all other *Hemirrhagus* in the stridulatory setae conformed by CLP and SP. Also differs in lacking tibial apophyses.

**Description of new features.**

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Holotype male CNAN T0395. Stridulatory setae: On palpal trochanter retrolateral face, almost as long as trochanter, with 6 CLP that gradually increase in size from 0.2 to 1.0 (ventral to dorsal) (Fig 23F). Trochanter I with 3 SP on prolateral face (Fig 23G). Legs and palpi LSC in: femur retrolateral face; leg I coxa retrolateral face, trochanter prolateral face, femur prolateral face.

Paratype female CNAN T0396. Stridulatory setae: On palpal trochanter retrolateral face, almost as long as trochanter, with 4 CLP wider at distal half, that gradually increase in size from 0.8 to 0.9 (ventral to dorsal) (Fig 25C). Trochanter I with 3 PL on prolateral face (Fig 25D). Legs and palpi LSC in: femur retrolateral face; leg I coxa retrolateral face, trochanter prolateral face, femur prolateral face.

**Distribution and natural history:** Known only from Cerro Tres Picos, Reserva de la Biosfera La Sepultura, Chiapas; inhabits in pine forest (Fig 48). The specimens were collected in pit-fall traps.

***Hemirrhagus pernix* (Ausserer, 1875)**  
(Figs 26A–K; 27A–C; 49)

*Crypsidromus pernix* Ausserer, 1875: 178, pl. 6 fig. 22–23 (D♂).  
*Hapalopus pernix* F.O.P.-Cambridge, 1897: 31, pl. 2 fig. 14, 14 a–c.  
*Cyrtopholis pernix* Pocock, 1903: 98; Simon, 1903: 931; Smith, 1986: 82, fig. 34h; Smith, 1987: 82, fig. 34h; Smith, 1995: 182, fig. 1011–1021.  
*Hemirrhagus pernix* Pérez-Miles & Loch, 2003: 374.

**Type material:** Holotype ♂ BMNH-351, MEXICO: Veracruz, Pic d' Orizaba. Coll. Keys. Examined by photos.

**Emended diagnosis:** The following character combination is diagnostic for *H. pernix*.

Male palpal bulb with slender embolus, longer than tegulum, SA retrolaterally extended ends at embolus retrolateral face; VG deep (Fig 27A–C). Embolus strongly curved retrolaterally on distal half (Fig 27C). Metatarsus I curved (Fig 26J). Ocular tubercle and eyes normally developed, periocular pigmentation complete (Fig 26C). With stridulatory setae conformed by SP on retrolateral face of palp trochanter and PL on prolateral face of trochanter I (Fig 26F–G). Urticating setae arranged in one dorsomedian patch, platinum in color.

*H. pernix* differs from most *Hemirrhagus* species in the stridulatory setae conformed by SP and PL. From *H. nahuanus* in the strongly curved metatarsus I. From *H. franckei* sp. nov. in the strong posterior curvature of SA.

**Redescription:** Holotype male: body length (not including chelicerae and spinnerets) 26.90, carapace: 10.90 long, 9.20 wide. Caput not markedly elevated; fovea recurved (Fig 26A).

Eyes: anterior eye row procurved, posterior eye row recurved. Periocular pigmentation complete and all eyes normally developed. Eye sizes and interocular distances: AME 0.29;

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ALE 0.31; PME 0.22; PLE 0.27; AME-AME 0.23; AME-ALE 0.15; PME-PME 0.82; PME-PLP 0.039; ALE-PLP 0.17. Ocular tubercle normally developed, width 1.80; length 1.40; clypeus lacking (Fig 26C). Labium: length 1.40; width 1.80; with 30 cuspsules (Fig 26D). Maxilla inner corner with approximately 120 cuspsules. Cheliceral promargin with 11 teeth (proximal to distal: 1-3 large, 4-6 medium, 7-11 large). Sternum length 4.30. Sigillae oval, third and fourth pairs hardly visible; fourth pair one and a half times its length from the margin (Fig 26B, E).

Leg formula: IV, I, III, II. Length of legs and palpal segments (femur, patella, tibia, metatarsus, tarsus, total): I: 8.6, 4.6, 6.7, 7.0, 5.5, 32.4. II: 8.3, 4.3, 6.3, 6.9, 5.3, 31.1. III: 8.4, 3.8, 6.3, 7.9, 5.5, 31.9. IV: 10.2, 4.3, 8.1, 10.9, 6.7, 40.2. Palp: 6.5, 3.6, 5.4, -, 1.54, 17.04. **Spinnerets: PMS, 0.9 long, 0.8 apart; PLS, 2.1 basal, 1.2 middle, 1.3 distal.**

Scopulae: tarsi I-IV densely scopulate, III and IV divided by strong band of setae. Metatarsi I densely scopulate, II scopulate on distal  $\frac{1}{2}$ , III scopulate on distal  $\frac{1}{3}$ , and IV scopulate on distal  $\frac{1}{5}$ .

Tibia I with two apophyses which do not originate from a common base, the Pap is normally developed with one large spinose seta on ventral face, the spinose seta does not exceed the apex of Pap; the Rap is normally developed, broad at its base, with one large spinose seta on dorsal face, the spinose seta does not exceed the apex of Rap (Fig 26H, I). Metatarsus I curved (Fig 26J).

Stridulatory setae: On palpal trochanter retrolateral face located in proximal, with *ca.* 11 SP of similar size, disorganized. Trochanter I with PL on prolateral face (Fig 26F-G).

Legs and palpi LSC in: Unknown, the specimen does not conserve most of its body setae. Chaetotaxy (left side): femora I 1p; II 3p, 3r; III 2p, 4r; IV 2p, 3r; palp 1p, 1r; patellae III 1d; IV 1d; palp 1d; tibiae I 3p, 9v; II 4p, 12v; III 5p, 12v, 3r; IV 6p, 11v, 4r; palp 6p, 4r; metatarsi I 3v; II 1d, 5v; III 3p, 11v, 5r; IV 2d, 6p, 13v, 5r.

Palp. Embolus wide at the base, tapering distally, longer than tegulum, SA retrolaterally extended ends at embolus retrolateral face; VG deep (Fig 27A). Embolus strongly curved retrolaterally on distal half (Fig 27C).

Urticating setae: Type VI, arranged in one dorsomedian patch, platinum in color, all margins of the patch well defined, anterior and posterior margins undivided.

Color pattern: The color is black in ethanol preserved specimen (Fig 27K).

**Distribution and natural history:** Known only from Pico de Orizaba, Veracruz-Puebla, México, presumed habitat of this species is pine forest (Fig 49).

**Note:** The exact distribution site of this species is unknown. However, in 2012 after a review of potential sites for these tarantulas near Pico de Orizaba, two *Hemirrhagus* juveniles were collected that seem to match the diagnostic features of *H. pernix*. These specimens are being kept alive waiting for them to mature in order to establish their specific identity.

***Hemirrhagus puebla* (Gertsch, 1982)**  
(Figs 28A-F, 49)

*Spelopelma puebla* Gertsch, 1982: 91, fig. 16 (D♀); Schmidt, 1993: 68, fig. 132; Smith, 1995: 36, figs. 44-54; Schmidt, 2003: 118, fig. 70.  
*Hemirrhagus puebla* Pérez-Miles & Loch, 2003: 373.



**Type material:** holotype ♀ AMNH, MEXICO: Puebla, Mpio. Cuetzalan del Progreso, Cueva de Tasalolpan. 22-XII-1976, Col. J. Reddell, A. Grubbs, C. Soileau and D. McKenzie. Examined.

**Note:** Smith, 1995 mentioned 1 juvenile specimen deposited in AMNH belonging to *H. puebla*, this specimen was collected in Cueva de la Barranca, 8km SW of Cuetzalan, Puebla, 25-XII-1973, Col. D. McKenzie. After review it was determined that this specimen does not belong to *H. puebla* and it is an undescribed species.

**Emended diagnosis:** The following character combination is diagnostic for *H. puebla*. Ocular tubercle not developed, PLE reduced, AME and PME as integumentary spots; periocular pigmentation absent (Fig 28C). Lacking urticating setae on abdomen (Fig 28E). Tarsus I and II scopulae divided by narrow band of setae, III and IV divided by strong band of setae. Spermathecae paired, receptacles close together and strongly fused at their base (Fig 28F).

*H. puebla* differs from all other *Hemirrhagus* species in the spermathecae receptacles which are close together and strongly fused at their base. Also in having the AME and PME as integumentary spots.

**Redescription.** Holotype female: body length (not including chelicerae and spinnerets) 12.99, carapace: 6.64 long, 4.68 wide. Caput not elevated; fovea recurved, width 1.10 (Fig 28A).

Eyes: anterior eye row procurved, posterior eye row straight. Periocular pigmentation absent, PLE reduced, AME and PME as integumentary spots. Eye sizes and interocular distances: AME 0.24; ALE 0.11; PME 0.081; PLE 0.15; AME-AME 0.15; AME-ALE 0.14; PME-PME 0.48; PME-PLA 0.065; ALE-PLA 0.073. Ocular tubercle undeveloped, width 1.10; length 0.3; clypeus lacking (Fig 28C). Labium: length 0.65; width 1.20; with 8 cuspules. Maxilla inner corner with approximately 115 cuspules (Fig 28D). Cheliceral promargin with 13 teeth (proximal to distal: 1 medium, 2-5 large, 6-7 medium, 8-13 large) (Fig 22F). Sternum length 2.6. Sigillae oval, second, third and fourth pairs hardly visible; fourth pair one and a half times its length from the margin (Fig 28B).

Leg formula: IV, I, III, II. Length of legs and palpal segments (femur, patella, tibia, metatarsus, tarsus, total): I: 6.60, 3.49, 6.08, 5.30, 3.53, 25.0. II: 5.85, 3.33, 5.23, 4.74, 3.45, 22.60. III: 5.73, 3.18, 5.30, 5.93, 4.14, 24.28. IV: 7.28, 3.04, 7.24, 8.32, 4.25, 30.13. Palp: 4.90, 2.71, 4.07, -, 2.97, 14.65. Spinnerets: PMS, 0.3 long, 0.1 apart; PLS, 1.1 basal, 0.5 middle, 0.8 distal.

Scopulae: tarsi I-IV densely scopulate; I and II divided by narrow band of setae, III and IV divided by strong band of setae. Metatarsi I and II densely scopulate; III scopulate on distal  $\frac{1}{2}$ , and IV scopulate on distal  $\frac{1}{3}$ .

Stridulatory setae: Lacking

Legs and palpi LSC in: palp trochanter prolateral and retrolateral faces, femur prolateral and retrolateral faces; leg I coxa retrolateral face, trochanter prolateral face.

Chaetotaxy (left side): femora I 1p; II 1p; III 1p, 2r; IV 1p, 1r; palp 1p; patellae palp 1v; tibiae I 4v; II 2p, 3v; III 2p, 8v, 2r; IV 2p, 7v, 3r; palp 1p, 9v; metatarsi I 2v; II 3v; III 5p, 7v, 1r; IV 3p, 10v, 2r.



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Genitalia: Spermathecae paired, receptacles close together and strongly fused at their base; slightly curved outwards from the base, without neck defined by interior and exterior margins (Fig 28F).

Urticating setae: Lacking (Fig. 28E).

Color pattern: Live specimens have not been observed. In ethanol the color is yellowish.

**Distribution and natural history:** Known only from Cueva de Tasalolpan in Cuetzalan, Puebla, México (Fig 49). It is only known that the species inhabits in a cave.

***Hemirrhagus reddelli* (Gertsch, 1973)**

(Fig 29A–K, 49)

*Schizopelma reddelli* Gertsch, 1973: 143, fig. 2b (D♀).

*Spelopelma reddelli* Gertsch, 1982: 91, fig. 15; Schmidt, 1993: 68, fig. 131; Smith, 1995: 36, figs. 55–63; Schmidt, 2003: 118, fig. 71.

*Hemirrhagus reddelli* Pérez-Miles & Loch, 2003: 374.

**Type material:** holotype ♀ AMNH, MEXICO: Oaxaca, Cueva del Nacimiento del rio San Antonio. 09-III-1973, Col. J. Reddell, S. Murphy, D. McKenzie, M. McKenzie and M. Butterwick. Examined.

**Additional material examined:** 1 ♀ AMNH, MEXICO: Oaxaca, 10km SSW Acatlán, Cueva del Nacimiento del rio San Antonio. 31-XII-1973, Col. J. Reddell, W. Elliott, R. Jameson.

**Emended diagnosis:** The following character combination is diagnostic for *H. reddelli*.

Ocular tubercle undeveloped; PME reduced to integumentary spots; perioocular pigmentation only in AME (Fig 29C). With stridulatory setae conformed by HFS on the base of retrolateral face of palp femur, PL on retrolateral face of palp trochanter and three SP distally on prolateral face of trochanter I (Fig 29F–H). Lacking urticating setae on abdomen. Labium with fewer than 10 cuspules (Fig 29D). Metatarsus IV lacking scopula. Spermathecae paired, receptacles separated at base, straight and slender throughout their length (Fig 29J, K).

*H. reddelli* differs from all other *Hemirrhagus* species in the stridulatory setae conformed by HFS on retrolateral face of palp femur.

**Redescription.** Holotype female: body length (not including chelicerae and spinnerets) 20.22, carapace: 8.99 long, 7.05 wide. Caput not elevated; fovea recurved, width 2.50 (Fig 29A).

Eyes: anterior eye row recurved, posterior eye row recurved. Perioocular pigmentation only present in AME, PME very reduced, only integumentary spots. Eye sizes and interocular distances: AME 0.185; ALE 0.14; PME 0.11; PLE 0.16; AME-AME 0.071; AME-ALE 0.23; PME-PME 0.625; PME-PL 0.057; ALE-PL 0.071. Ocular tubercle undeveloped, width 1.25; length 0.4; clypeus lacking (Fig 29C). Labium: length 1.15; width 1.70; with 7 cuspules. Maxilla inner corner with approximately 122 cuspules (Fig 29D). Cheliceral promargin with 11 teeth (proximal to distal: 1 medium, 2–5 large, 6 medium, 7–10 large, 11

medium) (Fig 29I). Sternum length 4.1. Sigillae large oval, second, third and fourth pairs hardly visible; fourth pair once its length from the margin (Fig 29B, E).  
 Leg formula: IV, I, II, III. Length of legs and palpal segments (femur, patella, tibia, metatarsus, tarsus, total): I: 10.37, 4.77, 10.88, 10.09, 6.68, 42.79. II: 9.90, 4.74, 10.06, 10.02, 6.97, 41.69. III: 10.11, 3.95, 9.16, 10.89, 7.12, 41.23. IV: 11.90, 4.32, 12.59, 15.05, 8.34, 52.20. Palp: 7.48, 3.93, 6.32, -, 6.09, 23.82. **Spinnerets: PMS, 2.0 long, 1.1 apart; PLS, 2.4 basal, 1.7 middle, 2.3 distal.**  
 Scopulae: tarsi I-IV densely scopulate, III and IV divided by strong band of setae. Metatarsi I and II densely scopulate; III scopulate on distal one-half, and IV without scopulae.  
 Stridulatory setae: SP on trochanter I prolateral located distocentrally, with three spinose setae large and curved (Fig 29G). There are also a group of ca. 20 hard setae (FHS), congregated in a subcircular spot basally on palp femur retrolateral (Fig 29F). Palp trochanter with PL retrolaterally (Fig 29H).  
 Legs and palpi LSC in: palp femur retrolateral face; leg I coxa retrolateral face, trochanter prolateral and retrolateral faces, femur prolateral face; leg II trochanter prolateral face.  
 Chaetotaxy (left side): femora I 1p; II 2p; III 2p, 2r; IV 1p, 1r; palp 1p; patellae none; tibiae I 2p, 6v; II 2p, 5v, 1r; III 2p, 8v, 3r; IV 2p, 8v, 3r; palp 1p, 8v, 1r; metatarsi I 1v; II 5v; III 4p, 9v, 3r; IV 2d, 4p, 8v, 1r.  
 Genitalia: Spermathecae paired; receptacles completely separated at their base, longer than wide, straight and slender throughout their length; with neck defined by interior and exterior margins (Fig 29J).  
 Urticating setae: Lacking.  
 Color pattern: Live specimens have not been observed. In ethanol the color is yellowish.

**Distribution and natural history:** Known only from Cueva del Nacimiento del Rio San Antonio, Oaxaca, México (Fig 49). It is only known that the species inhabits a cave.

***Hemirrhagus stygius* (Gertsch, 1971)**

(Figs 1J, K; 2H; 30A–H; 31A–I; 32A–D; 48)

*Aphonopelma stygia* Gertsch, 1971: 49 (D juv.).

*Schizopelma stygia* Gertsch, 1973: 142, fig. 1, 2a (D♀)

*Spelopelma stygium* Gertsch, 1982: 89, fig. 13; Brignoli, 1983: 140; Schmidt, 1993: 68, fig. 129; Smith, 1995: 37, figs. 64–65; Schmidt, 2003: 118, fig. 72.

*Hemirrhagus stygius* Pérez-Miles & Loch, 2003: 374.

**Type material:** holotype juvenile AMNH, MEXICO: San Luis Potosí, 1 mi. W Ahuacatlán, Cueva de los Potrerillos. 12-VII-1967, Col. J. Reddell, J. Fish and P. Russell. Examined.

**Additional material examined:** 1 ♀ AMNH, MEXICO: San Luis Potosí, 2 mi. W Ahuacatlán, Cueva de los Potrerillos. 12-VII-1967, Col. J. Reddell, J. Fish and W. Russell; 1 ♀ AMNH, MEXICO: San Luis Potosí, 1 mi. W Ahuacatlán, Cueva de los Potrerillos. 12-VII-1967, Col. J. Reddell, J. Fish and P. Russell; 1 ♀ AMNH, MEXICO: San Luis Potosí, Ahuacatlán, Cueva de Potrerillos. 31-VIII-1961, Col. P. Sprouse and T. Tracy; 2 ♀ AMNH, MEXICO: San Luis Potosí, 2km W Ahuacatlán, Sótano del pozo. 25-V-1974, Col. C.

Elliott; 4 ♀ and 1 ♂ CNAN 4462, MEXICO: San Luis Potosi, Mpio. Xilitla, Cueva de los Potrerillos. 10-V-2012, Col. J. Mendoza, J. Cruz, G. Contreras and R. Monjaraz.

**Emended diagnosis:** The following character combination is diagnostic for *H. stygius*. Male palpal bulb with embolus broad at base, tapering distally and longer than tegulum; SA retrolaterally extended ends before the embolus base (Fig 32C). SA does not curve posteriorly; VG shallow (Fig 32D). Embolus slightly curved retrolaterally on distal half (Figs 32A–B). Metatarsus I straight (Fig 31I); tibial apophyses very reduced, with large spines (Fig 31G–H). Ocular tubercle undeveloped; AME and PLE as integumentary spots, ALE and PME reduced; periocular pigmentation absent (Figs 30C, 31D). Abdomen lacking urticating setae (Fig 30E, 31A). Spermathecae paired, slightly fused at base, receptacles slender throughout their length and slightly bent laterally (Fig 30H).

*H. stygius* differs from all other *Hemirrhagus* species in the SA retrolaterally extended which ends before the embolus base. Also differs in tibial apophyses very reduced with large spines.

**Redescription.** Female CNAN 4462: body length (not including chelicerae and spinnerets) 24.22, carapace: 10.08 long, 8.58 wide. Caput not elevated; fovea recurved, width 2.6. Carapace with brown setae (Fig 30A).

Eyes: anterior eye row procurved, posterior eye row recurved. Periocular pigmentation absent. AME and PLE as integumentary spots, ALE and PME reduced. Eye sizes and interocular distances: AME 0.126; ALE 0.38; PME 0.21; PLE 0.22; AME-AME 0.19; AME-ALE 0.24; PME-PME 0.81; PME-PL 0.11; ALE-PL 0.13. Ocular tubercle undeveloped, width 1.8; length 0.4; clypeus lacking (Fig 30C). Labium: length 1.8; width 2.3; with 14 cuspules. Maxilla inner corner with approximately 151 cuspules (Fig 30D). Cheliceral promargin with 19 teeth (proximal to distal: 1-2 medium, 3 large, 4 small, 5 large, 6 medium, 7 small, 8 large, 9-11 medium, 12 large, 13 medium, 14-17 large, 18-19 medium) (Fig 30G). Sternum length 4.5. Sigillae large oval, second, third and fourth pairs hardly visible; fourth pair one and a half times its length from the margin (Figs 30B, 30F). Leg formula: IV, I, III, II. Length of legs and palpal segments (femur, patella, tibia, metatarsus, tarsus, total): I: 10.34, 5.40, 9.59, 8.55, 6.09, 39.97. II: 8.12, 4.17, 6.96, 7.02, 5.20, 31.47. III: 9.20, 4.43, 7.43, 9.71, 6.15, 36.92. IV: 11.39, 4.47, 10.27, 13.44, 6.75, 46.32. Palp: 7.14, 4.47, 6.39, -, 5.37, 23.37. **Spinnerets: PMS, 1.3 long, 0.7 apart; PLS, 2.2 basal, 1.1 middle, 2.0 distal.**

Scopulae: tarsi I-IV densely scopulate, I divided by narrow band of setae; II, III and IV divided by strong band of setae. Metatarsi I and II densely scopulate; III scopulate on distal  $\frac{1}{2}$ , and IV scopulate on distal  $\frac{1}{5}$ .

Stridulatory setae: Lacking

Legs and palpi LSC in: palp trochanter retrolateral face, femur retrolateral face; leg I coxa retrolateral face, trochanter prolateral and retrolateral faces, femur prolateral face; leg II trochanter prolateral face, femur prolateral face.

Chaetotaxy (left side): femora I 1p; II 1p; III 3p, 3r; IV 2p, 2r; palp 1p; patellae none; tibiae I 1p, 4v; II 2p, 9v; III 2p, 9v, 2r; IV 2p, 9v, 3r; palp 1p, 7v; metatarsi I 2v; II 1p, 2v; III 3p, 8v, 2r; IV 3p, 10v, 3r.

Genitalia: Spermathecae paired, slightly fused at their base; receptacles slender throughout their length and slightly bent laterally (Fig 30H).



Urticating setae: Lacking (Fig 30E).

Color pattern: In ethanol the color is brown; with carapace, legs and palps darker; chelicerae reddish. In live specimens the color is dark brown with the femora slightly darker (Fig 1K).

**Description.** Male: body length (not including chelicerae and spinnerets) 9.6, carapace: 4.6 long, 4.0 wide. Caput not markedly elevated; fovea recurved, 0.54 width. Carapace with brown setae (Fig 31A).

Eyes: anterior eye row procurved, posterior eye row straight. Periocular pigmentation absent. AME and PLE as integumentary spots, ALE and PME reduced. Eye sizes and interocular distances: AME 0.06; ALE 0.12; PME 0.06; PLE 0.08; AME-AME 0.12; AME-ALE 0.08; PME-PME 0.36; PME-PLE 0.02; ALE-PLE 0.02. Ocular tubercle undeveloped, width 0.8; length 0.24; clypeus lacking (Fig 31D). Labium: length 0.625; width 1.0; with 17 cuspules. Maxilla inner corner with approximately 77 cuspules (Fig 31E). Cheliceral promargin with 11 teeth (proximal to distal: 1-2 large, 3 small, 4 medium, 5 small, 6-7 medium, 8-10 large, 11 small). Sternum length 2.07. Sigillae circular, second, third and fourth pairs hardly visible; fourth pair once its length from the margin (Fig 31C, F). Leg formula: IV, I, II, III. Length of legs and palpal segments (femur, patella, tibia, metatarsus, tarsus, total): I: 6.20, 2.83, 6.04, 5.57, 4.28, 24.92. II: 5.99, 2.49, 5.44, 5.35, 4.17, 23.44. III: 5.80, 2.19, 5.48, 5.58, 3.96, 23.01. IV: 7.07, 2.68, 6.68, 8.89, 5.10, 30.42. Palp: 3.72, 2.60, 4.21, -, 1.27, 11.80. Spinnerets: PMS, 0.6 long, 0.3 apart; PLS, 1.2 basal, 0.6 middle, 1.0 distal.

Scopulae: tarsi I-III densely scopulate; I and II divided by narrow band of setae, III divided by strong band of setae, IV almost replaced by strong bands of setae. Metatarsi I-II densely scopulate; III scopulate on distal  $\frac{1}{2}$ , and IV scopulate on distal  $\frac{1}{8}$ .

Tibia I with two apophyses which do not originate from a common base, the Pap is very reduced with one large spinose seta on ventral face, the spinose seta is very long and almost replaces the Pap; the Rap is reduced with one very large spinose seta on prolateral face, the spinose seta almost replaces the Rap (Fig 31G, H). Metatarsus I straight (Fig 31I).

Stridulatory setae: Lacking.

Legs and palpi LSC in: palp trochanter retrolateral face, femur prolateral and retrolateral faces; leg I coxa retrolateral face, trochanter prolateral and retrolateral faces, femur prolateral and retrolateral faces; leg II trochanter prolateral face, femur prolateral face. Chaetotaxy (left side): femora I 1p; II 2p; III 2p, 2r; IV 1p, 1r; palp 1p; patellae none; tibiae I 2p, 5v, 2r; II 2p, 4v; III 2p, 7v, 2r; IV 2p, 8v, 2r; palp 1p, 6v; metatarsi I 2p, 6v, 1r; II 2p, 7v, 1r; III 3p, 8v, 3r; IV 3p, 8v, 3r.

Palp. Embolus as wide as tegulum at the base, tapering distally and larger than tegulum; SA retrolaterally extended ends before the embolus base (Fig 32C). SA does not curve in posterior; VG shallow (Fig 32D). Embolus slightly curved retrolaterally on distal half (Fig 32A, B).

Urticating setae: Lacking.

Color pattern: In ethanol the color is brown, with the opisthosoma, legs and palps darker (Fig 31A). In live specimens the color is dark brown, with the femora slightly darker (Fig 1J).

**Distribution and natural history:** Known only from Cueva de los Potrerillos and Sótano del Pozo in San Luis Potosí, México (Fig 48). It is only known that the species inhabits the

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caves. The adult male was collected on May, so it is possible that the mating season is between April and May. All the specimens were collected on the walls about 300m from the entrance (Fig 2H).

***Hemirrhagus benzaa* sp. nov.**

(Figs 1F, 2I; 33A–I, 34A–D; 35A–F; 49)

**Type material:** holotype ♂ and paratype ♀ AMNH, MEXICO: Oaxaca, 1km N Llano de las Flores, Sierra de Juárez IV-1985, Col. C. M. Bogert; 1 paratype ♀ and 1 immature AMNH, MEXICO: Oaxaca, Cerro Pelón IV-1962, Col. W. S. Miller.

**Additional material examined:** 1 ♀ CNAN 3492, MEXICO: Oaxaca, Mpio. Ixtlán de Juárez, Paradero Puerta del Sol 13-XI-2005, Col. O. Francke, M. Córdova, A. Jaimes, G. Montiel and C. Santibañez. 1 immature AMNH, MEXICO: Oaxaca, 1km N Llano de las Flores, Sierra de Juárez 17-IX-1961, Col. M. R. Bogert.

**Diagnosis:** The following character combination is diagnostic for *H. benzaa*. Male palpal bulb with slender embolus, longer than tegulum, SA retrolaterally extended ends at embolus retrolateral face; VG shallow (Fig 34A–D). Metatarsus I curved (Fig 33I). Males with spinose setae on patellae I to IV, which are absent on females. Ocular tubercle and eyes normally developed, periocular pigmentation complete (Figs 33C, 35D). Urticating setae arranged in one dorsomedian patch, yellowish-orange in color; with well-defined margins, posterior margin notched medially, with rounded edges (Figs 33E, 35C). Spermathecae paired, very short and close at the base, receptacles almost as long as wide (Fig 35F).

*H. benzaa* differs from most *Hemirrhagus* species in the male with spinose setae on patellae I to IV. From *H. eros* in the SA retrolaterally extended which ends at embolus retrolateral face. From *H. guichi* sp. nov. in the femora III and IV with more than 4 spinose setae and the posterior margin of urticating setae patch notched medially and with rounded sides.

**Etymology:** The specific name is a noun by apposition in honor of the Zapotecas, people inhabiting the central region of Oaxaca in ancient Mesoamerica. They call themselves as Ben'Zaa, which means Cloud People.

**Description:** Holotype male (Fig 33A–I; 34A–D): body length (not including chelicerae and spinnerets) 20.73, chelicera length 1.87; carapace: 10.18 long, 10.22 wide. Caput not markedly elevated; fovea recurved, 2.20 wide (Fig 33A). Eyes: anterior eye row procurved, posterior eye row recurved. Periocular pigmentation complete and all eyes normally developed. Eye sizes and interocular distances: AME 0.225; ALE 0.375; PME 0.30; PLE 0.375; AME-AME 0.275; AME-ALE 0.05; PME-PME 0.75; PME-PLA 0.05; ALE-PLA 0.15. Ocular tubercle normally developed, width 1.80, length 1.30; clypeus lacking (Fig 33C). Labium: length 1.25; width 1.70; with 20 cuspules. Maxilla inner corner with approximately 98 cuspules (Fig 33D). Cheliceral promargin with 11 teeth (proximal to distal: 1-3 large, 4-6 medium, 7-11 small) (Fig 33F). Sternum length

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380. Sigillae large oval, third and fourth pairs hardly visible; fourth pair half its length from the margin (Fig 33B).

Leg formula: IV, I, II, III. Length of legs and palpal segments (femur, patella, tibia, metatarsus, tarsus, total): I: 9.72, 4.95, 7.76, 7.24, 5.47, 35.14. II: 9.03, 5.03, 6.87, 6.90, 5.36, 33.19. III: 8.62, 4.22, 6.20, 8.36, 5.64, 33.04. IV: 10.35, 5.14, 8.54, 11.28, 6.51, 41.82. Palp: 6.50, 3.49, 5.27, -, 2.48, 17.74. Spinnerets: PMS, 0.6 long, 0.7 apart; PLS, 1.5 basal, 0.8 middle, 1.6 distal.

Scopulae: tarsi I-IV densely scopulate; III and IV divided by strong band of setae. Metatarsi I-II densely scopulate; III and IV scopulate on distal  $\frac{1}{2}$ , divided by strong band of setae. Tibia I with two apophyses which do not originate from a common base, the Pap is normally developed with one large spinose seta on ventral face, the spinose seta is shorter than the Pap; the Rap is normally developed, broad at its base with one large spinose seta on dorsal face, the spinose seta does not exceed the apex of Rap (Fig 33G, H). Metatarsus I curved (Fig 33I).

Stridulatory setae: Lacking.

Legs and palpi LSC in: palp trochanter retrolateral face, femur retrolateral face; leg I trochanter prolateral face, femur prolateral face.

Chaetotaxy (left side): femora I 3p; II 4p, 3r; III 1d, 6p, 4r; IV 2p, 2r; palp 1p; patellae I 1p, 3v; II 1p, 3v; III 1p, 1v, 1r; IV 1p, 1v, 1r; palp none; tibiae I 2p, 7v, 4r; II 3p, 11v, 4r; III 4p, 13v, 6r; IV 6p, 13v, 7r; palp 1p, 6v; metatarsi I 2v; II 1p, 3v, 1r; III 4p, 12v, 4r; IV 1d, 5p, 13v, 6r.

Palp. Embolus slender, longer than tegulum; SA retrolaterally extended ends at embolus base on retrolateral face. VG shallow. Embolus strongly curved retrolaterally on distal third (Fig 34A–D).

Urticating setae: Type VI arranged in one dorsomedian patch, yellowish-orange in color, with well-defined margins, posterior margin notched medially and with convex (Fig 33E).

Color pattern: In ethanol the color is dark brown, with the carapace, femora of legs and palps darker. In live specimens the color is very dark brown, almost black, with the femora a little darker than rest of the body.

Paratype female (Fig 35A–F): body length (not including chelicerae and spinnerets) 23.69, carapace: 10.46 long, 10.81 wide. Caput not elevated; fovea straight, width 2.1 (Fig 35A).

Eyes: anterior eye row procurved, posterior eye row recurved. Periocular pigmentation complete, all eyes normally developed. Eye sizes and interocular distances: AME 0.275; ALE 0.50; PME 0.35; PLE 0.425; AME-AME 0.35; AME-ALE 0.175; PME-PME 0.80; PME-PLA 0.10; ALE-PLA 0.125. Ocular tubercle normally developed, width 2.0; length 1.4; clypeus lacking (Fig 35D). Labium: length 1.2; width 1.8; with 12 cuspules. Maxilla inner corner with approximately 97 cuspules (Fig 35E). Cheliceral promargin with 11 teeth (proximal to distal: 1 small, 2-3 large, 4-7 medium, 8-11 large). Sternum length 4.2.

Sigillae large oval, third and fourth pairs hardly visible; fourth pair once its length from the margin (Fig 35B).

Leg formula: IV, I, III, II. Length of legs and palpal segments (femur, patella, tibia, metatarsus, tarsus, total): I: 9.76, 5.21, 7.55, 6.05, 4.81, 33.38. II: 8.73, 4.83, 6.35, 5.98, 4.97, 30.86. III: 8.24, 4.62, 5.77, 7.32, 5.22, 31.17. IV: 11.06, 5.08, 8.64, 10.81, 6.25, 41.84. Palp: 6.30, 4.32, 5.04, -, 4.79, 20.45. Spinnerets: PMS, 1.2 long, 0.7 apart; PLS, 2.0 basal, 1.1 middle, 1.7 distal.



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Scopulae: tarsi I-IV densely scopulate, III divided by narrow band of setae and IV divided by strong band of setae. Metatarsi I and II densely scopulate, III scopulate on distal  $\frac{2}{3}$ , and IV scopulate on distal  $\frac{1}{2}$ .

Stridulatory setae: Lacking

Legs and palpi LSC in: palp trochanter retrolateral face, femur retrolateral face; leg I coxa retrolateral face, trochanter prolateral and retrolateral faces, femur prolateral face; leg II trochanter prolateral face, femur prolateral face.

Chaetotaxy (left side): femora I 1p; II 1p; III 3p, 2r; IV 1p, 4r; palp 1p; patellae none; tibiae I 2p, 3v; II 2p, 6v; III 3p, 9v, 2r; IV 3p, 8v, 6r; palp 1p, 10v; metatarsi I 2v; II 3v; III 4p, 11v, 4r; IV 5p, 13v, 4r.

Genitalia: Spermathecae paired; receptacles fused at their base, very short and close at the base, almost as long as wide and slightly bent laterally (Fig. 35F).

Urticating setae: Type VI arranged in one dorsomedian patch, yellowish-orange in color, with well-defined margins, posterior margin notched medially and with convex sides (Fig. 35C).

Color pattern: In ethanol the color is dark brown, with the carapace, femora of legs and palps darker. In live specimens the color is very dark brown, almost black, with the femora a little darker than rest of the body (Fig. 1F).

**Distribution and natural history:** Known only from Sierra de Juárez, Oaxaca, Mexico (Fig. 49). This species inhabits in high altitudes and lives in pine forest (Fig. 2I).

***Hemirrhagus embolulatus* sp. nov.**

(Figs 2A, B, J; 36A–I; 37A–E; 38A–G; 48)

**Type material:** holotype ♂ CNAN-T0774 and paratype ♀ CNAN-T0775, MEXICO: Guerrero, Mpio. Chilpancingo de los Bravo, Parque Nacional Omiltemi, Omiltemi, 03-XII-2009, Col. E. Goyer and E. Hijmensen.

**Diagnosis:** The following character combination is diagnostic for *H. embolulatus*. Male palpal bulb with wide embolus throughout its length, similar in length to tegulum, with well developed PS, PI and R keels (Fig. 37E); SA retrolaterally extended ends at embolus retrolateral face (Fig. 37B, D); VG shallow and embolous strongly curved retrolaterally on distal half (Fig. 37A–C). Metatarsus I straight (Fig. 36G). Prolateral tibial apophysis weakly developed (Fig. 36I). Ocular tubercle and eyes normally developed, pericocular pigmentation complete (Fig. 36D, 38C). Urticating setae arranged in one dorsomedian patch, yellowish-orange in color, with well-defined margins, anterior and posterior margins slightly notched medially (Fig. 36C). Female metatarsus IV with 10 spinose setae distally (Fig. 38F). Spermathecae paired, separated at their base, with rounded receptacles wider than long (Fig. 38G).

*H. embolulatus* differs from all other *Hemirrhagus* species in the embolus with well-developed PS, PI and R keels. Also differs in the spermathecae with rounded receptacles wider than long.

**Etymology:** The specific name is a word composed by latin words *embolus*, referring to the male embolus and *latus*, wide. The name makes reference to the wide embolus of this species.

**Description:** Holotype male CNAN-T0774 (Figs 2A, 36A–I, 37A–E): body length 19.70 (not including chelicerae and spinnerets); chelicera length 3.4; carapace 8.4 long, 7.4 wide. Caput not markedly elevated; fovea straight, 0.83 wide (Fig 36A).

Eyes: anterior eye row procurved, posterior eye row recurved. Periocular pigmentation complete and all eyes normally developed. Eye sizes and interocular distances: AME 0.27; ALE 0.40; PME 0.27; PLE 0.33; AME-AME 0.27; AME-ALE 0.07; PME-PME 0.63; PME-PLA 0.10; ALE-PLA 0.10. Ocular tubercle normally developed, width 1.50, length 0.93; clypeus lacking (Fig 36D). Labium: length 1.05, width 1.5; with 29 cuspules. Maxilla inner corner with approximately 114 cuspules (Fig 36E). Cheliceral promargin with 10 teeth (proximal to distal: 1 medium, 2–3 large, 4 small, 5–9 large and 10 small) (Fig 36F). Sternum length 3.7. Sigillae circular, second, third and fourth pairs hardly visible; fourth pair once its length from margin (Fig 36B).

Leg formula: IV, I, II, III. Length of legs and palpal segments (femur, patella, tibia, metatarsus, tarsus, total): I: 8.96, 4.30, 7.15, 6.83, 5.18, 32.42. II: 7.92, 4.21, 5.85, 6.64, 5.07, 29.69. III: 6.73, 3.22, 5.85, 7.33, 5.21, 28.34. IV: 9.31, 4.15, 7.85, 10.21, 6.21, 37.73. Palp: 5.23, 2.99, 4.78, –, 1.80, 14.80. **Spinnerets:** PMS, 0.7 long, 0.4 apart, PLS, 1.0 basal, 1.1 middle, 1.8 distal.

Scopulae: tarsi I–IV densely scopulate, III–IV divided by strong band of setae. Metatarsi I–II densely scopulate, III scopulate on distal  $\frac{1}{2}$ , divided by strong band of setae; IV scopulate on distal  $\frac{1}{4}$ , divided by strong band of setae.

Tibia I with two apophyses which do not originate from a common base, the Pap is reduced with one large and broad spinose seta on ventral face which almost replace it, the spinose seta exceeds the apex of Pap; the Rap is normally developed, broad at its base with one short and wide spinose seta subapically on dorsal face, the spinose seta exceeds the apex of Rap (Fig 36H, I). Metatarsus I straight (Fig 36G).

Stridulatory setae: Lacking.

Legs and palpi LSC in: palp trochanter retrolateral face, femur prolateral and retrolateral faces; leg I coxa retrolateral face, trochanter prolateral face, femur prolateral face; leg II coxa prolateral face, trochanter prolateral face, femur prolateral face.

Chaetotaxy (left side): femora I 2p; II 1d, 3p; III 3d, 3p; IV 3p, 2r; palp 2p; patellae none; tibiae I 2p, 6v; II 2p, 9v; III 2p, 10v, 2r; IV 3p, 10v, 4r; palp 2p, 8v; metatarsi I 2v; II 1p, 2v, 3r; III 1d, 4p, 13v, 2r; IV 5p, 14v, 5r.

Palp. Wide embolus throughout its length, similar in length to tegulum, with well developed PS, PI and R keels (Fig 37E); SA retrolaterally extended ends at embolus retrolateral face (Fig 37D); VG shallow and embolous strongly curved retrolaterally on distal half (Figs 37A–C).

Urticating setae: Type VI arranged in one dorsomedian patch, yellowish-orange in color, with well-defined margins, anterior and posterior margins slightly notched medially (Fig 36C).

Color pattern: On live specimens color is black, except the urticating setae (Fig 2A).

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Paratype female CNAN-T0775 (Figs. 2B, 38A–G): body length (not including chelicerae and spinnerets) 25.86, carapace: 10.15 long, 9.24 wide. Caput not elevated; fovea recurved, width 1.75 (Fig. 38A).

Eyes: anterior eye row procurved, posterior eye row recurved. Periocular pigmentation complete, all eyes normally developed. Eye sizes and interocular distances: AME 0.38; ALE 0.50; PME 0.30; PLE 0.50; AME-AME 0.18; AME-ALE 0.15; PME-PME 0.75; PME-PLE 0.13; ALE-PLE 0.18. Ocular tubercle normally developed, width 1.83; length 1.28; clypeus lacking (Fig. 38C). Labium: length 1.68; width 1.78; with 26 cuspsules.

Maxilla inner corner with approximately 130 cuspsules (Fig. 38D). Cheliceral promargin with 8 teeth (proximal to distal: 1–3 large, 4 medium, 5–6 large, 7 medium, 8 small).

Sternum length 2.15. Sigillae circular, second, third and fourth pairs hardly visible; fourth pair one and a half times its length from the margin (Fig. 38B, E).

Leg formula: IV, I, III, II. Length of legs and palpal segments (femur, patella, tibia, metatarsus, tarsus, total): I: 8.04, 4.81, 6.63, 6.35, 4.45, 30.28. II: 7.54, 4.06, 5.63, 5.44, 4.64, 27.31. III: 6.88, 3.87, 5.30, 6.62, 4.58, 27.25. IV: 8.89, 3.71, 7.71, 10.14, 5.42, 35.87. Palp: 5.93, 3.62, 4.58, -, 4.41, 18.54. **Spinnerets are damaged.**

Scopulae: tarsi I–IV densely scopulate, III divided by narrow band of setae and IV divided by strong band of setae. Metatarsi I and II densely scopulate, III scopulate on distal  $\frac{1}{2}$ , and IV scopulate on distal  $\frac{1}{4}$ .

Stridulatory setae: Lacking

Legs and palpi LSC in: palp trochanter retrolateral face, femur prolateral and retrolateral faces; leg I coxa retrolateral face, trochanter prolateral and retrolateral faces, femur prolateral face; leg II coxa prolateral, trochanter prolateral face, femur prolateral face.

Chaetotaxy (left side): femora I 1p; II 1p; III 2p, 2r; IV 1p, 2r; palp 1p; patellae none; tibiae I 2p, 4v; II 2p, 5v; III 2p, 8v, 2r; IV 2p, 10v, 3r; palp 1p, 11v; metatarsi I 2v; II 1p, 5v; III 5p, 10v, 3r; IV 5p, 19v, 4r. Metatarsus IV with 10 spinose setae distally (Fig. 31F).

Genitalia: Spermathecae paired, separated at their base but receptacles close together, rounded, wider than long (Fig. 38G).

Urticating setae: Type VI arranged in one dorsomedian patch, yellowish-orange in color, with well-defined margins, anterior and posterior margins slightly notched medially.

Color pattern: On live specimens color is black, except the urticating setae (Fig. 2B).

**Distribution and natural history:** Known only from Omiltemi, Guerrero, Mexico (Fig. 48). The species was collected in tropical forest-pine forest ecotone (Fig. 2J). The specimens were found under rocks or fallen logs.

***Hemirhagus franckei* sp. nov.**

(Figs 1L, 2E, 39A–L, 40A–D, 41A–I, 49)

**Type material:** holotype ♂ CNAN-T0776, MEXICO: Oaxaca, Mpio. Huautla de Jimenez, 4km W of Puerto de la Soledad, 10-XII-2011, Col. J. Mendoza, G. Contreras, E. Hijmensen and E. Goyer; paratype ♀ CNAN-T0777, MEXICO: Oaxaca, Mpio. Huautla de Jimenez, 4km W of Puerto de la Soledad, 11-IX-2010, Col. O. Francke, A. Valdez, J. Cruz and D. Barrales; paratype ♀ CNAN-T0778, MEXICO: Oaxaca, Mpio. Huautla de Jimenez, 4km W

of Puerto de la Soledad, 10-XII-2011, Col. J. Mendoza, G. Contreras, E. Hijmensen and E. Goyer.

*Additional material examined:* 1 ♂ immature CNAN-3487, MEXICO: Oaxaca, Mpio. Huautla de Jimenez, 4km W of Puerto de la Soledad, 11-IX-2010, Col. O. Francke, A. Valdez, J. Cruz and D. Barrales.

**Diagnosis:** The following character combination is diagnostic for *H. franckei*. Male palpal bulb with slender embolus, similar in length to tegulum, SA retrolaterally extended ends at embolus retrolateral face (Fig 40A, C), VG shallow (Fig 40B); embolus strongly curved retrolaterally on distal half (Figs 40C, D). Metatarsus I curved (Fig 39J). Ocular tubercle and eyes normally developed, periorcular pigmentation complete (Figs 39C, 41E). With stridulatory setae conformed by SP on retrolateral face of palp trochanter and PL on prolateral face of trochanter I (Figs 39K, L, 41G, H). Urticating setae arranged in one dorsomedian patch, platinum in color, without well-defined posterior margin (Figs 39E, 41C). Spermathecae paired, slightly fused at the base, receptacles curved outwards from the base (Fig 41I).

