

# Venifurca, a new genus of neotropical Doryctinae (Hymenoptera: Braconidae), and its phylogenetic placement

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## Abstract

A new genus belonging to the braconid wasp subfamily Doryctinae, *Venifurca* **gen. n.**, is described containing one species, *Venifurca leiosoma* **sp. n.** The new genus is morphologically similar to *Johnsonius* Marsh and *Semirhytus* Szépligeti. A phylogenetic analysis based on one nuclear (28S) and one mitochondrial (COI) gene marker supported the close affinity of these three genera + *Boliviar* Zaldívar-Riverón & Rodríguez-Jiménez and *Parallorhogas* Marsh. All these genera are mainly characterized by having vein m-cu of the hind wing slightly curved distally.

## Keywords

Ichneumonoidea, cyclostome braconids, taxonomy, parasitoid wasps, phylogeny

## Introduction

With about 201 genera and 1700 described species (Yu et al. 2012, Braet 2016, Gadelha et al. 2016, Martínez et al. 2016) Doryctinae is one of most diverse subfamilies of Braconidae. This subfamily was erected over 150 years ago (Forster 1862); however, it is far from being fully known even at the supraspecific level. Proof of this is the considerable number of new doryctine genera that have been described over the last few years (Nunes et al. 2012, Marsh et al. 2013, Zaldívar-Riverón et al. 2013, 2014, Belokobylskij et al. 2015, Gadelha et al. 2016, Martínez et al. 2016). This emphasizes the necessity of conducting more studies in the New World tropics, where most of its species-richness occurs (Hanson and Gauld 1995, Wharton et al. 1997, Marsh 2002, Braet et al. 2003).

Most members of the Doryctinae are distinguished by the following external morphological features (Zaldívar-Riverón et al. 2008): 1) presence of a row of spines on the fore tibia, 2) separate insertion of two secondary venom ducts into the primary duct, 3) a heavily sclerotized ovipositor apex, 4) double nodus on the upper valve, 5) and modified serration on the lower valves of the ovipositor, usually as isolated tooth-like processes or as well-developed distal grooves along the dorsolateral edge of the valve (Quicke et al. 1992).

Morphological and molecular phylogenetic studies that have been conducted for the Doryctinae have demonstrated high levels of morphological homoplasy at different taxonomic levels (Belokobylskij et al. 2004, Zaldívar-Riverón et al. 2007, 2008). The use of coupled molecular and morphological data in taxonomic studies within this subfamily is therefore necessary to establish with more confidence its higher-level classification. In this work, we describe a new genus, and reconstruct its phylogenetic relationships with respect to other members of the Doryctinae.

## Methods

### Specimens and terminology

The specimens examined in this study are deposited in the Coleção de Invertebrados do Instituto Nacional de Pesquisas da Amazônia (INPA) and Colección Nacional de Insectos, Instituto de Biología, Universidad Nacional Autónoma de México (CNIN IB-UNAM). Morphological comparisons were performed using the relevant literature (Marsh 1997, 2002) and by direct comparison with material deposited in the above collections. We followed the terminology proposed by Sharkey and Wharton (1997), except for surface sculpture, which follows Harris (1979).

Digital photographs were taken with a Leica® stereomicroscope M165C coupled with a Leica® DFC420 camera and the Leica Application Suite program version 3.4.1.

## Phylogenetic affinities of the new genus

We generated sequences of one nuclear and one mitochondrial (mt) marker for one specimen of the new genus to reconstruct its phylogenetic affinities within the Doryctinae. These markers correspond to 546 bp of the cytochrome oxidase I (COI) mtDNA and about 600 bp of the second and third domain regions of the nuclear ribosomal 28S genes. The laboratory procedures to extract, amplify and sequence the above sample are described in Ceccarelli et al. (2012) and Ceccarelli and Zaldívar-Riverón (2013). These sequences were included in previously published 28S + COI datasets (Zaldívar-Riverón et al. 2008, Belokobylskij et al. 2015) that included 107 doryctine species and 21 members of other Braconidae subfamilies (see Suppl. material 1).

