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Type material of Acanthocephala, Nematoda and other non-helminths phyla (Cnidaria, Annelida, and Arthropoda) housed in the Helminthological Collection of the Oswaldo Cruz Institute/ FIOCRUZ (CHIOC), Rio de Janeiro, Brazil, from 1979 to 2016

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Abstract

The third part of the catalogue of type material in the Helminthological Collection of the Oswaldo Cruz Institute/FIOCRUZ (CHIOC), comprising types deposited between 1979 and 2016, is presented to complement the first list of all types that was published in 1979. This part encompasses Acanthocephala, Nematoda and the other non-helminth phyla Cnidaria, Annelida, and Arthropoda. Platyhelminthes was covered in the first (Monogenoidea) and second (Rhabditophora Trematoda and Cestoda) parts of the catalogue published in September 2016 and March 2017, respectively. The present catalogue comprises type material for 116 species distributed across five phyla, nine classes, 50 families, and 80 genera. Specific names are listed systematically, followed by type host, infection site, type locality, and specimens with their collection numbers and references. Species classification and nomenclature are updated.

Keywords
Acanthocephalans, annelids, catalogue, copepods, holotype, myxozoans, nematodes, parasites, paratype

Introduction

The century-old Helminthological Collection of the Oswaldo Cruz Institute/FIOCRUZ (CHIOC), Rio de Janeiro, Brazil, contains helminths that form part of the fauna of Brazil, and other countries, and are from a wide range of hosts captured in a variety of different biomes. The samples are holotypes, paratypes, and representative specimens of Platyhelminthes, Acanthocephala, Nematoda, and other non-helminth phyla. The CHIOC holds around 38,400 samples of helminth parasites from South America and other continents, and represents the largest such collection in Latin America and one of the largest collections worldwide (Rego 1982, Knoff et al. 2010). Details about the history and composition of CHIOC were presented in Lopes et al. (2016).

The first catalogue of all type material held in the CHIOC recorded 719 types of helminths (only holotypes or type series): 408 nematodes, 216 digenetic trematodes, 11 monogenoids, 52 acanthocephalans, 28 cestodes, and four of pentastomids (Rego et al. 1979). Since its publication, the collection has grown substantially with the number of types increasing significantly as well. Recently, Lopes et al. (2016, 2017) published another catalogue listing 203 type species of Monogenoidea and 104 type species of the other three classes of platyhelminths (Rhabditophora, Trematoda, and Cestoda). Thus, the present catalogue is the third list of type species held in this collection, and encompasses those of Acanthocephala, Nematoda, and the non-helminth phyla Cnidaria, Annelida and Arthropoda that have been deposited in CHIOC since 1979. The purpose of this article is to inform the scientific community about the types deposited in CHIOC as of December 1, 2016, and follows the articles of the International Code of Zoological Nomenclature (ICZN 1999).

Materials and methods

The specimens are stored in glass or plastic vials in 70% ethanol (with or without 5% glycerin), 4–10% formaldehyde (with or without 2% acetic acid), 70% ethanol-formaldehyde-acetic acid (AFA) or as microscope slide preparations. All the material is available for consultation, but holotypes are not loaned. Unless otherwise stated, all type material is in good condition.

The catalogue is arranged taxonomically as phyla, classes, orders, families, genera, and species, under the original spelling and combinations. Phyla and classes are arranged phylogenetically, starting with helminth phyla. Orders, families, genera, and species are arranged alphabetically. The information on each entry is presented in the following format:

1. Original genus-species combination with author(s) and year of publication. An asterisk (*) denotes the type species of the genus.
2. Type host: updated scientific name, author(s) and year, with original scientific name in square brackets (when changed), followed by principal taxonomic group in parentheses.
3. Infection site in the host.
4. Type locality: country, province or state, department, specific locality and coordinates (if available).
5. Primary type status: sex (if applicable/ possible), CHIOC catalog number. Categories for types follow articles 73–75 of the Code (ICZN 1999).
6. Remark sections are inserted when necessary and include additional information about host, locality, or status of the types.
7. References include publications in which the species was described and those that mention type specimens in the CHIOC.

The valid names adopted for parasitized hosts follow specific bibliographies. Diplopod names are in accordance with Pérez-Asso (1996); beetles with Boucher (2005); crustaceans with Young (1998); fishes with Froese and Pauly (2016); amphibians with Frost (2016); reptiles with Uetz et al. (2016); birds with Lepage and Warnier (2014); and mammals with Wilson and Reeder (2005). Mention of acanthocephalans, nematodes, myxozoans, annelids, copepods, and host species in this list does not imply that the authors of the present report agree with their validity or taxonomy. Some species catalogued have been synonymized and the comments about their taxonomy are provided in the remark sections. The higher classification of Acanthocephala follows Amin (1985, 2013); Nematoda follows De Ley and Blaxter (2002, 2004); Myxozoa follows Fiala et al. (2015); Annelida follows Beesley et al. (2000) and Sawyer (1986); and Copepoda follows Martin and Davis (2001). The classification of families and genera follows specific references.

Abbreviation list

BMNH	British Museum of Natural History, Collection at the Department of Zoology, Natural History Museum, London, England;
CHFC	Helminthological Collection of the Science College, University of the Republic, Montevideo, Uruguay;
CHIBB	Reference Helminthological Collection of the Parasitology Department, Bioscience Institute, Paulista State University (UNESP), Botucatu, São Paulo, Brazil;
CHIOC	Helminthological Collection of the Oswaldo Cruz Institute, FIOCRUZ, Rio de Janeiro, Brazil;

CHIP–URG	Helminthological Collection of the Laboratory of Ichthyoparasitology, University of Rio Grande, Rio Grande, Rio Grande do Sul, Brazil;
CHMLP/MLP	Helminthological Collection of the Museum of La Plata, La Plata, Buenos Aires, Argentina;
CMNPA	Canadian Museum of Nature Invertebrate Collections-Parasites, Ottawa, Canada;
CNHE	National Collection of Helminths, Institute of Biology, National Autonomous University of Mexico, Mexico City, Mexico;
CZACC	Helminthological Collection of the Zoological Collections, Institute of Ecology and Systematic, Havana, Cuba;
FCAV/UNESP	Helminthological Collection of the Parasitic Diseases Laboratory, Department of Preventive Veterinary Medicine, Paulista State University, São Paulo, Brazil;
HWML	Harold W. Manter Laboratory, University of Nebraska State Museum, Lincoln, Nebraska, USA;
INPA	National Institute for Amazon Research, Manaus, Amazonas, Brazil;
IPCAS/IPCR/ASCR	Institute of Parasitology, Academy of Sciences of the Czech Republic, České Budějovice, Czech Republic;
MNHN/INVE	National Museum of Natural History, Paris, France;
MNRJ	Carcinological Collection of the National Museum of Rio de Janeiro, Rio de Janeiro, Brazil;
RIT	Royal Belgian Institute of Natural Sciences, Brussels, Belgium;
RMCA	Collection of the Royal Museum of Central Africa, Tervuren, Belgium;
USNM	United States National Museum, Smithsonian Institution, Washington, D.C, USA;
USNPC	United States National Parasitological Collection, Beltsville, Maryland, USA.

Results and discussion

This database and bibliographic survey provides the diversity types of Acanthocephala, Nematoda and other non-helminth phyla, such as Cnidaria (Myxozoa), Annelida (Polychaeta and Hirudinea) and Arthropoda (Copepoda), in CHIOC, from Brazil and other countries of the world, for a period of more than 35 years of parasitological studies. This catalogue adds 38 primary types of Acanthocephala, represented by eight species distributed among eight families and eight genera; approximately 420 primary types of Nematoda, represented by 99 species, distributed across 36 families and 64 genera; four primary types of Myxozoa, represented by one family, two genera and two species; eight primary types of one species of Polychaeta and six primary types of one species of Hirudinea; and 22 primary types of Copepoda, represented by five species, distributed in three families, and four genera. The most representative families were the nematode families Cucullanidae, with 18 species, followed by Pharyngodonidae, with seven.

One hundred and sixteen parasites of 101 species of vertebrate and eight species of invertebrate hosts were catalogued. The invertebrate hosts were beetles, diplopods, and crustaceans. Most of the type species recorded (47%) were parasites of bony fishes, such as those of Monogenoidea, Trematoda, and Cestoda (Lopes et al. 2016, 2017). Only one species was a parasite of cartilaginous fishes. The hosts of parasite species of Tetrapoda were frogs, birds, reptiles, and mammals. Cricetidae (Rodentia) was the host family that exhibited the greatest diversity of parasites, with ten species.

Among the Acanthocephala listed, five species were parasites of bony fishes, one species was a parasite of frogs (Bufonidae), one species was a parasite of birds (Phalacrocoracidae), and one species was a parasite of crab-eating foxes (Canidae). Among the nematodes, five species were parasites of beetles (Passalidae) and two were parasites of diplopods (Rhinocricidae and Spirobolellidae). Species of nematode parasites of fishes included 41 of bony fishes and only one of cartilaginous fishes (Arhynchobatidae). Three nematode species were parasites of frogs (Bufonidae). The nematodes parasites of reptiles included five species parasitic on the suborder Autarchoglossa (Gymnophthalmidae, Scincidae and Teiidae), five parasites of snakes (Boidae, Colubridae, and Viperidae), and three parasites of lizards (Hoplocercidae, Liolaemidae, and Tropiduridae). Nine nematode species were parasites of birds (Ardeidae, Bucconidae, Cuculidae, Dendrocolaptidae, Opisthocomidae, Threskiornithidae, Tinamidae, and Tyrannidae). Species of nematode parasites of mammals included 16 parasites of rodents (Caviidae, Cricetidae, Dasyproctidae, Echimyidae, and Muridae), four parasites of the order Carnivora (Canidae, Felidae, and Mustelidae), two parasites of armadillos (Dasypodidae), two parasites of opossums (Didelphidae), and one parasite of bats (Molossidae). Myxozoans and copepods parasitized bony fishes. The single polychaeta species was a parasite of freshwater crayfish (Parastacidae) and the single Hirudinea species was a parasite of turtles (Podocnemididae).

Most of the species catalogued were collected in Brazil (88%), coming from all regions of the country. Other countries with cataloged material are from America (United States, Mexico, Panama, Colombia, Venezuela, Bolivia, and Argentina), the Caribbean (Cuba) and Africa (Democratic Republic of Congo). This third part of the catalogue of type material housed in CHIOC from 1979 to 2016 includes, in total, 423 species of parasites from 251 different hosts caught in almost all Brazilian states, and almost all continents, with the exception of the Middle East and Oceania (Lopes et al. 2016, 2017). Most of the deposits were made by Brazilian researchers, but foreigners also made a significant contribution, expanding and diversifying the country's known parasitological heritage. All these data testify to the importance of CHIOC and its recognition on the world stage as a depositary, and serve as testimony of helminth parasite biodiversity, thereby placing CHIOC among the most significant collections of the world.

List of type species

Phylum Acanthocephala Kohlreuther, 1771
Class Archiacanthocephala Meyer, 1931
Order Oligacanthorhynchida Petrochenko, 1956
Oligacanthorhynchidae Southwell & Macfie, 1925
***Prosthenorchis* Travassos, 1915**

Prosthenorchis cerdocyonis Gomes, Olifiers, Souza, Barbosa, D'Andrea, & Maldonado Jr., 2015

Type host. *Cerdocyon thous* (Linnaeus, 1766) (Carnivora: Canidae).
Infection site. Small intestine.
Type locality. Brazil, Mato Grosso do Sul State, Nhumirim Ranch (18°59'S, 56°39'W).
Holotype. ♂ CHIOC 35804 a.
Paratypes. CHIOC 35804 b (allotype ♀), 30812 c (5♀♀, 6♂♂).
Reference. Gomes et al. (2015).

Class Eoacanthocephala Van Cleave, 1936
Order Gyracanthocephala Van Cleave, 1936
Quadrigyridae Van Cleave, 1920
***Machadosentis* Noronha, 1992**

**Machadosentis travassosi* Noronha, 1992

Type host. *Gymnothorax ocellatus* Agassiz, 1831 (Osteichthyes: Muraenidae).
Infection site. Intestine.
Type locality. Brazil, Bahia State, Arembepe.
Syntypes. CHIOC 32742 a–b (♂♂), c (♀).
Remarks. CHIOC 32742 a–c referred as type material in the original description.
Reference. Noronha (1992).

Order Neoechinorhynchida Southwell & MacFie, 1925
Neoechinorhynchidae (Ward, 1917) Van Cleave, 1928
***Neochinorhynchus* Stiles & Hassal, 1905**

Neoechinorhynchus pimelodi Brasil-Sato & Pavanelli, 1998

Type host. *Pimelodus maculatus* Lacépède, 1803 (Osteichthyes: Pimelodidae).
Infection site. Anterior intestine.
Type locality. Brazil, Minas Gerais State, São Francisco River basin, Três Marias.
Holotype. ♂ CHIOC 33718 a.

Paratypes. CHIOC 33718 b (allotype ♀), c, e (♂♂), d (♀).
Remarks. Other paratypes deposited in USNPC.
Reference. Brasil-Sato and Pavanelli (1998).

Class Palaeacanthocephala Meyer, 1931
Order Echinorhynchida Southwell & MacFie, 1925
Arhythmacanthidae Yamaguti, 1935
Heterosentis Van Cleave, 1931

Heterosentis brasiliensis Vieira, Felizardo & Luque, 2009

Type host. *Pseudopercis numida* Miranda-Ribeiro, 1903 (Osteichthyes: Pinguipedidae).
Infection site. Intestine.
Type locality. Brazil, Rio de Janeiro State, Cabo Frio (22°52'43.26"S, 42°1'11.55"W).
Holotype. ♂ CHIOC 37103.
Paratypes. CHIOC 36672 (♂), 37104 (allotype ♀), 37105 (♀).
Reference. Vieira et al. (2009).

Diplosentidae Tubangui & Masilungan, 1937
Amapacanthus Salgado-Maldonado & Santos, 2000

**Amapacanthus amazonicus* Salgado-Maldonado & Santos, 2000

Type host. *Sciades passany* (Valenciennes, 1840) [= *Arius passany*] (Osteichthyes: Ariidae).
Infection site. Intestine.
Type locality. Brazil, Amapá State, Maraca Island (2°0'N, 50°24'W).
Holotype. ♂ CHIOC 34199 a.
Paratypes. CHIOC 34199 b (allotype ♀), c–j (♀♀).
Remarks. Other paratypes deposited in CNHE and BMNH.
Reference. Salgado-Maldonado and Santos (2000).

Echinorhynchidae Cobbold, 1876
Acanthocephalus Koelreuter, 1771

Acanthocephalus ula Lent & Santos, 1989

Type host. *Atelopus oxyrhynchus* Boulenger, 1903 (Amphibia: Bufonidae).
Infection site. Small intestine.
Type locality. Venezuela, Mérida.
Holotype. ♂ CHIOC 32173.
Paratypes. CHIOC 31667, 32174 (allotype ♀), 32175 a–b (♂♂).
Reference. Lent and Santos (1989).

Gymnorhadinorhynchidae Braicovich, Lanfranchi, Farber, Marvaldi, Luque & Timi, 2014
Gymnorhadinorhynchus Braicovich, Lanfranchi, Farber, Marvaldi, Luque & Timi, 2014

**Gymnorhadinorhynchus decapteri* Braicovich, Lanfranchi, Farber, Marvaldi, Luque & Timi, 2014

Type host. *Decapterus punctatus* (Cuvier, 1829) (Osteichthyes: Carangidae).

Infection site. Intestine.

Type locality. Brazil, Rio de Janeiro State, Cabo Frio (22°53'S, 42°00'W).

Holotype. ♂ CHIOC 35941 a.

Paratypes. CHIOC 35941 b (allotype ♀), 35941 c (♂), d–e (♀♀).

Remarks. Two additional paratypes deposited in the IPCAS collection.

Reference. Braicovich et al. (2014).

Order Polymorphida Petrochenko, 1956
Polymorphidae Meyer, 1931
Andracantha Schmidt, 1975

Andracantha tandemtesticulata Monteiro, Amato & Amato, 2006

Type host. *Phalacrocorax brasilianus* (Gmelin, 1789) (Aves: Phalacrocoracidae).

Infection site. Small and large intestine.

Type locality. Brazil, Rio Grande do Sul State, Guaíba Lake, Guaíba (30°00'S, 51°15'W).

Holotype. ♂ CHIOC 36630 a.

Paratypes. CHIOC 36630 b (allotype ♀), 36630 c (♀).

Reference. Monteiro et al. (2006).

Phylum Nematoda Potts, 1932
Class Enoplea Inglis, 1983
Order Trichinellida Hall, 1916
Capillariidae Railliet, 1915
Capillostrongyloides Freitas & Lent, 1935

Capillostrongyloides arapaimae Santos, Moravec & Venturieri, 2008

Type host. *Arapaima gigas* (Schinz, 1822) (Osteichthyes: Arapaimidae).

Infection site. Anterior part of intestine and pyloric caeca.

Type locality. Brazil, Pará State, Mexiana Island (Amazon River delta), natural canals and breeding tanks of fish farm at Santo Ambrósio Farm (00°05'30"S, 49°34'50"W).

Holotype. ♂ CHIOC 35559 a.

Paratypes. CHIOC 35559 b (allotype ♀), 35559 c–d (♂, ♀).

Reference. Santos et al. (2008a).

Pseudocapillaria (*Ichthyocapillaria*) Moravec, 1982

Pseudocapillaria (*Ichthyocapillaria*) *maricaensis* Rodrigues, 1992

Type host. *Liolaemus lutzae* Mertens, 1938 (Iguania: Liolaemidae).

Infection site. Small intestine.

Type locality. Brazil, Rio de Janeiro State, Maricá.

Holotype. ♂ CHIOC 32796 a.

Paratypes. CHIOC 32796 b (2♂♂), c (3♂♂), d (4♀♀), e (5♀♀), f (6♀♀), g (7♀♀), h (8♀♀), i (9♀♀).

Reference. Rodrigues (1992).

Trichuridae Ransom, 1911
Trichuris Roederer, 1761

Trichuris thrichomysi Lopes Torres, Nascimento, Menezes, Garcia, Santos, Maldonado Jr., Miranda, Lanfredi & Souza, 2011

Type host. *Thrichomys apereoides* Lund, 1839 (Rodentia: Echimyidae).

Infection site. Cecum.

Type locality. Brazil, Minas Gerais State, Capitão Andrade (19°02'14"S, 41°49'59"W).

Holotype. ♂ CHIOC 35210 a.

Paratypes. CHIOC 35710 b (allotype ♀), 35710 c (♂), 37365 a–b (♂♂), 37365 c (♀).

Reference. Lopes Torres et al. (2011).

Trichuris travassosi Gomes, Lanfredi, Pinto & Souza, 1992

Type host. *Oligoryzomys nigripes* (Olfers, 1818) [= *Oryzomys nigripes*] (Rodentia: Cricetidae).

Infection site. Large intestine.

Type locality. Brazil, Rio Grande do Sul State, Arvorezinha (28°45'S, 52°15'W).

Holotype. ♂ CHIOC 32790 a.

Paratypes. CHIOC 32790 b (♀), 32791 a–b, f–g, m (♀♀), c–e, h–l (♂♂).

Reference. Gomes et al. (1992).

Class Chromadorea Inglis, 1983
Order Rhabditida Chitwood, 1933
Acuariidae Railliet, Henry & Sissoff, 1912
Deliria Vicente, Pinto & Noronha, 1980

**Deliria gomesae* Vicente, Pinto & Noronha, 1980

Type host. *Pitangus sulphuratus* (Linnaeus, 1766) (Aves: Tyrannidae).

Infection site. Stomach.

Type locality. Brazil, Rio de Janeiro State, Rio de Janeiro, Raimundo Island.

Holotype. ♂ CHIOC 31780 a.

Paratypes. CHIOC 31780 b–c, g–h (♀♀), d–f (♂♂).

Remarks. There is no paratype “i” as indicated in the original description, which was a mistake.

Reference. Vicente et al. (1980).

Anisakidae Railliet & Henry, 1912
Goezia Zeder, 1800

Goezia brasiliensis Moravec, Kohn & Fernandes, 1994

Type host. *Brycon hilarii* (Valenciennes, 1850) (Osteichthyes: Bryconidae).

Infection site. Stomach.

Type locality. Brazil, Paraná State, Paraná River, Foz do Iguaçú.

Paratype. ♀ CHIOC 32961.

Remarks. Holotype and allotype deposited in the IPCAS collection.

Reference. Moravec et al. (1994).

Goezia leporini Martins & Yoshitoshi, 2003

Type host. *Leporinus macrocephalus* Garavello & Britski, 1988 (Osteichthyes: Anostomidae).

Infection site. Stomach.

Type locality. Brazil, São Paulo State, Batatais.

Holotype. ♂ CHIOC 34675 a.

Paratypes. CHIOC 34675 b (allotype ♀), 34675 c (♂♂), 34675 d (♀♀).

Reference. Martins and Yoshitoshi (2003).

Pseudanisakis Layman & Borovkova, 1926

Pseudanisakis sulamericana Santos, Lent & Gibson, 2004

Type host. *Rioraja agassizii* (Müller & Henle, 1841) (Chondrichthyes: Arhynchobatidae).

Infection site. Intestine.

Type locality. Brazil, São Paulo State, off Ubatuba (23°30'S, 45°00'W).

Holotype ♂ and allotype ♀. CHIOC 35235.

Paratypes. CHIOC 35236, 35237.

Remarks. CHIOC 35237 collected from *Psammobatis extenta* (Garman, 1913) (Arhynchobatidae). Other paratypes deposited in the BMHN collection.

Reference. Santos et al. (2004).

Raphidascaris (*Sprentascaris*) (Petter & Cassone, 1984) Moravec, Kohn & Fernandes, 1990

Raphidascaris (*Sprentascaris*) *lanfrediae* Melo, Santos, Giese, Santos & Santos, 2011

Type host. *Satanoperca jurupari* (Heckel, 1840) (Osteichthyes: Cichlidae).

Infection site. Intestine.

Type locality. Brazil, Pará State, Belém, Guamá River (01°27'21"S, 48°30'14"W).

Holotype ♂. CHIOC 35714 a.

Paratypes. CHIOC 35714 b–c (5♀♀, 4♂♂).

Remarks. Paratype from CHIOC cited as "35716" in the original description due to a mistake.

Reference. Melo et al. (2011).

Raphidascaroides Railliet & Henry, 1915

Raphidascaroides moraveci Pereira, Tavares, Scholz & Luque, 2015

Type host. *Platydoras armatulus* (Valenciennes, 1840) (Osteichthyes: Doradidae).

Infection site. Intestine.

Type locality. Brazil, Mato Grosso do Sul State, Miranda River (19°34'S, 57°00'W).

Holotype ♂ and allotype ♀. CHIOC 36728 a.

Paratypes. CHIOC 36728 b (3♂♂, 3♀♀), c (hologenophore).

Remarks. Other paratypes deposited in the IPCAS collection.

Reference. Pereira et al. (2015).

Aproctidae Yorke & Maplestone, 1926
Aprocta Linstow, 1883

Aprocta brevipenis Rodrigues & Rodrigues, 1980

Type host. *Guira guira* (Gmelin, 1788) (Aves: Cuculidae).

Infection site. Ocular cavity.

Type locality. Brazil, São Paulo State, Ilha Seca.

Holotype. ♂ CHIOC 31808 a.

Paratypes. CHIOC 31808 b (allotype ♀), 31808 c–d (♀♀).

Reference. Rodrigues and Rodrigues (1980).

Ascaridiidae Travassos, 1919
Ophidascaris Baylis, 1920

Ophidascaris durissus Panizzutti, Santos, Vicente, Muniz-Pereira & Pinto, 2003

Type host. *Crotalus durissus* Linnaeus, 1758 (Serpentes: Viperidae).

Infection site. Stomach.

Type locality. Brazil, Paraná State, Itaipú Binacional Reserve, Foz do Iguaçú (24°05'–25°33'S, 54°00'–54°37'W).

Holotype. CHIOC 34937 a.

Paratypes. CHIOC 34937 b–f.

Reference. Panizzuti et al. (2003).

Ophidascaris tuberculatum Siqueira, Panizzutti, Muniz-Pereira & Pinto, 2005

Type host. *Bothrops jararaca* (Wied-Neuwied, 1824) (Serpentes: Viperidae).

Infection site. Stomach.

Type locality. Brazil, Rio de Janeiro State, Petrópolis, Serra das Araras (22°30'39"S, 43°11'4"W), 857 m high.

Holotype. ♂ CHIOC 36232 a.

Paratypes. CHIOC 35315, 36232 b (allotype ♀), 36232 c (♀), d (anterior extremity).

Reference. Siqueira et al. (2005).

Aspidoderidae Skrjabin & Schikhobalova, 1947
Aspidodera Railliet & Henry, 1912

Aspidodera sogandaresi Jiménez-Ruiz, Gardner & Varela-Stokes, 2006

Type host. *Dasypus novemcinctus* Linnaeus, 1758 (Cingulata: Dasypodidae).

Infection site. Large intestine.

Type locality. United States, Texas, El Pedregal, 18 miles north by road (U.S. 281) from Lampasas (31°19'34"N, 98°09'33"W), 311 m high.

Paratypes. CHIOC 35429 (4♂♂, 4♀♀), 35430 (10♂, 10♀), 35431 (3♂♂, ♀).

Remarks. There are two paratypes in CHIOC collected from Mexico, but there are some inconsistencies with regard to the collecting localities in the original description and the cataloging data. Holotype, allotype, and other paratypes are deposited in the HWML collection. Additional paratypes are deposited in CMNPA, CNHE, and USNM.

Reference. Jiménez-Ruiz et al. (2006).

Aspidodera vicentei Pinto, Kohn, Fernandes & Mello, 1982

Type host. *Nectomys squamipes* (Brants, 1827) (Rodentia: Cricetidae).

Infection site. Small intestine.

Type locality. Brazil, Goiás State, Formosa.

Holotype. ♂ CHIOC 31879 a.

Paratypes. CHIOC 31879 b–f.

Reference. Pinto et al. (1982).

Camallanidae Railliet & Henry, 1915

Camallanus Railliet & Henry, 1915

Camallanus acaudatus Ferraz & Thatcher, 1990

Type host. *Osteoglossum bicirrhosum* (Cuvier, 1829) (Osteichthyes: Osteoglossidae).

Infection site. Intestine.

Type locality. Brazil, Amazonas State, Anavilhanas Archipelago, Negro River.

Paratypes. CHIOC 32557 a–b (♂, ♀).

Remarks. Holotype and allotype deposited in the INPA collection. CHIOC numbers were not included in the original description.

Reference. Ferraz and Thatcher (1990).

Camallanus maculatus Martins, Garcia, Piazza & Ghiraldelli, 2007

Type host. *Xiphophorus maculatus* (Günther, 1866) (Osteichthyes: Poeciliidae).

Infection site. Intestine.

Type locality. Brazil, São Paulo State, Araraquara.

Holotype ♂, allotype ♀ and paratypes. CHIOC 35283.

Reference. Martins et al. (2007).

Paracamallanus Yorke & Maplestone, 1926

Paracamallanus amazonensis Ferraz & Thatcher, 1992

Type host. *Hypophthalmus edentatus* Spix & Agassiz, 1829 (Osteichthyes: Pimelodidae).

Infection site. Intestine.

Type locality. Brazil, Amazonas State, Marchantaria Island, Solimões River.

Paratypes. CHIOC 32756 (♂), 32757 (♀).

Remarks. Holotype, allotype and other paratypes deposited in the collection of INPA. CHIOC numbers were not included in the original description.

Reference. Ferraz and Thatcher (1992).

Procamallanus (*Procamallanus*) (Baylis, 1923) Ali, 1957

Procamallanus (*Procamallanus*) *annipetterae* Kohn & Fernandes, 1988

Type host. *Hypostomus albopunctatus* (Regan, 1908) (Osteichthyes: Loricariidae).

Infection site. Intestine.

Type locality. Brazil, Paraná State, Iguaçú River, Hydroelectric Power station Salto Osório.

Holotype. ♂ CHIOC 32430 a.

Paratype. CHIOC 32430 b (allotype ♀).

References. Kohn and Fernandes (1988a, b).

Procamallanus (*Spirocamallanus*) (Olsen, 1952) Moravec & Sey, 1988

Procamallanus (*Spirocamallanus*) *belenensis* Giese, Santos & Lanfredi, 2009

Type host. *Ageneiosus ucayalensis* Castelnau, 1855 (Osteichthyes: Auchenipteridae).

Infection site. Intestine.

Type locality. Brazil, Pará State, Belém, Guajará Bay (1°15'–1°29'S, 48°32'–48°29'W).

Holotype. ♂ CHIOC 35604 a.

Paratypes. CHIOC 35604 b (allotype ♀), 35604 c.

Reference. Giese et al. (2009).

Procamallanus (*Spirocamallanus*) *pintoi* Kohn & Fernandes, 1988

Type host. *Corydoras paleatus* (Jenyns, 1842) (Osteichthyes: Callichthyidae).

Infection site. Intestine.

Type locality. Brazil, Paraná State, Iguaçú River, Hydroelectric Power station Salto Osório.

Holotype. ♂ CHIOC 32432 a.

Paratypes. CHIOC 32431 a (allotype ♀), 32431 b (♂), 32432 b–c (♀♀).

Reference. Kohn and Fernandes (1988a).

Carnoyidae Filipjev, 1934
Carnoya Gilson, 1898

Carnoya isabelica García & Morffe, 2014

Type host. *Nesobolus piedra* Pérez-Asso, 1996 (Diplopoda: Rhinocricidae).

Infection site. Hind gut.

Type locality. Cuba, Santiago de Cuba province, La Gran Piedra, La Isabelica, (20°00'32.68"N, 75°37'18.8"W).

Paratypes. CHIOC 38210 a–b (2♂♂, 3♀♀).

Remarks. Holotype female and other paratypes males and females deposited in CZACC.

Reference. García and Morffe (2014).

Cosmocercidae Railliet, 1916
Cosmocercoides Wilkie, 1930

Cosmocercoides sauria Ávila, Strüssmann & Silva, 2010

Type host. *Iphisa elegans* Gray, 1851 (Autarchoglossa: Gymnophthalmidae).

Infection site. Large intestine.

Type locality. Brazil, Mato Grosso State, São Domingos Valley (15°07'S, 58°58'W).

Holotype. ♂ CHIOC 35654 a.

Paratype. CHIOC 35654 b (allotype ♀).

Remarks. Three paratypes deposited in CHIBB.

Reference. Ávila et al. (2010).

Crenosomatidae Skrjabin, 1933
Crenosoma Molin, 1861

Crenosoma brasiliense Vieira, Muniz-Pereira, Lima, Moraes Neto, Guimarães & Luque, 2012

Type host. *Galictis cuja* (Molina, 1782) (Carnivora: Mustelidae).

Infection site. Bronchi and bronchioles.

Type locality. Brazil, Minas Gerais State, Juiz de Fora (21°76'S, 43°21'W).

Holotype. ♂ CHIOC 35813 a.

Paratypes. CHIOC 35813 b (allotype ♀), 35813 c (♂), 35813 d (2♀♀).

Remarks. One paratype male and two females deposited in the IPCAS collection.

Reference. Vieira et al. (2012).

Cucullanidae Cobbold, 1864

Cucullanus Mueller, 1777

Cucullanus ageneiosi Giese, Lanfredi & Santos, 2010

Type host. *Ageneiosus ucayalensis*

Infection site. Small intestine.

Type locality. Brazil, Pará State, Belém, Guajará Bay (1°15'–1°29'S, 48°32–48°29'W).

Holotype. ♂ CHIOC 35657 a.

Paratype. CHIOC 35657 b (allotype♀).

Reference. Giese et al. (2010).

Cucullanus brevicaudatus Pereira, Vieira & Luque, 2014

Type host. *Balistes capriscus* Gmelin, 1789 (Osteichthyes: Balistidae).

Infection site. Intestine.

Type locality. Brazil, Rio de Janeiro State, Angra dos Reis Bay (23°00'S, 44°–10'W).

Holotype. ♂ CHIOC 35896 a.

Paratypes. CHIOC 35896 b (allotype ♀), 35897 (3♂♂, 3♀♀).

Remarks. Two paratypes males and two females deposited in the IPCAS collection.

Reference. Pereira et al. (2014c).

Cucullanus brevispiculus Moravec, Kohn & Fernandes, 1993

Type host. *Auchenipterus nuchalis* (Spix & Agassiz, 1829) (Osteichthyes: Auchenipteridae).

Infection site. Intestine.

Type locality. Brazil, Paraná State, Foz do Iguaçú, Reservoir of the hydroelectric power station of Itaipú.

Holotype. ♂ CHIOC 32951.

Remarks. One specimen deposited, no paratypes.

Reference. Moravec et al. (1993).

Cucullunus cassinensis Pereira Jr. & Costa, 1996

Type host. *Micropogonias furnieri* (Desmarest, 1823) (Osteichthyes: Sciaenidae).

Infection site. Digestive tract.

Type locality. Brazil, Rio Grande do Sul State, Rio Grande.
Holotype. ♀ CHIOC 33655.
Paratype. CHIOC 33656 (allotype ♂).
Remarks. Other paratypes deposited in CHIP-URG.
Reference. Pereira Jr. and Costa (1996).

Cucullanus gastrophysi Pereira, Vieira & Luque, 2015 in Vieira et al. (2015)

Type host. *Lophius gastrophysus* Miranda-Ribeiro, 1915 (Osteichthyes: Lophiidae).
Infection site. Intestine.
Type locality. Brazil, Rio de Janeiro State, Cabo Frio (22°52' S, 42°01' W).
Holotype. ♂ CHIOC 36745 a.
Paratypes. CHIOC 36745 b (allotype ♀), 36746 (2♂♂, 2♀♀).
Remarks. One paratype male and one female deposited in the IPCAS collection.
Reference. Vieira et al. (2015).

Cucullanus protudens Pereira, Vieira & Luque, 2015 in Vieira et al. (2015)

Type host. *Pagrus pagrus* (Linnaeus, 1758) (Osteichthyes: Sparidae).
Infection site. Intestine.
Type locality. Brazil, Rio de Janeiro State, Cabo Frio (22°52'S, 42°01'W).
Holotype. ♂ CHIOC 36747 a.
Paratypes. CHIOC 36747 b (allotype ♀), 36748 (♀).
Reference. Vieira et al. (2015).

Cucullanus pseudopercis Pereira, Vieira & Luque, 2015 in Vieira et al. (2015)

Type host. *Pseudopercis semifasciata* (Cuvier, 1829)
Infection site. Intestine.
Type locality. Brazil, Rio de Janeiro State, Cabo Frio (22°52' S, 42°01' W).
Holotype. ♂ CHIOC 36749 a.
Paratypes. CHIOC 36749 b (allotype ♀), 36750 (♂, ♀).
Remarks. One paratype male deposited in the IPCAS collection.
Reference. Vieira et al. (2015).

Cucullanus grandistomis (Ferraz & Thatcher, 1988)

Type host. *Oxydoras niger* (Valenciennes, 1821) (Osteichthyes: Doradidae).
Infection site. Intestine.
Type locality. Brazil, Amazonas State, Solimões River near Manaus.

Paratypes. CHIOC 32456 a–b (♂, ♀).

Remarks. Holotype and allotype deposited in the INPA collection. CHIOC numbers were not included in the original description.

Reference. Ferraz and Thatcher (1988).

Cucullanus heliomartinsi Moreira, Rocha & Costa, 2000

Type host. *Trachelyopterus striatulus* (Steindachner, 1877) [= *Parauchenipterus striatulus*] (Osteichthyes: Auchenipteridae).

Infection site. Intestine.

Type locality. Brazil, Minas Gerais State, Central Lake of the State Park of Rio Doce (19°50'S, 42°35'W).

Holotype. ♂ CHIOC 33863 a.

Paratype. CHIOC 33863 b (allotype ♀).

Reference. Moreira et al. (2000).

Cucullanus pimelodellae Moravec, Kohn & Fernandes, 1993

Type host. *Pimelodella lateristriga* (Lichtenstein, 1823) (Osteichthyes: Heptapteridae).

Infection site. Intestine.

Type locality. Brazil, Paraná State, Guaíra.

Paratype. CHIOC 32826 (♂).

Remarks. Holotype deposited in the ASCR collection.

Reference. Moravec et al. (1993).

Cucullanus pinnai pterodorasi Moravec, Kohn & Fernandes, 1997

Type host. *Pterodoras granulosus* (Valenciennes, 1821) (Osteichthyes: Doradidae).

Infection site. Intestine.

Type locality. Brazil, Paraná State, Guaíra (Paraná River basin), Reservoir of Itaipú.

Holotype ♂, allotype ♀ and paratype. CHIOC 33532.

Remarks. Paratype from CHIOC cited as "33697" in the original description due to a mistake. Other paratypes deposited in the ASCR collection.

Reference. Moravec et al. (1997).

Cucullanus pseudoplatystomae Moravec, Kohn & Fernandes, 1993

Type host. *Pseudoplatystoma corruscans* (Spix & Agassiz, 1829) (Osteichthyes: Pimelodidae).

Infection site. Intestine.

Type locality. Brazil, Paraná State, Paraná River, Guaíra.

Holotype. ♂ CHIOC 32829 a.

Paratypes. CHIOC 32829 b (allotype ♀), 32829 c–d, 32910, 32913, 32914.

Remarks. Other paratypes deposited in the ASCR collection.

Reference. Moravec et al. (1993).

Cucullanus rhamphichthydis Moravec, Kohn & Fernandes, 1997

Type host. *Rhamphichthys rostratus* (Linnaeus, 1766) (Osteichthyes: Rhamphichthyidae).

Infection site. Intestine.

Type locality. Brazil, Paraná State, Santa Helena, reservoir of the hydroelectric power station of Itaipú.

Holotype. ♀ CHIOC 33533.

Paratypes. CHIOC 33533 (2♀♀)

Remarks. Type material from CHIOC cited as "33716" in the original description due to a mistake. Other paratypes deposited in the ASCR collection.

Reference. Moravec et al. (1997).

Cucullanus tucunarensis Lacerda, Takemoto, Marchiori, Martins & Pavanelli, 2013

Type host. *Cichla piquiti* Kullander & Ferreira, 2006 (Osteichthyes: Cichlidae).

Infection site. Intestine.

Type locality. Brazil, Tocantins State, Lajeado reservoir (10°66'55"S, 48°42'36"W).

Holotype. ♀ CHIOC 35877 a.

Paratype. CHIOC 35877 b (allotype ♂).

Remarks. Other paratypes deposited in CNHE.

Reference. Lacerda et al. (2013).

Dichelyne (*Cucullanellus*) (Tornquist, 1931)

Dichelyne (*Cucullanellus*) *sciaenidicola* Timi, Lanfranchi, Tavares & Luque, 2009

Type host. *Umbrina canosai* Berg, 1895 (Osteichthyes: Sciaenidae).

Infection site. Posterior end of intestine.

Type locality. Argentina, Buenos Aires Province, Mar del Plata (38°08'S, 57°32'W).

Paratypes. CHIOC 35615 (5♂♂), 35616 (2♀♀), 35617 (5♂♂), 35618 (5♀♀).

Remarks. CHIOC 35617 and 35618 collected in Pedra de Guaratiba (23°01'S, 43°38'W), Rio de Janeiro (Rio de Janeiro State, Brazil) from the sciaenid fish *Micropogonias furnieri*. Holotype, allotype, and other paratypes deposited in CHMLP.

Reference. Timi et al. (2009).

Dichelyne (*Cucullanellus*) *tornquisti* Paschoal, Vieira, Cezar & Luque, 2014

Type host. *Orthopristis ruber* (Cuvier, 1830) (Osteichthyes: Haemulidae).

Infection site. Intestine.

Type locality. Brazil, coast of the Rio de Janeiro State (21–23°S, 42–45°W).

Holotype. ♂ CHIOC 35894 a.

Paratypes. CHIOC 35894 b (allotype ♀), 35895 (2♂♂, 2♀♀).

Remarks. One paratype male and two females deposited in the IPCAS collection.

Reference. Paschoal et al. (2014).

Dichelyne (*Dichelyne*) Jägerskiöld, 1902

Dichelyne (*Dichelyne*) *pimelodi* Moravec, Kohn & Fernandes, 1997

Type host. *Pimelodus maculatus*

Infection site. Intestine.

Type locality. Brazil, Paraná State, Guaíra (Paraná River basin), Reservoir of Itaipú.

Holotype. ♂ CHIOC 33534.

Remarks. Holotype cited as "33717" in the original description due to a mistake.

Reference. Moravec et al. (1997).

Dichelyne (*Dichelyne*) *micropogonii* Pereira Jr. & Costa, 1996

Type host. *Micropogonias furnieri*

Infection site. Digestive tract.

Type locality. Brazil, Rio Grande do Sul State, Rio Grande.

Holotype. ♀ CHIOC 33649.

Paratypes. CHIOC 33650 (allotype ♂), 33651 (♀), 33652 (♀), 33653 a–b (♂♂), 33654 (♂).

Remarks. Other paratypes deposited in CHIP-URG.

Reference. Pereira Jr. and Costa (1996).

Cystidicolidae Skrjabin, 1946

Ascarophis van Beneden, 1871

Ascarophis brasiliensis Pinto, Vicente & Noronha, 1984

Type host. *Trachinotus carolinus* (Linnaeus, 1766) (Osteichthyes: Carangidae).

Infection site. Stomach.

Type locality. Brazil, Rio de Janeiro State, Araruama (22°52'23"S, 42°20'20"W).
Holotype. ♂ CHIOC 32032 a.
Paratypes. CHIOC 32032 b–d, f, h (♀♀), e, g (♂♂), 32033 a–b (♀, ♂).
Reference. Pinto et al. (1984).

Comephoronema Layman, 1933

Comephoronema multipapillatum Pereira, Pereira & Luque, 2014

Type host. *Holocentrus adscensionis* (Osbeck, 1765) (Osteichthyes: Holocentridae).
Infection site. Anterior intestine and caecum.
Type locality. Brazil, Rio de Janeiro State, Angra dos Reis Bay.
Holotype. ♂ CHIOC 35879 a.
Paratypes. CHIOC 35879 b (allotype ♀), 35880 (♀), 35881 (♂), 35882 (♂).
Remarks. Two paratypes males and one female deposited in the IPCAS collection.
Reference. Pereira et al. (2014b).

Neoascarophis Skrjabin, 1946

Neoascarophis mariae Pereira, Timi, Vieira & Luque, 2012

Type host. *Mullus argentinae* Hubbs & Marini, 1933 (Osteichthyes: Mullidae).
Infection site. Stomach and intestine.
Type locality. Brazil, Rio de Janeiro State, Rio de Janeiro (22°55'S, 43°12'W).
Holotype. ♂ CHIOC 35802 a.
Paratypes. CHIOC 35802 b (15♀♀), 35803 a (allotype ♀), 35803 b (12♂♂).
Remarks. Other paratypes deposited in the IPCAS collection.
Reference. Pereira et al. (2012a).

Pseudascarophis Ko, Margolis & Machida, 1985

Pseudascarophis brasiliensis Pereira, Pereira, Timi & Luque, 2013

Type host. *Kyphosus sectatrix* (Linnaeus, 1758) (Osteichthyes: Kyphosidae).
Infection site. Stomach.
Type locality. Brazil, Rio de Janeiro State, Angra dos Reis (23°00'S, 44°10'W).
Holotype. ♂ CHIOC 35848 a.
Paratypes. CHIOC 35848 b (allotype ♀), 35849 a–b (2♂♂, 2♀♀).
Reference. Pereira et al. (2013).

