



<http://dx.doi.org/10.11646/zootaxa.4028.2.9>

<http://zoobank.org/urn:lsid:zoobank.org:pub:1E8566D8-2E16-4BA1-A3D4-871F116910F1>

## A new species of *Parakari* (Ephemeroptera: Baetidae) from Guiana Highlands

TOMÁŠ DERKA<sup>1,5</sup>, CAROLINA NIETO<sup>2</sup> & MAREK SVITOK<sup>3,4</sup>

<sup>1</sup>Department of Ecology, Faculty of Natural Sciences, Comenius University, Mlynská dolina, Ilkovičova 6, SK–84215 Bratislava, Slovakia. E-mail: [derka@fns.uniba.sk](mailto:derka@fns.uniba.sk)

<sup>2</sup>CONICET-Instituto de Biodiversidad Neotropical, Facultad de Ciencias Naturales e IML, Miguel Lillo 251. Tucumán, Argentina, UNASUR (4000). E-mail: [macarolina\\_nieto@yahoo.com.ar](mailto:macarolina_nieto@yahoo.com.ar)

<sup>3</sup>Department of Biology and General Ecology, Faculty of Ecology and Environmental Sciences, Technical University in Zvolen, T. G. Masaryka 2117/24, SK–96053 Zvolen, Slovakia. E-mail: [svitok@tuzvo.sk](mailto:svitok@tuzvo.sk)

<sup>4</sup>Eawag, Swiss Federal Institute of Aquatic Science and Technology, Department of Aquatic Ecology, Centre of Ecology, Evolution and Biogeochemistry, Seestrasse 79, 6047 Kastanienbaum, Switzerland

<sup>5</sup>Corresponding author. E-mail: [derka@fns.uniba.sk](mailto:derka@fns.uniba.sk)

**Abstract.** The genus *Parakari* was described from Guiana Highlands in southeastern Venezuela by Nieto & Derka in 2011 for two species inhabiting streams draining isolated, flat-topped table mountains called tepuis. A description of a third representative, *Parakari roraimensis* sp. n., is given here based on material collected from a coldwater stream at the foothills of Roraima-tepui (SE Venezuela). Detailed morphological descriptions of mature nymph and female adult are given. A differential diagnosis and a key to nymphs of the three *Parakari* species are provided.

**Key words:** mayflies, Pantepui, tepui, taxonomy, Venezuela

The genus *Parakari* was described from Guiana Highlands in southeastern Venezuela by Nieto & Derka (2011). The original description included two species collected in coldwater streams at summits and foothills of isolated flat-topped table mountains called tepuis. *P. churiensis* was collected at Churi-tepui while type-material of *P. auyanensis* came from Auyán-tepui. About one hundred of these tepuis with flat summits are isolated from surrounding tropical lowlands or uplands by vertical escarpments up to 1,000 m high that make them virtually inaccessible. The ecological community of the tepui summits is considered a distinct and discontinuous biogeographical province called Pantepui (Mayr & Phelps 1967). The Pantepui ranges from 1,500 to 3,000 m a.s.l. covering an area of about 5,000 km<sup>2</sup> (Berry *et al.* 1995). The province is known for its extraordinary diversity and high level of endemism, frequently at the scale of a single tepui or massif (Berry & Riina 2005; McDiarmid & Donnelly 2005; Aubrecht *et al.* 2012; Derka *et al.* 2012).

The genus *Parakari* can be distinguished from the other genera in the family Baetidae by the absence of hind wings, a constriction on segment II of the forceps and by the elongated segment III of the forceps in male imago. At the nymphal stage, gill I is absent; the subapical denticles of the tarsal claws are larger than the other; the maxillae bear four denticles, the first and the fourth denticle with an apically pointed projection; segment II of the maxillary palpi has a concavity and a hole apically; the labium has rectangular paraglossae with three robust and pectinate setae; and segment II of the labial palpi has a well developed distomedial projection.

Here we describe a new species of *Parakari*, found in spring streams at the Roraima-tepui foothills.