A partitioned Bayesian analysis was performed for the 28S + COI matrix with the program MrBayes version 3.2.2 (Ronquist et al. 2012). The analysis had two simultaneous runs of 20 million generations each, saving trees every 1,000 generations, using four chains and default priors. Three partitions were considered for COI according to their codon position, and one partition was established for 28S. The evolutionary models selected for each partition were selected as in Zaldívar-Riverón et al. (2008). Burn-in was established after the first 10 million generations, and the remaining trees were used to reconstruct a phylogram with posterior probability of clades, considering values  $\geq 0.95$  as significantly supported (Huelsenbeck and Ronquist 2001).

## Results

### Phylogeny

The reconstructed Bayesian phylogram showing the phylogenetic placement of the new genus within the Doryctinae is shown in Figure 1. The new genus was recovered within the “South American major doryctine clade” previously proposed by Zaldívar-Riverón et al. (2008), nested with significant support in a clade with the following four genera: *Parallorhogas* Marsh, *Bolivar* Zaldívar-Riverón & Rodríguez-Jiménez, *Semirhytus* Szépligeti and *Johnsonius* Marsh.

### Taxonomy

#### ***Venifurca* Gadelha, Nunes & Zaldívar-Riverón, gen. n.**

<http://zoobank.org/74CE1EC7-F570-48A0-8E0F-E87FF088ABBD>

**Type species.** *Venifurca leiosoma* Gadelha, Nunes & Zaldívar-Riverón, sp. n.

**Diagnosis.** *Venifurca* gen. n. differs from the remaining doryctine genera by having hind wing vein m-cu bifurcate, with its two sides curving towards the base and apex (Fig. 2E). It is morphologically similar to *Semirhytus* and *Johnsonius*; however, it



mainly differs from them by having the propodeal areola poorly defined or absent (always present and defined in *Johnsonius* and *Semirhytus*). It also differs from *Semirhytus* by having a smaller oral cavity, less than four times the malar space length (equal to or greater than four times the malar space length in *Semirhytus*).

**Description.** Body length 6.6–7.9 mm; body mostly smooth and polished, with few carinae (Fig. 2A–B); clypeus margined dorsally by a distinct carina; occipital carina not meeting hypostomal carina; mesoscutum declivous anteriorly; notauli narrow and smooth, not meeting, present only on anterior part of mesoscutum; propodeum smooth and polished, sometimes with weak lateral and median carinae, areola absent or poorly defined; fore wing vein r-m present; first subdiscal cell open at apex, vein 2cu-a absent; hind wing vein M+CU 0.5 times length of 1M; vein m-cu bifurcate at apex (Fig. 2E); hind coxa with anteroventral basal tubercle; first metasomal tergite with two parallel longitudinal carinae, extending to half length of tergite, area between longitudinal carinae higher than tergite edges; basal sternal plate of first metasomal segment 0.2 times length of tergum; remaining tergites smooth and polished; ovipositor length equal to metasoma.

**Distribution.** French Guiana and Brazil.

**Biology.** Unknown

**Etymology.** This genus refers to the Latin words *vena* and *furca* in reference to its main feature, hind wing vein m-cu bifurcate at the apex.

### Key to *Venifurca* Gadelha, Nunes & Zaldívar-Riverón, gen. n.

*Venifurca* gen. n. runs to couplet 71 of the key to New World doryctine genera (Marsh 1997) as follows:

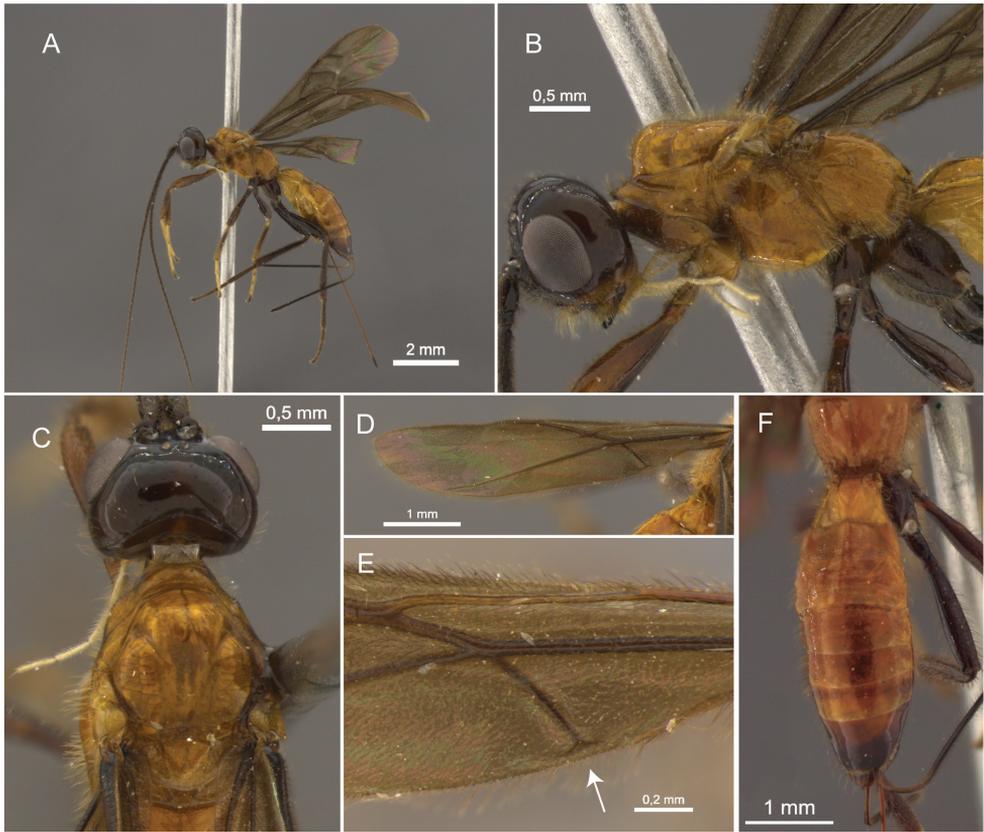
- 71 Cyclostome opening wide and oval, nearly as wide as eye height; clypeus long and thin.....*Semirhytus Szépligeti*, 1902
- Cyclostome opening circular, at most as wide as half height of eye; clypeus wide..... 71a
- 71a Hind wing vein m-cu bifurcate at apex, next to the posterior margin of wing (Fig. 2E) ..... *Venifurca Gadelha, Nunes & Zaldívar-Riverón, gen. n.*
- Hind wing vein m-cu curved distally toward apical margin of wing or extending straight to posterior margin of wing, but never bifurcate.....72

### *Venifurca leiosoma* Gadelha, Nunes & Zaldívar-Riverón, sp. n.

<http://zoobank.org/8FE53E4F-A380-4CFF-A119-1E03F824AD16>

Figures 2A–F

**Description.** Female. Body length: 6.6 mm (Fig. 2A). *Body colour:* head dark brown, including scape and pedicel; clypeus honey yellow; mandible honey yellow at base, turning dark brown at apex; palpi light yellow; mesosoma honey yellow, except for pro-



**Figure 2.** *Venifurca leiosoma* sp. n. (Holotype). Lateral habitus (A), lateral head and mesosoma (B), dorsal head and mesonotum (C), hind wing (D), hind wing with emphasis on the bifurcate m-cu (E), dorsal propodeum and metasoma (F).

pleuron, which is slightly darker; fore coxa yellow, trochanter, trochantellus, femur and tibia brown, tarsi yellow; mid and hind legs brown, except mid tarsus, which is yellow; first to sixth metasomal tergites honey yellow, seventh tergite honey yellow anteriorly, turning dark brown distally; eighth tergite dark brown; ovipositor sheath dark brown only in basal third, remaining area black; ovipositor dark brown, strongly sclerotized at apex; wings light brown, veins and pterostigma brown; tegula yellow.

*Head:* clypeus smooth, with a row of setae on its ventral margin and dorsally delimited by carina; face covered with setae inserted into punctations; remainder of head smooth, polished and covered with more widely spaced setae (Fig. 2B–C); scape and pedicel covered with setae inserted into punctations; antenna with 44 flagellomeres; oral cavity oval, width 1.5 times length of malar space; ocellar–ocular distance three times diameter of lateral ocellus; occipital carina present, poorly marked in dorsal region and not meeting hypostomal carina.