*H. franckei* differs from most *Hemirrhagus* species in the stridulatory setae conformed by SP and PL; from *H. pernix* in the metatarsus I straight and in the most numerous PL on trochanter I prolateral face. Differs from *H. nahuamus* in ocular tubercle normally developed, periorcular pigmentation complete and in the Pap with only one spinose seta.

**Etymology:** The specific name is a patronym in honor of Oscar F. Francke Ballve, for his contribution to the knowledge of Mexican arachnology.

**Description:** Holotype male CNAN-T0776 (Figs 1L, 39A–L, 40A–D): body length 20.76 (not including chelicerae and spinnerets), carapace 8.80 long, 8.45 wide. Caput not markedly elevated; fovea recurved, 1.30 wide (Fig 39A).

Eyes: anterior eye row procurved, posterior eye row recurved. Periorcular pigmentation complete and all eyes normally developed. Eye sizes and interocular distances: AME 0.30; ALE 0.375; PME 0.225; PLE 0.325; AME-AME 0.175; AME-ALE 0.01; PME-PME 0.525; PME-PL 0.05; ALE-PL 0.10. Ocular tubercle normally developed, width 1.4, length 0.875; clypeus lacking (Fig 39C). Labium length 1.15, width 1.58; with 42 cuspules. Maxilla inner corner with approximately 101 cuspules (Fig 39D). Cheliceral promargin with 11 teeth (proximal to distal: 1 small, 2-11 large) (Fig 39F). Sternum length 3.8. Sigillae oval, second, third and fourth pairs hardly visible; fourth pair once its length from the margin (Fig 39B, G).

Leg formula: IV, I, III, II. Length of legs and palpal segments (femur, patella, tibia, metatarsus, tarsus, total): I: 7.47, 4.80, 5.77, 6.76, 5.76, 30.56. II: 7.13, 3.58, 5.39, 6.33, 5.03, 27.46. III: 7.42, 3.41, 5.80, 7.59, 5.67, 29.89. IV: 8.92, 4.29, 7.68, 10.40, 6.56, 37.85. Palp: 4.99, 3.51, 5.10, -, 2.42, 16.02. Spinnerets: PMS, 0.7 long, 0.3 apart; PLS, 1.3 basal, 1.1 middle, 1.6 distal.

Scopulae: tarsi I-IV densely scopulate, III divided by narrow band of setae, IV divided by strong band of setae. Metatarsi I-II densely scopulate; III scopulate on distal  $\frac{1}{2}$ , divided by narrow band of setae; IV scopulate on distal  $\frac{1}{2}$ , divided by strong band of setae.

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Tibia I with two apophyses which do not originate from a common base, the Pap is normally developed, with one large spinose seta on ventral face, the spinose seta slightly exceeds the apex of Pap; the Rap is normally developed, broad at its base with one short and wide spinose seta on dorsal face, the spinose seta slightly exceeds the apex of Rap (Fig 39H, I). Metatarsus I straight (Fig 39J).

Stridulatory setae: On palpal trochanter retrolateral face located in proximal, with *ca.* 11 SP of similar size, disorganized (Fig 39K). Trochanter I with *ca.* 20 PL on prolateral face (Fig 39L).

Legs and palpi LSC in: palp femur prolateral and retrolateral faces; leg I coxa prolateral and retrolateral faces, femur prolateral face; leg II coxa prolateral face.

Chaetotaxy (left side): femora I 1p, II 1p, 1r, III 2p, 2r; IV 2p, 2r; palp 1p; patellae III 1p; IV 1p; tibiae I 2p, 7v; II 2p, 8v; III 2p, 7v, 3r; IV 5p, 7v, 3r; palp 1p, 3v, 2r; metatarsi I 3v; II 4v; III 1d, 3p, 11v, 2r; IV 2d, 4p, 9v, 4r.

Palp. Embolus slender, similar in length to tegulum, SA retrolaterally extended ends at embolus retrolateral face, VG shallow. Embolous strongly curved retrolaterally on distal half (Fig 40A–D).

Urticating setae: Type VI arranged in one dorsomedian patch, platinum in color, without well-defined posterior margin (Fig 39E).

Color pattern: On live specimens color is black, except the urticating setae (Fig 1L).

Paratype female CNAN-T0777 (Fig 41A–I): body length 24.79 (not including chelicerae and spinnerets), carapace 8.7 long, 8.4 wide. Caput not markedly elevated; fovea straight, 2.17 wide (Fig 41A).

Eyes: anterior eye row straight to slightly procurved, posterior eye row recurved. Periocular pigmentation complete and all eyes normally developed. Eye sizes and interocular distances: AME 0.20; ALE 0.43; PME 0.27; PLE 0.37; AME-AME 0.20; AME-ALE 0.13; PME-PME 0.57; PME-PLP 0.07; ALE-PLP 0.13. Ocular tubercle normally developed, width 1.53, length 0.93; clypeus lacking (Fig 41E). Labium length 1.2, width 4.3; with 37 cuspules. Maxilla inner corner with approximately 107 cuspules (Fig 41F). Cheliceral promargin with 12 teeth (proximal to distal: 1 small, 2-4 large, 5-7 medium, 8-12 large) (Fig 41D). Sternum length 3.75. Sigillae oval, third and fourth pairs hardly visible; fourth pair one and a half its length from the margin (Fig 41B).

Leg formula: IV, I, III, II. Length of legs and palpal segments (femur, patella, tibia, metatarsus, tarsus, total): I: 7.44, 4.13, 5.93, 4.88, 4.51, 26.89. II: 6.70, 3.48, 5.13, 5.13, 4.18, 24.98. III: 6.63, 3.66, 5.10, 6.55, 4.51, 26.45. IV: 8.92, 3.96, 7.44, 9.63, 5.71, 35.66. Palp: 5.72, 3.31, 4.47, -, 4.29, 17.79. Spinnerets: PMS, 0.8 long, 0.5 apart; PLS, 1.6 basal, 1.1 middle, 1.8 distal.

Scopulae: tarsi I-IV densely scopulate, I-II divided by narrow band of setae, III-IV divided by strong band of setae. Metatarsi I-II densely scopulate, II divided by narrow row of setae; III scopulate on distal  $\frac{1}{2}$ , divided by narrow row setae; IV scopulate on distal  $\frac{1}{3}$ , divided by strong row of setae.

Stridulatory setae: On palpal trochanter retrolateral face located in proximal, with *ca.* 30 SP of different size, disorganized (Fig 41H). Trochanter I with *ca.* 30 PL on prolateral face, not as wide as in males (Fig 41G).

Legs and palpi LSC in: palp femur prolateral and retrolateral faces; leg I coxa prolateral and retrolateral faces, femur prolateral face; leg II coxa prolateral face.



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Tibia I with two apophyses which do not originate from a common base, the Pap is normally developed, with one large spinose seta on ventral face, the spinose seta slightly exceeds the apex of Pap; the Rap is normally developed, broad at its base with one short and wide spinose seta on dorsal face, the spinose seta slightly exceeds the apex of Rap (Fig 39H, I). Metatarsus I straight (Fig 39J).

Stridulatory setae: On palpal trochanter retrolateral face located in proximal, with *ca.* 11 SP of similar size, disorganized (Fig 39K). Trochanter I with *ca.* 20 PL on prolateral face (Fig 39L).

Legs and palpi LSC in: palp femur prolateral and retrolateral faces; leg I coxa prolateral and retrolateral faces, femur prolateral face; leg II coxa prolateral face.

Chaetotaxy (left side): femora I 1p, II 1p, 1r, III 2p, 2r; IV 2p, 2r; palp 1p; patellae III 1p; IV 1p; tibiae I 2p, 7v; II 2p, 8v; III 2p, 7v, 3r; IV 5p, 7v, 3r; palp 1p, 3v, 2r; metatarsi I 3v; II 4v; III 1d, 3p, 11v, 2r; IV 2d, 4p, 9v, 4r.

Palp. Embolus slender, similar in length to tegulum, SA retrolaterally extended ends at embolus retrolateral face, VG shallow. Embolus strongly curved retrolaterally on distal half (Fig 40A–D).

Urticating setae: Type VI arranged in one dorsomedian patch, platinum in color, without well-defined posterior margin (Fig 39E).

Color pattern: On live specimens color is black, except the urticating setae (Fig 1L).

Paratype female CNAN-T0777 (Fig 41A–I): body length 24.79 (not including chelicerae and spinnerets), carapace 8.7 long, 8.4 wide. Caput not markedly elevated; fovea straight, 2.17 wide (Fig 41A).

Eyes: anterior eye row straight to slightly procurved, posterior eye row recurved. Periocular pigmentation complete and all eyes normally developed. Eye sizes and interocular distances: AME 0.20; ALE 0.43; PME 0.27; PLE 0.37; AME-AME 0.20; AME-ALE 0.13; PME-PME 0.57; PME-PLP 0.07; ALE-PLP 0.13. Ocular tubercle normally developed, width 1.53, length 0.93; clypeus lacking (Fig 41E). Labium length 1.2, width 4.3; with 37 cuspules. Maxilla inner corner with approximately 107 cuspules (Fig 41F). Cheliceral promargin with 12 teeth (proximal to distal: 1 small, 2–4 large, 5–7 medium, 8–12 large) (Fig 41D). Sternum length 3.75. Sigillae oval, third and fourth pairs hardly visible; fourth pair one and a half its length from the margin (Fig 41B).

Leg formula: IV, I, III, II. Length of legs and palpal segments (femur, patella, tibia, metatarsus, tarsus, total): I: 7.44, 4.13, 5.93, 4.88, 4.51, 26.89. II: 6.70, 3.48, 5.13, 5.13, 4.18, 24.98. III: 6.63, 3.66, 5.10, 6.55, 4.51, 26.45. IV: 8.92, 3.96, 7.44, 9.63, 5.71, 35.66. Palp: 5.72, 3.31, 4.47, -, 4.29, 17.79. Spinnerets: PMS, 0.8 long, 0.5 apart; PLS, 1.6 basal, 1.1 middle, 1.8 distal.

Scopulae: tarsi I–IV densely scopulate, I–II divided by narrow band of setae, III–IV divided by strong band of setae. Metatarsi I–II densely scopulate, II divided by narrow row of setae; III scopulate on distal  $\frac{1}{2}$ , divided by narrow row setae; IV scopulate on distal  $\frac{1}{3}$ , divided by strong row of setae.

Stridulatory setae: On palpal trochanter retrolateral face located in proximal, with *ca.* 30 SP of different size, disorganized (Fig 41H). Trochanter I with *ca.* 30 PL on prolateral face, not as wide as in males (Fig 41G).

Legs and palpi LSC in: palp femur prolateral and retrolateral faces; leg I coxa prolateral and retrolateral faces, femur prolateral face; leg II coxa prolateral face.

Chaetotaxy (left side): femora I 1p; II 1p; III 2p, 2r; IV 1p, 1r; palp 2p; patellae none; tibiae I 1p, 3v; II 2p, 4v; III 2p, 7v, 2r; IV 2p, 7v, 3r; palp 1p, 6v; metatarsi I 1v; II 4v; III 3p, 7v, 2r; IV 3d, 3p, 8v, 2r.

Genitalia: Spermathecae paired, slightly fused at the base, curved outwards from the base; each receptacle longer than wide and slender throughout its length (Fig 41D).

Urticating setae: Type VI arranged in one dorsomedian patch, platinum in color, without well-defined posterior margin (Fig 41C).

Color pattern: On live specimens color is black, except the urticating setae.

**Distribution and natural history:** Known only from type locality near Huautla de Jiménez, Oaxaca, Mexico (Fig 49). The species inhabits in pine forest, living under fallen logs (Fig 2E).

***Hemirrhagus guichi* sp. nov.**

(Figs 42A–H, 43A–D; 44A–F, 49)

**Type material:** holotype ♂ and paratype ♀ AMNH, MEXICO: Oaxaca, La Cofradia (8mi SW of San Vicente Lachixio), 24-VII-1966, Col. C. M. B., K. S., J. S. and P. P. Examined.

**Diagnosis:** The following character combination is diagnostic for *H. guichi*. Male palpal bulb with slender embolus, as long as tegulum (Fig 43A, B), SA retrolaterally extended ends at embolus retrolateral face (Fig 43B, C); VG shallow (Fig 43A). Metatarsus I curved (Fig 42F). Males with spinose setae on patellae I to IV, which are absent in females. Ocular tubercle and eyes normally developed, periocular pigmentation complete (Figs 42C, 44D). Urticating setae arranged in one dorsomedian patch, yellowish-orange in color; with well-defined margins, posterior margin notched medially with sides straight forming a “V” (Figs 42E, 44C). Spermathecae paired, very short and close at the base, almost as long as wide (Fig 44F).

*H. guichi* differs from most *Hemirrhagus* species in the male with spinose setae on patellae I to IV. From *H. eras* in the SA retrolaterally extended which ends at embolus retrolateral face. From *H. benzaa* sp. nov. in the posterior margin of urticating setae patch, notched medially with straight sides forming a “V”. Also differs in males which possess more than 5 spinose setae on patellae I and II, and the embolus as long as tegulum.

**Etymology:** The specific name is a noun in apposition formed by the Zapotec word *guichi*, which means spine, referring to the large number of spinose setae that the male presents on the legs.

**Description:** Holotype male (Fig 42A–H; 43A–D): body length (not including chelicerae and spinnerets) 32.28, chelicera length 5.64; carapace: 14.91 long, 12.97 wide. Caput not markedly elevated; fovea recurved, 2.75 wide (Fig 42A).

Eyes: anterior eye row straight, posterior eye row recurved. Periocular pigmentation complete and all eyes normally developed. Eye sizes and interocular distances: AME 0.28; ALE 0.45; PME 0.275; PLE 0.40; AME-AME 0.25; AME-ALE 0.125; PME-PME 0.825; PME-PLE 0.05; ALE-PLE 0.225. Ocular tubercle normally developed, width 1.93, length 1.45; clypeus lacking (Fig 42C). Labium length 1.90; width 2.45; with 15 cuspules.

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Maxilla inner corner with approximately 134 cuspules (Fig 42D). Cheliceral promargin with 14 teeth (proximal to distal: 1 medium, 2 large, 3-6 medium, 7-8 large, 9 medium, 10 large, 11-12 medium, 13 large, 14 small). Sternum length 6.30. Sigillae large oval, third and fourth pairs hardly visible; fourth pair half its length from the margin (Fig 42B). Leg formula: IV, I, II, III. Length of legs and palpal segments (femur, patella, tibia, metatarsus, tarsus, total): I: 14.99, 7.38, 12.93, 12.48, 8.56, 56.34. II: 13.91, 7.05, 11.60, 11.46, 8.16, 52.18. III: 13.13, 6.33, 10.28, 11.52, 7.85, 49.11. IV: 15.42, 6.80, 13.03, 17.37, 9.05, 61.67. Palp: 9.25, 4.91, 8.38, -, 3.64, 26.18. Spinnerets: PMS, 1.3 long, 0.8 apart; PLS, 2.5 basal, 2.0 middle, 2.3 distal.

Scopulae: tarsi I-IV densely scopulate; III divided by narrow band of setae and IV divided by strong band of setae. Metatarsi I-II densely scopulate; III scopulate on distal  $\frac{1}{2}$ , divided by narrow band of setae and IV scopulate on distal  $\frac{1}{3}$ , divided by strong band of setae. Tibia I with two apophyses which do not originate from a common base, the Pap is normally developed, with one short spinose seta on ventral face, the spinose seta does not exceed the apex of Pap; the Rap is normally developed, broad at its base with one large and wide spinose seta on dorsal face, the spinose seta does not exceed the apex of Rap (Fig 42G, H). Metatarsus I curved (Fig 42F).

Stridulatory setae: Lacking.

Legs and palpi LSC in: palp trochanter retrolateral face, femur retrolateral face; leg I trochanter prolateral face, femur prolateral face.

Chaetotaxy (left side): femora I 3p, 2r; II 1d, 3p, 3r; III 7p, 8r; IV 8p, 5r, palp 1p; patellae I 1p, 6v; II 2p, 6v; III 1v, 2r; IV 2v; palpi 1v; tibiae I 4p, 11v, 3r; II 2p, 16v, 1r; III 4p, 16v, 5r; IV 4p, 15v, 6r; palpi 1p, 6v; metatarsi I 4v; II 6v; III 6p, 13v, 7r; IV 6p, 14v, 10r.

Palp. Embolus slender, as long as tegulum; SA retrolaterally extended ends at embolus base on retrolateral face. VG shallow. Embolus strongly curved retrolaterally on distal third (Fig 43A-D).

Urticating setae: Type VI arranged in one dorsomedian patch, yellowish-orange in color, with well-defined margins, posterior margin notched medially, with straight sides forming a "V" (Fig 42E).

Color pattern: In ethanol the color is dark brown, with the carapace, femora of legs and palps darker.

Paratype female (Fig 44A-F): body length (not including chelicerae and spinnerets) 29.03, carapace: 12.60 long, 11.92 wide. Caput not elevated; fovea recurved, width 2.5 (Fig 44A). Eyes: anterior eye row procurved, posterior eye row recurved. Periocular pigmentation complete, all eyes normally developed. Eye sizes and interocular distances: AME 0.325; ALE 0.45; PME 0.375; PLE 0.55; AME-AME 0.25; AME-ALE 0.10; PME-PME 0.75; PME-PLE 0.05; ALE-PLE 0.20. Ocular tubercle normally developed, width 2.1; length 1.2; clypeus lacking (Fig 44D). Labium length 1.6; width 2.2; with 12 cuspules. Maxilla inner corner with approximately 154 cuspules (Fig 44E). Cheliceral promargin with 12 teeth (proximal to distal: 1-3 large, 4 small, 5-6 medium, 7-8 large, 9 small, 10-12 large). Sternum length 5.7. Sigillae large oval, second, third and fourth pairs hardly visible; fourth pair once its length from the margin (Fig 44B).

Leg formula: IV, I, II, III. Length of legs and palpal segments (femur, patella, tibia, metatarsus, tarsus, total): I: 11.17, 6.74, 9.61, 7.60, 5.89, 41.01. II: 10.41, 5.69, 8.07, 7.41, 5.54, 37.12. III: 9.88, 5.36, 7.36, 8.22, 5.55, 36.37 IV: 12.17, 5.88, 9.91, 11.72, 6.47, 46.15.



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Palp: 8.04, 5.05, 6.12, -, 5.85, 25.06. Spinnerets: PMS, 1.1 long, 0.6 apart; PLS, 2.0 basal, 1.2 middle, 2.1 distal.

Scopulae: tarsi I-IV densely scopulate, III and IV divided by strong band of setae. Metatarsi I and II densely scopulate, III scopulate on distal  $\frac{1}{2}$ , divided by strong band of setae and IV scopulate on distal  $\frac{1}{3}$ , divided by strong band of setae.

Stridulatory setae: Lacking

Legs and palpi LSC in: palp trochanter retrolateral face, femur retrolateral face; leg I trochanter prolateral face, femur prolateral face.

Chaetotaxy (left side): femora I 1p; II 1p; III 1p; IV 1r; palp 1p; patellae none; tibiae I 1v; II 1v; III 2p, 4v, 2r; IV 2p, 5v, 2r; palp 1p, 9v; metatarsi I 2v; II 2v; III 3p, 10v, 2r; IV 2p, 8v, 3r.

Genitalia: Spermathecae paired, very short and close at the base, almost as long as wide and slightly bent laterally (Fig 44F).

Urticating setae: Type VI arranged in one dorsomedian patch, yellowish-orange in color, with well-defined margins, posterior margin notched medially, with straight sides forming a "V" (Fig 44C).

Color pattern: In ethanol the color is dark brown, with the carapace, femora of legs and palps darker.

**Distribution and natural history:** Known only from La Cofradia, Oaxaca, Mexico (Fig 49). This species lives in pine forest.

***Hemirhagus valdezi* sp. nov.**

(Figs 2C, 45A–J; 46A–D; 47A–G, 49)

**Type material:** holotype ♂ CNAN-T0779, 1 paratype ♀ CNAN-T0780, 5 paratype ♂ CNAN-T0781, 3 paratype ♀ CNAN-T0782 and 1 paratype ♂ AMNH, MEXICO: Guerrero, Mpio. Teloloapan, La Yerbabuena, Cueva Redonda, 22-X-2010, Col. A. Valdez, J. Cruz, G. Contreras and D. Barrales.

**Additional material examined:** 1 ♀ CNAN 3468, MEXICO: Guerrero, Mpio. Teloloapan, La Yerbabuena, Cueva Redonda, 9-XI-2004, Col. A. Valdez and H. Montaño; 1 ♀ and 2 immatures CNAN 3483, MEXICO: Guerrero, Mpio. Teloloapan, La Yerbabuena, Cueva Redonda, 30-VII-2009, Col. O. Francke, C. Quijano, A. Valdez, C. Santibañez and T. Palafox; 1 ♂ and 1 immature CNAN 3482, MEXICO: Guerrero, Mpio. Teloloapan, La Yerbabuena, Cueva Redonda, 22-X-2010, Col. A. Valdez, J. Cruz, G. Contreras and D. Barrales.

**Diagnosis:** The following character combination is diagnostic for *H. valdezi*. Male palpal bulb with slender embolus, similar in length to tegulum, SA retrolaterally extended ends at embolus retrolateral face; the posterior curvature of SA, occurs at the base of the embolus and forms an angle of 90° (Fig 46A), VG deep (Fig 46B); embolous curved retrolaterally on distal half (Fig 46C, D). Metatarsus I curved (Fig 45H). Ocular tubercle and eyes normally developed, pericocular pigmentation complete (Figs 45C, 47D). Urticating setae arranged in two lateral patches, black in color, with poorly defined margins (Figs 45E, I, 47C). Spermathecae paired, slightly fused at the base; receptacles curved outwards from the middle, without a clearly defined neck by either exterior or interior margins (Fig 47F).

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*H. valdezi* differs from most *Hemirrhagus* species in the urticating setae arranged in two lateral patches, black in color. From *H. chilango* in the metatarsus I curved and urticating setae patches with poorly defined margins.

**Etymology:** The specific name is a patronym in honor of Alejandro Valdez Mondragon, for his contribution to the knowledge of Mexican arachnology and who collected the first specimen of the species.

**Description:** Holotype male CNAN-T0779 (Figs 45A–J; 46A–D): body length (not including chelicerae and spinnerets) 23.37, chelicera length 3.69; carapace: 9.40 long, 8.94 wide. Caput not markedly elevated; fovea recurved, 1.55 wide (Fig 45A).

Eyes: anterior eye row procurved, posterior eye row recurved. Periocular pigmentation complete, all eyes normally developed. Eye sizes and interocular distances: AME 0.30; ALE 0.35; PME 0.275; PLE 0.35; AME-AME 0.225; AME-ALE 0.075; PME-PME 0.625; PME-PLA 0.05; ALE-PLA 0.15. Ocular tubercle normally developed, width 1.5, length 1.125; clypeus lacking (Fig 45C). Labium length 0.95, width 1.50; with 21 cuspules.

Maxilla inner corner with approximately 68 cuspules (Fig 45D). Cheliceral promargin with 10 teeth (proximal to distal: 1-2 small, 3 large, 4-6 medium, 7-10 large). Sternum length 4.5. Sigillae oval, third and fourth pairs hardly visible; fourth pair twice its length from the margin (Fig 45B).

Leg formula: IV, I, II, III. Length of legs and palpal segments (femur, patella, tibia, metatarsus, tarsus, total): I: 9.47, 5.05, 7.44, 7.68, 6.21, 35.85. II: 9.02, 4.85, 6.97, 7.71, 5.79, 34.34. III: 8.64, 4.43, 6.91, 8.60, 5.73, 34.31. IV: 11.06, 4.90, 9.30, 13.66, 7.14, 46.06. Palp: 6.83, 4.23, 5.89, -, 2.90, 19.85. Spinnerets: PMS, 0.8 long, 0.3 apart; PLS, 1.9 basal, 1.2 middle, 2.0 distal.

Scopulae: tarsi I-IV densely scopulate, III-IV divided by strong band of setae. Metatarsi I-II densely scopulate; III scopulate on distal  $\frac{1}{2}$ , divided by narrow band of setae; IV scopulate on distal  $\frac{1}{3}$ , divided by strong band of setae.

Tibia I with two apophyses which do not originate from a common base, the Pap is normally developed, with one large spinose seta on ventral face, the spinose seta is bent in the middle and exceeds the apex of Pap; the Rap is normally developed, broad at its base with one short and wide spinose seta on dorsal face, the spinose seta exceeds the apex of Rap (Fig 45F–G). Metatarsus I curved (Fig 45H).

Stridulatory setae: Lacking.

Legs and palpi LSC in: palp trochanter retrolateral face (Fig 45J), femur prolateral and retrolateral faces; leg I coxa prolateral and retrolateral faces, trochanter prolateral face (Fig 45J), femur prolateral face; leg II coxa prolateral face, trochanter prolateral face, femur prolateral face.

Chaetotaxy (left side): femora I 3p, II 3p, III 3p, 6r; IV 2p, 4r; palp 2p; patellae III 1r; tibiae I 3p, 6v, 1r; II 4p, 7v, 3r; III 4p, 17v, 10r; IV 7p, 29v, 16r; palp 2p, 10v; metatarsi I 1v; II 1p, 8v; III 6p, 11v, 4r; IV 8p, 20v, 13r.

Palp. Embolus slender, similar in length to tegulum, SA retrolaterally extended ends at embolus retrolateral face, VG deep. Embolus curved retrolaterally on distal half (Figs 46A–D).

Urticating setae: Type VI arranged in two lateral patches, black in color, with poorly defined margins (Fig 45E, I).

Color pattern: In life carapace dark brown; ventrally coxae, labium, maxillae and sternum brown; abdomen dorsally shiny brown, ventrally brown. Legs and palps: femur dark brown, patella, tibia and metatarsus with brown.

Paratype female CNAN-T0780 (Figs. 2C, 47A–G): body length 26.39 (not including chelicerae and spinnerets), carapace 9.21 long, 8.24 wide. Caput not markedly elevated; fovea procurved, 4.53 wide (Fig 47A).

Eyes: anterior eye row procurved, posterior eye row recurved. Periocular pigmentation complete, all eyes normally developed. Eyes sizes and interocular distances: AME 0.73; ALE 1.30; PME 0.60; PLE1 2.0; AME-AME 0.53; AME-ALE 0.20; PME-PME1 1.53; PME-PLP 0.13; ALE-PLP 0.23. Eye tubercle normally developed, width 4.33, length 2.73; clypeus lacking (Fig 47D). Labium length 2.6, width 3.86; with 24 cuspules. Maxilla inner corner with approximately 100 cuspules (Fig 47E). Cheliceral promargin with 10 teeth (proximal to distal: 1–4 large, 5–6 medium, 7–10 large). Sternum length 4.35. Sigillae oval, third and fourth pairs hardly visible; fourth pair one and a half its length from the margin (Fig 47B).

Leg formula: IV, I, III, II. Length of legs and palpal segments (femur, patella, tibia, metatarsus, tarsus, total): I: 8.61, 4.85, 6.88, 6.32, 5.18, 31.84. II: 7.72, 4.90, 6.01, 5.27, 5.08, 28.98. III: 7.43, 4.38, 6.09, 6.75, 5.08, 29.73. IV: 9.70, 4.53, 8.29, 10.86, 6.22, 39.60. Palp: 6.03, 3.98, 4.79, -, 4.58, 19.38. Spinnerets: PMS, 0.8 long, 0.4 apart, PLS, 2.0 basal, 1.3 middle, 1.9 distal.

Scopulae: tarsi I–IV densely scopulate, III–IV divided by strong setae. Metatarsi I–II densely scopulate; III scopulate on distal  $\frac{1}{2}$  and IV scopulate on distal  $\frac{1}{3}$ , divided by strong band of setae.

Stridulatory setae: Lacking.

Legs and palpi LSC in: palp trochanter retrolateral face (Fig 47G), femur prolateral and retrolateral faces; leg I coxa retrolateral face, trochanter prolateral face (Fig 47G), femur prolateral face; leg II coxa prolateral face, trochanter prolateral face, femur prolateral face. Chaetotaxy (left side): femora I 1d; II 2d; III 4d; IV 4d; palp 2d; patellae III 1v; tibiae I 2p, 4v; II 2p, 4v; III 3p, 12v, 6r; IV 6d, 4p, 17v, 5r; palp 1p, 12v; metatarsi I 3v; II 1p, 4v; III 2d, 4p, 12v, 4r; IV 6d, 5p, 13v, 5r.

Genitalia: Spermathecae paired, slightly fused at their base, curved outwards from the middle, without a clearly defined neck by either exterior or interior margins (Fig 47F).

Urticating setae: Type VI arranged in two lateral patches, black in color, with poorly defined margins (Fig 47C).

Color pattern: In life carapace dark brown; ventral coxae, labium, maxillae and sternum brown; abdomen dorsally shiny brown, ventrally brown. Legs and palps: femur dark brown, patella, tibia and metatarsus brown (Fig 2C).

**Distribution and natural history:** Known only from Cueva Redonda in Guerrero, Mexico (Fig 49). This is a troglophile species that does not live deep into the cave system (less than 50m from the entrance); specimens were collected on walls.

**Note:** On 9 November 2010 a couple of *Hemirrhagus valdezi* were placed together and they mated. Towards the beginning of spring (18 March 2011), the female laid a fixed hammock egg sac between two rocks placed perpendicularly in the terrarium. The female kept her palpi and legs in contact with the egg sac. Spiderlings emerged 31 days following



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oviposition (17 April 2011). The count was 40 spiderlings of less than 1 cm of legspan, light brown in color.

#### Discussion

In their revision, Pérez-Miles & Locht (2003) proposed two synapomorphies of *Hemirrhagus*: 1) the retrolateral-ventral coxae with heels and 2) the presence of type VI urticating setae; they also mentioned that another probable synapomorphy of the genus is the presence of only one wide keel on the palpal organ, but this was not included in their analysis since only a few males were known. With the revision of new material and description of adult males, here it is confirmed that the SA retrolaterally extended is present in all known *Hemirrhagus* males. It was also found that in the genus the transition of tegulum to embolus forms a VG, and metatarsus I of males passing retrolaterally the tibial apophyses when flexed, with the only exception of *H. perzmilesi* which lacks tibial apophyses. All these features are here proposed as diagnostic for *Hemirrhagus*. However, until a cladistics analysis is carried out cannot be said that these diagnostic characters are synapomorphies for the genus.

Bertani (2000) revised and homologized the keels of male palpal bulbs in Theraphosinae, indicating that the prolateral keels are a synapomorphy for all theraphosines except *Euathlus* Ausserer 1875 which lacks prolateral keels. He mentioned that because of the basal position in a polytomy occupied by *Euathlus* in the cladistic analysis of Theraphosinae by Pérez-Miles *et al.* 1996, it is possible this is the most basal taxon of all Theraphosinae. Most *Hemirrhagus* species only present SA retrolaterally extended, which is considered here as diagnostic for the genus, however *H. embolulatus* is the only known species that has PI, PS and R keels, which according to Bertani (2000) are plesiomorphic to Theraphosinae. Pérez-Miles (2000) analyzed the cladistic relationships of the genus *Maraca* Pérez-Miles 2006 (formerly *Iracema* Pérez-Miles 2000) within the Theraphosinae. He includes *Hemirrhagus* in this cladistic analysis, which occupied a basal position in the cladogram (just below *Euathlus*) suggesting this as the most basal taxon of all Theraphosinae. However, most of the characters codified were inapplicable due to lack of information of *Hemirrhagus* males. Therefore it is most likely that the basal position of *Hemirrhagus* was due to lack of information.

Another important feature which suggests the basal placement of *Hemirrhagus* is the shape of the spermathecae, which in most of the species is paired and slender throughout its length, except in *H. embolulatus* whose spermathecae is also paired, but with rounded receptacles, wider than long. In their work, Pérez-Miles *et al.* (1996) showed that a transformation series in the spermathecae occurs from the primitive condition of two separate spermathecae, to a widely fused condition, and finally to a single semicircular receptacle. This transformation series was also accepted by Bertani (2001), with the additional condition of slightly fused spermathecae. Because some of these character states are found in *Hemirrhagus*, and those it is difficult to suggest its placement (basal or derived) within the Theraphosinae without performing a cladistic analysis.

Stridulation can be defined as the process of sound production by friction of one rigid body part (the scraper) across a second part (the comb) (Uetz & Stratton, 1982; Vol, 2002). It plays a role in different contexts such as in intraspecific (reproduction) and interspecific

(defense) communication (Marshall *et al.*, 1995). It was Pocock (1903) who first mentioned the stridulating setae in *Hemirrhagus pernix* (formerly *Cyrtopholis pernix*); he noticed the stridulating setae on first leg spatulate and that on palp few and not plumose. Later, Smith (1995) and Pérez-Miles & Locht (2003) only make reference to the setae on prolateral face of trochanter I as specialized plumose setae, but they did not mention the spinose setae on retrolateral palp trochanter, possibly thinking this feature does not have to much relevance other than for this species. However, as Pocock (1903) noted, the stridulating organs are useful in taxonomy because they allow one to distinguish between different species. In the present work it was possible identify and describe three different groups of stridulating organs as follows: 1) composed by SP of different size on palpal trochanter retrolateral face proximally and PL on trochanter I prolateral face; this is the kind present in *H. pernix*, *H. nahuanus* and *H. franckeri*; 2) composed by CLP almost as long as trochanter, located on palpal trochanter retrolateral face and small PL on trochanter I prolateral face; this condition is present in *H. perezmilesi*; 3) composed by PL on palpal trochanter retrolateral face, SP on trochanter I prolateral located distally which contact with a group of FHS congregated in a subcircular spot basally on palp femur retrolateral; this stridulatory organ is present in *H. reddelli*.

Most of the stridulatory organs in the Theraphosinae are positioned on the first appendages and consist of plumose hairs found between the coxae and/or trochanters of the palps and first legs. The function of stridulation is not well understood for theraphosid spiders. The different morphologies and positions of the stridulatory apparatus among the theraphosid subfamilies suggest that they are not homologous. Presumably, these organs developed independently several times in theraphosid evolution (Bertani *et al.*, 2008).

Gallon & Gabriel (2006) reviewed theraphosid egg-sacs and cataloged the egg-sac structure recorded from each theraphosid genus. They categorized theraphosid egg-sac structure into three types as follows: 1) Mobile cocoon, a fully detached sac which is carried by the female during incubation; 2) Fixed hammock, a sac permanently attached to the female's retreat by distinct silk bands, forming a hammock-like structure; and 3) Fixed flat, a sac permanently attached to the female's retreat, and secured flat against a structure. According to their observations the subfamily Theraphosinae elaborates mobile cocoon egg-sacs only, whereas the Harpactirinae and Thrigmopoeinae produces only fixed hammock egg-sacs. The mobile cocoon egg-sac is considered to be plesiomorphic with the respect to the theraphosids according to Gallon (2003). The only reported genus of American theraphosids which produces fixed egg-sacs is *Oligoxystre* Vellard 1924, an Ischnocolinae (Gallon & Gabriel 2006). Costa & Pérez-Miles 2002 reported that *Oligoxystre argentinense* lays fixed egg-sacs, but this species was transferred to the genus *Catumiri* by Guadanucci 2004 and considered as misidentification by Fukushima *et al.* 2011 which create the new combination *Catumiri parvum* (Keyserling 1878), so that *Catumiri* would be the second known New World Ischnocolinae genus with fixed egg-sacs. Here it is reported that *H. papaloti* and *H. valdezi* produce fixed hammock egg-sacs; these were fixed between two protuberances on a wall and on perpendicular rocks, respectively. They are the first two species of Theraphosinae that construct this kind of egg-sac. However, these two species inhabit in caves, so it is possible that this fixed egg-sac behavior is an adaptation to the cave environments, and thus it will be very interesting to record egg-sac structure for other troglolitic *Hemirrhagus* species. It is not possible at this time to assume that all

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*Hemirrhagus* species construct fixed hammock egg-sacs, until observations on more species with epigean, troglophile and troglobitic habits are made.

*Hemirrhagus* is a genus which possesses epigean, troglophile and troglobitic species. Those adapted to cave environments have uncommon characteristics such as reduction of eye tubercle and eye-size, loss of some eyes, loss of urticating setae, elongated appendages and loss of pigmentation. For long time, *Hemirrhagus* was the only Theraphosidae genus containing troglobitic species, but recently Bertani, Bichuette and Pedroso (2013) described *Tmesiphantes hypogeus* as the first record of a troglobitic mygalomorph from Brazil. This species shares with troglophile and troglobitic *Hemirrhagus* the reduction of eyes, legs long and slender, lacking pigmentation and the urticating setae (type III) arranged in two posterior dorsal paramedian patches. All these features are considered as adaptations to cave life (Juan *et al.*, 2010; Smith, 1995; Pérez-Miles & Locht, 2003); although in *Hemirrhagus* there are epigean species that present reduction in the eye tubercle, have the urticating setae arranged in two dorsal or lateral patches, and have the legs long and slender.

Cave animals have historically attracted the attention of evolutionary biologist because of their bizarre “regressive” characters and convergent evolution. However, clear understanding of their biogeographic and evolutionary history, including mechanisms of speciation, has remained elusive (Juan *et al.*, 2010). It is considered necessary to perform more field work to collect and complete the series of troglobitic *Hemirrhagus* species, since some are known only from one sex or from juveniles. The additional material will allow for a better understanding of the relationships, diversity and evolutionary history of the different species in the genus.

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#### References

- Ausserer, A. 1875. Zweiter Beitrag zur Kenntniss der Arachniden-Familie der Territelariae Thorell (Mygalidae Autor). *Verhandlungen der Zoologisch-Botanischen Gesellschaft in Wien* 25: 125–206.
- Bertani, R. 2000. Male palpal bulbs and homologous features in Theraphosinae (Araneae, Theraphosidae). *The Journal of Arachnology* 28: 29–42.
- Bertani, R. 2001. Revision, cladistic analysis and zoogeography of *Vitalius*, *Nhandu* and *Proshapalopus*, with notes on other theraphosine genera (Araneae, Theraphosidae). *Arquivos de Zoologia* 36 (3): 265–356.
- Bertani, R., Fukushima, C. S. & Da Silva Junior, P. I. 2008. Two new species of *Pamphobeteus* Pocock 1901 (Araneae: Mygalomorphae: Theraphosidae) from Brazil, with a new type of stridulatory organ. *Zootaxa* 1826: 45–58.
- Bertani, R., Bichuette, M. E. & Pedroso, D. R. 2013. *Tmesiphantes hypogeus* sp. nov. (Araneae, Theraphosidae), the first troglobitic tarantula from Brazil. *Annals of the Brazilian Academy of Sciences* 85 (1): 235–243.
- Cambridge, F. O. P. 1897. Arachnida - Araneida and Opiliones. In *Biologia Centrali-Americana, Zoology* 2: 1–40.
- Cambridge, F. O. P. 1899. Arachnida - Araneida and Opiliones. In *Biologia Centrali-Americana, Zoology* 2: 41–88.
- Costa, F. G. & Pérez-Miles, F. 2002. Reproductive biology of Uruguayan theraphosids (Araneae, Mygalomorphae). *Journal of Arachnology* 30: 571–587.
- Estrada-Alvarez, J. C. & Cameron, H. D. 2012. Etymological origins of the generic names of Mexican tarantulas (Araneae: Theraphosidae). *Revista Ibérica de Aracnología* 21: 153–160.
- Fukushima, C. S., Pérez-Miles, F. & Bertani, R. 2011. On the *Avicularia* (Araneae: Theraphosidae: Aviculariinae) species from Uruguay. *Journal of Arachnology* 39: 528–532.
- Gallon, R. C. 2003. A new African arboreal genus and species of theraphosid spider (Araneae, Theraphosidae, Stromatopelminae) which lacks spermathecae. *Bulletin of the British Arachnological Society* 12 (9): 405–411.
- Gallon, R. C. & Gabriel, R. 2006. Theraphosidae egg-sac types. *Newsletter of the British Arachnological Society* 106: 5–10.

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- García-Villafuerte, M. A. 2008. Primer registro fósil del género *Hemirrhagus* (Araneae, Theraphosidae) en ámbar del Terciario, Chiapas, México. *Revista Ibérica de Aracnología* 16: 79–94.
- García-Villafuerte, M. A. & Loch, A. 2010. Una nueva especie de *Hemirrhagus* Simon, 1903 (Theraphosidae, Theraphosinae) de Chiapas, México. *Revista Ibérica de Aracnología* 18: 81–86.
- Gertsch, W. J. 1971. A report on some Mexican cave spiders. *Bulletin of the Association for Mexican Cave Studies* 4: 47–111.
- Gertsch, W. J. 1973. A report on cave spiders from Mexico and Central America. *Bulletin of the Association for Mexican Cave Studies* 5: 141–163.
- Gertsch, W. J. 1982. The troglitic mygalomorphs of the Americas (Arachnida, Araneae). *Bulletin of the Association for Mexican Cave Studies* 8: 79–94.
- Guadanucci, J. P. L. 2004. Description of *Catumiri* n. gen. and three new species (Theraphosidae: Ischnocolinae). *Zootaxa* 671: 1–14.
- Guadanucci, J. P. L. 2005. Tarsal scopula significance in Ischnocolinae phylogenetics (Araneae, Mygalomorphae, Theraphosidae). *Journal of Arachnology* 33: 456–467.
- Hoffman, A., Palacios-Vargas, J. G. & Morales-Malacara, J. B. 1986. *Manual de Biospeleología*. Universidad Nacional Autónoma de México, 274pp.
- Juan, C., Guzik, M. T., Jaume, D. & Cooper, S. J. B. 2010. Evolution in caves: Darwin's wrecks of ancient life in the molecular era. *Molecular Ecology* 19: 3865–3880.
- Locht, A. 2008. *Estudio sobre la sistemática y distribución de la familia Theraphosidae* (Arachnida, Araneae) en México. Tesis de Maestría. Facultad de Ciencias, Universidad Nacional Autónoma de México, México DF, 116 pp.
- Marshall, S.D., Thoms, E.M. & Uetz, G.W. 1995. Setal entanglement: an undescribed method of stridulation by a neotropical tarantula (Araneae: Theraphosidae). *Journal of Zoology* 235: 587–595.
- Platnick, N.I. 2013. The world spider catalog, version 13.5. The American Museum of Natural History, New York, Available from: <http://research.amnh.org/iz/spiders/catalog/INTRO1.html> (accessed 26 february 2013).
- Pérez-Miles, F. 1994. Tarsal scopula division in Theraphosinae (Araneae, Theraphosidae): Its systematic significance. *The Journal of Arachnology* 22: 46–53.
- Pérez-Miles, F., Lucas S. M., Da Silva Jr. P. I. and Bertani R. 1996. Systematic revision and cladistic analysis of Theraphosinae (Araneae: Theraphosidae). *Mygalomorph* 1: 33–68.
- Pérez-Miles, F. & Loch, A. 1998. Notes on the systematics of the little known theraphosids spider *Hemirrhagus cervinus*, with a description of a new type of urticating hair. *Journal of arachnology* 26: 120–123.
- Pérez-Miles, F. 2000. *Iracema cabloca* new genus and species of a theraphosid spider from Amazonic Brazil (Araneae, Theraphosinae). *Journal of Arachnology* 28: 141–148.
- Pérez-Miles, F. & Loch, A. 2003. Revision and cladistic analysis of the genus *Hemirrhagus* Simon, 1903 (Araneae, Theraphosidae, Theraphosinae). *Bulletin of the British arachnological Society* 12 (8): 365–375.