Diplotriaenidae Skrjabin, 1916
Diplotriaena Railliet & Henry, 1909

Diplotriaena zederi Pinto, Vicente & Noronha, 1981

Type host. *Xiphocolaptes albicollis* (Vieillot, 1818) (Aves: Dendrocolaptidae).

Infection site. Body cavity.

Type locality. Brazil, Rio de Janeiro State, Angra dos Reis.

Holotype. ♂ CHIOC 31826 a.

Paratypes. CHIOC 31826 b–d, g (♂♂), e–f, h (♀♀), 31827 a (♂), b–c (♀♀).

Reference. Pinto et al. (1981).

Dracunculidae Stiles, 1907
Dracunculus Reichard, 1759

Dracunculus brasiliensis Moravec & Santos, 2009

Type host. *Eunectes murinus* (Linnaeus, 1758) (Serpentes: Boidae).

Infection site. Subcutaneous tissue (inside skin swelling) and body cavity (mesentery near lung).

Type locality. Brazil, Pará State, Mexiana Island (Amazon River delta), Santo Ambrósio Farm (00°05'30"S, 49°34'50"W).

Holotype. ♀ CHIOC 35610 a.

Remarks. Paratype deposited in the IPCAS collection.

Reference. Moravec and Santos (2009).

Habronematidae Chitwood & Wehr, 1932
Procyrnea Chabaud, 1975

Procyrnea anterovulvata Pinto, Vicente & Noronha, 1996

Type host. *Chelidoptera tenebrosa brasiliensis* Sclater, 1862 (Aves: Bucconidae).

Infection site. Gizzard.

Type locality. Brazil, Espírito Santo State, Conceição da Barra.

Holotype. ♂ CHIOC 32783 a.

Paratypes. CHIOC 32783 b (♂), 32783 c, e–f (♀♀), 32783 d (allotype ♀).

Reference. Pinto et al. (1996).

Heligmonellidae Durette-Desset & Chabaud, 1977
Freitastrongylus Gonçalves, Pinto & Durette-Desset, 2007

**Freitastrongylus angelae* Gonçalves, Pinto & Durette-Desset, 2007

Type host. *Dasyprocta fuliginosa* Wagler, 1832 (Rodentia: Dasyproctidae).

Infection site. Stomach.

Type locality. Brazil, Amazonas State, Barcelos, Jauari waterway, left margin of the Aracá River.

Holotype. ♂ CHIOC 35044 a.

Paratypes. CHIOC 34844, 35044 b (allotype ♀), c–f (♀♀), g–k (♂♂), l–m (synlophe ♂♂), n (synlophe).

Remarks. *Dasyprocta leporina* (Linnaeus, 1758) was cited as the type host in the original description, but *D. fuliginosa* is the host of all type material of CHIOC as indicated in the cataloguing data. Other male and female paratypes deposited in the MNHN collection.

Reference. Gonçalves et al. (2007).

Guerrerostrongylus Sutton & Durette-Desset, 1991

Guerrerostrongylus gomesae Simões, Santos & Maldonado Jr., 2012

Type host. *Oecomys mamorae* (Thomas, 1906) (Rodentia: Cricetidae).

Infection site. Small intestine.

Type locality. Brazil, Mato Grosso do Sul State, Rio Negro Farm, Aquidauana (19°34'54"S, 56°14'62"W).

Holotype. ♂ CHIOC 37233.

Paratypes. CHIOC 37234 (allotype ♀), 35667 (10♂♂, 6♀♀).

Reference. Simões et al. (2012).

Guerrerostrongylus marginalis Weirich, Catzeflis & Jiménez, 2016

Type host. *Oecomys auyantepui* Tate, 1939

Infection site. Small intestine.

Type locality. French Guiana, Municipality of Roura, Cacao (04°33'708"N, 52°26'590"W), 197 m high.

Paratypes. CHIOC 38104, 38105.

Remarks. Holotype, allotype and other paratypes deposited in the MNHN collection. Additional paratypes deposited in CNHE and HWML.

Reference. Weirich et al. (2016).

Hassalstrongylus Durette-Desset, 1971

Hassalstrongylus luquei Costa, Maldonado Jr., Bóia, Lucio & Simões, 2014

Type host. *Euryoryzomys russatus* (Wagner, 1848) (Rodentia: Cricetidae).

Infection site. Small intestine.

Type locality. Brazil, Rio de Janeiro State, Angra dos Reis, Ilha Grande (23°09'07.50"S, 44°13'44.20"W).

Holotype. ♂ CHIOC 35928 a.

Paratypes. CHIOC 35928 b–c (7♂♂).

Reference. Costa et al. (2014).

Stilestrongylus Freitas, Lent & Almeida, 1937

Stilestrongylus lanfrediae Souza, Digiani, Simões, Luque, Rodrigues-Silva & Maldonado Jr., 2009

Type host. *Oligoryzomys nigripes*

Infection site. Small intestine.

Type locality. Brazil, Rio de Janeiro State, Serra dos Órgãos, Teresópolis (22°12'44"S, 42°48'40"W).

Holotype. ♂ CHIOC 36925 a.

Paratypes. CHIOC 35536 (10♂♂, 10♀♀), 36925 b (allotype ♀).

Reference. Souza et al. (2009).

Heterakidae Railliet & Henry, 1912
Africana Travassos, 1920

Africana dardanelosi Ávila & Silva, 2009

Type host. *Hoplocercus spinosus* Fitzinger, 1843 (Iguania: Hoplocercidae).

Infection site. Small and large intestine.

Type locality. Brazil, Mato Grosso State, Aripuanã (10°9'0"S, 59°27'0"W).

Holotype. ♂ CHIOC 35614 a.

Paratype. CHIOC 35614 b (allotype ♀).

Remarks. Holotype and allotype cited as “CHIOC 3561” in the original description due to a mistake. Other paratypes deposited in CHIBB.

Reference. Ávila and Silva (2009).

Heterakis Dujardin, 1845

Heterakis inglisi Vicente, Pinto & Noronha, 1993

Type host. *Crypturellus variegatus variegatus* (Gmelin, 1789) (Aves: Tinamidae).

Infection site. Intestine.

Type locality. Brazil, Espírito Santo State.

Holotype. ♂ CHIOC 32850 a.

Paratypes. CHIOC 32850 b–e (♂♂), f–j (♀♀), 32851 a–d (♂♂).

Reference. Vicente et al. (1993).

Hystrignathidae Travassos, 1919
Artigasia Christie, 1934

Artigasia milerai Morffe & García, 2010

Type host. *Passalus interstitialis* Eschischoltz, 1829 (Coleoptera: Passalidae).

Infection site. Gut caeca.

Type locality. Cuba, La Habana province, Jaruco, Escaleras de Jaruco.

Paratypes. CHIOC 37823 (2♀♀).

Remarks. CHIOC number was not included in the original description. Holotype female and additional paratypes females deposited in CZACC.

Reference. Morffe and García (2010a).

Hystrignatus Leidy, 1850

Hystrignatus dearmasi Morffe & García, 2010

Type host. Unidentified, short, blackish passalid beetle (Coleoptera: Passalidae).

Infection site. Gut caeca.

Type locality. Panama, Panama Province, Summit National Park.

Paratypes. CHIOC 37525 (2♀♀).

Remarks. CHIOC number was not included in the original description. Holotype female and additional paratypes females deposited in CZACC.

Reference. Morffe and García (2010b).

Batwanema Morffe & García, 2013

******Batwanema congo* Morffe & García, 2013

Type host. *Pentalobus barbatus* (Fabricius, 1801) (Coleoptera: Passalidae).

Infection site. Gut caeca.

Type locality. Democratic Republic of Congo, Ituri province, Mogwalu.

Paratype. CHIOC 37903 (♀).

Remarks. CHIOC number was not included in the original description. Holotype and paratype females deposited in CZACC. Other paratypes deposited in the RMCA collection.

Reference. Morffe and García (2013a).

Chokwenema Morffe & García, 2013

**Chokwenema lepidophorum* Morffe & García, 2013

Type host. *Didimoides* cf. *parastictus* (Imhoff, 1843) (Coleoptera: Passalidae).

Infection site. Gut caeca.

Type locality. Democratic Republic of Congo, Ituri province, Mogwalu.

Paratype. CHIOC 37904 (♀).

Remarks. CHIOC number was not included in the original description. Holotype and paratype females deposited in CZACC. Other paratypes deposited in the RMCA collection.

Reference. Morffe and García (2013a).

Kongonema Morffe & García, 2013

**Kongonema meyeri* Morffe & García, 2013

Type host. *Didimus* sp. (Coleoptera: Passalidae).

Infection site. Gut caeca.

Type locality. Democratic Republic of Congo, Kivu Region, Katale (01°19'S, 29°22'E).

Paratypes. CHIOC 37822 a–d (♂♂).

Remarks. CHIOC number was not included in the original description. Female holotype and male and female paratypes deposited in CZACC. Other paratypes deposited in the RMCA collection.

Reference. Morffe and García (2013b).

Metastrongylidae Leiper, 1908
Angiostrongylus Kamensky, 1905

Angiostrongylus felineus Vieira, Muniz-Pereira, Lima, Moraes Neto, Guimarães & Luque, 2013

Type host. *Puma yagouaroundi* (Geoffroy, 1803) (Carnivora: Felidae).

Infection site. Pulmonary arteries.

Type locality. Brazil, Minas Gerais State, Juiz de Fora (21°41'20"S, 43°20'40"W).

Holotype. ♂ CHIOC 35812 a.

Paratypes. CHIOC 35812 b (allotype ♀), 35812 c–d (♂, ♀).

Reference. Vieira et al. (2013).

Molineidae Durette-Desset & Chabaud, 1977
Hadrostrongylus Hoppe & Nascimento, 2007

**Hadrostrongylus speciosum* Hoppe & Nascimento, 2007

Type host. *Dasypus novemcinctus*

Infection site. Mucosa and lumen of the cecum and colon.

Type locality. Brazil, Mato Grosso do Sul State, Aquidauana.

Paratypes. CHIOC 35448 (2♂♂, 2♀♀).

Remarks. Male holotype and female allotype deposited in the FCAV/UNESP helminthological collection of Jaboticabal, São Paulo State.

Reference. Hoppe and Nascimento (2007).

Oswaldocruzia Travassos, 1917

Oswaldocruzia belenensis Santos, Geise, Maldonado & Lanfredi, 2008

Type host. *Rhinella marina* (Linnaeus, 1758) [= *Chaunus marinus*] (Amphibia: Bufonidae).

Infection site. Small intestine.

Type locality. Brazil, Pará State, Belém (01°28'03"S, 48°20'18"W).

Holotype. CHIOC 36855 a.

Paratypes. CHIOC 36855 b (allotype ♀), 36855 c, f (♀♀), d–e (♂♂).

Reference. Santos et al. (2008b).

Schulzia Travassos, 1937

Schulzia usu Lent & Santos, 1989

Type host. *Atelopus oxyrhynchus*

Infection site. Small intestine.

Type locality. Venezuela, Mérida.

Holotype ♂ and allotype ♀. CHIOC 31668.

Paratype. CHIOC 32355.

Reference. Lent and Santos (1989).

Onchocercidae Leiper, 1911

Cercopithifilaria Eberhard, 1980

Cercopithifilaria bainae Almeida & Vicente, 1984

Type host. *Canis familiaris* Linnaeus, 1758 (Carnivora: Canidae).

Infection site. Subcutaneous and intramuscular tissue.

Type locality. Brazil, Rio de Janeiro State, Rio de Janeiro.

Holotype. ♂ CHIOC 32176 a.

Paratype. CHIOC 32176 b (allotype ♀).

Reference. Almeida and Vicente (1984).

Litomosoides Chandler, 1931

Litomosoides chagasfilhoi Moraes Neto, Lanfredi & Souza, 1997

Type host. *Akodon cursor* (Winge, 1887) (Rodentia: Muridae).

Infection site. Abdominal cavity.

Type locality. Brazil, Rio de Janeiro State, Rio Bonito, Catimbau Grande (22°42'30"S, 42°37'34"W).

Holotype. ♂ CHIOC 33529.

Paratype. CHIOC 33530 (allotype ♀).

Remarks. Other paratypes deposited in the MNHN collection.

Reference. Moraes Neto et al. (1997).

Litomosoides galizai Bain, Petit & Diagne, 1989

Type host. *Oecomys trinitatis* (Allen & Chapman, 1893)

Infection site. Body cavity and lung.

Type locality. Brazil, Pará State, Carajás.

Paratypes. CHIOC 32643 (2♀♀).

Remarks. Holotype and allotype deposited in the MNHN collection. CHIOC number was not included in the original description.

Reference. Bain et al. (1989).

Litomosoides kohnae Bain, Petit & Diagne, 1989

Type host. *Nectomys squamipes*

Infection site. Body cavity and lung.

Type locality. Brazil, São Paulo State, São Paulo.

Holotype. ♀ CHIOC 31056 c.

Paratypes. CHIOC 31056 a (♂), 31056 b (allotype ♂), 32642 (♀, = 31056 d).

Remarks. The slide CHIOC 31056 d was dismounted and received the number 32642.

Reference. Bain et al. (1989).

Ornithofilaria Gonnert, 1937

Ornithofilaria pitangi Vicente, Pinto & Noronha, 1980

Type host. *Megarynchus pitangua* (Linnaeus, 1766) (Aves: Tyrannidae).

Infection site. Infraorbital sinus.

Type locality. Brazil, Rio de Janeiro State, Angra dos Reis.

Holotype. ♂ CHIOC 31782 a.

Paratypes. CHIOC 31782 b–e (♂♂), f–j (♀♀).

Reference. Vicente et al. (1980).

Oxyuridae Cobbold, 1864
Caroloxyuris Jiménez-Ruiz & Gardner, 2003

**Caroloxyuris boliviensis* Jiménez-Ruiz & Gardner, 2003

Type host. *Oxymycterus paramensis* Thomas, 1902 (Rodentia: Cricetidae).

Infection site. Cecum and large intestine.

Type locality. Bolivia, Chuquisaca Department, 2 km SW of Monteagudo (19°49'S, 63°58'W), 1130 m high.

Paratype. CHIOC 34809.

Remarks. Paratype from CHIOC collected in Cochabamba, 13 km N of Colomi (17°13'29"S, 65°53"30"W), 3152 m high. Holotype, allotype, and paratypes deposited in the HWML collection. Other two paratypes deposited in CNHE.

Reference. Jiménez-Ruiz and Gardner (2003).

Gracilioxyuris Feijó, Lopes Torres, Maldonado Jr. & Lanfredi, 2008

**Gracilioxyuris agilis* Feijó, Torres, Maldonado Jr. & Lanfredi, 2008

Type host. *Gracilinanus agilis* (Burmeister, 1854) (Didelphimorphia: Didelphidae).

Infection site. Cecum.

Type locality. Brazil, Mato Grosso do Sul State, Pantanal, Nhumirim Farm (18°59'00"S, 56°39'00"W).

Holotype. ♂ 35518 a.

Paratypes. CHIOC 35517 (allotype ♀), 35518 b.

Remarks. CHIOC 35517 was collected in the Rio Negro Farm, Nhecolândia Region (19°34'54"S, 56°14'62"W), Pantanal, Mato Grosso do Sul State.

Reference. Feijó et al. (2008).

Pharyngodonidae Travassos, 1919
Brasilnema Moravec, Kohn & Fernandes, 1992

**Brasilnema pimelodellae* Moravec, Kohn & Fernandes, 1992

Type host. *Pimelodella lateristriga*

Infection site. Intestine.

Type locality. Brazil, Paraná State, Paraná River, Guaíra.

Paratypes. CHIOC 32718 a–b, e (♂♂), c–d, f–i (♀♀), 32719 a–d (♀♀).

Remarks. Holotype, allotype, and other paratypes deposited in the IPCAS collection. Additional paratypes deposited in MNHN.

Reference. Moravec et al. (1992a).

Ichthyouris Inglis, 1962

Ichthyouris brasiliensis Moravec, Kohn & Fernandes, 1992

Type host. *Megalancistrus paranamus* (Peters, 1881) (Osteichthyes: Locariidae).

Infection site. Intestine.

Type locality. Brazil, Paraná State, Paraná River, Guaíra.

Paratypes. CHIOC 32649, 32721 a–b (♂, ♀).

Remarks. Holotype, allotype, and other paratypes deposited in the IPCAS collection. Additional paratypes deposited in MNHN.

Reference. Moravec et al. (1992a).

Ichthyouris laterifilamenta Moravec, Kohn & Fernandes, 1992

Type host. *Trachydoras paraguayensis* (Eigenmann & Ward, 1907) (Osteichthyes: Doradidae).

Infection site. Intestine.

Type locality. Brazil, Paraná State, Foz do Iguaçú, Reservoir of the hydroelectric power of Itaipú (24°20'S, 52°38'W).

Paratype. CHIOC 32925.

Remarks. Holotype, allotype, and other paratypes deposited in the IPCAS collection.

Reference. Moravec et al. (1992b).

Ichthyouris voltagrandensis Martins, Yoshitoshi & Umekita, 2001

Type host. *Myleus tiete* (Eigenmann & Norris, 1900) (Osteichthyes: Serrasalmidae).

Infection site. Intestine.

Type locality. Brazil, Minas Gerais State, Volta Grande Reservoir.

Holotype. ♂ CHIOC 33852 a.

Paratypes. CHIOC 33852 b (allotype ♀), 33852 c (5♂♂), 33852 d (7♀♀).

Reference. Martins et al. (2001).

Parasynodontisia Moravec, Kohn & Fernandes, 1992

**Parasynodontisia petterae* Moravec, Kohn & Fernandes, 1992

Type host. *Rhinelepis aspera* Spix & Agassiz, 1829 (Osteichthyes: Locariidae).

Infection site. Intestine.

Type locality. Brazil, Paraná State, Paraná River, Guaíra.

Paratypes. CHIOC 32652, 32720 a (♂), b (♀).

Remarks. Holotype, allotype, and other paratypes deposited in the IPCAS collection. Additional paratypes deposited in MNHN.

Reference. Moravec et al. (1992b).

Skrjabinodon Inglis, 1968

Skrjabinodon heliocostai Vicente, Vrcibradic, Muniz-Pereira & Pinto, 2000

Type host. *Notomabuya frenata* (Cope, 1862) [= *Mabuya frenata*] (Autarchoglossa: Scincidae).

Infection site. Large intestine.

Type locality. Brazil, São Paulo State, Valinhos.

Holotype. ♂ CHIOC 33965 a.

Paratypes. CHIOC 33965 b (allotype ♀), CHIOC 33965 c–e (♂♂), f–h (♀♀).

Reference. Vicente et al. (2000b).

Skrjabinodon spinosulus Vicente, Vrcibradic, Rocha & Pinto, 2002

Type host. *Aspronema dorsivittatum* (Cope, 1862) [= *Mabuya dorsivittata*] (Autarchoglossa: Scincidae).

Infection site. Large and small intestine.

Type locality. Brazil, Rio de Janeiro State, National Park of Itatiaia, Prateleiras.

Holotype. ♀ CHIOC 34539 a.

Paratypes. CHIOC 34539 b–c (♀♀), 34540 a–b (♂♂), 34541 a–b (♀♀), c (♂), d (2♀♀), e–f (larvae).

Remarks. Paratypes CHIOC 34541 a–f collected in the Ecological Station of Itirapina, São Paulo State.

Reference. Vicente et al. (2002).

Philometridae Baylis & Daubney, 1926

Philometra Costa, 1845

Philometra nattereri Cárdenas, Moravec, Fernandes & Morais, 2012

Type host. *Pygocentrus nattereri* Kner, 1858 (Osteichthyes: Serrasalmidae).

Infection site. Oculo-orbits and nasal mucosa.

Type locality. Brazil, Amazonas State, Maracá Lake (03°50'32.8"S, 62°34'32.4"W), Coari.

Holotype. ♀ CHIOC 35777.

Paratypes. CHIOC 35778 (2♀♀), 35779 (♀), 35780 (♀), 35781 (♀), 35782.

Remarks. CHIOC 35779 collected in the Baixio Lake (03°17'27.2"S, 60°04'29.6"W), Iranduba; CHIOC 35780 collected in the Iauara Lake (03°36'39.2"S, 61°16'33.0"W), Manacapuru; CHIOC 35781 collected in the Araçá Lake (03°46'15.8"S, 62°20'10.3"W), Codajás; CHIOC 35782 collected in the Ananá Lake (03°53'54.8"S, 61°40'18.4"W), Anori (all localities in the Amazonas State). Other paratypes deposited in the INPA collection.

Reference. Cárdenas et al. (2012).

Physalopteridae Railliet, 1893
Physaloptera Rudolphi, 1819

Physaloptera bainae Pereira, Alves, Rocha, Souza Lima & Luque, 2014

Type host. *Salvator merianae* (Duméril & Bibron, 1839) (Autarchoglossa: Teiidae).

Infection site. Stomach.

Type locality. Brazil, Minas Gerais State, Juiz de Fora, Parque da Lajinha (21°47'32"S, 43°22'6"W).

Holotype. ♂ CHIOC 35885 a.

Paratypes. CHIOC 35885 b (allotype ♀), 35885 c (♂), 35885 d (2♀♀).

Reference. Pereira et al. (2014b).

Physaloptera galvaoi São Luiz, Simões, Lopes Torres, Barbosa, Santos, Giese, Rocha & Maldonado Jr., 2015

Type host. *Cerradomys subflavus* (Wagner, 1842) (Rodentia: Cricetidae).

Infection site. Stomach.

Type locality. Brazil, Minas Gerais State, São Roque de Minas, Serra da Canastra National Park (20°13'28.30"S, 46°30'39.20"W).

Holotype. ♂ CHIOC 36758 a.

Paratype. CHIOC 36758 b (allotype ♀).

Reference. São Luiz et al. (2015).

Physaloptera herthameyerae Lopes Torres, Maldonado Jr. & Lanfredi, 2009

Type host. *Gracilinanus agilis*

Infection site. Stomach.

Type locality. Brazil, Mato Grosso do Sul State, Pantanal, Alegria Farm (19°15'01"S, 57°01'29"W).

Holotype. ♂ CHIOC 35651 a.

Paratypes. CHIOC 35651 b (♂), 35652 a (allotype ♀), 36652 b (♀).

Reference. Lopes Torres et al. (2009).

Physaloptera tupinambae Pereira, Alves, Rocha, Lima & Luque, 2012

Type host. *Salvator merianae* [= *Tupinambis merianae*]

Infection site. Stomach.

Type locality. Brazil, Minas Gerais State, Juiz de Fora.

Holotype. ♂ CHIOC 35811 a.

Paratypes. CHIOC 35811 b (allotype ♂), 35811 c (♂, ♀).

Reference. Pereira et al. (2012b).

Quimperiidae Gendre, 1928
Neoparaseuratum Moravec, Kohn & Fernandes, 1992

**Neoparaseuratum travassosi* Moravec, Kohn & Fernandes, 1992

Type host. *Pterodoras granulosus*

Infection site. Intestine.

Type locality. Brazil, Paraná State, Paraná River near Guaíra.

Holotype. ♂ CHIOC 32722 a.

Paratype. CHIOC 32722 b (allotype ♀).

Remarks. There is no paratype CHIOC 32722 "c" as indicated in the original description, which was a mistake. Other paratype deposited in the IPCAS collection.

Reference. Moravec et al. (1992c).

Raphidascarididae Hartwich, 1954
Hysterothylacium Ward & Magath, 1917

Hysterothylacium deardorffoverstreetorum Knoff, Felizardo, Iñiguez, Maldonado Jr., Torres, Pinto & Gomes, 2012

Type host. *Paralichthys isosceles* Jordan, 1891 (Osteichthyes: Paralichthyidae).

Infection site. Abdominal cavity, abdominal musculature, stomach, stomach mucosa, mesentery, intestine, heart serosa, kidney serosa, liver serosa, ovary, ovary serosa, and spleen serosa.

Type locality. Brazil, Rio de Janeiro State, Angra dos Reis (21°15'–23°23'S, 40°29'–44°28'W).

Holotype. CHIOC 37523 a (L3 larvae).

Paratypes. CHIOC 37523 b–e, 35771 (L3 larvae).

Reference. Knoff et al. (2012).

Rhabdiasidae Railliet, 1916
Rhabdias Stilles & Hassall, 1905

Rhabdias filicaudalis Barrella, Santos & Silva, 2010

Type host. *Spilotes pullatus* Linnaeus, 1758 (Serpentes: Colubridae).

Infection site. Lungs.

Type locality. Brazil, São Paulo State, Avaré (23°6'S, 48°55'W).

Holotype. ♀ CHIOC 35653 a.

Paratypes. CHIOC 35653 b (5♀♀).

Remarks. Other paratypes deposited in CHIBB.

Reference. Barella et al. (2010).

Rhabdias paraensis Santos, Melo, Silva, Giese & Furtado, 2011

Type host. *Rhinella marina*

Infection site. Lungs.

Type locality. Brazil, Pará State, Belém (01°28'03"S, 48°20'18"W).

Holotype. Hermaphrodite ♀ CHIOC 35705 a.

Paratypes. CHIOC 35705 b (ten paratypes).

Reference. Santos et al. (2011).

Serpentirhabdias Trach, Kuzmin & Snyder, 2014

Serpentirhabdias viperidicus Morais, Aguiar, Müller, Narciso, Silva & Silva, 2016

Type host. *Bothrops moojeni* Hoge, 1966

Infection site. Lungs.

Type locality. Brazil, São Paulo State, Castilho, Private Reserve of Natural Heritage 'Foz do Rio Aguapeí' (21°03'04.9"S, 51°52'52.6"W).

Holotype. CHIOC 38318 a.

Paratype. CHIOC 38318 b.

Remarks. Other paratypes deposited in CHIBB.

Reference. Morais et al. (2016).

Rictulariidae Hall, 1915

Pterygodermatites (*Multipectines*) Quentin, 1969

Pterygodermatites (*Multipectines*) *pluripectinata* Hoppe, Araújo, Tebaldi & Nascimento, 2010

Type host. *Cerdocyon thous*

Infection site. Small intestine.

Type locality. Brazil, Paraíba State, Patos (06°46'19"–07°38'52"S, 36°42'52"–38°08'56"W).

Paratypes. CHIOC 35628 (♂, ♀).

Remarks. Paratype from CHIOC cited as "35525" in the original description due to a mistake. Holotype and allotype deposited in the FCAV/UNESP of Jaboticabal, São Paulo State.

Reference. Hoppe et al. (2010).

***Pterygodermatites* (*Paucipectines*) Quentin, 1969**

***Pterygodermatites* (*Paucipectines*) *andyraicola* Cardia, Tebaldi, Fornazari, Menozzi, Langoni, Nascimento, Bresciani & Hoppe, 2015**

Type host. *Eumops glaucinus* (Wagner, 1843) (Chiroptera: Molossidae).

Infection site. Mucosa of the small intestine.

Type locality. Brazil, São Paulo State, Botucatú (22°52'47"S, 48°26'42"W).

Paratypes. CHIOC 35826 (♂, ♀).

Remarks. Holotype, allotype and additional paratypes deposited in FCAV/UNESP of Araçatuba, São Paulo State. Paratypes from CHIOC cited as "35824" in the original description due to a mistake. CHIOC 35826 collected in Jaú (22°17'44"S, 48°33'28"W), São Paulo State.

Reference. Cardia et al. (2015).

Strongyloididae Chitwood & McIntosh, 1934
***Strongyloides* Grass, 1879**

***Strongyloides ferrerai* Rodrigues, Vicente & Gomes, 1985**

Type host. *Kerodon rupestris* (Wied-Neuwied, 1820) (Rodentia: Caviidae).

Infection site. Small intestine.

Type locality. Brazil, Piauí State, Floriano Peixoto.

Holotype. ♀ CHIOC 32172 a.

Paratypes. CHIOC 32172 b–e (♀♀).

Reference. Rodrigues et al. (1985).

Subuluridae Travassos, 1914
***Subulura* Molin, 1860**

***Subulura lacertilia* Vicente, Van Sluys, Fontes & Kiefer, 2000**

Type host. *Eurolophosaurus nanuzae* (Rodrigues, 1981) [= *Tropidurus nanuzae*] (Iguania: Tropiduridae).

Infection site. Large and small intestine.

Type locality. Brazil, Minas Gerais State, Serra do Cipó (19°20'S, 43°44'W).

Holotype. ♂ CHIOC 34196 a.

Paratypes. CHIOC 34196 d (allotype ♀), 34196 b, c (♂♂), 34197 a, c, e, g (♀♀), 34197 b, d, f (♂♂), 33853, 33854 (♂), 33855 (♂), 33856 (♂).

Reference. Vicente et al. (2000a).

Tetrameridae Travassos, 1914
Synhimantus (*Synhimantus*) Railliet, Henry & Sisoff, 1912

Synhimantus (*Synhimantus*) *magnipapillatus* Vicente, Pinto e Noronha, 1996

Type host. *Nyctanassa violacea cayennensis* (Gmelin, 1789) (Aves: Ardeidae).
Infection site. Gizzard.
Type locality. Brazil, Rio de Janeiro State, Rio de Janeiro.
Holotype. ♂ CHIOC 33182 a.
Paratypes. CHIOC 33182 b, f–h (♂♂), c–e (♀♀).
Reference. Vicente et al. (1996).

Tetrameres (*Tetrameres*) Creplin, 1846

Tetrameres (*Tetrameres*) *spirospiculum* Pinto & Vicente, 1995

Type host. *Theristicus caudatus caudatus* (Boddaert, 1783) (Aves: Threskiornithidae).
Infection site. Gizzard (females in proventricular glands, males free in the lumen).
Type locality. Brazil, Mato Grosso do Sul State, Salobra.
Holotype. ♂ CHIOC 33173 a.
Paratypes. CHIOC 33173 b–c (♂♂), 33186 c (allotype ♀).
Reference. Pinto and Vicente (1995).

Trichostrongylidae Witenberg, 1925
Hoazinstrongylus Pinto & Gomes, 1985

**Hoazinstrongylus amazonensis* Pinto & Gomes, 1985

Type host. *Opisthocomus hoazin* (Müller, 1776) (Aves: Opisthocomidae).
Infection site. Proventriculus and gizzard.
Type locality. Brazil, Amazonas State, Paraná de Cambixa, Careiro Island.
Holotype. ♂ CHIOC 32024 a.
Paratypes. CHIOC 32024 b–e (♀♀), 32025 a–b (♀♀), 32026 a–b (♂♂), c–d (♀♀).
Reference. Pinto and Gomes (1985).

Viannaiidae Durette-Desset & Chabaud, 1981
Avellaria Freitas & Lent, 1934

Avellaria intermedia Durette-Desset, Gonçalves & Pinto, 2006

Type host. *Dasyprocta fuliginosa*

Infection site. Small intestine.

Type locality. Brazil, Amazonas State, Barcelos, Jauari waterway, left margin of the Aracá River, Três Barracas settlement (0°58'29"S, 62°55'27"W).

Holotype ♂ and allotype ♀. CHIOC 35416.

Paratypes. CHIOC 34883, 35072 a–g, 35417 (6♂♂), 35418 (7♀♀).

Reference. Durette-Desset et al. (2006).

Vianella Neveu-Lemaire, 1934

Vianella trichospicula Durette-Desset, Gonçalves & Pinto, 2006

Type host. *Dasyprocta fuliginosa*

Infection site. Small intestine.

Type locality. Brazil, Amazonas State, Barcelos, Jauari waterway, left margin of the Aracá River, Três Barracas settlement (0°58'29"S, 62°55'27"W).

Holotype ♂ and allotype ♀. CHIOC 35419.

Paratypes. CHIOC 34857 (♂, ♀), 35420 (7♂♂), 35421 (4♀♀), 35052 a–k (♂♂).

Reference. Durette-Desset et al. (2006).

Xustrostomatidae Hunt, 2002
Trachyglossoides García & Morffe, 2015

**Trachyglossoides jimenoi* García & Morffe, 2015

Type host. *Spirobollelus* sp. (Diplopoda: Spirobolellidae).

Infection site. Hind gut.

Type locality. Cuba, Mayabeque Province, San José de las Lajas, La Jaula.

Paratypes. CHIOC 38211 a (♀), 38211 b (♂).

Remarks. CHIOC number was not included in the original description. Male holotype and male and female paratypes deposited in CZACC. Other paratypes deposited in the RIT collection.

Reference. García and Morffe (2015).

Phylum Cnidaria Hatschek, 1888
Unranked subphylum Myxozoa Grassé, 1970
Class Myxosporea Bütschli, 1881
Order Bivalvulida Shulman, 1959
Myxobolidae Thélohan, 1892
***Henneguya* Thélohan, 1892**

Henneguya garavelli Martins & Onaka, 2006

Type host. *Cyphocharax nagelii* (Steindachner, 1881) (Osteichthyes: Curimatidae).

Infection site. Gill filaments.

Type locality. Brazil, São Paulo State, São José do Rio Pardo, Rio do Peixe Reservoir.

Holotype. CHIOC 34986.

Paratype. CHIOC 34818 (fixed gills).

Remarks. CHIOC samples cited as "specimens deposited" in the original description. No additional type material is deposited in other collections.

Reference. Martins and Onaka (2006).

***Myxobolus* Bütschli, 1882**

Myxobolus peculiaris Martins & Onaka, 2006

Type host. *Cyphocharax nagelii*

Infection site. Gill filaments.

Type locality. Brazil, São Paulo State, São José do Rio Pardo, Rio do Peixe Reservoir.

Holotype. CHIOC 34987.

Paratype. CHIOC 34834 (fixed gills).

Remarks. CHIOC samples cited as "specimens deposited" in the original description. No additional type material is deposited in other collections.

Reference. Martins and Onaka (2006).

Phylum Annelida Lamarck, 1809
Class Polychaeta Grube, 1850
Order Eunicida Dales, 1962
Histriobdellidae Vaillant, 1890
***Stratiodrilus* Haswell, 1900**

Stratiodrilus vilae Amato, 2001

Type host. *Parastacus brasiliensis* (von Martens, 1869) (Decapoda: Parastacidae).

Infection site. Branchial chamber.

Type locality. Brazil, Rio Grande do Sul State, Taquara (29°37'S, 50°47'W).

Holotype. ♀ CHIOC 34334 a.

Paratypes. CHIOC 34334 b (allotype ♂), 34335 a–b, e (♀♀), c–d, f (♂♂).

Remarks. Other paratypes deposited in the USNM collection.

Reference. Amato (2001).

Class Hirudinea Linnaeus, 1758
Order Rhynchobdellida (Blanchard, 1894)
Ozobranchidae (Pinto, 1921)
Unoculubranchiobdella Peralta, Matos & Serra-Freire, 1998

**Unoculubranchiobdella expansa* Peralta, Matos & Serra-Freire, 1998

Type host. *Podocnemis expansa* (Schweigger, 1812) (Testudines: Podocnemididae).

Infection site. Carapace, plastron, head, over the eyes, pelvic appendages, cloaca, mouth and nostrils.

Type locality. Brazil, Pará State, Belém, Zoobotanical Park of the Emílio Goeldi Museum.

Holotype. CHIOC 37524 a.

Paratypes. CHIOC 33598, 37524 b–e.

Remarks. The holotype and some paratypes received new numbers because part of the type material was mounted from CHIOC 33598 by the authors after the publication. CHIOC 33598 was indicated as holotype and paratypes in the original description.

Reference. Peralta et al. (1998).

Phylum Arthropoda von Siebold, 1848
Class Maxillopoda Dahl, 1956
Subclass Copepoda Milne Edwards, 1840
Order Poecilostomatoida Thorell, 1859
Bomolochidae Sumpf, 1871
Hamaticolax Ho & Lin, 2006

Hamaticolax unisagittatus (Tavares & Luque, 2003)

Type host. *Centropomus undecimalis* (Block, 1792) (Osteichthyes: Centropomidae).

Infection site. Gills.

Type locality. Brazil, Rio de Janeiro State, Angra dos Reis (23°01'S, 44°19'W).

Paratypes. CHIOC 34819 (10♀♀).

Remarks. Species placed in *Acantholochus* Cressey, 1984 by Tavares and Luque (2003) and transferred to *Hamaticolax* by Morales-Serna and Gómez (2010). Holotype and other female paratypes deposited in the MNRJ carcinological collection.

References. Tavares and Luque (2003), Morales-Serna and Gómez (2010).

Chondracanthidae Milne Edwards, 1840
Pseudolernentoma Luque & Alves, 2003

**Pseudolernentoma brasiliensis* Luque & Alves, 2003

Type host. *Genypterus brasiliensis* Regan, 1903 (Osteichthyes: Ophidiidae).

Infection site. Oral cavity.

Type locality. Brazil, coastal zone of the Rio de Janeiro State (21–23°S, 41–45°W).

Paratypes. CHIOC 34892 (5♀♀), 34893 (3♂♂).

Remarks. Female holotype, male allotype, and other male and female paratypes deposited in the MNRJ carcinological collection.

Reference. Luque and Alves (2003).

Ergasilidae von Nordmann, 1832
Brasergasilus Thatcher & Boeger, 1983

Brasergasilus bifurcatus Santos, Thatcher & Brasil-Sato, 2007

Type host. *Pygocentrus piraya* (Cuvier, 1819)

Infection site. Gill filaments and nasal fossae.

Type locality. Brazil, Minas Gerais State, Upper São Francisco River, Três Marias Reservoir (18°12'59"S, 45°17'34"W).

Holotype. ♀ CHIOC 36841.

Paratypes. CHIOC 35502 (♀), 35503 (♀), 35504 (♀), 36842 (♀), 36843 (♀), 36844 (♀).

Remarks. CHIOC 35504, 36843, and 36844 collected from the serrasalmid fish *Serrasalmus brandtii* Lütken, 1875.

Reference. Santos et al. (2007).

Ergasilus von Nordmann, 1832

Ergasilus thatcheri Engers, Boeger & Brandão, 2000

Type host. *Rhamdia quelen* (Quoy & Gaimard, 1824) (Osteichthyes: Heptapteridae).

Infection site. Gills filaments.

Type locality. Brazil, Rio Grande do Sul State, Barragem do Capané, Cachoeira do Sul.

Holotype. ♀ CHIOC 34008 a.

Paratypes. CHIOC 33840 a–c, 34008 b–f (♀♀).

Remarks. Other paratypes deposited in the collections of HWML and USNM.

Reference. Engers et al. (2000).

Ergasilus youngi Tavares & Luque, 2005

Type host. *Aspistor luniscutis* (Valenciennes, 1840) (Osteichthyes: Ariidae).
Infection site. Gills.
Type locality. Brazil, Rio de Janeiro State, Angra dos Reis (23°01'S, 44°19'W).
Holotype. ♀ CHIOC 35393.
Paratypes. CHIOC 35392 (5♀♀), 35394 (5♀♀).
Reference. Tavares and Luque (2005).

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RESEARCH ARTICLE

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Salangathelphusa peractio, a new species of lowland freshwater crab from Pulau Langkawi, Peninsular Malaysia (Crustacea, Brachyura, Gecarcinucidae)

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Abstract

A new species of lowland freshwater crab of the family Gecarcinucidae, *Salangathelphusa peractio*, is described from Langkawi, an island off the northwestern coast of peninsular Malaysia. *Salangathelphusa peractio* **sp. n.** can be separated from *S. brevicarinata* (Hilgendorf, 1882) in having a proportionately broader external orbital tooth, a distinctly concave posterolateral margin, and the terminal segment of the male first gonopod is not distinctly bent laterally outwards; and from *S. anophrys* (Kemp, 1923) by its more quadrate carapace and the terminal segment of the male first gonopod possessing a relatively longer and less curved distal part. This is sixth wholly freshwater brachyuran species known from the island.

Keywords

Gecarcinucidae, Langkawi Island, Malaysia, new species, *Salangathelphusa*, taxonomy

Introduction

The gecarcinucid genus *Salangathelphusa* was established by Bott (1968: 406) for *Parathelphusa salangensis* Ortmann, 1893, from southwestern Thailand (including Phuket) and northern Peninsular Malaysia. The choice of type species was unusual because Bott (1968) decided in the same publication that *Parathelphusa salangensis* Ortmann, 1893, described from "Salanga Island" (= Phuket) was a junior subjective synonym of *Parathelphusa brevicarinata* Hilgendorf, 1882 (misspelt by Bott [1968, 1970] as '*brevimarginata*').

Salangathelphusa can easily be distinguished from all other southeast Asian gecarcinucids by possessing the following combination of characters: four teeth on its anterolateral margin (including the external orbital tooth); a dorsal carapace surface which is smooth with the postorbital cristae barely visible or absent; a male first gonopod which is very short and stout, with the terminal and subterminal segments clearly demarcated and a short terminal segment which has the basal part dilated and the distal part sharply tapering; and the male second gonopod has a long distal segment which is longer than half the length of the basal segment (Bott 1968, 1970; Ng 1988, 2004).

Bott (1970: 108) synonymised *Paratelphusa* (*Paratelphusa*) *anophrys* Kemp, 1923, with *S. brevicarinata* without any comment. Ng et al. (2008: 71), however, listed *S. anophrys* (Kemp, 1923) as a valid species of *Salangathelphusa* in their synopsis of the world Brachyura but did not elaborate. The genus *Salangathelphusa* will need to be revised as there are clearly more than the two recognised species. The author (with Darren Yeo) have examined the types of *Parathelphusa salangensis* Ortmann, 1893, and *S. anophrys* Kemp, 1923 (the type of *Parathelphusa brevicarinata* Hilgendorf, 1882, is no longer extant), as well as material from various parts of southern Thailand and northern Malaysia. It is clear that what is now called "*S. brevicarinata*" is a species complex. More material is currently being consolidated to present a more complete revision in subsequent years.

In 2015, the author examined old collections collected from the northwestern peninsular Malaysian island of Langkawi that had been collected during an expedition there by the Malayan Nature Society in 2003 (see Ahmad and Lim 2006). Among the unidentified material were two specimens of *Salangathelphusa*. Subsequent collections in Langkawi obtained more specimens of the same species, which can easily be distinguished from *S. brevicarinata* and *S. anophrys* by its distinctive male first gonopod. The present note has been prepared to make the name of this new species from Langkawi available for other studies (including conservation) because the revision of *Salangathelphusa* is still some years in the future. This present discovery of another freshwater crab species from Langkawi is somewhat surprising because the fauna of the island has been well studied. Currently four primary freshwater crab species are known – one species of Potamidae: *Stoliczia bella* Ng & Ng, 1987), and three species of Gecarcinucidae: *Sayamia sexpunctata* (Lanchester, 1906), *Phricotelphusa gracilipes* Ng & Ng, 1987, and *Siamthelphua improvisa* (Lanchester, 1902) (Ng and Ng 1987, 1989; Ng 1988, 2004). In addition, there is an endemic species of wholly freshwater sesarmid, *Geosesarma foxi* (Kemp, 1918) in the highlands of Langkawi Island (Ng 2017).

Materials and methods

Specimens examined are deposited in the Zoological Reference Collection (**ZRC**) of the Lee Kong Chian Natural History Museum, National University of Singapore; and the Zoological Survey of India (ex Indian Museum), Calcutta, India. Measurements, in millimetres, are of the maximum carapace width and length, respectively; while the abbreviations G1 and G2 are used for the male first and second gonopods, respectively. The terminology used follows that in Ng (1988) and Davie et al. (2015).