### Material and methods

Nymphs were collected from all submerged substrates or microhabitats (gravel, stones and woody debris) by using a hydrobiological net. Adults were collected by using an entomological hand net. Some subimagines were captured and reared. Nymphs and adults were associated by the coloration patterns. Material was conserved in 96 % ethyl alcohol. For morphological study, mature larvae and adults were selected and dissected. Dissected parts of the specimens (3 nymphs and 2 female imagoes) were mounted on microscope slides with Canada balsam. Line drawings were made using a camera lucida attached to a microscope Leica DM 1000. Photographs of the female imagoes were taken with a

Leica DFC 425 digital camera with a Leica M 205 C stereomicroscope and Auto-Montage Pro version 5.0 software. The material examined is housed at the following institutions (abbreviations are used in the text): IBN—Instituto de Biodiversidad Neotropical, Tucumán, Argentina; MIZA—Museo del Instituto de Zoología Agrícola, Facultad de Agronomía, Universidad Central de Venezuela, Maracay, Venezuela; and FNS—Department of Ecology, Faculty of Natural Sciences, Comenius University, Bratislava, Slovakia.

## Results

### *Parakari roraimensis* new species Derka, Nieto & Svitok

(Figs. 1–14)

**Female Imago** (Figs. 1–3). Length (mm): body 4.5–4.7; fore wings 6.1–6.6. Head reddish brown (Figs. 1–2), compound eyes blackish, ocelli black. Antennae: scape and flagella pale yellow, pedicel reddish brown. Thorax reddish brown, a yellowish band along midline. Pleurae yellowish, sterna pale yellowish. Legs pale yellow. Wings hyaline (Fig. 3), costal and subcostal fields of fore wings translucent, with paired marginal intercalary veins, except in the cubital field where they are single. Abdomen, terga I–VIII, reddish, terga IX–X reddish brown, segment II–VII with a pair of yellowish marks along lateral margin, sterna pale yellow.

**Nymph** (Figs. 4–14). Length (mm): body 4.2–5.2; cerci 2.1; terminal filament 1.8. Head yellowish brown. Eyes: compound eyes yellowish-brown, ocelli black. Antennae yellowish. Mouthparts (Figs. 4–9): Labrum wider than long (Fig. 4), dorsally with four subapical setae near midline, two inner shorter than the others. Left mandible (Fig. 5) with incisor bearing 8–9 teeth apically, prosthema robust with 15–16 denticles, thumb of molar area transverse to anterior margin. Right mandible (Fig. 6) with prosthema bifid basally. Hypopharynx with lingua subequal to superlinguae (Fig. 7). Maxillae (Fig. 8) with palpi slightly longer than galea-lacinia, segment I shorter than segment II. Labium (Fig. 9) with paraglossae with one nonpectinate blade-like seta on apical margin of each paraglossa, segment II of palpi with a thin distomedial projection, segment III 1.5 longer than wide.

Thorax, forewing pads and pleurae yellowish brown. Sterna pale yellow. Legs (Fig. 10) yellowish, fore femur with a row of 25–27 spines like setae on dorsal margin, mid femur and hind femur with 22–23 and 14–15 spines like setae respectively; all femora with a pair of spine like setae apically. Tarsal claws with 10–12 denticles (Fig. 11). Abdomen yellowish brown. Terga with scales and scale bases, posterior margin of terga I–II with rounded projection, terga III–IX with pointed spines, rounded projections, and with spaces between them (Fig. 12). Sterna pale yellow. Gills whitish, elongated, subequal in length to each tergum, main and few secondary trachea pigmented (Fig. 13). Paraprocts with 9–11 spines and a blunt lateral process (Fig. 14). Caudal filaments yellowish.

**Etymology.** The species is named after the mountain Roraima-tepui, where it was collected.

**Diagnosis.** *Parakari roraimensis* sp. n. can be distinguished from the other species of the genus by the following combination of characters. In the nymph: 1) labrum (Fig. 4) with four subapical setae near midline, two shorter than the others; 2) prosthema of right mandible bifid basally (Fig. 6); 3) segment II of labial palpi with a thin distomedial projection (Fig. 9); 4) posterior margin of terga III–IX with pointed spines and rounded projections (Fig. 12); 5) paraprocts with a blunt lateral process (Fig. 14). In the female imago: abdominal terga II–VII with a pair of yellowish marks along lateral margin.