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10 Petrunkevich, A. 1911. A synonymic index-catalogue of spiders of North, Central and  
11 South America with all adjacent islands, Greenland, Bermuda, West Indies, Tierra del  
12 Fuego, Galapagos, etc. *Bulletin of the American Museum of Natural History* 29: 1–791.  
13 Petrunkevitch, A. 1928 Systema Araneorum. *Transactions Connecticut Academy of Arts  
14 and Sciences* 29: 1–270.  
15 Pocock, R. I. 1903. On some genera and species of South American Aviculariidae. *Annals  
16 and Magazine of Natural History* 7 (11): 81–115.  
17 Raven, R. J. 1985. The spider infraorder Mygalomorphae (Araneae): Cladistics and  
18 systematics. *Bulletin of American Museum of Natural History* 182: 1–180.  
19 Raven, R.J. 2005. A new tarantula species from northern Australia (Araneae,  
20 Theraphosidae) *Zootaxa* 1004: 15–28.  
21 Roewer, C. F. 1942. *Katalog der Araneae von 1758 bis 1940*. Bremen 1: 1040pp.  
22 Schmidt, G. 1993 *Vogelspinnen: Vorkommen, Lebensweise, Haltung und Zucht, mit  
23 Bestimmungsschlüsseln für alle Gattungen*, Vierte Auflage. Landbuch Verlag, Hannover,  
24 151 pp.  
25 Schmidt, G. 1997. Zur Position der Gattung *Spelapelma* Gertsch, 1982 (Araneae:  
26 Theraphosidae). *Arachnologisches Magazin* 5 (8): 1–5.  
27 Simon, E. 1891. Liste des Aviculariides qui habitent le Mexique et l'Amérique centrale.  
28 *Actes de la Société Linnéenne de Bordeaux* 44: 327–339.  
29 Simon, E. 1903. *Histoire naturelle des araignées*. Paris, 2 (4): 669–1080.  
30 Smith, A. M. 1995 *Tarantula Spiders: Tarantulas of the U.S.A. and Mexico*. Fitzgerald,  
31 London, 196 pp.  
32 Strand, E. 1907. Aviculariidae und Atypidae des Kgl. Naturalienkabinetts in Stuttgart.  
33 *Jahresbericht des Vereins für vaterländische Naturkunde in Württemberg*. Stuttgart, 63: 1–  
34 100.  
35 Strand E. 1912. Bemerkungen zu dem Katalog amerikanischer Spinnen von Alexander  
36 Petrunkevitch. *Jahrbücher des Nassauischen Vereins für Naturkunde* 65: 171–177.  
37 Uetz G.W. & Stratton G.E. 1982. Acoustic communication and reproductive isolation in  
38 spiders. In: P. Witt & J. Rovner (Eds.), *Spider Communication, Mechanisms and  
39 Ecological Significance*. Princeton University Press, Princeton, New Jersey, 123–159.  
40 Vol F. 2002. Stridulation in tarantulas. *Journal of the British Tarantula Society* 18 (1):  
41 21–27.

#### 42 Legends of illustrations.

43 **Figure 1.** A–H, J–L, *Hemirrhagus* spp habitus; I, *H. papaloti* egg-sac. A, *H. chilango*,  
44 male CNAN 4253, in life; B–C, *H. eros*, B, female, C, male; D–E, *H. ocellatus*, D, male  
45 CNAN 4457, in life, E, female; F, *H. benzaa* sp. nov., female; G–I, *H. papaloti*, G, male  
46 CNAN 4461, in life, H, female CNAN 4461, in life, I, female CNAN 4459 with fixed  
47 hammock egg-sac, in life; J–K, *H. stygius*, J, male CNAN 4462, in life, K, female CNAN  
48 4462, in life; L, *H. franckei* sp. nov., holotype male CNAN-T0776, in life. Photos: A, C, D,  
49 E, G–K, J. Mendoza; B, F, L, E. Goyer.

50 **Figure 2.** A–C, *Hemirrhagus* spp habitus; D–K, habitat. A–B, *H. embolulatus* sp. nov., A,  
51 holotype male CNAN-T0774, in life, B, paratype female CNAN-T0775, in life; C, *H.*  
52 *valdezi* sp. nov., paratype female CNAN-T0780, in life; D, Cueva de la Peña Blanca  
53 entrance, type locality of *H. ocellatus*; E, 4km W of Puerto de la Soledad, pine forest, type  
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locality of *H. franckei* sp. nov.; F, Bosque del ajusco, pine forest, locality of *H. chilango*; G, Valle de los fantasmas, oak forest on the road to Cueva de la Laguna, type locality of *H. elliotti*; H, Cueva de los Potrerillos entrance, type locality of *H. stygius*; I, Paradero Puerta del Sol, pine forest, locality of *H. benzaa* sp. nov.; J, Omiltemi, tropical forest-pine forest ecotone, type locality of *H. embolulatus* sp. nov.; K, El punto, type locality of *H. eros*. Photos: (A), M. Gamache; (B, E, I, K), E. Goyer; (C), L. Vazquez; (D, F, J), J. Mendoza; (G, H), J. Cruz.

**Figure 3.** A–I, *Hemirrhagus chilango* Pérez-Miles & Locht 2003, male CNAN 3470. A, carapace, dorsal view. B, prosoma, ventral view showing the RP on coxae of all legs (arrows show this feature only on coxa of third and fourth leg). C, opisthosoma, dorsal view. D, ocular tubercle, dorsal view. E, labial and maxillary cuspules. F, opisthosoma, lateral view showing urticating setae patch. G, tibial apophyses, prolateral view. H, metatarsus I, prolateral view. I, tibial apophyses, ventral view. Scale = 2mm (A–C, F), 1mm (E, G–I), 0.5mm (D).

**Figure 4.** A–D, *Hemirrhagus chilango* Pérez-Miles & Locht 2003, male CNAN 3470, left palpal bulb. A, retrolateral view. B, prolateral view. C, dorsal view. D, ventral view. Scale = 1mm.

**Figure 5.** A–G, *Hemirrhagus coztic* Pérez-Miles & Locht 2003, holotype female LAAH. A, carapace, dorsal view. B, prosoma, ventral view showing the RP on coxae of all legs (arrows show this feature only on coxa of third and fourth leg). C, opisthosoma, dorsal view. D, opisthosoma, ventral view. E, ocular tubercle, dorsal view. F, labial and maxillary cuspules. G, spermathecae, ventral view. Scale = 2mm (A–C), 1mm (E, F), 0.5mm (D, G).

**Figure 6.** A–G, *Hemirrhagus elliotti* (Gertsch 1973), holotype female AMNH; H, female AMNH. A, carapace, dorsal view. B, prosoma, ventral view showing the RP on coxae of all legs (arrows show this feature only on coxa of third and fourth leg). C, opisthosoma, dorsal view. D, opisthosoma, ventral view. E, ocular tubercle, dorsal view. F, labial and maxillary cuspules. G, holotype spermathecae, dorsal view. H, spermathecae, dorsal view. Scale = 4mm (D), 2mm (A–C), 1mm (E–F), 0.5mm (G, H).

**Figure 7.** A–G, *Hemirrhagus eros* Pérez-Miles & Locht 2003, male holotype AMNH. A, carapace, dorsal view. B, prosoma, ventral view showing the RP on coxae of all legs (arrows show this feature only on coxa of third and fourth leg). C, opisthosoma, dorsal view. D, labial and maxillary cuspules. E, metatarsus I, prolateral view. F, tibial apophyses, prolateral view. G, tibial apophyses, ventral view. Scale = 4mm (A), 2mm (B–D), 1mm (E–G).

**Figure 8.** A–D, *Hemirrhagus eros* Pérez-Miles & Locht 2003, male holotype AMNH, right palpal bulb: A, prolateral view. B, retrolateral view. C, dorsal view. D, ventral view. Scale = 1mm.

**Figure 9.** A–D, *Hemirrhagus eros* Pérez-Miles & Locht 2003, paratype A female AMNH; E, paratype B female AMNH. A, carapace, dorsal view. B, opisthosoma, dorsal view. C,



ocular tubercle, dorsal view. D, spermathecae, dorsal view. E, spermathecae, dorsal view. Scale = 4mm (A, B), 1mm (C–E).

**Figure 10.** A–H, *Hemirrhagus gertschi* Pérez-Miles & Locht 2003, holotype male LAAH. A, carapace, dorsal view. B, prosoma, ventral view showing the RP on coxae of all legs (arrows show this feature only on coxa of third and fourth leg). C, opisthosoma, dorsal view. D, metatarsus I, prolateral view. E, ocular tubercle, dorsal view. F, labial and maxillary cuspules. G, tibial apophyses, prolateral view. H, tibial apophyses, ventral view. Scale = 2mm (A–D), 1mm (E–H).

**Figure 11.** A–D, *Hemirrhagus gertschi* Pérez-Miles & Locht 2003, holotype male LAAH, left palpal bulb: A, retrolateral view. B, prolateral view. C, dorsal view. D, ventral view. Scale = 1mm.

**Figure 12.** A–F, *Hemirrhagus gertschi* Pérez-Miles & Locht 2003, paratype female LAAH. A, carapace, dorsal view. B, prosoma, ventral view showing the RP on coxae of all legs (arrows show this feature only on coxa of third and fourth leg). C, opisthosoma, dorsal view. D, trochanter I LSC, ventral view. E, ocular tubercle, dorsal view. F, spermathecae, dorsal view. Scale = 4mm (A, C), 2mm (B), 1mm (D–F).

**Figure 13.** A–F, *Hemirrhagus grieta* (Gertsch 1982), holotype female AMNH. A, carapace, dorsal view. B, opisthosoma, dorsal view. C, prosoma, ventral view showing the RP on coxae of all legs (arrows show this feature only on coxa of third and fourth leg). D, ocular tubercle, dorsal view. E, labial and maxillary cuspules. F, spermathecae, dorsal view. Scale = 2mm (B), 1mm (A, C, E), 0.5mm (D, F).

**Figure 14.** A–F, *Hemirrhagus mitchelli* (Gertsch 1982), holotype female AMNH. A, carapace, dorsal view. B, prosoma and opisthosoma, ventral view. C, ocular tubercle, dorsal view. D, labial and maxillary cuspules. E, sternum (arrow shows the RP on coxa of first leg). F, spermathecae, dorsal view. Scale = 3mm (B), 2mm (A), 1mm (D, E), 0.5mm (C, F).

**Figure 15.** A–K, *Hemirrhagus nahuanus* (Gertsch 1982), holotype male AMNH. A, carapace, dorsal view. B, prosoma, ventral view showing the RP on coxae of all legs (arrows show this feature only on coxa of second and third leg). C, ocular tubercle, dorsal view. D, labial and maxillary cuspules. E, opisthosoma, right side. F, trochanter I PL, ventral view. G, palp trochanter SP, retrolateral view. H, cheliceral teeth, ventral view. I, trochanter I PL and femur I LSC, ventral view. J, tibial apophyses, prolateral view. K, metatarsus I, prolateral view. Scale = 2mm (A, B, E, K), 1mm (D, F, I, J), 0.5mm (C, G, H).

**Figure 16.** A–B, *Hemirrhagus nahuanus* (Gertsch 1982), holotype male AMNH, right palpal bulb: A, retrolateral view. B, prolateral view. Scale = 1mm.

**Figure 17.** A–J, *Hemirrhagus ocellatus* Pérez-Miles & Locht 2003, male CNAN 4457. A, carapace, dorsal view. B, prosoma, ventral view showing the RP on coxae of all legs (arrows show this feature only on coxa of third and fourth leg). C, opisthosoma, dorsal view. D, opisthosoma, ventral view. E, ocular tubercle, dorsal view. F, sternum. G, tibial

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apophyses, ventral view. H, tibial apophyses, prolateral view. I, labial and maxillary cuspules. J, metatarsus I, prolateral view. Scale = 2mm (A–C), 1mm (F–J), 0.5mm (D, E).

**Figure 18.** A–D, *Hemirrhagus ocellatus* Pérez-Miles & Locht 2003, male CNAN 4457, left palpal bulb: A, retrolateral view. B, prolateral view. C, dorsal view. D, ventral view. Scale = 1mm.

**Figure 19.** A–D, *Hemirrhagus ocellatus* Pérez-Miles & Locht 2003, holotype female LAAH. A, prosoma, ventral view showing the RP on coxae of all legs (arrows show this feature only on coxa of third and fourth leg). B, opisthosoma, dorsal view. C, ocular tubercle, dorsal view. D, spermathecae, ventral view. Scale = 2mm (A, B), 1mm (D), 0.5mm (C).

**Figure 20.** A–J, *Hemirrhagus papalotl* Pérez-Miles & Locht 2003, male CNAN 4460. A, carapace, dorsal view. B, prosoma, ventral view showing the RP on coxae of all legs (arrows show this feature only on coxa of third and fourth leg). C, opisthosoma, dorsal view. D, ocular tubercle, dorsal view. E, labial and maxillary cuspules. F, sternum. G, cheliceral teeth, ventral view. H, tibial apophyses, ventral view. I, metatarsus I, prolateral view. J, tibial apophyses, prolateral view. Scale = 2mm (A–C, F, H, I), 1mm (E, G, J), 0.5mm (D).

**Figure 21.** A–D, *Hemirrhagus papalotl* Pérez-Miles & Locht 2003, male CNAN 4460, left palpal bulb. A, ventral view. B, dorsal view. C, retrolateral view. D, prolateral view. Scale = 1mm.

**Figure 22.** A–C, *Hemirrhagus papalotl* Pérez-Miles & Locht 2003, holotype female LAAH; D, female CNAN 4459. A, ocular tubercle, dorsal view. B, opisthosoma, dorsal view. C, spermathecae, ventral view. D, spermathecae, ventral view. Scale = 2mm (B), 1mm (D), 0.5mm (A, C).

**Figure 23.** A–G, *Hemirrhagus perezmilei* Garcia-Villafuerte & Locht 2010, holotype male CNAN-T0395. A, carapace, dorsal view. B, opisthosoma, lateral view. C, ocular tubercle, dorsal view. D, metatarsus I, prolateral view. E, tibia I, ventral view. F, palp trochanter CLP, retrolateral view. G, trocánter I SP, prolateral view. Scale = 2mm (A, B), 1mm (D–G), 0.5mm (C).

**Figure 24.** A–D, *Hemirrhagus perezmilei* Garcia-Villafuerte & Locht 2010, holotype male CNAN-T0395, left palpal bulb: A, retrolateral view. B, prolateral view. C, dorsal view. D, ventral view. Scale = 0.5mm.

**Figure 25.** A–F, *Hemirrhagus perezmilei* Garcia-Villafuerte & Locht 2010, paratype female CNAN-T0396. A, carapace, dorsal view. B, opisthosoma, dorsal view. C, palp trochanter CLP, retrolateral view. D, palp trochanter CLP and trochanter I SP, ventral view. E, ocular tubercle, dorsal view. F, spermathecae, dorsal view. Scale = 2mm (A, B), 1mm (C, D), 0.5mm (E), 0.4mm (F).

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**Figure 26.** A–K, *Hemirrhagus pernix* (Ausserer 1875), holotype male BMNH 351. A, carapace, dorsal view. B, prosoma, ventral view showing the RP on coxae of all legs (arrows show this feature only on coxa of third and fourth leg). C, ocular tubercle, dorsal view. D, labial cuspules. E, sternum. F, trochanter I PL, prolateral view. G, palp trochanter SP, retrolateral view. H, tibial apophyses, ventral view. I, tibial apophyses, ventral view. J, metatarsus and tarsus I, retrolateral view. K, habitus. Scale = 10mm (K), 4mm (J), 2mm (A, B, E, H, I), 1mm (C, D, F), 0.5mm (G).

**Figure 27.** A–C, *Hemirrhagus pernix* (Ausserer 1875), holotype male BMNH 351, right palpal bulb: A, prolateral view. B, retrolateral view. C, ventral view. Scale = 1mm.

**Figure 28.** A–F, *Hemirrhagus puebla* (Gertsch 1982), holotype female AMNH. A, carapace, dorsal view. B, prosoma, ventral view showing the RP on coxae of all legs (arrows show this feature only on coxa of third and fourth leg). C, ocular tubercle, dorsal view. D, labial and maxillary cuspules. E, opisthosoma, dorsal view. F, spermathecae, dorsal view. Scale = 2mm (A, B, E), 1mm (C, D), 0.2mm (F).

**Figure 29.** A–J, *Hemirrhagus reddelli* (Gertsch 1973), holotype female AMNH; K, female AMNH. A, carapace, dorsal view. B, prosoma, ventral view showing the RP on coxae of all legs (arrows show this feature only on coxa of third and fourth leg). C, ocular tubercle, dorsal view. D, labial and maxillary cuspules. E, sternum. F, palp trochanter PL and femur FHS, retrolateral view. G, trochanter I SP distally, ventral view. H, palp trochanter PL and femur FHS, dorsal view. I, cheliceral teeth, ventral view. J, spermathecae, dorsal view. K, spermathecae, dorsal view. Scale = 2mm (A, B, E), 1mm (C, D, F, H, I), 0.5mm (G, J, K).

**Figure 30.** A–H, *Hemirrhagus stygius* (Gertsch 1971), female CNAN 4462. A, carapace, dorsal view. B, prosoma, ventral view showing the RP on coxae of all legs (arrows show this feature only on coxa of third and fourth leg). C, ocular tubercle, dorsal view. D, labial and maxillary cuspules. E, opisthosoma, dorsal view. F, sternum. G, cheliceral teeth, ventral view. H, spermathecae, ventral view. Scale = 4mm (B), 2mm (A, D, E), 1mm (C, G, F), 0.5mm (H).

**Figure 31.** A–I, *Hemirrhagus stygius* (Gertsch 1971), male CNAN 4462. A, body, dorsal view. B, carapace, dorsal view. C, prosoma, ventral view showing the RP on coxae of all legs (arrows show this feature only on coxa of third and fourth leg). D, ocular tubercle, dorsal view. E, labial and maxillary cuspules. F, sternum. G, tibial apophyses, ventral view. H, tibial apophyses, prolateral view. I, metatarsus I, prolateral view. Scale = 2mm (A–C), 1mm (E, F), 0.8mm (G, H, I), 0.2mm (D).

**Figure 32.** A–D, *Hemirrhagus stygius* (Gertsch 1971), male CNAN 4462, left palpal bulb: A, ventral view. B, dorsal view. C, retrolateral view. D, prolateral view. Scale = 1mm.

**Figure 33.** A–I, *Hemirrhagus benzaa* new species, male holotype AMNH. A, carapace, dorsal view. B, prosoma, ventral view showing the RP on coxae of all legs (arrows show this feature only on coxa of third and fourth leg). C, ocular tubercle, dorsal view. D, labial and maxillary cuspules. E, opisthosoma, dorsal view. F, cheliceral teeth, ventral view. G,

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tibial apophyses, prolateral view. H, tibial apophyses, ventral view. I, metatarsus I, prolateral view. Scale = 2mm (A, B, E, I), 1mm (C, D, F–H).

**Figure 34.** A–D, *Hemirrhagus benzaa* new species, male holotype AMNH, right palpal bulb: A, prolateral view. B, retrolateral view. C, dorsal view. D, ventral view. Scale = 1mm.

**Figure 35.** A–F, *Hemirrhagus benzaa* new species, female paratype AMNH. A, carapace, dorsal view. B, prosoma, ventral view showing the RP on coxae of all legs (arrows show this feature only on coxa of third and fourth leg). C, opisthosoma, dorsal view. D, ocular tubercle, dorsal view. E, labial and maxillary cuspules. F, spermathecae, dorsal view. Scale = 2mm (A–C), 1mm (D–F).

**Figure 36.** A–I, *Hemirrhagus embolulatus* new species, male holotype CNAN-T0774. A, carapace, prolateral view. B, prosoma, ventral view showing the RP on coxae of all legs (arrows show this feature only on coxa of third and fourth leg). C, opisthosoma, dorsal. D, ocular tubercle, dorsal view. E, labial and maxillary cuspules. F, cheliceral teeth, ventral view. G, metatarsus I, prolateral view. H, tibial apophyses, ventral view. I, tibial apophyses, prolateral view. Scale = 2mm (A–C, G), 1mm (D–F, H, I).

**Figure 37.** A–E, *Hemirrhagus embolulatus* new species, male holotype CNAN-T0774, left palpal bulb: A, dorsal view. B, ventral view. C, prolateral view. D, retrolateral view. E, embolus, dorsal view, showing keels. Scale = 1mm (A–D), 0.5mm (E).

**Figure 38.** A–G, *Hemirrhagus embolulatus* new species, female paratype CNAN-T0775. A, carapace, dorsal view. B, prosoma, ventral view showing the RP on coxae of all legs (arrows show this feature only on coxa of third and fourth leg). C, ocular tubercle, dorsal view. D, labial and maxillary cuspules. E, sternum. F, metatarsus IV, ventral, showing spinose setae distally. G, spermathecae, ventral view. Scale = 2mm (A, B, E), 1mm (C, D, F), 0.5mm (G).

**Figure 39.** A–L, *Hemirrhagus franckei* new species, male holotype CNAN-T0776. A, carapace, dorsal view. B, prosoma, ventral view showing the RP on coxae of all legs (arrows show this feature only on coxa of third and fourth leg). C, ocular tubercle, dorsal view. D, labial and maxillary cuspules. E, opisthosoma, dorsal view. F, cheliceral teeth, ventral view. G, sternum. H, tibial apophyses, prolateral view. I, tibial apophyses, ventral view. J, metatarsus I, prolateral view. K, palp trochanter SP, retrolateral view. L, trochanter I PL, ventral view. Scale = 2mm (A, B, E, G, J), 1mm (C, D, F, H, I), 0.5mm (K, L).

**Figure 40.** A–D, *Hemirrhagus franckei* new species, male holotype CNAN-T0776. Left palpal bulb: A, retrolateral view. B, prolateral view. C, ventral view. D, dorsal view. Scale = 1mm.

**Figure 41.** A–I, *Hemirrhagus franckei* new species, female paratype CNAN-T0777. A, carapace, dorsal view. B, prosoma, ventral view showing the RP on coxae of all legs (arrows show this feature only on coxa of third and fourth leg). C, opisthosoma, dorsal view. D, cheliceral teeth, ventral view. E, ocular tubercle, dorsal view. F, labial cuspules.



G, trochanter I PL, ventral view. H, palp trochanter SP, retrolateral view. I, spermathecae, ventral view. Scale = 4mm (C), 2mm (A, B), 1mm (D–H), 0.5mm (I).

**Figure 42.** A–H, *Hemirrhagus guichi* new species, male holotype AMNH. A, carapace, dorsal view. B, prosoma, ventral view showing the RP on coxae of all legs (arrows show this feature only on coxa of third and fourth leg). C, ocular tubercle, dorsal view. D, labial and maxillary cuspules. E, opisthosoma, dorsal view. F, metatarsus I, prolateral view. G, Tibial apophyses, ventral view. H, tibial apophyses, prolateral view. Scale = 4mm (A, B, E, F), 2mm (D, G, H), 1mm (C).

**Figure 43.** A–D, *Hemirrhagus guichi* new species, male holotype AMNH, right palpal bulb: A, prolateral view. B, retrolateral view. C, ventral view. D, dorsal view. Scale = 1mm

**Figure 44.** A–F, *Hemirrhagus guichi* new species, female paratype AMNH. A, carapace, dorsal view. B, prosoma, ventral view showing the RP on coxae of all legs (arrows show this feature only on coxa of third and fourth leg). C, opisthosoma, dorsal view. D, ocular tubercle, dorsal view. E, labial and maxillary cuspules. F, spermathecae, dorsal view. Scale = 4mm (A–C), 2mm (E), 1mm (D, F).

**Figure 45.** A–J, *Hemirrhagus valdezi* new species, male holotype CNAN-T0779. A, carapace, dorsal view. B, prosoma, ventral view showing the RP on coxae of all legs (arrows show this feature only on coxa of third and fourth leg). C, ocular tubercle, dorsal view. D, labial and maxillary cuspules. E, opisthosoma, dorsal view. F, tibial apophyses, prolateral view. G, tibial apophyses, ventral view. H, metatarsus I, prolateral view. I, opisthosoma, lateral view. J, palp trochanter and trochanter I LSC, ventral view. Scale = 4mm (B, E, I), 2mm (A, H, J), 1mm (C, D, F, G).

**Figure 46.** A–D, *Hemirrhagus valdezi* new species, male holotype CNAN-T0779, left palpal bulb: A, retrolateral view. B, prolateral view. C, dorsal view. D, ventral view. Scale = 1mm.

**Figure 47.** A–G, *Hemirrhagus valdezi* new species, female paratype CNAN-T0780. A, carapace, dorsal view. B, prosoma ventral view showing the RP on coxae of all legs (arrows show this feature only on coxa of third and fourth leg). C, opisthosoma, dorsal view. D, ocular tubercle, dorsal view. E, labial and maxillary cuspules. F, spermathecae, ventral view. G, palp trochanter and trochanter I LSC, ventral view. Scale = 4mm (C), 2mm (A, B), 1mm (D, E, G), 0.5mm (F).

**Figure 48.** Known distribution of *Hemirrhagus stygius* (Gertsch 1971), *Hemirrhagus ellioti* (Gertsch 1973), *Hemirrhagus embolulatus* new species, *Hemirrhagus eros* Pérez-Miles & Locht 2003, *Hemirrhagus chilango* Pérez-Miles & Locht 2003, *Hemirrhagus nahuanus* (Gertsch 1982), *Hemirrhagus papalotl* Pérez-Miles & Locht 2003, *Hemirrhagus grieta* (Gertsch 1982), *Hemirrhagus coztic* Pérez-Miles & Locht 2003 and *Hemirrhagus perezmilei* Garcia-Villafuerte & Locht 2010.

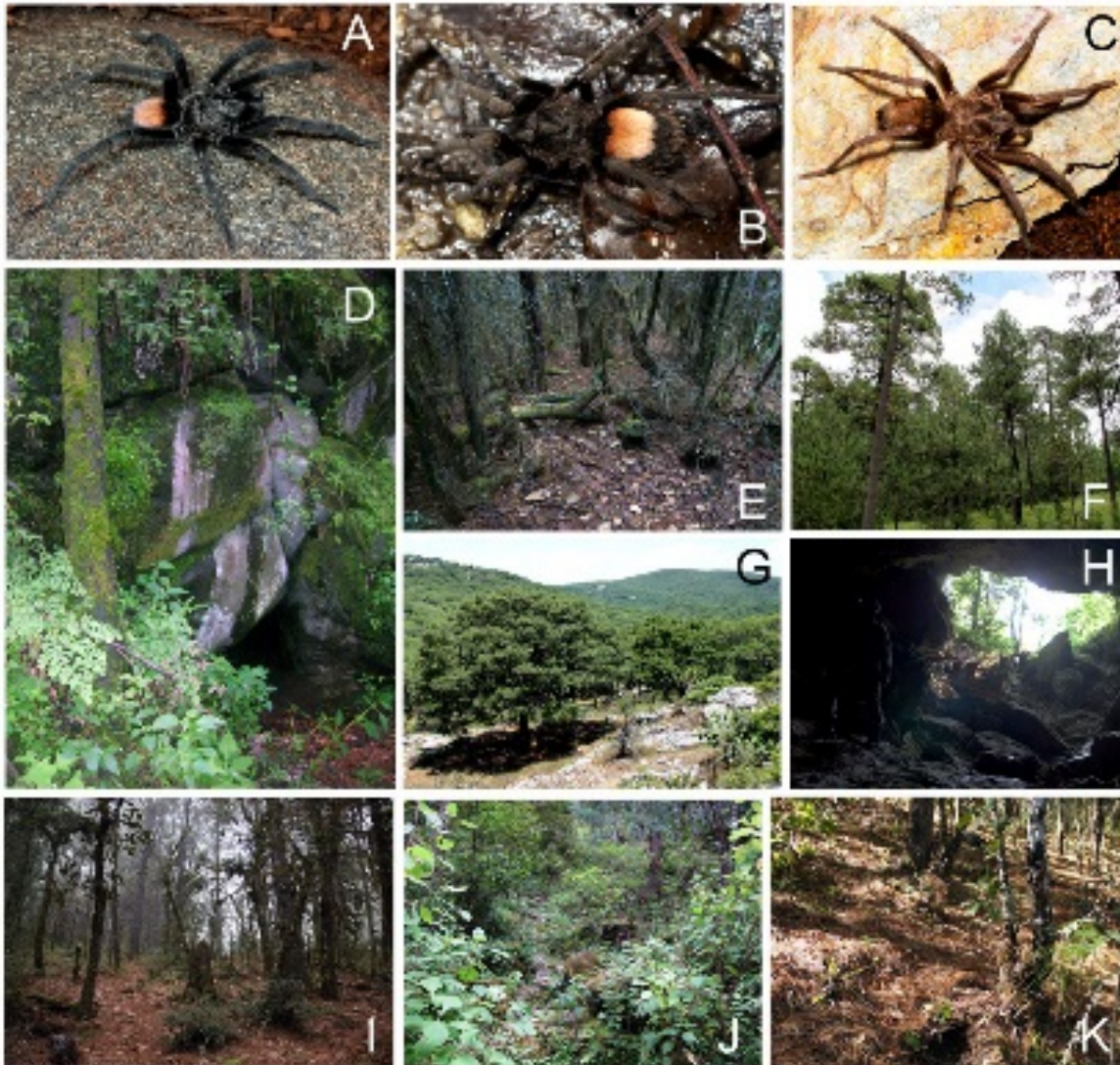
**Figure 49.** Known distribution of *Hemirrhagus mitchelli* (Gertsch 1982), *Hemirrhagus puebla* (Gertsch 1982), *Hemirrhagus ocellatus* Pérez-Miles & Locht 2003, *Hemirrhagus*

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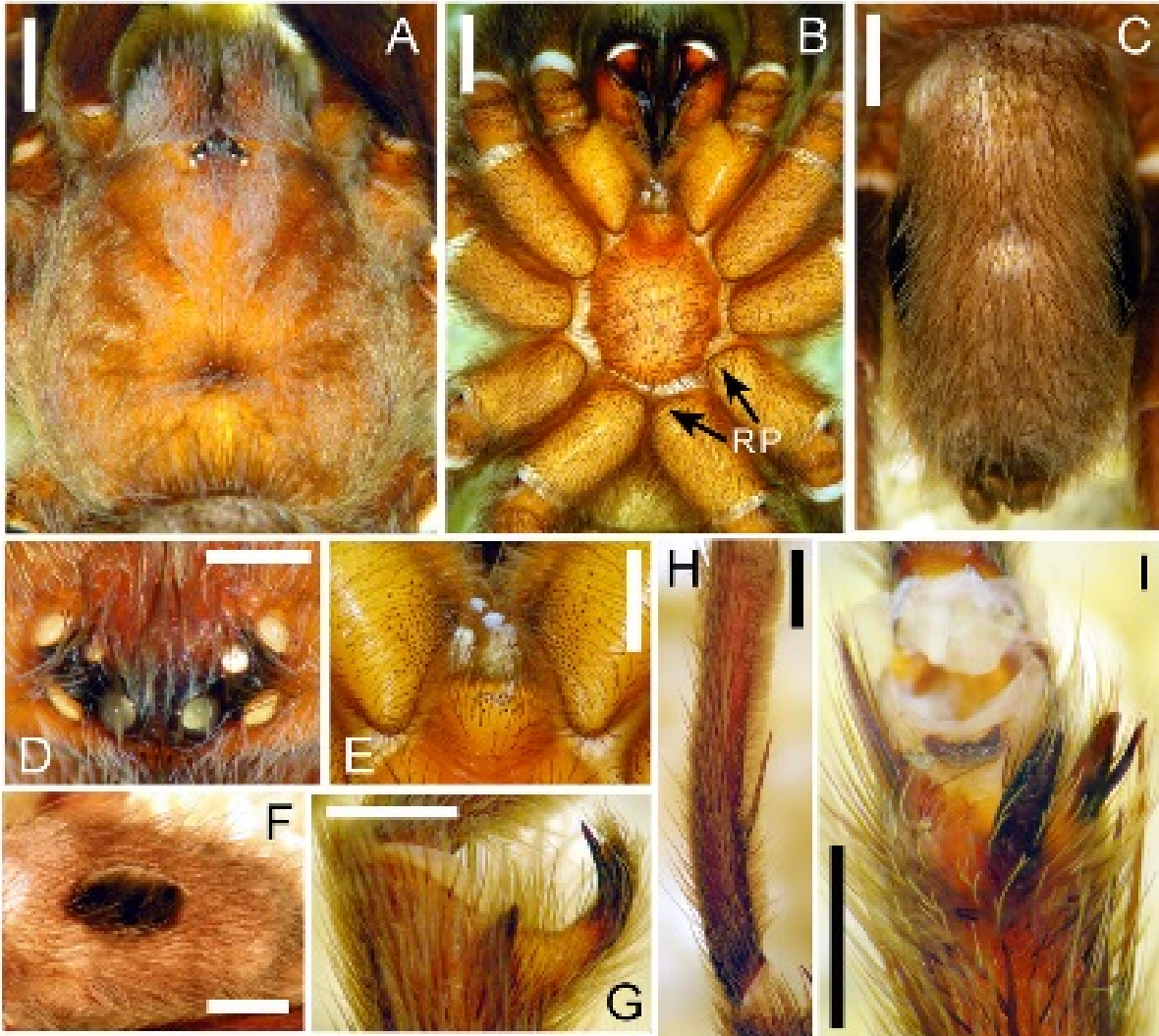


**Figure 1.** A–H, J–L, *Hemirrhagus* spp habitus; I, *H. papalotl* egg-sac. A, *H. chilango*, male CNAN 4253, in life; B–C, *H. eros*, B, female, C, male; D–E, *H. ocellatus*, D, male CNAN 4457, in life, E, female; F, *H. benzaa* sp. nov., female; G–I, *H. papalotl*, G, male CNAN 4461, in life, H, female CNAN 4461, in life, I, female CNAN 4459 with fixed hammock egg-sac, in life; J–K, *H. stygius*, J, male CNAN 4462, in life, K, female CNAN 4462, in life; L, *H. franckei* sp. nov., holotype male CNAN-T0776, in life. Photos: A, C, D, E, G–K, J. Mendoza; B, F, L, E. Goyer.

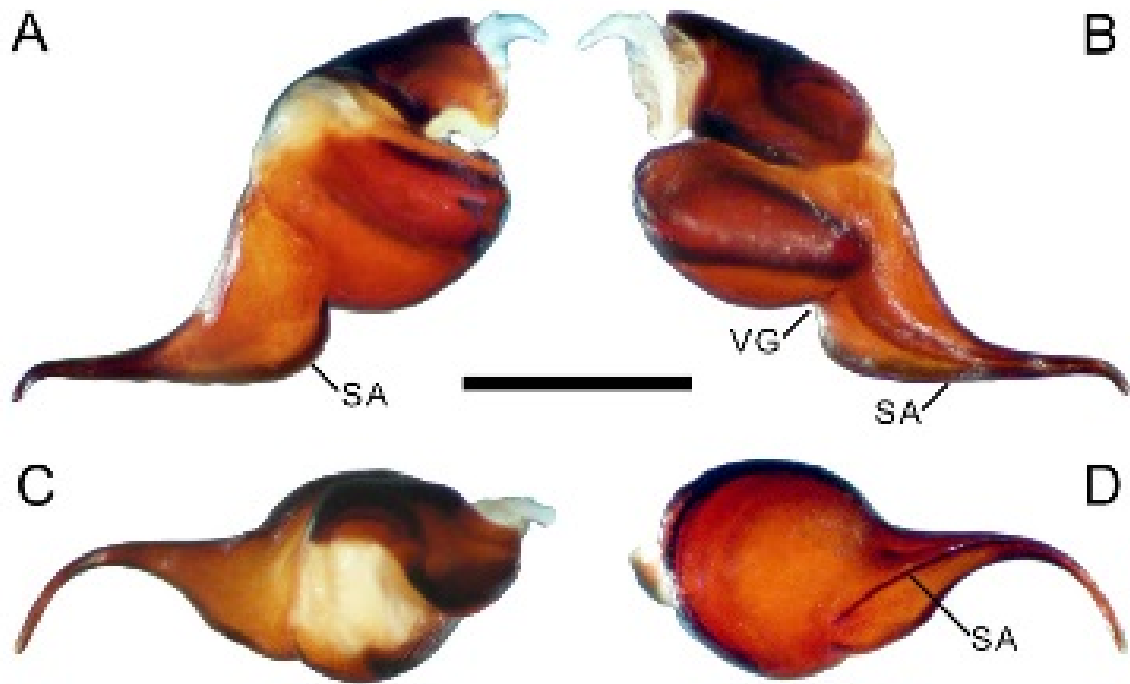




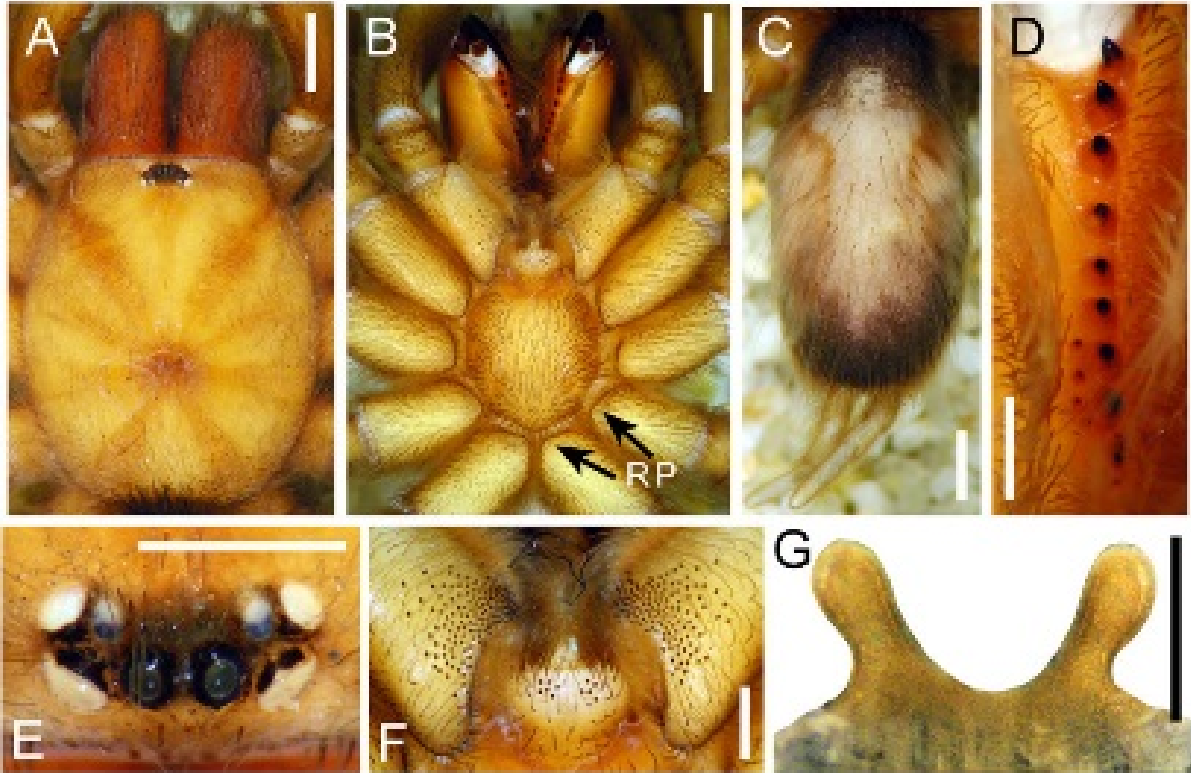
**Figure 2.** A–C, *Hemirrhagus spp* habitus; D–K, hábitat. A–B, *H. embolulatus sp. nov.*, A, holotype male CNAN-T0774, in life, B, paratype female CNAN-T0775, in life; C, *H. valdezi sp. nov.*, paratype female CNAN-T0780, in life; D, Cueva de la Peña Blanca entrance, type locality of *H. ocellatus*; E, 4km W of Puerto de la Soledad, pine forest, type locality of *H. franckei sp.nov.*; F, Bosque del ajusco, pine forest, locality of *H. chilango*; G, Valle de los fantasmas, oak forest on the road to Cueva de la Laguna, type locality of *H. elliotti*; H, Cueva de los Potrerillos entrance, type locality of *H. stygius*; I, Paradero Puerta del Sol, pine forest, locality of *H. benzaa sp. nov.*; J, Omiltemi, tropical forest-pine forest ecotone, type locality of *H. embolulatus sp. nov.*; K, El punto, type locality of *H. eros*. Photos: (A), M. Gamache; (B, E, I, K), E. Goyer; (C), L. Vazquez; (D, F, J), J. Mendoza; (G, H), J. Cruz.



**Figure 3.** A–I, *Hemirrhagus chilango* Pérez-Miles & Locht 2003, male CNAN 3470. A, carapace, dorsal view. B, prosoma, ventral view showing the RP on coxae of all legs (arrows show this feature only on coxa of third and fourth leg). C, opisthosoma, dorsal view. D, ocular tubercle, dorsal view. E, labial and maxillary cuspules. F, opisthosoma, lateral view showing urticating setae patch. G, tibial apophyses, prolateral view. H, metatarsus I, prolateral view. I, tibial apophyses, ventral view. Scale = 2mm (A–C, F), 1mm (E, G–I), 0.5mm (D).

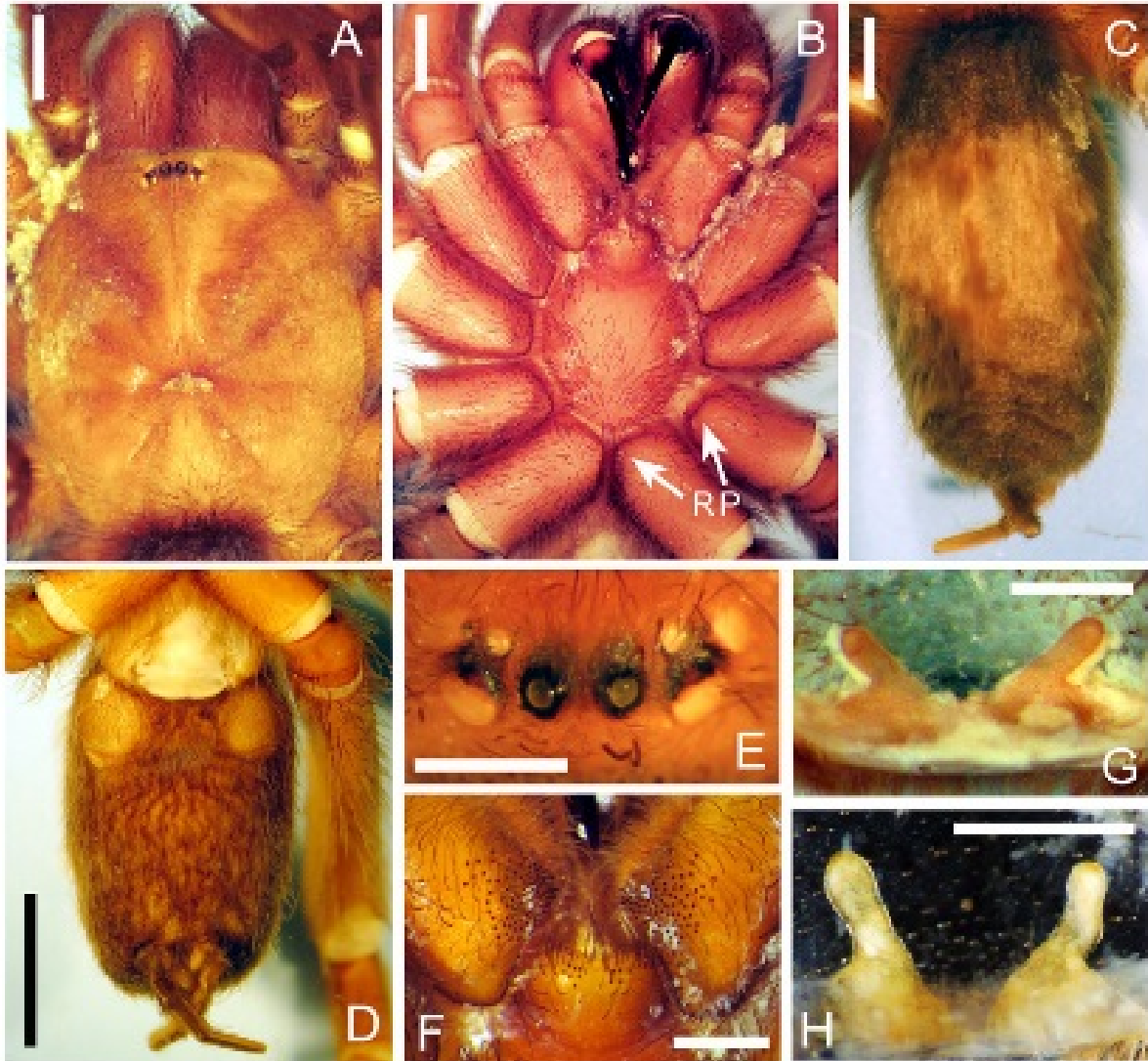


**Figure 4.** A–D, *Hemirrhagus chilango* Pérez-Miles & Locht 2003, male CNAN 3470, left palpal bulb. A, retrolateral view. B, prolateral view. C, dorsal view. D, ventral view. Scale = 1mm.



**Figure 5.** A–G, *Hemirrhagus coztic* Pérez-Miles & Loch 2003, holotype female LAAH. A, carapace, dorsal view. B, prosoma, ventral view showing the RP on coxae of all legs (arrows show this feature only on coxa of third and fourth leg). C, opisthosoma, dorsal view. D, cheliceral teeth, ventral view. E, ocular tubercle, dorsal view. F, labial and maxillary cuspules. G, spermathecae, ventral view. Scale = 2mm (A–C), 1mm (E, F), 0.5mm (D, G).