Systematics

Family Gecarcinucidae Rathbun, 1904

Genus *Salangathelphusa* Bott, 1968

Type species. *Parathelphusa salangensis* Ortmann, 1893, by original designation.

Salangathelphusa peractio sp. n.

http://zoobank.org/6321FE32-9FAA-47BB-88D0-BDE7B1E6FC32
Figures 1–5

Material examined. Holotype: male (22.3 × 17.7 mm) (ZRC 2017.208), Sungai Batu Asah, Kuah, Langkawi, Kedah, 6°20'22.13"N, 99°48'33.55"E, Peninsular Malaysia, coll. A. Ahmad et al., University of Sains Malaysia expedition to Langkawi, 11 April 2003. Paratypes: 1 young male (12.0 × 10.6 mm) (ZRC 2017.209), same data as holotype; 10 males (largest 22.4 × 17.7 mm, 21.9 × 17.3 mm), 2 juvenile males, 1 female (largest 21.7 × 17.3 mm), 5 young females (largest 15.3 × 13.0 mm) (ZRC 2017.210), small sandy shaded stream with rocks, 4–5 cm depth, adjacent to main river, downstream with dense waterweeds, Lubuk Semilang Park, south of Gunung Raya mountain, Langkawi, Kedah, 6°21'49.2"N, 99°47'29.39"E, Peninsular Malaysia, coll. P. K. L. Ng, 14–15 July 2017.

Comparative material. *Salangathelphusa brevicarinata* (Hilgendorf, 1882): 25 males (largest 25.5 × 20.6 mm), 7 females (ZRC), Nam Tok Tone Sai, 08°01.64'N 98°21.74'E, Phuket, Thailand, coll. P. K. L. Ng and H. H. Tan, 8 April 1999; 2 males (larger 25.8 × 21.2 mm) (ZRC), same locality as above, coll. P. K. L. Ng, December 1999; 3 males, 2 females, 2 juveniles (ZRC), same locality as above, coll. S. S. C. Chong, 3 April 1985; 4 males (largest 24.7 × 19.9 mm), 2 females (ZRC), Nam Tok Kathun, 07°55.96'N, 98°19.43'E, Phuket, Thailand, coll. P. K. L. Ng and H. H. Tan, 8 April 1999. *Salangathelphusa anophrys* (Kemp, 1923): holotype male (25.4 × 19.0 mm) (ZSI C 603/1), Khao Ram, 366 m asl, Nakhon Si Thammarat mountains, Peninsular Siam (= southern Thailand), coll. M. Smith, no date; 1 male (26.9 × 20.7 mm) (ZRC 1989.2011), Sai Rung waterfall, Trang Province, southern Thailand, coll. P. Naiyanetr, 27 October 1988.

Diagnosis. Carapace subquadrate, broader than long (Fig. 1); external orbital tooth broadly triangular, outer margin twice length of inner margin (Fig. 1); all ambulatory legs relatively short, merus not elongate (Fig. 1A); male pleonal somite 6 subquadrate, lateral margins gently sinuous, distal margin slightly shorter than proximal margin

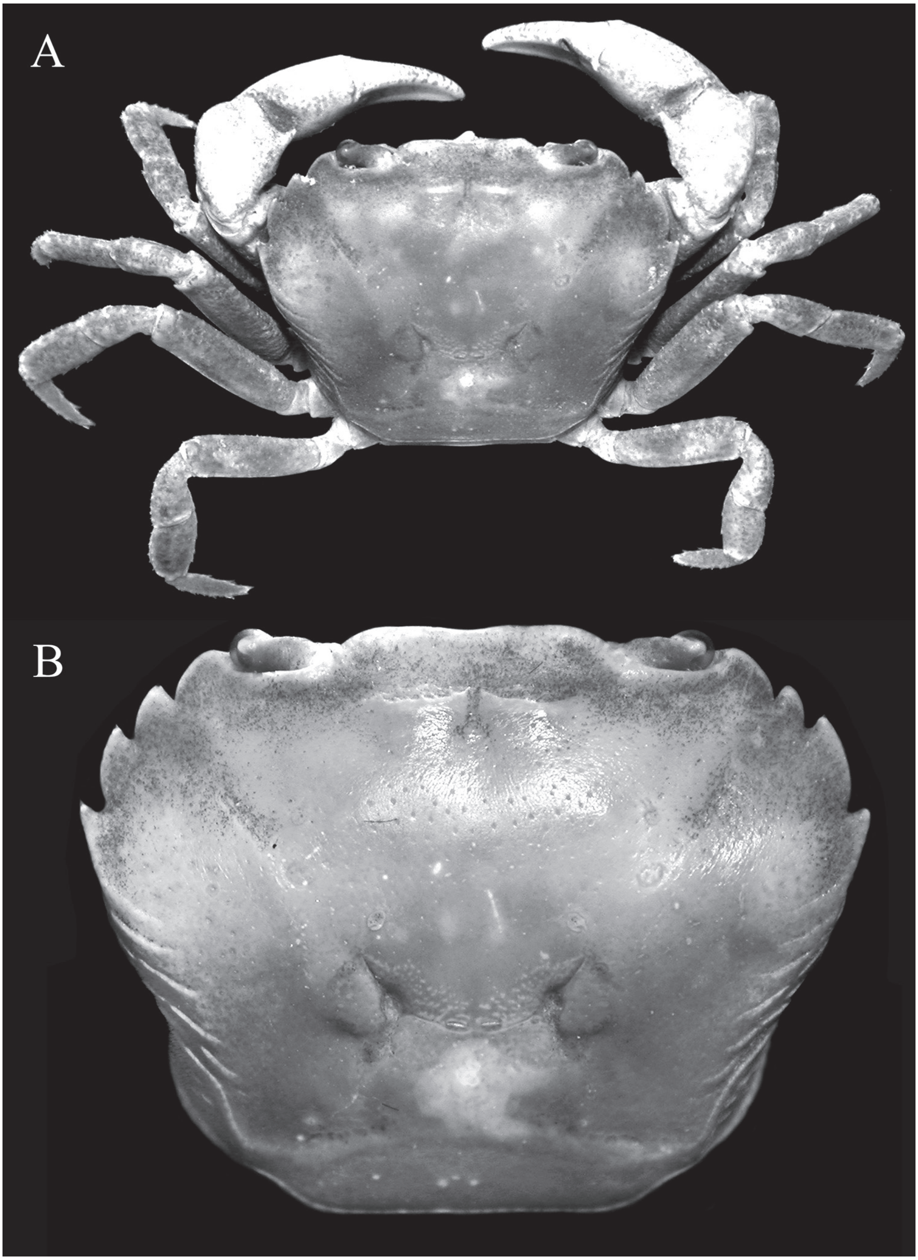

Figure 1. *Salangathelphusa peractio* sp. n., holotype: male (22.3 × 17.7 mm) (ZRC 2017.208), Langkawi. **A** overall habitus **B** dorsal view of carapace.

(Fig. 2C); posterolateral margin concave (Fig. 1); G1 with stout subterminal segment, terminal segment with tip directed upwards towards buccal cavity (Fig. 3A–E).

Description of adult male. Carapace subquadrate, broader than long, adult carapace width to length ratio 1.25–1.27; dorsal surface gently convex, glabrous; regions poorly defined, cervical grooves shallow but, distinct, H-shaped gastrocardiac groove well developed (Fig. 1). Epigastric cristae low, sharp, smooth, separated by distinct Y-shaped groove; postorbital cristae not visible, surface smooth (Figs 1, 2A). Frontal margin gently emarginated, approximately divided into 2 broad lobes; dorsal crista of complete frontal median triangle merging with lateral cristae (Figs 1, 2A). Antennular fossae rectangular when viewed frontally, antennules folding laterally; basal antennal article quadrate, antennal flagellum short, just entering orbit (Fig. 2A). Supraorbital margin almost straight, entire; infraorbital margin gently concave, entire; orbit large, eyes completely filling orbit; sub-hepatic, pterygostomial and sub-branchial regions with low striae or smooth (Figs 1B, 2A). External orbital tooth well developed, broadly triangular, outer margin twice length of inner margin, convex, separated from first anterolateral tooth by deep triangular cleft; anterolateral margin with 3 distinct teeth, first and third of similar size, second widest, outer margins of all teeth convex with tips directed obliquely anteriorly; posterolateral margin concave, surface with strong oblique striae, distinctly converging posteriorly to almost straight posterior carapace margin (Fig. 1). Posterior margin of epistome with broadly triangular median lobe, lateral margins sinuous (Fig. 2A).

Mandibular palp 2-segmented, terminal segment prominently bilobed. Third maxilliped with ischium rectangular, with distinct longitudinal submedian sulcus; merus squarish, anterolateral margin convex, not prominently auriculiform; exopod slender, reaching to midpoint of merus, with long flagellum (Fig. 2D).

Chelipeds subequal, outer surface of merus, carpus and palm rugose; palm of right chela slightly larger; fingers not gaping, longer than palm, tips gently hooked, cutting edges without molariform teeth; merus short, stout, surface rugose with distinct subdistal tubercle on dorsal margin; carpus with strong, obliquely directed subdistal spine on inner margin; merus with low subterminal spine (Figs 1, 2B).

Ambulatory legs relatively short, stout, almost glabrous, surfaces gently rugose; second and third legs longest; merus not elongate, dorsal margin gently carinate, uneven, appearing serrated, ventral margins carinate, dorsal subdistal spine or tooth short but distinct; dactylus short, with short, sharp spines on margins (Fig. 1A).

Suture between anterior thoracic sternites 2 and 3 laterally interrupted, just visible as shallow transverse groove; sternite 3 distinctly compressed, longitudinally narrow, separated from sternite 4 by shallow lateral grooves; suture between sternites 4 and 5 medially interrupted; sutures between sternites 5/6, 6/7 and 7/8 complete with distinct median longitudinal groove on sternites 6 and 7; sternopleonal cavity extending beyond imaginary line joining anterior edge of cheliped bases, reaching to sternite 3 (Fig. 2C). Pleonal locking mechanism with strong peg-like tubercle on anterior third of sternite 5.

Pleon distinctly T-shaped, all somites and telson free; telson tongue-shaped, subequal to somite 6, lateral margins gently concave, tip broadly rounded; somite 6 subquadrate, lateral margins gently sinuous, distal margin slightly shorter than proximal margin; somites 3–5 trapezoidal (Fig. 2C).

G1 relatively short, stout; subterminal segment proportionately stout, gradually tapering towards distal half, outer margin gently sinuous; terminal segment less than half length of subterminal segment, outer margin convex, rounded tip directed upwards

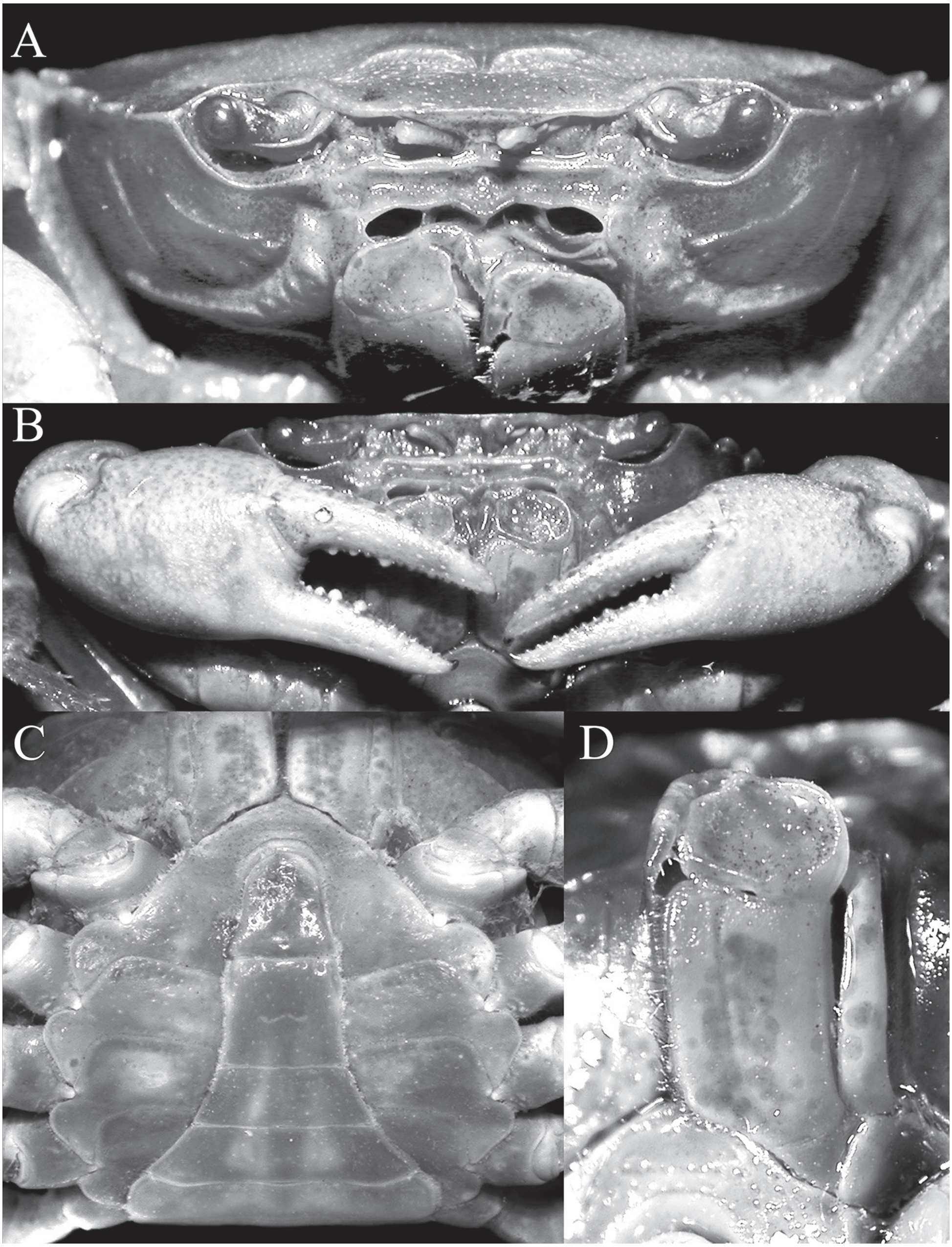

Figure 2. *Salangathelphusa peractio* sp. n., holotype: male (22.3 × 17.7 mm) (ZRC 2017.208), Langkawi. **A** frontal view of cephalothorax **B** outer view of chelae **C** anterior thoracic sternum and pleon **D** left third maxilliped.

towards buccal cavity, inner basal part swollen, much wider than distal half, entire structure gently twisted towards sternal surface (Fig. 3A–E). G2 longer than G1; distal segment with long flagellum, ca. 0.6 times length of elongate basal segment (Fig. 3F).

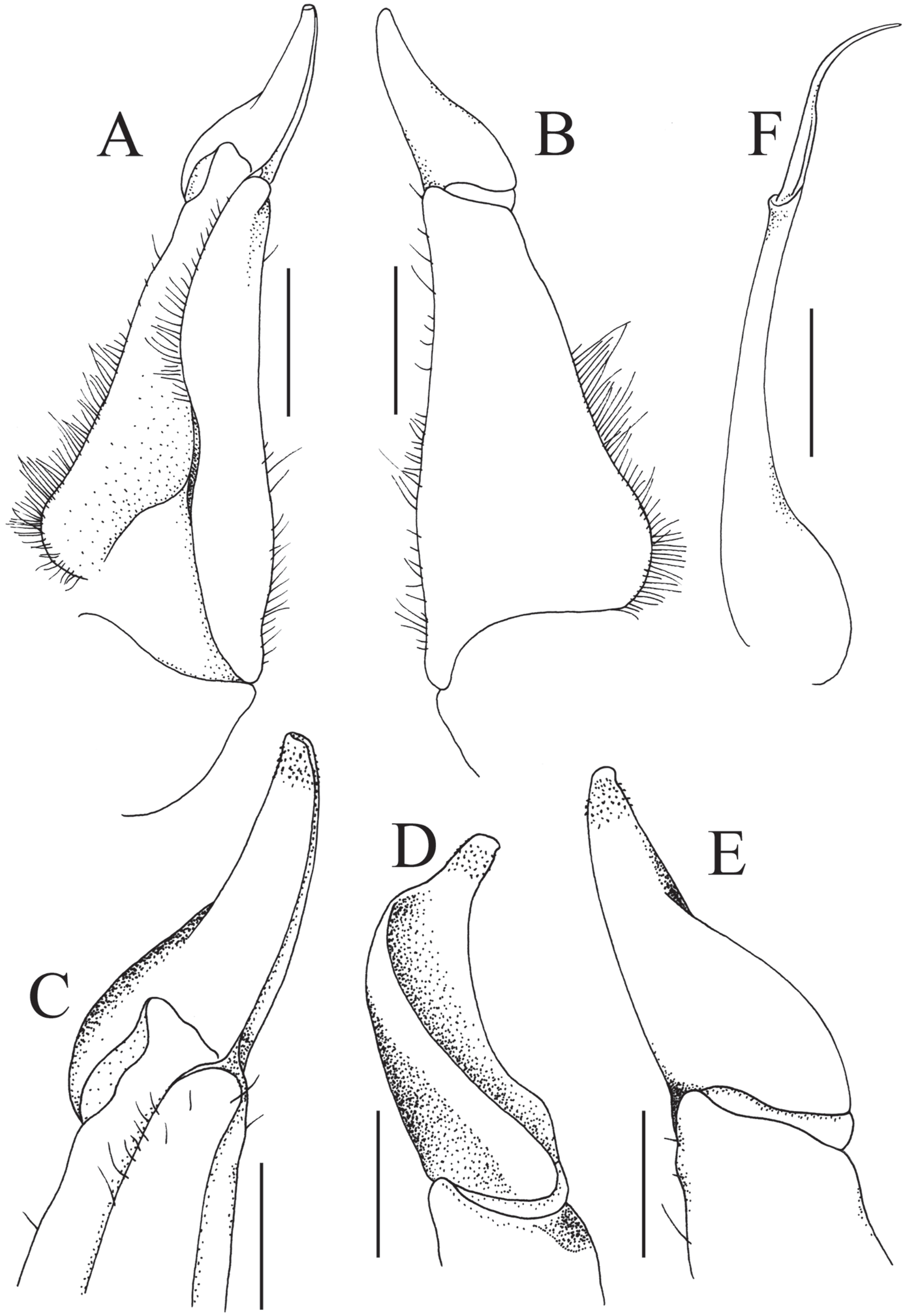

Figure 3. *Salangathelphusa peractio* sp. n., holotype male (22.3 × 17.7 mm) (ZRC 2017.208), Langkawi. **A** left G1 (ventral view) **B** left G1 (dorsal view) **C** distal part of left G1 (ventral view) **D** distal part of left G1 (mesial view) **E** distal part of left G1 (dorsal view) **F** left G2. Scale bars **A**, **B**, **F** 1.0 mm **C–E** 0.5 mm.

Figure 4. *Salangathelphusa peractio* sp. n. **A**, **B** paratype male (12.0 × 10.6 mm) (ZRC 2017.209), Langkawi **C**, **D** paratype female (21.7 × 17.3 mm) (ZRC 2017.210), Langkawi. **A**, **C** overall habitus **B** male anterior thoracic sternum and pleon **D** female anterior thoracic sternum and pleon **E** female sternopleonal cavity showing vulvae.

Females. Adult females closely resemble adult males except that the chelae are relatively more slender. The adult female pleon is ovate and covers most of the thoracic sternum (Fig. 4D), with the vulvae on the anterior half of sternite 6 being large, ovate, and possessing a prominent operculum (Fig. 4E).

Variation. Smaller specimens (ca. 15 mm carapace width and below) have relatively more quadrate carapaces (width to length ratio 1.13–1.17), the merus of the

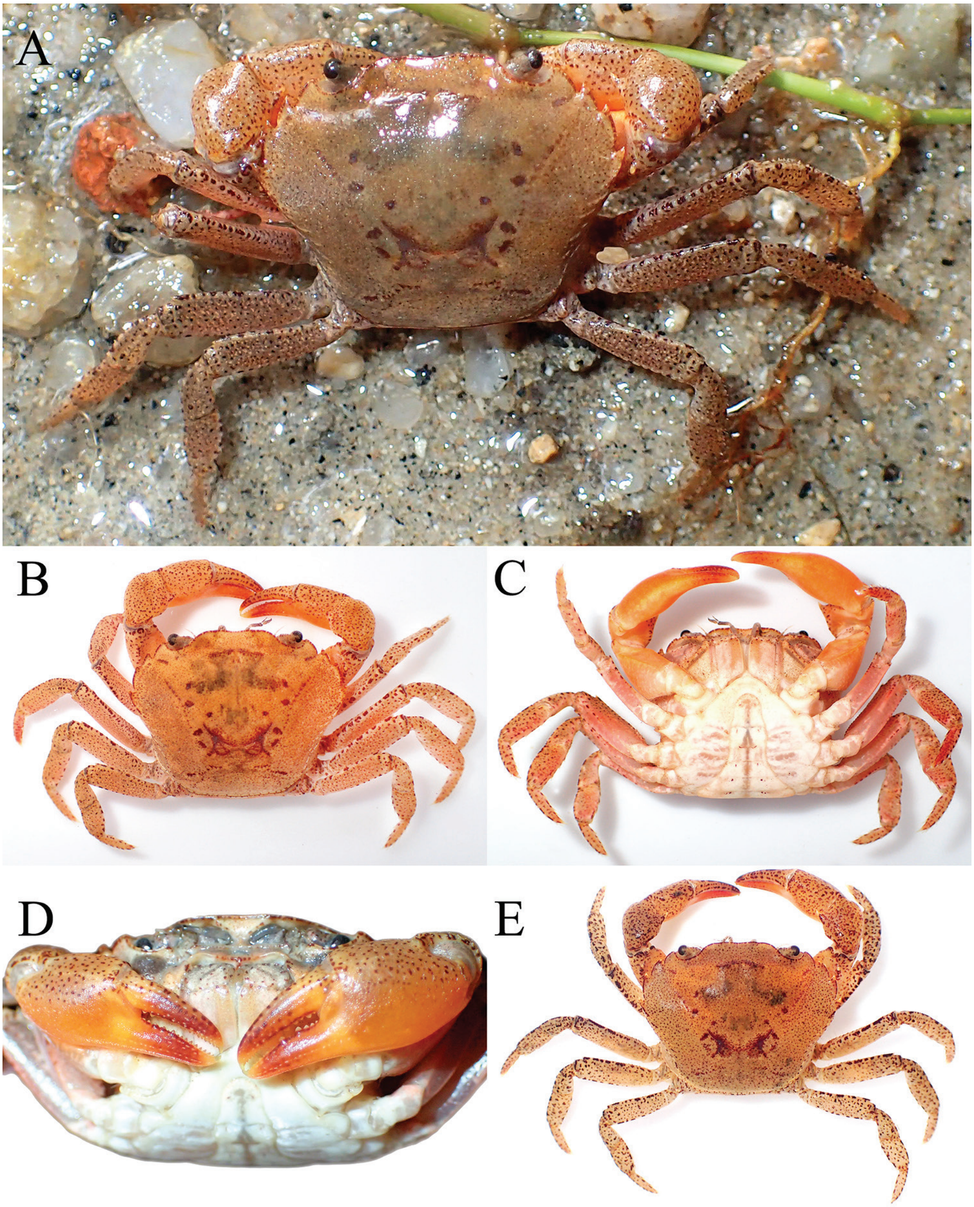

Figure 5. *Salangathelphusa peractio* sp. n., colour in life. **A–D** male (22.4 × 17.7 mm) (ZRC 2017.210) **E** male (21.9 × 17.3 mm) (ZRC 2017.210), Langkawi.

ambulatory leg has a small dorsal subdistal spine and the male pleonal somite 6 is proportionately more trapezoidal in shape (Fig. 4A, B).

Colour. In life, *Salangathelphusa peractio* sp. n. is light brown to orange on all its dorsal surfaces; the dorsal surface of the carapace has large reddish-brown spots and markings at or near the cervical and gastro-cardiac grooves; and the chelipeds and am-

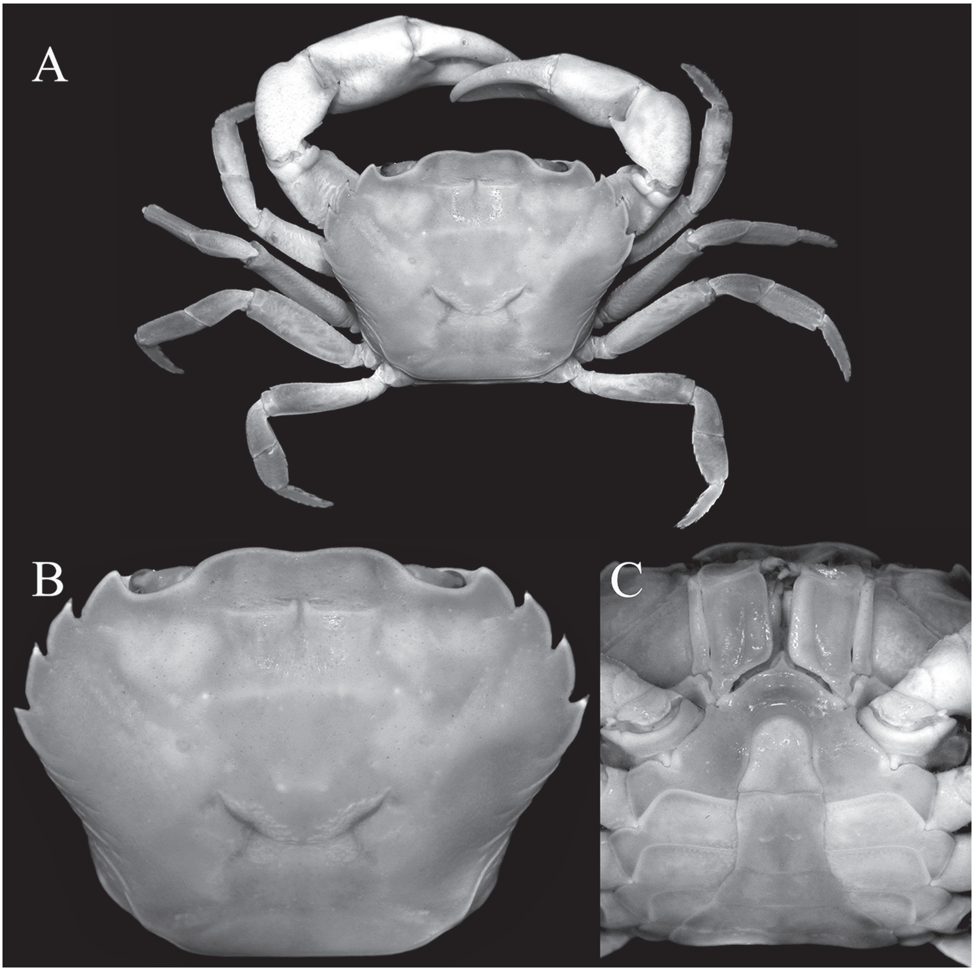

Figure 6. *Salangathelphusa anophrys* (Kemp, 1923), male (26.9 × 20.7 mm) (ZRC 1989.2011), Trang, Thailand. **A** overall habitus **B** dorsal view of carapace **C** male anterior thoracic sternum and pleon.

bulatory legs have numerous small reddish-brown spots (Fig. 5A–C, E). The fingers of the chela are dark orange and the ventral surfaces of the cephalothorax white (Fig. 5D).

Etymology. The species name is derived from the Latin word "peractio" which means "ending of a story". It alludes to the discovery of the present freshwater species, arguably the last one the author will describe from Langkawi, ending his 30-year history with the island. Gender feminine.

Remarks. *Salangathelphusa peractio* sp. n. can easily be separated from *S. brevicarinata* in that its external orbital tooth is proportionately broader (Fig. 1A, B) (external orbital tooth more acutely triangular in *S. brevicarinata*; cf. Bott 1970: pl. 20 fig. 33); the posterolateral margin is distinctly concave (Fig. 1A, B) (posterolateral margin gently concave to almost straight in *S. brevicarinata*; cf. Bott 1970: pl. 20 fig. 33); and the subterminal segment of the G1 is proportionately stouter with the distal half less slender

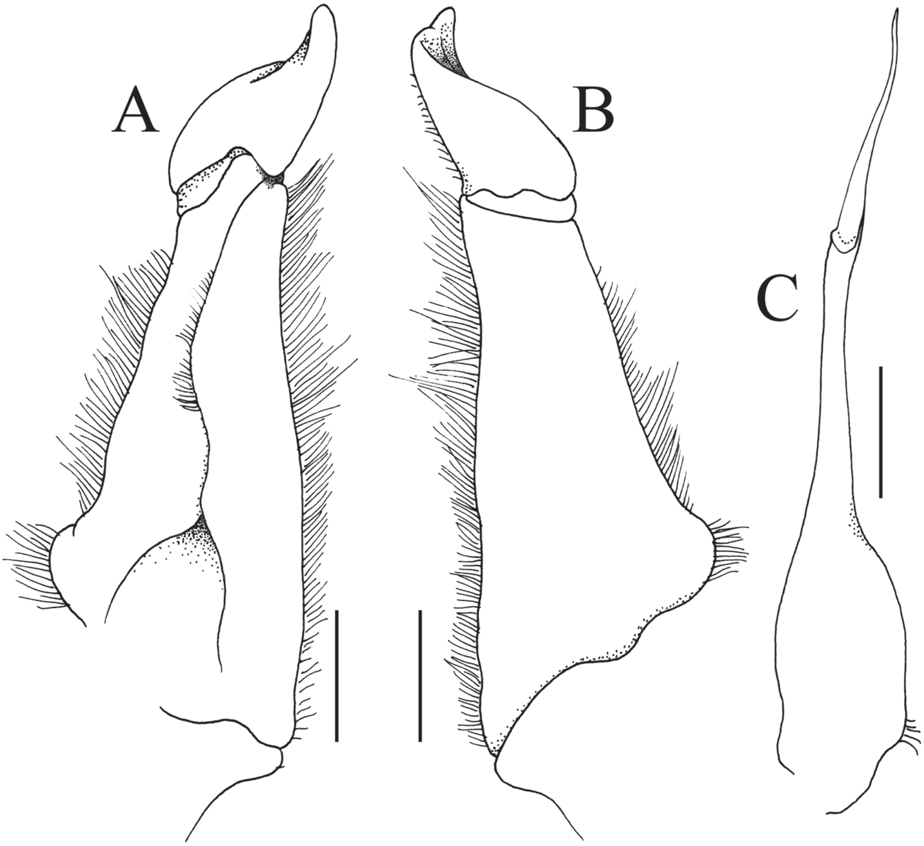

Figure 7. *Salangathelphusa anophrys* (Kemp, 1923), male (26.9 × 20.7 mm) (ZRC 1989.2011), Trang, Thailand. **A** left G1 (ventral view) **B** left G1 (dorsal view) **C** left G2. Scale bars 1.0 mm

and the terminal segment is not distinctly bent laterally outwards with the distal part directed upwards towards the buccal cavity (Fig. 3A, B, C, E) (G1 subterminal segment more slender along distal half with the terminal segment bent inwards and the distal part directed obliquely laterally in *S. brevicarinata*; cf. Bott 1970: pl. 30 fig. 78). From *S. anophrys*, *S. peractio* can be separated by its relatively more quadrate carapace (Fig. 1A, B) (carapace proportionately wider in *S. anophrys*; cf. Fig. 6A, B; Kemp 1923: pl. 4 fig. 10); and most significantly, the subterminal segment of the G1 is proportionately less stout and the terminal segment has the distal part relatively longer and less curved (Fig. 3A, B, C, E) (G1 subterminal segment stouter along entire length with the distal part of the terminal segment shorter and more strongly curved in *S. anophrys*; Fig. 7A, B).

Salangathelphusa peractio is known thus far only from southern streams at the base of Gunung Raya, the highest peak on Langkawi. Its distribution appears to be localised, being confined to shallow streams with fast flowing water, the substrate of the stream bed and banks being rocks of various sizes. The gecarcinucid *Siamthelphusa improvisa* was sometimes found together with *Salangathelphusa peractio*, but the former species prefers areas with dense underwater vegetation and larger rocks. At Lubuk Semilang Park, *Salangathelphusa peractio* was found only in a small area a few hundred square metres, although there are several other similar areas with similar habitats which were not accessible. The park is not a protected area and is used by the public for all manner of recreational activities which partially pollute the area as well as causing substantial disturbance to the overall habitat. How these impacts affect the crabs is not known. Unfortunately, the species is not found in any fully protected site. The restricted distribution and potential habitat impacts means that the species should perhaps be regarded as vulnerable under current conservation guidelines (see Ng and Yeo 2007; Cumberlidge et al. 2009). Its precise status will need more surveys and studies on how habitat changes will affect its population.

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Thanks are due to Amir Ahmad for first passing material of *Salangathelphusa* to the author 14 years ago. The author is also grateful to Darren Yeo for sharing his unpublished photographs and notes of the type material of *S. anophrys*; and to him and Neil Cumberlidge for their helpful comments on the manuscript. Thanks are also due to Oliver Coleman for his hospitality during the author's visit to examine types in the Berlin Museum in 2015.

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RESEARCH ARTICLE

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A new species of *Physoctonus* Mello-Leitão, 1934 from the 'Campos formations' of southern Amazonia (Scorpiones, Buthidae)

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Abstract

Further studies on new specimens of the rare genus *Physoctonus* Mello-Leitão, 1934, lead to the description of a third new species. Until now only *Physoctonus debilis* (C. L. Koch, 1840) and *Physoctonus striatus* Esposito et al., 2017, were known from sites located in the caatingas of the north-east region of Brazil. The new species of *Physoctonus* was collected by the French arachnologist J. Vellard in the Campos do Pará during his field trips back to the 1920/1930, and entrusted to the author in the early 1980s. The populations of *P. debilis* and *P. striatus* from north-east Brazil and that of the new species certainly present disrupted distributions. Biogeographical comments on this pattern of distribution are also added.

Keywords

Campos of Amazonia, disrupt distribution, new species, *Physoctonus*, scorpion

Introduction

The two known species belonging to the genus *Physoctonus*, *P. debilis* (C. L. Koch, 1840) and *P. striatus* Esposito et al., 2017 are found exclusively in sites of the north-east region of Brazil (Fig. 1), but remain uncommon (Lourenço 2007; Porto et al. 2014; Esposito et al. 2017). For several decades, *Physoctonus debilis* was associated to the genus

Figure 1. *Physoctonus debilis*, female from Juazeiro, Bahia, Brazil, in natural habitat (photograph Tiago J. Porto).

Rhopalurus Thorell, 1876 as *Rhopalurus debilis*, but for long was also the subject of great taxonomic confusion. The species was originally described in the genus *Vaejovis*, and later included in the family Buthidae by Kraepelin (1899) (as *incertae sedis*). Subsequently, it was transferred to the genus *Rhopalurus* by Borelli (1910) who was able to examine a single specimen. A few decades later, Mello-Leitão (1934) proposed a new genus *Physoctonus* to accommodate a new species *Physoctonus physurus* Mello-Leitão, 1934 from Brazil. In this study Mello-Leitão (1934) apparently ignored *Vaejovis debilis*. In a note concerning several amendments, Francke (1977) discussed the status of *Physoctonus physurus*. He clearly demonstrated that this species was a junior synonym of *Rhopalurus debilis*, and attributed the taxonomic errors cited above to the scarcity of the known material belonging to this species. The decisions taken by Francke (1977) appeared to be justified and were not re-discussed for quite many years. SEM (Scanning Electron Microscopy) studies in the 1990s started to be available for several species of the genus *Rhopalurus* (Lourenço and Cloudsley-Thompson 1995; Lourenço et al. 2000) bringing further evidence about the importance of the stridulatory apparatus in the taxonomy of this genus. However, due to the scarcity of the available material, not all species of *Rhopalurus* were examined with the use of SEM or light microscopy. A few years ago, specimens of *R. debilis* became available for studies with the use of SEM microscopy (Lourenço 2007). The examination of the pectines of this species leads to surprising results since it was found that *R. debilis* lacked any stridulatory apparatus, therefore excluding it from the genus *Rhopalurus*. Moreover, the distribution of the rows of granulations on the pedipalpal chela fingers showed a quite distinct pattern from those observed for the species of *Rhopalurus*. These results lead to the revalidation of the genus *Physoctonus* Mello-Leitão, 1934, described for the single species *P. physurus* (a junior synonym of *R. debilis*). The species described by Koch was consequently placed in a new combination, *Physoctonus debilis* (C. L. Koch, 1840). Since the publication of SEM studies (Lourenço 2007) the genus *Physoctonus* remained monotypic. In an unpublished thesis Yamaguti (2011) suggested the existence of a new species from a region of Caatinga formation in the city of Oeiras in the north-east state of Piauí. Finally, this presumably new species was recently described by Esposito et al. (2017). In this contribution, one new species of *Physoctonus*, collected in the Amazonian Campos of Pará is described.

The field trips performed by J. Vellard in Brazil

As outlined in previous publications (Lourenço 2001a, 2016), among the zoologists who worked in South America during the first half of the 20th century, the name of Jean A. Vellard is often poorly known or even totally neglected by arachnologists. In fact, his contribution to the study of scorpions was limited to two publications (Vellard 1932, 1934); however, the results he obtained remain very accurate and have been often confirmed in subsequent publications (see Lourenço 2001a, 2016).

Among the field trips that J. Vellard made in Brazil, one was quite long and important. By the end of the 1920s he left the town of Goyaz (Goiás Velho) in the state of Goiás and navigated to the north along the rivers Araguaia and Tocantins. All this travel was done inside totally unexplored regions at the time. One may recall that the Araguaia River is a tributary of the Tocantins River which is itself a tributary of the Amazon River. During this long trip J. Vellard was able to visit and collect in regions such as the north of Goiás (now state of Tocantins), the south of Pará, in the Campos of Pará (Fig. 2), also known as 'Campos dos Cayapos', north of the state of Mato Grosso and particularly in the biggest fluvial island of the world (Bananal) where he dedicated a long period studying venomous fishes (genus *Taeniura*, now *Potamotrygon*) and scorpions (Lourenço 2001a; Adler 2007). J. Vellard described only four new species of scorpions (Vellard 1932, 1934), but all remain valid today. By the end of the 1970s and again in the 1980s field trips were conducted over the same regions previously visited by J. Vellard (Lourenço 2001a) and three of the four species described by him were collected. Nevertheless during the 50–60 years separating our field trips, the natural habitats of these scorpion species suffered intensely due to anthropic activities, in particular cattle grazing. During the north winter of 1980, I had the opportunity to meet J. Vellard in Paris, and he entrusted me a number of scorpion specimens collected in the 1920–1930 period, but never studied. One of these specimens, a new species of *Tityus* C. L. Koch, 1836, was recently described from the state of Tocantins (Lourenço 2016).

The new *Physoctonus* described here is also one of the scorpions Vellard entrusted to the author almost 40 years ago.

Figure 2. Campos of Pará in southern Amazonia, natural habitat of the new species. Photograph taken by the author in 1979. The region was largely threatened in recent years by anthropic action.

Materials and methods

Illustrations and measurements were obtained using a Wild M5 stereomicroscope with a drawing tube and ocular micrometre. Measurements follow Stahnke (1970) and are given in millimetres. Trichobothrial notations follow Vachon (1974) and morphological terminology mostly follows Hjelle (1990).

Several specimens of *Physoctonus debilis* (Koch) have been examined in detail (Fig. 3). The male holotype of *Physoctonus physurus* Mello-Leitão, 1934 (= *Physoctonus debilis*), Santa Luzia, Paraíba state, Brazil, (MNRJ 41823, Brazil), the female of *Rhopalurus debilis* (Borelli, 1910) from the state of Ceará, Brazil (MIZSUT, now MRSN, Italy), and other specimens of *Physoctonus debilis* (C. L. Koch, 1840) were from Brazil, Pernambuco, Tacaratu (Fazenda Paquiú), 15/VII/2005 (G. Freitas leg.), 2 males (UFPE – MNHN); Maranhão, Caxias, Reserva ecológica, 2/X/2004 (F. Limeira-de-Oliveira), 2 females (MNHN); idem, 5-7/VI/2009 (F. Limeira-de-Oliveira, 1 female (MNHN).

Museum depository abbreviations are as follows:

MNRJ	Museu Nacional, Rio de Janeiro;
MIZSUT	Museo ed Istituto di Zoologia Sistematica della Università, Torino (now MRSN = Museo Regionale di Scienze Naturali di Torino);
UFPE	Universidade Federal de Pernambuco;
MNHN	Muséum national d'Histoire naturelle, Paris.

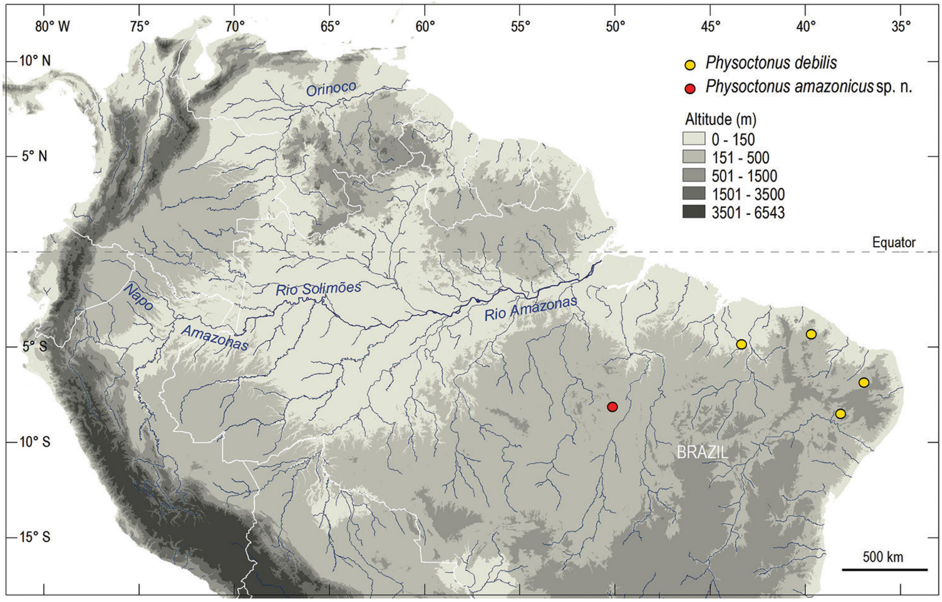

Figure 3. Map of northern South America, showing only the locations in north-east Brazil from where *P. debilis* was studied, and the type locality of the new species.

Taxonomic treatment

Esposito et al. (2017) proposed important modifications in the classification of the scorpions associated to the genera *Rhopalurus, Physoctonus,* and *Troglorhopalurus* Lourenço, Cerqueira Baptista & Giupponi, 2004 within a redefined subfamily Rhopalurusinae. In this difficult and sometimes confusing publication, the authors propose a division of the genus *Rhopalurus* creating what I would define as artificial generic groups. Many previously described species are also placed in synonymy, sometimes without the examination of the type material. Worse, some of their conclusions can have a sarcastic tone and push the boundaries of ethics, such as in cases where original type localities are considered as not reliable, naturally based on pure speculation or by stating that other authors published in "obscure journals". However, these matters will be considered in more details in future publications since the present contribution focuses only on the genus *Physoctonus*.