**Material.** Holotype: male nymph (IBN): VENEZUELA, Bolívar Province, Roraima-tepui, stream in the tourist base camp below SW wall of Roraima-tepui, N 5° 08' 56.71" W 60° 46' 52.34", 1870 m a.s.l., 7.II. 2014, leg. T. Derka. Paratypes (IBN, MIZA, FNS): 8 females, 18 nymphs (2 dissected): same data as holotype, 16 nymphs, same locality and collector, 14.II. 2012; 2 females imagoes, 2 nymphs, same locality and collector, 10.II. 2015; 1 nymph, same locality and collector, 3.II. 1999; 1 nymph (dissected and preserved on slide), same locality, 3.II. 2007, leg. T. Derka & M. Svitok.

**Habitat.** The specimens were collected in a 2 m wide, cool hypocrenal-epirhithral stream with a temperature of 16 °C. The stream is completely shaded by a dense cloud forest. The stream bed is composed of stones, boulders, sand and debris accumulations in pools.

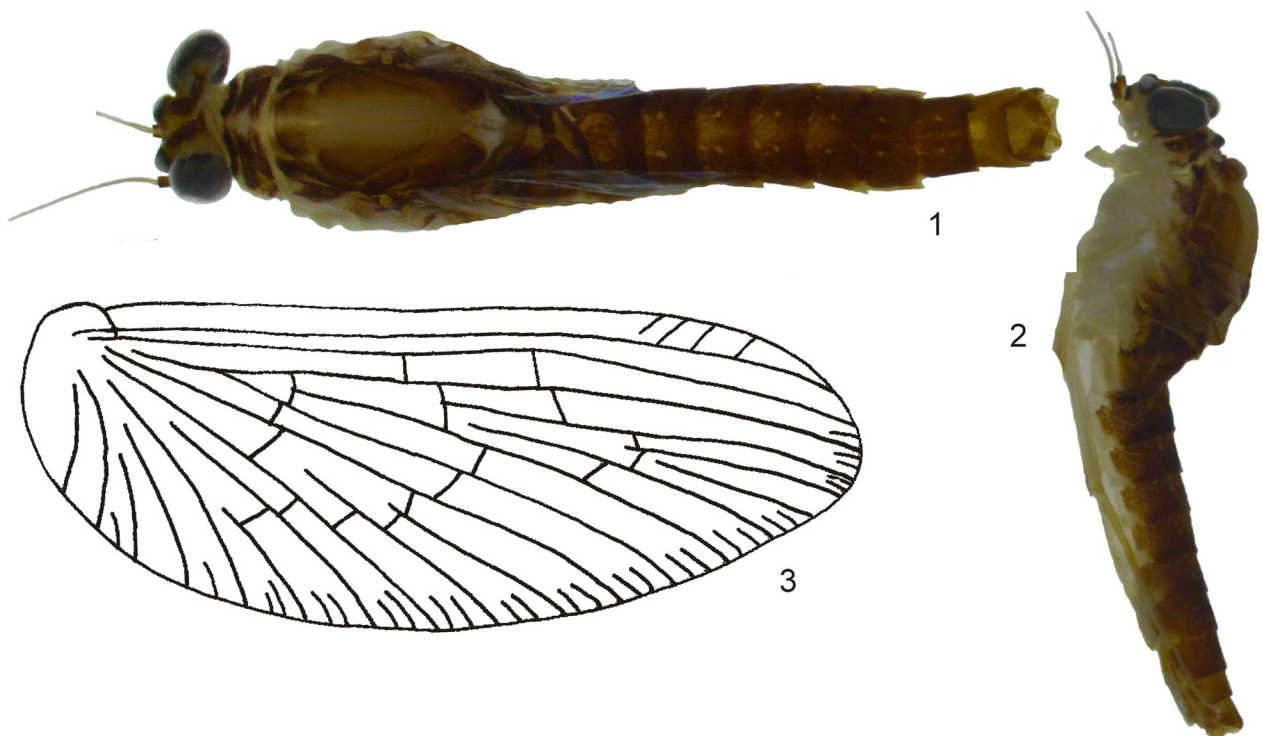
### Key to nymphs of *Parakari* (modified from Nieto & Derka, 2011)

- 1 Segment II of labial palpi with a broad distomedial projection (Fig. 24a, Nieto & Derka 2011) ..... *P. churiensis*
- Segment II of labial palpi with a thin distomedial projection (Fig. 9)..... 2