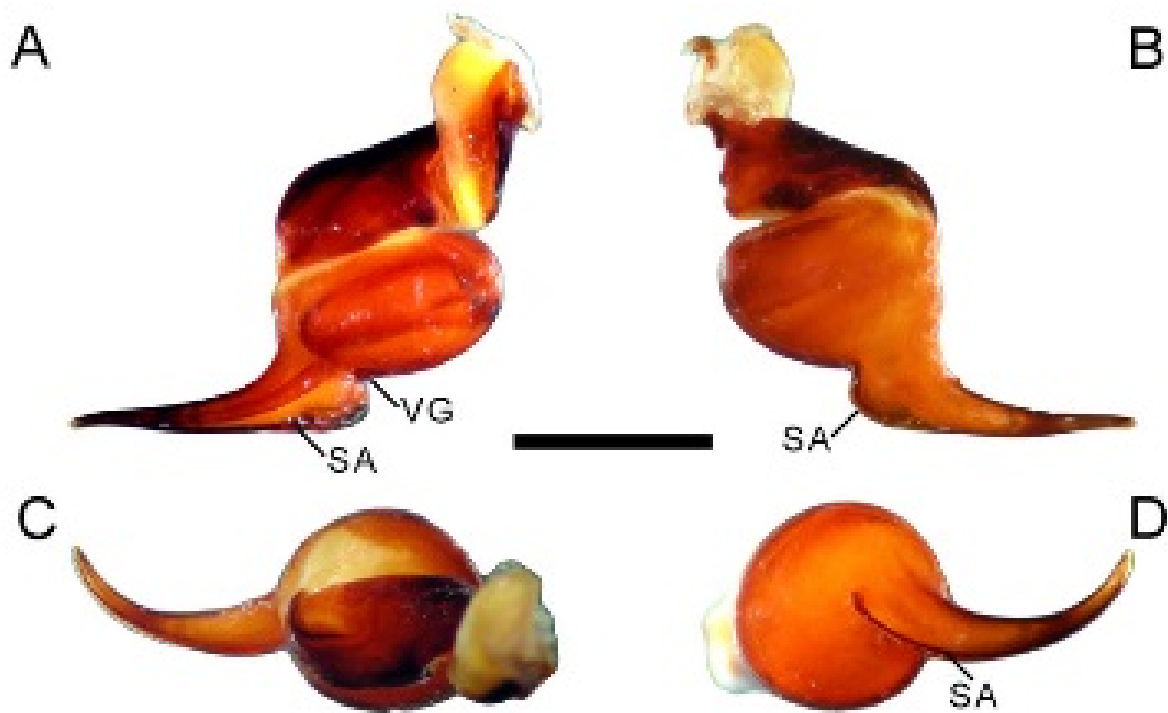


**Figure 6.** A–G, *Hemirrhagus elliotti* (Gertsch 1973), holotype female AMNH; H, female AMNH. A, carapace, dorsal view. B, prosoma, ventral view showing the RP on coxae of all legs (arrows show this feature only on coxa of third and fourth leg). C, opisthosoma, dorsal view. D, opisthosoma, ventral view. E, ocular tubercle, dorsal view. F, labial and maxillary cuspules. G, holotype spermathecae, dorsal view. H, spermathecae, dorsal view. Scale = 4mm (D), 2mm (A–C), 1mm (E–F), 0.5mm (G, H).





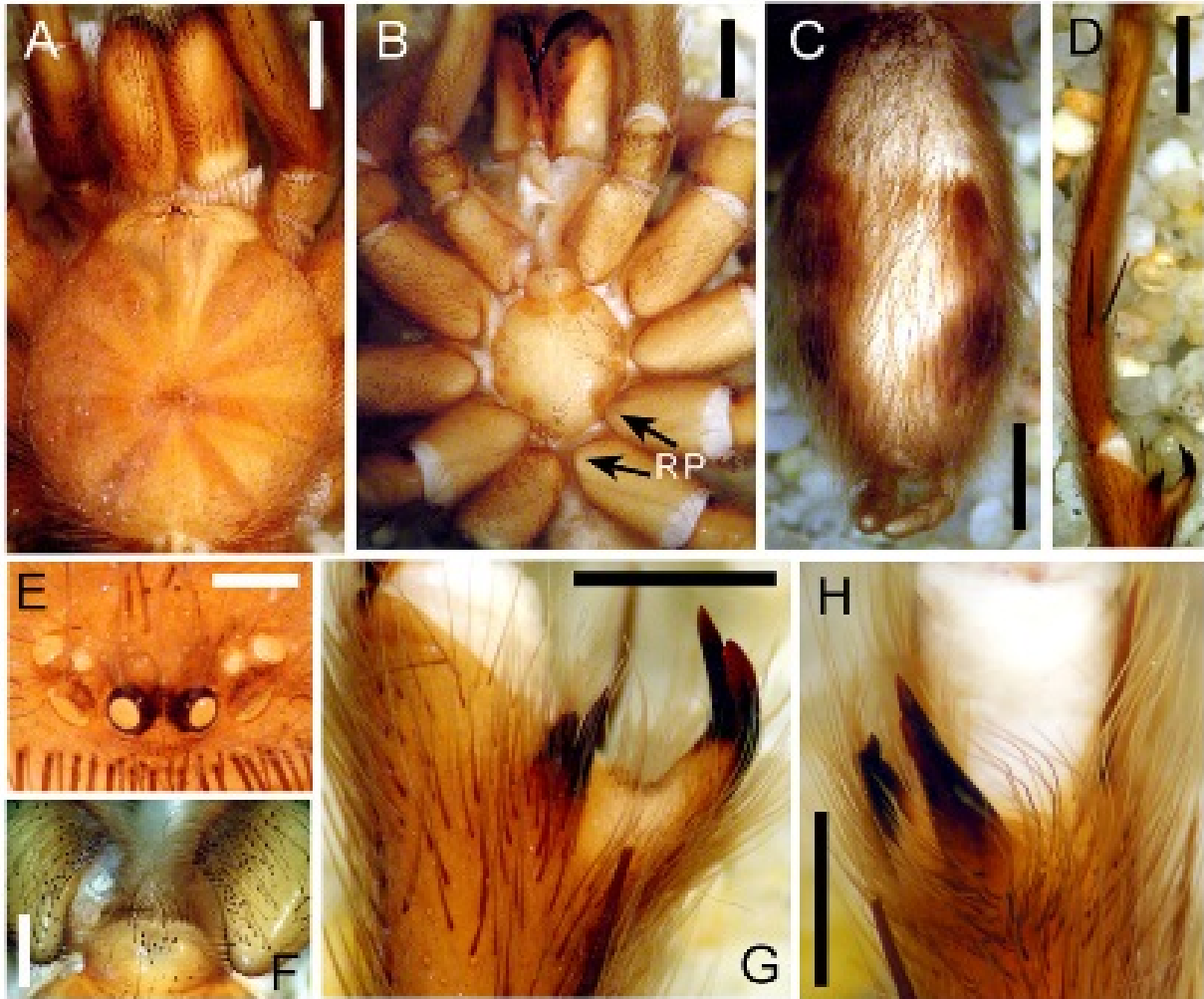
**Figure 7.** A–G, *Hemirrhagus eros* Pérez-Miles & Locht 2003, male holotype AMNH. A, carapace, dorsal view. B, prosoma, ventral view showing the RP on coxae of all legs (arrows show this feature only on coxa of third and fourth leg). C, opisthosoma, dorsal view. D, labial and maxillary cuspules. E, metatarsus I, prolateral view. F, tibial apophyses, prolateral view. G, tibial apophyses, ventral view. Scale = 4mm (A), 2mm (B–D), 1mm (E–G).



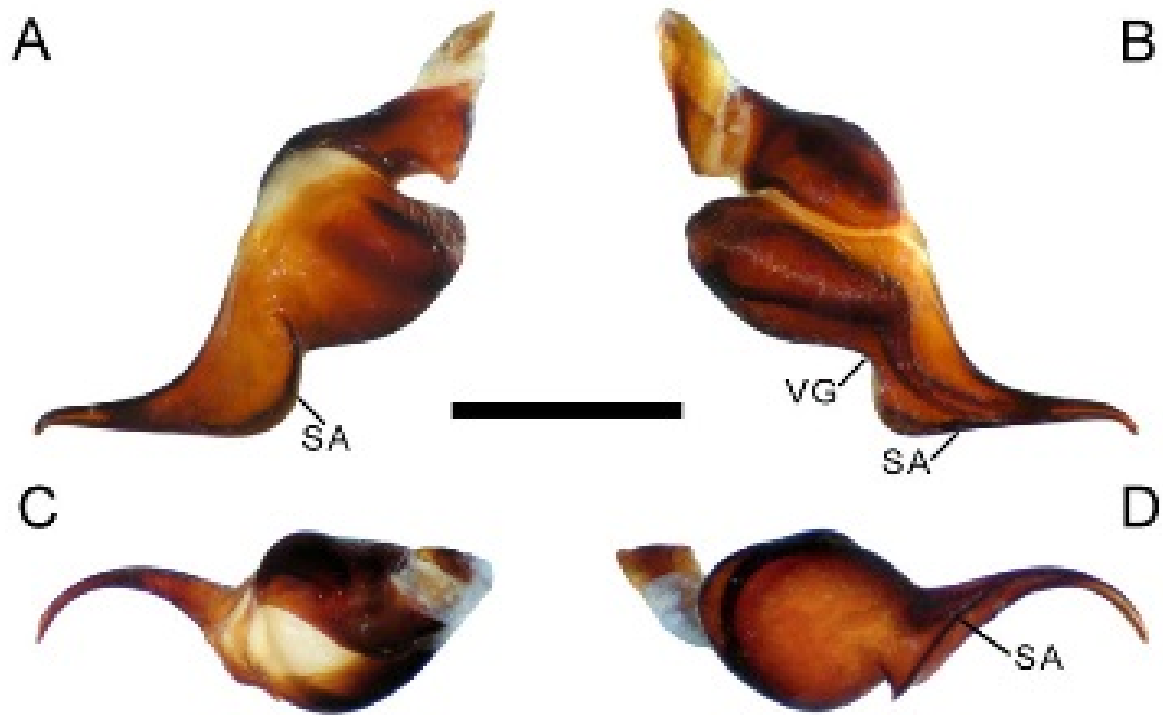
**Figure 8.** A–D, *Hemirrhagus eros* Pérez-Miles & Locht 2003, male holotype AMNH, right palpal bulb: A, prolateral view. B, retrolateral view. C, dorsal view. D, ventral view. Scale = 1mm.



**Figure 9.** A–D, *Hemirrhagus eros* Pérez-Miles & Locht 2003, paratype A female AMNH; E, paratype B female AMNH. A, carapace, dorsal view. B, opisthosoma, dorsal view. C, ocular tubercle, dorsal view. D, spermathecae, dorsal view. E, spermathecae, dorsal view. Scale = 4mm (A, B), 1mm (C–E).

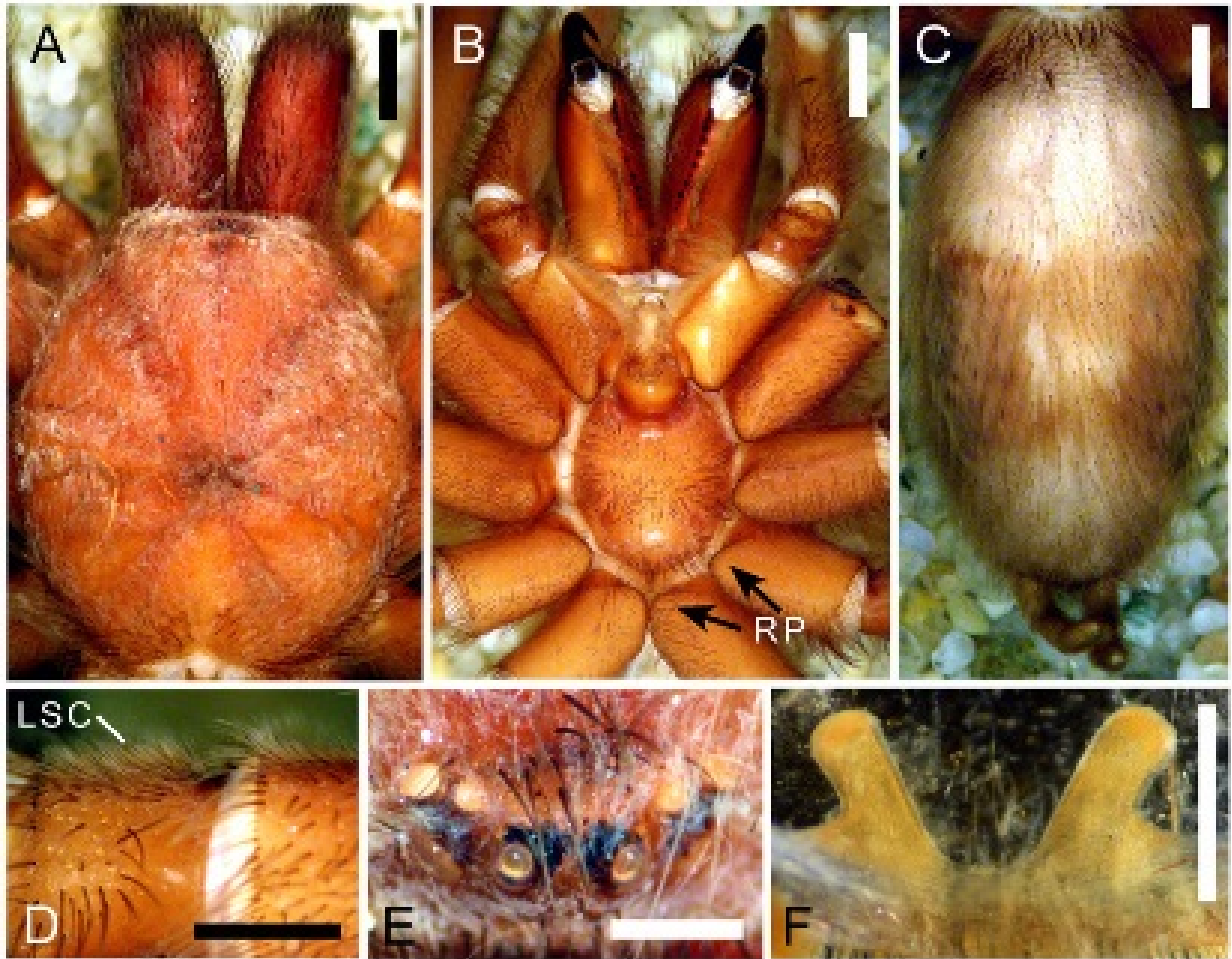


**Figure 10.** A–H, *Hemirrhagus gertschi* Pérez-Miles & Locht 2003, holotype male LAAH. A, carapace, dorsal view. B, prosoma, ventral view showing the RP on coxae of all legs (arrows show this feature only on coxa of third and fourth leg). C, opisthosoma, dorsal view. D, metatarsus I, prolateral view. E, ocular tubercle, dorsal view. F, labial and maxillary cuspules. G, tibial apophyses, prolateral view. H, tibial apophyses, ventral view. Scale = 2mm (A–D), 1mm (E–H).

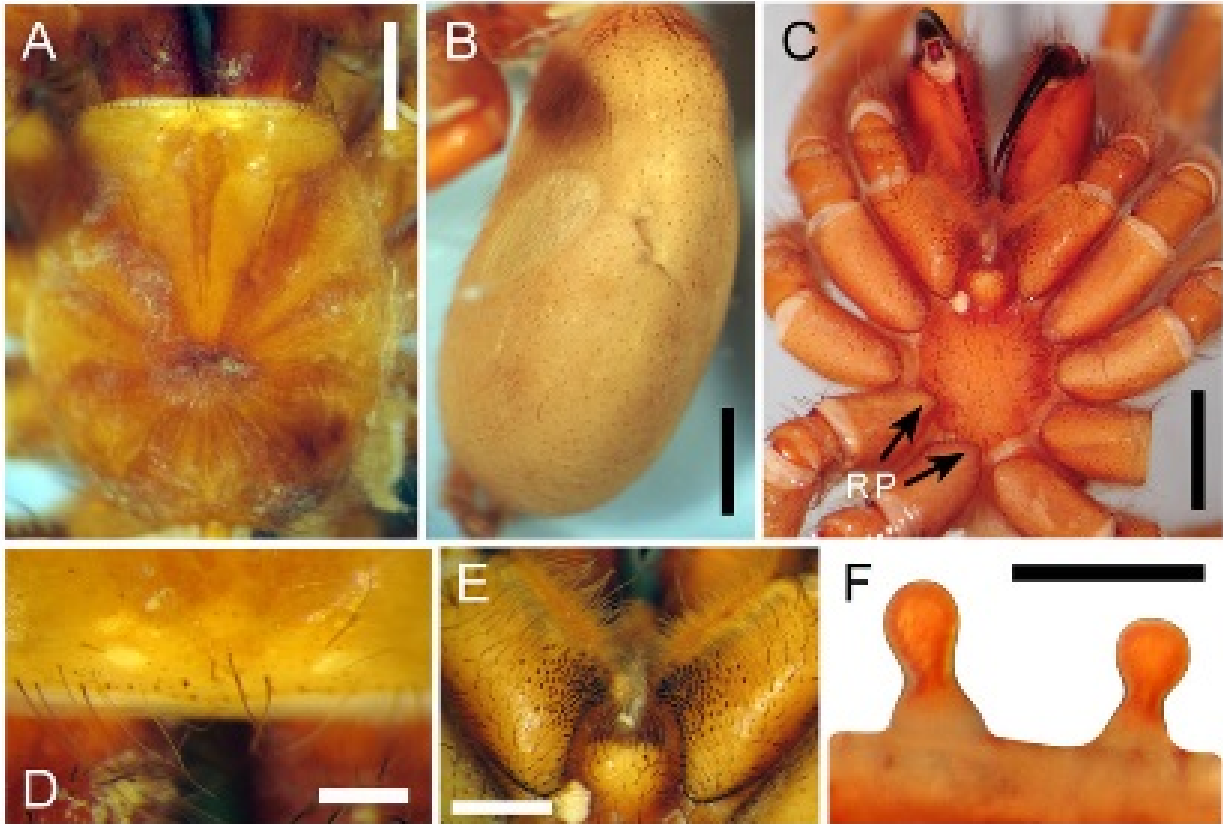


**Figure 11.** A–D, *Hemirrhagus gertschi* Pérez-Miles & Locht 2003, holotype male LAAH, left palpal bulb: A, retrolateral view. B, prolateral view. C, dorsal view. D, ventral view. Scale = 1mm.

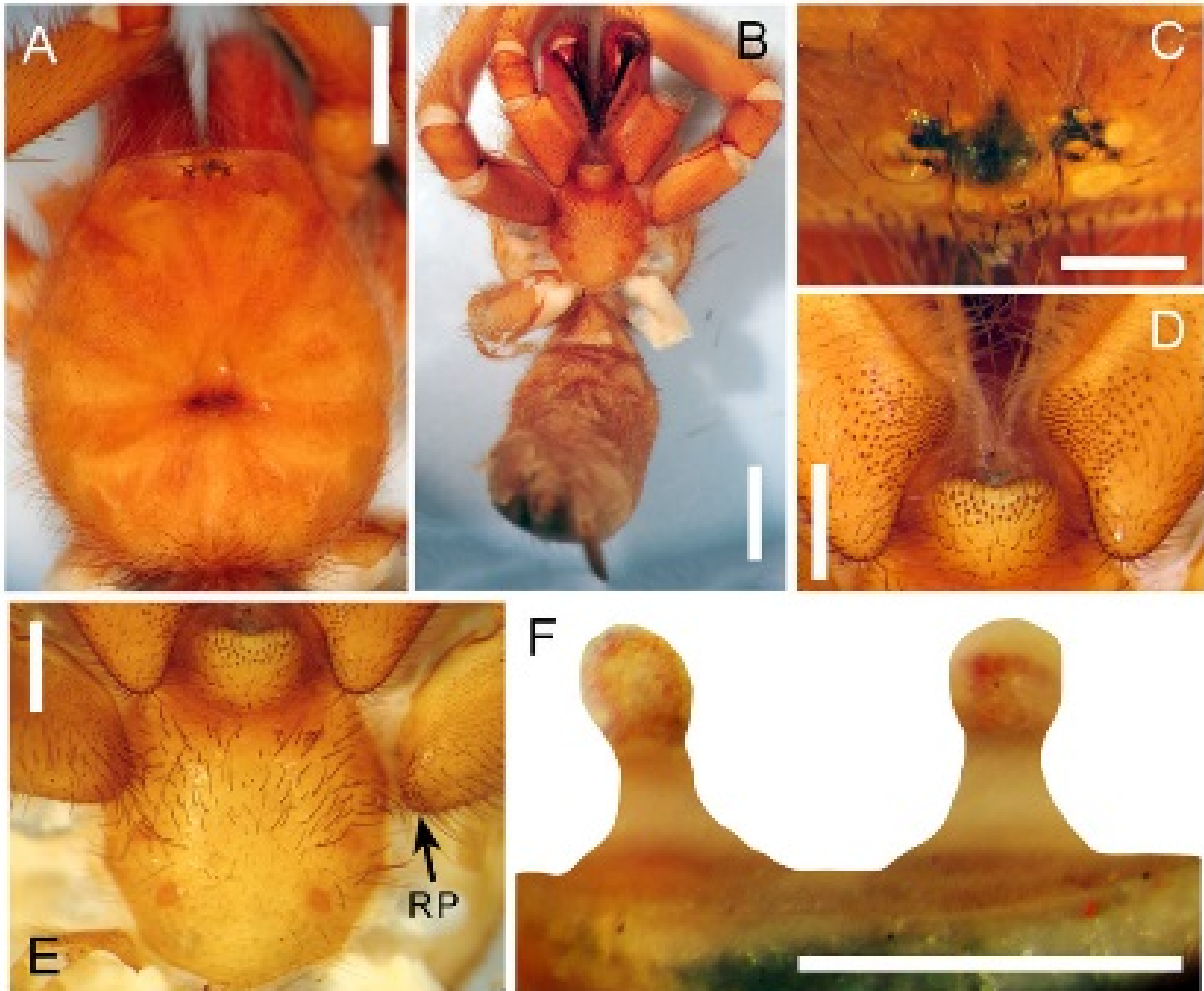




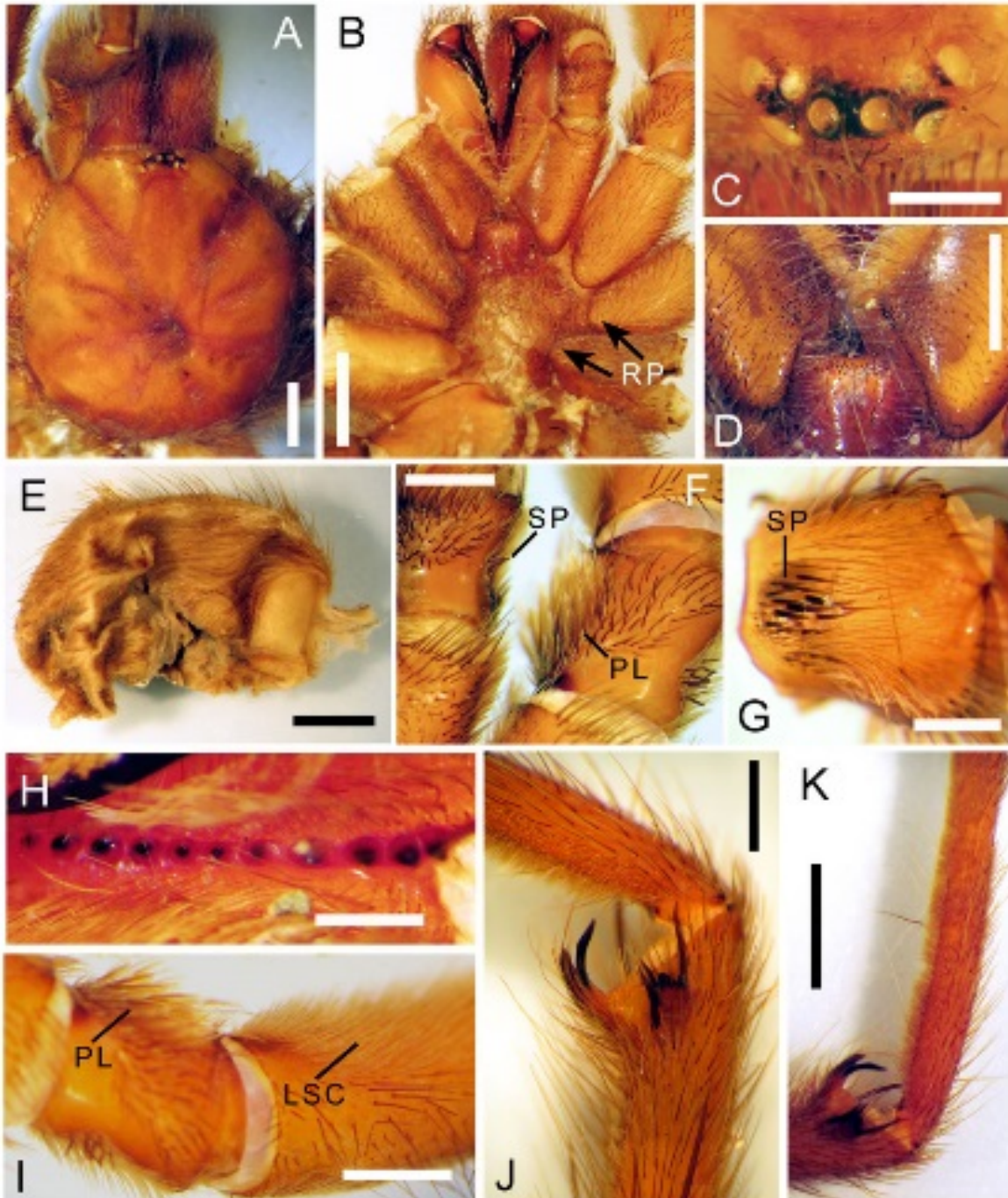
**Figure 12.** A–F, *Hemirrhagus gertschi* Pérez-Miles & Locht 2003, paratype female LAAH. A, carapace, dorsal view. B, prosoma, ventral view showing the RP on coxae of all legs (arrows show this feature only on coxa of third and fourth leg). C, opisthosoma, dorsal view. D, trochanter I LSC, ventral view. E, ocular tubercle, dorsal view. F, spermathecae, dorsal view. Scale = 4mm (A, C), 2mm (B), 1mm (D–F).



**Figure 13.** A–F, *Hemirrhagus grieta* (Gertsch 1982), holotype female AMNH. A, carapace, dorsal view. B, opisthosoma, dorsal view. C, prosoma, ventral view showing the RP on coxae of all legs (arrows show this feature only on coxa of third and fourth leg). D, ocular tubercle, dorsal view. E, labial and maxillary cuspules. F, spermathecae, dorsal view. Scale = 2mm (B), 1mm (A, C, E), 0.5mm (D, F).



**Figure 14.** A–F, *Hemirrhagus mitchelli* (Gertsch 1982), holotype female AMNH. A, carapace, dorsal view. B, prosoma and opisthosoma, ventral view. C, ocular tubercle, dorsal view. D, labial and maxillary cuspules. E, sternum (arrow shows the RP on coxa of first leg). F, spermathecae, dorsal view. Scale = 3mm (B), 2mm (A), 1mm (D, E), 0.5mm (C, F).



**Figure 15.** A–K, *Hemirrhagus nahuanus* (Gertsch 1982), holotype male AMNH. A, carapace, dorsal view. B, prosoma, ventral view showing the RP on coxae of all legs (arrows show this feature only on coxa of second and third leg). C, ocular tubercle, dorsal view. D, labial and maxillary cuspules. E, opisthosoma, right side. F, trochanter I PL, ventral view. G, palp trochanter SP, retrolateral view. H, cheliceral teeth, ventral view. I, trochanter I PL and femur I LSC, ventral view. J, tibial apophyses, prolateral view. K, metatarsus I, prolateral view. Scale = 2mm (A, B, E, K), 1mm (D, F, I, J), 0.5mm (C, G, H).

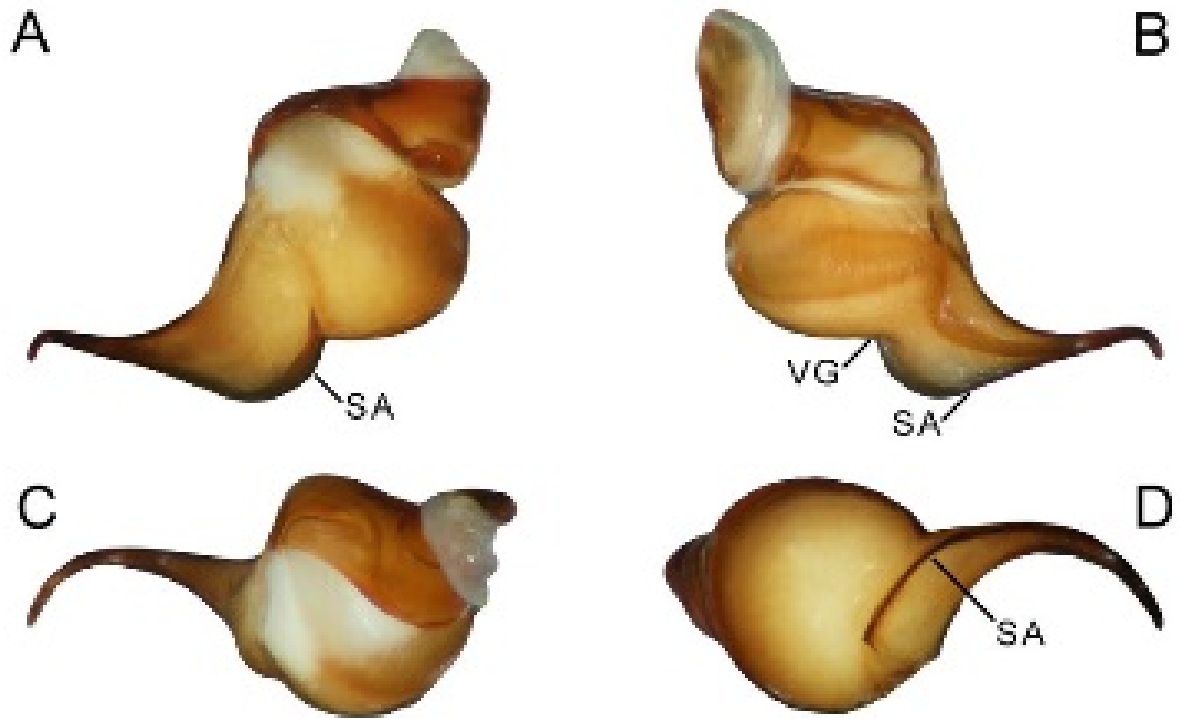


**Figure 16.** A–B, *Hemirrhagus nahuanus* (Gertsch 1982), holotype male AMNH, right palpal bulb: A, retrolateral view. B, prolateral view. Scale = 1mm.

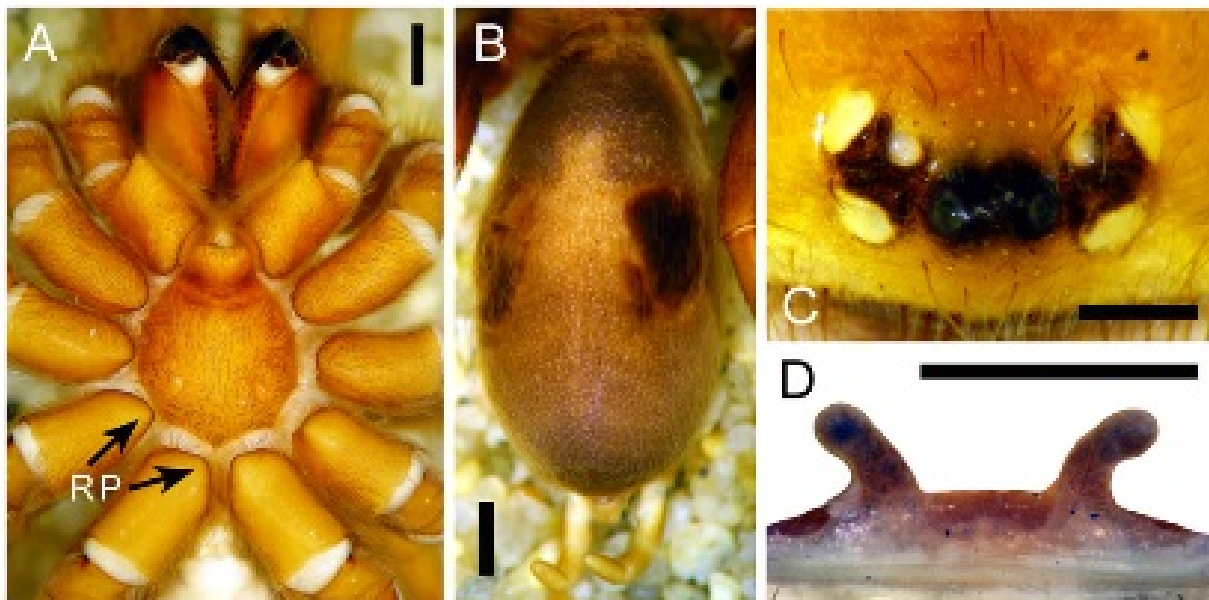




**Figure 17.** A–J, *Hemirrhagus ocellatus* Pérez-Miles & Locht 2003, male CNAN 4457. A, carapace, dorsal view. B, prosoma, ventral view showing the RP on coxae of all legs (arrows show this feature only on coxa of third and fourth leg). C, opisthosma, dorsal view. D, opisthosoma, ventral view. E, ocular tubercle, dorsal view. F, sternum. G, tibial apophyses, ventral view. H, tibial apophyses, prolateral view. I, labial and maxillary cuspules. J, metatarsus I, prolateral view. Scale = 2mm (A–C), 1mm (F–J), 0.5mm (D, E).



**Figure 18.** A–D, *Hemirrhagus ocellatus* Pérez-Miles & Locht 2003, male CNAN 4457, left palpal bulb: A, retrolateral view. B, prolateral view. C, dorsal view. D, ventral view. Scale = 1mm.

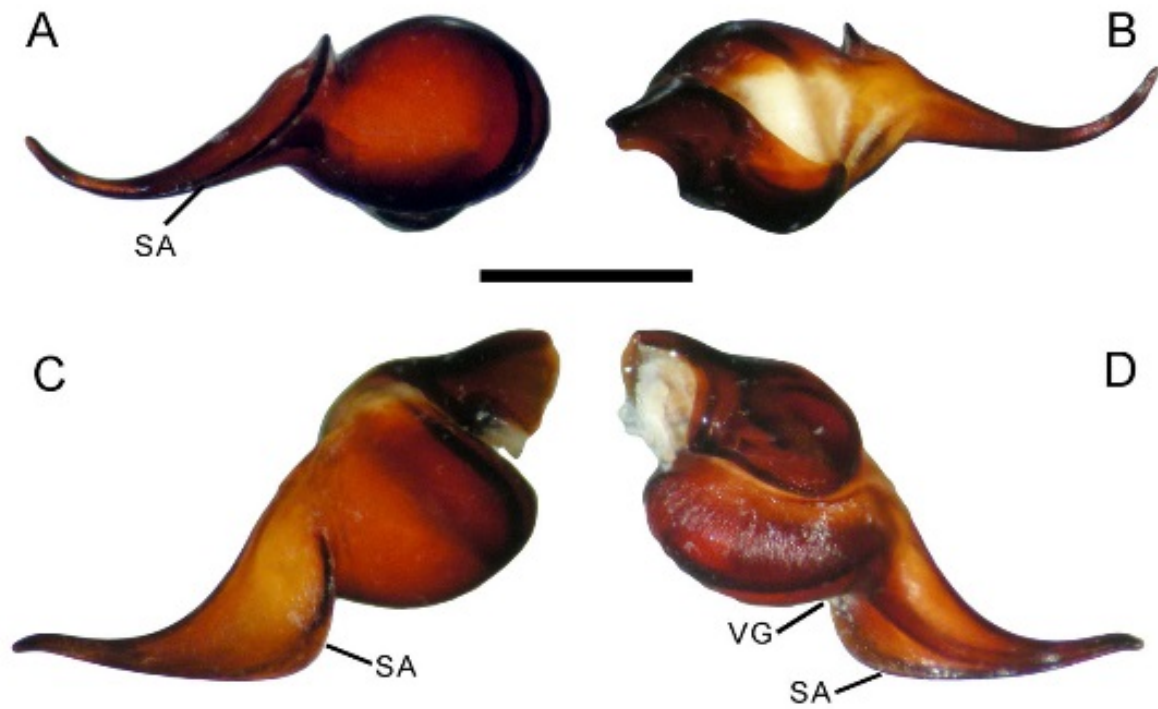


**Figure 19.** A–D, *Hemirrhagus ocellatus* Pérez-Miles & Locht 2003, holotype female LAAH. A, prosoma, ventral view showing the RP on coxae of all legs (arrows show this feature only on coxa of third and fourth leg). B, opisthosoma, dorsal view. C, ocular tubercle, dorsal view. D, spermathecae, ventral view. Scale = 2mm (A, B), 1mm (D), 0.5mm (C).



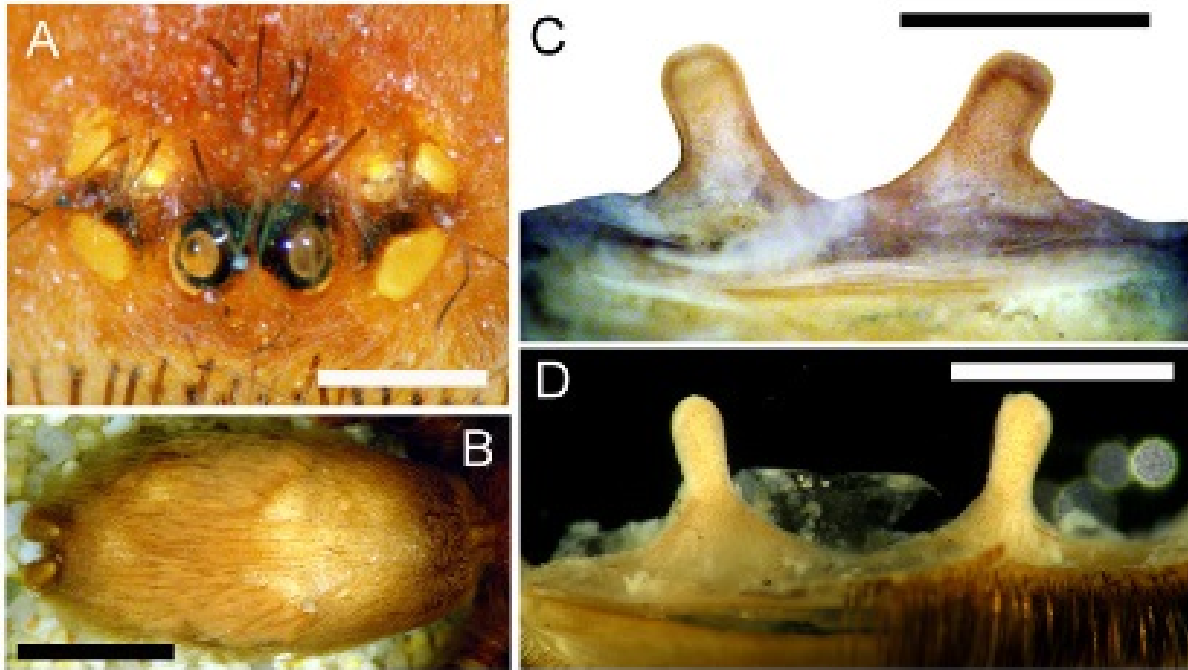


**Figure 20.** A–J, *Hemirrhagus papalotl* Pérez-Miles & Locht 2003, male CNAN 4460. A, carapace, dorsal view. B, prosoma, ventral view showing the RP on coxae of all legs (arrows show this feature only on coxa of third and fourth leg). C, opisthosoma, dorsal view. D, ocular tubercle, dorsal view. E, labial and maxillary cuspules. F, sternum. G, cheliceral teeth, ventral view. H, tibial apophyses, ventral view. I, metatarsus I, prolateral view. J, tibial apophyses, prolateral view. Scale = 2mm (A–C, F, H, I), 1mm (E, G, J), 0.5mm (D).

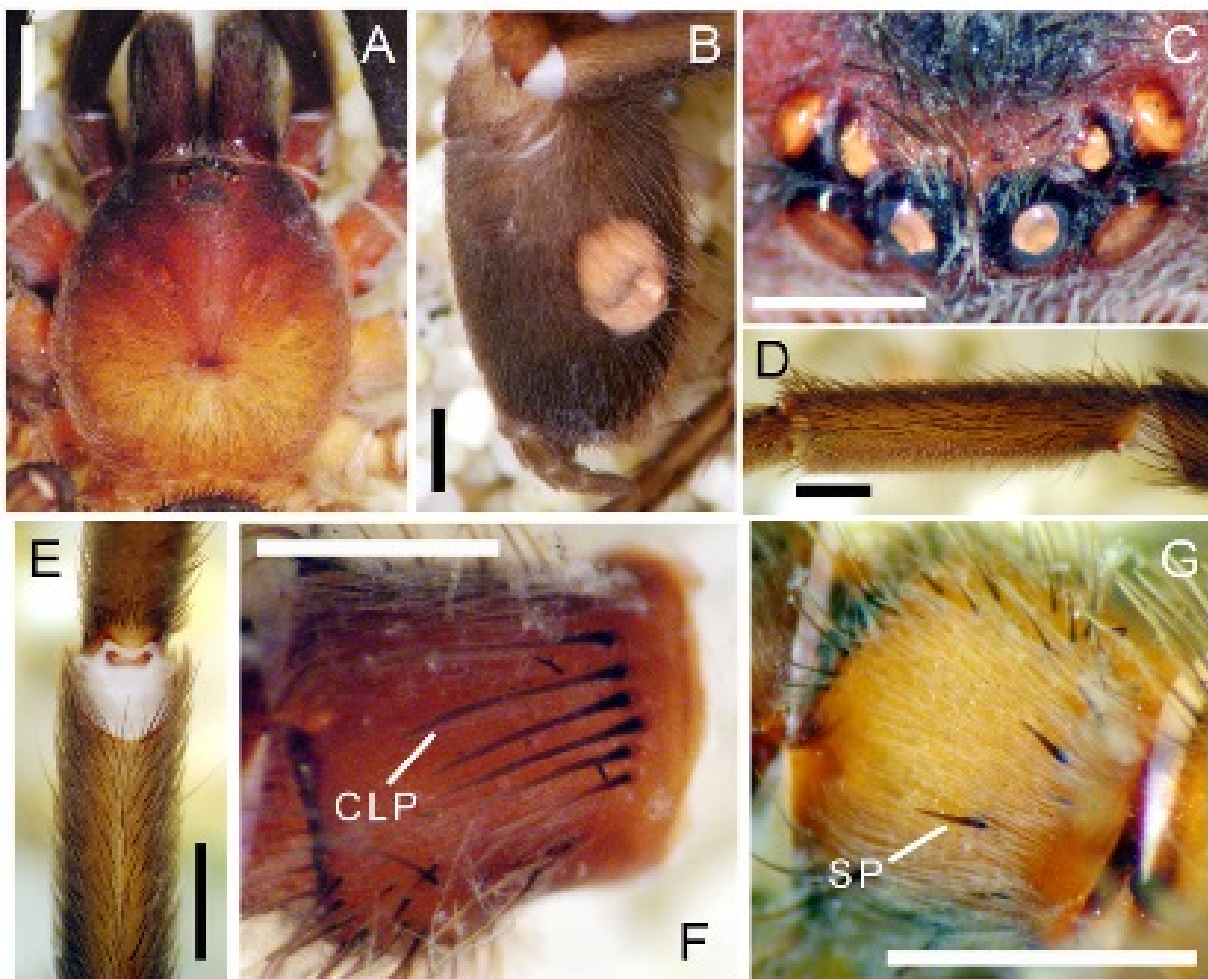


**Figure 21.** A–D, *Hemirrhagus papalotl* Pérez-Miles & Locht 2003, male CNAN 4460, left palpal bulb. A, ventral view. B, dorsal view. C, retrolateral view. D, prolateral view. Scale = 1mm.