The genus *Physoctonus* as treated by Esposito et al. (2017) includes the description of a new species, but also contains a number of inaccuracies concerning the diagnoses, ranges of distribution, and ecological aspects, maybe due the lack of sufficient communication among the authors. In this sense, a few points need attention: i) in more than one passage, the revalidation of the genus *Physoctonus* is attributed to Lourenço 2002, when the correct date is 2007; ii) the distribution of *P. debilis* is recorded in the states of Bahia, Ceará, Paraiba, Pernambuco and Piauií (page 89) but in page 93 Bahia is no longer listed. More confusingly, in the map, figure 9B, at least two sites in Maranhão state are both plotted, but no material from Maranhão was examined by the authors. Maybe they refer to the records in Lourenço (2007). The description of the new species *P. striatus* should correspond to *Physoctonus* sp. cited by Yamaguti (2011) in his unpublished thesis. However, Yamaguti (2011) refers the new species to material collected in Oeiras, Piauí, but in the paper by Esposito et al. (2017) the new species is described from Xique-Xique, Bahia, a location of approximately 400 km distance from Oeiras. Moreover, in the abstract of their paper, Esposito et al. (2017) cite Castelo do Piaui as the type locality of *P. striatus*. The material from Oeiras cited by Yamaguti (2011) as new is listed by Esposito et al. (2017) as *P. debilis*. Again, these errors may be the result of a lack of coordination among authors, but are unacceptable, as is this change of the type locality.

In most of their critical remarks of previous papers, Esposito et al. (2017) are very dismissive on the use of colouration patterns by other authors in their diagnoses of new species. Nevertheless, this character is largely used in their diagnosis of *P. striatus*. The use of colour photos in their publication would have been very helpful to illustrate their new species. *Physoctonus striatus* is also defined on the basis of other characters: in particular the position of trichobothrium **db** of pedipalpal chela fixed finger. According to Esposito et al. (2017), **db** is aligned with trichobothrium **et** in *P. striatus* but situated distal to **et** in *P. debilis* - but no illustrations are provided for these characters. In the specimens of *P. debilis* I examined from Pernambuco, trichobothrium **db** is slightly distal or almost aligned with **et**. In the specimens I examined from Maranhão, presumably conspecific with *P. debilis*, trichobothium **db** is clearly basal to **et** whereas in the new species I describe in this work, **db** is only slightly basal to **et** (Fig. 6E–F). Most certainly, the variability of this character should be tested. However, since I did not examine the type material of *P. striatus*, I will presume, a priori, that this is a valid species.

Family Buthidae C. L. Koch, 1836
Genus *Physoctonus* Mello-Leitão, 1934

Physoctonus amazonicus sp. n.

http://zoobank.org/1D016803-F350-4481-8621-4B7310E8C445
Figs. 4, 5, 6

Diagnosis. Medium to small sized scorpion, measuring 28.4 mm in total length for female. General colouration yellow with a brownish inverted triangle covering the anterior margin of carapace; well-marked brownish spots over the lateral edges of carapace and tergites; tergites with a median longitudinal spot which becomes confluent on III to VI; ventral aspect of metasomal segments and appendages intensely spotted. Median ocular tubercle anterior to the centre of carapace; three pairs of lateral eyes. Chelicerae with dentition following the buthid pattern; movable fingers with two small basal teeth, not fused (Vachon 1963). Pedipalps fixed and movable fingers with 7–8 linear rows of granules, and inconspicuous internal and external accessory granules. Sternum between subtriangular and subpentagonal. Pectines small with 13–14 teeth; no

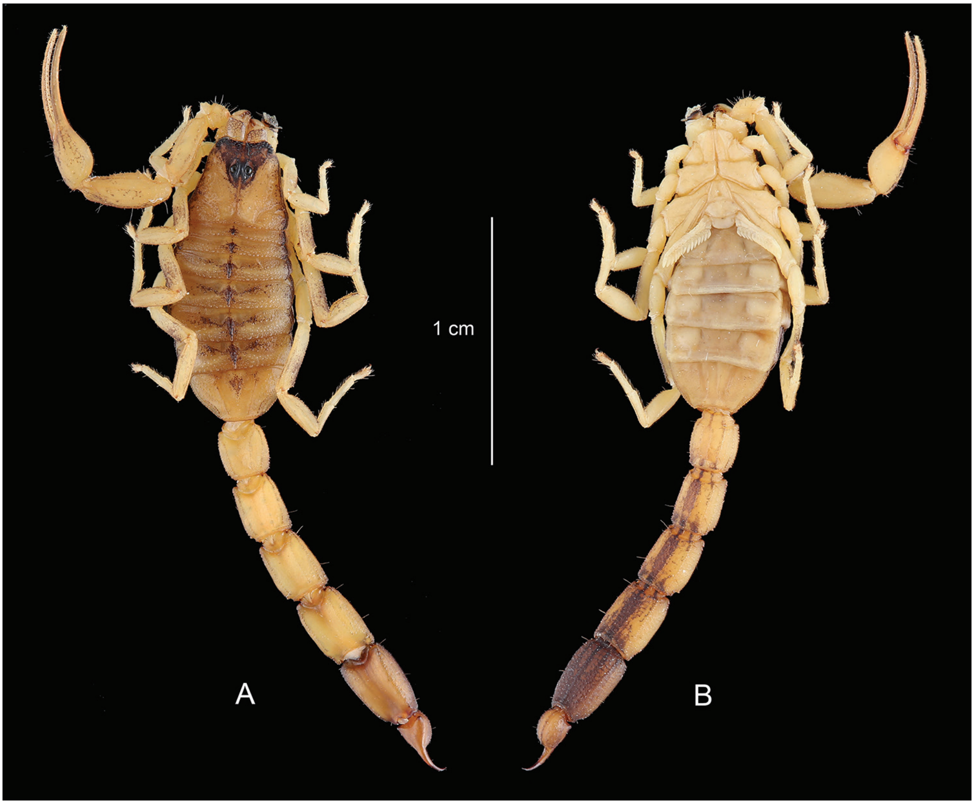

Figure 4. *Physoctonus amazonicus* sp. n., Habitus of female holotype, dorsal and ventral aspects.

stridulatory apparatus; fulcra moderately marked; basal middle lamellae not dilated in female; basal piece strongly marked. Sternites with short linear spiracles. Telson with a globular vesicle; aculeus long and strongly curved, with a vestigial spinoid subaculear tooth. Trichobothrial pattern of type A-α (alpha) – orthobothriotaxic (Vachon 1974, 1975) Tibial spurs absent; pedal spurs reduced.

Type material. Brazil, State of Pará, Campos do Pará, region between rivers Xingu and Araguaya, under termite mound (Fig. 7), XII/1929 (J. Vellard). One female holotype deposited in the collections of the Muséum national d'Histoire naturelle, Paris.

Etymology. The specific name refers to Amazonia, region where the new species was found.

Relationships. The new species seems to be closer related to *Physoctonus debilis* (C. L. Koch, 1840). Both species can, however, be distinguished by a number of features: (i) a darker general colouration with pigmentation and spots more clearly marked on legs, pedipalps, lateral edges of carapace, tergites, and ventral aspect of metasoma (Figs 4–8), (ii) a more flattened body with a larger mesosoma, (iii) a more strongly marked basal piece, (iv) telson aculeus more strongly curved, (v) trichobothrium **db** of fixed finger only slightly basal to **et**. Moreover, the two species are found in different habitats and are geographically isolated (see ecological and biogeographical comments).

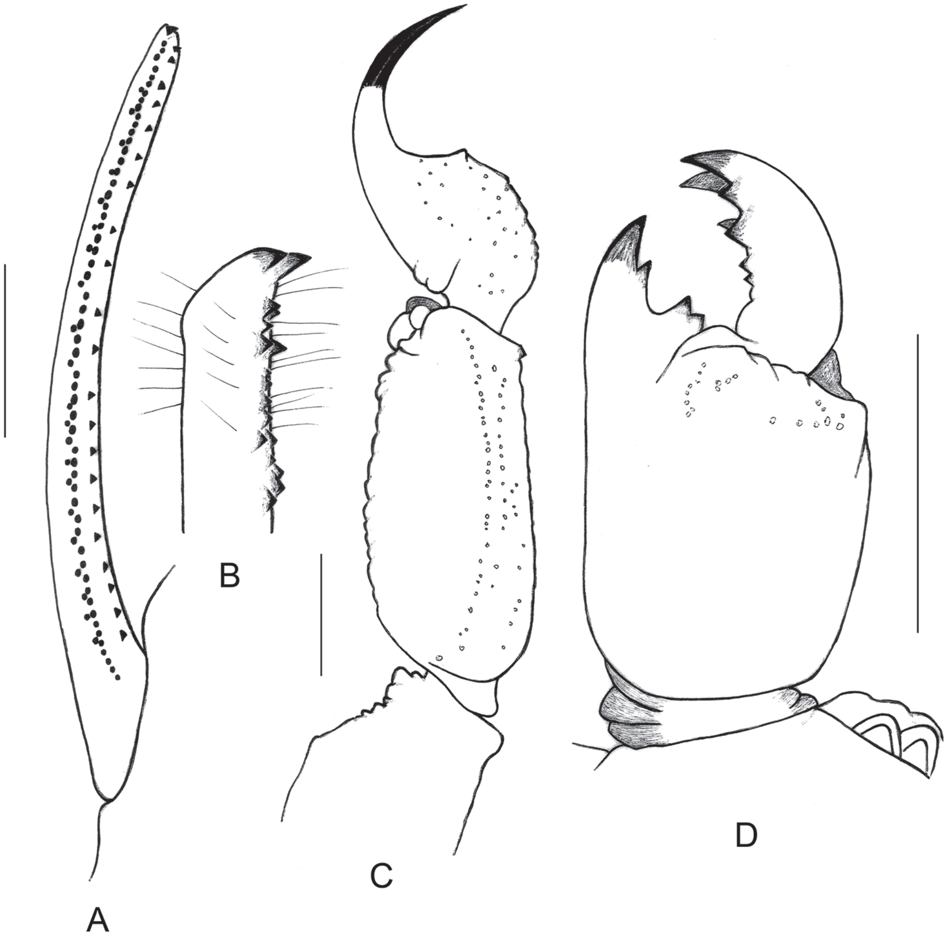

Figure 5. *Physoctonus amazonicus* sp. n., female holotype. **A** Cutting edge of chela movable finger **B** Idem, extremity in detail **C** Metasomal segment V and telson, lateral aspect **D** Chelicera, dorsal aspect. Scale bars: 1 mm.

Description. Based on female holotype. Measurements after the description.

Colouration. Basically yellow strongly marked with brownish spots. Prosoma: carapace yellow with a brownish inverted triangle covering the anterior margin of carapace and well-marked brownish spots over the lateral edges; eyes surrounded with black pigment. Mesosoma: tergites yellow with a median longitudinal spot which becomes confluent on III to VI; lateral edges equally spot as for carapace. Metasomal segments I to IV yellow; V reddish-yellow to reddish-brown; segments II to V strongly infuscate ventrally; carinae dark. Vesicle of same colour as segment V; aculeus yellow at the base and reddish on tip. Venter yellow; genital operculum and pectines pale yellow. Chelicerae yellow with a brownish thread; fingers yellow with reddish teeth. Pedipalps yellow with intense but diffused brownish spots; carinae and granulations on the edge of fingers reddish. Legs yellow with intense diffused brownish spots.

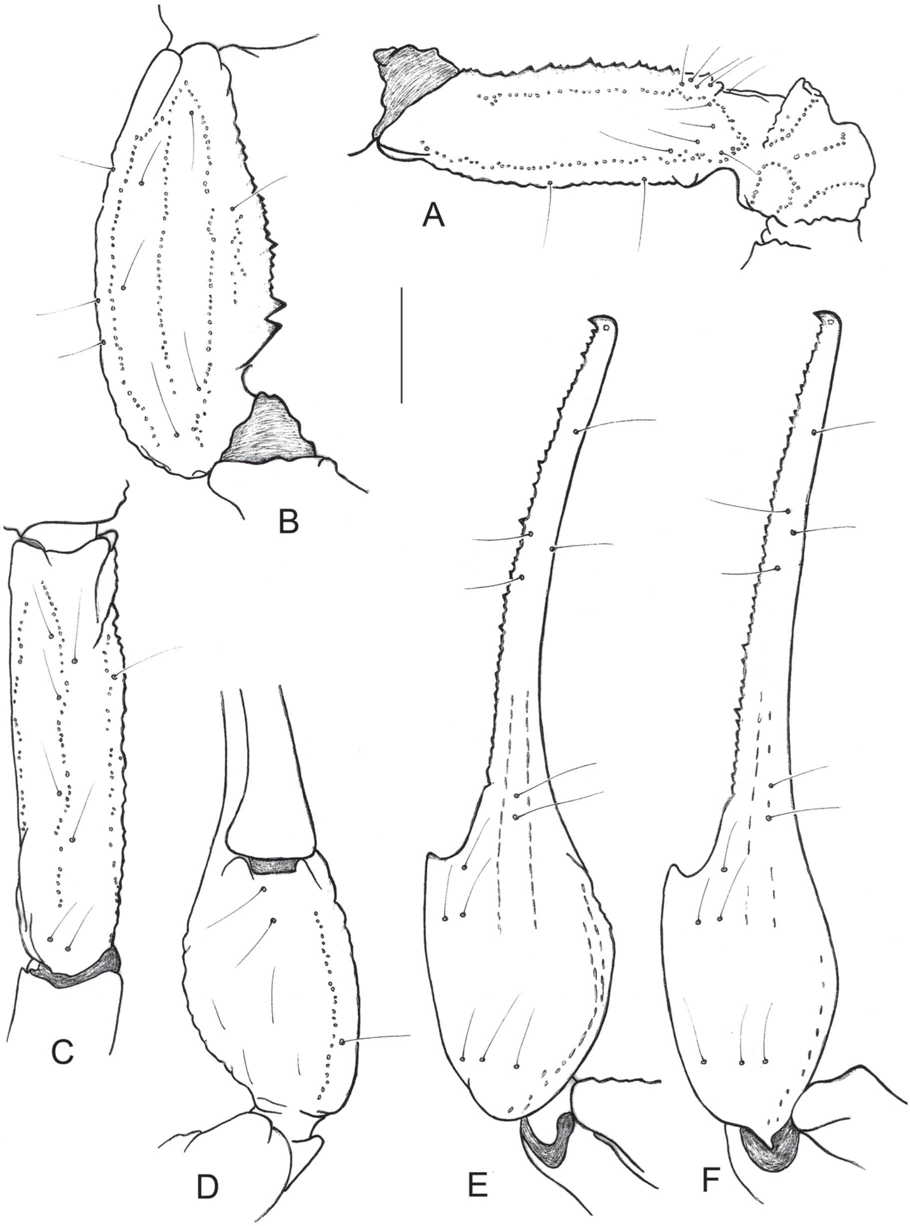

Figure 6. *Physoctonus amazonicus* sp. n., female holotype. Trichobothrial pattern. **A** Femur, dorsal aspect **B–C** Patella, dorsal and external aspects **D–E** Chela, ventral and dorso-external aspects **F** Idem, *Physoctonus debilis*, female from Caxias. Scale bar: 1 mm.

Morphology. Carapace strongly granular but with a thin granulation; anterior margin with a median concavity. Anterior median and posterior median carinae moderate to weak. All furrows moderately to weakly deep. Median ocular tubercle distinctly

Figure 7. Termite mound of *Armitermes* sp., natural habitat of the new species in the Campos of Pará (photograph by the author, 1979).

anterior to the centre of the carapace. Eyes separated by approximately one ocular diameter. Three pairs of lateral eyes. Sternum subtriangular to subpentagonal. Mesosoma flattened and enlarged; tergites moderately to strongly granular. Median carina moderate to strong in all tergites. Tergite VII pentacarinate. Venter: genital operculum divided longitudinally, forming two oval plates; basal piece strongly marked. Pectines with 13–14 teeth. Sternites smooth with short linear spiracles; sternite III with some punctations; sternite VII with four carinae and minute granulations. Metasomal segments I to III with ten carinae; IV with eight carinae; V with five carinae; intermediate carinae totally incomplete on segment III. Intercarinal spaces weakly granular on segments I to IV; more clearly marked on V. Telson roughly granular with a long and strongly curved aculeus, slightly shorter than vesicle. Subaculear tooth vestigial. Cheliceral dentition characteristic of the family Buthidae; basal teeth on movable finger reduced but not fused; ventral aspect of both fingers and manus with dense, long setae (Vachon 1963). Pedipalps: femur pentacarinate; patella with seven carinae; chela with nine carinae, weakly marked; internal aspects of femur and patella with several spinoid granules; all faces weakly granular. Fixed and movable fingers with 7–8 linear rows of granules and weakly marked internal and external accessory granules. Trichobothriotaxy: orthobothriotaxy A- (alpha) (Vachon 1974, 1975). Legs: tarsus ventrally with numerous short fine setae; pedal spurs moderate; tibial spurs absent.

Comparative morphometric values (in mm) of an adult female of *Physoctonus debilis* from Caxias Maranhão state and the female holotype of *Physoctonus amazonicus* sp. n. Total length, 28.3/28.4 (including telson). Carapace: length, 3.7/3.6; anterior width, 2.3/2.4; posterior width, 3.9/4.4. Mesosoma length, 8.6/8.2. Metasomal seg-

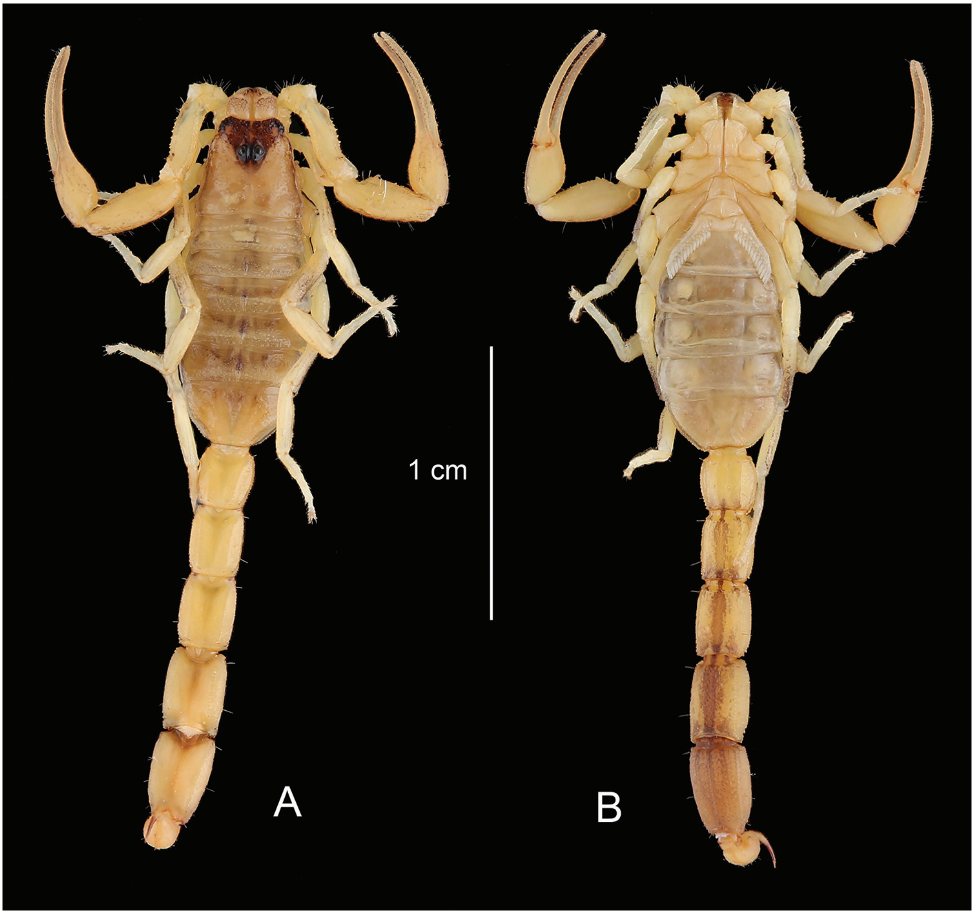

Figure 8. *Physoctonus debilis*. Habitus of female from Caxias, Maranhão, Brazil, dorsal and ventral aspects.

ments. I: length, 2.0/2.1; width, 2.2/2.1; II: length, 2.3/2.5; width, 1.9/2.0; III: length, 2.6/2.7; width, 2.1/2.0; IV: length, 3.0/3.1; width, 2.2/2.2; V: length, 3.1/3.4; width, 2.2/2.2; depth, 1.6/1.4. Telson: length, 3.0/2.8; width, 1.2/1.3; depth, 1.2/1.2. Pedipalp: femur length, 3.5/3.4, width, 1.2/1.1; patella length, 3.9/3.7, width, 1.6/1.5; chela length, 6.8/6.7, width, 1.3/1.5, depth, 1.0/1.2; movable finger length, 4.6/4.5.

Biogeographical and ecological considerations

The genus *Physoctonus* is a typically Neotropical element distributed only in the north range of South America (Fig. 3). The only two species included in this genus until now, *P. debilis* and *P. striatus* seem to be typical elements of the caatinga formations of the northeast of Brazil (Esposito et al. 2017), but the population from Maranhão is located in a transitional area, between cerrados and matas (Lourenço in prep.). Apparently the two previously known *Physoctonus* species are only found under stones and bark of the xerophytic vegetation, and under logs in the sites of Maranhão. Contrarily, the new species described at present was found under a termite mound of *Armitermes* sp., a typical microhabitat of cerrados and campos from Central Brazil and southern Amazonia (Lourenço 2000).

With the discovery of a third species of *Physoctonus* in the Campos of southern Amazonia (Fig. 2), it seems possible to establish a parallel between this pattern of distribution and the one presented by the species of the genus *Rhopalurus* (sensu Lourenço, 2007). For details on the ecology of these Amazonian savannahs refer to Lourenço (2000). In both cases, these two genera constitute suitable examples of groups presenting discontinuous distributions over open vegetation formations. These examples have an important relationship with species endemic to present islands of savannah in Amazonian and Guayanian enclaves (Mori 1991). The endemic populations isolated inside savannah islands provide good evidence in support to the hypothesis of past connections between the savannahs and Caatingas of Central and northeastern Brazil and the savannah enclaves in Amazon and Guayana regions. During past palaeoclimatic vicissitudes associated with major dry periods, forest cover was reduced; open vegetation formations probably coalesced during these climatic events which took place at the end of Cenozoic and during Pleistocene times (Ab'Saber 1977; Van der Hammen 1983).

Scorpion patterns of distributions represent good examples to support this hypothesis. The species of *Physoctonus* (as those of the genus *Rhopalurus*) most certainly exhibited a continuous distribution during Pleistocene dry periods and the present disrupted distribution is a possible consequence of the reestablishment of rainforest over the regions which previously served as corridors (Lourenço 1986, 2001b, 2008). In the case of *Rhopalurus*, at least one species *R. amazonicus* Lourenço, 1986 is endemic to a savannah enclave in the region of Alter do Chão (State of Pará, Brazil) in total isolation within oriental Amazon forest (Murça-Pires and Prance 1985). This example offers additional support to the theory of disrupted distributions. The present description of a new species of *Physoctonus* from the Campos of southern Amazonia seems to conform to this biogeographic model.

This rather recent geographic isolation probably led to a minor process of speciation and differentiation, and as consequence the Amazonian population now found in an isolate fragment of savannah shows little morphological differences. In face of the observed patterns of distribution and differentiation it becomes difficult to be certain about the true taxonomic status of some isolated populations. Consequently one question can be addressed: are these populations true species, subspecies, or only local morphs belonging to large polymorphic populations?

The consequences on the process of speciation during the subsequent wet/dry/wet periods is difficult to measure, but probably they were rather weak on groups such as scorpions with long term reproduction process and a low number of generations when compared to other zoological groups such as insects (Prance 1982; Lourenço 2001b). It is therefore difficult to assign a precise status to the two allopatric populations. Are we in face of species, subspecies or only morphs of a large polymorphic species? If their specific condition could be demonstrated in association with a clear allopatric distribution of the populations, then the condition of super-species sensu Mayr (1931) may be applied to each of the two lineages. The species within each lineage would be represented by allopatric, parapatric, or weakly sympatric groups, really or potentially intersterile in nature (Bernardi 1980). Each of these species could then be defined as a prospecies in the sense of Birula (1910).

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Five new species of the genus *Euplocania* Enderlein (Psocodea, 'Psocoptera', Psocomorpha, Ptiloneuridae) from Colombia

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Abstract

Five new species of *Euplocania* from Colombia belonging in four species groups are here described and illustrated. They increase to 22 the number of species described in the genus, thirteen of which are endemic to Colombia, with one species shared with Brazil and Peru. Three new species groups of *Euplocania* are here diagnosed. A key to the identification of males of Colombian *Euplocania* is included.

Keywords

Neotropics, South America, Taxonomy

Introduction

Euplocania Enderlein (1910) presently includes fifty six species, 16 of which have been described (García Aldrete et al. 2013; González-Obando et al. 2015). Nine species of this genus are known in Colombia (Table 1), as well as an undetermined fossil species in Quaternary copal (Azar et al. 2009; García Aldrete et al. 2013; González-Obando et al. 2015).

Table 1. List of Colombian species of *Euplocania* Enderlein, groups and distribution.

Species	Group	Department
E. badonneli New & Thornton*	*Amabilis*	Amazonas, Caquetá, Putumayo
E. bonaverensis González, García Aldrete & Carrejo	*C*	Valle del Cauca
E. caliensis González, García Aldrete & Carrejo	*A*	Valle del Cauca
E. caquetaensis sp. n.	*B*	Caquetá
E. daguaensis González, García Aldrete & Carrejo	*B*	Valle del Cauca
E. danubiana González, García Aldrete & Carrejo	*E*	Valle del Cauca
E. gaitanae sp. n.	*B*	Caquetá
E. guentherbuchi González, García Aldrete & Carrejo	*Guentherbuchi***	Huila
E. laelsa sp. n.	*Laelsa***	Valle del Cauca
E. macarenaensis González, García Aldrete & Carrejo	*Amabilis*	Meta
E. nasa sp. n.	*Guentherbuchi***	Huila
E. reyesi García Aldrete, González & Carrejo	*Zelayensis*	Magdalena
E. vallecaucana González, García Aldrete & Carrejo	*C*	Valle del Cauca
E. yalcona sp. n.	*Yalcona***	Huila

*Distribution: Peru (Madre de Dios), Brazil (Rondônia), Colombia.
**New group

Specimens collected in the framework of the project "Revisión Taxonómica y Endemismo de los Psócidos (Insecta: Psocodea: 'Psocoptera') de Areas Protegidas de Colombia", financed by Colciencias-Universidad del Valle, increase this number to 31 species, 22 of them undescribed. García Aldrete et al. (2013) and González et al. (2015) proposed several species groups in the genus. The purpose of this work is to describe and illustrate five new species that belong in one of those groups (B) and to define three additional groups that are diagnosed here. The species here described were found in natural areas of three Colombian departments, one in Valle del Cauca (western slope of the western mountain range), two in Huila (central cordillera), and two in Caquetá (eastern slope of the eastern cordillera, within the Amazon Basin).

Materials and methods

Ten males and four females were available for study. They belong to the collection of the Group of Entomological Investigations (Departamento de Biología, Facultad de Ciencias Naturales y Exactas, Universidad del Valle, Santiago de Cali, Colombia), and are deposited in the Entomological Museum of the Universidad del Valle (MUSENUV), Santiago de Cali, Colombia.

One male and one female of each species were dissected in 80% ethanol, and their parts (head, right wings and legs and terminalia), were mounted on slides in Canada balsam, following standard procedures. Color was recorded by placing whole specimens, before dissection, under a stereoscopic microscope, illuminated with cold, white light at 50×. Parts on the slides were measured, following standard procedures, and the measurements are given in mm; the illustrations were made from digital photographs, taken with a Canon T5i camera and Helicon Focus program, processed in a vector graphics editor Clip Studio Paint.

Abbreviations of parts measured are as follows:

al/ah	areola postica length/height
ctt$_1$	number of ctenidiobothria on t_1
f_1-f_n	lengths of flagellomeres 1-n of right antenna
F, T, t_1-t_3	lengths of femur, tibia, and tarsomeres 1-3 of right hindleg
FW and **HW**	lengths of fore- and hind wings
IO, D, and **d**	minimum distance between compound eyes, antero-posterior diameter and transverse diameter, respectively, of right compound eye, all in dorsal view of head
L/W	forewing length/forewing width
lp/wp	pterostigma length/pterostigma width
l/w	hindwing length/hindwing width
Mx4	length of fourth segment of right maxillary palpus
MxW	maximum width of head capsule in frontal view
PO	d/D, H: head length (in dorsal view)

Results

Key to males of Colombian *Euplocania*.

(*E. macarenaensis* González et al., of which males are unknown, is not included)

1 Forewings mostly hyaline, with slender pigmented band from R_{4+5} to cell Cu_2, pterostigma rounded, not extended to Rs, veins with brown areolae at insertion of setae. Hypandrium of one sclerite, deeply cleft in the middle .... **Group D...2**

– Forewings variable; hypandrium of three sclerites, the laterals separated from the central (Figs 4, 16, 28, 40) **3**

2 Posterior projections of hypandrium with apices rounded (see fig. 67 in González-Obando et al. 2015). Phallosome with two pairs of endophallic sclerites, acuminate projections of anterior pair wide based (see fig. 68 in González-Obando et al. 2015).. .... ***E. vallecaucana* González, García Aldrete & Carrejo**

– Posterior projections of hypandrium dilated anteapically (see fig. 7 in González-Obando et al. 2015). Phallosome with a long, mesal, distally acuminate sclerite, in addition to the two pairs of endophallic sclerites; projections of the anterior pair slender, not wide based (see fig. 8 in González-Obando et al. 2015) ....***E. bonaverensis* González, García Aldrete & Carrejo**

3 Forewings hyaline, or with a pigmented marginal band, from cell R$_3$ to ends of cells Cu$_2$ and 1A or to wing base; pterostigma long, slender; central sclerite of hypandrium with two or four tapered posterior projections (Figs 1, 13, 25, 37, 43).. **4**

– Forewings with deeply pigmented, broad marginal band, from cell R$_3$ or R$_5$ to wing base; pterostigma distinctly projected towards Rs; central sclerite of hypandrium with two posterior projections variable in shape and position ... . **Groups Amabilis, A, E**...**11**

4 Central sclerite of hypandrium wide, posteriorly with four posterior projections, two broad lateral and two acuminated small, median (Figs 4 and 16). Forewings with pigmented marginal band, from cell R$_3$ to near wing base, M four branched, M$_4$ simple (Figs 1, 13).. **5**

– Central sclerite of hypandrium with two-four posterior lateral projections, lateral ones acuminate (Figs 28, 40, 46). Forewings with or without marginal band, M four-five branched (Figs 25, 37, 43), if M four branched, then M$_4$ simple or forked **7**

5 Lateral projections of central sclerite of hypandrium with a blunt ended process, directed inwards, median projections separated from the base or from the distal portion (Fig. 16).. **6**

– Lateral projections of central sclerite of hypandrium without a blunt ended process, with abundant distal teeth, some thick, median projections separated from the base (Fig. 4).. ***E. caquetaensis* sp. n.**

6 Central sclerite of hypandrium with teeth on the inner side of the lateral projection, median projections separated from the base (see fig. 25 in González-Obando et al. 2015) ....***E. daguaensis* González, García Aldrete & Carrejo**

– Central sclerite of hypandrium without teeth on the inner side of the lateral projection, median projections separated from the distal portion (Fig. 16).... .... ***E. gaitanae* sp. n.**

7 Forewings with a slender or broad pigmented band, M four branched, M4 simple (Figs 25 and 43). Central sclerite of hypandrium with two-four posterior acuminate projections, if four, two lateral and two median (Fig. 46), if two, lateral (Fig. 28) **8**

– Forewings almost hyaline, without pigmented marginal band (Fig. 37), M of four-five branches, M$_4$ or M$_5$ forked. Central sclerite of hypandrium with two posterior projections, broad or acuminate (Fig. 40).. **9**

8 Forewings with broad, marginal, pigmented band, from cell r2+3 to vein A1 (Fig. 25). Central sclerite of hypandrium with two lateral, broad convergent projections, apically overlapping, distally denticulate (Fig. 28)...***E. laelsa* sp. n.**

– Forewings with narrow, marginal, pigmented band, from R$_{2+3}$ to wing base (Fig. 43). Central sclerite of hypandrium with four acuminate projections, the median ones shorter and separated by a U-shaped concavity (Fig. 46)..... .... ***E. yalcona* sp. n.**

9 Posterior projections of central sclerite of hypandrium convergent, distally rounded and crossed (see García Aldrete et al. 2013). Phallosome with two

mesal endophallic sclerites, clearly separated and distally acuminate (see fig. 5 in García Aldrete et al. 2013)...***E. reyesi*** **García Aldrete, González & Carrejo**

– Posterior projections of central sclerite of hypandrium not convergent, broad or acuminate, never distally crossed (Fig. 40). Phallosome as in Fig. 42, with mesal endophallic sclerite fused, transverse, postero-mesal endophallic sclerites tapered and distally bent outwards...**10**

10 Central sclerite of hypandrium with slender posterior projection, with apex bent inwards (see fig. 49 in González-Obando et al. 2015). Mesal endophallic sclerites with a rounded protuberance in the middle of the bridge, each arm dilated mesally, curved outwards, distally acuminate (see fig. 50 in González-Obando et al. 2015) ....***E. guentherbuchi*** **González, García Aldrete & Carrejo**

– Central sclerite of hypandrium with posterior projections proximally wide (Fig. 40). Phallosome as in Fig. 42.. ***E. nasa*** **sp. n.**

11 Central sclerite of hypandrium with two posterior projections; side sclerites smaller than central sclerite..**12**

– Central sclerite of hypandrium with four posterior projections, two central ones long, slender, glabrous, and two side ones broad, setose, with digitiform posterior processes bearing setae; side sclerites about twice as large as central sclerite (see fig. 37 in González-Obando et al. 2015). Phallosome with posterior, transverse endophallic sclerite, with posterior border projected in the middle (see fig. 38 in González-Obando et al. 2015)..............***E. danubiana*** **González, García Aldrete & Carrejo**

12 Central sclerite of hypandrium with blunt ended lateral posterior projections, median concavity U-shaped; phallosome with mesal endophallic sclerite transverse but not W-shaped (see figs 23 and 24 in New and Thornton 1988)...***E. badonneli*** **New & Thornton**

– Posterior projections of central sclerite of hypandrium median, arising from a common stem, each arm distally acuminate; phallosome with a transverse, mesal endophallic sclerite W-shaped (see figs 13 and 14 in González-Obando et al. 2015) ....***E. caliensis*** **González, García Aldrete & Carrejo**

Taxonomy

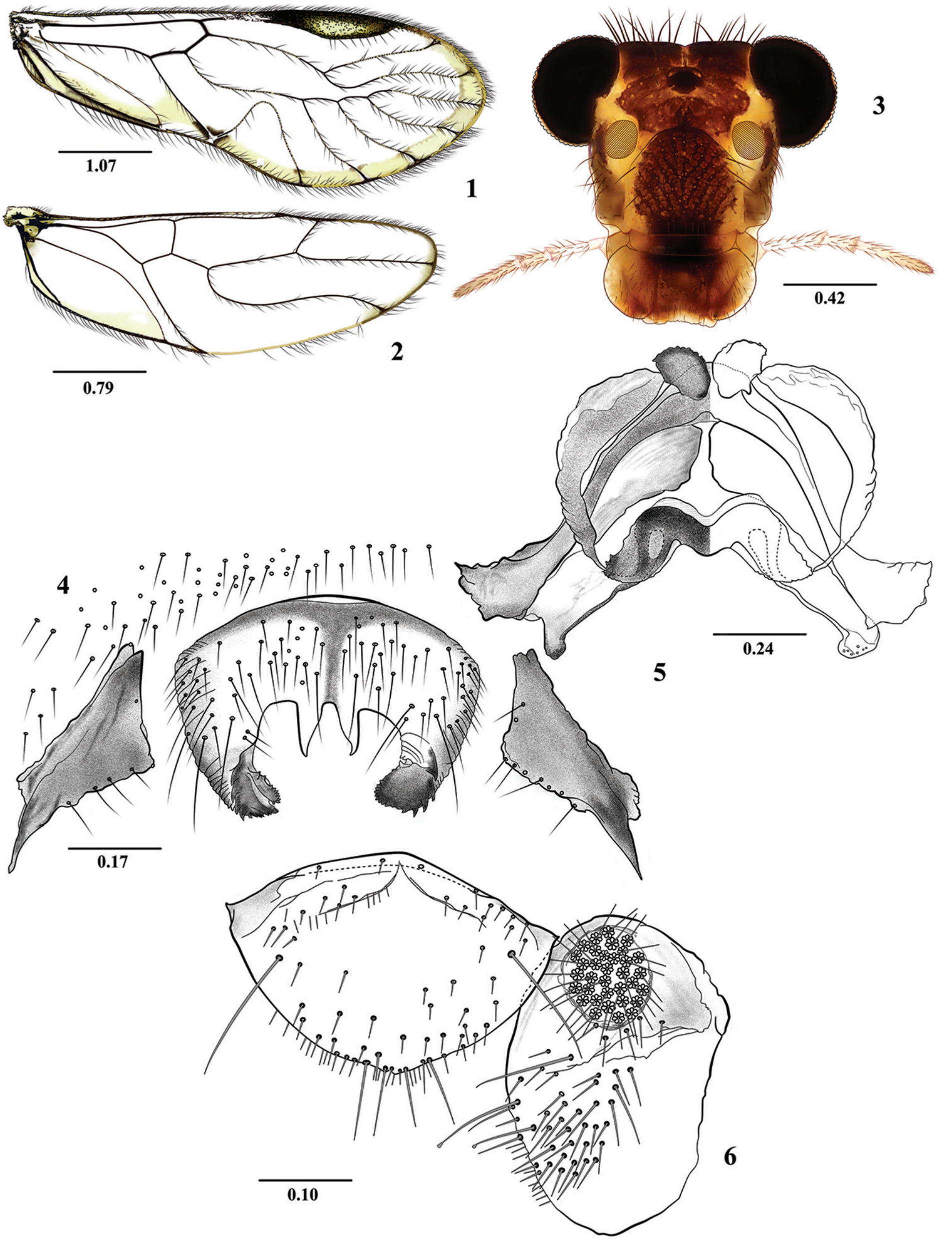
Euplocania caquetaensis sp. n.

http://zoobank.org/97DD41A4-943B-4A49-99C0-4F2201051E55

Figs 1–12

Type locality. COLOMBIA. Caquetá. San Vicente del Caguán, Laureles, Resguardo Indígena Altamira, 917 m., 2°27'50.14"N; 74°55'02.06"W. Paratype female. Caquetá. Belén de Los Andaquíes, Resguardo Indígena La Esperanza, 844 m., 1°36'19.18"N: 75°56'12.46"W.

Type material. Holotype male. 27.IV.2017. Led light trap. J. Panche. MUSENUV, slide code No. 28777. Paratype female, 1.III.2017. Led light trap. J. Panche. MUSENUV, slide code 28778).



Figures 1–6. *Euplocania caquetaensis* sp. n. Male. **1** Forewing **2** Hindwing **3** Front view of head **4** Hypandrium **5** Phallosome **6** Epiproct and right paraproct. Scales in millimeters.

Etymology. The specific epithet refers to the Colombian department of Caquetá, where the types were collected.

Diagnosis. Belonging in species group B, in the classification of García Aldrete et al. (2013). It is close to *E. daguaensis* González, García Aldrete & Carrejo and to *E.*

gaitanae sp. n., described below; differing from them by having the lateral processes of the central sclerite of the hypandrium with abundant distal teeth and not bent distally inwards. Median projections separated from the basal part as in *E. daguaensis* (Fig. 4). Forewing with a pigmented marginal band, from cell R_3 to wing base. Female IX sternum trapeziform, slightly convex anteriorly (Fig. 11).

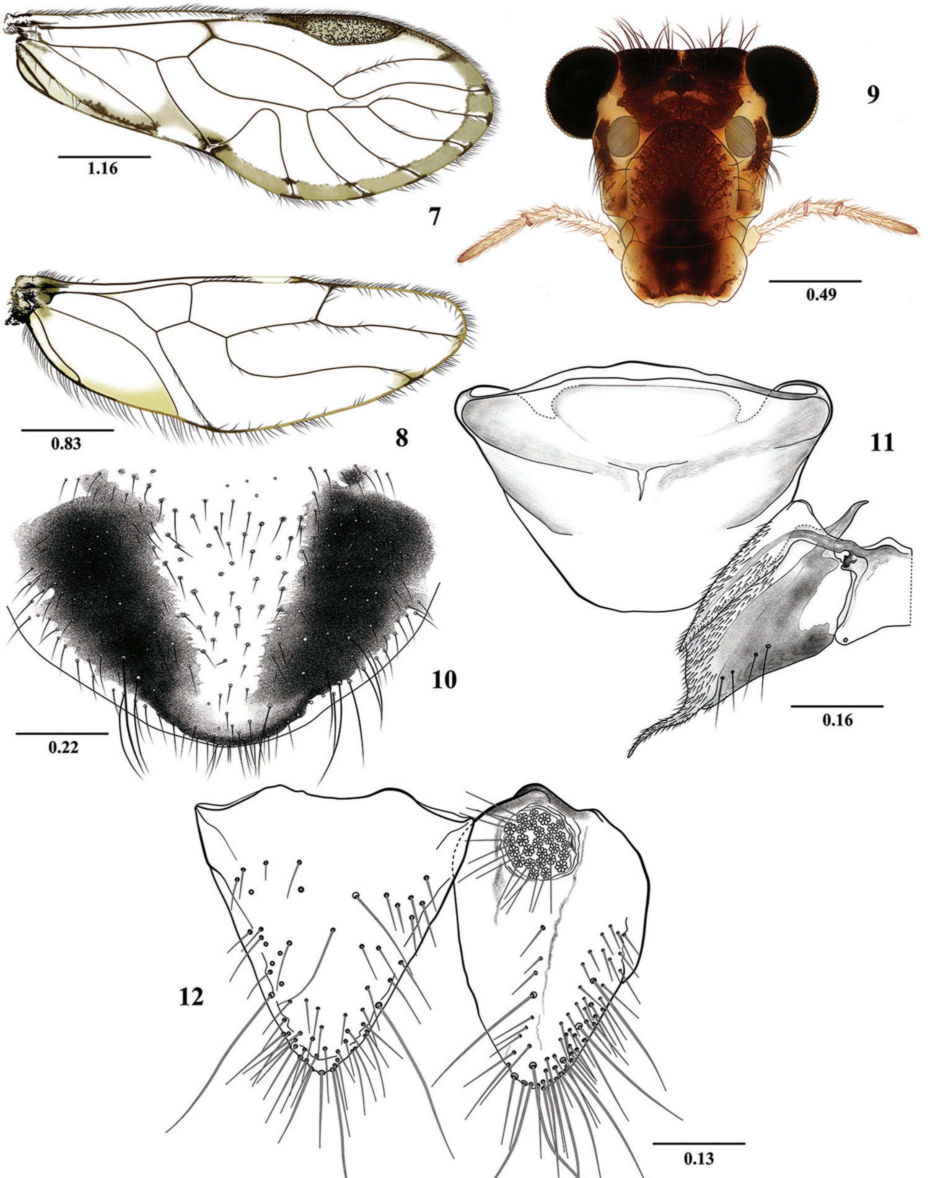
Description. *Male.* Color (in 80% ethanol). Head pattern (Fig. 3). Compound eyes black, ocelli hyaline, with ochre centripetal crescents. Frons, postclypeus, anteclypeus, and labrum dark brown centrally, with sides pale brown. Genae brown. Antennae creamy. Mx 1-3 creamy; Mx4 creamy, brown distally. Tergal lobes of meso- and metathorax dark brown. Thoracic pleura creamy, with small brown ochre spots. Coxae of all legs brown; femora of all legs pale brown; trochanters, tibiae and tarsi of all legs brown. Forewings almost hyaline, with a pale brown-yellowish band along margin, from R_{2+3} to near the wing base; veins brown, with a dark brown spot at wing margin. Pterostigma peripherally dark brown, pale brown in the middle (Fig. 1). Hindwings hyaline, veins brown, with a dark brown spot at end of R_{4+5} and M_1 (Fig. 2). Abdomen creamy, with brown ochre spots. Central sclerite of hypandrium pale brown, basal and distal part of lateral processes dark brown. Epiproct and paraprocts creamy.