*Mesosoma*: smooth and polished, almost with no clearly defined carinae (Fig. 2B-C); pronotum densely setose posterolaterally, pronotal groove smooth and narrow; propleuron with setae over entire surface; mesoscutum covered with setae, notauli smooth and narrow, not converging, finishing before middle of mesoscutum (Fig. 2C); scutellar disk smooth anteriorly, with setae posteriorly; mesopleuron with a smooth, polished and shallow precoxal sulcus, extending along half of mesopleuron; posteroventral area more setose than remaining part of mesopleuron; venter of mesosoma smooth, polished and with few setae; propodeum and metapleuron setose, propodeal lateral carinae poorly defined (Fig. 2F).

*Wings*: fore wing vein r equal to 3RSa; m-cu in line with 2RS; 1cu-a slightly distal to 1M; first subdiscal cell open, 2cu-a absent; hind wing vein M+CU equal to 0.52 length of vein 1M (Fig. 2D); m-cu vein clearly bifurcate at apex (Fig. 2E).

*Legs*: smooth, polished and covered with setae; ventral and lateral areas of coxae more setose than dorsal area; hind coxa with a well defined anteroventral basal tubercle; tibiae and tarsi more setose than femora.

*Metasoma*: first metasomal tergite with two parallel longitudinal carinae, extending half length of tergite, area between two longitudinal carinae higher than tergite edges; dorsope distinct and deep; basal sternal plate 0.20 length of first tergum; suture between second and third tergites indistinct (Fig. 2F); remaining part of metasoma smooth and polished; ovipositor length equal to metasoma.

**Male.** Unknown.

**Variation.** Propleuron yellow to dark brown; fore coxa yellow to brown; clypeus and face smooth to slightly striate; occipital carina even throughout or slightly sinuous laterally; propodeal areola poorly defined to absent.

**Distribution.** French Guiana and Brazil (Amazonas and Pará states).

**Etymology.** The specific name comes from the Greek *leio* (= smooth) and *soma* (= body), in reference to the smooth body of this species.

**Material examined.** *Holotype*: female, BRAZIL, Amazonas, Manaus, Reserva Ducke, Igarapé Bolívia, 28.ii.2003, Arm. Malaise, J. M. F. Ribeiro, (INPA). *Paratypes*: three specimens. One female, FRENCH GUIANA, Regina Road Roura – Kaw Km 37.5, Kaw Mountain, 04°33'20"N 52°08'19"W, 217m, i.2005, J. A. Cerda leg, CNIN 2204, (CNIN IB-UNAM); One female, BRAZIL, Amazonas, Manaus, Reserva Ducke – INPA, 09-16.x.2005, Arm. Malaise, A. P. Aguiar, (INPA); One female, BRAZIL, Pará, Repartimento, Vicinal 08, 04°26'42"S / 49°54'25"W, 28.xi.2001, Malaise, J. A. Rafael & J. Vidal, (INPA).

## Discussion

The four genera that were recovered in the same clade with *Venifurca* gen. n. (*Paralorbogas*, *Bolivar*, *Semirhytus* and *Johnsonius*) (Fig. 1) are mainly characterised by having hind wing vein m-cu distinctly curved towards the apex and the propodeal areola present and well defined. However, in *Venifurca* gen. n. m-cu is clearly bifurcate, with

its two sides curving towards the base and apex of the wing, and the propodeal areola is poorly defined or absent. The only described species of this genus, *Venifurca leiosoma* sp. n., is morphologically similar to those of *Semirhytus* and *Johnsonius* in various external morphological features, including the smooth and polished body, the declivous mesoscutum, a distinct dorsope and the length of hind wing vein M+CU, which is 0.5 or less of the length of vein 1M. Further morphological examination and molecular phylogenetic studies will clarify whether the above genera form a monophyletic group and thus deserve to be recognized as a separate tribe.

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## Supplementary material I

### 28S + COI matrix

Authors: Sian de Souza Gadelha, Juliano Fiorelini Nunes, Alejandro Zaldívar-Riverón, Marcio Luiz de Oliveira

Data type: Nexus file

Explanation note: 28S + COI data set including 107 doryctine species and 21 members of other Braconidae subfamilies, used in the Bayesian analysis.

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