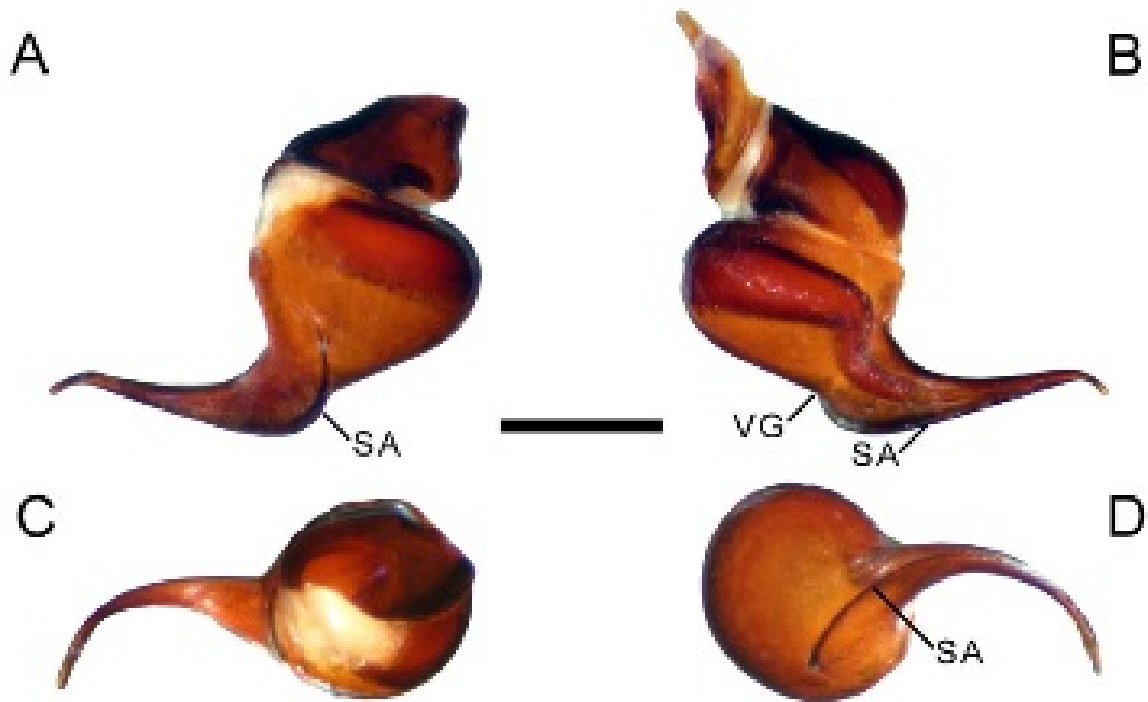




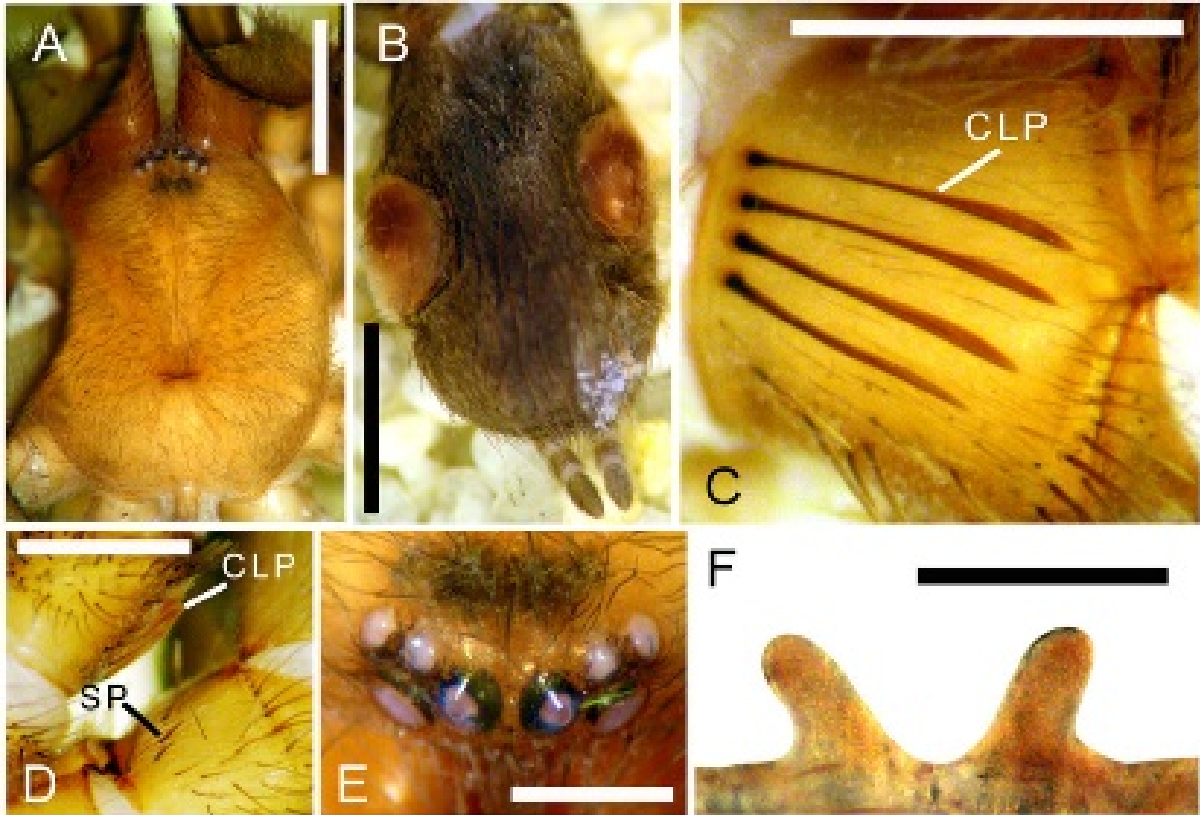
**Figure 22.** A–C, *Hemirrhagus papalotl* Pérez-Miles & Locht 2003, holotype female LAAH; D, female CNAN 4459. A, ocular tubercle, dorsal view. B, opisthosoma, dorsal view. C, spermathecae, ventral view. D, spermathecae, ventral view. Scale = 2mm (B), 1mm (D), 0.5mm (A, C).



**Figure 23.** A–G, *Hemirrhagus perezmilei* García-Villafuerte & Locht 2010, holotype male CNAN-T0395. A, carapace, dorsal view. B, opisthosoma, lateral view. C, ocular tubercle, dorsal view. D, metatarsus I, prolateral view. E, tibia I, ventral view. F, palp trochanter CLP, retrolateral view. G, trocánter I SP, prolateral view. Scale = 2mm (A, B), 1mm (D–G), 0.5mm (C).



**Figure 24.** A–D, *Hemirrhagus perezmilei* García-Villafuerte & Locht 2010, holotype male CNAN-T0395, left palpal bulb: A, retrolateral view. B, prolateral view. C, dorsal view. D, ventral view. Scale = 0.5mm.



**Figure 25.** A–F, *Hemirrhagus perezmilei* García-Villafuerte & Locht 2010, paratype female CNAN-T0396. A, carapace, dorsal view. B, opisthosoma, dorsal view. C, palp trochanter CLP, retrolateral view. D, palp trochanter CLP and trochanter I SP, ventral view. E, ocular tubercle, dorsal view. F, spermathecae, dorsal view. Scale = 2mm (A, B), 1mm (C, D), 0.5mm (E), 0.4mm (F).

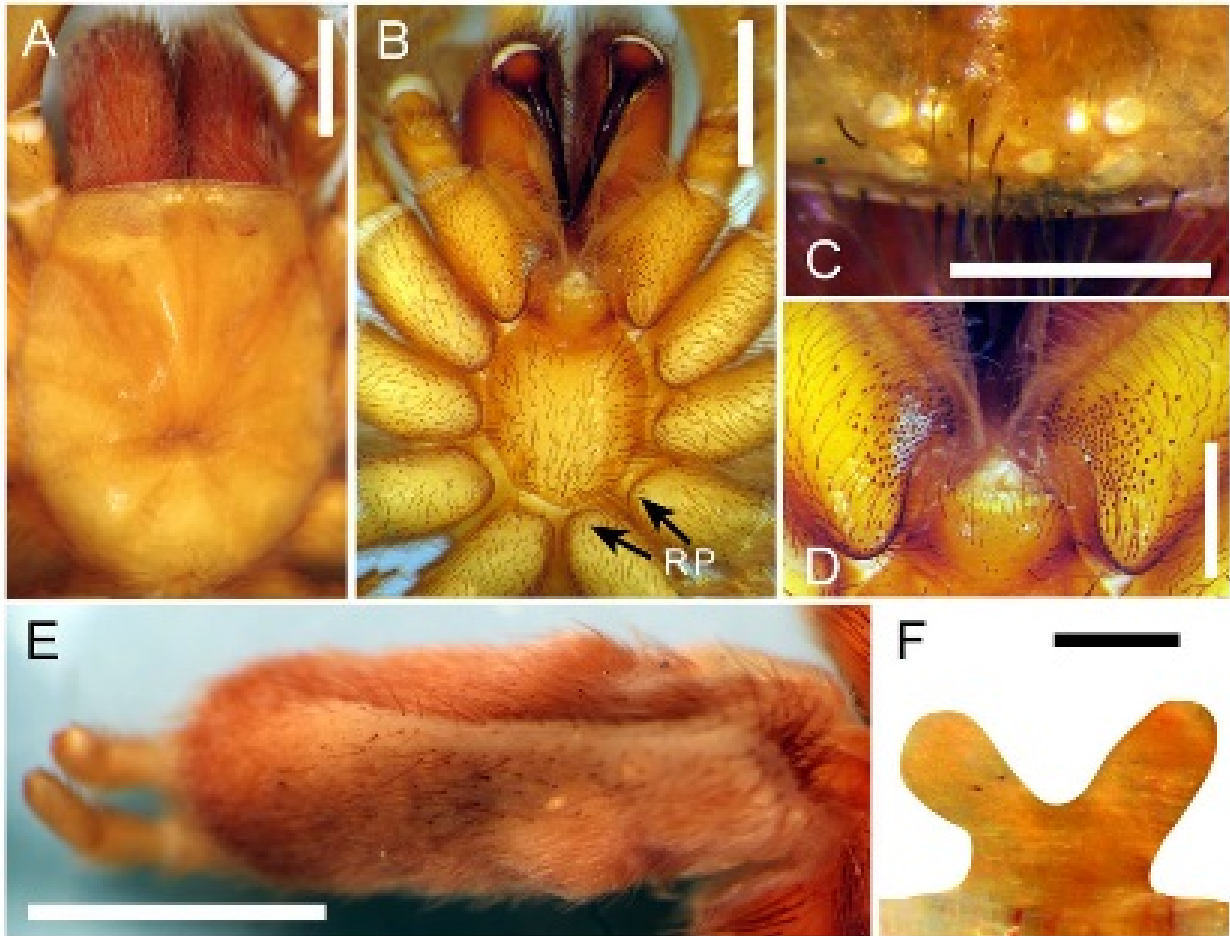


**Figure 26.** A–K, *Hemirrhagus pernix* (Ausserer 1875), holotype male BMNH 351. A, carapace, dorsal view. B, prosoma, ventral view showing the RP on coxae of all legs (arrows show this feature only on coxa of third and fourth leg). C, ocular tubercle, dorsal view. D, labial cuspules. E, sternum. F, trochanter I PL, prolateral view. G, palp trochanter SP, retrolateral view. H, tibial apophyses, ventral view. I, tibial apophyses, ventral view. J, metatarsus and tarsus I, retrolateral view. K, habitus. Scale = 10mm (K), 4mm (J), 2mm (A, B, E, H, I), 1mm (C, D, F), 0.5mm (G).

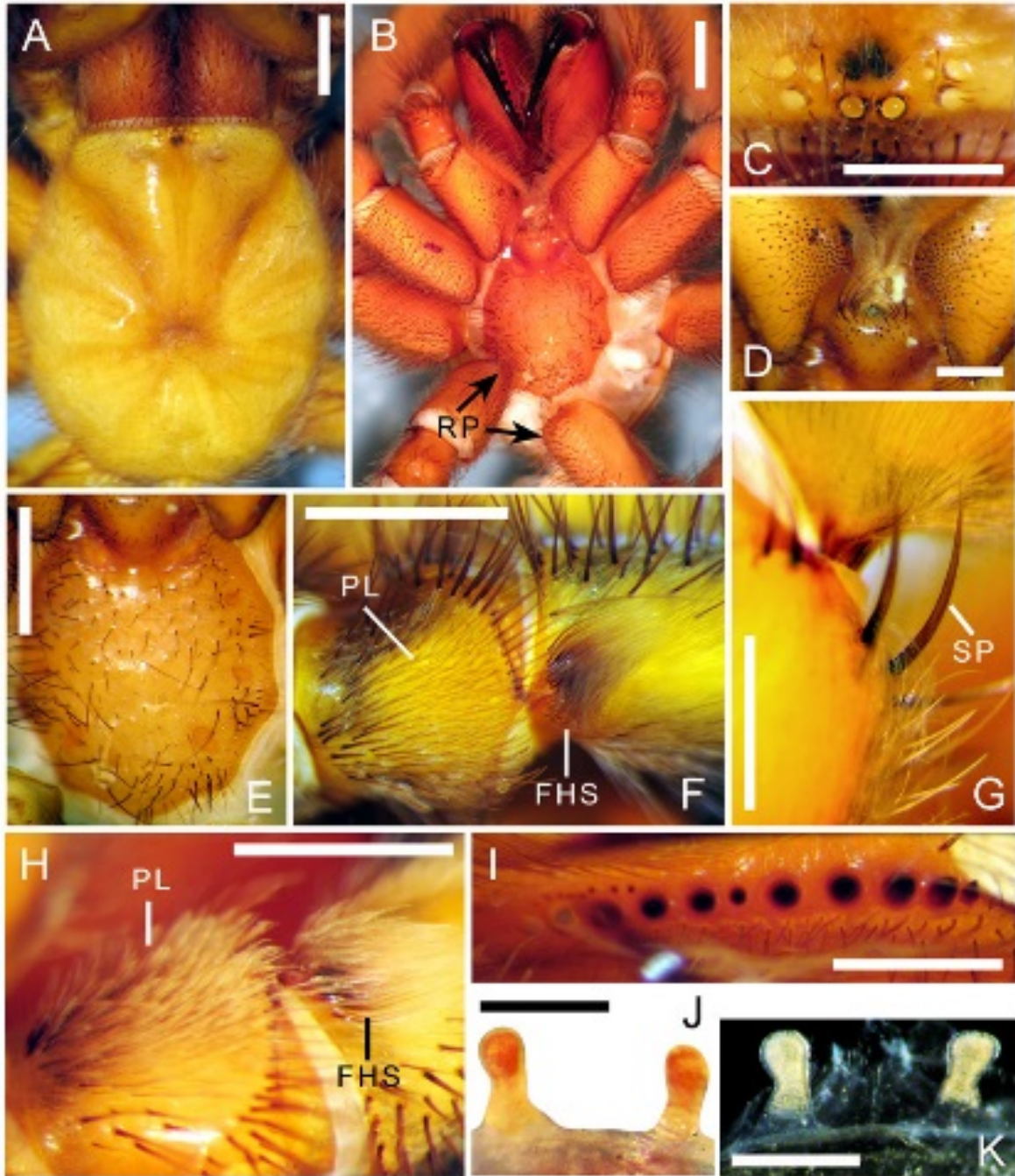




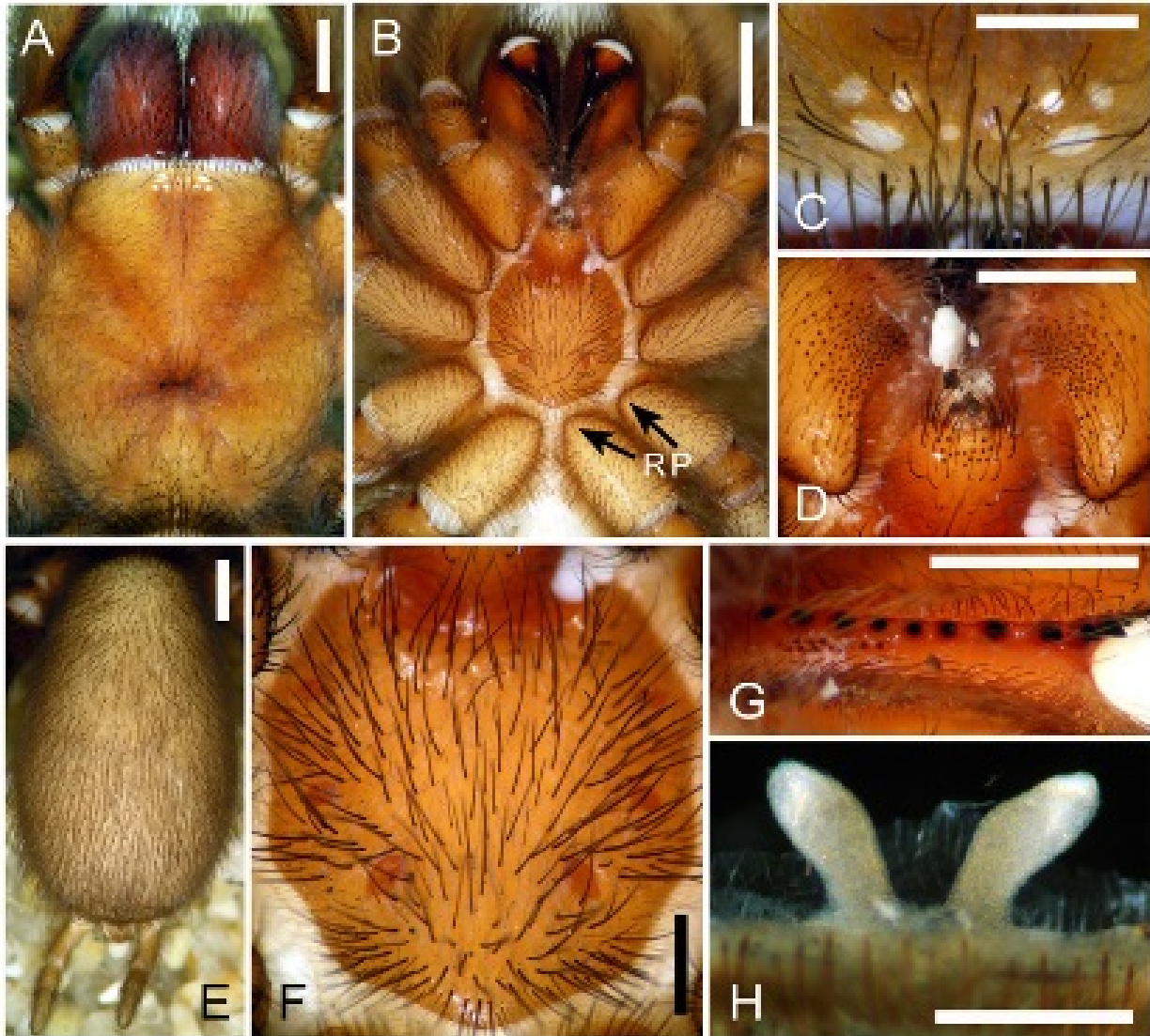
**Figure 27.** A–C, *Hemirrhagus pernix* (Ausserer 1875), holotype male BMNH 351, right palpal bulb: A, prolateral view. B, retrolateral view. C, ventral view. Scale = 1mm.



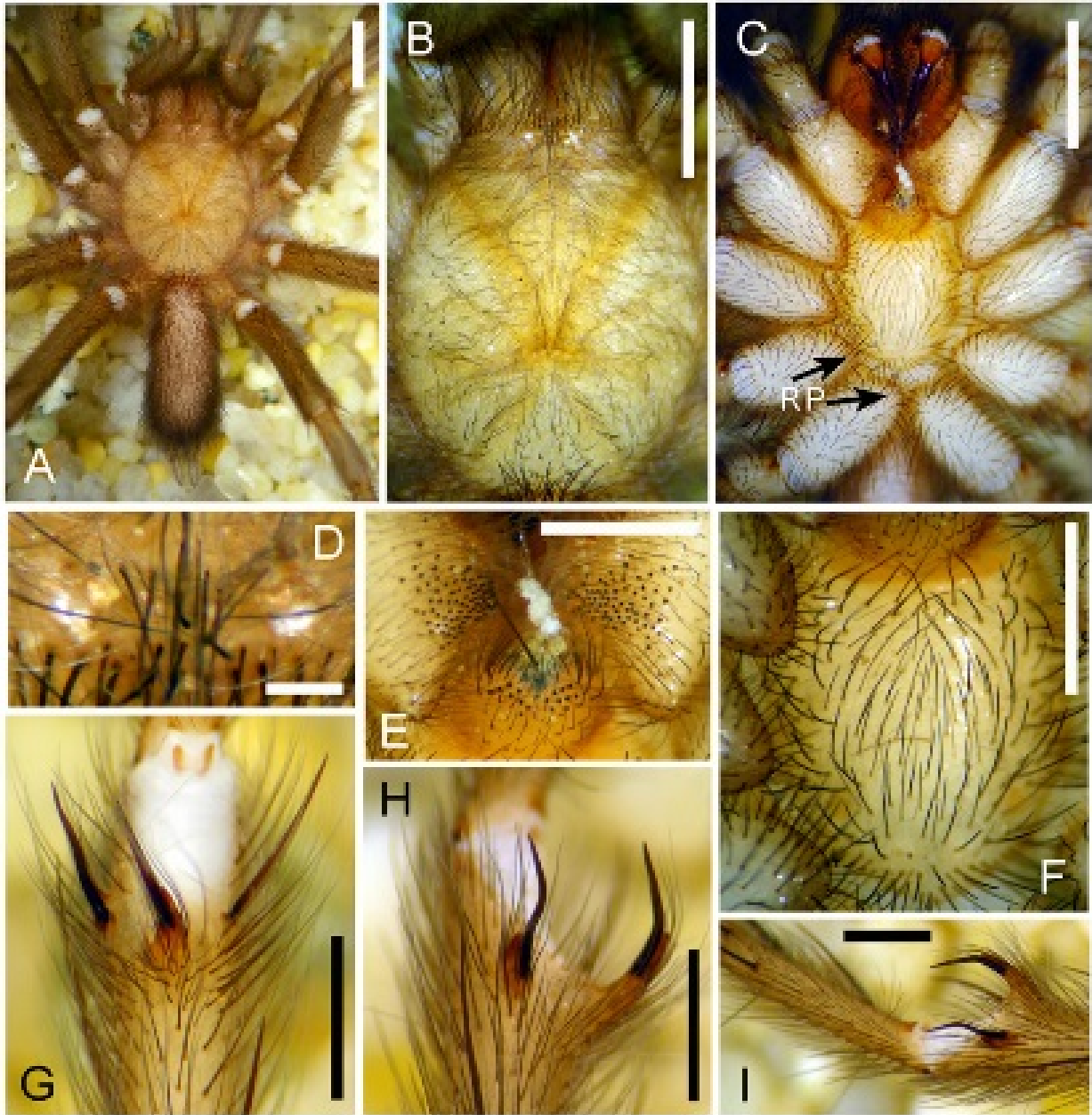
**Figure 28.** A–F, *Hemirrhagus puebla* (Gertsch 1982), holotype female AMNH. A, carapace, dorsal view. B, prosoma, ventral view showing the RP on coxae of all legs (arrows show this feature only on coxa of third and fourth leg). C, ocular tubercle, dorsal view. D, labial and maxillary cuspules. E, opisthosoma, dorsal view. F, spermathecae, dorsal view. Scale = 2mm (A, B, E), 1mm (C, D), 0.2mm (F).



**Figure 29.** A–J, *Hemirrhagus reddelli* (Gertsch 1973), holotype female AMNH; K, female AMNH. A, carapace, dorsal view. B, prosoma, ventral view showing the RP on coxae of all legs (arrows show this feature only on coxa of third and fourth leg). C, ocular tubercle, dorsal view. D, labial and maxillary cuspules. E, sternum. F, palp trochanter PL and femur FHS, retrolateral view. G, trochanter I SP distally, ventral view. H, palp trochanter PL and femur FHS, dorsal view. I, cheliceral teeth, ventral view. J, spermathecae, dorsal view. K, spermathecae, dorsal view. Scale = 2mm (A, B, E), 1mm (C, D, F, H, I), 0.5mm (G, J, K).

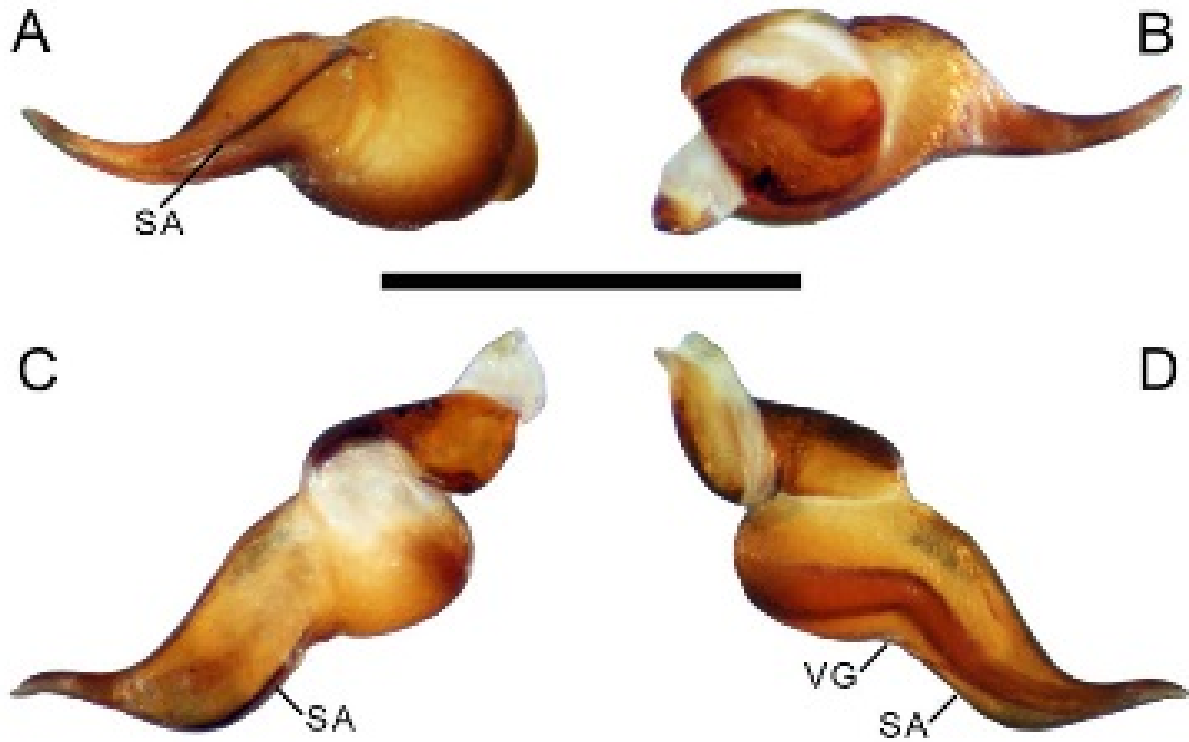


**Figure 30.** A–H, *Hemirrhagus stygius* (Gertsch 1971), female CNAN 4462. A, carapace, dorsal view. B, prosoma, ventral view showing the RP on coxae of all legs (arrows show this feature only on coxa of third and fourth leg). C, ocular tubercle, dorsal view. D, labial and maxillary cuspules. E, opisthosma, dorsal view. F, sternum. G, cheliceral teeth, ventral view. H, spermathecae, ventral view. Scale = 4mm (B), 2mm (A, D, E), 1mm (C, G, F), 0.5mm (H).

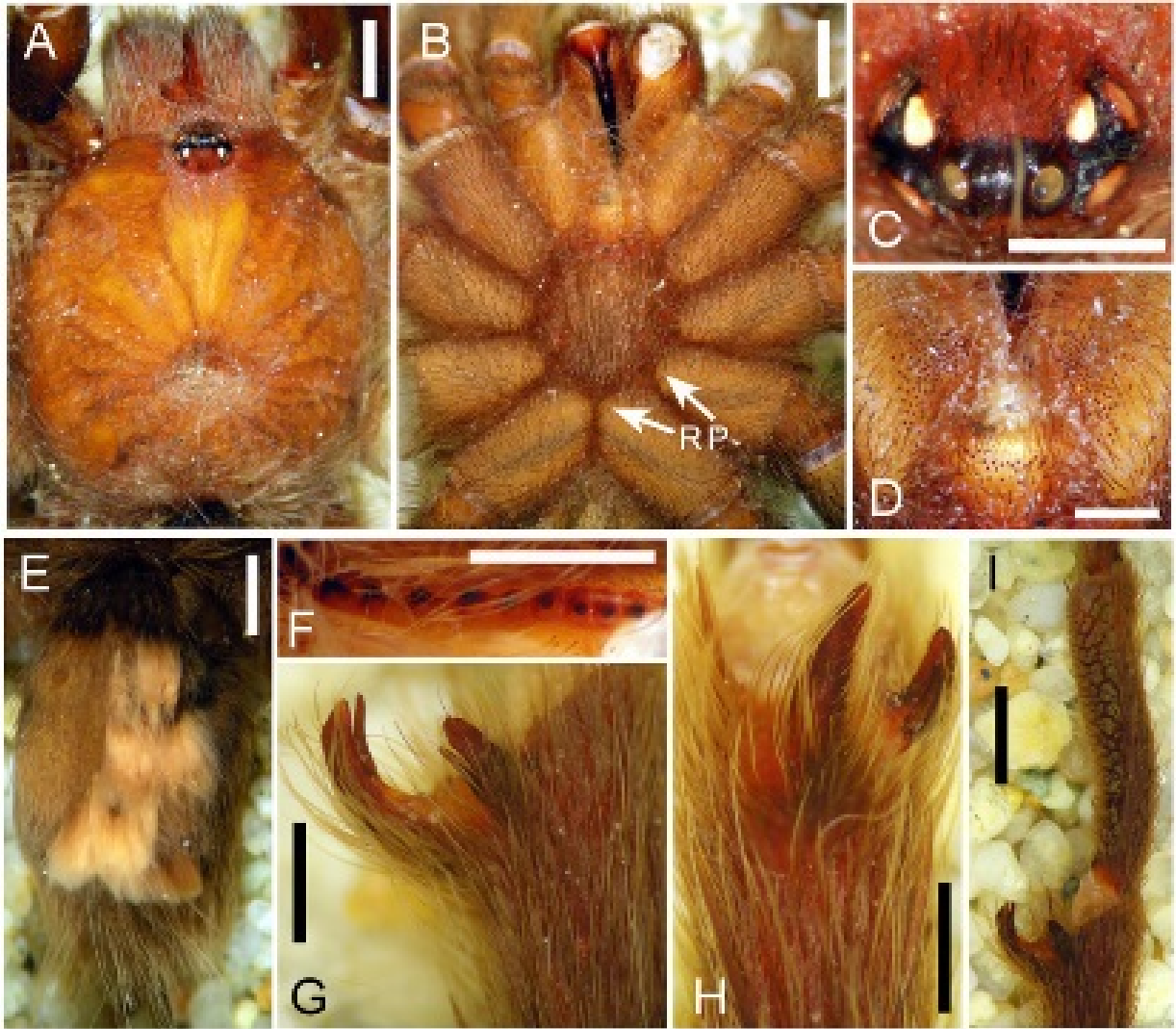


**Figure 31.** A–I, *Hemirrhagus stygius* (Gertsch 1971), male CNAN 4462. A, body, dorsal view. B, carapace, dorsal view. C, prosoma, ventral view showing the RP on coxae of all legs (arrows show this feature only on coxa of third and fourth leg). D, ocular tubercle, dorsal view. E, labial and maxillary cuspules. F, sternum. G, tibial apophyses, ventral view. H, tibial apophyses, prolateral view. I, metatarsus I, prolateral view. Scale = 2mm (A–C), 1mm (E, F), 0.8mm (G, H, I), 0.2mm (D).

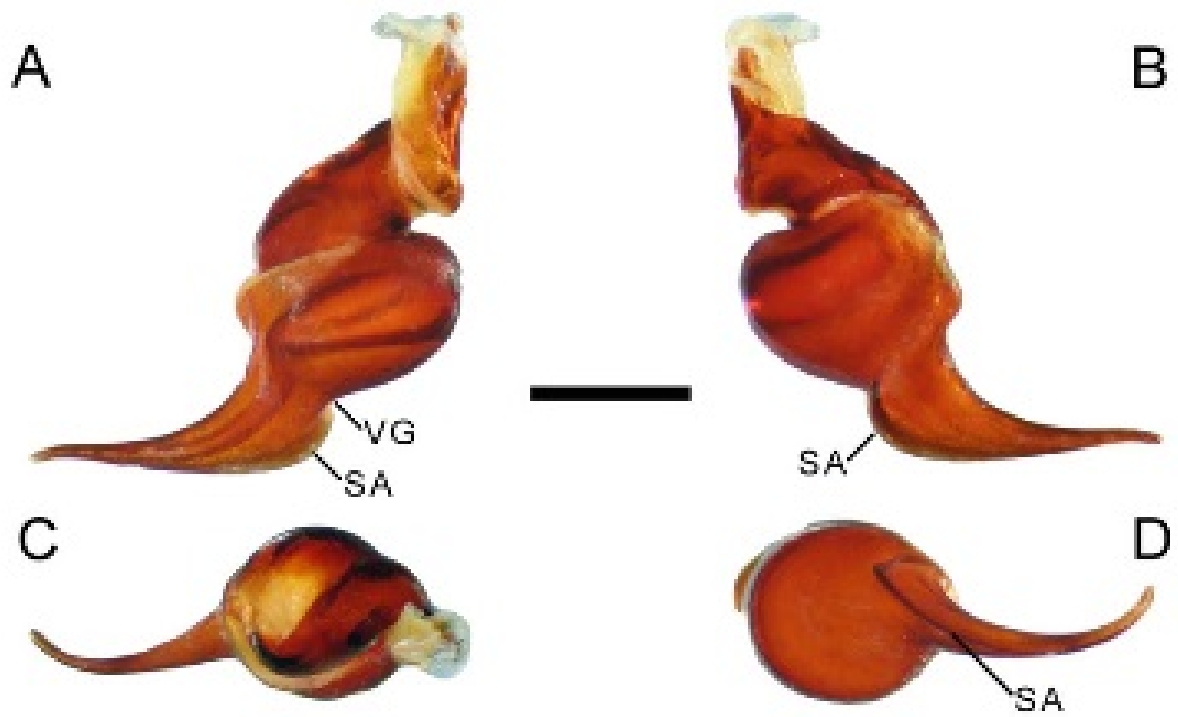




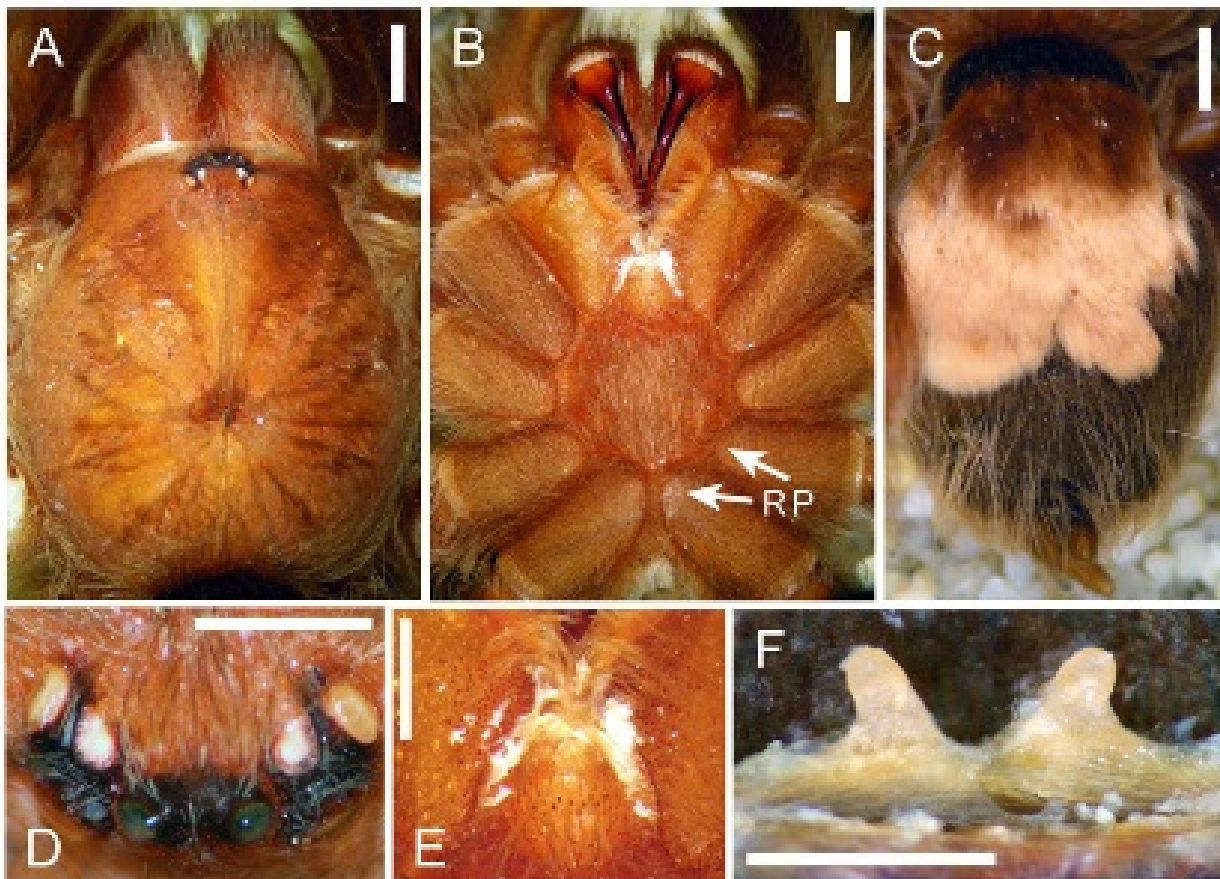
**Figure 32.** A–D, *Hemirrhagus stygius* (Gertsch 1971), male CNAN 4462, left palpal bulb: A, ventral view. B, dorsal view. C, retrolateral view. D, prolateral view. Scale = 1mm.



**Figure 33.** A–I, *Hemirrhagus benzaa* new species, male holotype AMNH. A, carapace, dorsal view. B, prosoma, ventral view showing the RP on coxae of all legs (arrows show this feature only on coxa of third and fourth leg). C, ocular tubercle, dorsal view. D, labial and maxillary cuspules. E, opisthosoma, dorsal view. F, cheliceral teeth, ventral view. G, tibial apophyses, prolateral view. H, tibial apophyses, ventral view. I, metatarsus I, prolateral view. Scale = 2mm (A, B, E, I), 1mm (C, D, F–H).



**Figure 34.** A–D, *Hemirrhagus benzaa* new species, male holotype AMNH, right palpal bulb: A, prolateral view. B, retrolateral view. C, dorsal view. D, ventral view. Scale = 1mm.

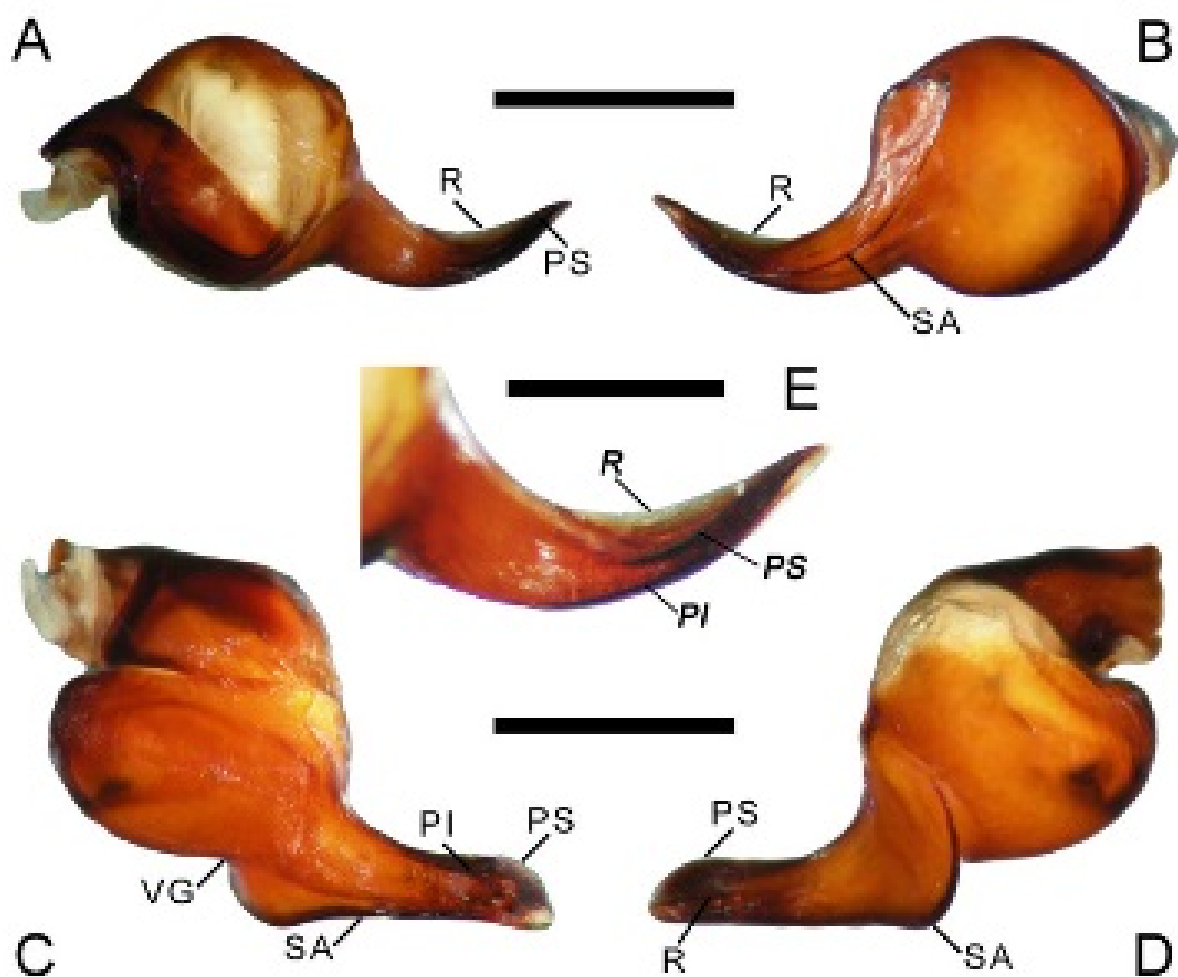


**Figure 35.** A–F, *Hemirrhagus benzaa* new species, female paratype AMNH. A, carapace, dorsal view. B, prosoma, ventral view showing the RP on coxae of all legs (arrows show this feature only on coxa of third and fourth leg). C, opisthosoma, dorsal view. D, ocular tubercle, dorsal view. E, labial and maxillary cuspules. F, spermathecae, dorsal view. Scale = 2mm (A–C), 1mm (D–F).

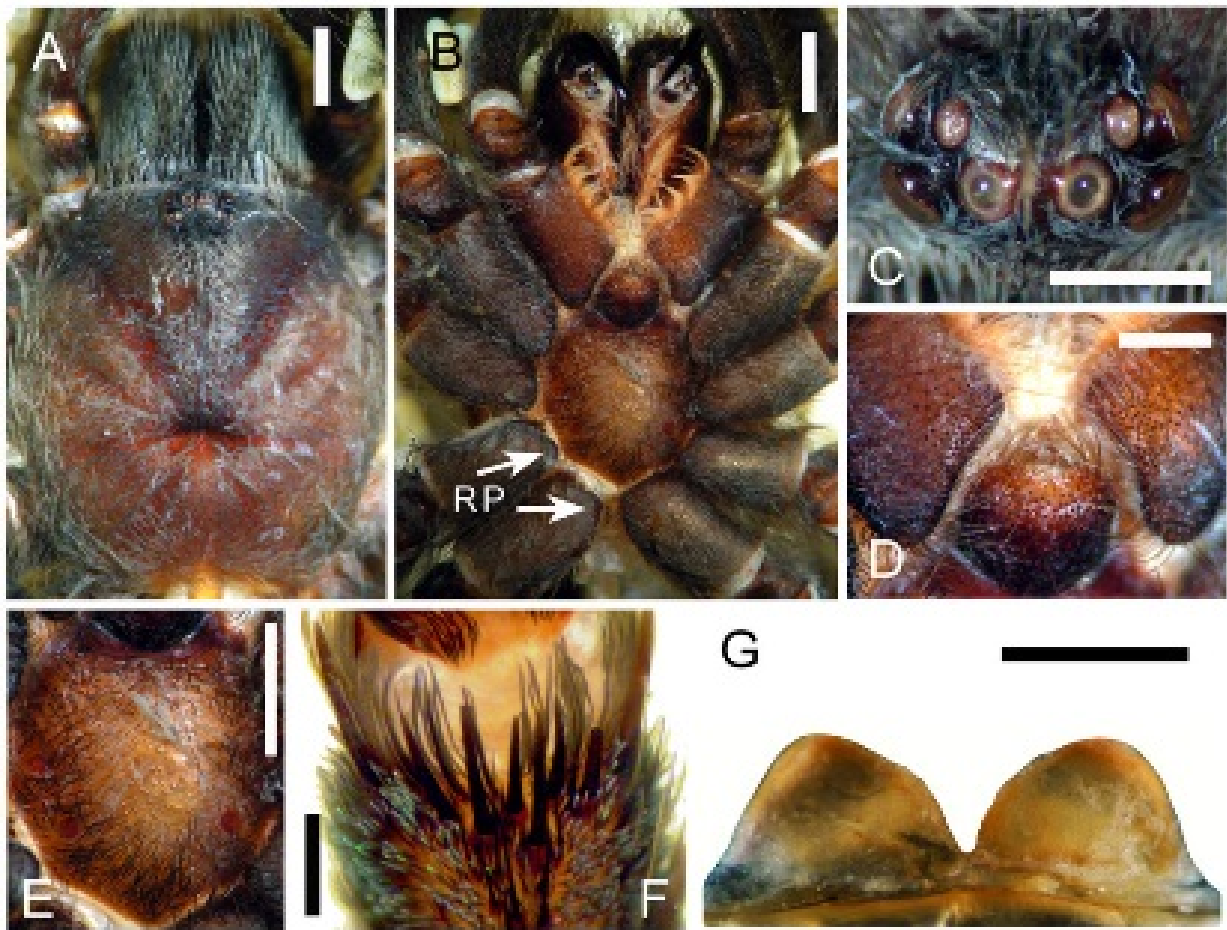


**Figure 36.** A–I, *Hemirrhagus embolulatus* new species, male holotype CNAN-T0774. A, carapace, prolateral view. B, prosoma, ventral view showing the RP on coxae of all legs (arrows show this feature only on coxa of third and fourth leg). C, opisthosoma, dorsal. D, ocular tubercle, dorsal view. E, labial and maxillary cuspules. F, cheliceral teeth, ventral view. G, metatarsus I, prolateral view. H, tibial apophyses, ventral view. I, tibial apophyses, prolateral view. Scale = 2mm (A–C, G), 1mm (D–F, H, I).