Morphology. As in diagnosis, plus the following: Head (Fig. 3): H/MxW: 1.36; compound eyes large, H/d: 2.54; IO/MxW: 0.69. Outer cusp of lacinial tip broad, with seven denticles. Mx4/Mx2: 1.21. Forewings (Fig. 1): L/W: 2.73. Pterostigma: lp/wp: 5.76, areola postica tall, with rounded apex: al/ah: 1.52. Hindwings (Fig. 2): l/w: 3.07. Central sclerite of hypandrium rounded anteriorly, triconcave posteriorly, side sclerites broadly triangular (Fig. 4). Phallosome (Fig. 5) anteriorly U shaped, with broad distally side struts; external parameres membranous, distally rounded, bearing pores; two pairs of endophallic sclerites, and one transverse mesal sclerite as illustrated. Paraprocts (Fig. 6) almost elliptic, with a dense setal field; sensory fields with 33 trichobothria on basal rosettes. Epiproct (Fig. 6) broad, convex anteriorly, with rounded apex and four apical macrosetae; setal field broad, with abundant small setae and two macrosetae, one on each side, as illustrated.

Measurements. FW: 5400, HW: 3650, f1: 1440, f2: 1520, f3: 1390, Mx4: 350, IO: 570, D: 500, d: 390, IO/d: 1.46, PO: 0.78.

***Female.* Color**. As in the male**.** Subgenital plate hyaline in the middle, with sides dark brown, as illustrated (Fig. 10).

Morphology. As in diagnosis, plus the following: Head (Fig. 9): H/MxW: 1.42; H/d: 3.30; IO/MxW: 0.70. Outer cusp of lacinial tip broad, with eight denticles. Mx4/Mx2: 1.25. Wings (Figs 7 and 8) as in the male, L/W: 2.65. Pterostigma: lp/wp: 5.33, areola postica: al/ah: 1.36. Hindwings (Fig. 8): l/w: 2.88. Subgenital plate (Fig. 10) broad, posteriorly rounded, setose. Gonapophyses (Fig. 11): v1 elongate, broad and pilose, acuminate; v2+3 pilose, with a row of 4 setae on v2; distal process sinuous, acuminate, with microsetae on surface. Paraprocts (Fig. 12) triangular, distal setal field with abundant setae as illustrated, sensory field with 23 trichobothria on basal rosettes. Epiproct (Fig. 12) triangular, mesal field with three macrosetae and abundant setae distally as illustrated.



Figures 7–12. *Euplocania caquetaensis* sp. n. Female. **7** Forewing **8** Hindwing **9** Front view of head **10** Subgenital plate **11** Ninth sternum and left gonapophyses (ventral view) **12** Epiproct and right paraproct. Scales in millimeters.

Measurements. FW: 6125, HW: 4075, F: 1525, T: 2725, t1: 1100, t2: 105, t3: 175, ctt1: 36, f1: 1310, f2: 1440, f3: 1290, Mx4: 405, IO: 655, D: 500, d: 400, IO/d: 1.31, PO: 0.8.

***Euplocania gaitanae* sp. n.**

http://zoobank.org/C434D2D3-9F04-408D-92DA-FEB3DE6E8C8E
Figs 13–24

Type locality. COLOMBIA. Caquetá. Belén de Los Andaquíes, Resguardo Indígena La Esperanza, 844 m., 1°36'19.18"N; 75°56'12.46"W.

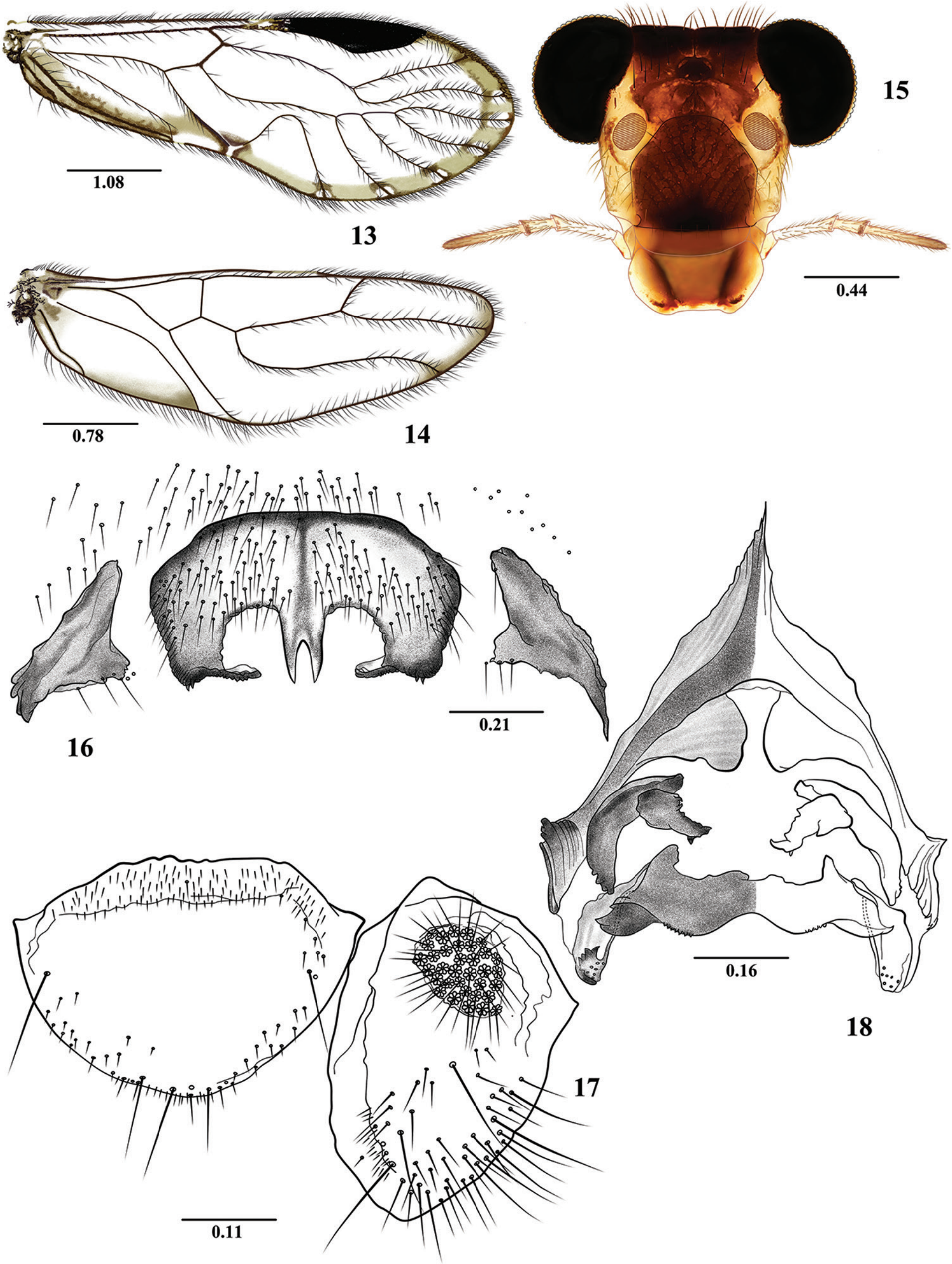
Type material. Holotype male. 1.III.2017. Led light trap. J. Panche. MUSENUV slide code No. 28779. Paratypes: 2 males, 1 female. MUSENUV slide code 28780, same data as the holotype.

Etymology. This species is dedicated to the female cacique Gaitana (Guaitipán), indigenous heroine of the XVI century, who led a ferocious resistance against the Spanish invaders in the mountains of the Huila-Caquetá Departments, in the Colombian Andes.

Diagnosis. Belonging in species group B, in the classification of García Aldrete et al. (2013). It is similar to *E. daguaensis* González, García Aldrete & Carrejo and to *E. caquetaensis* sp. n. It differs from them by the shape of the median and lateral processes of the central sclerite of the hypandrium and in details of phallosomes and forewings (see identification key above). Central sclerite of hypandrium wide, posteriorly with two short acuminate projections in the middle, and two lateral processes, bearing two short apical teeth, without teeth on the inner border, bent inwards (Fig. 16). Phallosome V shaped, with a large transverse mesal endophallic sclerite (Fig. 18). Forewings with a pigmented marginal band, from R_{2+3} to wing base (Figs 13 and 19). Female IX sternum semioval, anteriorly concave medially, sides with narrow pigmented area bent towards the mesal line (Fig. 24).

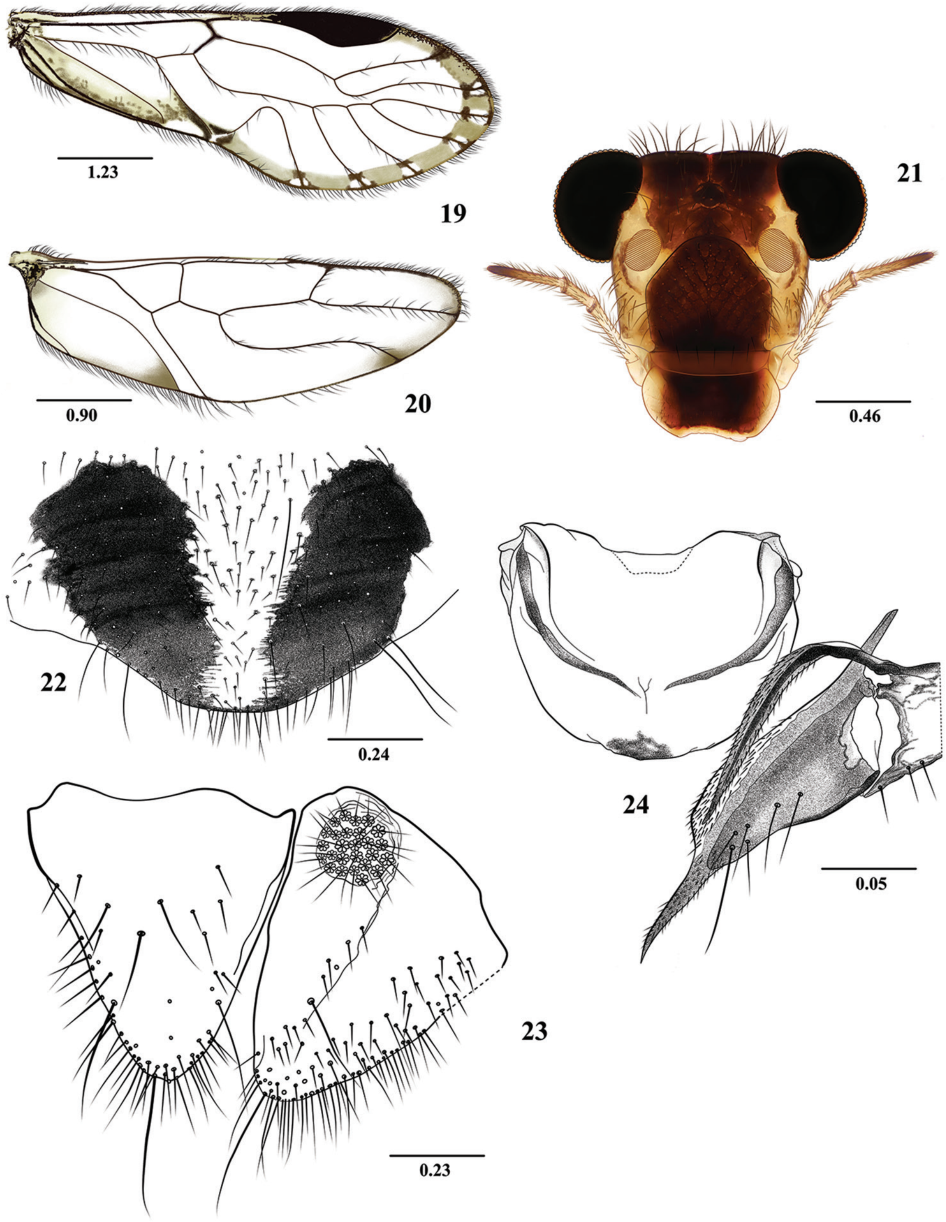
Description. ***Male.*** **Color.** Head dark brown frontally, pale brown laterally (Fig. 15). Compound eyes black, ocelli hyaline, with ochre centripetal crescents. Vertex, clypeus and labrum dark brown. Genae pale brown, with small ochre band near the antennal fossae. Antennae pale brown to brown, with apex cream. Maxillary palps brown, Mx4 distally dark brown. Tergal lobes of meso- and metathorax dark brown. Thoracic pleura creamy, with ochre and white spots. Legs brown, coxae dark brown. Forewings hyaline, with a pale brown marginal band, from R_{2+3} to wing base; veins brown, with a dark brown spot at wing margin. Pterostigma dark brown (Fig. 13). Hindwings hyaline, veins brown, with a pale brown spot at wing margin (Fig. 14). Abdomen creamy, with ochre subcuticular bands. Central sclerite of hypandrium pale brown, with sides dark brown. Epiproct and paraprocts creamy.

Morphology. As in diagnosis, plus the following: Head (Fig. 15): H/MxW: 1.48; compound eyes large, H/d: 2.77; IO/MxW: 0.64. Outer cusp of lacinial tip broad, with nine denticles. Mx4/Mx2: 1.11. Forewings (Fig. 13): L/W: 2.77. Pterostigma: lp/wp: 5.13, areola postica tall, with rounded apex: al/ah: 1.63. Hindwings (Fig. 14): l/w: 3.05. Central sclerite of hypandrium rounded anteriorly, triconcave posteriorly, side sclerites triangular (Fig. 16). Phallosome (Fig. 18) anteriorly Y shaped, with broad side struts; external parameres membranous, distally rounded, bearing pores; two pairs of endophallic sclerites, and one posterior, transverse mesal sclerite. Paraprocts (Fig. 17)



Figures 13–18. *Euplocania gaitanae* sp. n. Male. **13** Forewing **14** Hindwing **15** Front view of head **16** Hypandrium **17** Epiproct and right paraproct **18** Phallosome. Scales in millimeters.

almost elliptic, with a dense setal field distally; sensory fields with 29 trichobothria on basal rosettes. Epiproct (Fig. 17) broad, semioval, rounded posteriorly, setal field on sides and anteriorly; one large setae on each side and three macrosetae posteriorly.



Figures 19–24. *Euplocania gaitanae* sp. n. Female. **19** Forewing **20** Hindwing 21. Front view of head **22** Subgenital plate **23** Epiproct and right paraproct **24** Ninth sternum and left gonapophyses (ventral view). Scales in millimeters.

Measurements. FW: 5750, HW: 3962, F: 1475, T: 2600, t1: 1057, t2: 100, t3: 150, ctt1: 36, f1: 1250, f2: 1390, f3: 1310, Mx4: 365, IO: 560, D: 600, d: 470, IO/d: 1.19, PO: 0.78.

Female. **Color**. Essentially as in the male**.** Subgenital plate hyaline in the middle, with sides dark brown, as illustrated (Fig. 22).

Morphology. As in diagnosis, plus the following: Head (Fig. 21): H/MxW: 1.41; H/d: 3.09; IO/MxW: 0.68. Outer cusp of lacinial tip broad, with eight denticles. Mx4/Mx2: 1.25. Wings (Figs 19 and 20) as in the male, L/W: 2.76. Pterostigma: lp/wp: 4.71, areola postica: al/ah: 1.82. Hindwings (Fig. 20): l/w: 3.06. Subgenital plate (Fig. 22) broad, posteriorly rounded, setose. Gonapophyses (Fig. 24): v1 elongate, slender, setose, acuminate; v2+3 with a row of 6 setae on v2; distal process sinuous, acuminate, with microsetae on surface. Paraprocts (Fig. 23) triangular, with distal setal field as illustrated, sensory field with 27 trichobothria on basal rosettes. Epiproct (Fig. 23) triangular, apically rounded, setae as illustrated.

Measurements. FW: 6200, HW: 4250, F: 1550, T: 2700, t1: 1050, t2: 100, t3: 152.5, ctt1: 28, f1: 1320, f2: 1470, f3: 1360, Mx4: 390, IO: 640, D: 536, d: 430, IO/d: 1.19, PO: 0.80.

Euplocania laelsa **sp. n.**

http://zoobank.org/1BF3832A-065D-4D72-8DFF-47B5AEE67301
Figs 25–36

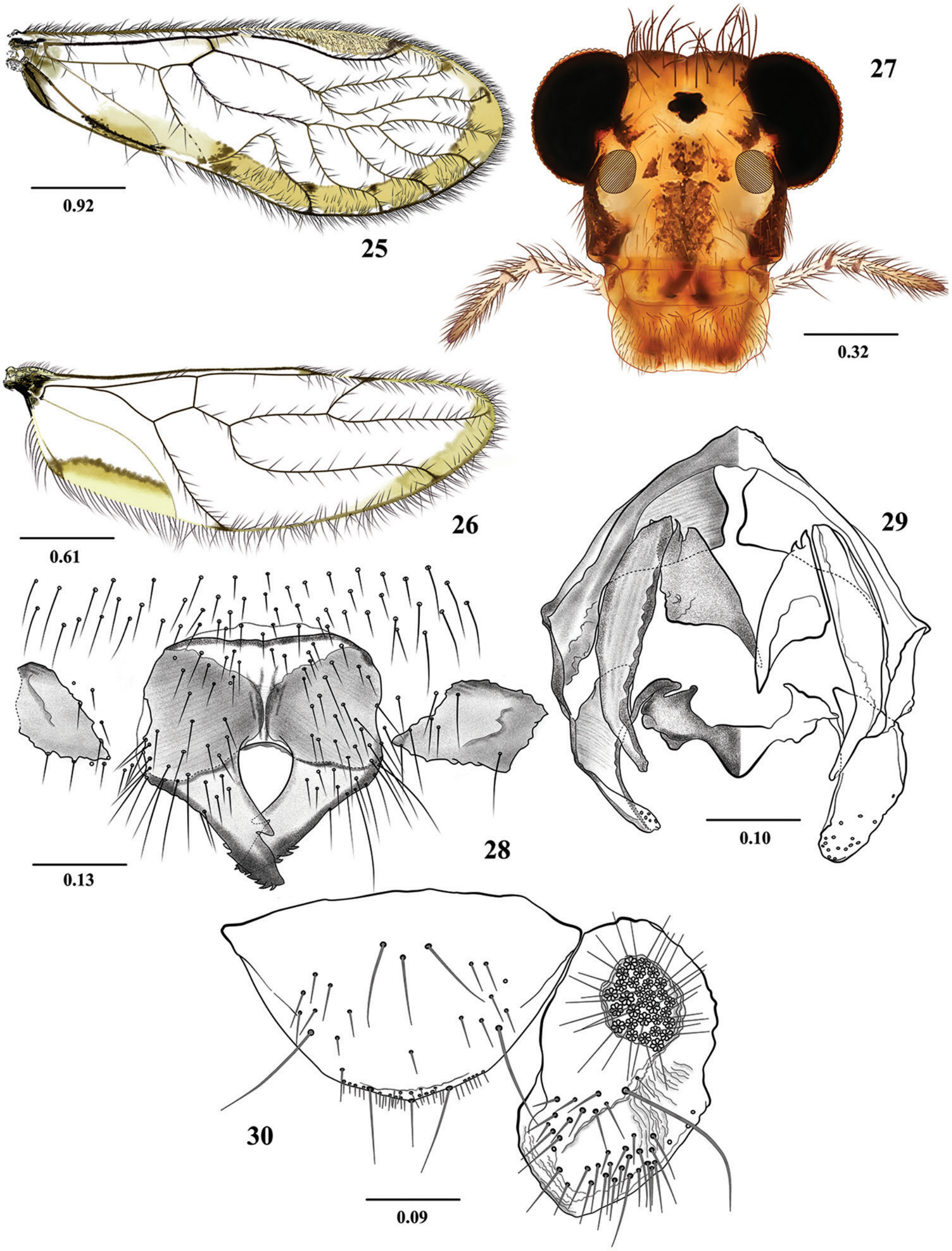
Type locality. COLOMBIA. Valle del Cauca. Dagua, La Elsa, Finca La Elsa, 942 m., 03°34'18.9"N; 76°45'46"W. Paratypes: 2 females, 2 males. Same data as the holotype.

Type material. Holotype male. 7.IV.2017. Shannon light trap. J. S. Ramírez and R. González. MUSENUV, slide code No. 28781. Paratypes: 1 female, MUSENUV slide code 28782, 2 males, 1 female, same locality, 21.IV.2017. Shannon light trap. A. F. Vinasco and R. González. MUSENUV.

Etymology. The specific name, a noun in apposition, refers to the type locality, Finca La Elsa, where the types were found.

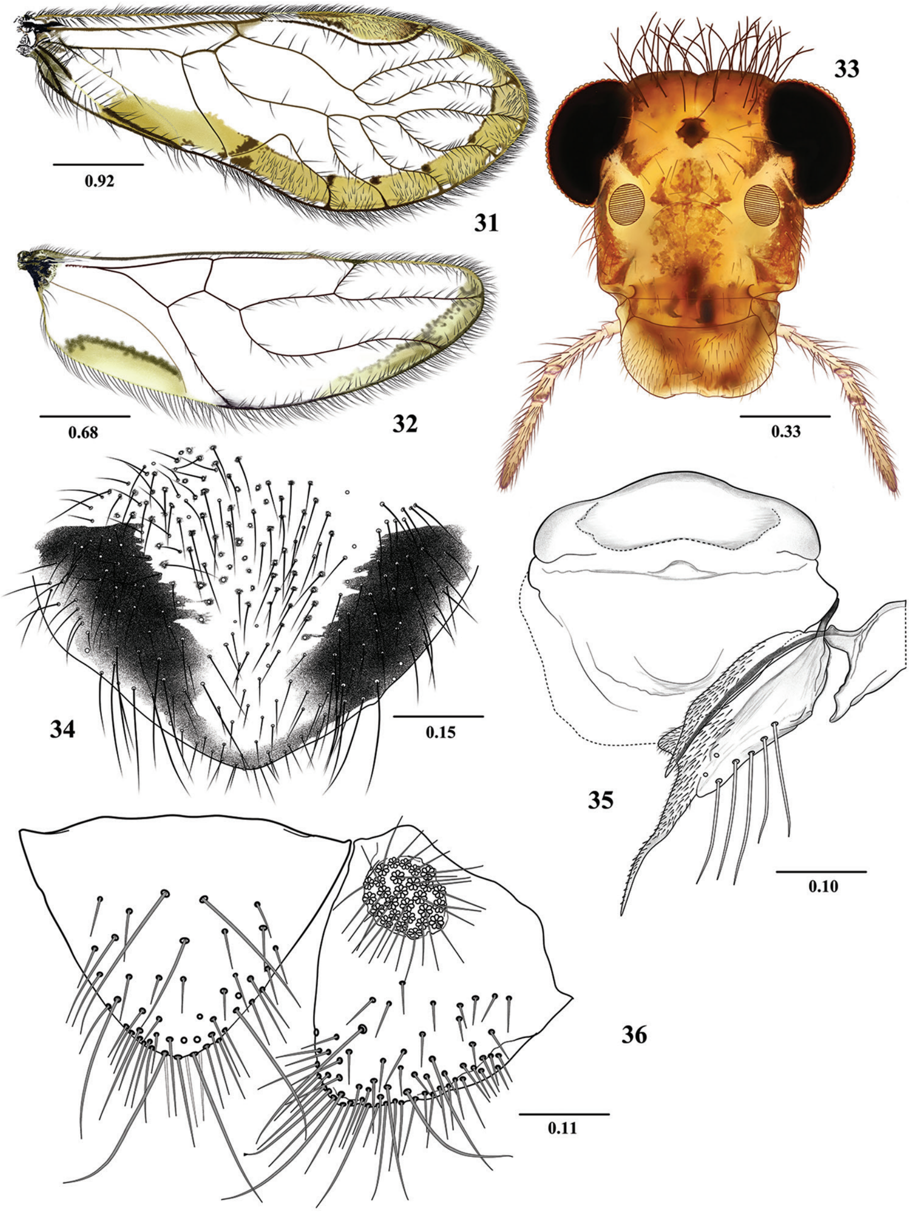
Diagnosis. Belonging to the new species group *Laelsa*. Forewings with a broad, pigmented marginal band from R_{4+5} to Cu2-1A. Pterostigma elongate, not angulated towards Rs (Fig. 25). Hypandrium of three sclerites, central one large, almost rectangular, with two stout lateral posterior processes, distally crossed, each bearing a mesal tooth on inner border, and a row of teeth distally along the outer border (Fig. 28). The sclerite above is reminiscent of the central sclerite of the hypandrium of *E. reyesi* García Aldrete, González & Carrejo (Group *Zelayensis*), but in the latter the posterior processes are smooth, the forewings are hyaline, and the phallosome is distinct, lacking a transverse mesal sclerite (Fig. 29).

Description. ***Male.*** **Color** (in 80% ethanol). Body pale brown, with creamy areas and brown ochre spots, as indicated below. Head frontally creamy, with ochre areas as illustrated (Fig. 27), genae ochre. Compound eyes black, ocelli hyaline, with ochre centripetal crescents. Antennae pale brown, flagellomeres 1-4 cream, flagellomeres 5-11 pale brown proximally and cream distally. Maxillary palps brown, Mx4 with distal third dark brown. Tergal lobes of meso- and metathorax dark brown. Thorax: mesepimeron dark brown, pro- and metapleura cream, with ochre spots. Legs: fore-



Figures 25–30. *Euplocania laelsa* sp. n. Male. **25** Forewing **26** Hindwing **27** Front view of head **28** Hypandrium **29** Phallosome **30** Epiproct and right paraproct. Scales in millimeters.

and middle brown; hind coxae, trochanter and femur cream, hind tibia and tarsi pale brown. Forewings with pigmented marginal band, from R_{2+3} to near the wing base, veins brown, with a dark brown spot at wing margin. Pterostigma peripherally pale, brown-yellowish in the middle (Fig. 25). Hindwings hyaline, veins brown, with a pig-



Figures 31–36. *Euplocania laelsa* sp. n. Female. **31** Forewing **32** Hindwing **33** Front view of head **34** Subgenital plate **35** Ninth sternum and left gonapophyses (ventral view) **36** Epiproct and right paraproct. Scales in millimeters.

mented marginal band on apex and near the wing base (Fig. 26). Abdomen cream, with broad subcuticular ochre spots. Clunium and hypandrium pale brown, lateral processes of the central sclerite of hypandrium dark brown apically. Epiproct and paraprocts cream, with ochre spots; phallosome pale brown.

Morphology. As in diagnosis, plus the following: Head (Fig. 27): Vertex with abundant setae. H/MxW: 1.56; compound eyes large, H/d: 3.12; IO/MxW: 0.57. Outer cusp of lacinial tip broad, with six denticles. Mx4/Mx2: 1.17. Forewings (Fig. 25): L/W: 2.67. Pterostigma: lp/wp: 6.09, areola postica tall, with rounded apex: al/ah: 2.05. Hindwings (Fig. 26): l/w: 2.98. Hypandrium of three sclerites (Fig. 28). Phallosome (Fig. 29) anteriorly U shaped, with distally broad side struts; external parameres membranous, distally rounded, bearing pores; two pairs of endophallic sclerites, and one transverse mesal sclerite as illustrated; mesal sclerite with posterior central projection triangular. Paraprocts (Fig. 30) almost elliptic, with a dense setal field; sensory fields with 26 trichobothria on basal rosettes. Epiproct (Fig. 30) broad, semi-oval, with rounded apex and three apical macrosetae, mesal field with abundant small setae, two macrosetae, one on each side and central field with three macrosetae as illustrated.

Measurements. FW: 4800, HW: 3125, F: 1150, T: 2025, t1: 825, t2: 80, t3: 157, ctt1: 23, f1: 880, f2: 750, f3: 690, f4: 620, f5: 440, f6: 420, f7: 360, f8: 310, f9: 280, f10: 230, f11: 260, Mx4: 280, IO: 386, D: 470, d: 340, IO/d: 1.14. PO: 0.72.

Female. **Color**. As in the male. Subgenital plate hyaline in the middle, with sides pale brown, as illustrated (Fig. 34).

Morphology. As in diagnosis, plus the following: Head (Fig. 33): vertex with abundant large setae. H/MxW: 1.52; H/d: 3.25; IO/MxW: 0.61. Outer cusp of lacinial tip broad, with six denticles. Mx4/Mx2: 1.33. Wings (Figs 31 and 32) as in the male, L/W: 2.56. Pterostigma: lp/wp: 5.08, areola postica: al/ah: 2.09. Hindwings (Fig. 32): l/w: 2.98. Subgenital plate (Fig. 34) broad, posteriorly rounded, setose. Gonapophyses (Fig. 35): v1 elongate, pilose, acuminate; v2+3, pilose, with a row of five macrosetae on v2; distal process sinuous, acuminate, with microsetae on surface. Paraprocts (Fig. 36) broadly triangular, distal setal field with abundant setae as illustrated, sensory fields with 26 trichobothria on basal rosettes. Epiproct (Fig. 36) triangular, mesal field with three macrosetae, distal field with abundant setae as illustrated.

Measurements. FW: 5250, HW: 3500, F: 1250, T: 2125, t1: 837, t2: 92, t3: 137, ctt1: 27, f1: 930, f2: 870, f3: 800, f4: 690, Mx4: 350, IO: 470, D: 480, d: 360, IO/d: 0.98, PO: 0.75.

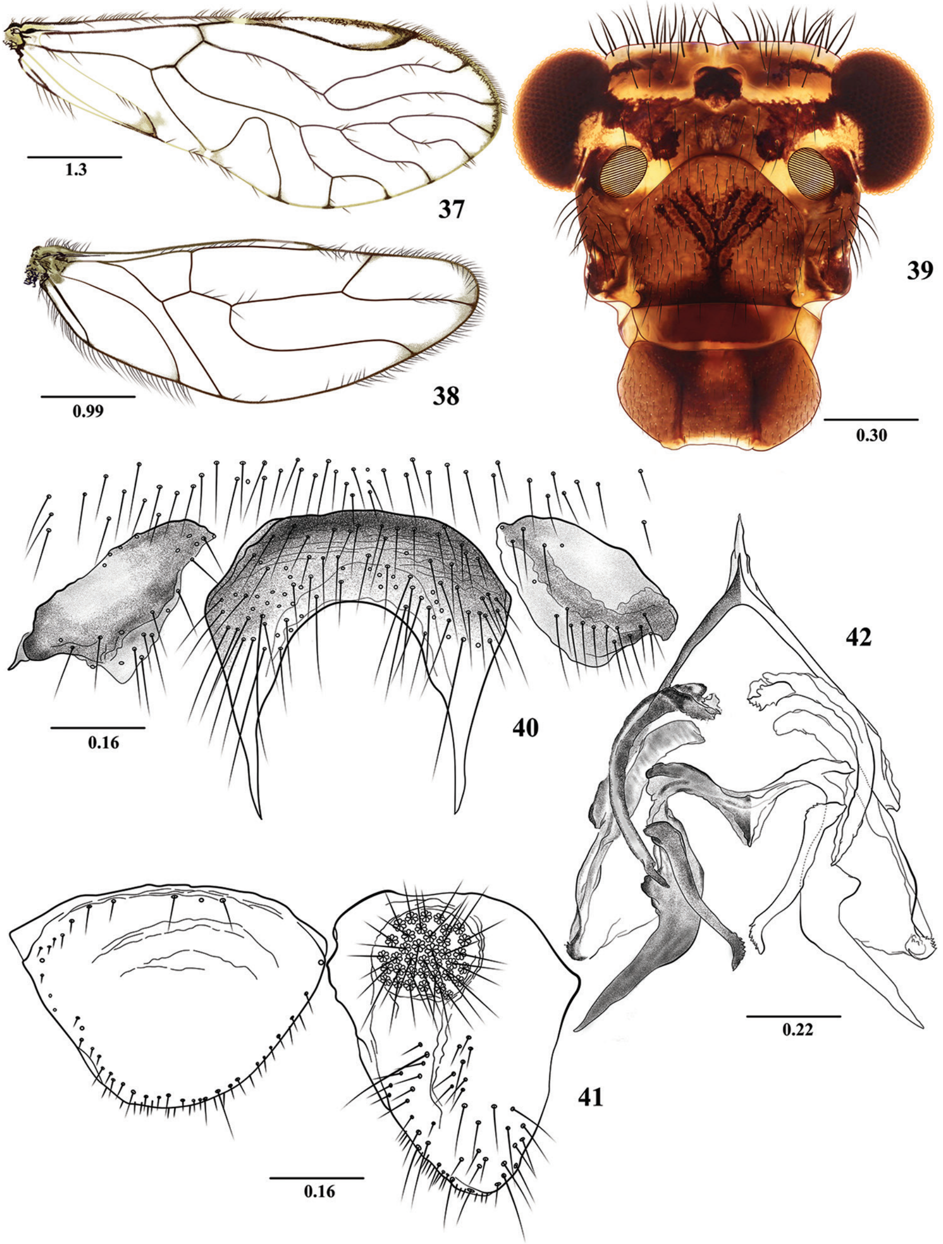
Euplocania nasa **sp. n.**

http://zoobank.org/A97EB2A8-BB13-4CAD-A3C1-DB154E15D8CD
Figs 37–42
Male

Type locality. COLOMBIA. Huila. Acevedo, National Natural Park Los Guácharos, 1882 m., 1°36'45.9"N; 76°06'15.4"W.

Type material. Holotype male. 31.VII.2016. On tree trunk. N. Carrejo, R. González & J. Mendivil. MUSENUV, slide code No. 28783.

Etymology. This species is dedicated to the Nasa tribe, that inhabits a wide region of mountains in the departments of Huila and Caquetá. The name is a noun in apposition.



Figures 37–42. *Euplocania nasa* sp. n. Male. **37** Forewing **38** Hindwing **39** Front view of head **40** Hypandrium **41** Epiproct and right paraproct **42** Phallosome. Scales in millimeters.

Diagnosis. Belonging to the new species group *Guentherbuchi*. Forewings hyaline. Pterostigma elongate, not angulated towards Rs (Fig. 37). Hypandrium of three sclerites, central one rounded anteriorly, with two lateral, slender, elongate, acuminate posterior processes (Fig. 40). Related to *E. guentherbuchi* González, García Aldrete & Carrejo, differing from it by having the posterior processes of the central sclerite of the hypandrium stouter and much broader proximally. The phallosomes in both species are built on the same plan, but differ in details of the endophallic sclerites (compare Fig. 42 in this paper with fig. 50 in González-Obando et al. 2015).

Description. Color (in 80% ethanol). Body brown. Head dark brown with small areas cream (Fig. 39). Compound eyes black, ocelli hyaline, with ochre centripetal crescents. Antennae brown, flagellomeres pale brown, with apices cream. Maxillary palps pale brown, Mx4 with distal third dark brown. Tergal lobes of meso- and metathorax brown. Thoracic mesopleura brown, mesepisternum more pigmented. Legs: fore- and hind- coxae creamy, with small proximal and distal brown spots; mid coxae brown, trochanters and femora creamy, tibia, tarsi and apex of femora brown. Wings hyaline, veins brown, vein ends more pigmented as illustrated (Figs 37 and 38). Abdomen creamy, with subcuticular, transverse ochre bands. Clunium, hypandrium, epiproct and paraprocts pale brown, phallosome brown, with endophallic sclerites more pigmented.

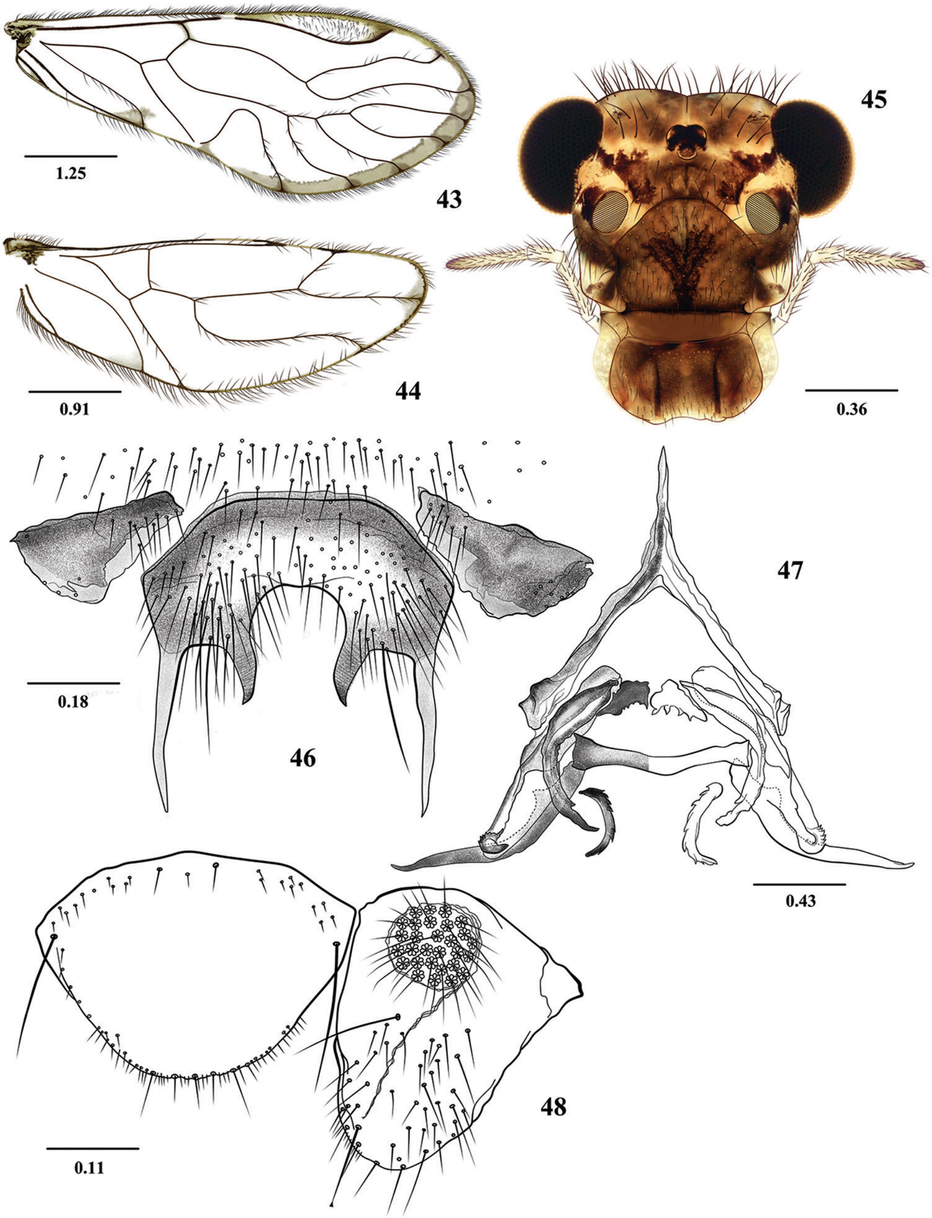
Morphology. As in diagnosis, plus the following: Head (Fig. 39): H/MxW: 1.40, H/d: 3.86, compound eyes large: IO/MxW: 0.78. Vertex slightly concave in the middle. Outer cusp of lacinial tip broad, with seven denticles. Mx4/Mx2: 1.23. Forewings (Fig. 37) with M four-branched; M4 distally forked, L/W: 2.56, pterostigma elongate: lp/wp: 6.0; areola postica tall, slightly slanted posteriorly, apex rounded, al/ah: 1.30. Hindwing (Fig. 38): l/w: 2.74. Hypandrium of three sclerites, the central one abundantly setose, convex anteriorly, with a deep concavity posteriorly; side sclerites elongate, broadly triangular (Fig. 40). Phallosome anteriorly Y-shaped (Fig. 42), external parameres distally rounded, bearing pores; anterior endophallic sclerites curved, distally acuminate, antero-central sclerites small, denticulate. Mesal endophallic sclerites transverse, with meso-posterior projection triangular, postero-mesal sclerite with a rounded protuberance basally, each arm dilated basally, bent outwards, distally acuminate; posterior pair elongate, directed inwards, distally bent outwards, denticulate. Paraprocts (Fig. 41) robust, elongate, setose as illustrated, sensory fields with 32 trichobothria on basal rosettes. Epiproct wide, semioval, rounded posteriorly, straight anteriorly, setae as illustrated (Fig. 41).

Measurements. FW: 6900, HW: 4625, F: 1725, T: 3050, t1: 1275, t2: 100, t3: 167, ctt1: 35, f1: 1450, f2: 1570, f3: 1390, Mx4: 395, IO: 690, D: 460, d: 324, IO/d: 2.13, PO: 0.70.

Euplocania yalcona **sp. n.**

http://zoobank.org/5B714FD9-44D7-43FE-8374-D699447F4664
Figs 43–48
Male

Type locality. COLOMBIA. Huila. Palestina, El Encanto Nature Reserve, 1462 m., 1°43'10.3"N; 76°07'1.7"W.



Figures 43–48. *Euplocania yalcona* sp. n. Male. **43** Forewing **44** Hindwing **45** Front view of head **46** Hypandrium **47** Phallosome **48** Epiproct and right paraproct. Scales in millimeters.

Type material. Holotype male. 29.VII.2016. On rock surfaces. J. Mendivil & R. González. MUSENUV slide code No. 28784.

Etymology. The specific epithet (feminine form of the adjective *yalconus, -a, -um*) refers to the Yalcon indigenous people, who inhabited the Upper Magdalena Valley, in the Department of Huila, Colombia.

Diagnosis. Belonging to the new species group *Yalcona*. Forewings with a slender, pigmented marginal band, from R_{4+5} to areola postica (Fig. 43). Pterostigma elongate, not angulated towards Rs. Hypandrium of three sclerites, central one anteriorly straight, with two lateral, long, slender acuminate posterior processes, and two median, shorter, acuminate posterior processes (Fig. 46). Phallosome built on the same plan as in species group *Guentherbuchi*, but differing in details of the endophallic sclerites.

Description. *Male.* Color (in 80% ethanol). Body pale brown, with creamy areas, as indicated below. Head creamy, with dark brown areas as illustrated (Fig. 45). Compound eyes black, ocelli hyaline, with ochre centripetal crescents. Antennae pale brown, flagellomeres with apices cream. Maxillary palps pale brown, Mx4 dark brown apically. Tergal lobes of meso- and metathorax dark brown. Thoracic mesopleura brown, more pigmented than pro- and metapleura. Legs: fore- and hind- coxae creamy, with small proximal and distal brown spots; mid coxae brown, trochanters and femora pale brown, tibia and tarsi brown. Wings almost hyaline, forewings as diagnosed above (Figs 43 and 44). Abdomen creamy, with subcuticular transverse ochre bands. Clunium and hypandrium brown. Epiproct and paraprocts pale brown, phallosome pale brown, with endophallic sclerites more pigmented.