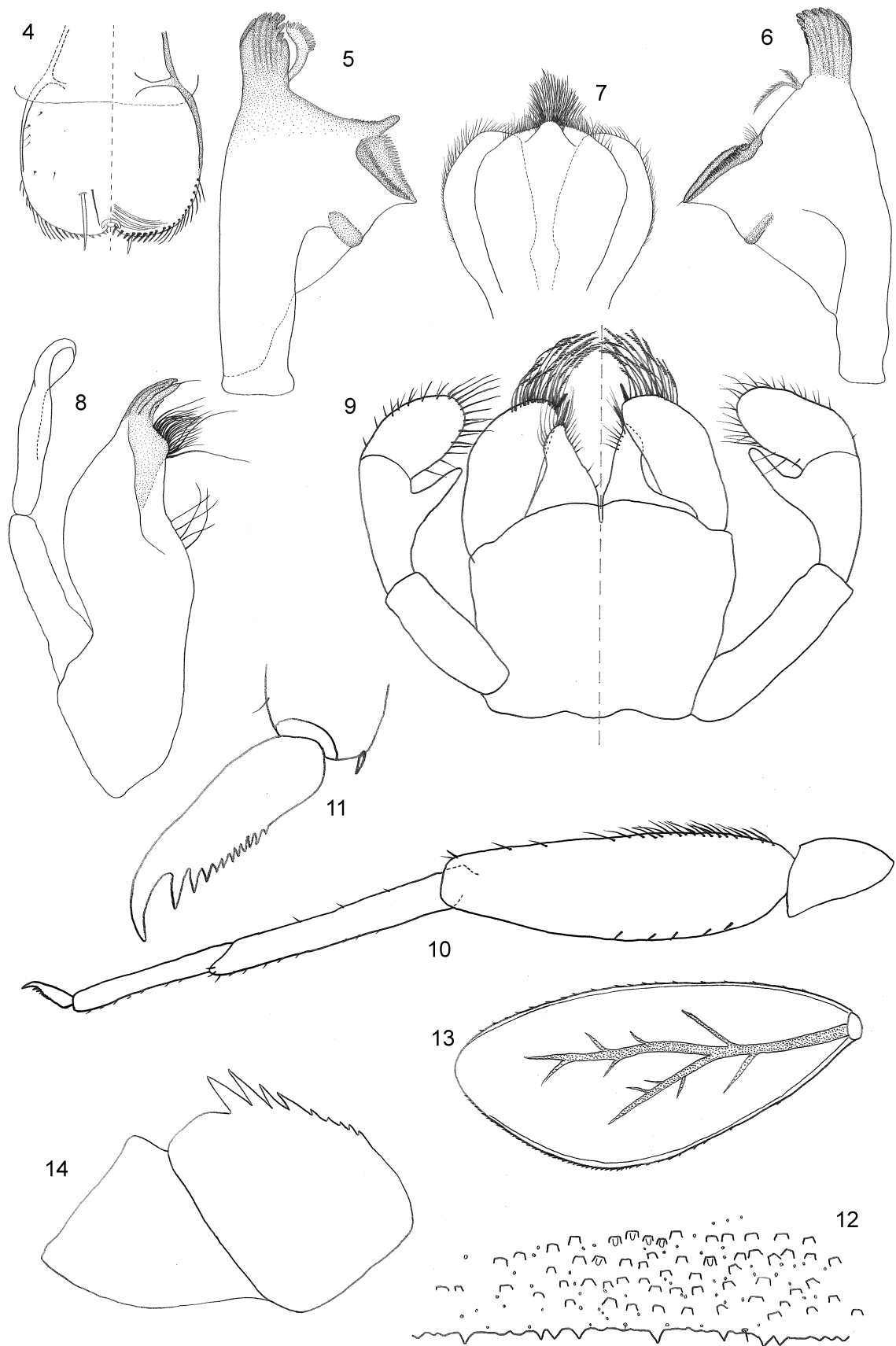
- 2 Labrum dorsally with two subapical setae near midline (Fig. 4, Nieto & Derka, 2011); posterior margin of abdominal tergum IV with pointed spines (Fig. 12, Nieto & Derka, 2011); right mandible with prosthema bifid apically (Fig. 6, Nieto & Derka 2011); mandibles with incisors short (Figs. 5–6, Nieto & Derka 2011) ..... *P. auyanensis*
- Labrum (Fig. 4) dorsally with four subapical setae near midline; posterior margin of abdominal tergum IV with rounded spines intercalated with pointed spines (Fig. 12); right mandible with prosthema bifid basally (Fig. 6); mandibles with incisors elongate (Figs. 5–6) ..... *P. roraimensis* **sp. n.**