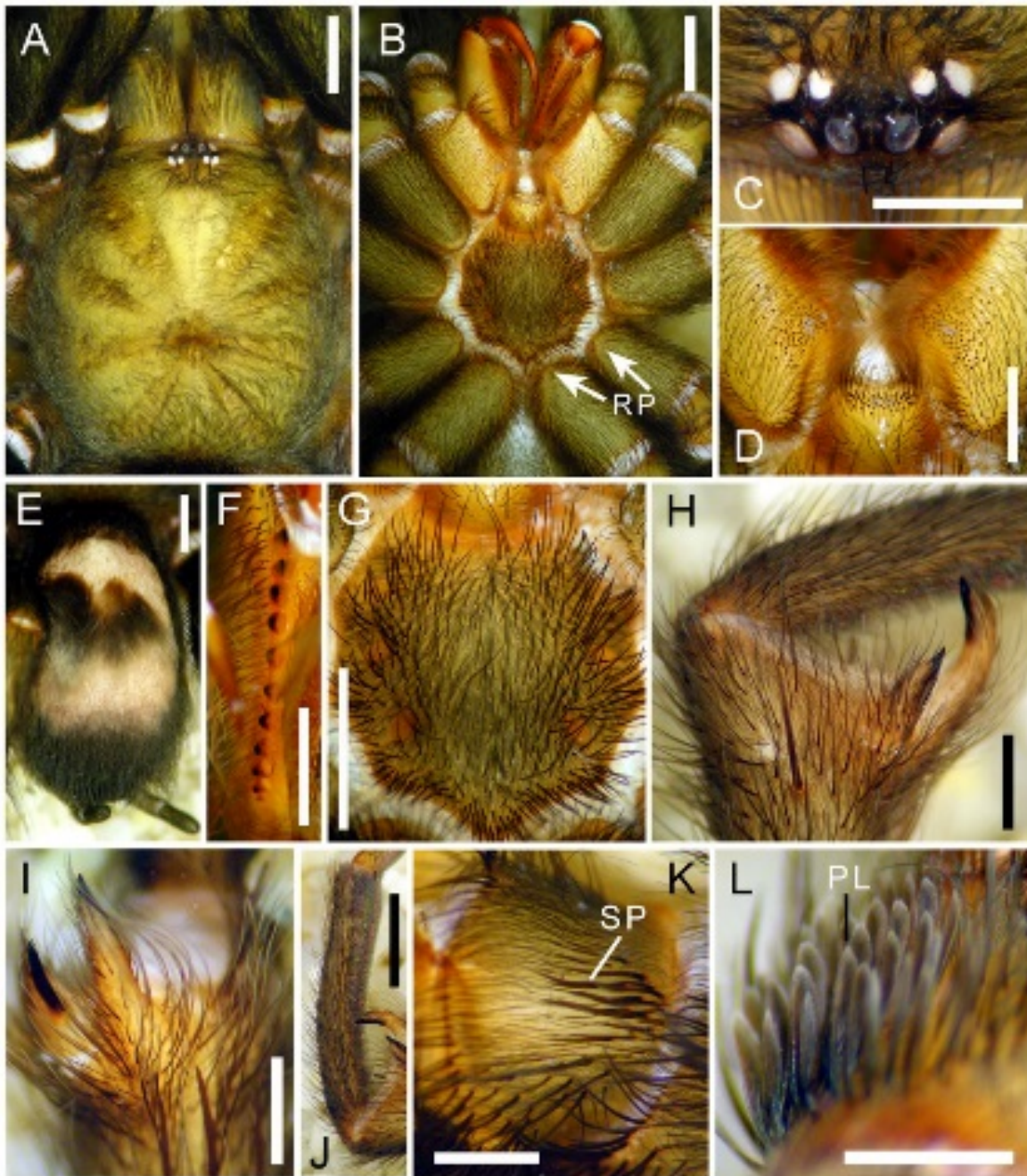




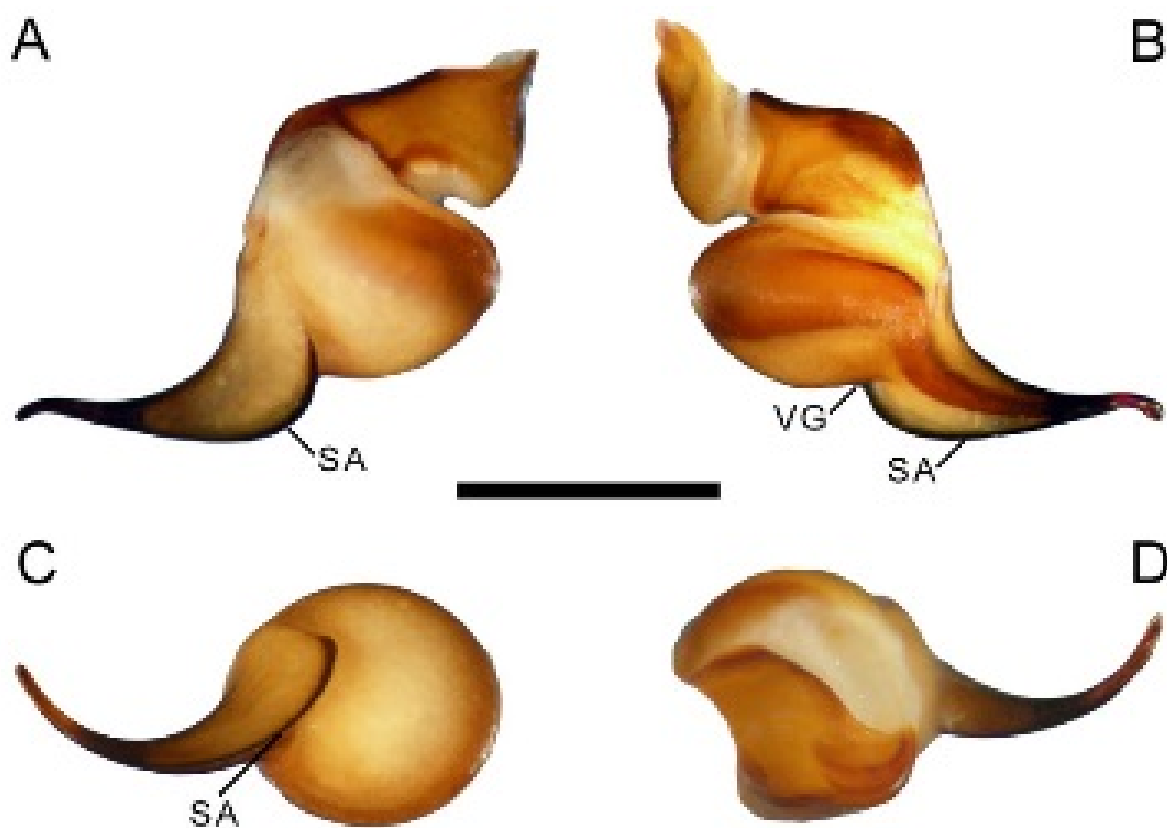
**Figure 37.** A–E, *Hemirrhagus embolulatus* new species, male holotype CNAN-T0774, left palpal bulb: A, dorsal view. B, ventral view. C, prolateral view. D, retrolateral view. E, embolus, dorsal view, showing keels. Scale = 1mm (A–D), 0.5mm (E).



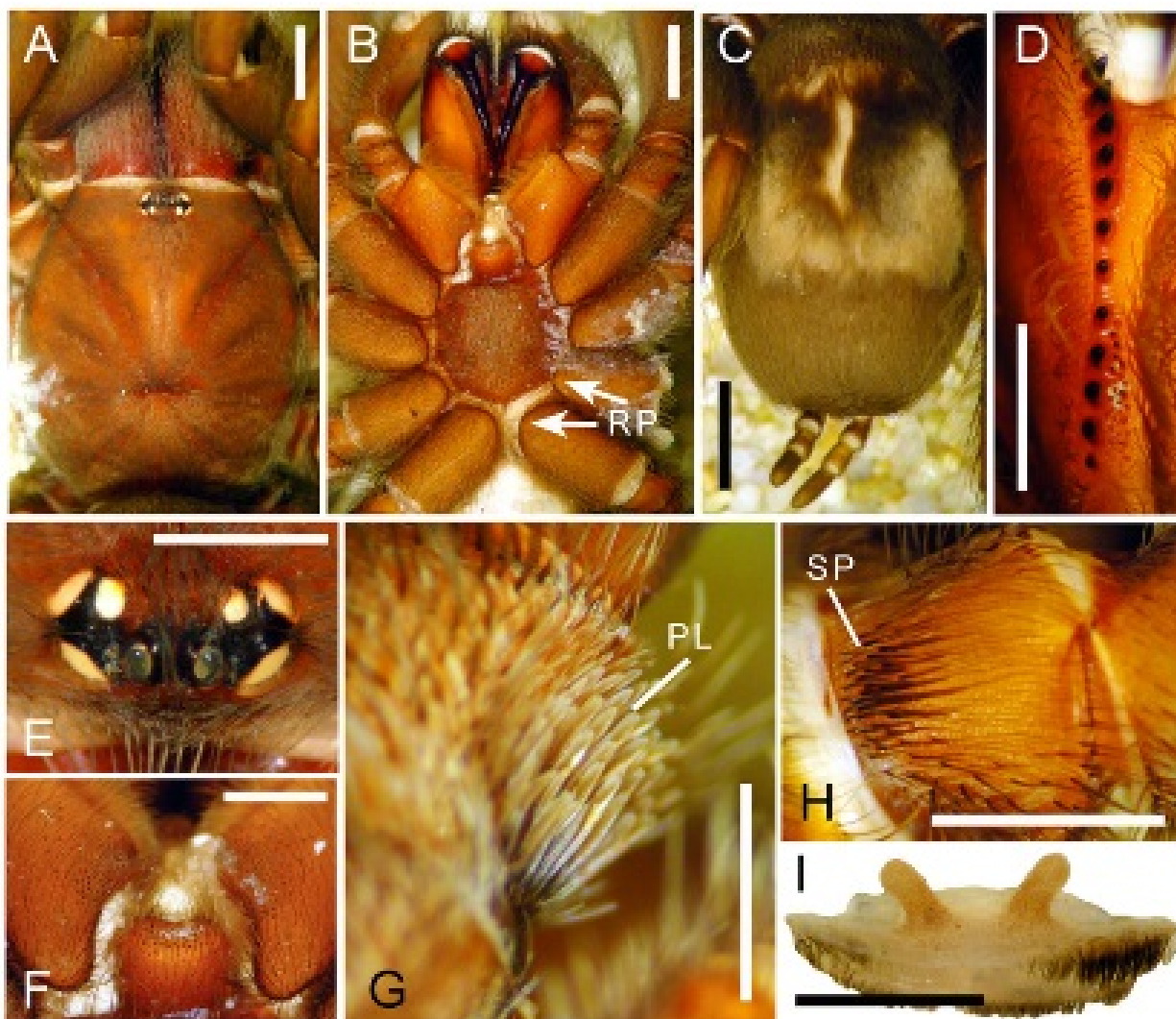
**Figure 38.** A–G, *Hemirrhagus embolulatus* new species, female paratype CNAN-T0775. A, carapace, dorsal view. B, prosoma, ventra view showing the RP on coxae of all legs (arrows show this feature only on coxa of third and fourth leg). C, ocular tubercle, dorsal view. D, labial and maxillary cuspules. E, sternum. F, metatarsus IV, ventral, showing spinose setae distally. G, spermathecae, ventral view. Scale = 2mm (A, B, E), 1mm (C, D, F), 0.5mm (G).



**Figure 39.** A–L, *Hemirrhagus franckei* new species, male holotype CNAN-T0776. A, carapace, dorsal view. B, prosoma, ventral view showing the RP on coxae of all legs (arrows show this feature only on coxa of third and fourth leg). C, ocular tubercle, dorsal view. D, labial and maxillary cuspules. E, opisthosoma, dorsal view. F, cheliceral teeth, ventral view. G, sternum. H, tibial apophyses, prolateral view. I, tibial apophyses, ventral view. J, metatarsus I, prolateral view. K, palp trochanter SP, retrolateral view. L, trochanter I PL, ventral view. Scale = 2mm (A, B, E, G, J), 1mm (C, D, F, H, I), 0.5mm (K, L).

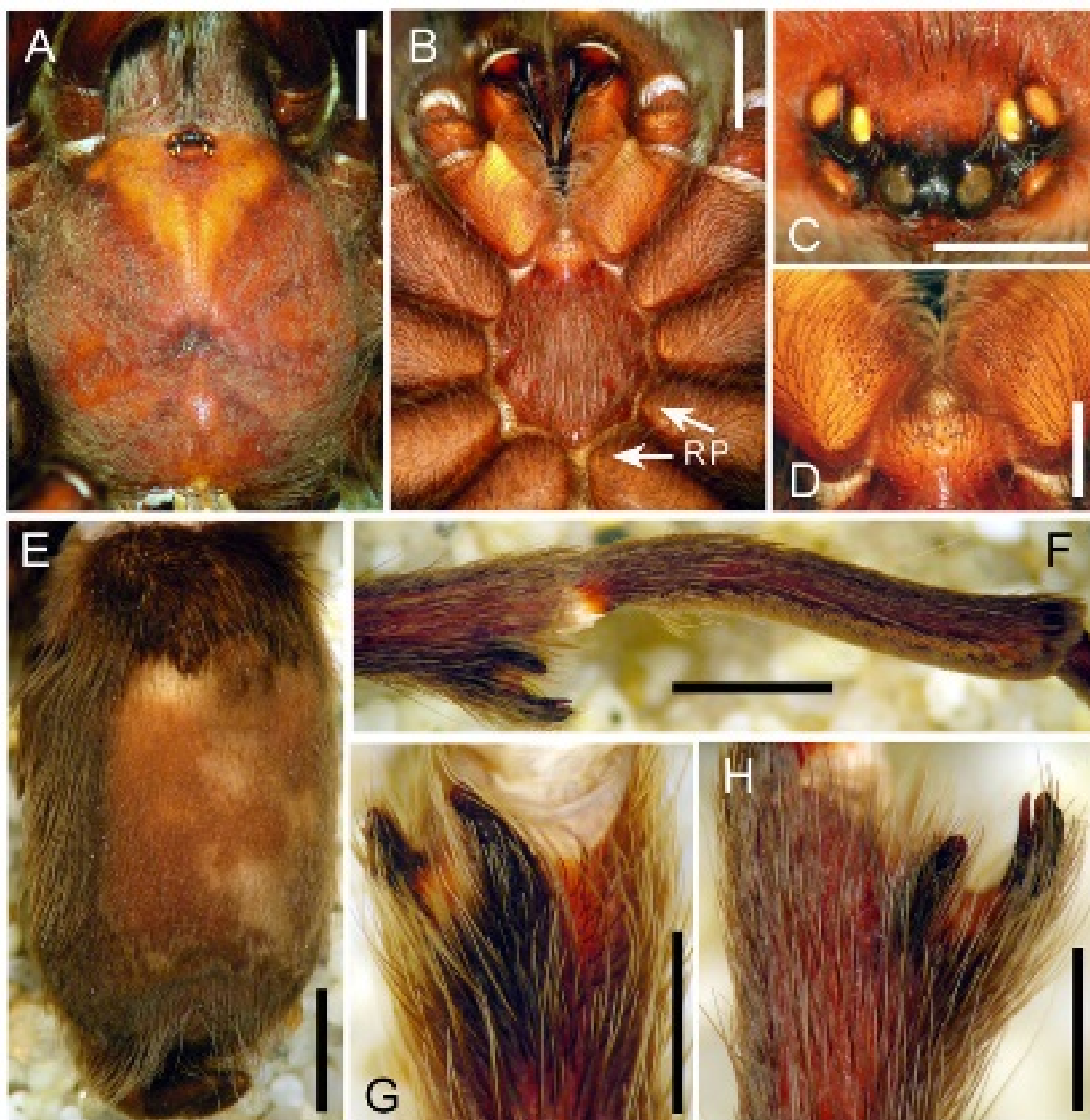


**Figure 40.** A–D, *Hemirrhagus franckei* new species, male holotype CNAN-T0776. Left palpal bulb: A, retrolateral view. B, prolateral view. C, ventral view. D, dorsal view. Scale = 1mm.

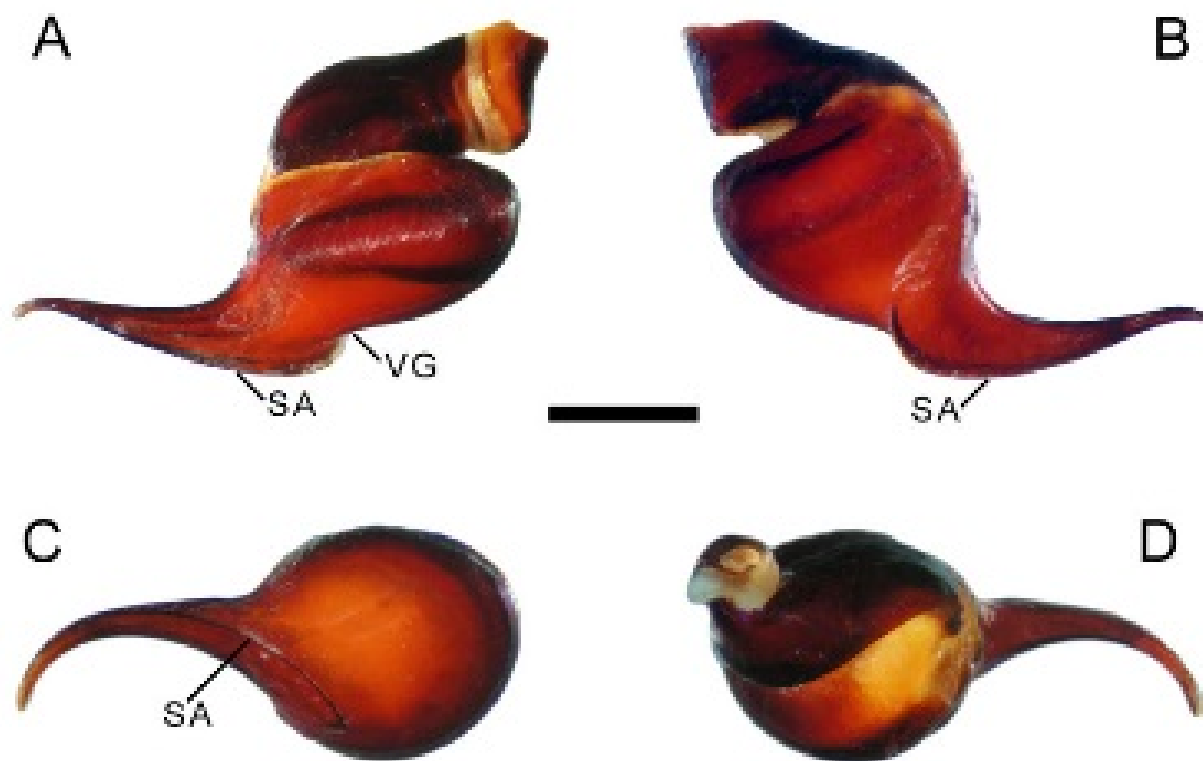


**Figure 41.** A–I, *Hemirrhagus franckei* new species, female paratype CNAN-T0777. A, carapace, dorsal view. B, prosoma, ventral view showing the RP on coxae of all legs (arrows show this feature only on coxa of third and fourth leg). C, opisthosoma, dorsal view. D, cheliceral teeth, ventral view. E, ocular tubercle, dorsal view. F, labial cuspules. G, trochanter I PL, ventral view. H, palp trochanter SP, retrolateral view. I, spermathecae, ventral view. Scale = 4mm (C), 2mm (A, B), 1mm (D–H), 0.5mm (I).

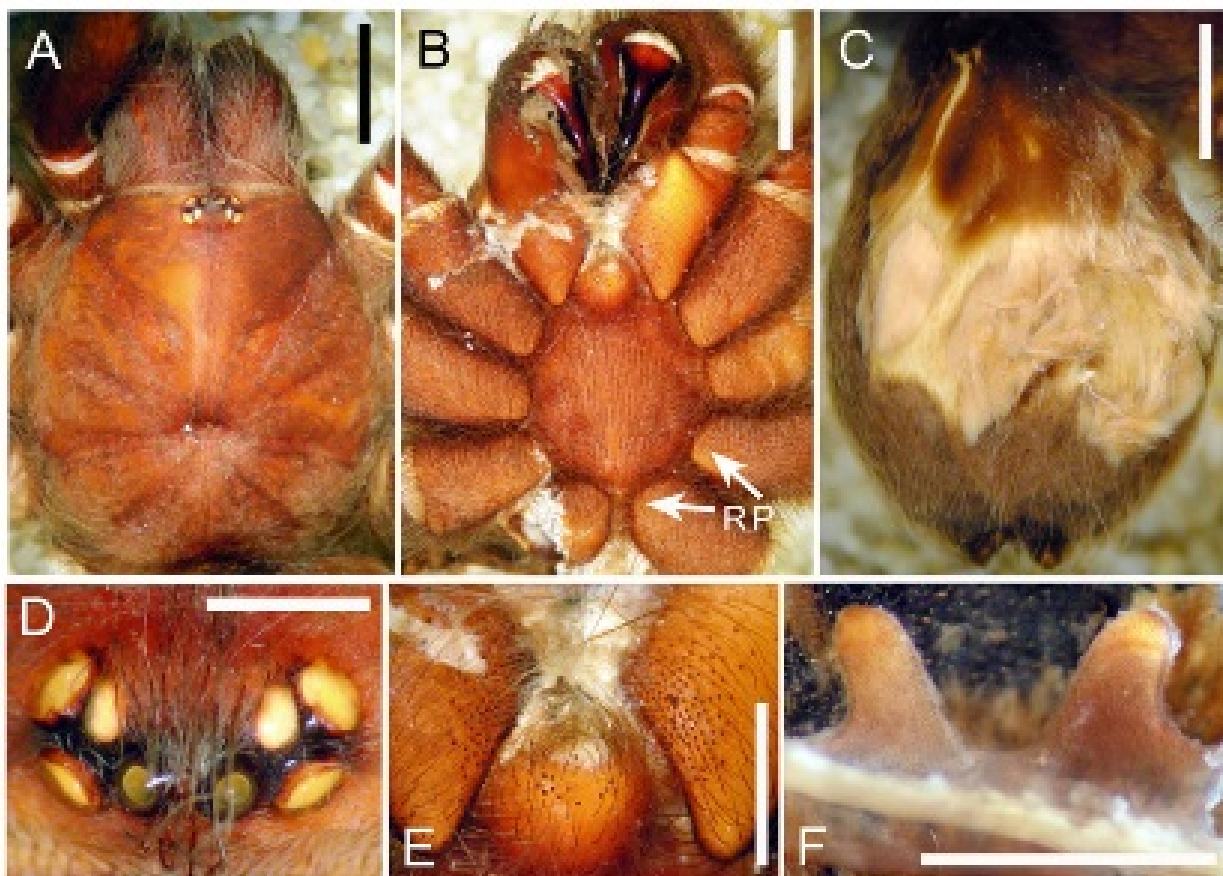




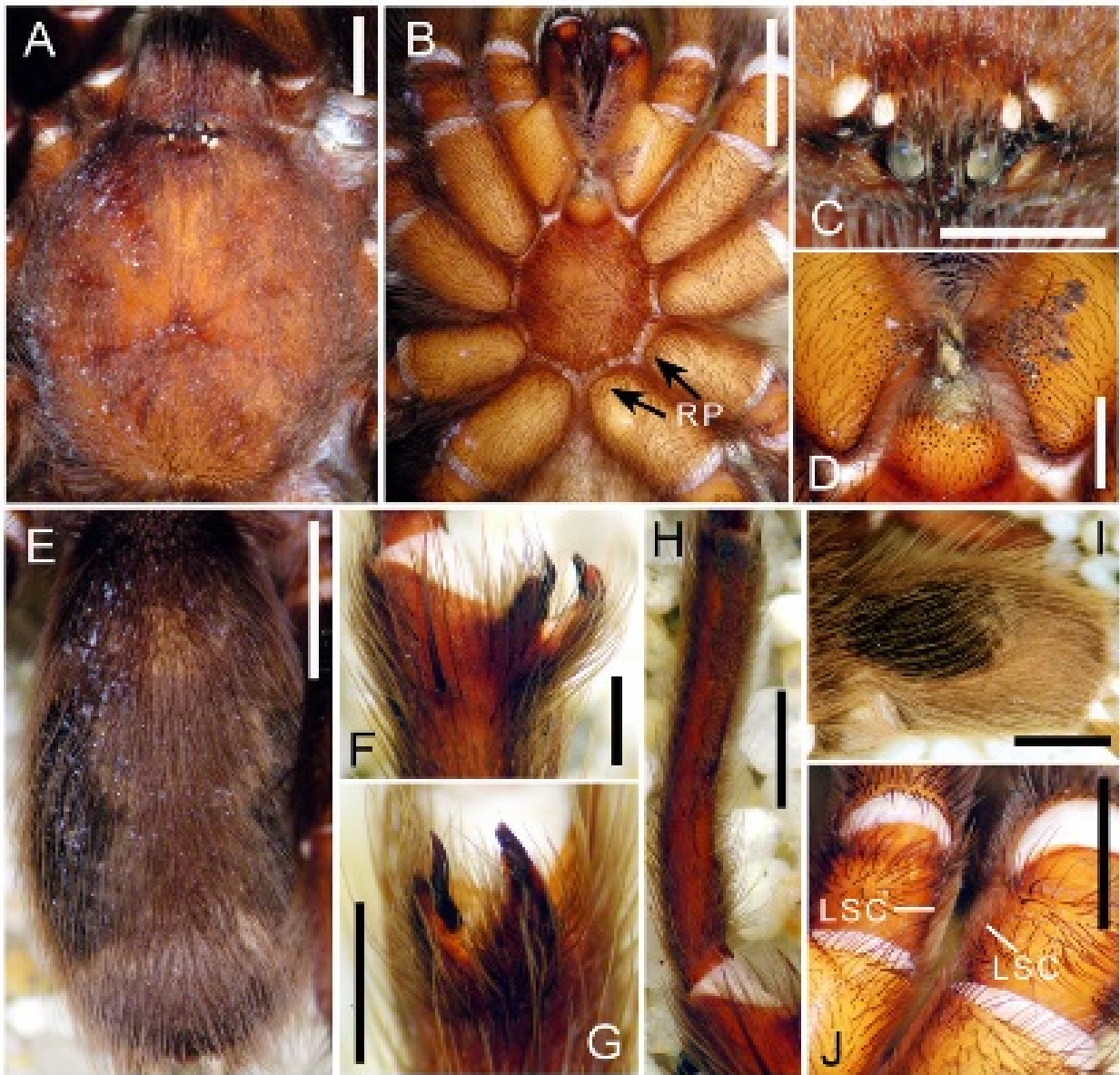
**Figure 42.** A–H, *Hemirrhagus guichi* new species, male holotype AMNH. A, carapace, dorsal view. B, prosoma, ventral view showing the RP on coxae of all legs (arrows show this feature only on coxa of third and fourth leg). C, ocular tubercle, dorsal view. D, labial and maxillary cuspules. E, opisthosoma, dorsal view. F, metatarsus I, prolateral view. G, Tibial apophyses, ventral view. H, tibial apophyses, prolateral view. Scale = 4mm (A, B, E, F), 2mm (D, G, H), 1mm (C).



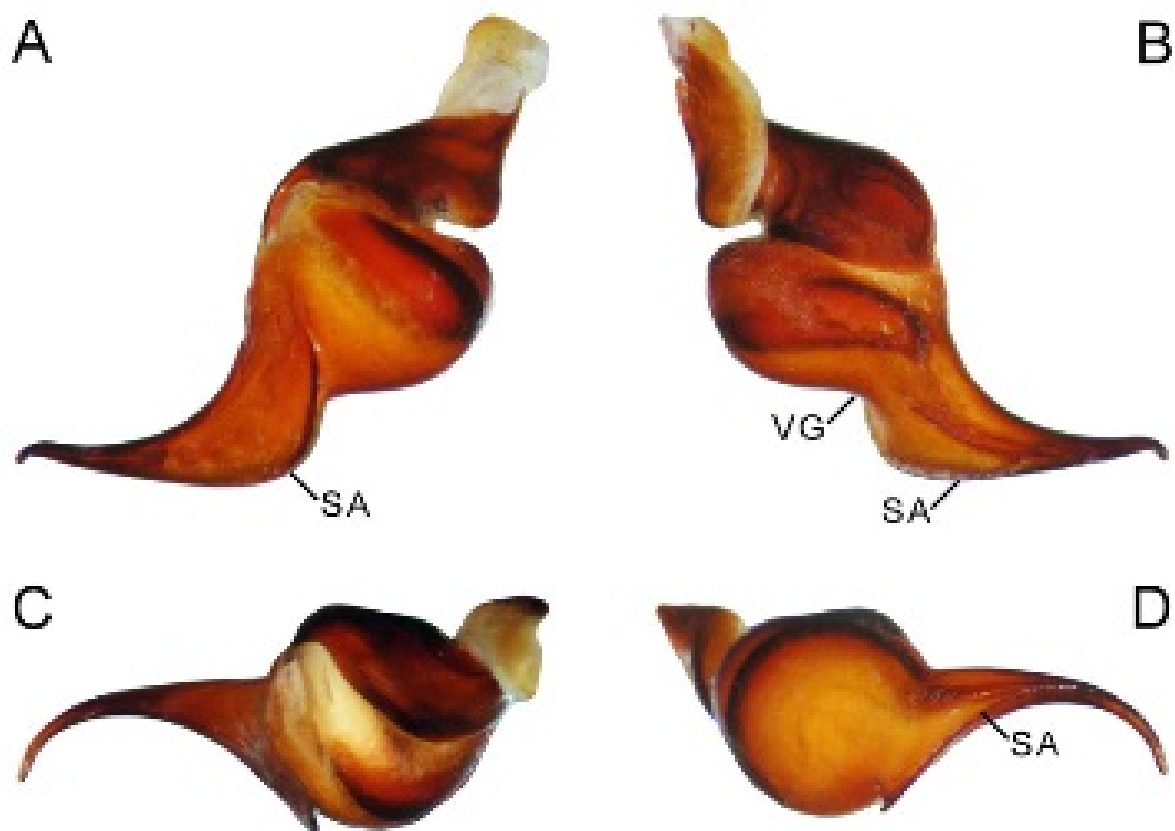
**Figure 43.** A–D, *Hemirrhagus guichi* new species, male holotype AMNH, right palpal bulb: A, prolateral view. B, retrolateral view. C, ventral view. D, dorsal view. Scale = 1mm



**Figure 44.** A–F, *Hemirrhagus guichi* new species, female paratype AMNH. A, carapace, dorsal view. B, prosoma, ventral view showing the RP on coxae of all legs (arrows show this feature only on coxa of third and fourth leg). C, opisthosoma, dorsal view. D, ocular tubercle, dorsal view. E, labial and maxillary cuspules. F, spermathecae, dorsal view. Scale = 4mm (A–C), 2mm (E), 1mm (D, F).

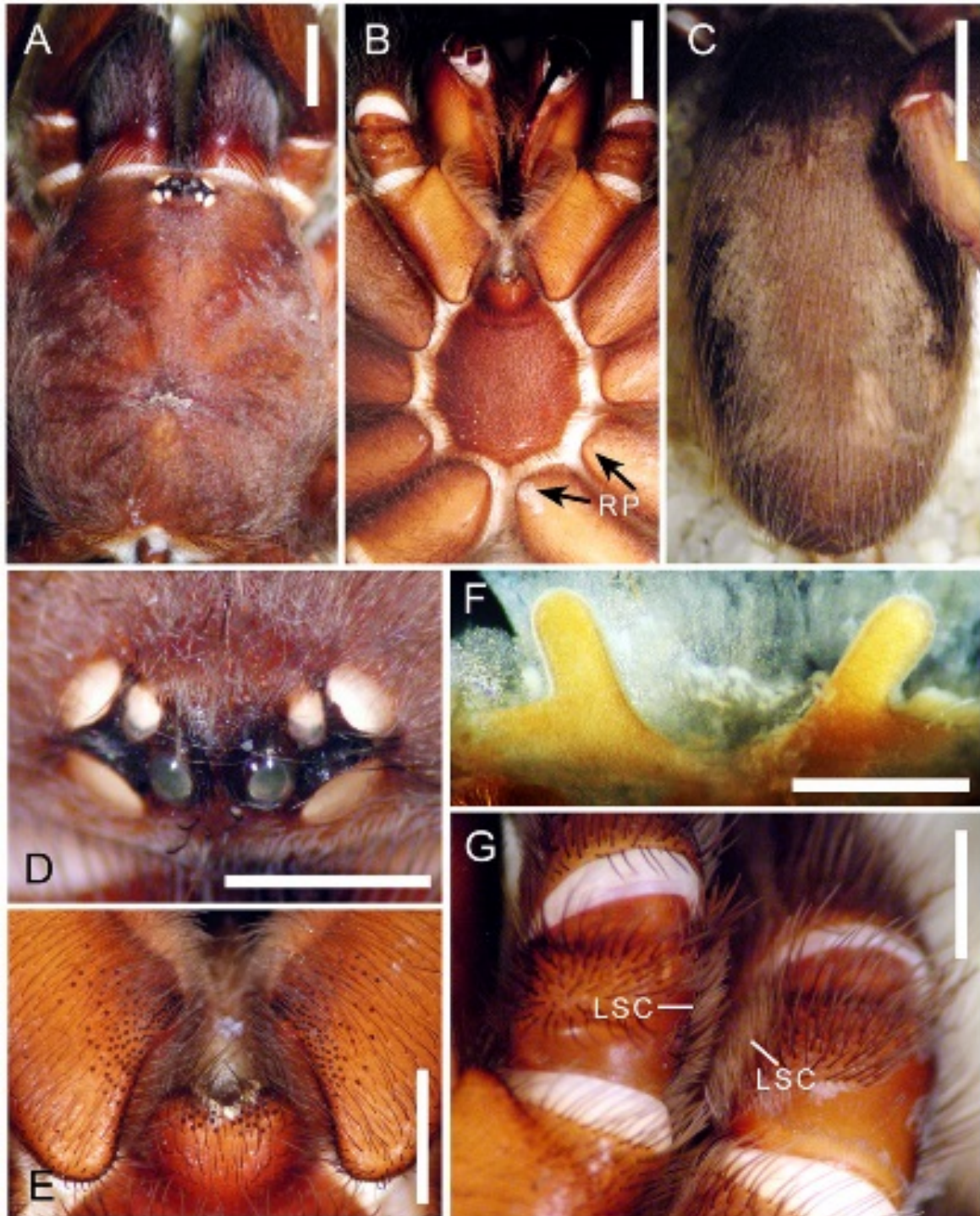


**Figure 45.** A–J, *Hemirrhagus valdezi* new species, male holotype CNAN-T0779. A, carapace, dorsal view. B, prosoma, ventral view showing the RP on coxae of all legs (arrows show this feature only on coxa of third and fourth leg). C, ocular tubercle, dorsal view. D, labial and maxillary cuspules. E, opisthosoma, dorsal view. F, tibial apophyses, prolateral view. G, tibial apophyses, ventral view. H, metatarsus I, prolateral view. I, opisthosoma, lateral view. J, palp trochanter and trochanter I LSC, ventral view. Scale = 4mm (B, E, I), 2mm (A, H, J), 1mm (C, D, F, G).

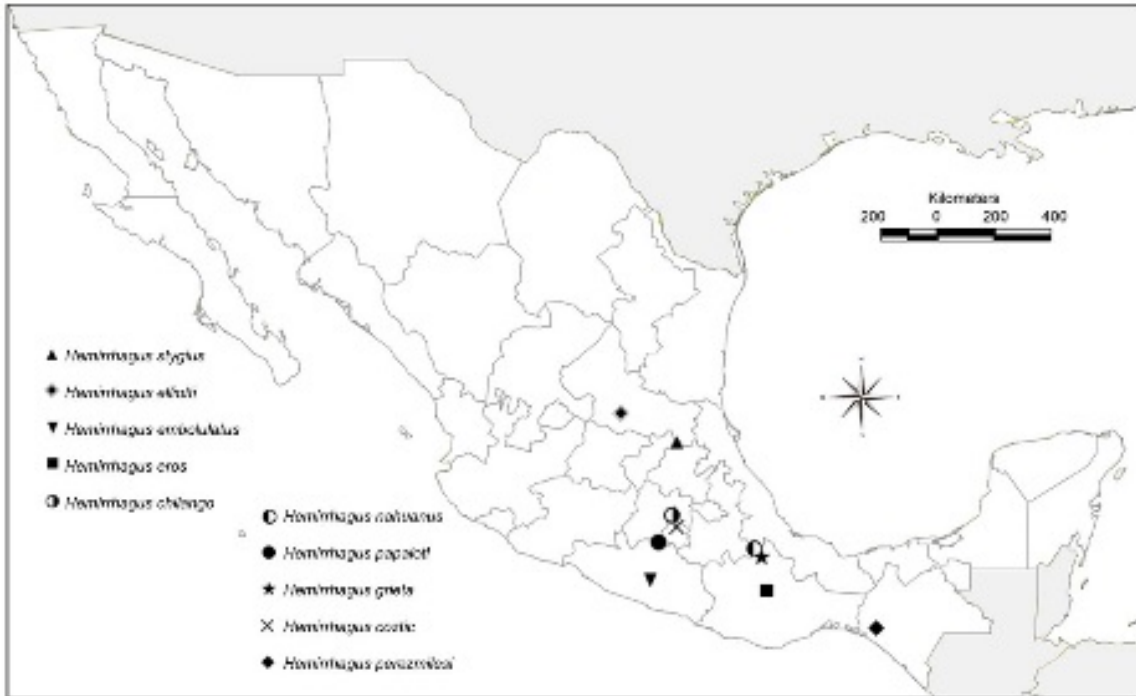


**Figure 46.** A–D, *Hemirrhagus valdezi* new species, male holotype CNAN-T0779, left palpal bulb: A, retrolateral view. B, prolateral view. C, dorsal view. D, ventral view. Scale = 1mm.

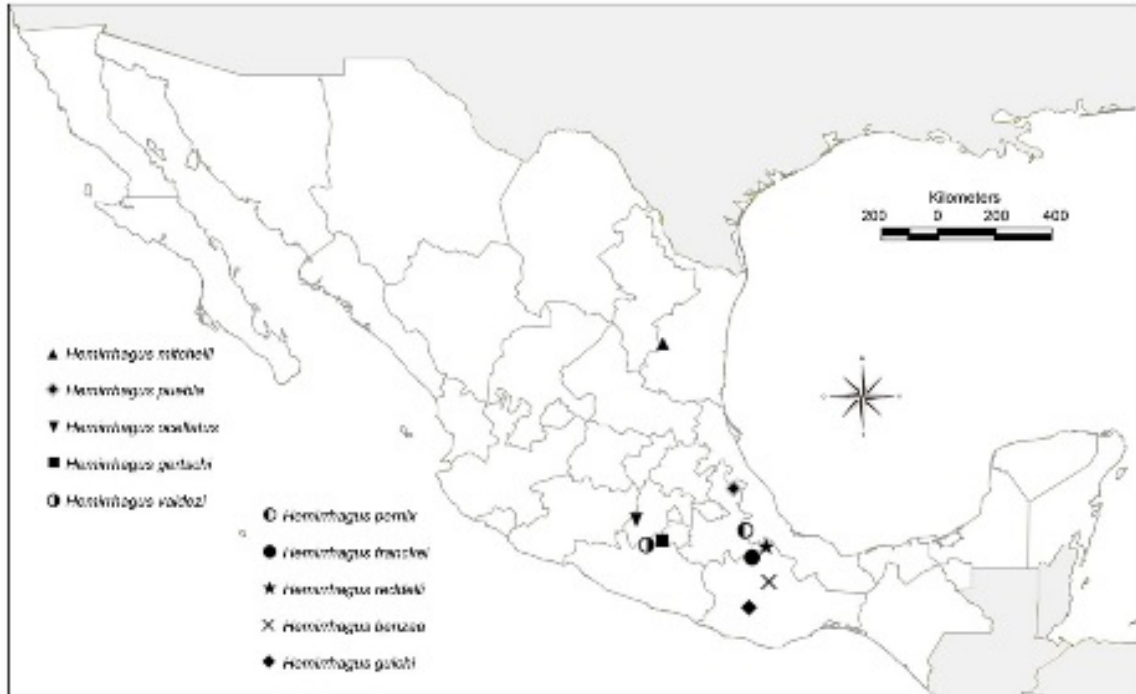




**Figure 47.** A–G, *Hemirrhagus valdezi* new species, female paratype CNAN-T0780. A, carapace, dorsal view. B, prosoma ventral view showing the RP on coxae of all legs (arrows show this feature only on coxa of third and fourth leg). C, opisthosoma, dorsal view. D, ocular tubercle, dorsal view. E, labial and maxillary cuspules. F, spermathecae, ventral view. G, palp trochanter and trochanter I LSC, ventral view. Scale = 4mm (C), 2mm (A, B), 1mm (D, E, G), 0.5mm (F).



**Figure 48.** Known distribution of *Hemirrhagus stygius* (Gertsch 1971), *Hemirrhagus elliotti* (Gertsch 1973), *Hemirrhagus embolulatus* new species, *Hemirrhagus eros* Pérez-Miles & Locht 2003, *Hemirrhagus chilango* Pérez-Miles & Locht 2003, *Hemirrhagus nahuanus* (Gertsch 1982), *Hemirrhagus papalotl* Pérez-Miles & Locht 2003, *Hemirrhagus grieta* (Gertsch 1982), *Hemirrhagus coztic* Pérez-Miles & Locht 2003 and *Hemirrhagus perezmilesi* García-Villafuerte & Locht 2010.



**Figure 49.** Known distribution of *Hemirrhagus mitchelli* (Gertsch 1982), *Hemirrhagus puebla* (Gertsch 1982), *Hemirrhagus ocellatus* Pérez-Miles & Locht 2003, *Hemirrhagus gertschi* Pérez-Miles & Locht 2003, *Hemirrhagus valdezi* new species, *Hemirrhagus pernix* (Ausserer 1875), *Hemirrhagus franckei* new species, *Hemirrhagus reddelli* (Gertsch 1973), *Hemirrhagus benzaa* new species and *Hemirrhagus guichi* new species.

## FILOGENIA

### *Análisis Filogenético con todos los caracteres.*

El análisis con pesos iguales de los 96 caracteres informativos localizó tres árboles más parsimoniosos (AMPs) (L= 421, Ci= 0.432, Ri= 0.535). El género *Hemirrhagus* se recupera como grupo natural conformado por tres clados. La topología de estos AMPs cambia únicamente en la posición relativa de *H. franckei* donde aparece como especie basal del tercer clado en uno de los árboles, como especie hermana de *H. perezmilei* y *H. nahuanus* en el segundo y como especie hermana de los clados dos y tres en el tercero. El árbol de consenso estricto muestra que los tres grandes clados se conservan, salvo por el colapso de la base del tercer clado debido a los cambios de posición de *H. franckei* (fig 1). El primer clado está conformado por cuatro especies *H. pernix*, *H. guichi*, *H. eros* y *H. benzaa*. El segundo clado se compone de ocho especies *H. ocellatus*, *H. ellioti*, *H. embolulatus*, *H. chilango*, *H. valdezi*, *H. coztic*, *H. papalotl* y *H. gertschi*. El tercer clado estaba conformado en dos de los árboles por nueve especies, no obstante debido a los cambios de posición de *H. franckei*, en el consenso estricto la base de este grupo colapsa dejando agrupados a *H. perezmilei* y *H. nahuanus* por una parte y un clado conformado por *H. cervinus*, *H. puebla*, *H. stygius*, *H. mitchelli*, *H. reddelli* y *H. grieta*. Este último clado agrupa a las cinco especies de *Hemirrhagus* con alto grado de troglomorfofismo (fig 1).

El análisis con pesos implicados aplicando nueve valores de *K* encontró un único AMP con la misma topología que la de uno de los AMPs obtenidos por el análisis con pesos iguales (Cuadro 1, fig 2). Los clados obtenidos en esta topología se encuentran en la mayoría de los análisis de pesos implicados, minimizando así la longitud del árbol y maximizando el ajuste de los caracteres, por lo que se considera como la hipótesis óptima. Las sinapomorfías se encuentran señaladas en esta topología, la cual también muestra la presencia de los clados para los diferentes valores de *K*. La longitud, el ajuste de caracteres, índice de retención e índice de consistencia también son presentados.