Morphology. As in diagnosis, plus the following: Head (Fig. 45): H/MxW: 1.44, H/d: 3.70, compound eyes large: IO/MxW: 0.73. Vertex slightly concave in the middle. Outer cusp of lacinial tip broad, with five denticles. Mx4/Mx2: 1.09. Forewings (Fig. 43) with M four-branched; M4 simple, paratypes often with M of 5 branches, L/W: 2.58, pterostigma elongate: lp/wp: 5.63; areola postica tall, slightly slanted posteriorly, apex rounded, al/ah: 1.66. Hindwings (Fig. 44): l/w: 2.70. Hypandrium (Fig. 46). Phallosome anteriorly Y-shaped (Fig. 47), external parameres membranous, distally rounded, bearing pores; anterior endophallic sclerites curved, distally acuminate, central sclerite short, denticulate. Mesal endophallic sclerites transverse, postero-mesal sclerite curved outwards, distally acuminate, each arm with a rounded protuberance proximally; posterior pair slender, denticulated, and bent outwards. Paraprocts (Fig. 48) robust, elongate, setose as illustrated, sensory fields with 32 trichobothria on basal rosettes. Epiproct wide, semioval, posteriorly rounded, convex anteriorly, with macrosetae on each basal angle, posterior border with setae as illustrated (Fig. 48).

Measurements. FW: 6325, HW: 4125, F: 1600, T: 2675, t1: 1162, t2: 105, t3: 175, ctt1: 34, f1: 1320, f2: 1450, f3: 1240, f4: 1130, f5: 690, f6: 630, f7: 490, f8: 390, Mx4: 350, IO: 620, D: 450, d: 330, IO/d: 1.88, PO: 0.73.

New Colombian records

Euplocania badonneli New & Thornton, 1988

1 male. Amazonas, Leticia, San Martín de Amacayacú. Agua Blanca trail, 3°42'19.0"S; 70°20'26.1"W, 70 m. 12-13.VIII.2015. R. González, N. Carrejo, N. Calderón, O. Saenz. Led light trap on forest canopy. 1 male. Caquetá, Jericó-Consayá, La Raya

trail, 0°33'21.18"N; 75°05'15.57"W, 201 m. 29.IX.2016, J. Panche. Led light trap. 1 male. Caquetá, San Vicente del Caguán, Laureles, Resguardo Indigena Altamira, 2°27'50.14"N; 74°55'02.06"W, 917 m. 26.IV.2017, J. Panche. Led light trap. 1 male. Putumayo, Puerto Asis, Las Delicias, 0°22'09.50"N; 76°31'01.98"W, 264 m. 5.III.2014. J. Panche, led light trap.

Discussion

The species of *Euplocania* here dealt with, have increased the spectrum of morphological variability within the genus, making necessary the creation of three additional species groups, modifying the initial scheme presented by García Aldrete et al. (2013), diagnosed as follows:

Group *Guentherbuchi*. Forewings hyaline. Pterostigma elongate, not angulated towards Rs (Fig. 37). Hypandrium of three sclerites, central one rounded anteriorly, with two lateral, slender, elongate, acuminate posterior processes (Fig. 40). Mesal endophallic sclerites transverse, with meso-posterior projection, postero-mesal sclerite with a protuberance basally, each arm dilated proximally, bent outwards, distally acuminate (Fig. 42). *E. guentherbuchi* had been assigned in species group *Zelayensis*, but it does not belong there and constitutes a different species group. Species included: *E. guentherbuchi* González et al. (2015), *E. nasa* sp. n.

Group *Laelsa*. Forewings with a broad, pigmented marginal band from R_{4+5} to Cu2-1A. Pterostigma elongate, not angulated towards Rs (Fig. 25). Hypandrium of three sclerites, central one large, almost rectangular, with two stout lateral posterior processes, distally crossed, each bearing a mesal tooth on inner border, and a row of teeth distally along the outer border (Fig. 28). Phallosome with two pairs of endophallic sclerites one transverse mesal with posterior central projection (Fig. 29). Species included: *E. laelsa* sp. n.

Group *Yalcona*. Forewings with a slender, pigmented marginal band, from R_{4+5} to areola postica (Fig. 43). Pterostigma elongate, not angulated towards Rs. Hypandrium of three sclerites, central one anteriorly straight, with two lateral, long, slender acuminate posterior processes, and two median, shorter, acuminate posterior processes (Fig. 46). Phallosome with mesal endophallic sclerites transverse, postero-mesal sclerite distally acuminate, each arm with a rounded protuberance proximally (Fig. 47). Species included: *E. yalcona* sp. n.

The species here treated raise to 22 the species known in the genus, and raise to 14 the species of the genus known in Colombia (Table 1), one of them shared with Brazil and Peru; the rest are possibly endemic to this country. Many undescribed species of *Euplocania* from South America are known, already available for study in our collections; they will be dealt with in the near future, they increase the number of Colombian species to 30 (16 undescribed); Brazil has 13 species but to date only four species have been described, Ecuador has 14 species, but none has been described. Their study will bring additional modifications to the classification of the genus proposed by García Aldrete et al. (2013) and it will be necessary to conduct a phylogenetic analysis to verify its monophyly, as well as its relationships with other genera of the family Ptiloneuridae.

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RESEARCH ARTICLE

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A new genus of protorhyssaline wasps in Raritan amber (Hymenoptera, Braconidae)

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Abstract

A second species of protorhyssaline wasps (Braconidae) is described and figured from inclusions in Upper Cretaceous (Turonian) amber of the Raritan Formation in New Jersey, USA. *Rhetinorhyssalites emersoni*, **gen. n., sp. n.**, is distinguished from other protorhyssalines, particularly the contemporaneous *Protorhyssalus goldmani*.

Keywords

Apocrita, Euhymenoptera, Ichneumonoidea, parasitoid, Turonian, taxonomy

Introduction

The parasitoid wasp subfamily Protorhyssalinae includes a variety of generally plesiomorphic cyclostome braconids known only from Cretaceous deposits. The subfamily was initially described based on a species from the Upper Cretaceous

(Turonian) amber of New Jersey (Basibuyuk et al. 1999), but was subsequently recognized in Lower Cretaceous amber from Spain (Ortega-Blanco et al. 2011) as well as Upper Cretaceous amber from Myanmar, France, and Canada (Perrichot et al. 2009, Engel and Wang 2016, Engel 2016), bringing the total to seven species and genera. These wasps are generally plesiomorphic in most traits relative to other cyclostome lineages and the few attempts to place them within a phylogenetic framework with other basal Braconidae failed to recover the subfamily as monophyletic, the two genera then known falling into an extensive basal polytomy (Perrichot et al. 2009). In fact, the lack of defining apomorphies was noted by the original authors when proposing the subfamily (Basibuyuk et al. 1999), and as more specimens and taxa become known future analyses may demonstrate protorhyssalines to be a grade, necessitating their breakup. Nonetheless, despite the rarity of Braconidae in Cretaceous resins, most of the known species can be ascribed to this assemblage of plesiomorphically similar and generalized braconids (e.g., Basibuyuk et al. 1999, Perrichot et al. 2009, Ortega-Blanco et al. 2011, Quicke 2015, Engel and Wang 2016).

Here we describe a second species of protorhyssaline wasps (Fig. 1) from the same Upper Cretaceous (Turonian) deposits as the type genus of the subfamily. The new species has some similarities with a slightly older species from the Cenomanian of Myanmar, and is placed in a genus distinct from other protorhyssalines based particularly on features of the wing venation.

Material and methods

Two individuals were identified in slightly turbid amber pieces from the Upper Cretaceous Raritan Formation of New Jersey. The amber has been dated palynologically to the Turonian, at approximately 90 Ma, and the localities mapped by Grimaldi et al. (2000) and Grimaldi and Nascimbene (2010). The pieces were embedded in epoxy following the procedure of Nascimbene and Silverstein (2000) and the surfaces polished flat, giving lateral views of the inclusions. The holotype is complete but positioned near edges of the amber preventing direct facial and dorsal views (Fig. 1), and the animal's left side is partially obscured by adjoining bubbles. The paratype is covered in places by a fine layer of fine, microscopic bubbles and the metasoma is damaged, opened laterally and infilled by amber, but otherwise complete (Figs 2, 3). Both pieces are deposited in the American Museum of Natural History, New York.

The descriptions are formatted like those recently presented for related Cretaceous braconids (e.g., Engel and Wang 2016, Engel 2016), with morphological terminology generally based on Huber and Sharkey (1993) and Sharkey and Wharton (1997). Microphotographs were taken with the aid of an Infinity K-2 lens and Canon 7D digital camera, while measurements and the wing drawings were made using ocular micrometers and a camera lucida, respectively, and affixed to an Olympus SZX-12 stereomicroscope. Measurements of the holotype are provided with those of the paratype, when possible, in parentheses.

Systematic paleontology

Family Braconidae Nees von Esenbeck

Subfamily Protorhyssalinae Basibuyuk et al.

Included genera. *Archaeorhyssalus* Engel in Engel & Wang (2016), *Diorhyssalus* Engel (2016), *Protorhyssalodes* Perrichot et al. (2009), *Protorhyssalopsis* Ortega-Blanco et al. (2011), *Protorhyssalus* Basibuyuk & Quicke in Basibuyuk et al. (1999), *Rhetinorhyssalites* gen. n. (*vide infra*), and *Rhetinorhyssalus* Engel (2016).

Rhetinorhyssalites gen. n.

http://zoobank.org/E6F92137-F91C-479C-8B8D-C0055517E109

Type species. *Rhetinorhyssalites emersoni* sp. n.

Diagnosis. Head cyclostome, with hypoclypeal depression deep; antenna with 20–24 flagellomeres (18–20 in *Protorhyssalus* Basibuyuk et al.); flagellum with scattered multiporous plate sensilla; occipital carina present and complete, albeit particularly weak dorsally; compound eyes not emarginate, without evident setae. Pronotal collar short, with subpronope scarcely indicated; notauli deeply impressed, percurrent; mesoscutal lateral areas sculptured as on remainder of mesoscutum; mesoscutellum not raised relative to mesoscutum (distinctly raised in *Protorhyssalus*); epicnemial carina absent (present in *Protorhyssalus*: “prepectal carina” sensu Basibuyuk et al. 1999); postpectal carina absent. Forewing (Fig. 4) with minute costal cell apically, otherwise C+Sc+R fused, without indication of fusion line except proximally; 1Rs present, forming straight line with 1M (1Rs/1M straight), slightly more than one-half length 1M (very short in *Protorhyssalus*); rs-m present; 1m-cu meeting second submarginal cell, second submarginal cell narrowly elongate postero-proximally (not so in *Protorhyssalus*); 2m-cu absent; 1cu-a strongly postfurcal; 2cu-a scarcely present (represented only by hint of stub at angle in 3Cu; stubs 1a and 2a present. Hind wing with sc+r-m lacking bulla, much shorter than 1M; bulla lacking between 1A and stub of 2Cu (present in *Protorhyssalus*); minute stub of 2Cu present. Metasomal tergum I with dorsope and laterope deeply impressed; dorsal carina strong, extending to posterior margin of tergum.

Etymology. The generic name is a combination of *Rhetinorhyssalus* Engel, a genus with somewhat similar venation, and the suffix *–ites* (Greek, “having the nature of”). The gender of the name is feminine.

Rhetinorhyssalites emersoni **sp. n.**
http://zoobank.org/CDEBECC1-2E8A-412C-88E5-689DCD502431
Figs 1–4

Holotype. ♂, AMNH NJ-892A; deposited in the Division of Invertebrate Zoology, American Museum of Natural History, New York.

Paratype. ♂, AMNH NJ-692; same locality and repository as the holotype.

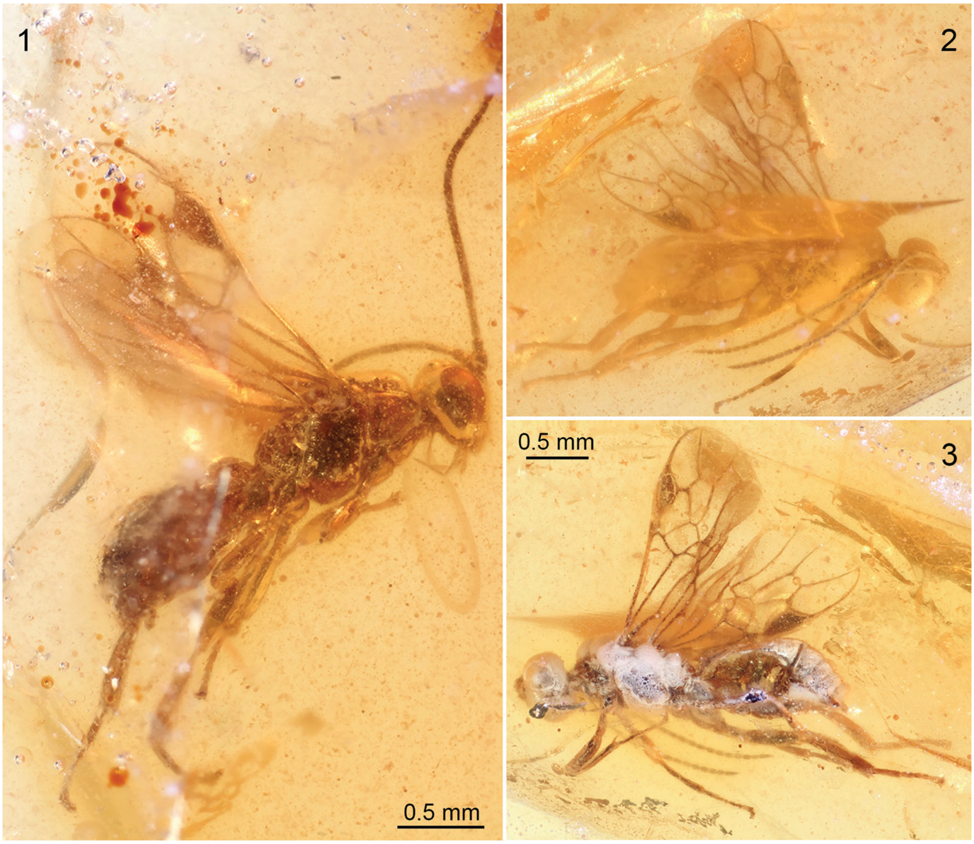
Locality and horizon. Upper Cretaceous (Turonian) amber, New Jersey, Middlesex County, Sayreville, white oaks pit. The locality has been discussed and the Raritan amber deposits mapped by Grimaldi et al. (2000) and Grimaldi and Nascimbene (2010).

Diagnosis. As for the genus (*vide supra*).

Description. ♂: Total length 2.54 mm as preserved (2.53 mm); forewing length 1.98 mm (1.90 mm), hind wing length 1.66 mm (1.60 mm); integument, where evident, dark brown, lighter on appendages; wing veins dark brown to brown, membranes hyaline and clear.

Head apparently about as long as wide (direct frontal view not possible in either holotype or paratype), with small punctures separated by about 2 or more times a puncture width, integument between smooth, with scattered, suberect, minute setae, setae more numerous on lower face; face below antennal toruli somewhat flat; clypeus slightly protruding, rounded, short; hypoclypeal depression deep and wide; mandible short (mandibles closed in both specimens); labial palpus short, apparently with three palpomeres; maxillary palpus elongate, apparently slightly longer than head, with six palpomeres, palpomeres IV–VI elongate, thinner than preceding palpomeres, palpomere III thickened and dorsally hunched, with abundant distinctive setae dorsally; compound eye large and glabrous, length 0.36 mm, broader than gena, inner margin not emarginate; ocelli positioned close together on top of vertex; occipital carina complete, weak dorsally; antenna slightly shorter than body length; scape squat, only slightly longer than wide, length 0.11 mm, width 0.09 mm, truncate apically; pedicel about as long as wide, slightly narrower than scape, length 0.07 mm, width 0.06 mm; flagellum with 20 flagellomeres (24 flagellomeres); basal flagellomeres elongate, approximately 3–4 times as long as wide, flagellomere I length 0.16 mm, width 0.04 mm; flagellomere II length 0.14 mm, width 0.04 mm; flagellomere III length 0.13 mm, width 0.04 mm; remaining flagellomeres progressively shorter, apical flagellomeres about 1.25–2.0 times as long as wide; multiporous plate sensilla sparse.

Mesosoma length 0.98 mm (0.98 mm); pronotal surface smooth; mesoscutum with minute, setigerous punctures separated by a puncture width or less, integument between punctures smooth; notauli deeply impressed, crenulate, percurrent; lateral sectors of mesoscutum (outside of notauli) distinctly raised, convex, with sculpturing as on remainder of mesoscutum; mesoscutellar sulcus deeply impressed; mesoscutellum not raised, on same level with mesoscutum; mesopleuron largely smooth and impunctate, with borders areolate; sternaulus absent; metapleuron areolate; propodeum coarsely and deeply areolate. Legs slender, with numerous minute setae; tibial spurs short, protibial calcar slightly curved, without comb; metafemur tubular except with



Figures 1–3. Photographs of males of *Rhetinorhyssalites emersoni*, gen. et sp. n., in Raritan amber. **1** Right lateral habitus of holotype (AMNH NJ-892A) **2** Right lateral view of paratype (AMNH NJ-692), to same scale as figure C **3** Left lateral view of paratype.

weak subapical concavity on inner ventral surface; metatibia length 1.26 mm (1.23 mm); basitarsi longest tarsomeres, but shorter than combined length of remaining tarsomeres, slightly longer than fifth tarsomeres; pretarsal claws short, simple; arolium small. Forewing (Fig. 4) with minute costal cell present apically near pterostima, remainder of C+Sc+R completely fused with faint indication of fusion line proximally; pterostigma large, longer than wide, border inside marginal cell faintly convex, anterior border bulging; marginal cell large, extending nearly to wing apex; R slightly extending beyond marginal cell apex along apical wing margin to wing apex; 1Rs present, slightly more than one-half length 1M; 1Rs/1M straight; Rs+M weakly arched (nearly straight); 1m-cu entering second submarginal cell near base, thus short 2M present (and "2Rs+M" lacking); 2M angled posteriorly, giving second submarginal cell narrowly elongate extension postero-proximally; 2Rs elongate; r-rs arising in apical half of pterostigma, short, shorter than 1Rs; 1rs-m present, about as long as 3Rs; 3M much longer than 2Rs; 1cu-a strongly postfurcal (positioned beyond one-third discal cell length); 1Cu about as long as 1cu-a; 2Cu longer than 1Cu; 2cu-a present only has hint

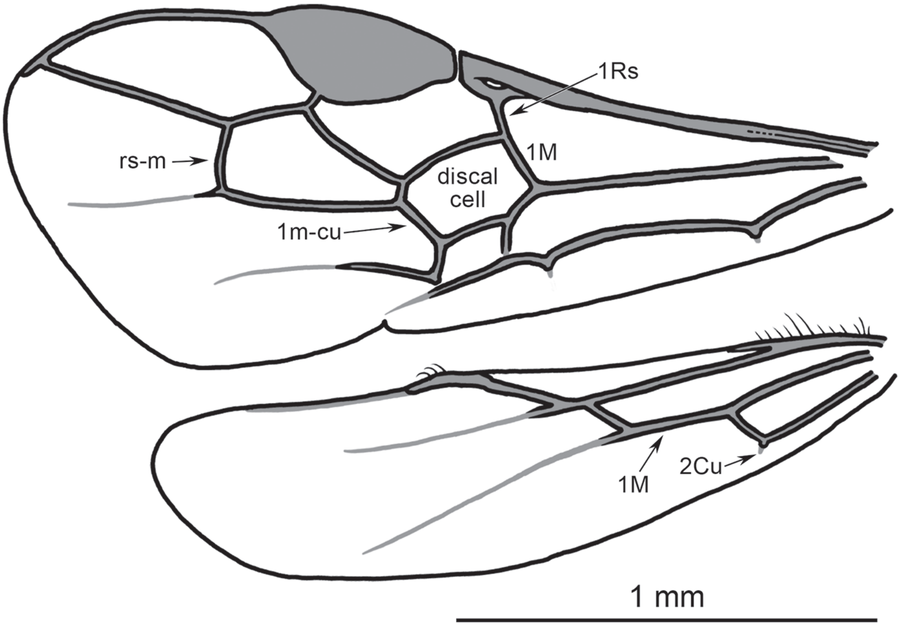


Figure 4. Wing venation of *Rhetinorhyssalites emersoni*, gen. et sp. n., with most marginal setae omitted; forewing above, hind wing below.

of stub, with subdiscal cell minutely open apically; stubs of 1a and 2a present. Hind wing (Fig. 4) with margins setose; three distal hamuli present on R and set of "secondary hamuli" (sensu Basibuyuk et al. 1999) on proximal portion of C; R tubular for short distance along with margin, otherwise extending as nebulous vein, terminating well prior to wing apex; 2Sc+R extremely short; Rs tubular for short distance then extending as nebulous vein; sc+r-m without bulla, longer than 2Sc+R, much shorter than 1M; 2M tubular near base then nebulous; 1Cu much shorter than 1M; 2Cu present as minute stub; bulla lacking between 1A and 2Cu stub.

Metasoma length 1.21 mm (1.20 mm), with terga II and III fused and with distinct suture line; integument generally smooth an impunctate, with scattered, short, appressed setae; first metasomal tergum with dorsal carinae strong, extending to posterior tergal margin, dorsopes deeply impressed and areolate; lateral carinae strong, with lateropes deeply impressed; tergum I about as long as wide, remaining terga wider than long.

♀: *Latet*.

Etymology. The specific epithet honors the late William K. Emerson (1925–2016), a leading malacologist with the American Museum of Natural History (Mikkelsen and Landman 2017) and good friend to the senior author for the last 20 years of his life. In 1999, after one of many relaxing enjoyable chats and before I (M.S.E.) departed, Bill pulled from a shelf his copy of his 1976 guide to shells (Emerson and Jacobson 1976), autographed it, and placed it in my hands. It remains a treasured possession and reminder of joyful days and Bill's kindness and good humor.

Discussion

As the name implies, there is some similarity in the wing venation between *Rhetinorhyssalites emersoni* and the slightly older *Rhetinorhyssalus morticinus* Engel from Cenomanian amber of Myanmar (Engel 2016). Although there are many differences between these two taxa, such as the complete absence of an occipital carina; shortened 1Rs, shorter rs-m relative to 3Rs, longer r-rs, more basad 1cu-a in the forewing; and absence of both 2Cu and a bulla between 1A and 1Cu in the hind wing (Engel 2016), the general appearance of the forewings are superficially similar. In both species the form of the submarginal cell is quite similar, particularly in the narrowly elongate proximal extension of the second submarginal cell (Fig. 4). *Rhetinorhyssalites* differs from the coeval *Protorhyssalus* in Raritan amber (Basibuyuk et al. 1999) in the unraised mesoscutellum (strongly raised in the latter); the absence of an epicnemial carina (present in the latter); forewing 1Rs long, proximally extended second submarginal cell, and more prominently postfurcal 1cu-a; and in the hind wing the scarcely present 2Sc+R, the absence of a bulla in 1A, and the scarcely evident 2Cu stub. The former species is also slightly larger, approximately 2.5 mm in length versus 1.5–2.0 mm in the latter, and has a larger number of flagellomeres (20–24 in *R. emersoni* versus 18–20 in *Protorhyssalus*); however, until both sexes are known for both genera these differences shall require further testing. The more prominent 1Rs and absence of a bulla between 1A and 1Cu is distinctive relative to all other protorhyssalines, although most characters agree more closely with *Protorhyssalus* than any other genera.

Unfortunately, protorhyssalines remain a great rarity and it is impossible at present to elaborate more fully on these early parasitoids, particularly in regards to their biology. Putatively primitive braconids such as rhyssalines, are ectoparasitoids of larval Coleoptera and Lepidoptera (Quicke 2015), and it may be that this biology is plesiomorphic for the clade, and potentially shared symplesiomorphically with protorhyssalines. However, the biology of basal groups such as Apozyginae and Trachypetinae remain unknown and this could alter any interpretation of groundplan host associations for Braconidae. Nonetheless, parasitism of wood-boring larva is often primitive within apocritan clades (Grimaldi and Engel 2005), and perhaps this trend is true for Ichneumonoidea and basal Braconidae, with those rhyssalines found on arboreal moth larvae representing isolated shifts away from more typical wood-infesting lineages. The female of *Archaeorhyssalus subsolanus* Engel (Engel and Wang 2016) has a moderately long ovispositor which is at least consistent with possible wood-boring hosts. Regardless, the continued discovery of Cretaceous braconids, particularly those preserved in amber, will hopefully add considerable character data toward resolving basal relationships and host associations within this hyperdiverse family.

The Cretaceous diversity of Braconidae remains scarcely known, although a significant expansion in our knowledge has been made during the last 20 years. Although the family is vast and cosmopolitan today, with about 20,000 described species, its fossil record is scant despite extending well into the Mesozoic. The discovery of *Rhetinorhyssalus emersoni* in Turonian Raritan amber expands not only our general understanding of the faunal composition of Hymenoptera from the Raritan Formation of eastern North America, but builds upon our meager knowledge of Braconidae from the Cretaceous. Although we still look 'through a glass darkly', the continued discovery and description of further species such as *R. emersoni* remains our only means of clearing our view into the distant history of the braconids and other significant diversifications.

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The dipteran family Celyphidae in the New World, with discussion of and key to world genera (Insecta, Diptera)

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Abstract

The family Celyphidae (Diptera, Lauxanioidea) is verified as part of the New World fauna, with a second specimen discovered of a species described from French Guiana in 1844 by P.J.M. Macquart. As this species possesses characteristics that clearly suggest a separate lineage from the Old World celyphids, a new genus is proposed, *Atopocelyphus* **gen. n.**, with the type species, *Celyphus ruficollis* Macquart, in the new combination *Atopocelyphus ruficollis* (Macquart), **comb. n.** A key to world genera of Celyphidae is presented, along with discussion of generic concepts. *Chamaecelyphus* Frey is synonymized under *Spaniocelyphus* Hendel, **syn. n.**, resulting in the following 10 new combinations: *Spaniocelyphus africanus* (Walker), **comb. n.**; *S. dichrous* (Bezzi), **comb. n.**; *S. gutta* (Speiser), **comb. n.**; *S. halticinus* (Frey), **comb. n.**; *S. kalongensis* (Vanschuytbroek), **comb. n.**; *S. ruwenzoriensis* (Vanschuytbroek), **comb. n.**; *S. straeleni* (Vanschuytbroek), **comb. n.**; *S. upembaensis* (Vanschuytbroek), **comb. n.**; *S. violaceus* (Vanschuytbroek), **comb. n.**; *S. vrydaghi* (Vanschuytbroek), **comb. n.** The subgenera of *Celyphus* Dalman are elevated to genus rank, as *Paracelyphus* Bigot, **stat. rev.**, and *Hemiglobus* Frey, **stat. rev.**, resulting in the following 17 new and revised combinations: *Hemiglobus cheni* (Shi), **comb. n.**; *H. eos* (Frey), **comb. n.**; *H. lacunosus* Frey, **comb. rev.**; *H. pellucidus* Frey, **comb. rev.**; *H. planitarsalis* (Shi), **comb. n.**; *H. porosus* (Tenorio), **comb. n.**; *H. pulchmaculatus* (Liu & Yang), **comb. n.**; *H. quadrimaculatus* (Tenorio), **comb. n.**; *H. resplendens* Frey, **comb. rev.**; *H. rugosus* (Tenorio), **comb. n.**; *H. testaceus* (Malloch), **comb. n.**; *H. trichoporis* (Shi), **comb. n.**; *H. unicolor* Frey, **comb. rev.**; *H. violaceus* Chen, **comb. rev.**; *Paracelyphus hyacinthus* Bigot, **comb. rev.**; *P. medogis* (Shi), **comb. n.**; *P. vittalis* (Shi), **comb. n.**

Keywords

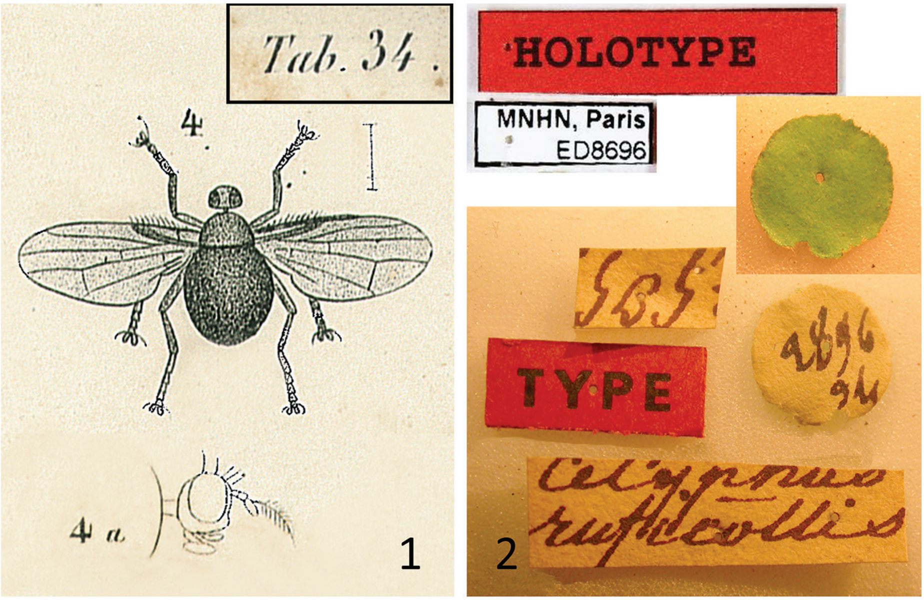
Diptera, Lauxanioidea, new genus, new combination, new synonym, revised status, distribution

Introduction

The Celyphidae is a small family in the Lauxanioidea (Diptera, Acalyptratae) characterized by their greatly enlarged scutellum and sharp reductions in chaetotaxy. Their gestalt is suggestive of certain metallic chrysomelid beetles. They are known to have their greatest diversity in tropical Asia and Southeast Asia, with a smaller number of species in the Afrotropical Region. The topic of this paper is one of the earliest described species in the group. The species *Celyphus ruficollis* Macquart, 1844 was the third species described in what is now the family Celyphidae, preceded only by *Celyphus obtectus* Dalman, 1818 and *Celyphus scutatus* Wiedemann, 1830. By the end of that century, an additional 14 species had been described (2 of them in an additional genus, *Paracelyphus* Bigot). Since that time, the family Celyphidae has grown to 115 valid species (of nearly 130 described) within 8 valid genera (of 9 described). Tenorio (1972) is the most comprehensive work on the family, although only dealing with the fauna of the Oriental Region, describing 21 new species-group taxa in addition to redescribing the then-known species in that region. Only 30 additional species have been described in the 45 years since that work.

After the original description by Macquart (1844), *Celyphus ruficollis* has been rarely mentioned in the literature, and only ever by repeating information from the original description. For example, Bigot (1878) included the species, along with its type locality, in a list of species included in the "*Celyphes*". Later, in the catalog of celyphids authored by Jacobson (1896), this species is listed as "*? C. ruficollis*", properly recording it from Guyana gallica (=French Guiana). Given the footnote for this entry ("*Secundum figuram cl. Macquarti haec species ob oculos haud prominentes aristamque aliter constructam genus peculiare, Paracelypho affine, constituere videtur.*" = According to the figure of Macquart this species has eyes that do not overhang the arista so is a different genus built more specifically akin to *Paracelyphus*), it seems his questioning its inclusion within *Celyphus* Dalman was only meant to suggest it may represent a different genus more similar to *Paracelyphus*. The following year, Wandolleck (1897) repeated the list of celyphid species as reported by Jacobson (1896). Later, Frey (1941) suggested that *Celyphus ruficollis* is likely not a celyphid due to the presence of fronto-orbital setae evident on plate 34, figure 4a of Macquart (1844) (Fig. 1), and afterwards, Vanschuytbroek (1952) did not mention the species when listing the species known at that time. Tenorio (1972), in her revision of Celyphidae of the Oriental Region, mistakenly referred to the species as having been described from Australia, and offered no further information. However, this was likely a mix-up with a different species, *Celyphus inaequalis* Costa, 1864, which was described from "Australia ?", and is, like the current species under study, unknown after its initial description, with the family otherwise not known from the continent of its type locality.

The single syntype of *Celyphus ruficollis* was collected by François René Mathias Leprieur, during his time collecting in French Guiana (recorded by Macquart as "de la Guyane"). According to Papavero (1971), Leprieur spent much of his life in French Guiana, where he explored as an entomologist, including collections made in Cayenne, and a trip into the interior up the Oyapock River (which forms much of the



Figures 1–2. *Celyphus ruficollis* Macquart (=*Atopocelyphus ruficollis*), original materials. **1** Planche 34, figures 4 and 4a from Macquart (1844) **2** Labels on male syntype from MNHN (inset green circle is bottom of circular label).

border between French Guiana and Brazil) in 1832. Although some of his collections survived, much was lost in a shipwreck in 1833. In 1834, Leprieur donated at least 550 insect specimens, including this one, to the MNHN (see remarks below).

Methods

The specimens examined of this New World celyphid were from two collections, as follows:

BMNH	The Natural History Museum, London, England, United Kingdom.
MNHN	Muséum national d'Histoire naturelle, Paris, France.

The specimens photographed of other genera of celyphids were from the following collections:

CSCA	California State Collection of Arthropods, California Department of Food & Agriculture, Sacramento, California, USA.
IZAS	Institute of Zoology, Academia Sinica, Beijing, China.
USNM	National Museum of Natural History, Washington, DC, USA.

Morphological terminology follows Cumming and Wood (2009). In the description below, the state in the female is given in square brackets [ ] if different from the male, noting that having a single male and a single female for study, differences may be due to simple variation in the species or minor sexual dimorphism, or the remote possibility of being a different species.

Taxonomy

Atopocelyphus Gaimari, gen. n.

http://zoobank.org/74AF83BD-16AF-4489-95EE-66C67E0C37AD

Type species. *Celyphus ruficollis* Macquart, 1844, by present designation.

Etymology. From Greek, *Atopos*, meaning out of place, combined with the genus name *Celyphus*, referring to the unexpected occurrence of this taxon in the New World; masculine.

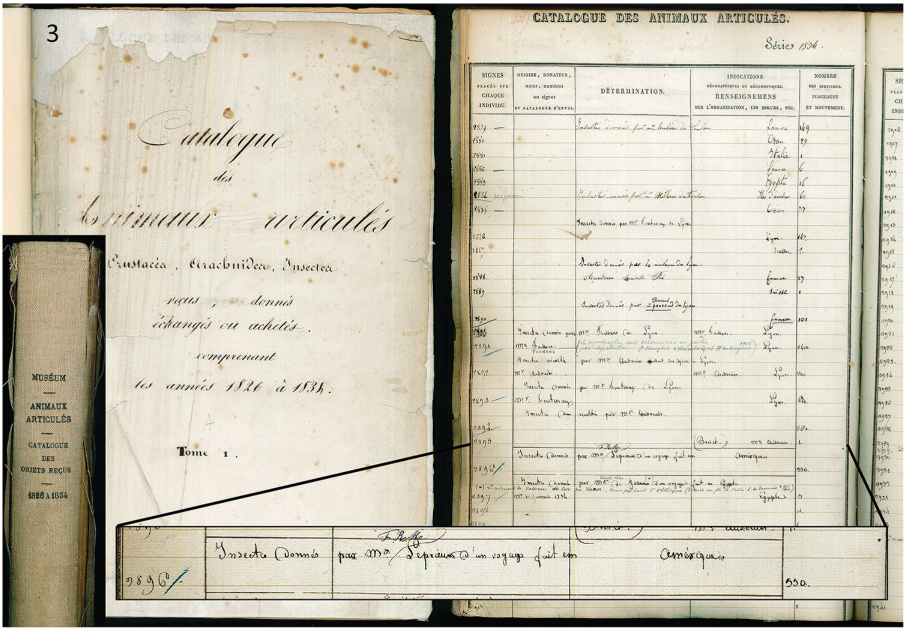
Diagnosis. This genus differs from all other Celyphidae in having an elongate first flagellomere with a subbasal, plumose arista (Fig. 13), and in having abdominal tergites 5 and 6 each subdivided or creased medially with a strong triangular notch along each posterior edge in both sexes (Figs 18, 20).

Remarks. The other celyphid genera have a much shorter first flagellomere with a subapical arista that is pubescent and often expanded and leaf-shaped in the basal 1/3 (see Fig. 29). The abdominal tergites are sometimes subdivided (i.e., in *Spaniocelyphus*), but this is always tripartite, with a central section and two lateral sections (Fig. 31); otherwise, the tergites are undivided (Fig. 28). With regards to other dipteran families in the Neotropics with superficially similar genera, *Celypholauxania* Hendel (Lauxaniidae) and *Peltopsilopa* Hendel (Ephydridae) share a characteristically enlarged scutellum, although none to the extent of the Celyphidae. One of the species currently in *Peltopsilopa* had been originally described as a species of *Celyphus* (Savaris et al. 2016), and other genera (outside the New World) had also been originally described as celyphids, such as *Afrocelyphus* Vanschuytbroek, now considered a junior synonym of *Nomba* Walker (Chloropidae).

Atopocelyphus ruficollis (Macquart)

Celyphus ruficollis Macquart, 1844: 253; Planche 34, figs 4, 4a.

Specimens examined. ***Type.*** French Guiana. 1 syntype male (Figs 4–5, 9–12, 17–18); MNHN: Specimen MNHN-ED-ED8696 (permalink http://coldb.mnhn.fr/catalognumber/mnhn/ed/ed8696), in the Macquart collection. Labels (Fig. 2; explanation below, in Remarks) as follows: 2896 / 34 [handwritten, circular label, pale green on opposite side]; 535 [handwritten]; Celyphus / ruficollis [handwritten]; TYPE [red label]; HOLOTYPE [red label]; MNHN, Paris / ED8696. Pinned through mesonotum; good condition (antennal flagellomeres both broken off, right fore tarsus broken off, lower third of the right wing missing, lower edge of left wing damaged).



MUSÉUM
ANIMAUX ARTICULÉS
CATALOGUE DES OBJETS REÇUS
1826 A 1834

Catalogue
des
Animaux articulés
Crustacéa, Arachnidea, Insectea
reçus, donnés
échangés ou achetés.
comprenant
les années 1826 à 1834.
Tome I.

CATALOGUE DES ANIMAUX ARTICULÉS.

Série 1834.

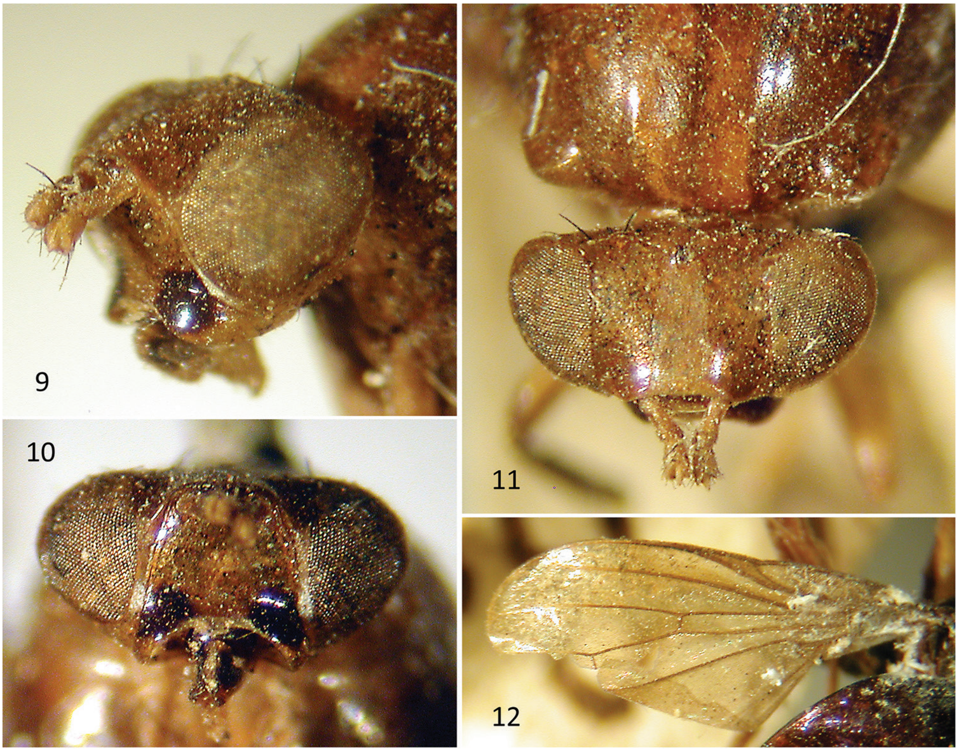
SIGNES PLACÉS SUR CHAQUE INDIVIDU.	ORIGINE, DONATEUR, noms, numéros ou signes DU CATALOGUE D'ENVOI.	DÉTERMINATION.	INDICATIONS GÉOGRAPHIQUES OU GÉOGNOSTIQUES. RENSEIGNEMENS SUR L'ORGANISATION, LES MŒURS, etc.	NOMBRE DES INDIVIDUS. PLACEMENT ET MOUVEMENT.
2896	Insecta donnés	par Mr F. Roffe Depréaux d'un voyage fait en	Amérique	550.

Figure 3. Catalogue des Animaux articulés Crustacéa, Arachnidea, Insectea, reçus, donnés échangés ou achetés comprenant les années 1826 à 1834. Tome I. **3** Spine (far left), front page (left side), page from the "Série 1834" (right side) containing the line for accession number 2896 (enlargement).

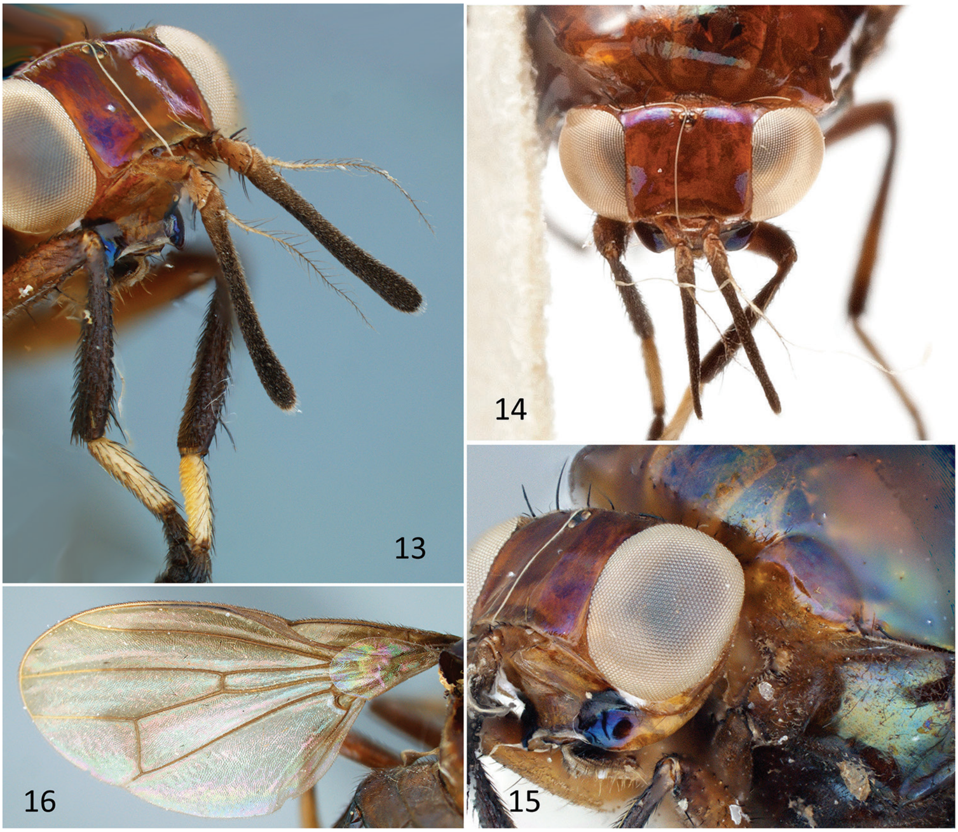
Figures 4–5. *Celyphus ruficollis* Macquart (=*Atopocelyphus ruficollis*), syntype male (MNHN). **4** Habitus, lateral **5** Habitus, dorsal oblique.