## Discussion

A disjunct distribution found in the *Parakari* species which inhabit cold-water streams at isolated tepui summits and foothills (Nieto & Derka 2011) can be attributed to the tepuis' peculiar shape. Vertical escarpments reaching a height of 1,000 m make most of these mountains isolated horizontally from one another, but also vertically from surrounding tropical forests and savannas (Rull & Nogué 2007). Isolation, moreover, is not only geographical but also environmental since flat summits face harsher climatic (strong winds, extreme diurnal temperature oscillation, high rainfalls) and edaphic (highly acidic, oligotrophic soils) conditions than surrounding savannas and forests (Galán 1992, Aubrecht *et al.* 2012). The summits support different types of aquatic habitats with a specific hydrological and thermal regime. Spring streams of subterranean origin have constant temperatures around 14–16 °C and these low temperatures are also typical for upper reaches of Pantepui streams (Aubrecht *et al.* 2012). These streams form ecological islands of cold-water habitats which support cool adapted aquatic fauna, usually confined to a single tepui (Čiampor & Kodada 1999, Kodada & Jäch 1999, Derka 2002, Derka *et al.* 2009, 2010, 2012, Nieto & Derka 2011, Kodada *et al.* 2012) or less commonly to several tepuis (Nieto & Derka 2012, Zamora-Muñoz *et al.* 2013). No records of the genus are known from streams in the adjacent La Gran Sabana region (Nieto *et al.* 2011, Derka unpublished). *P. auyanensis* was found in streams at the plateau of Auyán-tepui as well as cold water streams at its foothills, while *P. churiensis* is known only from the Churí-tepui plateau. However, the streams at the Churí-tepui foothills were not sampled. *P. roraimensis* is known from Roraima-tepui foothills only, although streams at the Roraima-tepui plateau were sampled thoroughly. Harsh environmental conditions at the plateau of this high-elevation tepui (2700 m a.s.l.) are probably responsible for the absence of *P. roraimensis* and the generally low biodiversity of streams (Aubrecht *et al.* 2012). The presence of other *Parakari* species can be reasonably expected given the disjunct distribution of the genus.



**FIGURES 1–3.** *Parakari roraimensis* **sp. n.** Female imago. 1, dorsal view; 2, lateral view; 3, fore wing.



**FIGURES 4–14.** *Parakari roraimensis* sp. n. Nymph. Mouthparts (Figs. 4–9): 4, labrum, left d.v., right v.v.; 5, left mandible v.v.; 6, right mandible v.v.; 7, hypopharynx v.v.; 8, maxilla v.v.; 9, labium, left d.v., right v.v.; 10, fore leg I; 11, fore tarsal claw I; 12, posterior margin of tergum IV; 13, gill IV; 14, paraproct. (v.v: ventral view; d.v.: dorsal view).

## Acknowledgements

This study was supported by projects APVV-0213-10, APVV-14-0276 and PIP 0330. Financial support from the Argentine National Council of Scientific and Technological Research (CONICET) to which CN belongs, is acknowledged. We are grateful to Rebecca Best for reviewing an early version of the manuscript.