Análisis	AMP	Longitud	Ajuste (fit)	Ci	Ri	Estatus de <i>Hemirrhagus</i>
Pesos iguales	3	421	-	0.432	0.535	Monofilético
Pesos implicados (k= 1)	1	438	56.727	0.416	0.502	Monofilético
Pesos implicados (k= 3)	1	428	37.537	0.425	0.521	Monofilético
Pesos implicados (k= 6)	1	424	25.19	0.429	0.529	Monofilético
Pesos implicados (k= 9)	1	422	19.025	0.431	0.533	Monofilético
Pesos implicados (k= 12)	1	422	15.31	0.431	0.533	Monofilético
Pesos implicados (k= 15)	1	422	12.826	0.431	0.533	Monofilético
Pesos implicados (k= 18)	1	422	11.038	0.431	0.533	Monofilético
Pesos implicados (k= 21)	1	421	9.69	0.432	0.535	Monofilético
Pesos implicados (k= 24)	1	421	8.634	0.432	0.535	Monofilético

Cuadro 1. Resumen de las hipótesis filogenéticas recuperadas en los análisis de pesos iguales y pesos implicados con distintos valores de *K*, empleando TNT, incluyendo todos los caracteres.

De acuerdo con el cladograma óptimo obtenido a partir del análisis con todos los caracteres informativos, el género *Hemirrhagus* presenta cinco sinapomorfías conformadas por los siguientes caracteres: región retrolateral posterior de las coxas I-IV retrolateralmente extendida (7), surco ventral presente en la transición tegulum-embolo (70), quilla subapical extendida retrolateralmente hasta la región posterior del embolo (79), presencia de setas urticantes tipo VI (89) y espermateca ligeramente curvada lateralmente (98) (fig 3).

Aunque el carácter 98 es considerado una sinapomorfía, existen varias especies de *Hemirrhagus* que presentan la espermateca fuertemente curvada o que la tienen recta, por lo que es posible que el estatus de este carácter, en los términos que está planteado, no se soporte como una sinapomorfía del género tras la inclusión de un mayor número de terminales.

Tanto el carácter 7 como el 89, representan los rasgos diagnósticos más reconocidos del género hasta ahora. La extensión retrolateral posterior de las coxas se encuentra presente en todas las especies sujetas a este estudio. Las setas urticantes tipo VI fueron identificadas en todos los ejemplares, a excepción de aquellos con alto grado de troglomorfismo, por lo que al igual que Pérez-Miles y Loch (2003) mencionan, se considera que estas sedas se perdieron como consecuencia de la adaptación a las cuevas.



La quilla subapical extendida retrolateralmente (caracter 79) ya había sido propuesta como posible sinapomorfía por Pérez-Miles y Locht (2003), no obstante al no contar con suficiente material de machos adultos para poder asegurarlo, se limitaron a dejarlo como posibilidad. Tras el análisis aquí realizado en el que se incluyen machos para 14 especies, se confirma que este carácter es uno de los más importantes para sustentar la monofilia del género, así como para ayudar en la diferenciación interespecífica.

El surco ventral en la transición del tegulum al émbolo (70), se encuentra también presente en los machos, por lo que no había sido codificado con anterioridad. En este trabajo surge como una sinapomorfía, aunque en algunas especies es más evidente que en otras. Si bien no se conocen otras especies de la subfamilia Theraphosinae que posean esta característica, sí se encuentra reportado en algunas especies de las subfamilias asiáticas Ornithoctoninae y Selenocosmiinae (Von Wirth y Striffler 2005; Ming-Sheng y Zhang 2008).

La monofilia del género es además soportada por varios caracteres homoplásticos (16, 54, 74, 82, 90, 92). De entre estos, vale la pena resaltar por su utilidad diagnóstica, los caracteres 16 y 90. El primero se refiere al cierre del metatarso I del macho con respecto a las apófisis tibiales, que en *Hemirrhagus* cierra retrolateralmente a las apófisis; en la mayoría de los géneros de Theraphosinae el metatarso I del macho cierra generalmente sobre la apófisis ventral o entre ambas apófisis. Si bien en todas las especies conocidas de las Ischnocolinae de América el metatarso I del macho cierra sobre las apófisis de la misma forma que en *Hemirrhagus*, ninguno de los géneros de tarántulas conocidos para México presenta esta característica, por lo que se considera que es una herramienta útil para identificar ejemplares al menos a nivel de género. El carácter 90 representa la coloración que presenta el parche de setas urticantes, *Hemirrhagus* tiene una gran variación cromática en las sedas urticantes, observándose cuatro coloraciones diferentes, algo que no se observa en ningún otro género de Theraphosinae. El color

del parche de setas urticantes puede ayudar en la identificación de algunas especies combinado con la forma que posee.

Aunque la monofilia de *Hemirrhagus* se encuentra estadísticamente bien soportada, no ocurre lo mismo con los grupos internos, donde se observa que los valores de soporte Jackknife son bajos. Dentro del clado donde se incluye *H. pernix* es posible observar que sólo caracteres homoplásticos sustentan su relación con el grupo más inclusivo conformado por *H. guichi*, *H. benzaa* y *H. eros*, que se encuentra soportado por seis caracteres de los cuales cuatro son sinapomorfías (fig 2, J= 25%): espinas en fémur III (36), más de 5 espinas en patela I (39), más de 5 espinas en patela II (40) y más de 3 espinas en patela III (41). Esto podría deberse a que algunos caracteres de *H. pernix* no pudieron ser codificados debido al deterioro del material tipo.

El clado más grande que incluye a *H. franckei* como especie hermana del clado que incluye *H. ellioti* y del clado que incluye *H. cervinus* es soportado por ocho caracteres de los que sólo uno es sinapomorfía: espina de la apófisis retrolateral de mayor longitud que la longitud de la apófisis retrolateral.

El clado que incluye a *H. ellioti* y *H. chilango* es soportado sólo por homoplasias (fig 3). Esto dificulta la caracterización de este clado a partir de los caracteres empleados en la reconstrucción filogenética, debido a que los caracteres que soportan la rama basal se encuentran presentes en especies de otros clados. Posiblemente la adición de caracteres y codificación de los machos de *H. ellioti* y *H. coztic* puedan definir las sinapomorfías de este arreglo o derivar en hipótesis alternativas.

La rama donde se incluye a la especie tipo del género *H. cervinus* y donde también se incluyen a las especies con mayor grado de troglomorfismo se sustenta con tres caracteres de los cuales sólo uno es sinapomorfía: la apófisis retrolateral pobremente desarrollada (19). Cabe destacar que en esta rama sólo se encuentran

códificados los caracteres masculinos para dos especies (*H. nahuanus* y *H. stygius*), por lo que con seguridad las relaciones obtenidas pueden cambiar cuándo se conozcan y codifiquen los machos de las especies restantes.

Un punto importante a resaltar en esta topología óptima que incluye todos los caracteres informativos es que las cinco especies que presentan alto grado de troglomorfismo quedan agrupadas junto con *H. cervinus* (fig 2). Varios autores mencionan que los caracteres troglomorfoicos son susceptibles de generar homoplasia debido a convergencia evolutiva generada por adaptación a presiones similares del hábitat (Desutter-Grandcolas y Grandcolas, 1996; Desutter-Grandcolas, 1997a; Desutter-Grandcolas, 1997b; Juan *et al.*, 2010). Wiens *et al.* (2003) mencionan que la convergencia genera esta similitud entre organismos que no es resultado directo de una historia filogenética común y que por el contrario es resultado de adaptaciones independientes a ambientes similares. También indican que los caracteres morfológicos relacionados con adaptaciones al ambiente cavernícola son susceptibles de falsear las hipótesis filogenéticas debido a que son producto de esta clase de convergencia.

Aplicando este criterio a este estudio se observa que la rama donde se agrupan las especies troglobias está sustentada por caracteres troglomórficos (1, 2, 3, 4, 5, 86). El carácter 1 se refiere al tubérculo ocular no desarrollado, esta condición sólo se encuentra en especies troglobias. Los caracteres 2 a 5 indican el pobre o nulo desarrollo de los ojos. Finalmente el carácter 86 indica la ausencia de setas urticantes en estas especies. Todos estos caracteres son considerados como reducciones o pérdidas debido a la adaptación a la vida dentro de las cuevas.

En el cladograma se observa que *H. cervinus* guarda relación con las especies troglobias y se sustenta con cinco sinapomorfías (6, 20, 21, 80, 81) (fig 3). No obstante esta relación podría no ser verdadera tomando en consideración que el holotipo no pudo ser revisado personalmente, a que la especie carece de una localidad específica, sólo se conoce el holotipo hembra y que la codificación de

caracteres fue basada en la redescrición hecha por Pérez-Miles (1998) y Pérez-Miles y Locht (2003), por lo que es más probable que su relación con las especies troglobias se debe a la falta de caracteres codificados.

El carácter 6 hace referencia a la pérdida de pigmentación del tubérculo ocular, y esta característica también se considera consecuencia de una adaptación a las cuevas y se le relaciona con la pérdida del tubérculo ocular. Pérez-Miles y Locht (2003) mencionan que *H. cervinus* carece de pigmentación periocular, por lo que aun siendo una especie epigea, en el cladograma guarda relación con las especies troglobias. Por otra parte existe la posibilidad de que la falta de pigmentación del tubérculo ocular se deba al tiempo de preservación que tiene el espécimen, pues fue descrito en 1903 y es conocido que el alcohol con el tiempo puede deteriorar la coloración de los artrópodos. Así que para efectos de completar el estudio se ha tenido que trabajar con base en la información disponible, esperando poder en un futuro próximo esclarecer mucho mejor la morfología y características de *H. cervinus*.

En el caso de las sinapomorfías dadas por los caracteres 20, 21, 80 y 81 que se refieren a: Espina de apófisis prolateral de mayor longitud que la apófisis prolateral (20), espina de apófisis retrolateral de mayor longitud que la apófisis retrolateral (21), quilla subapical que termina antes de la base del embolo (80) y región posterior de la quilla subapical sin curvatura (81). Es importante mencionar que todos estos caracteres son exclusivos de los machos y que de todas las especies soportadas en esta rama sólo se conoce el macho de *H. stygius*, por lo que una vez que los machos de las demás especies sean codificados y analizados, estas sinapomorfías cambien de acuerdo a las nuevas relaciones internas en las especies.

El análisis filogenético de un conjunto de caracteres morfológicos que se piensa estan influenciados por un fenómeno de convergencia adaptativa a un entorno selectivo similar, puede generar un clado supuestamente convergente soportado por uno o más caracteres similares. Por lo que de acuerdo con Wiens *et al.* (2003)

es posible suponer que el clado de especies que comparte el mismo ambiente selectivo no se verá soportado en el árbol o conjunto de árboles óptimos cuando los supuestos caracteres adaptativos son removidos y el conjunto de datos es reanalizado. Por esta razón es que se realizó nuevamente un análisis de *Hemirrhagus* deshabilitando los caracteres considerados troglomórficos (1, 2, 3, 4, 5, 6 y 86).

#### *Análisis sin caracteres troglomórficos.*

El análisis con pesos iguales de los 89 caracteres informativos (habiendo deshabilitado los caracteres no informativos y los caracteres troglomórficos) localizó seis árboles más parsimoniosos (AMPs) (L= 389, Ci= 0.437, Ri= 0.54). El género *Hemirrhagus* se recupera como grupo natural conformado por dos clados. La topología de estos AMPs cambia en la posición relativa de *H. ellioti* en el clado conformado *H. pernix*, *H. guichi*, *H. eros* y *H. benzaa*, donde aparece en tres de los árboles como especie hermana de *H. benzaa*, mientras que en los otros tres queda fuera de esta rama. También cambia la posición relativa en el segundo clado de *H. franckei* y *H. cervinus*, en cinco de los AMPs *H. franckei* aparece como especie hermana de *H. perezilesi*, pero en el árbol restante aparece en la base del clado como especie hermana de todas las demás. *H. cervinus* presenta tres posibles posiciones dentro del segundo clado, en tres de los AMPs se encuentra como especie hermana de *H. puebla*, en dos de los AMPs se muestra como especie hermana de *H. embolulatus* y en el árbol restante se presenta como especie hermana de un grupo que incluye a *H. mitchelli*, *H. stygius* y *H. chilango*. Esta variación en la posición de *H. cervinus* dentro de la topología de los AMPs podría deberse a la falta de caracteres codificados, lo cual dificulta encontrar con que especie se encuentra más relacionada.

El árbol de consenso estricto muestra que la monofilia de *Hemirrhagus* se mantiene, sin embargo las relaciones internas de las especies se ven afectadas y doce especies forman un peine. Los únicos grupos que se conservan son tres pequeños clados terminales: 1 (*H. stygius* + *H. nahuanus*), 2 (*H. mitchelli*, (*H. reddelli* + *H.*



*grieta*) y 3 (*H. chilango*, (*H. valdezi*, (*H. papalotl* + *H. gertschi*))); sin embargo, los valores de Jackknife de estos clados terminales son muy bajos (J= 9, 3 y 5, respectivamente).

Todas las especies que presentan caracteres troglomórficos y que estaban agrupadas en el AMP con todos los caracteres se separan. *H. puebla* se mantiene casi en la base del segundo clado, siendo (*H. franckei* + *H. perezmilesi*) quienes están en la base como hermanas de *H. puebla* y el resto de las especies del clado. Tres especies con caracteres troglomorfoicos conforman un pequeño grupo terminal: (*H. mitchelli*, (*H. grieta* + *H. reddelli*)), que se mantiene en los 6 AMPs. Finalmente *H. stygius* aparece como especie hermana de *H. nahuanus* en todos los AMPs.

El análisis con pesos implicados aplicando seis valores de *K* encontró un único AMP con la misma topología que la de uno de los AMPs obtenidos por el análisis con pesos iguales (Cuadro 2, fig 4). Los clados obtenidos en esta topología se encuentran en la mayoría de los análisis de pesos implicados, minimizando así la longitud del árbol y maximizando el ajuste de los caracteres (fig 5), por lo que se considera como la hipótesis óptima. Las sinapomorfías se encuentran señaladas en esta topología, la cual también muestra la presencia de los clados para los diferentes valores de *K*. La longitud, el ajuste de caracteres, índice de retención e índice de consistencia también son presentados.

Análisis	AMP	Longitud	Ajuste (fit)	Ci	Ri	Estatus de <i>Hemirrhagus</i>
Pesos iguales	6	389	-	0.437	0.54	Monofilético
Pesos implicados (k= 1)	1	405	52.229	0.420	0.506	Monofilético
Pesos implicados (k= 3)	1	398	34.462	0.427	0.521	Monofilético
Pesos implicados (k= 6)	1	391	23.213	0.435	0.536	Monofilético
Pesos implicados (k= 7)	1	389	20.936	0.437	0.54	Monofilético
Pesos implicados (k= 8)	1	389	19.067	0.437	0.54	Monofilético
Pesos implicados (k= 9)	1	389	17.51	0.437	0.54	Monofilético

Cuadro 2. Resumen de las hipótesis filogenéticas recuperadas en los análisis de pesos iguales y pesos implicados con distintos valores de *K*, empleando TNT, inhabilitando los troglomorfoismos.

De acuerdo con el cladograma óptimo obtenido a partir del análisis sin caracteres troglomorfoicos, el género *Hemirrhagus* se resuelve monofilético sustentado por 12 caracteres, de los que seis son homoplásticos. Presenta seis sinapomorfías

conformadas por los siguientes caracteres: Región retrolateral posterior de las coxas I-IV retrolateralmente extendida (7), Presenta escopula prolateral en el fémur del pedipalpo (24), Surco ventral presente en la transición tegulum-embolo (70), quilla subapical extendida retrolateralmente hasta la región posterior del embolo (79), presencia de setas urticantes tipo VI (89) y setas urticantes color naranja (90).

El análisis de todos los caracteres muestra como sinapomorfía de *Hemirrhagus* al carácter 98 (espermateca ligeramente curvada), no obstante en esta topología aparece como homoplástico. La otra diferencia entre las sinapomorfías de ambas topologías es que el color naranja de las setas urticantes (90) aparece como plesiomórfico con respecto a los otros colores del parche de setas urticantes. Como se mencionó con anterioridad este carácter es útil para poder identificar las especies.

De los distintos valores de la constante  $K$  explorados ( $K = \{1, 3, 6, 7, 8 \text{ y } 9\}$ ) la topología con el mejor ajuste y valores de soporte se obtuvo con valores de  $K \geq 7$  (fig 5). Este árbol también fue recuperado entre los seis árboles más parsimoniosos obtenidos en el análisis sin troglomorfismos con pesos iguales, por lo que los agrupamientos obtenidos son congruentes con los observados en pesos iguales.

Aunque la monofilia del género *Hemirrhagus* se recupera, se encuentra por debajo del valor estadístico significativo de Jackknife ( $J = 48$ ). Y al igual que en el análisis con todos los caracteres, los grupos internos presentan un bajo soporte estadístico. Dentro del clado donde se incluye *H. pernix* podemos observar que sólo caracteres homoplásticos sustentan su relación con el grupo más inclusivo conformado por *H. guichi*, *H. eros*, *H. benzaa* y *H. ellioti*, que se encuentra soportado por siete caracteres de los cuales cuatro son sinapomorfías, exactamente las mismas que para el análisis con todos los caracteres (36, 39, 40, 41). Además este clado aparece en todas las topologías obtenidas con los diferentes valores de  $K$ , con excepción de  $K = 3$  (fig 5).

En esta topología *H. elliotti* aparece como especie hermana de *H. benzaa*, relación soportada por nueve caracteres de los que dos son sinapomorfías (39 y 40). Estos caracteres se refieren a las espinas en la patela I y II, respectivamente. En el caso de estas especies el carácter que comparten es la ausencia de estas setas espinosas en las hembras. Aquí es importante considerar dos circunstancias, la primera es que *H. elliotti* es una especie troglófila y habita exclusivamente en Cueva de la Laguna en San Luis Potosí y aunque no presenta alto grado de troglomorfismo, si presenta características troglomorfas como reducción de tubérculo ocular, ojos laterales posteriores integumentarios y pigmentación periocular sólo alrededor de los ojos anteriores medios. Por lo que estos caracteres considerados troglomorfismos si afectaban sus relaciones filogenéticas en la topología considerando todos los caracteres. Aunque esta especie habita dentro de la cueva, posee un parche dorsal de setas urticantes de color naranja, igual que el de otras especies epigeas. El segundo punto a considerar es que se desconoce el macho de esta especie, por lo que en la matriz de datos 43 caracteres son inaplicables al ser exclusivos del macho adulto. Por lo cual se considera preciso sugerir que esta especie podría cambiar su posición dentro de *Hemirrhagus*, una vez que el macho sea colectado, descrito y codificado.

A diferencia de la topología obtenida con todos los caracteres donde *H. franckei* salía como especie hermana de dos grandes clados. En el análisis sin troglomorfismos esta especie aparece como hermana de *H. perezmilei*, soportada por cinco caracteres homoplásticos, con un valor de soporte ( $J= 7$ ) y soportada en todas las topologías obtenidos con los diferentes valores de  $K$  (fig 5). Los dos grandes clados que se mencionó aparecían en el análisis de todos los caracteres, no se mantienen al deshabilitar los troglomorfismos y todas las especies que se incluían en ellos conforman ahora un único clado. Este clado se conforma del grupo (*H. franckei* + *H. perezmilei*) y del grupo que incluye a *H. cervinus* y el resto de las especies. Se encuentra soportado por siete caracteres de los que solamente uno es sinapomorfía: espina de la apófisis retrolateral es de mayor longitud que la apófisis retrolateral (21). El grupo donde se encuentra *H. cervinus* sólo se sustenta

por tres caracteres homoplásticos y no tiene soporte jackknife, no obstante se recupera en cuatro de las seis topologías obtenidas con pesos implicados ( $K= 6, 7, 8, 9$ ) (fig 3). Los grupos más inclusivos tampoco muestran un soporte estadísticamente significativo, salvo la relación del grupo más terminal de (*H. papalotl* + *H. gertschi*) con un valor ( $J= 56$ ).

Un punto importante a resaltar en esta topología óptima es que las especies que presentan alto grado de troglomorfismo quedan separadas. *H. puebla* queda en la base de la rama más larga, donde se ubica *H. cervinus*. Tres especies troglomórficas forman un pequeño grupo (*H. mitchelli*, (*H. grieta* + *H. reddelli*)) que está soportado por una sinapomorfía: espermateca con cuello definido por ambos márgenes (97), este carácter sin embargo no es concluyente para este grupo de especies, puesto que de ninguna se ha descrito el macho y por ende no se conocen sus características morfológicas. Por lo que es probable que la adición de estos caracteres permita definir las sinapomorfías de este arreglo, o que proporcionen hipótesis alternativas.

La única especie troglobia de la que se conoce tanto la hembra como el macho es *H. stygius*, sin embargo esta también se encontraba agrupada con las demás especies troglobias en la topología del análisis con todos los caracteres. Habiendo inhabilitado los troglomorfismos esta especie quedó agrupada con otras dos especies (*H. ocellatus*, (*H. nahuanus* + *H. stygius*)), este grupo está soportado por seis caracteres homoplásticos y sólo el grupo (*H. nahuanus* + *H. stygius*) presenta un valor de jackknife, aunque es muy bajo ( $J= 5$ ).

En este trabajo se ha mostrado un criterio que podría servir para observar si las relaciones filogenéticas obtenidas del análisis con todos los caracteres se veía influenciada por caracteres que más que compartir un origen común, pudieron ser producto de una convergencia adaptativa. Sin embargo aunque con este resultado no se justifica la exclusión de caracteres morfológicos, sí se sugiere tener precaución en algunos casos. Pues como se observó en este análisis estos

caracteres que surgieron por convergencia adaptativa pueden causar problemas en la filogenia al falsear las relaciones existentes entre las especies de nuestro grupo de estudio.

En este caso en particular, la omisión de los caracteres troglomórficos parece resolver de mejor manera las relaciones filogenéticas de *Hemirrhagus*. Aunque el propósito del uso de pesos implicados es acceder a topologías distintas de las obtenidas en los análisis tradicionales (Goloboff, 1995), el resultado recuperado nos proporciona un criterio para preferir una de las seis hipótesis óptimas obtenidas en el esquema de pesos iguales.

Los resultados obtenidos con los esquemas de pesos iguales y pesos implicados tanto para el análisis de todos los caracteres como para el análisis sin troglomorfismos, permiten justificar a *Hemirrhagus* como monofilético. Aunque las relaciones internas seguramente cambiarán una vez que los caracteres faltantes de las especies de las que sólo se cuenta con uno de los dos sexos sean codificados y analizados. El alto índice de homoplasia encontrado en los diferentes grupos internos puede tener diversas explicaciones. Una posible explicación es que la hipótesis de homología representada en el carácter sea incorrecta (homología secundaria, De Pinna, 1991), y por lo tanto nuevas modificaciones en la codificación y argumentación de los caracteres sean necesarias. Otra posible explicación es que los estados de caracteres no sean fijos para los taxones, y la posesión de un estado u otro se deba a variaciones ontogénicas o poblacionales (Ballesteros, 2010). Para lo cual sería recomendable analizar series grandes de ejemplares y observar que tan variables son ciertos caracteres (p.e. la espinación de las patas o la coloración del tubérculo ocular). Hay que considerar también que la recolecta de especies troglobias es más difícil debido al acceso restringido a estos ambientes, la profundidad a la que algunas especies se encuentran y a la baja densidad poblacional en comparación con las especies epigeas. El alto grado de homoplasia también puede deberse a que la codificación de los caracteres no sea excluyente de otros estados y que dos o más estados distintos exhiban algún grado de



traslapamiento. Este podría ser el caso de los caracteres que implican un tamaño relativo de las estructuras como las espinas de las apófisis tibiales o el grado de separación de las espermatecas, pues al analizar más ejemplares de cada especie podría observarse que este tamaño relativo es más variable de lo observado hasta ahora.

La presencia de caracteres homoplásticos es recurrente en todos los análisis filogenéticos, tanto en los estudios que parten de evidencia morfológica como molecular. La homoplasia es un fenómeno inherente de la reconstrucción filogenética. Los análisis realizados en grupos poco estudiados como es el caso de *Hemirrhagus*, y cuya pérdida de caracteres (troglomorismos) pueda ser producto de una convergencia adaptativa, contribuye al análisis de caracteres que parcial o totalmente, no cumplen con las propiedades deseables en los caracteres filogenéticamente informativos.

Dadas estas condiciones se pueden obtener hipótesis filogenéticas con alto índice de homoplasia y/o con pobre resolución en el cladograma. La homoplasia por convergencia adaptativa puede también manifestarse en clados que son incorrectos y están pobremente soportados, en politomias, o en clados que están reconstruidos correctamente pero débilmente soportados debido a la evidencia contradictoria causada por convergencia (Wiens *et al.* 2003). Debe tenerse en consideración que los caracteres adaptativos potencialmente pueden ser indicadores fiables de filogenia (incluso si algunos presentan homoplasia), especialmente si existe una fuerte selección para mantener un rasgo dado en un linaje de millones de años sin reversiones (Donoghue y Sanderson, 1992).

### **Biogeografía.**

De acuerdo con la regionalización de las provincias biogeográficas de México propuesta por Morrone (2005) y la consultada en CONABIO (1997), el género *Hemirrhagus* se restringe a 5 provincias biogeográficas: Sierra Madre Oriental (SMO), Sierra de Oaxaca (SNO), Eje Volcánico Transmexicano (EVT), Sierra Madre

del Sur (SMS) y Sierra de Chiapas (Soconusco) (SCH) (figs 6 y 7). De acuerdo con Morrone & Márquez (2003) estas provincias forman parte de un trazo generalizado denominado como Mexicano de Montaña, con excepción de la Sierra de Chiapas que forma parte del trazo Mesoamericano. El área del Valle de los Fantasma en San Luis Potosí es un área de distribución de *Hemirrhagus* que mediante coordenadas geográficas queda señalada dentro de la provincia del Altiplano Mexicano, sin embargo al revisar la regionalización misma de la provincia Sierra Madre Oriental, Tardy *et al.* (1975) indican que el Valle de los Fantasma forma parte de una región de la SMO denominada Plataforma de Valles-San Luis Potosí, esta región es precisamente el punto limítrofe entre la SMO y el Altiplano mexicano. A la altura del Valle de los Fantasma, una Serie Parrense del límite del Altiplano descansa según un contacto tectónico sub-horizontal sobre algunos metros de una formación del Cretácico Superior la cual descansa a su vez sobre las calizas subarrecifales y menos deformadas de la plataforma Valles-San Luis Potosí (Tardy *et al.* 1975), esto explica porque en la generalidad de los mapas de provincias biogeográficas esta área se encuentra como parte del Altiplano Mexicano. Y es la justificante utilizada en el presente estudio para tomar ese punto de distribución del Valle de los Fantasma como parte de la provincia de la SMO.

El área denominada como Sierra de Oaxaca es incluida por Morrone (2005) como parte de la SMS, pero se decidió utilizar la regionalización obtenida de CONABIO, desarrollada por Arriaga *et al.* (1997), esto con el fin de tomar separadamente las especies de Oaxaca y las de SMS debido a diferencias taxonómicas observadas en los órganos sexuales de machos y hembras. Por ello se quiso observar si las especies de estas dos regiones aparecían como grupos hermanos en el cladograma general de áreas.

En la figura 8 se presenta el cladograma taxonómico de áreas a partir del cual se obtuvo la matriz de datos para realizar el análisis de parsimonia de Brooks. Se puede observar que de las especies actualmente conocidas, la mayoría se ubica dentro de la provincia del EVT, que a su vez parece estar más relacionada con las

provincias de SMO, SNO, y SMS. La matriz obtenida del cladograma taxonómico de áreas fue analizada y se obtuvo un solo árbol más corto que muestra el siguiente arreglo: (SCH, ((SMO + SNO), (SMS + EVT))) (fig 9). Como se puede observar, el cladograma general de áreas obtenido muestra que la región de SCH es hermana del resto y se muestra congruente con la propuesta del trazo generalizado reconocido por Morrone y Marquez (2001, 2003), donde la Sierra de Chiapas forma parte del sistema Mesoamericano, mientras que el resto de las provincias donde habita *Hemirrhagus* son del Mexicano de Montaña. Dada esta distribución es posible inferir que el género tuvo que estar distribuido hasta Chiapas antes de que las regiones se separaran, este patrón parece coincidir con el denominado Patrón Neotropical antiguo de Montaña (Morrone, 2010), donde indica que esta distribución incluye taxones que se distribuyeron más tempranamente que el mesoamericano y el neártico, y que se diversificaron en la Zona de Transición Mexicana antes del cierre del Istmo de Tehuantepec durante el Plioceno. Esto tiene mayor sentido si tomamos en consideración que la especie de *Hemirrhagus* encontrada en ámbar de Simojovel Chiapas, está datada entre un periodo de 22.5mda, durante el Mioceno (García-Villafuerte, 2008). Lo cual da un mayor soporte a la hipótesis de que este género tiene un origen antiguo dentro de la familia Theraphosidae, de la cual los registros más viejos datan de hace unos 25mda (Selden y Penney, 2010). Tal vez esta cantidad de tiempo permita explicar el porque *Hemirrhagus* presenta especies en hábitats epigeos y subterráneos, pues posiblemente han tenido una gran cantidad de tiempo para divergir. Pues como mencionan Galan y Herrera (1998) la evolución de los organismos cavernícolas no es distinta a la que opera de modo general en la naturaleza. Los organismos colonizan los ambientes disponibles y se adaptan a ellos, y en la medida que lo hacen van siendo modificados por las fuerzas selectivas del ambiente.

Las áreas geográficas pueden poseer más de una historia evolutiva, por lo que independientemente de las críticas que pudieran surgir con respecto a las hipótesis biogeográficas, no es posible seleccionar preferentemente una de otra. Es evidente que los estudios biogeográficos del complejo de especies que se encuentran en

nuestro país distan de ser completos. Trabajos como este en el que se realizan revisiones enfocadas en un grupo en particular y en cómo pudieron ser sus patrones de dispersión contribuyen a enriquecer más este conocimiento y quizá hasta a reforzar ciertos patrones encontrados en otros grupos. Morrone 2005 menciona que varios autores han citado a la biogeografía de México como compleja y que al elemento biótico que habitó originalmente el territorio hay que añadirle los elementos neárticos y neotropicales. La mezcla de estos elementos es la que caracteriza en mayor o menor medida las regiones del país, aunque es en especial en la Zona de Transición Mexicana en donde esta “mezcla” es tan compleja que es muy difícil de limitar a que elemento biótico pertenece. La tarea de identificar las áreas de endemismo robustas es bastante difícil, pero el poder reconocer los componentes bióticos principales constituye una primera etapa hacia una teoría biogeográfica sintética. Por lo que todos los estudios que puedan aportar información son valiosos y con este trabajo se espera que los resultados obtenidos y discutidos sobre la distribución de *Hemirrhagus* puedan contribuir con esta teoría.

### **Conclusiones.**

La revisión de ejemplares depositados en las colecciones examinadas, los tipos específicos y material colectado en campo permitieron identificar al menos tres tipos diferentes de órganos estridulatorios en *Hemirrhagus*. Así como asegurar la importancia de la quilla subapical como sinapomorfía del género, al encontrarse presente en todos los machos conocidos.

Tras el análisis de los ejemplares depositados en las colecciones científicas y del material recolectado en campo fue posible aumentar de 16 a 21 el número formal de especies descritas, mediante la descripción de cinco nuevos taxones. Adicionalmente se describieron los machos de *H. papalotl*, *H. stygius* y *H. ocellatus* anteriormente desconocidos.

El análisis realizado con la evidencia disponible permite postular a *Hemirrhagus* como un género natural o monofilético.

La homoplasia observada en los caracteres morfológicos relacionados con adaptaciones al ambiente cavernícola puede ser producto de adaptaciones independientes a ambientes similares. No se justifica la exclusión de caracteres morfológicos de los análisis filogenéticos, sino que se sugiere tener precaución en casos como el aquí expuesto.

La hipótesis filogenética ha permitido precisar los caracteres diagnósticos del género, y junto con la morfología le dan mayor solidez. Y aunque las relaciones internas de las especies presentan un bajo soporte estadístico y homoplasia en los caracteres, la alta frecuencia de recuperación de estos grupos tanto en el análisis con pesos iguales y los de pesos implicados, sugiere que estas relaciones son válidas y congruentes con el conocimiento actual del género. Los estudios posteriores donde se incluyan los datos completos de las especies que sólo se conocen por uno de los sexos, así como la inclusión y codificación de nuevos caracteres permitirán corroborar o modificar la hipótesis filogenética presentada.

Las relaciones biogeográficas de las especies son congruentes con los patrones establecidos para el área denominada como Mexicana de Montaña y la región Mesoamericana. Con base en evidencia fósil del periodo Mioceno es posible que *Hemirrhagus* forme parte del denominado Patrón Neotropical Antiguo. Una comparación con otros grupos de especies y la revisión de otros taxones en estas regiones podrán brindar más claridad en cuanto a la biogeografía de las especies y quizá ayude a explicar la existencia de especies epigeas, troglófilas y troglobias compartiendo una misma área de distribución.



### Literatura Citada.

- Agnarsson, I. y Miller, J. A. 2008. Is ACCTRAN better than DELTRAN? *Cladistics*, 24: 1032–1038.
- Arriaga, L., Aguilar, C., Espinosa-Organista, D. y Jiménez, R. 1997. Regionalización ecológica y biogeográfica de México. Taller de la Comisión Nacional para el Conocimiento y Uso de la Biodiversidad (Conabio), México, D.F.
- Ausserer, A. 1875. Zweiter Beitrag zur Kenntniss der Arachniden-Familie der Territelariae Thorell (Mygalidae Autor). *Verhandlungen der Zoologisch-Botanischen Gesellschaft in Wien* 25: 125–206.
- Ballesteros, J. 2010. *Sistemática filogenética del género Paraphrynus Moreno* (Arachnida: Amblypygi, Phrynidae). Tesis de Maestría. Instituto de Biología, Universidad Nacional Autónoma de México, México DF, 160 pp.
- Bertani, R. 2000. Male palpal bulbs and homologous features in Theraphosinae (Araneae, Theraphosidae). *The Journal of Arachnology* 28: 29–42.
- Bertani, R. 2001. Revision, cladistic analysis and zoogeography of *Vitalius*, *Nhandu* and *Proshapalopus*, with notes on other theraphosine genera (Araneae, Theraphosidae). *Arquivos de Zoologia*, 36 (3): 265–356.
- Cambridge, F. O. P. 1897. Arachnida - Araneida and Opiliones. In: *Biologia Centrali-Americana, Zoology* 2: 1–40.
- Cambridge, F. O. P. 1899. Arachnida - Araneida and Opiliones. In *Biologia Centrali-Americana, Zoology* 2: 41–88.
- Comisión Nacional para el Conocimiento y Uso de la Biodiversidad (Conabio). 1997. Provincias Biogeográficas de México. Escala 1: 4 000 000. Disponible en: <http://www.conabio.gob.mx/informacion>
- Desutter-Grandcolas, L. y Grandcolas, P. 1996. The evolution toward troglobitic life: A phylogenetic reappraisal of climatic relict and local hábitat shift hypotheses. *Mémoires de Biospéologie*, 23: 57–63.
- Desutter-Grandcolas, L. 1997a. Studies in cave life evolution: a rationale for future theoretical developments using phylogenetic inference. *Journal of Systematic Evolution Research*, 35: 23–31.
- Desutter-Grandcolas, L. 1997b. Are troglobitic taxa troglobiomorphic? A test using phylogenetic inference. *International Journal of Speleology*, 26 (1): 1–19.
- De Pinna, M. C. 1991. Concepts and tests of homology in the cladistic paradigm. *Cladistics*, 7: 367–394.
- Donoghue, M. J. y Sanderson, M. J. 1992. The suitability of molecular and morphological evidence in reconstructing plant phylogeny. Pag 340–368. En: *Molecular systematics of plants* (P. S. Soltis, D. E. Soltis & J. J. Doyle eds.) Chapman and Hall, New York.
- Fitch, W. M. 1971. Toward defining the course of evolution: Minimum change for a specific tree topology. *Systematic Zoology*, 20: 406–416.

- Fukushima, C. S., Bertani R. y Da Silva Jr, P. 2005. Revision of *Cyriocosmus* Simon, 1903, with notes on the genus *Hapalopus* Ausserer, 1875 (Araneae: Theraphosidae). *Zootaxa*, 846: 1–31.
- Fukushima, C. S., Pérez-Miles, F. y Bertani, R. 2011. On the *Avicularia* (Araneae: Theraphosidae: Aviculariinae) species from Uruguay. *Journal of Arachnology*, 39: 528–532.
- Galan, C. y Herrera, F. 1998. Fauna cavernícola: ambiente y evolución. *Boletín de la Sociedad Venezolana de Espeleología*, 32: 13–43.
- García-Villafuerte, M. A. 2008. Primer registro fósil del género *Hemirrhagus* (Araneae, Theraphosidae) en ámbar del Terciario, Chiapas, México. *Revista Ibérica de Aracnología*, 16: 79–94.
- García-Villafuerte, M. A. y Loch, A. 2010. Una nueva especie de *Hemirrhagus* Simon, 1903 (Theraphosidae, Theraphosinae) de Chiapas, México. *Revista Ibérica de Aracnología*, 18: 81–86.
- Gertsch, W. J. 1971. A report on some Mexican cave spiders. *Bulletin of the Association for Mexican Cave Studies*, 4: 47–111.
- Gertsch, W. J. 1973. A report on cave spiders from Mexico and Central America. *Bulletin of the Association for Mexican Cave Studies*, 5: 141–163.
- Gertsch, W. J. 1982. The troglobitic mygalomorphs of the Americas (Arachnida, Araneae). *Bulletin of the Association for Mexican Cave Studies* 8: 79–94.
- Goloboff, P. A. 1993. Estimating character weights during tree search. *Cladistics*, 9: 83–91.
- Goloboff, P. A. 1995. Parsimony and weighting: a reply to Turner and Zandee. *Cladistics*, 11: 91–104.
- Goloboff, P., Farris, S. y Nixon, K. 2000. TNT (Tree analysis using New Technology) (BETA) ver. 1.1, Tucumán, Argentina. Disponible en: <http://www.cladistics.com/index.html>
- Goloboff, P., Farris, S. y Nixon, K. 2008. TNT, a free program for phylogenetic analysis. *Cladistics*, 24: 774–786.
- Juan, C., Guzik, M. T., Jaume, D. y Cooper, S. J. B. 2010. Evolution in caves: Darwin's wrecks of ancient life in the molecular era. *Molecular Ecology*, 19: 3865–3880.
- Kitching, I. J., 1992. Tree building techniques. En: Forey, P. L., Humphries, C. J., Kitching, I. J., Scotland, R. W., Siebert, D. J., and D. M. Williams, eds., *Cladistics. A practical course in systematics*: 44–71. Clarendon Press, Oxford.
- Kitching, I. J., Forey, P. L., Humphries, C. J. y Williams, D. M. 1998. *Cladistics. The Theory and Practice of Parsimony Analysis*, 2nd ed. Syst. Assoc. Publ. Oxford University Press, New York.
- Locht, A. 2008. *Estudio sobre la sistemática y distribución de la familia Theraphosidae* (Arachnida, Araneae) en México. Tesis de Maestría. Facultad de Ciencias, Universidad Nacional Autónoma de México, México DF, 116 pp.

- Ming-Sheng, Z. y Zhang, R. 2008. Revision of the theraphosid spiders of China (Araneae: Mygalomorphae). *The Journal of Arachnology*, 36: 425–447.
- Morrone, J. J. 2005. Hacia una síntesis biogeográfica de México. *Revista Mexicana de Biodiversidad*, 76 (2): 207–252.
- Morrone, J. J. 2010. Fundamental biogeographic patterns across the Mexican Transition Zone: an evolutionary approach. *Ecography*, 33: 355–361.
- Morrone J. J. 2013. *Sistemática. Fundamentos, métodos, aplicaciones*. 1er Ed. Universidad Nacional Autónoma de México, Facultad de Ciencias, Ciudad Universitaria, México DF. 505p.
- Morrone, J. J. y Márquez, J. 2001. Halffter's Mexican Transition Zone, beetle generalised tracks, and geographical homology. *Journal of Biogeography*, 28: 635–650.
- Morrone, J. J. y Márquez, J. 2003. Aproximación a un Atlas Biogeográfico Mexicano: componentes bióticos principales y provincias biogeográficas. En: Una perspectiva latinoamericana de la biogeografía, J. J. Morrone, y J. Llorente-Bousquets (eds.). Las prensas de Ciencias, UNAM, México, D.F., p. 217–220.
- Platnick, N.I. 2013. The world spider catalog, version 13.5. The American Museum of Natural History. New York, Available from: <http://research.amnh.org/iz/spiders/catalog/INTRO1.html> (visitado 26 febrero 2013).
- Pérez-Miles, F., Lucas, S. M., Da Silva Jr., P. I. y Bertani, R. 1996. Systematic revision and cladistic analysis of Theraphosinae (Araneae: Theraphosidae). *Mygalomorph* 1: 33–68.
- Pérez-Miles, F. 1998. Notes on the systematics of the little known theraphosids spider *Hemirrhagus cervinus*, with a description of a new type of urticating hair. *Journal of arachnology*, 26: 120–123.
- Pérez-Miles, F. 2000. *Iracema cabloca* new genus and species of a theraphosid spider from Amazonic Brazil (Araneae, Theraphosinae). *Journal of Arachnology*, 28: 141–148.
- Pérez-Miles, F. y Locht, A. 2003. Revision and cladistic analysis of the genus *Hemirrhagus* Simon, 1903 (Araneae, Theraphosidae, Theraphosinae). *Bulletin of the British arachnological Society*, 12 (8): 365–375.
- Pocock, R. I. 1903. On some genera and species of South American Aviculariidae. *Annals and Magazine of Natural History*, 7 (11): 81–115.
- Raven, R. J. 1985. The spider infraorder Mygalomorphae (Araneae): Cladistics and systematics. *Bulletin of American Museum of Natural History*, 182: 1–180.
- Selden, P. y Penney, D. 2010. Fossil spiders. *Biological Reviews*, 85: 171–206.
- Sereno, P. 2007. Logical basis for morphological characters in phylogenetics. *Cladistics*, 23: 565–587
- Schmidt, G. 1997. Zur Position der Gattung *Spelopelma* Gertsch, 1982 (Araneae: Theraphosidae). *Arachnologisches Magazin*, 5 (8): 1–5.
- Simon, E. 1891. Liste des Aviculariides qui habitent le Mexique et l'Amérique centrale. *Actes de la Société Linnéenne de Bordeaux*, 44: 327–339.
- Simon, E. 1903. *Histoire naturelle des araignées*. Paris, 2 (4): 669–1080.
- Smith, A. M. 1995 *Tarantula Spiders: Tarantulas of the U.S.A. and Mexico*. Fitzgerald, London, 196 pp.

- Tardy, M., Longoria, J. F., Martínez-Reyes, J., Mitre, L. M., Patiño, M., Podilla, R. y Ramírez, C. 1975. Observaciones generales sobre la estructura de la Sierra Madre Oriental: La aloctonia del conjunto Cadena alta-Altiplano Central, entre Torreón, Coahuila y San Luis Potosí, S.L.P. México. *Revista del Instituto de Geología, UNAM*, 75 (1): 1–11.
- West, R. C., Marshall, S.D., Fukushima, C.S. y Bertani, R. (2008) Review and cladistic analysis of the Neotropical tarantula genus *Epebopus* Simon 1892 (Araneae: Theraphosidae) with notes on the Aviculariinae. *Zootaxa*, 1849, 35–58.
- West, R. y Nunn, C. 2010. A taxonomic revision of the tarantula spider genus *Coremiocnemis* Simon 1892 (Araneae, Theraphosidae), with further notes on the Selenocosmiinae. *Zootaxa*, 2443: 1–64.
- Von Wirth, V. y Striffler, B. F. 2005. Neue Erkennstisse zur Vogelspinnen - Unterfamilie Ornithoctoninae, mit Beschreibung von *Ornithoctonus aureotibialis* sp. n. und *Haplopelma longipes* sp. n. (Araneae, Theraphosidae). *Arthropoda*, 13 (2): 2–27.
- Wiens, J., Chippindale, P. y Hillis, D. 2003. When are Phylogenetic Analyses misled by Convergence? A case study in Texas Cave Salamanders. *Systematic Biologist*, 52 (4): 501–514.
- Wiley, E. O. 1987. Methods in vicariance Biogeography. En: *Systematics and Evolution: A Matter of Diversity* (P. Hovenkamp, ed.). Utrecht University, Utrecht, the Netherlands: 283–306.
- Wiley, E. O. y Lieberman, B. S. 2011. *Phylogenetics, theory and practice of Phylogenetic Systematics*. Wiley-Blackwell 2nd ed. Singapore. 406 pp.
- Watrous, J. E. y Wheeler, Q. D. 1981. The outgroup comparison method of character analysis. *Systematic Zoology*, 30: 1–11.