Additional specimen. French Guiana: Réserve Trésor, xii.2009, Window trap, N 4°36'37.6" / W 52°16'44.5", altitude = ± 225 m. 1 female (Figs 6–8, 13–16, 19–20); BMNH, mounted on triangular point, scutellum removed and mounted on top of point; excellent condition.

Figures 6–8. *Atopocelyphus ruficollis* (Macquart), female specimen (BMNH). **6** Habitus, lateral **7** Scutellum, lateral **8** Scutellum, dorsal.



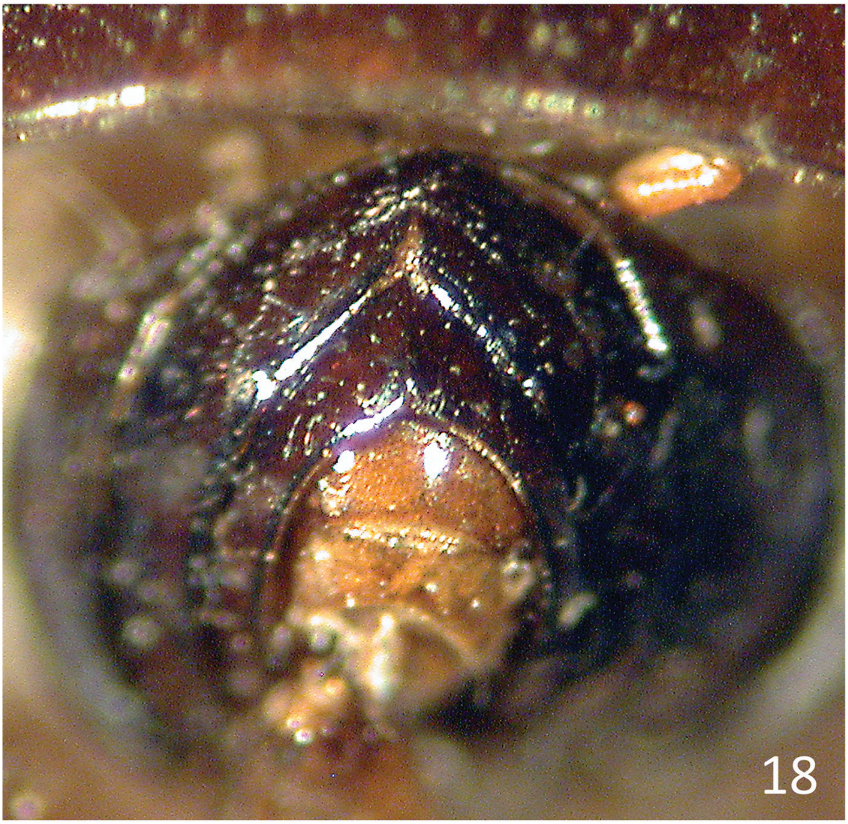
Figures 9–12. *Celyphus ruficollis* Macquart (=*Atopocelyphus ruficollis*), syntype male (MNHN). **9** Head, anterolateral. **10** Head, anteroventral **11** Head, dorsal. **12** Wing.



Figures 13–16. *Atopocelyphus ruficollis* (Macquart), female specimen (BMNH). **13** Head and forelegs, anterolateral **14** Head, dorsal **15** Head and anterior part of pleuron, anterolateral **16** Wing.

Description. Body (Figs 4–8) length (head through base of halter, plus base of halter through abdomen tip, to account for differential curling of the abdomen), [4.6–] 5.6 mm. Head through thorax length, including scutellum (head through posterior edge of scutum, plus scutellum), [6.2–] 6.4 mm. Head and thorax predominantly orange.

Head (Figs 9–11, 13–15). Head length (excluding antennae) [0.9–] 1.1 mm, height [1.1–] 1.2 mm, width [1.6–] 1.8 mm; 1.6 [–1.8] × wider than long, 1.5 X wider than high. Vertex rounded; inner vertical seta incurved, 0.25 mm; outer vertical seta outcurved, 0.2 mm; postocellar setae cruciate, 0.2 mm, thinner than vertical setae; distance between inner and outer vertical setae subequal to distance between outer vertical seta and postocellar seta. Ocellar triangle equilateral, with distance from one ocellus to another 0.1 mm. Frons length (anterior ocellus to lunule) [0.55–] 0.65 mm, width [0.8–] 0.9 mm parallel sided, extending [0.16–] 0.18 mm anteriorly beyond edge of eye. Median vitta visible as roughened texture relative to fronto-orbital area being smooth and shiny (in holotype, only visible from dorsolateral aspect); width at ocellar triangle 0.2 mm, expanding anteriorly to 0.25



Figures 17–18. *Celyphus ruficollis* Macquart (=*Atopocelyphus ruficollis*), syntype male (MNHN). **17** Abdomen and genitalia, ventrolateral **18** Abdomen, posterior.

mm at lunule. Antennae (Figs 13–14) separated by [2.5–] 3 × width of an antennal base, rounded between antennae with no facial keel; scape and pedicel orange; scape length [0.15–] 0.25 mm, widening distally, fully exposed; pedicel 0.18 [–0.2] mm, with enlarged dorsal seta and 2 slightly enlarged ventral setae. Antennal first flagellomere black except orange basally to aristal base (broken off in holotype); length 1.05 mm; height 0.1 mm, slightly expanded distally to 0.15 mm at tip. Arista orange, becoming slightly darker distally; length 0.9 mm, not extended beyond tip of first flagellomere; plumose, with rays up to 0.15 mm. Face flat in upper 2/3, descending sharply from plane of frons; lower 1/3 of face + subgena recurved anteriorly. Gena narrow, with white pruinescence at interface with parafacial; 2 small, fine genal setulae (not evident in holotype). Subgena larger than gena, and bulging; with dark brown spot confluent with dark brown spot at lower corner of face. Clypeus narrow, dark brown ventrally. Palpus black, yellow basally, slightly flattened and spatulate, fuzzy and with several longer thin setulae.

Thorax (Figs 4–6, 15). Scutum dorsal length 1.5 mm, width at suture 2.0 mm; lateral length (anterior edge to halter) [2.0–] 2.2 mm. Scutellum (Figs 5, 7–8) length [3.8–] 4.2 mm, width [2.8–] 3.4 mm, height [1.3–] 1.5 mm, extending beyond apex of abdomen (Fig. 4); concave ventrally, with sharpened ventral edge; dorsal surface smooth with irregular dimpling; ventrally hairy anterolaterally, with tiny hairs scattered throughout venter. Postpronotum with 1 small postpronotal seta, otherwise bare dorsally, setulose ventrolaterally; patch of small black setulae medial to postpronotum on anterior surface of mesonotum. Proepisternal seta present, short and fine. Prosternum orange, lightly fuzzy, but lacking setae or setulae. Mesonotum with dorsocentral setae 1 + 3, small and hair-like; with smaller and hair-like acrostichal setulae (1–2 presutural, 3 or 4 postsutural), with prescutellar pair slightly thickened (obscured by pin in holotype); 1 strong supra-alar seta above wing base; 2 fine postalar setae present; notopleuron with 2 black setae, posterior one stronger than anterior. Anepisternum and katepisternum orangish brown and with sparse whitish setulae; posterior margin of anepisternum with short black anepisternal seta (slightly longer than inner vertical seta); upper margin of katepisternum with 2 subequal, short, fine black katepisternal setae (broken off in holotype).

Wing (Figs 12, 16). Wing length [4.2–] 4.5 mm, height [2.0–] 2.1 mm; sapromyziform, with spinules on costa ending at tip of R_{2+3}; hyaline, but darkened brown basally and within costal cell, subcostal cell, and along costal vein to point between apices of R_1 and R_{2+3}, along vein R_{2+3} except apical 1/4, and with some slight darkening on R_{4+5} and crossvein r-m; veins brown except yellow on distal half of costal vein and distal parts of veins R_{2+3}, R_{4+5} and M_1; costal vein ends at apex of M_1; crossvein r-m slightly beyond midpoint of discal cell; CuA_1 short, 1/5 length of crossvein dm-cu, not reaching wing margin; A_1+CuA_2 short; A_2 present only as darkened fold. Halter brown.

Legs. Legs orangish brown, except as noted. Fore coxa orange; femur yellow orange, becoming dark brown distally, with 1 strong preapical posteroventral seta and row of [4–] 5 long thin posterodorsal setae; fore tibia dark brown, with 1 apicoventral spur and 1 strong preapical dorsal seta; fore tarsus with tarsomere 1 white, slightly longer than tarsomeres 2–5 combined, ventrally with dense pad of thickened orange yellow setulae; tarsomeres 2–5 dark brown. Mid coxa dark brown; mid femur setulose, but with no outstanding setae or setal rows; mid tibia with basal and apical parts dark brown, with 1 apicoventral spur and one strong preapical dorsal seta; mid tarsus with tarsomeres 1–2 yellow, tarsomeres 3–5 brown, ventrally with dark brown setulae. Hind coxa dark brown; hind femur setulose, but with no outstanding setae or setal rows; hind tibia with basal and apical parts dark brown, lacking apicoventral spur and preapical dorsal seta, but inner edge of apex with tight comb of yellowish brown setulae; hind tarsus with tarsomeres 1–2 pale yellow, tarsomeres 3–5 light brown, tarsomere 1 ventrally with dense pad of thickened orange yellow setulae, ventral setulae of remaining tarsomeres dark brown.

Abdomen (Figs 17–20). Abdomen length [2.2 –] 2.5 mm, width [1.8 –] 1.9 mm. Syntergite 1+2 and tergites 3 and 4 flattened (top part of tergites 3 and 4 of holotype missing due to dermestid damage), brown pruinose dorsally (Fig. 19) and shiny dark brown to blackish blue laterally; tergites 5 and 6 shiny dark brown to blackish blue (depending on angle of view); tergite 7 light brown. Tergites recurved laterally underneath abdomen, such that lateral parts visible from below; sparsely setulose, mostly smooth; tergite 4 with slight medial notch along posterior edge; tergites 5 and 6 each subdivided or creased medially, with strong triangular notch along posterior edge (Figs 18, 20); tergite 7 saddle-shaped. Sternites brown, irregularly hairy and with sparse setulae; each sternite wider than long.

Male terminalia (Fig. 17). Epandrium saddle-shaped, about as long as wide, concolorous and fitting easily within saddle-shaped tergite 7; surstylus small, bilobed distally, hairy on lobes (no other characteristics visible without dissection).

Female terminalia. Hypoproct orange, longer than wide, rounded distally, covered with pale brown setulae. Epiproct brownish, short, rounded distally, covered with dark setulae. Cerci orange, slightly longer than wide, with mixed pale and dark brown setulae, a few elongate.

Remarks. Crosskey (1971) discusses in detail the labeling standards in the Macquart collection, which are directly applicable to this specimen (Fig. 2). The circular label is green on one side, meaning it is from the Americas, and the handwritten number on the white side is the accession number, which represents the MNHN serial number given to the collection to which the specimen formed a part, and the year of accession, in this case 2896 / 34 (serial number 2896, year of accession 1834). This accession number is found in the accessions book at the MNHN (Fig. 3), titled “Catalogue des Animaux articulés Crustacèa, Arachnidea, Insectea, reçus, donnés échangés ou achetés comprenant les années 1826 à 1834. Tome I.” Within this catalogue is the line for accession number 2896 in the “Série 1834”, as follows (columns separated by “/”): Insectes donnés / par M^r F.R.M. Leprieur d’un voyage fait en / Amérique / 550 [specimens]. As discussed by Crosskey (1971), Macquart’s type labels did not consistently indicate “n.sp.” (or similar) at the time of this publication, although he did start to consistently use this term on his labels after this time.

Figures 19–20. *Atopocelyphus ruficollis* (Macquart), female specimen (BMNH). **19** Abdomen, tergite 3, dorsal **20** Abdomen, posterodorsal.

Besides these generalities of labeling of Macquart types, Pont (2012) also dealt with specimens of Leprieur from French Guiana in the MNHN, which, along with discussion with Adrian Pont, significantly aided my current interpretations of the labels on the type. The accession number 2896 refers to Leprieur's collections in French Guiana.

Figures 21–22. *Idiocelyphus bakeri* Malloch, PT female (USNM; Philippines). **21** Habitus, dorsal **22** Hind leg.

Noting that the label is slightly ripped at the bottom of the first number of the year, it is likely that this was accessioned in 1834, which is consistent with the types of the muscids *Limnophora elegans* Macquart and *Spilogaster maculipennis* Macquart, both collected by Leprieur "de la Guyane" from the same publication (Macquart, 1844). There is also reference in Pont (2012), but not Crosskey (1971), to an old handwritten 3 digit number label for the two preceding species, and the type of *Celyphus ruficollis* similarly has such a number label, 535. The handwriting on these labels is clearly that of Macquart, in comparison with labels presented by Crosskey (1971) and Pont (2012), and other Macquart specimens in the MNHN seen by the author. It is possible that this number represents a sort of "unique identifier" of the time, given that the Catalogue indicates 550 specimens were donated (i.e., that this was specimen 535 of 550). Another alternative is that the number was a reference to the species itself (i.e., that this number was a reference to Macquart's notes on this species, although no such notes have been located). In any case, the meaning of this secondary number remains a mystery.

It is worth noting that Macquart's description at least partly contradicts his figure 4a (plate 34) (Fig. 1), in that the description states that the arista is inserted near the tip (i.e., subapical, as is typical of all other celyphids), while the figure shows the arista as clearly subbasal. Unfortunately, the type specimen has lost the first flagellomere and arista, and given that the condition of these structures is important to the definition of this new genus, a further comment is warranted. In the newly collected specimen, the antennae are quite elongate, well beyond that of any other Celyphidae, and the arista is plumose and placed subbasally, all unique states in this species relative to other celyphids. Macquart (1844) does not mention an elongate antenna, and his figure 4a (plate 34) (Fig. 1) does not show an antenna of such length, but it does show the subbasal placement and the plumose condition of the arista, so it remains a possibility that the first flagellomere itself was broken (i.e., appearing short) when

Macquart examined the specimen, and only later completely broke off and was lost. Also note, neither the type specimen nor the new specimen possess what appears to be the fronto-orbital setae pictured in figure 4a (plate 34) (Fig. 1). This is significant because Frey (1941) specifically refers to this figure to point out that this species is likely not a celyphid due to the presence of these setae.

Key to world genera of Celyphidae

1 Scutellum and mesonotum subequal in length (Fig. 21); mesonotum and scutellum with strong setae (e.g., dorsocentral, postpronotal, scutellar) (Fig. 21); hind tibia with a long, strong apical spur (Fig. 22) .... ***Idiocelyphus*** **Malloch**

– Scutellum longer than mesonotum (Figs 23–25); setae of mesonotum tiny or absent and scutellum lacking strong setae (Figs 23–25); hind tibia lacking an apical spur **2**

2 Body stout (Figs 24–25); vertex rounded (Figs 33–34) **4**

– Body elongate (Fig. 23); vertex carinate (Figs 26, 29) **3**

3 Postocellar setae strong, convergent (Fig. 26); palpus broadly spatulate at apex (Fig. 27); abdominal tergites lacking longitudinal sutures (Fig. 28) .... ***Acelyphus*** **Malloch**

– Postocellar setae tiny, hair-like (Fig. 29); palpus cylindrical (Fig. 30); abdominal tergites with dorsolateral longitudinal sutures dividing each into three sections (Fig. 31) .... ***Spaniocelyphus*** **Hendel**

4 First flagellomere elongate (Fig. 13); arista plumose placed subbasally on first flagellomere (Fig. 13); abdominal tergites 5 and 6 each subdivided or creased medially with a strong triangular notch along each posterior edge (Figs 18, 20) .... ***Atopocelyphus*** **gen. n.**

– First flagellomere not elongate, at most subequal to pedicel plus scape length; arista pubescent (Fig. 34), or broadly flattened in basal part (Fig. 33), placed subapically on first flagellomere; abdominal tergites undivided **5**

5 Basal tarsomere on fore and hind tarsus (and sometimes mid tarsus) angularly produced at the outer side near the base (Fig. 32) .... ***Oocelyphus*** **Chen**

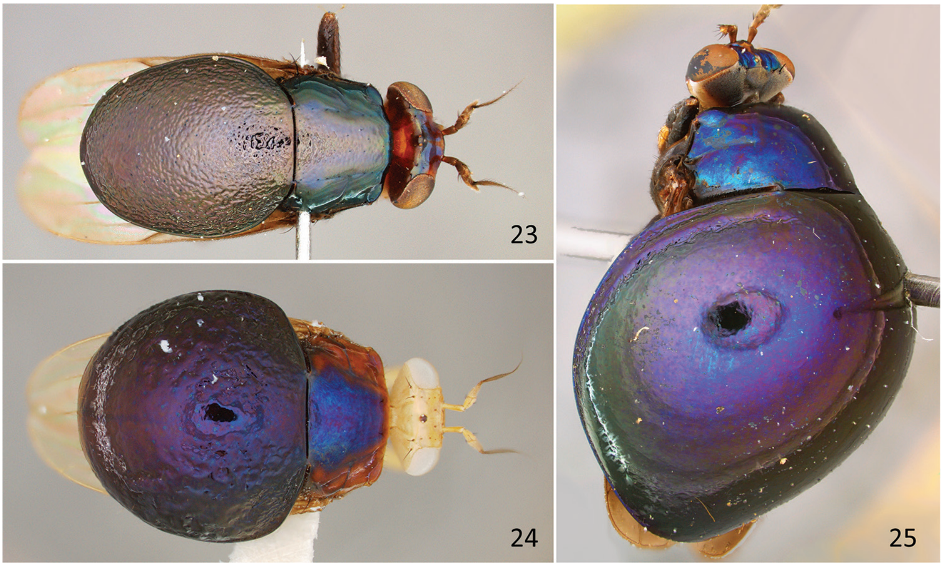
– Basal tarsomeres with no angularly produced areas **6**

6 First flagellomere tapering distally, 2 times longer than high (Fig. 33); arista broadly flattened and leaf-like in at least basal 1/3 (Fig. 33) ... ***Celyphus*** **Dalman**

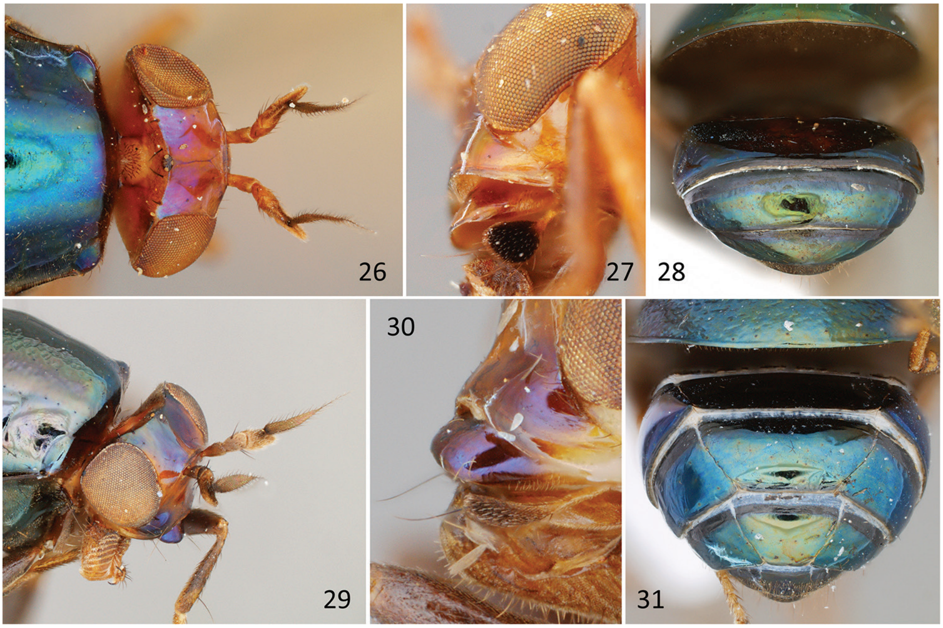
– First flagellomere rounded distally, at most 1.5 times longer than high (Fig. 34); arista setaceous and pubescent (Fig. 34) **7**

7 Scutellum with distinct lateral furrow (Fig. 36); ovoid and slightly tapering posteriorly (Fig. 25) .... ***Paracelyphus*** **Bigot, stat. rev.**

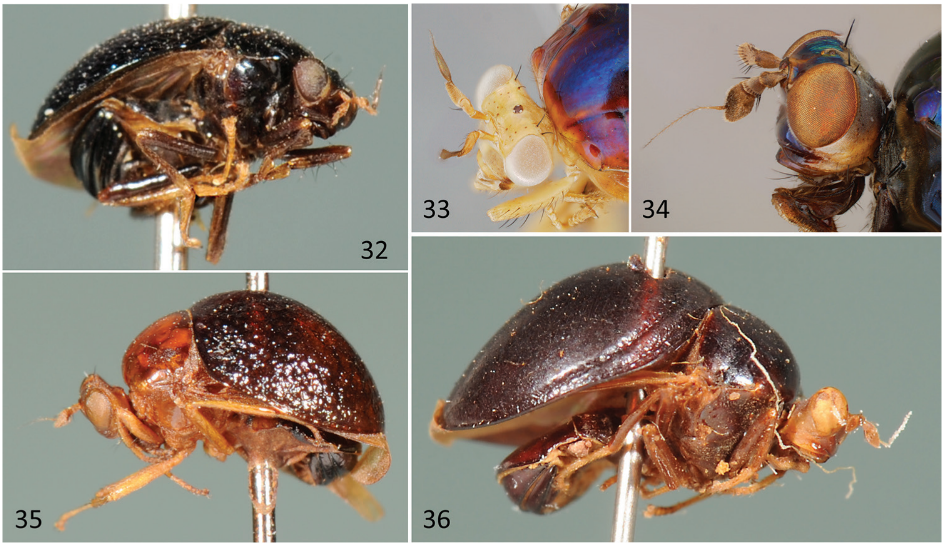
– Scutellum lacking lateral furrow (Fig. 35), broadly rounded posteriorly (as in Fig. 24) .... ***Hemiglobus*** **Frey, stat. rev.**



Figures 23–25. Habitus, dorsal. **23** *Spaniocelyphus cognatus* Karsch, female specimen (USNM; India) **24** *Celyphus aurora* Karsch, female specimen (USNM; Thailand) **25** *Paracelyphus hyacinthus* Bigot, male specimen (USNM; Malaysia), slightly dorsolateral.



Figures 26–31. *Acelyphus* and *Spaniocelyphus*. **26** *Acelyphus repletus* Malloch, PT male (USNM; Singapore), head and anterior thorax, dorsal **27** *Acelyphus politus* Malloch, PT female (USNM; Philippines), lower part of head and palpus, lateral **28** *Acelyphus repletus* Malloch, female specimen (CSCA; Malaysia), abdomen, dorsal **29** *Spaniocelyphus cognatus* Karsch, female specimen (USNM; India), head and anterior thorax, dorsolateral **30** *Spaniocelyphus cognatus* Karsch, male specimen (USNM; India), lower part of head and palpus, lateral **31** *Spaniocelyphus palmi palmi* Frey, male specimen (CSCA; Malaysia).



Figures 32–36. *Oocelyphus*, *Celyphus*, *Paracelyphus*, *Hemiglobus*. **32** *Oocelyphus nigritus* Shi, HT male (IZAS; China), habitus, ventrolateral **33** *Celyphus aurora* Karsch, female specimen (USNM; Thailand), head and anterior thorax, dorsolateral **34** *Paracelyphus hyacinthus* Bigot, male specimen (USNM; Malaysia), head, lateral **35** *Hemiglobus violaceus* Chen, HT male (IZAS; Vietnam), habitus, lateral **36** *Paracelyphus vittalis* (Shi), HT female (IZAS; China), habitus, lateral.

Remarks

In their treatments of Celyphidae, Frey (1941), who described *Chamaecelyphus*, and Vanschuytbroeck (1952, 1953, 1959, 1963), differentiated *Chamaecelyphus* from *Spaniocelyphus* based on the absence or presence of the bm-cu crossvein on the wing. At that time, geography also separated these genera, with *Chamaecelyphus* being restricted to the Afrotropics and *Spaniocelyphus* being from the Oriental Region. Stuckenberg (1960) described two species that had a faint bm-cu crossvein, recording *Spaniocelyphus* for the first time in the Afrotropics, and pointing out that the grounds for separating these two genera are very slight. With examination of numerous specimens from the Afrotropics, by Ray Miller and me, we have seen many series where the bm-cu crossvein is absent or present (even faintly) within the same species, concluding that this is not a consistent character, and is certainly not a good basis for separating genera. As such, *Chamaecelyphus* is herein synonymized under *Spaniocelyphus*, syn. n., resulting in the following 10 new combinations (original genus *Chamaecelyphus* unless otherwise indicated): *Spaniocelyphus africanus* (Walker, 1849; *Celyphus*), comb. n.; *S. dichrous* (Bezzi, 1908; *Celyphus*), comb. n.; *S. gutta* (Speiser, 1910; *Celyphus*), comb. n.; *S. halticinus* (Frey, 1941), comb. n.; *S. kalongensis* (Vanschuytbroek, 1963), comb. n.; *S. ruwenzoriensis* (Vanschuytbroek, 1963), comb. n.; *S. straeleni* (Vanschuytbroek, 1959), comb. n.; *S. upembaensis* (Vanschuytbroek, 1952), comb. n.; *S. violaceus* (Vanschuytbroek, 1959), comb. n.; *S. vrydaghi* (Vanschuytbroek, 1952), comb. n.

The genus-group taxa *Paracelyphus* and *Hemiglobus* have been considered as separate full genera or as subgenera of *Celyphus*. Authors since Tenorio (1972) have followed the latter scheme, although her justification did not take into account the genus *Oocelyphus* since she had never studied species in this genus. When considering the four "*Celyphus*-like" genus-group taxa (i.e., the stout-bodied genera, as in Fig. 24), there is no reason to infer that *Celyphus* forms a natural group with *Hemiglobus* and *Paracelyphus* to the exclusion of *Oocelyphus*. In fact, *Oocelyphus* shares the expanded and leaf-like arista, and the more elongate and tapering first flagellomere, found in *Celyphus*, and appears more generally similar to *Celyphus* than either of the other two genera. *Celyphus* and *Oocelyphus* are easily separated by the expanded and angularly produced basal tarsomeres in the latter genus. Both of the other genera are larger-bodied (especially *Paracelyphus*, but also some *Hemiglobus*), and share a setaceous arista. They are easily separated from each other by the presence of a lateral scutellar furrow and a posteriorly tapering scutellum in *Paracelyphus*. As such, these two genus-group taxa are removed from synonymy under *Celyphus* (as subgenera), and instead recognized at full genus rank, resulting in the following 17 new and revised combinations: *Hemiglobus cheni* (Shi, in Liu et al. 1998; *Celyphus*), comb. n.; *H. eos* (Frey, 1941; *Celyphus*), comb. n.; *H. lacunosus* Frey, 1941, comb. rev.; *H. pellucidus* Frey, 1941, comb. rev.; *H. planitarsalis* (Shi, in Liu et al. 1998; *Celyphus*), comb. n.; *H. porosus* (Tenorio, 1972; *Celyphus*), comb. n.; *H. pulchmaculatus* (Liu & Yang, in Yang and Liu 2002; *Celyphus*), comb. n.; *H. quadrimaculatus* (Tenorio, 1972; *Celyphus*), comb. n.; *H. resplendens* Frey, 1941, comb. rev.; *H. rugosus* (Tenorio, 1972; *Celyphus*), comb. n.; *H. testaceus* (Malloch, 1929; *Paracelyphus*), comb. n.; *H. trichoporis* (Shi, in Liu et al. 1998; *Celyphus*), comb. n.; *H. unicolor* Frey, 1941, comb. rev.; *H. violaceus* Chen, 1949, comb. rev.; *Paracelyphus hyacinthus* Bigot, 1859, comb. rev.; *P. medogis* (Shi, in Liu et al. 1998; *Celyphus*), comb. n.; *P. vittalis* (Shi, in Liu et al. 1998; *Celyphus*), comb. n.

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RESEARCH ARTICLE

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The larva of *Adicella syriaca* Ulmer 1907, including a key to the European larvae of *Adicella* McLachlan, 1877 (Trichoptera, Leptoceridae)

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Abstract

Adicella syriaca is a leptocerid caddisfly distributed throughout the Balkan Peninsula, the Carpathians, the Hungarian Lowlands, the Pontic Province, and the Caucasus. This paper describes the previously unknown larva of this species, based on material from the Greek island of Corfu. Information on the morphology of the fifth larval instar is given, and the most important diagnostic features are illustrated. A key to the known larvae of the European species of *Adicella* McLachlan, 1877 is provided. In the context of existing identification keys, the larva of *Adicella syriaca* Ulmer, 1907 keys together with *Adicella cremisa* Malicky, 1972, but the species pair can be easily separated by the number of setae on the pro- and mesonotum, and setation patterns on abdominal dorsum IX.

Keywords

Description, distribution, larva, identification, West Palearctic fauna

Introduction

Eleven species of *Adicella* McLachlan, 1877 are currently known in Europe (Graf et al. 2008; Malicky 2004, 2005a). However, with respect to larval taxonomy, descriptions for only four species were uncovered: *Adicella meridionalis* Morton, 1906 (Vieira-Lanero et al. 1997, Vieira-Lanero 2000), *A. filicornis* (Pictet, 1834), *A. reducta* (McLachlan, 1865) (Wallace et al. 2003, Waringer and Graf 2011) and *A. cremisa* Malicky, 1972 (Graf et al., submitted). However, of the remaining seven species where larvae are unknown, Malicky collected larvae of *A. syriaca* on the Greek island of Corfu. *Adicella syriaca* was described by Ulmer, 1907, based on material from Lebanon (Morse 2017); the species is rather widely distributed throughout Europe, ranging from the Balkans through the Carpathians and Hungarian Lowlands to the Caucasus (Ćukušić et al. 2017; Graf et al. 2008; Ibrahimi et al. 2012; Morse 2017; Živić et al. 2006). With our description of its larva and the key, proposed here, the identification of five out of eleven European *Adicella* species is now possible, without an adult male specimen as frequently required in caddisfly studies.

Materials and methods

Two final instar larvae and many adults of *Adicella syriaca* were collected by Malicky at Mesaria on the island of Corfu, Greece (39°44'N, 19°44'E, 40 m a.s.l.) on 1 May 1979. Larval caddisflies were picked from the mineral substrate with forceps, and adults were collected using light traps. The material was preserved in 70% ethanol. The larvae were studied and photographed using a Nikon SMZ 1500 binocular microscope with DS-Fi1 camera and NIS-elements D 3.1 image stacking software for combining 8–45 frames in one focused image. Larval morphological features are named following Wiggins (1998) and Waringer and Graf (2011), nomenclature of primary setae and setal areas (= sa) follows Wiggins (1998). Species association was enabled by the fact that final instar larvae and adults were collected at the same location; in addition, the other four Leptoceridae species known from Corfu are well known in the larval stage (*Leptocerus interruptus* (Fabricius, 1775), *L. tineiformis* Curtis, 1834, *Mystacides azurea* (Linnaeus, 1761): Wallace et al. 2003; Waringer and Graf 2011); *Triaenodes ochreellus lefkas* Malicky, 1974: Corallini Sorcetti and Moretti 1984; Vieira-Lanero (2000)). Although the location was repeatedly sampled, *A. syriaca* was the only *Adicella* species on this island. Final instar larvae and adults of *Adicella syriaca* used for the descriptions are deposited in the collection of Hans Malicky (Lunz am See, Austria). Comparative larval material of *Adicella cremisa*, *A. filicornis* and *A. reducta* is deposited in the collections of W. Graf and J. Waringer (Vienna, Austria). The larval material is intended to be subsequently transferred to Austrian Museum collections.

Results

Description of the fifth instar larva of *Adicella syriaca*

Adicella syriaca Ulmer, 1907

Diagnosis. Head with pattern composed of dark bands and dark muscle attachment spots; case with spiral pattern, constructed of plant material; metanotal sa3 reduced to a single seta per side; pronotum with 56–65 setae of varying length per pronotal half; total number of setae per mesonotal sclerite 11–13; outermost seta of abdominal dorsum IX setal group approximately as long as width of this segment.

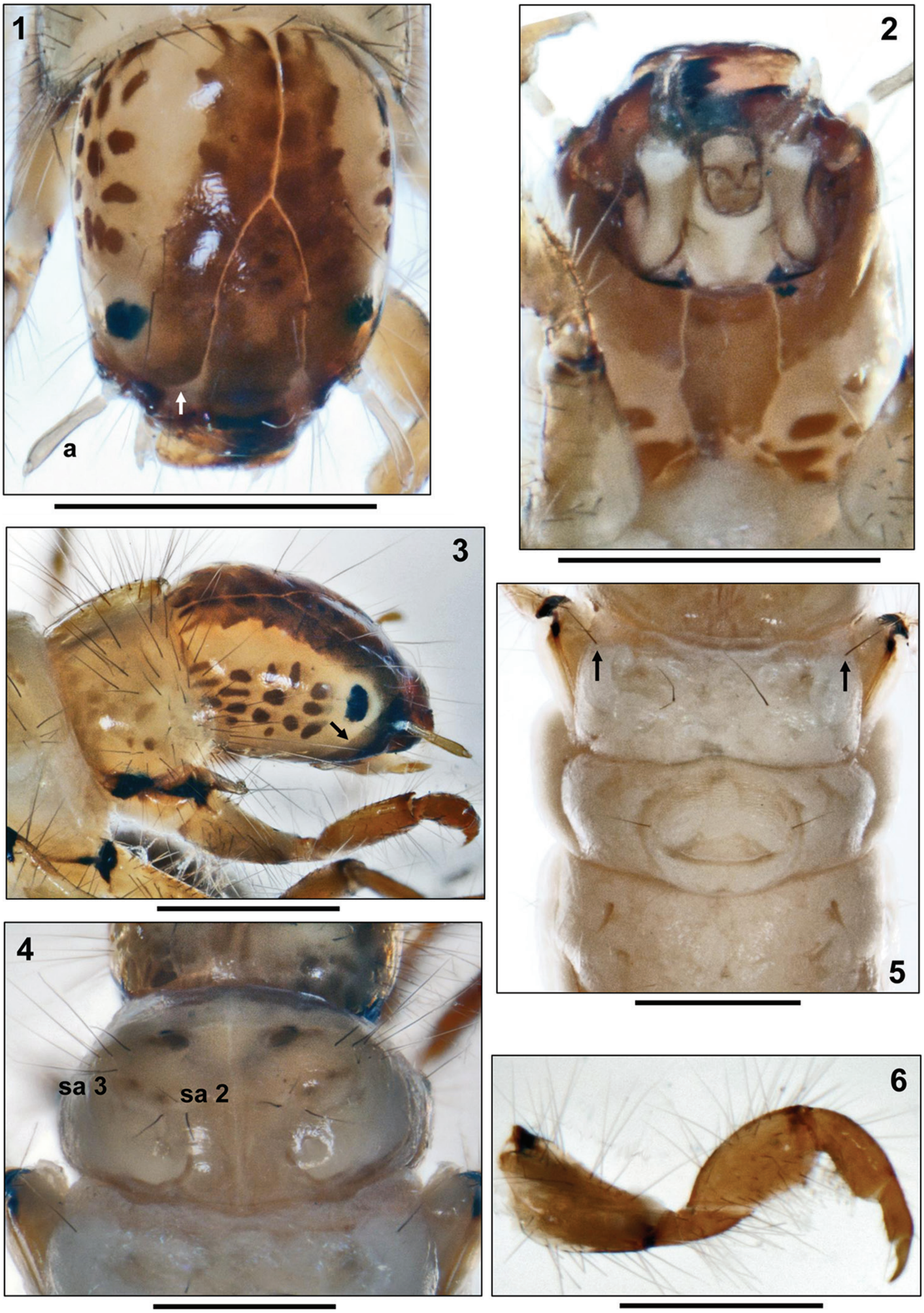
Biometry. Body length ranging from 6.8 to 7.7 mm, head width from 0.58 to 0.60 mm (n = 2).

Head. Head capsule surface smooth, with very shallow wrinkles, elongated and hypognathous. Base coloration pale yellow, with dark, reddish brown, oval muscle attachment spots on lateral and postero-ventral sections of parietalia. Frontoclypeus and parietal bands along frontoclypeal and coronal sutures dark reddish brown (Figs 1–3). White ring present around eyes (Fig. 3). Complete set of primary setae present (Figs 1–3). Frontoclypeus elongated, narrow, without central constriction (Fig. 1). Subocular ecdysial line running from foramen occipitale to ventro-lateral section of parietalia. Anteriorly of the eyes the subocular ecdysial line bends dorsally, eventually meeting frontoclypeal suture in a straight line (Fig. 3, arrow). Antennae slender, approximately six times longer than their basal width, situated at extreme anterior end of parietalia and originating from a socket-like ridge; antennal apex with single seta (Fig. 1a). Labrum light brown, quadrangular, with anterior median notch, ventral brush and six pairs of primary setae (Fig. 1). Ventral apotome medium brown, with darker brown anterior border, elongated quadrangular, with irregular lateral and posterior sides (Fig. 2). Mandibles black, each with ventral and dorsal cutting edge and terminal teeth along edge (Fig. 2).

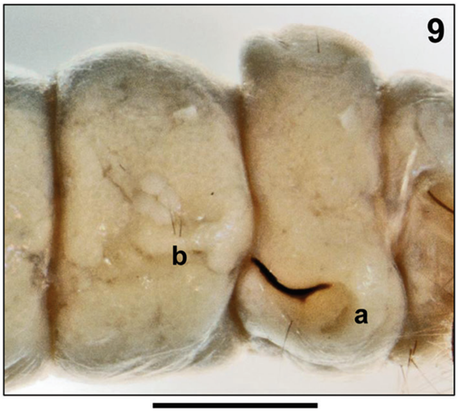
Thorax. Pronotum yellowish brown, with dark brown roundish muscle attachment spots (Fig. 3); with continuous row of widely-spaced, straight, black setae along anterior border; pronotal surface densely covered by 56–65 black setae of varying length per pronotal half (Fig. 3). Pleural sclerites irregular, elongated, pale, with black ventral margins; anteriorly, with brownish, finger-like protrochantin with blunt tip bearing one dark terminal seta (Fig. 3). Prosternal horn absent.

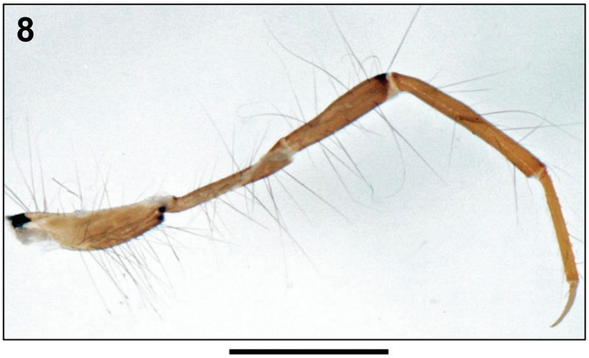
Mesonotum covered by two sclerites, each posterior half with large, semicircular central constriction; sclerites pale yellow, with distinct markings and muscle attachment spots along anterior margin and at center (Fig. 4). Total number of setae of varying lengths per mesonotal sclerite is 11–13 (sa1 without setae, each sa2 with 3 setae, each sa3 with 8–10 setae; Fig. 4). Mesopleurites pale, with narrow, blackish central bar (Fig. 3). Mesoventer without setae.

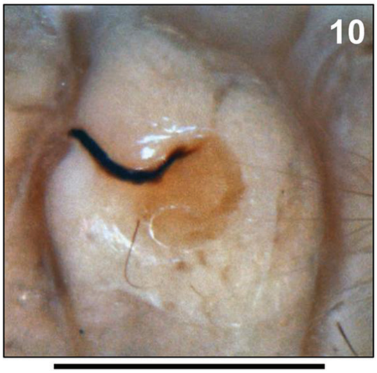
Metanotum without sclerotization except pleural sclerites; metanotal sa1 without setae, each sa2 with 1 seta each, sa3 reduced to a single seta per side (Fig. 5, arrows). Metaventer with a row of 4–5 setae per side (Fig. 11). Pleural sclerite arrangement as on mesonotum.

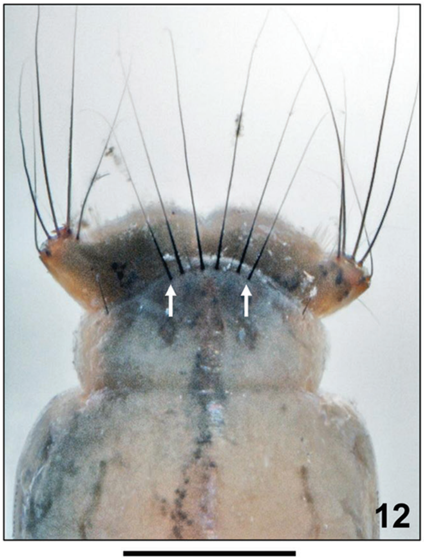


Figures 1–6. *Adicella syriaca* Ulmer 1907, final instar larva. **1** Head, dorsal view (a= antenna; arrow= subocular ecdysial line) **2** Head, ventral view **3** Head and pronotum, right lateral view (arrow= subocular ecdysial line) **4** Mesonotum, dorsal view (sa2, sa3= setal areas 2 and 3) **5** Metathorax and abdominal segments I and II, dorsal (arrows = single seta of sa3) **6** Right foreleg, posterior face. Scale bars: 0.5 mm.









Figures 7–12. *Adicella syriaca* Ulmer 1907, final instar larva. **7** Right midleg, posterior face (arrow: tarsal claw not hook-shaped) **8** Right hind leg, posterior face **9** Abdominal segments I and II, right lateral (a= lateral sclerite; b= lateral setae) **10** Lateral sclerite, detail **11** Sterna of metathorax and abdominal segments I and II **12** Tip of abdomen, dorsal (arrows= outermost setae of ninth abdominal tergite). Scale bars: 0.5 mm.

Legs orange-yellow, with very numerous setae, especially on coxae, trochanters, and femora (Figs 6–8); tibiae and tarsi undivided and without central constrictions. Femur of foreleg much wider than those of mid- and hind legs. Claw of mid leg curved and not hook-shaped as in genus *Leptocerus* (Fig. 7, arrow). Long fringes of swimming setae absent on hind legs.