## References

- Aubrecht, R., Barrio-Amorós, C.L., Breure, A.S.H., Brewer-Carías, C., Derka, T., Fuentes-Ramos, O.A., Gregor, M., Kodada, J., Kováčik, L., Lánčzos, T., Lee, N.M., Liščák, P., Schlögl, J., Šmída, B. & Vlček, L. (2012) Venezuelan tepuis: Their caves and biota. *Acta Geologica Slovaca - Monograph*, Comenius University, Bratislava, 168 pp.
- Berry, P.E., Huber, O. & Holst, B.K. (1995) Floristic analysis and phytogeography. In: Berry, P.E., Holst, B.K. & Yatskievych, K. (Eds.), *Flora of the Venezuelan Guayana, I. Introduction*. Missouri Botanical Garden Press, St. Louis, pp. 161–191.
- Berry, P.E. & Riina, R. (2005) Insights into the diversity of the Pantepui flora and the biogeographic complexity of the Guayana Shield. *Biologiske Skrifter*, 55, 145–167.
- Čiampor, F. Jr. & Kodada, J. (1999) Description of two new species of the genus *Jolyelmis* from Mount Roraima, Venezuela (Coleoptera: Elmidae). *Entomological Problems*, 30 (2), 55–60.
- Derka, T. (2002) *Massartella devani*, a new mayfly species from Venezuela's Highlands (Ephemeroptera: Leptophlebiidae: Atalophlebiinae). *Aquatic Insects*, 24, 309–316.  
<http://dx.doi.org/10.1076/aqin.24.4.309.8241>
- Derka, T., Svitok, M. & Schlögl, J. (2009) *Massartella hirsuta* sp. nov. (Ephemeroptera: Leptophlebiidae: Atalophlebiinae) and new data on mayflies of Guayana Highlands. *Aquatic Insects*, 31 (Supplement 1), 83–94.  
<http://dx.doi.org/10.1080/01650420902811992>
- Derka, T., Tierno de Figueroa, J.M. & Gamboa, M. (2010) First records of Plecoptera from Pantepui biogeographical province, with the first record of genus *Kempnyia* for Venezuela (Insecta: Plecoptera). *Boletín de la Asociación Española de Entomología*, 33 (3–4), 493–502.
- Derka, T., Nieto, C. & Svitok, M. (2012) Mayflies (Ephemeroptera) of the Pantepui biogeographical province. *Boletín de la Asociación Española de Entomología*, 36 (1–2), 119–135.
- Galán, C. (1992) El Clima. In: Huber, O. (Ed.), *Chimantá. Escudo de Guayana, Venezuela. Un Ensayo Ecológico Tepuyano*. Oscar Todtman Editores, Caracas, pp. 37–52.
- Kodada, J. & Jäch, M.A. (1999) *Roraima carinata* gen. et sp. nov. and *Neblinagena doylei* sp. nov., two Larinae from Mount Roraima, Venezuela (Coleoptera: Elmidae). *Entomological Problems*, 30 (1), 13–29.
- Kodada, J., Derka, T. & Čiampor, F. Jr. (2012) Description of *Jolyelmis spangleri* a new species from Churí-tepui (Chimantá Massif, Venezuela), with a description of the larva of *J. spangleri* and *J. reitmaieri* (Insecta: Coleoptera: Elmidae). *Zootaxa*, 3223, 1–23.
- Mayr, E. & Phelps, W.H. (1967) The origin of the bird fauna of the south Venezuelan highlands. *Bulletin of the American Museum of Natural History*, 136, 273–327.
- McDiarmid, R.W. & Donnelly, M.A. (2005) The herpetofauna of the Guayana Highlands: amphibians and reptiles of the Lost World. In: Donnelly, M.A., Crother, B.I., Guyer, C., Wake, M.H. & White, M.E. (Eds.), *Ecology and Evolution in the Tropics: A Herpetological Perspective*. University of Chicago Press, Chicago, Illinois, pp. 461–560.
- Nieto, C. & Derka, T. (2011) *Parakari* a New Genus of the Family Baetidae (Insecta: Ephemeroptera) from Guyana Highlands. *Zootaxa*, 3032, 47–59.
- Nieto, C., Grillet, M.E., Domínguez, E., Molineri, C. & Guerrero, E. (2011) The family Baetidae (Insecta: Ephemeroptera) from Venezuelan Guayana's Uplands. *Zootaxa*, 2808, 1–17.
- Nieto, C. & Derka, T. (2012) A new species of the genus *Spiritiops* (Ephemeroptera, Baetidae) from the Pantepui biogeographical province. *Zootaxa*, 3256, 58–63.
- Rull, V. & Nogué, S. (2007) Potential migration routes and barriers for vascular plants of the Neotropical Guyana Highlands during the Quaternary. *Journal of Biogeography*, 34, 1–16.  
<http://dx.doi.org/10.1111/j.1365-2699.2006.01602.x>
- Zamora-Muñoz, C., Derka, T. & Cressa, C. (2013) *Notalina roraima* Holzenthal 1986 (Trichoptera: Leptoceridae), male genitalia variability and larval description. *Zootaxa*, 3702 (5), 450–458.  
<http://dx.doi.org/10.11646/zootaxa.3702.5.4>