**Listado de caracteres.**

## PROSOMA

## Dorsal

1. Tubérculo ocular: Normalmente desarrollado (0); pobremente desarrollado (1); no desarrollado (2).
2. Ojos medios anteriores: normalmente desarrollados (0); pobremente desarrollados (1); no desarrollados (2).
3. Ojos laterales anteriores: normalmente desarrollados (0); pobremente desarrollados (1); no desarrollados (2).
4. Ojos medios posteriores: normalmente desarrollados (0); pobremente desarrollados (1); no desarrollados (2).
5. Ojos laterales posteriores: normalmente desarrollados (0); pobremente desarrollados (1); no desarrollados (2).
6. Ojos, pigmentación alrededor: completa en ocho ojos (0); solo en línea anterior (1); solo en ojos medios anteriores (2); sin pigmentación (3).

## Ventral

7. Coxas I-IV, región retrolateral posterior: no extendida (0); extendida (1), hacia el esternón.
8. Tarso I, escopula: no dividida (0); dividida (1), por setas suaves o rígidas.
9. Tarso II, escopula: no dividida (0); dividida (1), por setas suaves o rígidas.
10. Tarso III, escopula: no dividida (0); dividida (1), por setas suaves o rígidas.
11. Tarso IV, escopula: no dividida (0); dividida (1); casi remplazada (2), por setas rígidas.
12. Metatarso III, escopula distal, cobertura: 1/2 (0); 2/3 (1); 1/4 (2); 3/4 (3), respecto a la longitud del metatarso.
13. Metatarso IV, escopula distal, cobertura: 1/4 (0); 1/3 (1); 1/2 (2); 1/5 (3); 1/8 (4); sin escopula (5), respecto a la longitud del metatarso.
14. Metatarso I del macho: recto (0); curvado (1).
15. Tibia I del macho, apófisis tibiales, ausentes (0); presentes (1)
16. Metatarso I del macho, cierra: entre las dos apófisis (0); sobre la Apv (1); cara retrolateral de las dos apófisis (2).
17. Metatarso I, contacto al cierre con apófisis tibiales: Sin contacto (0); en cara retrolateral de Rap (1); con espina de Rap (2).
18. Apófisis prolatral: normalmente desarrollada (0); pobremente desarrollada (1).
19. Apófisis retrolateral: normalmente desarrollada (0); pobremente desarrollada (1).
20. Apófisis prolatral, espina, longitud con respecto a Pap: menor (0); mayor (1); casi sustituye (2).
21. Apófisis retrolateral, espina, longitud con respecto a Rap: menor (0); mayor (1); casi sustituye (2).

## Pedipalpo

22. Trocánter, setas retrolaterales: normales (0); escopulares (1); plumosas (2); estridulantes (3).
23. Trocánter, cara retrolateral, setas estridulantes: SP (0); CLP (1).



- 24. Fémur, escopula prolateral: ausente (0); presente (1).
- 25. Fémur, escopula retrolateral: ausente (0); presente (1).
- 26. Fémur, cara retrolateral proximal, setas FHS: ausentes (0); presentes (1).

#### Patatas

- 27. Coxa I, escopula retrolateral: ausente (0); presente (1).
- 28. Trocanter I, setas prolaterales: normales (0); escopulares (1); plumosas (2); estridulantes (3).
- 29. Trocanter I, escopula retrolateral: ausente (0); presente (1).
- 30. Fémur I, escopula prolateral: ausente (0); presente (1).
- 31. Coxa II, escopula prolateral: ausente (0); presente (1).
- 32. Trocanter II, escopula prolateral: ausente (0); presente (1).
- 33. Fémur II, escopula prolateral: ausente (0); presente (1).

#### Espinación Machos.

- 34. Espinas en fémur I: ninguna (0); 1 a 3 (1); 4 a 7 (2).
- 35. Espinas en fémur II: ninguna (0); 1 a 3 (1); 4 a 7 (2).
- 36. Espinas en fémur III: ninguna (0); 1 a 5 (1); 6 a 10 (2); 11 a 15 (3).
- 37. Espinas en fémur IV: ninguna (0); 1 a 5 (1); 6 a 10 (2); 11 a 15 (3).
- 38. Espinas en patela del pedipalpo: ninguna (0); una (1).
- 39. Espinas en patela I: ninguna (0); 1 a 2 (1); 3 a 4 (2); 5 o más (3).
- 40. Espinas en patela II: ninguna (0); 1 a 2 (1); 3 a 4 (2); 5 o más (3).
- 41. Espinas en patela III: ninguna (0); 1 a 2 (1); 3 a 4 (2).
- 42. Espinas en patela IV: ninguna (0); 1 a 2 (1); 3 a 4 (2).
- 43. Espinas en tibia del pedipalpo: ninguna (0); 1 a 5 (1); 6 a 10 (2); 11 a 15 (3).
- 44. Espinas en tibia I: ninguna (0); 1 a 5 (1); 6 a 10 (2); 11 a 15 (3); 16 a 20 (4).
- 45. Espinas en tibia II: ninguna (0); 1 a 5 (1); 6 a 10 (2); 11 a 15 (3); 16 a 20 (4).
- 46. Espinas en tibia III: 1 a 9 (0); 10 a 19 (1); 20 a 29 (2).
- 47. Espinas en tibia IV: 1 a 9 (0); 10 a 19 (1); 20 a 29 (2); 30 o más (3).
- 48. Espinas en metatarso I: ninguna (0); 1 a 5 (1); 6 a 9 (2).
- 49. Espinas en metatarso II: ninguna (0); 1 a 5 (1); 6 a 9 (2); 10 o más (3).
- 50. Espinas en metatarso III: 1 a 9 (0); 10 a 19 (1); 20 o más (2).
- 51. Espinas en metatarso IV: 1 a 9 (0); 10 a 19 (1); 20 a 29 (2); 30 o más (3).

#### Espinación hembras

- 52. Espinas en fémur I: ninguna (0); 1 a 3 (1); 4 a 7 (2).
- 53. Espinas en fémur II: ninguna (0); 1 a 3 (1); 4 a 7 (2).
- 54. Espinas en fémur III: ninguna (0); 1 a 5 (1); 6 a 10 (2).
- 55. Espinas en fémur IV: ninguna (0); 1 a 3 (1); 4 a 7 (2).
- 56. Espinas en patela del pedipalpo: ninguna (0); una (1); dos (2).
- 57. Espinas en patela I: ninguna (0); una (1).
- 58. Espinas en patela II: ninguna (0); una (1).
- 59. Espinas en patela III: ninguna (0); una (1).
- 60. Espinas en patela IV: ninguna (0); una (1).
- 61. Espinas en tibia del pedipalpo: ninguna (0); 1 a 5 (1); 6 a 10 (2); 11 a 15 (3).
- 62. Espinas en tibia I: ninguna (0); 1 a 5 (1); 6 a 10 (2); 11 a 15 (3).
- 63. Espinas en tibia II: ninguna (0); 1 a 5 (1); 6 a 10 (2); 11 a 15 (3).
- 64. Espinas en tibia III: 1 a 9 (0); 10 a 19 (1); 20 a 29 (2).

65. Espinas en tibia IV: 1 a 9 (0); 10 a 19 (1); 20 a 29 (2); 30 o más (3).  
 66. Espinas en metatarso I: ninguna (0); 1 a 5 (1); 6 a 9 (2).  
 67. Espinas en metatarso II: ninguna (0); 1 a 5 (1); 6 a 9 (2).  
 68. Espinas en metatarso III: 1 a 9 (0); 10 a 19 (1); 20 o más (2).  
 69. Espinas en metatarso IV: 1 a 9 (0); 10 a 19 (1); 20 a 29 (2); 30 o más (3).

#### Bulbo pedipalpo.

70. Bulbo pedipalpo, transición de tegulum a embolo: Sin surco ventral (0); Con surco ventral (1).  
 71. Bulbo pedipalpo, surco ventral: profundo (0); poco profundo (1).  
 72. Subtegulum: igual (0); mayor (1), de largo que ancho.  
 73. Tegulum: igual (0); 1.5 (1); 2 (2), veces de largo que ancho.  
 74. Embolo, curvatura: no curvado (0); curvado (1); curvado sólo en apíce (2), retrolateralmente.  
 75. Embolo, grosor: disminuyendo (0); constante (1), a través de su longitud.  
 76. Embolo, longitud: menor (0); igual (1); 1.5 (2); 2 o más (3), que el tegulum.  
 77. Embolo, longitud: 2 (0); 2.5 (1); 3 o más (2), veces que el ancho de su base.  
 78. Embolo, quilla subapical: ausente (0); presente (1).  
 79. Embolo, quilla subapical: no extendida (0); extendida (1), retrolateralmente.  
 80. Embolo, quilla subapical, extensión retrolateral termina hasta: antes de la base del embolo (0); justo en la base del embolo (1); la cara retrolateral del embolo (2).  
 81. Embolo, quilla subapical, región posterior: fuertemente curvada (0); ligeramente curvada (1); sin curvatura (2).  
 82. Embolo, quilla prolateral superior: ausente (0); presente (1).  
 83. Embolo, quilla prolateral inferior: ausente (0); presente (1).  
 84. Embolo, quilla apical: ausente (0); presente (1).  
 85. Embolo, quilla retrolateral: ausente (0); presente (1).

### OPISTOSOMA

#### Dorsal

86. Setas urticantes: ausentes (0); presentes (1).  
 87. Setas urticantes, tipo I: ausentes (0); presentes (1).  
 88. Setas urticantes, tipo III: ausentes (0); presentes (1).  
 89. Setas urticantes, tipo VI: ausentes (0); presentes (1).  
 90. Setas urticantes, color: negro (0); cobrizo (1); café (2); naranja (3); gris (4).  
 91. Setas urticantes, parche: uno dorso-lateral posterior (0); uno dorso-mediano extendido (1); dos dorsales paramedianos (2); dos laterales (3); uno dorso-mediano no extendido (4).  
 92. Setas urticantes, parche, márgenes: pobremente definidos (0); bien definidos (1).  
 93. Setas urticantes, parche, margen anterior: recto (0); con surco mediano.  
 94. Setas urticantes, parche, margen posterior: recto (0); con surco mediano.

#### Ventral

95. Espermateca: dividida (0); fusionada en la base (1); fusionada en la parte media (2); completamente fusionada (3).

96. Espermateca, longitud: disminuye distalmente (0); no disminuye distalmente (1).
97. Espermateca, cuello: no definido (0); definido por margen exterior (1); definido por ambos márgenes (2).
98. Espermateca, curvatura lateral: fuertemente curvada (0); ligeramente curvada (1); recta (2); retorcida (3).
99. Espermateca, separación en la base: ligeramente separadas (0); ampliamente separadas (1); no separadas (2).
100. Espermateca, receptáculos seminales, longitud: mayor (0); igual (1); menor (2), con respecto al ancho de su base.







Figura 1. Consenso Estricto de 3 arboles, Todos los caracteres incluidos, sin pesos implicados. (L= 421, Ci= 0.432, Ri= 0.535). Valores de jackknife remuestreo simétrico P= 50, 10000 replicas

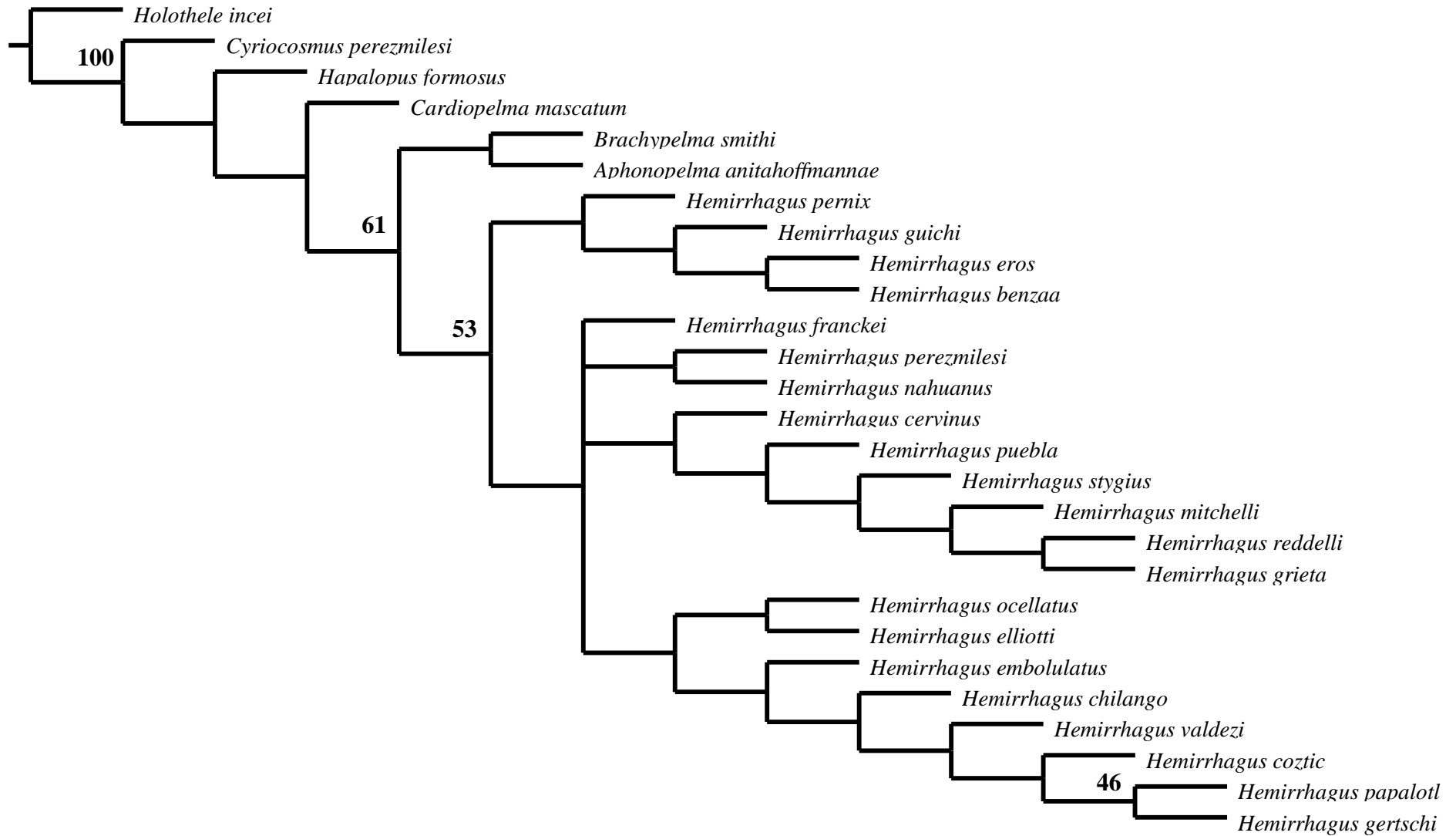


Figura 2. Árbol con todos los caracteres, pesos implicados K= 21. (L= 421, Ci= 0.432, Ri= 0.535, f= 9.70). Valores de jackknife remuestreo simétrico P= 50, 10000 replicas

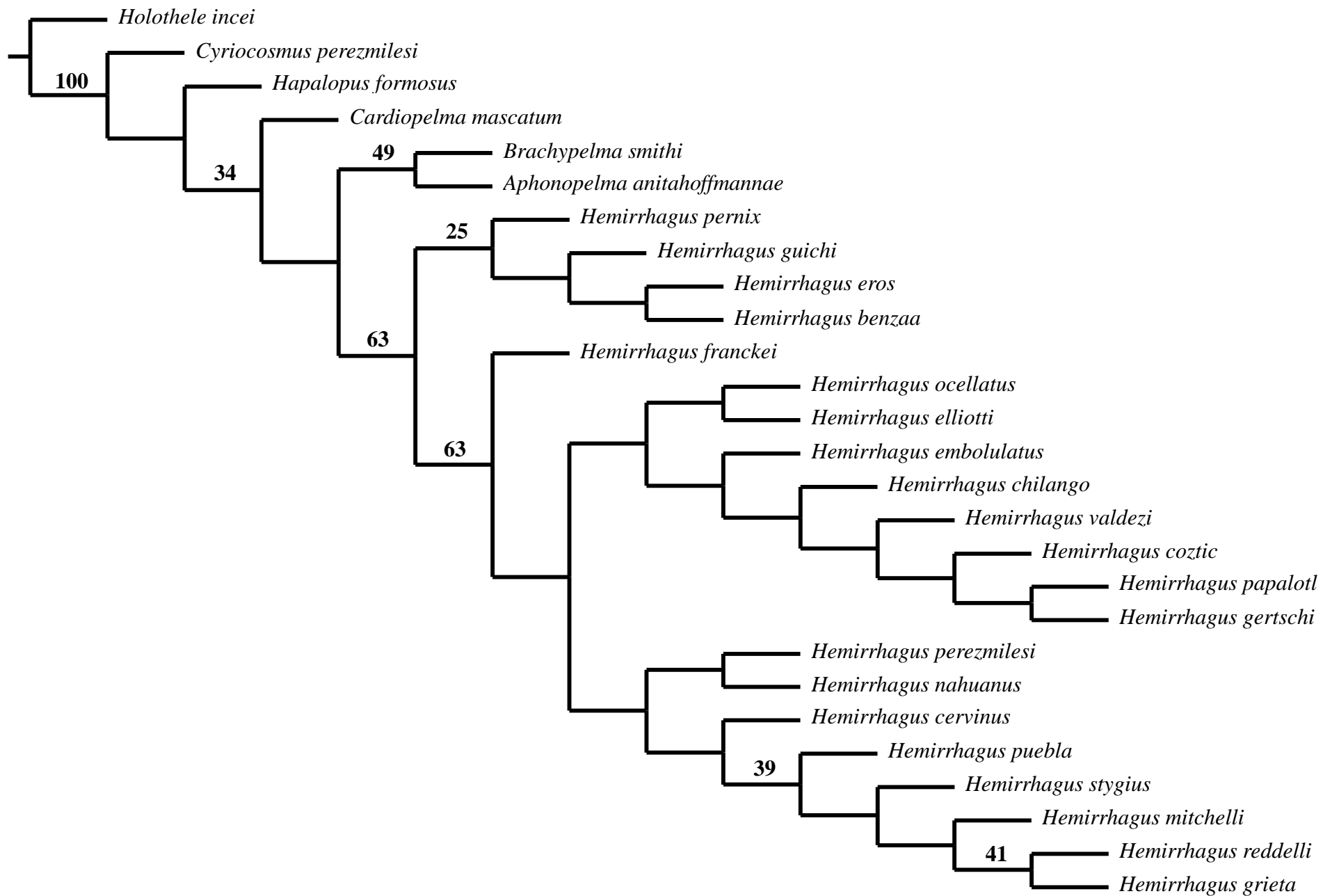


Figura 3. Árbol con todos los caracteres, mostrando la recuperación de clados de *Hemirrhagus* con pesos implicados y con los caracteres mapeados.

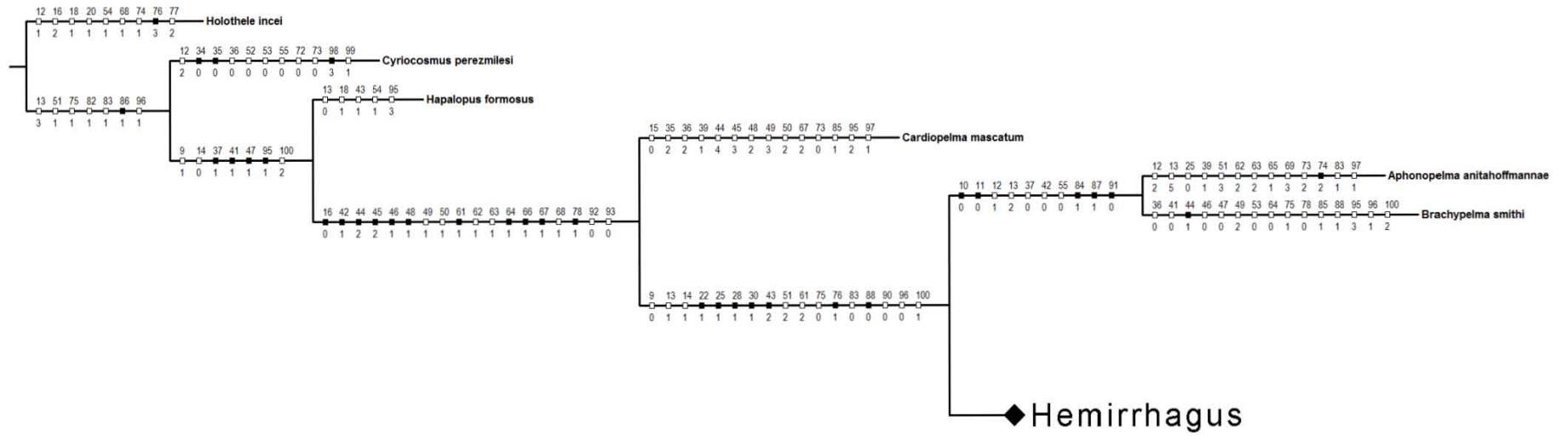


Figura 3 Continuación. Árbol con todos los caracteres, mostrando la recuperación de clados de *Hemirrhagus* con pesos implicados y con los caracteres mapeados.

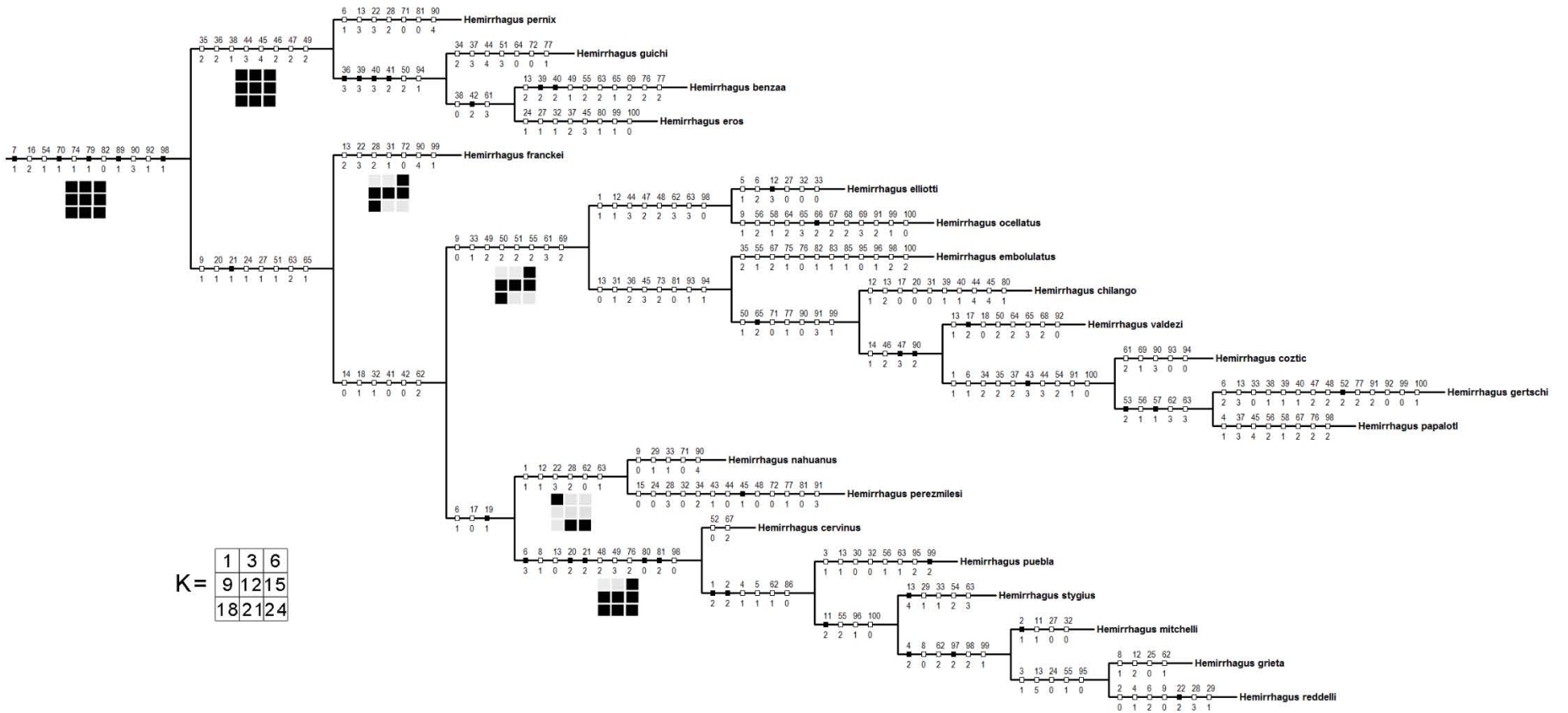


Figura 4. Arbol sin caracteres troglomorficos, pesos implicados K= 7. (L= 389, Ci= 0.437, Ri= 0.540, f= 20.93649) Valores de jackknife remuestreo simétrico P= 50, 10000 replicas

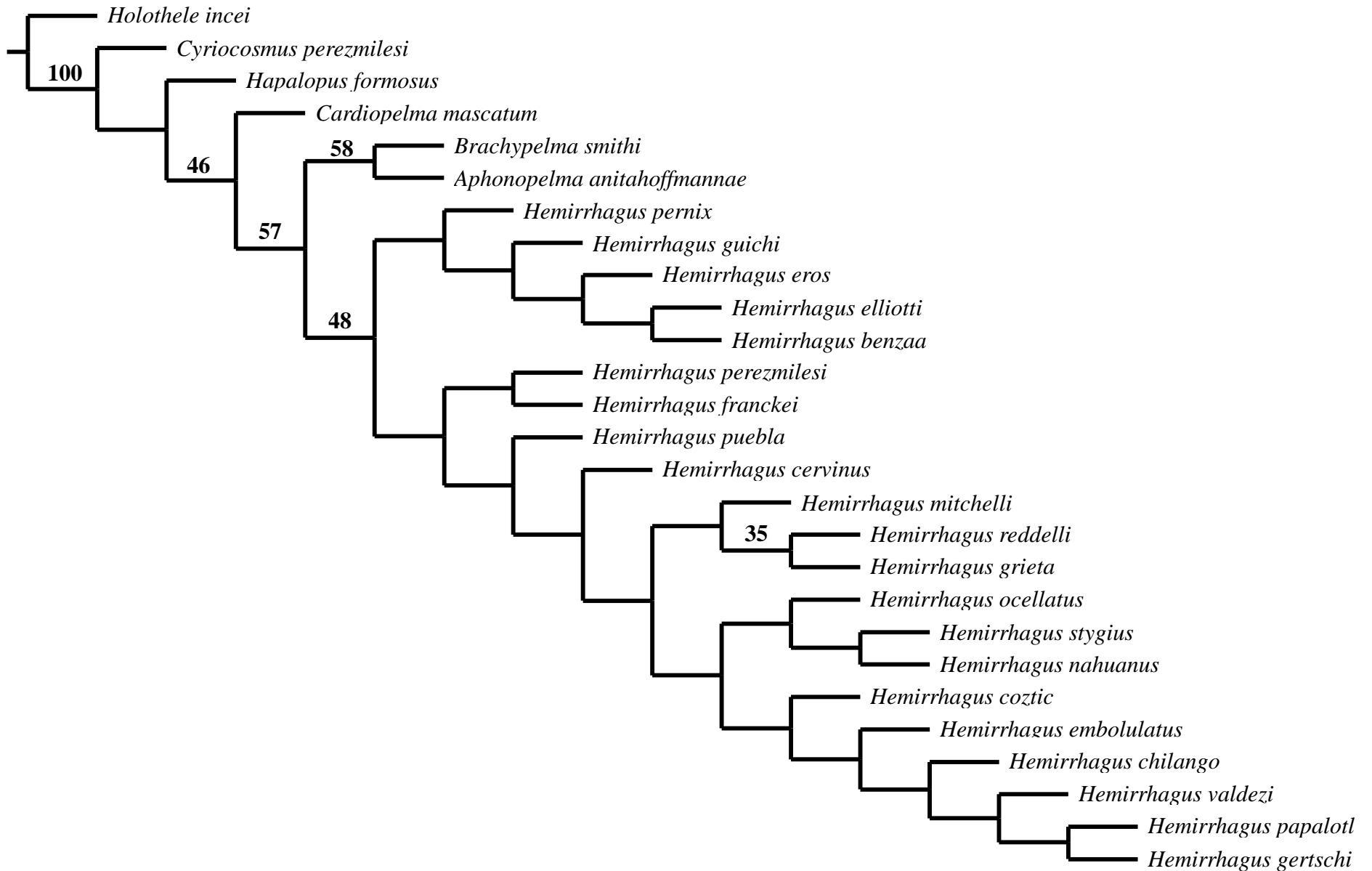




Figura 5. Árbol sin caracteres troglomorfoicos, mostrando la recuperación de clados de *Hemirrhagus* con pesos implicados y con los caracteres mapeados.

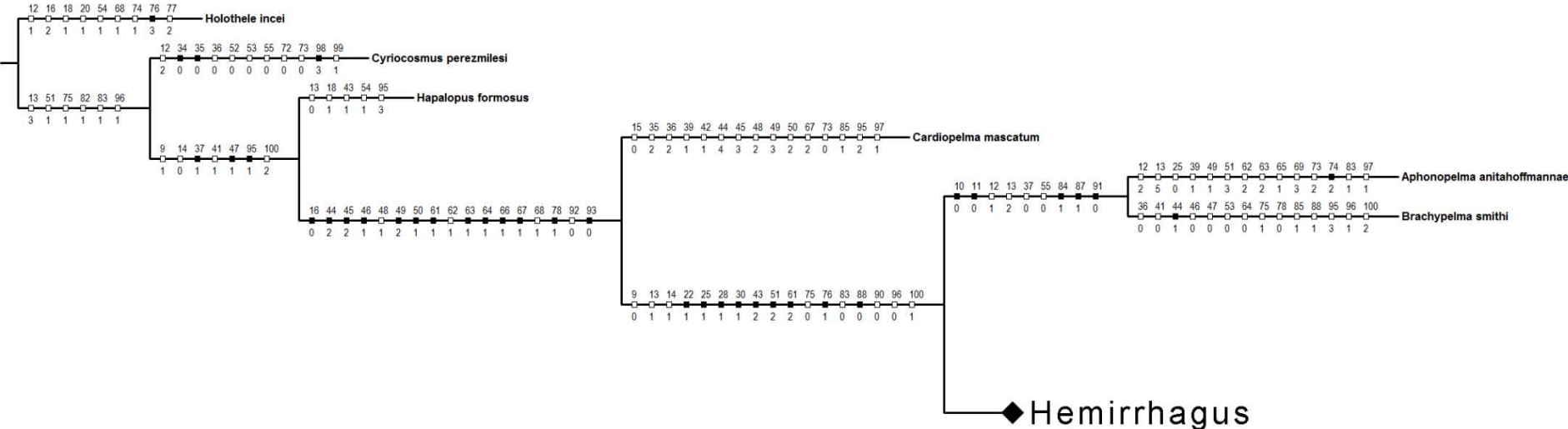
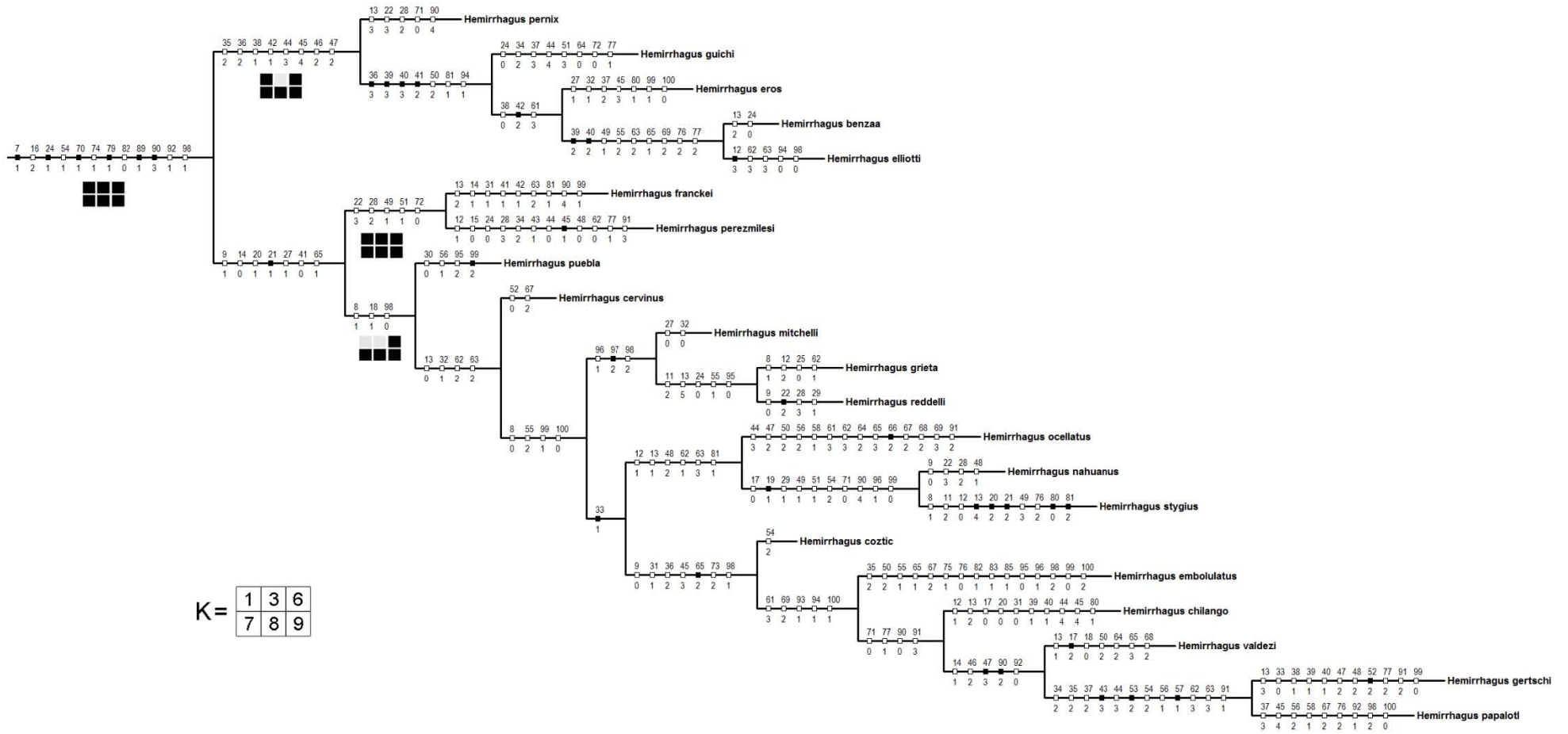


Figura 5 Continuación. Árbol sin caracteres troglomorfo, mostrando la recuperación de clados de *Hemirrhagus* con pesos implicados y con los caracteres mapeados.



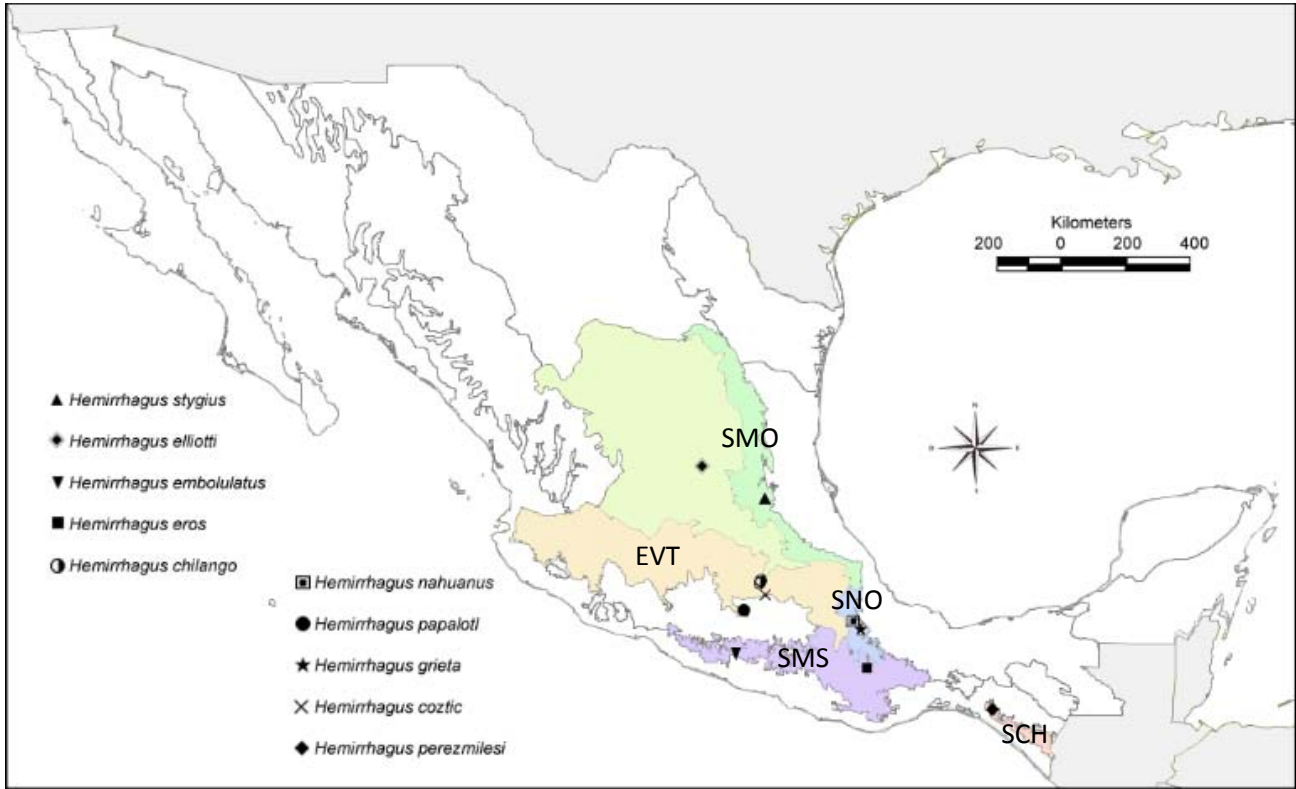


Figura 6. Distribución de *Hemirrhagus* en distintas regiones biogeográficas.

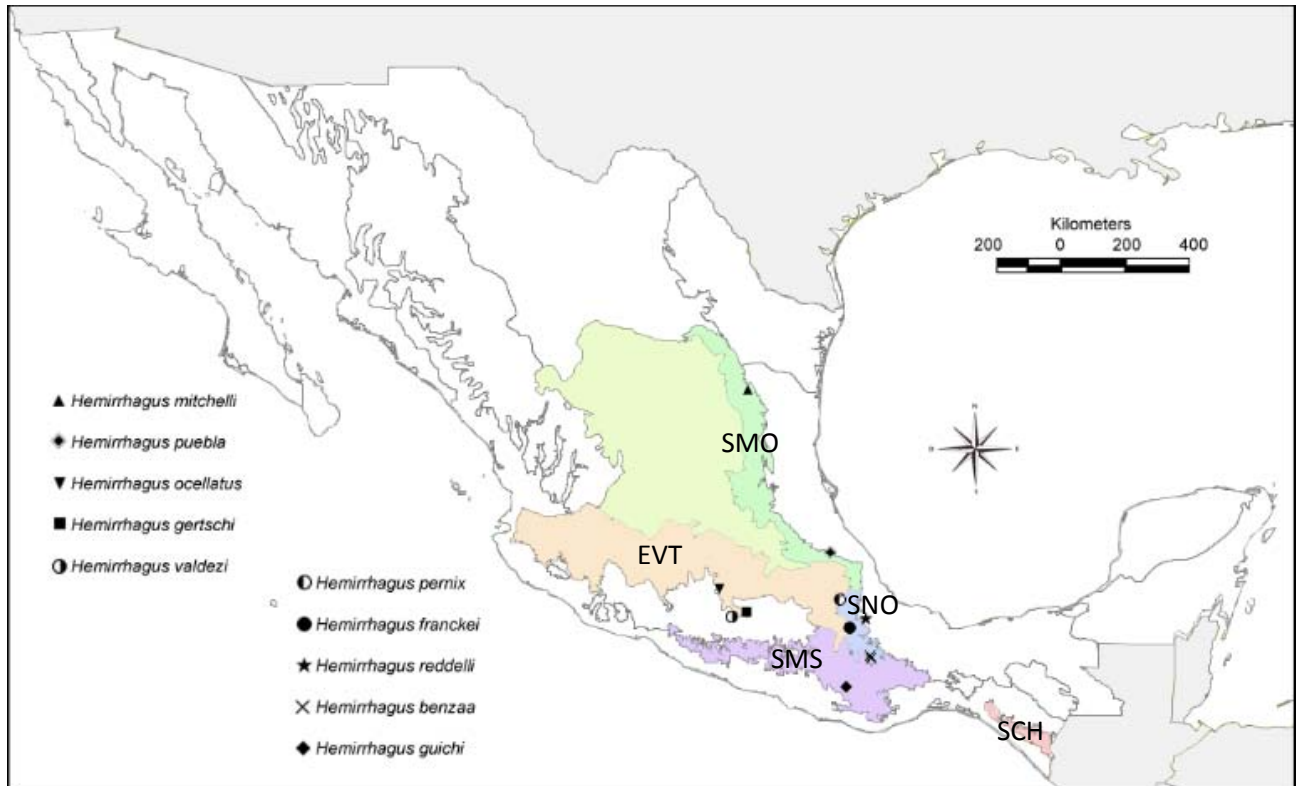


Figura 7. Distribución de *Hemirrhagus* en distintas regiones biogeográficas.

Figura 8. Cladograma taxonomico de areas de distribución de *Hemirrhagus* obtenido a partir del cladograma taxonomico.

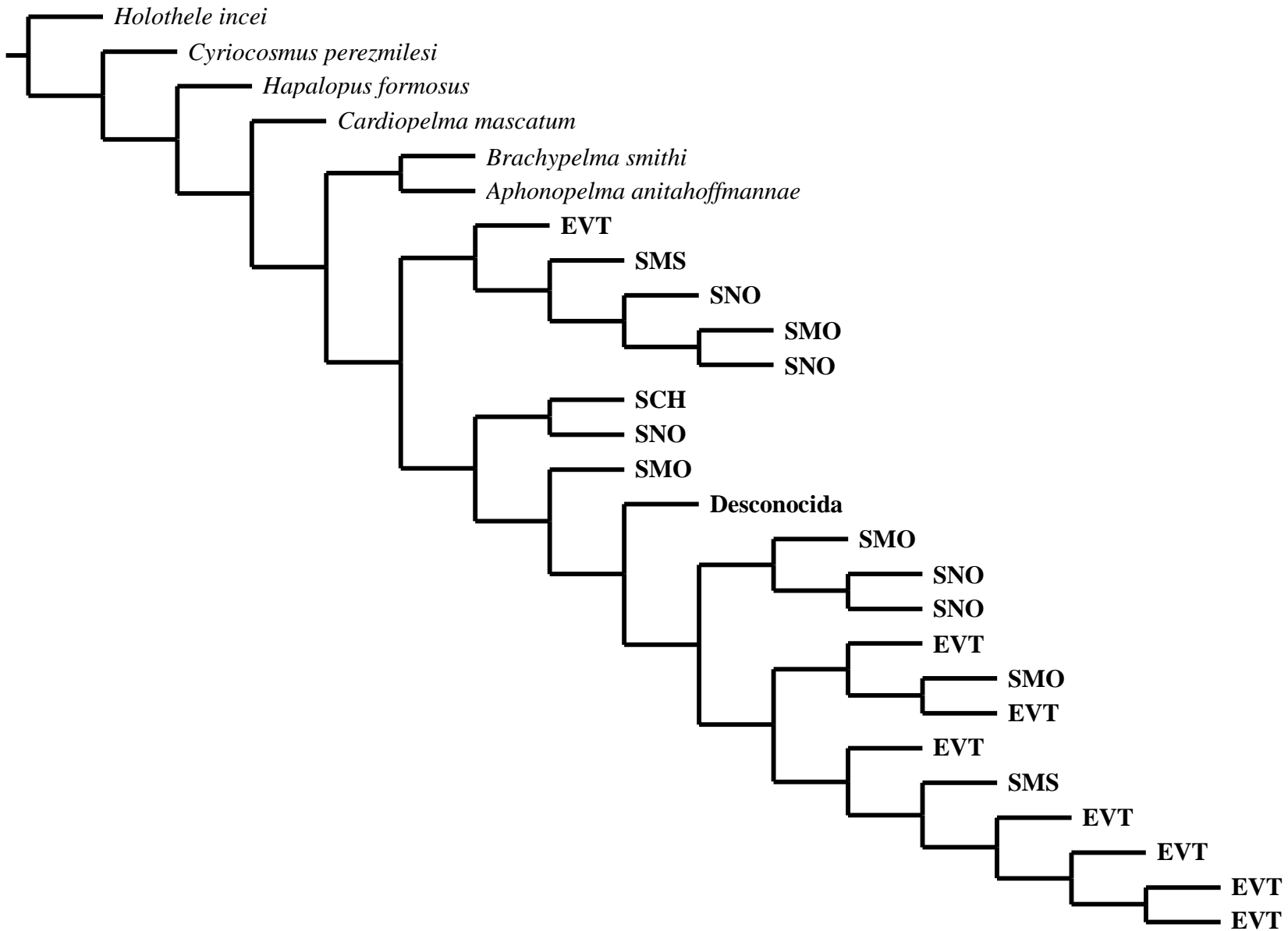


Figura 9. Árbol Parsimonia Brooks con áreas de distribución de *Hemirrhagus*