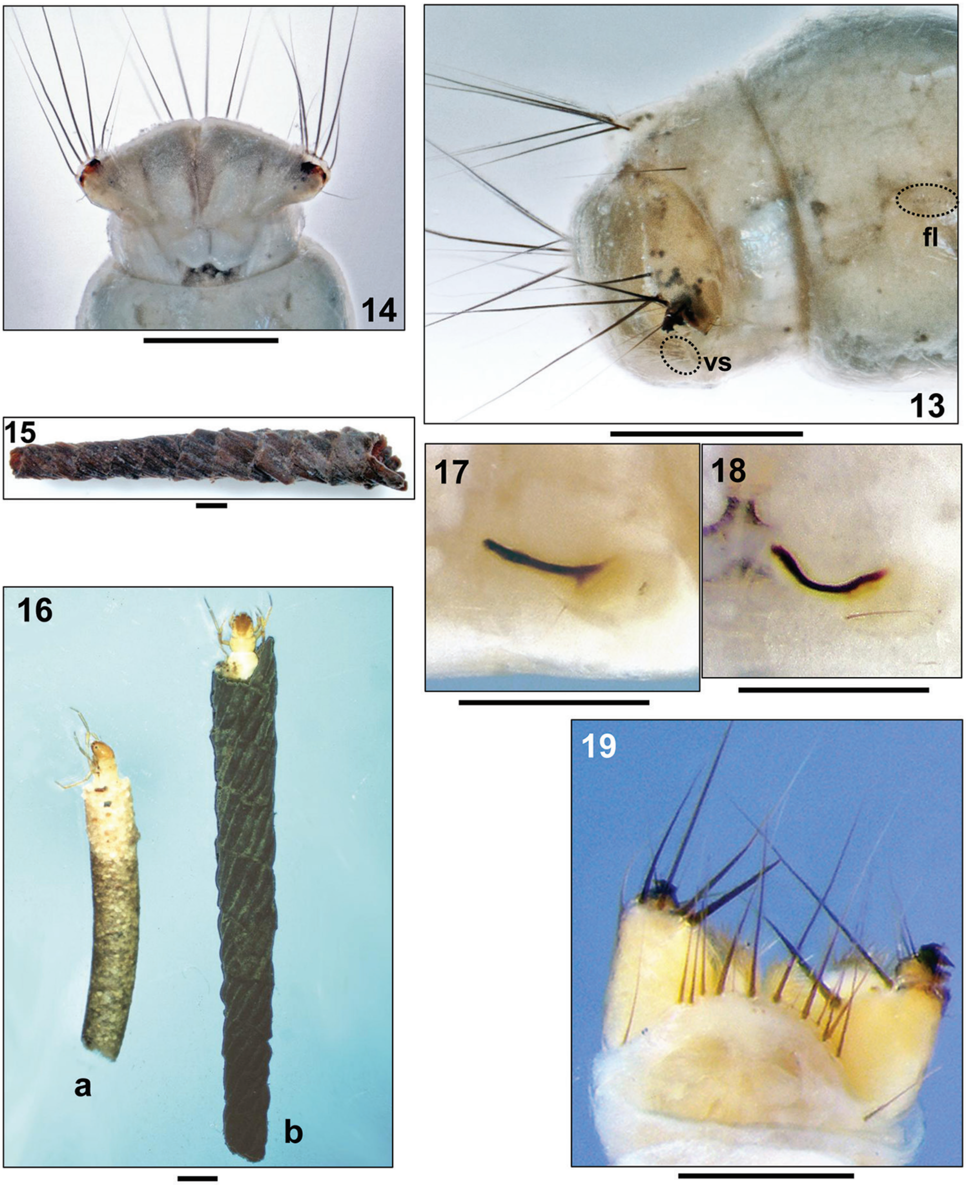
Abdomen. Abdomen white, cylindrical. First abdominal segment with one dorsal and two lateral protuberances (Fig. 9); dorsal sa1 and sa3 not developed, dorsal sa2 with single seta on each side (Fig. 5); oval and light orange lateral sclerite with strongly sclerotized, dark, curved and sickle-shaped posterior process; lateral sclerite with 1 ventral seta (Figs 9, 10). Abdominal tergum IX with pale, weakly sclerotized tergite, bearing 6 long and 4 short terminal setae; abdominal segment IX with 1 posterodorsal seta on either side (Fig. 12). Outermost seta on abdominal dorsum IX approximately as long as width of segment IX (Fig. 12, arrows). Anal prolegs pale and weakly sclerotized, each with large lateral sclerite and more strongly sclerotized anal claw with two tiny accessory hooks (Fig. 13). Each lateral sclerite bearing several long, black setae (Figs 13, 14). Each anal proleg medially with small group of pale, soft ventral setae (Fig. 13vs); tooth-edged plates around anal slit absent (Fig. 14). Gills and lateral line not visible; however, a lateral row of forked lamellae is present on abdominal segment VIII (Fig. 13fl).

Case. In the final instar larvae, straight, cylindrical, tapering, constructed of equally sized pieces of thin plant stems and roots arranged in a typical single spiral (Fig. 15). Case length 12.2–13.9 mm, anterior width 1.9–2.2 mm, posterior width 1.0–1.2 mm (n= 2).

Morphological separation of fifth instar larvae of *Adicella syriaca* from other European species of Leptoceridae and *Adicella*

A summary of morphological features for the identification of Leptoceridae larvae was provided by Wallace et al. (2003) and of Triaenodini larvae by Morse (1981). Within the framework of available leptocerid keys by Waringer and Graf (2011) and Graf et al. (2017), and the descriptions of Vieira-Lanero et al. (1997), Vieira-Lanero (2000), and Graf et al. (2017), *A. syriaca* is characterised by the following features:

- head with pattern composed of dark bands and dark muscle attachment spots (Figs 1, 3);
- metanotal sa3 reduced to a single seta per side (Fig. 5, arrows);
- pronotum with 56–65 setae of varying length per pronotal half (Fig. 3);
- total number of setae per mesonotal sclerite 11–13 (Fig. 4);
- lateral sclerites on 1st abdominal segment each with dark stripe, bent (Figs 10, 18) and not straight (Fig. 17);
- outermost seta of abdominal dorsum IX setal group (Fig. 12, arrow) approximately as long as width of this segment.



Figures 13–19. 13–15 *Adicella syriaca* Ulmer, 1907, final instar larva: **13** Tip of abdomen, right lateral (fl= forked lamellae on segment VIII; vs= ventral setae on segment IX) **14** Tip of abdomen, ventral **15** Larval case, right lateral **16** Final instar larvae in their cases. **a** *Adicella filicornis* (Pictet, 1834) **b** *Adicella reducta* (McLachlan, 1865) **17–18** Lateral sclerites on abdominal segment I of fifth instar larvae, right lateral view: **17** *Adicella reducta* (McLachlan, 1865) **18** *Adicella cremisa* Malicky, 1972 **19** *Adicella filicornis* (Pictet, 1834), final instar larva. Tip of abdomen, dorsal. Scale bars: 0.5 mm (except Figs 15, 17: 1 mm).

Key to the known final instar *Adicella* larvae of Europe

1 Head uniformly orange, without pattern; case cylindrical, smooth, constructed of mineral particles (Fig. 16a)..**2**

– Head pale, with pattern composed of dark bands and dark muscle attachment spots; case with spiral pattern, constructed of plant material (Figs 1, 16b) ..**3**

2 Abdominal dorsum IX (including both posterolateral setae) with 12 setae; species endemic to Iberic-Macaronesian Region (European Ecoregion I) ....***Adicella meridionalis* Morton, 1906**

– Abdominal dorsum IX (including both posterolateral setae) with 14–15 setae (Fig. 19); species widespread outside of European Ecoregion I..................... ....***Adicella filicornis* (Pictet, 1834)**

3 Metanotal sa3 with 13–18 setae per side (Fig. 20)....................................... ....***Adicella reducta* (McLachlan, 1865)**

– Metanotal sa3 reduced to a single seta per side (Fig. 5, arrows) **4**

4 Pronotum with 56–65 setae of varying length per pronotal half (Fig. 3); total number of setae per mesonotal sclerite is 11–13 (Fig. 4); outermost seta of abdominal dorsum IX setal group (Fig. 12, arrow) approximately as long as width of this segment....................................***Adicella syriaca* Ulmer, 1907**

– Pronotum with 35–37 setae of varying length per pronotal half; total number of setae per mesonotal sclerite is 7–8; outermost seta on abdominal dorsum IX approximately half as long as width of this segment (Fig. 21).................. ....***Adicella cremisa* Malicky, 1972**

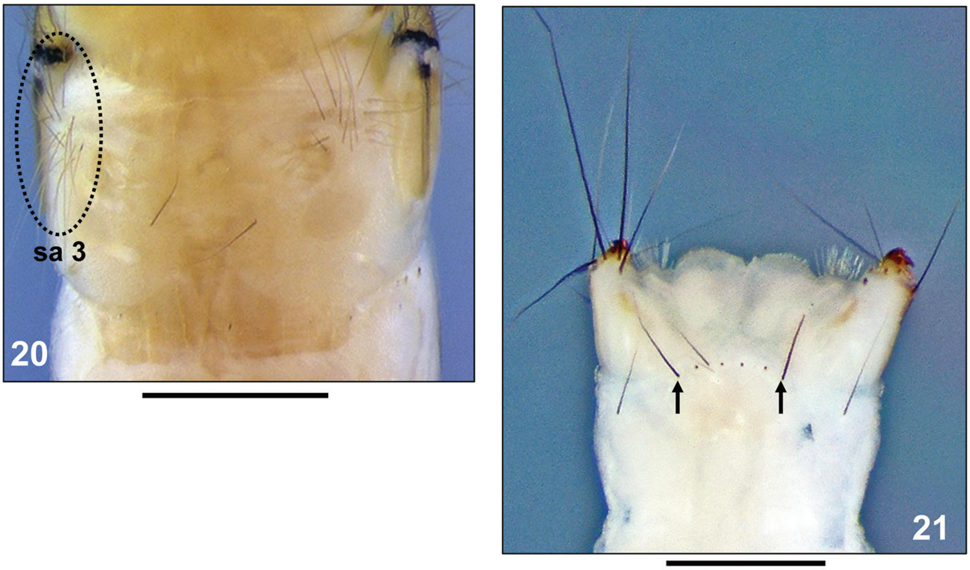


Figure 20–21. 20 *Adicella reducta* (McLachlan, 1865), final instar larva. Metanotum, dorsal view (sa3 = setal area 3) **21** *Adicella cremisa* Malicky, 1972, final instar larva. Tip of abdomen, dorsal (four setae are missing and only their alveolae visible). Scale bars: 0.5 mm.

Discussion

The larvae of *Adicella* species frequent a large range of habitats, including small shallow springs, rocky streams, marshes, canals and rivers, and often colonize root mats of riparian vegetation, with *A. reducta* remaining the only leptocerid caddisfly to persevere in large impoverished streams (Wallace et al. 2003). Cianficconi and Moretti (1987) also collected larvae of *A. cremisa* in standing water bodies and irrigated meadows. On Corfu, *A. syriaca* is most common relatively close to the shore (Malicky 2005b) where it inhabits streams and rivulets, and also mill brooks, shaded by *Nereum oleander*, *Arundo donax*, *Platanus orientalis*, *Ficus carnica,* and *Inula viscosa*. According to mandible morphology, *Adicella* larvae are shredders and, to a minor extent, also grazers (Graf et al. 2008); this also fully applies to *A. syriaca* where mandibles are fitted with ventral and dorsal cutting edges and terminal teeth along edges (Fig. 2).

The distribution of *Adicella syriaca* ranges from Tunisia, the Levant, and Turkey, throughout the Balkan Peninsula to Hungary and the Caucasus (Graf et al. 2008; Malicky, 2004, 2005a, b, 2014; Morse 2017). In Greece, *A. syriaca* is widespread on the mainland, but also on many islands, e.g., Euboea, Corfu, Lefkada, Kefallonia, Samothraki, Skiathos, Samos, Lesbos, Andros, and Rhodes (Malicky, 2005b).

The collection time of final instar larvae of *A. syriaca* in May fits well into the reported flight period of adults from the onset of April to mid-November. Within this period, a peak in May-June and in October can be observed which might be an indication of two generation cycles per year (Malicky 2005b). In *A. cremisa*, Graf et al. (2017) observed adults flying amongst dense riparian vegetation in vertical zig-zag patterns of about 10 cm extent; the long whitish antennae obviously played a role as an optical cue in courtship behavior in this species.

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RESEARCH ARTICLE

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A New Cryptic *Lactura* from Texas (Lepidoptera, Zygaenoidea, Lacturidae)

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Abstract

A new species of *Lactura* is described from Texas: *Lactura rubritegula* **sp. n.** Identity of the new species can be reliably determined by both larval and adult characters, CO1 haplotypes, and its late-spring period of flight activity. Male genitalic features overlap with those of *L. basistriga* (Barnes & McDunnough, 1913), whereas female structures differ markedly between the pair. The new *Sideroxylon*-feeding species, rare in collections, is found principally in limestone areas in the vicinity San Antonio, Texas, westward through the southern Hill Country. We illustrate the adult and larval stages and male and female genitalia, review available DNA barcode data that support the recognition of the new *Lactura*, and briefly characterize its life history.

Keywords

Sapotaceae, gum bully, *Sideroxylon*, DNA barcodes, CO1, *Sideroxylon celastrinum*, tropical burnet moth

Introduction

The Lacturidae (Tropical Burnet Moths) are a family of zygaenoid lepidopterans that inhabit tropical and subtropical regions of the world. Lacturid adults of North and Central America generally have white to gray forewings marked with antemedial and postmedial rows of red or black spots, and uniformly pink-red hindwings. Species delimitation in the New World has been hampered because this general description applies equally well to nearly all of the ca. 17 North and Central American species (Heppner and Duckworth 1983, Heppner 1984). And to further complicate taxonomic efforts, species such as *L. subfervens* (Walker, 1854) are exceedingly variable in color pattern with forms that overlap those of other members of the genus, including the new species described below.

The most recent checklist of Lepidoptera for the United States and Canada recognizes six species of *Lactura* (Heppner and Duckworth 1983). However, much confusion surrounds the taxonomic identity and validity of some of these species, and especially, the way these names have been applied in institutional collections, literature, genetic databases, and on-line identification resources. The chronic misidentification and misapplication of names within this genus, and the inadequate knowledge of the associated life histories, have made it heretofore difficult to recognize the new North American species described in this work, despite it having salient external features that allow identification of both its adult and larval stages. CO1 barcode data from authoritatively identified adults and larval collections helped us to unmask the existing tangle of misidentifications in collections and internet resources and recognize the new taxon.

Here we describe a new species of *Lactura* from the limestone areas and riparian corridors of south-central Texas's Hill Country. The new taxon is believed to be a specialist on *Sideroxylon lanuginosum* (Sapotaceae), a host it shares with both *L. pupula* (Hübner, [1831]) and *L. subfervens* at the type locality. We describe and illustrate the larval and adult stages of the new species, illustrate the male and female genitalia, and provide a brief account of its biology and distribution.

Methods

Adults were obtained by light trapping with UV and mercury-vapor lights. Larvae (of all US species) were collected from *Sideroxylon* (Sapotaceae). Preserved larval specimens were reared from ova deposited by gravid females collected at light traps. Most of the type specimens were collected by Delmar Cain from the type locality in Boerne, Kendall Co., Texas. Additional paratypes were collected by Ed Knudson (Uvalde Co., Harris Co., and Kerr Co.) and Ann Hendrickson (Edwards Co.). Ova acquired from the type locality in Kendall Co., were sent to Berry Nall in Falcon Heights, Texas (Rio Grande Valley), where they were reared on *Sideroxylon celastrinum*. The adult description of *L. rubritegula* is based on 20 pinned specimens; the larval description is based on two ex ova cohorts and one wild larva from the type locality. Forty-two genitalic slides of *Lactura* were examined: 29 on loan from the National Museum of Natural History (USNM) and 13 prepared by Tony Thomas for this study. Eight genitalic slides of *L. basistriga* and three of *L. rubritegula* were examined. Over the course of this study we examined the Nearctic *Lactura* holdings of the National Museum of Natural History (USNM) (Washington DC) (including primary types); Mississippi Entomological Museum (MEM) (Mississippi State, MS); Texas A&M University (TAMUIC) (College Station, TX), University of Connecticut (UCMS) (Storrs, CT), and the personal collections of Vernon A. Brou, Jr. (Albita Springs, LA); Edward C. Knudson (ECK) (Houston, TX); and James R. McDermott (JRM) (College Station, TX). CO1 barcodes for North American *Lactura* were compiled from holdings in the following institutions and personal collections: Canadian National Collection of Insects, Arachnids, and Nematodes, ECK, JRM, MEM, TAMUIC, UCMS, and USNM. We had access to 111 North American *Lactura* COI barcode submissions: for each of these we examined the associated voucher image. A neighbor-joining tree, using the default Kimura 2-P model, was generated by the Barcodes of Life Project (BOLD) (www.boldsystems.org) (Ratnasingham and Hebert 2007). DNA extraction, PCR amplification, and CO1 barcode sequencing were performed at the Canadian Centre for DNA Barcoding (Centre for Biodiversity Genomics – University of Guelph) using their standard protocol (Wilson 2012). Barcode sequences for the holotype and paratypes of *L. rubritegula* were deposited in GenBank. SimpleMappr (www.simplemappr.net) was used to generate the geographic distribution point map (Shorthouse 2010). Type material has been deposited in the USNM, TAMUIC, and UCMS.

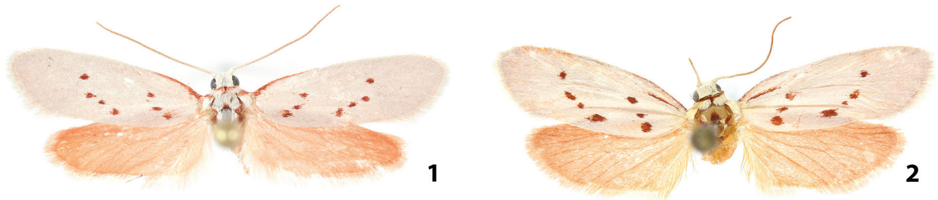
Taxonomy

Lactura rubritegula **Matson & Wagner, sp. n.**

http://zoobank.org/8AFB08C0-9E75-4DBC-BA69-6073EB35FA11
Figs 1, 3, 5, 7, 9, 10

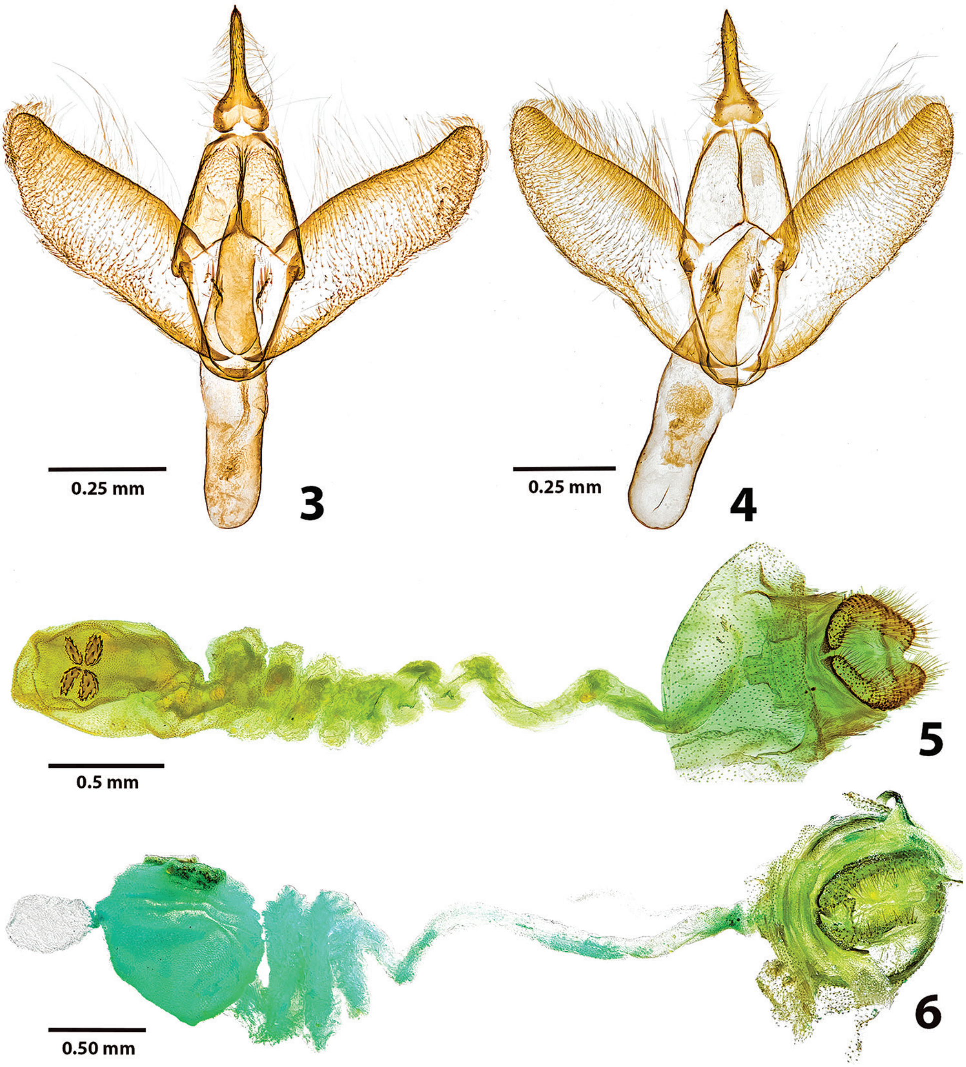
Diagnosis. *Lactura rubritegula* can be easily distinguished from its closest relative *L. basistriga* by the presence of red tegulae. It lacks the red subcostal dash that can be found in most forms of *L. basistriga* and the scattered flecking of red or brown scales characteristic of *L. subfervens*. Many, but not all, individuals can be distinguished by the basal displacement of the lowermost antemedial spot, somewhat enlarged upper postmedial spot, and the concave arcing (open to termen) of the three lower postmedial spots. We have not identified male genitalic characters that are unique to the new species. Females lack the small accessory pouch at the anterior end of the corpus bursae present in *L. basistriga* (Figs 5, 6) and some other *Lactura*; the anterior end of the ductus bursae is coiled six to seven times in *L. rubritegula*, but only 3–4 times in *L. basistriga*. Larvae are immediately distinguished from other Texas *Lactura* by their cinnamon-brown dorsum. In its various forms, the middorsal area of *L. basistriga* usually shows a green heart line. Supraspiracular stripes in *L. rubritegula* are about twice the width of those of *L. basistriga*. In the material that we have for study, the white pinacula are more prominent in *L. rubritegula* than those of other North American members of the genus.

Description. ***Adult male.*** Forewing length: 9.5–10.5 mm (n=12). Body salmon red. **Head.** Shiny, white decumbent scales over vertex and frons; lower frons sometimes with scattered pink scales. Labial palpus slightly porrect to straight, brick red, subequal to diameter of eye. Antenna filiform, 0.6 length of forewing; shiny, white decumbent



Figures 1, 2. Adults of *Lactura rubritegula* and *L. basistriga*. **1** HOLOTYPE male *Lactura rubritegula*. TX: Kendall Co., Boerne, D. Cain Home (29°52'51"N, 98°36'51"W), 27 April 2015, David Wagner & Delmar Cain colls., CO1 Barcode DLW-000816 Genitalia slide # TAM-2017-002 **2** Female *Lactura basistriga*. TX: Cameron Co. Sabal Palm Grove (25°51'9"N, 97°25'3.8"W), BBN15#27.a, larva collected 25 April 2015; emerged 21 May 2015, Berry Nall coll., Host: *Sideroxylon celastrinum,* Genitalia slide # TAM-2017-005.

scales over scape and basal $2/5^{\text{ths}}$, transitioning to admixture of white and red scales; distal $1/5^{\text{th}}$ brick red. **Thorax.** Predominantly white. Patagium and tegula red basally. Medial mesothoracic red spot flanked posterolaterally by ellipsoid red spots. Coxa and femora with whitish scaling along lower surface, other surfaces and segments brick red. Epiphysis well developed about ¼ protibial length. **Forewing.** Pearly white, with seven blood- to mahogany-red spots in oblique antemedial and postmedial series; without scattered dark scales (of *L. subfervens*). Antemedial row with three spots; lower spot usually displaced basally and often smaller than middle spot; postmedial series with four spots: uppermost usually larger or subequal to that below it; lower three forming straight line or (more commonly) slightly concave arc open to termen. (These same three spots often form convex arc in *L. basistriga* due to basal displacement of lowermost spot.) Basal red scaling along costa narrows and ends before antemedial spots. Underside red with white fringe scales. **Hindwing.** Uniformly light red, above and below, with elongate white fringe scales. **Abdomen.** Dorsum and sides brick red; venter white; paired ventral androconial brush composed of 20–40 white, thin scales hidden in intersegmental area between A5 and A6; second, subdorsal, paragenital androconial tuft of >40 straw-colored scales at base of tegumen. **Male genitalia.** Uncus basally cordiform; medial and distal part cylindrical, strongly down curved, ending in thorn-like spine. Tegumen lung shaped with strong medial crease. Valva elongated oval, 2.5× longer than wide, costa slightly concave pre-apically; broadly rounded; outer margin with shorter, thicker scales; lateral lobe of juxta with 6–8+ thickened spiniform setae. Vinculum narrow, U-shaped. Aedeagus exceeding length of valva; thickest at midlength; base broadly rounded; apex about half width of middle section, ending in short knob (Fig. 3). ***Female.*** **Forewing length.** 10–12 mm (n=9). Outwardly undifferentiated from male. **Female genitalia.** Papillae anales bowed inward, about 4× longer than wide, with long setae. Apophyses short and not especially well differentiated, approximately equal in length. Antrum thickened, hat shaped. Ductus bursae distally unmodified, anterior 2/3 spiraled into 6–7 tight whirls before entering corpus bursae; four strongly toothed signa arranged into two groups; corpus bursae ellipsoid, lacking anterior accessory pouch.



Figures 3–6. *Lactura* genitalia. **3** HOLOTYPE male *Lactura rubritegula* TX: Kendall Co., Boerne, D. Cain Home (29°52'51N, 98°36'51"W), 27 April 2015, David Wagner & Delmar Cain colls., CO1 Barcode DLW-000816 Genitalia slide # TAM-2017-002 **4** Male *Lactura basistriga* TX: Hidalgo Co., Bentsen St. Pk., 30 April 1995, Ed Knudson coll., Genitalia slide # TAM-2017-003, COI Barcode DLW-000513 **5** Female *Lactura rubritegula*. TX: Kendall Co., Boerne, D. Cain Home (29°52'51N, 98°36'50"W), 27 April 2015, David Wagner & Delmar Cain colls., Genitalia slide # TAM-2017-001 **6** Female *Lactura basistriga*. TX: Cameron Co. Sabal Palm Grove (25°51'9"N, 97°25'3.8"W), BBN15#27.a, larva collected 25 April 2015; emerged 21 May 2015, Berry Nall coll., Host: *Sideroxylon celastrinum*, Genitalia slide # TAM-2017-005.

Description of living final instar. Glossy pale green with broad cinnamon-brown middorsal stripe outwardly edged with black; white subdorsal and two, wavy-edged, pale supraspiracular stripes extending from T1–A8. Larger primary setae borne from minute white spots (~pinacula). Dorsum with black transverse lines at unions of each segment. White D1 pinacula from otherwise black warts. D2 seta also from white spot at apex of yellow wart with yellow washing down to SD seta. Thin, vague, wavy, pale spiracular stripe immediately ventral to light-orange spiracles, as well as single, white, straight-edged subventral stripe equal in width to supraspiracular stripes. Prothoracic shield well differentiated, medially divided, mostly black, although with little pigment deposition along its anterior and lateral margins (Fig. 7). Head black, partially retracted into prothorax.

Type material examined. Holotype male, dry pinned (Figs 1, 3) TX: Kendall Co., Boerne, D. Cain Home (29°52'51"N, 98°36'51"W), 27 April 2015, David Wagner & Delmar Cain colls., CO1 Barcode DLW-000816 Genitalia slide # TAM-2017-002, Deposited at USNM, Washington D.C., USA. **Paratypes adults**. (10♂, 9♀): TX: Kendall Co., Boerne, D. Cain Home (29.8808°, -986139°), 26 April 2017 – 02 June 2017, Delmar Cain coll. (3♂, 4♀) (UCMS); TX: Kendall Co., Boerne, D. Cain Home (29°52'51N, 98°36'50"W), 27 April 2015, David Wagner & Delmar Cain colls., Genitalia slide # TAM-2017-004, TAM-2017-001, DLW-000568 (2♂, 2♀) (UCMS); TX: Kendall Co., Boerne, Clear Creek Circle (29°52'51N, 98°36'50"W), 27 April 2015, (ex ova; DLW Lot 2015D60) emerged 27 May 2016, David Wagner & Delmar Cain colls., reared on *Sideroxylon celastrinum,* CO1 Barcode DLW-000280 (1♂) (UCMS); TX: Edwards Co., 1.3 mi NW Camp Wood (29.6822°, -100.0289°), 23 April 2016, Ann Hendrickson coll., (1♀) (UCMS); TX: Edwards Co., 1.3 mi NW Camp Wood, (29.6822°, -100.0289°), 11–25 April 2017, Ann Hendrickson coll., CO1 Barcode DLW-000817 (3♂) (TAMUIC); TX: Uvalde Co., Concan, 23–27 April 2017, Ed Knudson coll., (1♂, 1♀) (USNM); TX: Kerr Co., 10 mi. W. of Hunt, 20 May 1995, Ed Knudson coll., (1♀) (UCMS).

Other material examined. ***Adults.*** TX: Harris Co., Spring Valley, 28 May 1985, leg. E. Knudson **Larvae.** TX: Kendall Co., Boerne, Clear Creek Circle (29.8807°, -98.6146°), 11 May 2017, Delmar Cain coll., beaten from *Sideroxylon lanuginosum* (n=1). TX: Kendall Co., Boerne, 29°52'51N, 98°36'50"W, ex ova from female 27 April 2015, DLW Lot: 2015D60, David Wagner & Delmar Cain colls., (n=6) (UCMS).

Distribution. Hill Country around San Antonio, Texas, westward to Edwards and Uvalde counties, but range still unclarified due to taxonomic confusion with *L. basistriga* and other *Lactura*. A single specimen, seemingly out of range, was taken by Ed Knudson in Harris Co., Texas (Spring Valley). Range likely extends into Mexico.

Etymology. The new species is named for the extensive red scaling through the basal half of the tegula, much of which is visible from above—red scales immediately distinguish both sexes from other members of the *Lactura basistriga* group that occur in the Rio Grande Valley and northern Mexico, although similar scaling occurs in *L. subfervens*.

Biology. Larvae are specialists on *Sideroxylon* (formerly *Bumelia*) (Family Sapotaceae). *S. lanuginosum* is the only *Sideroxylon* that occurs at the three known localities for the species. Ex ova larvae of *L. rubritegula* were reared to maturity on *S. celastrinum* in captivity. Larvae preferred young leaves and rejected (and failed) on older leaves.

Peak flight of *L. rubritegula* appears to be tied to spring rains and the availability of new foliage. The moth begins flying in the second half of April. The majority of records

Figures 7, 8. Larvae of *Lactura rubritegula* and *L. basistriga*. **7** Last instar ex ova *L. rubritegula*; mother: TX: Kendall Co., Boerne, 25 April 2015, David L. Wagner and Delmar Cain colls., DLW Lot: 2015D60, COI Barcode DLW-000568 **8** Last instar ex ova *L. basistriga*; mother: TX: Cameron Co., Southmost, Sabal Palm Audubon Sanctuary, 7 November 2013, David L. Wagner coll., DLW Lot: 2013L29, COI Barcode DLW-000466. Both clutches reared by Berry Nall on *Sideroxylon celastrinum*.

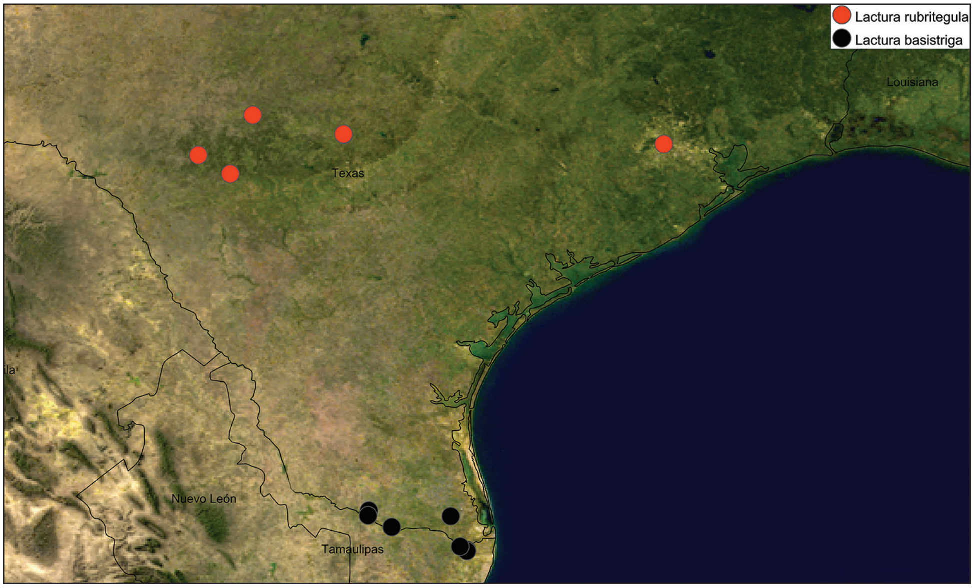


Figure 9. Geographic distribution of *Lactura rubritegula* (n=21, red) and *Lactura basistriga* (n=17, black). Single dots may represent >1 individuals.

are centered around the end of April and first half of May following the flights of *L. subfervens* and *L. pupula* at the type locality. It is unclear if early June captures represent late emergers or a small facultative second generation. An ex ova larva that was reared from a female taken on 25 April 2015 did not emerge until 27 May 2016.

In captivity the larvae typically feed from leaf undersides. Similar to other members of the genus, larvae emit slimy exudate from their integument; the function of the exudate remains unknown. At least in captivity, we often found feculae adhering to our caterpillars that remained attached until the next molt. Mature larvae spin a dense, red-brown cocoon in leaf litter or over soil. Presumably summer, fall, and winter months are passed as a prepupa.

Discussion

So far as known, *Lactura rubritegula* has a curiously restricted range relative to that of its hostplant, *Sideroxylon lanuginosum* (gum bully)—the most widely distributed *Sideroxylon* in the United States. Gum bully's range extends from Arizona to southern Kansas, Missouri, and Illinois, eastward to Georgia and Florida, and southward into Mexico. The moth is known principally from the southern Hill Country in the vicinity of San Antonio, westward and southward. Ed Knudson took a single specimen in west Houston (Spring Valley), which would suggest that the moth has simply been overlooked over parts of its range. We did not find additional examples in his collection, nor did we find any in the USNM collection, which includes Andre Blanchard's extensive Texas collection.

We had access to barcode data for 111 North American *Lactura* specimens representing approximately 15 species-level taxa. The species cluster that includes *L. rubritegula* is shown in Fig. 10, henceforth we refer to this group as the *basitriga* complex. Barcode data for the group includes group includes *basistriga* (n=3; southern Texas), near *basistriga* (n=3; Oaxaca, Mexico), and the new species (n=2; Boerne, Texas). *L. rubritegula* shows an (uncorrected) divergence of 3.6% to its nearest neighbor in the *basistriga* group (from Oaxaca) and a 4.8% divergence from its nearest Texas neighbor, nominate *basistriga*.

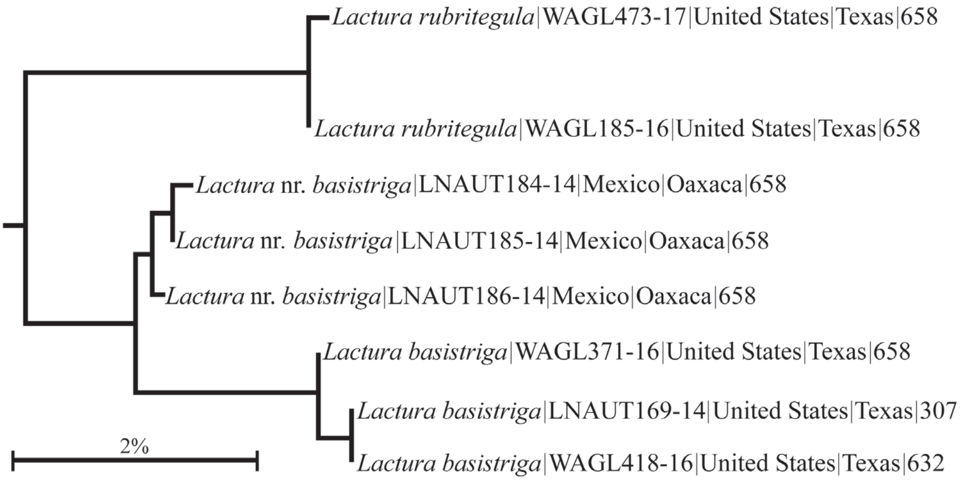


Figure 10. North American COI barcode tree for *Lactura basistriga* complex available as of 6 October 2017. Included for each taxon is the BOLD process ID, region, and sequence length.

Taxonomically, *Lactura* has proven itself to be a challenging genus to some of North America's top systematic microlepidopterists, past and present, including August Busck, Harrison Dyar, and Ronald Hodges. Larval phenotypes and COI barcodes guided our understanding of this group by unmasking a tangle of misidentifications and segregating otherwise cryptic lineages. Based on our assessment of the North American fauna informed by larvae, life history data, and CO1 barcodes, the identifications in institutional collections, BOLD, and GenBank are riddled with misidentifications—e.g., 46% of the North American specimens of *Lactura* in BOLD are misidentified. Much of the confusion traces to concepts of *L. subfervens*, a highly variable taxon whose phenotypes overlap with those of *L. basistriga*, *L. rubritegula*, *L. psammitis* (Zeller, 1872) (TAM unpubl. data). Of the 52 specimens of *L. subfervens* and in BOLD, 65% of these appear to be misidentified.

We have attempted to rear two ex ova clutches of *Lactura rubritegula* from the type locality. Females captured on 25 April 2015 and 13 June 2017 were reared successfully by Berry Nall on *Sideroxylon celastrinum* in Falcon Heights, Texas. Pupae from the first cohort yielded an adult the following spring that is part of the paratype series. However, a wild larva, presumably an antepenultimate instar, found feeding on *S. lanuginosum* at the type locality in Boerne, Texas, on 13 June 2017 by Delmar Cain, straggled and died even when sleeved on the same branch from which it came, perhaps because the *Sideroxylon lanuginosum* foliage was too aged by mid-June to be acceptable. Whereas many Texas moths from arid and semi-arid habitats fly in almost any month when there has been appreciable rainfall, we only have late spring captures for *L. rubritegula*.

In contrast to the phenotypically uniform and confusing adults, the larvae of North American *Lactura* can be reliably identified to species. Larval features even unambiguously differentiate regional segregates within the two most widespread North American species, *L. pupula* and *L. subfervens*. Likewise barcodes disambiguate the North America species in that they align with our larval, life history, and biogeographic data. The confused nature of barcode data in BOLD appears to be entirely due to the misapplication of names by those making the initial submissions. We are currently collecting data for eight nuclear genes and preparing additional genitalic dissections for the North American fauna, and will await the outcome of these studies before making formal synonymies, producing adult and larval keys, and emending current BOLD determinations for the *Lactura* that occur north of Mexico.

Perhaps not surprisingly, for nearly every North American *Lactura* species there appears to be a closely related Mexican sister taxon, and in some case a species cluster in BOLD. There is much taxonomic work to be done, especially southward into Central and South America. We suspect the Nearctic fauna will continue to yield cryptic species and otherwise new species for decades, and that molecular data will play a critical role in getting this genus of look-a-likes properly partitioned into valid evolutionary units.

Acknowledgments

We would like to thank the National Museum of Natural History, Smithsonian Institution for their generous contribution of genetic data; Dr. Scott E. Miller collected much of the DNA barcode data that formed the scaffolding that allowed for the genetic confirmation of our new taxon. Specimen loans were provided by Edward C. Knudson (Texas Lepidoptera Survey), James R. McDermott, Richard L. Brown (MEM), and Scott E. Miller (USNM). Anne Hendrickson sent photographs and collected specimens of *Lactura* from her ranch in Camp Wood, Texas. A special thanks to Delmar Cain who helped with many aspects of this effort: hosting DLW, collecting many of the specimens in the type series, providing phenological data for the three species of *Lactura* on his property, egging females, and more. We are much indebted to Berry Nall for his exceptional rearing and photographic assistance—both of the larval images in this work are his. We also thank Tony Thomas for preparing several genitalic dissections, and Marc Epstein and Jean-Francois Landry for their helpful suggestions that improved an earlier version of this manuscript. Jim Paz and Seth Patterson assisted with visits to the Sabal Palm Sanctuary in Brownsville Texas where comparative material of *L. basistriga* was secured. DLW is supported by USFS Co-op Agreement 14-CA-11420004-138 and an award from the Richard P. Garmany Fund (Hartford Foundation).

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Corrigenda: A new species of *Pristimantis* from eastern Brazilian Amazonia (Anura, Craugastoridae). ZooKeys 687: 101–129 (2017). https://doi.org/10.3897/zookeys.687.13221

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In our recent work on the description of the new species of *Pristimantis* (Oliveira et al. 2017), some errors that can impair your complete understanding were not noticed in the text. Corrections are as follows:

Material and methods (pag. 102)
In the section **Morphological analyzes** where it is written "twenty-two belonging to type series" read "twenty-nine belonging to type series".

Table 1 (p. 106)
Line 11 should be removed from the **Table 1** because this sequence was not used.

Individuals "BIOTA 1218, BIOTA 1111, MPEG 095, MPEG 109, MPEG 160, MPEG 165 e MPEG 177" are not part of the type series.

Table 1 (p. 106 and 107)
In the **Table 1**, individuals belonging to the Borba 1 group are INPA-H 34565, 34579 and 34580, while those belonging to the Borba 2 group are INPA-H 34571, 34577, 34562, 34573, 34578 and 34575.

Bioacoustic analysis (p. 111)
In **Figure 3C**, the vocalization belongs to populations from Bolivia (Padial and De La Riva 2009). The oscillograms were retrieved from Padial and De La Riva (2009). José M. Padial is the author of figure 3B, Ignacio De La Riva is the author of figure 3C and J. Kohler is the author of figure 3D.

Paratopotypes (p. 113)
Where it is written "and nine adult females:" read "and eight adult females:". Individual "LZATM 742" is mentioned twice, but it consists of only one.

Diagnosis (p. 114)
Where it is written "*dorsolateral fold absent*" read "*dorsolateral fold present*".

Table 4 (p. 115)
Add "Obs: The (*) indicates description by Duellman and Lehr (2009) for *Pristimantis fenestratus* Peru and (**) indicates description by Padial and De La Riva (2009) for *Pristimantis fenestratus* Bolivia".

Appendix 2 (pag. 129)
In the column **locality**, individuals from "Borba" should not be part of this table, since they do not belong to the taxon *Pristimantis latro*.

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We thank Miqueias Ferrão for calling our attention to some of these problems.

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