Zootaxa 4543 (1): 090–098
https://www.mapress.com/j/zt/
Copyright © 2019 Magnolia Press

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

https://doi.org/10.11646/zootaxa.4543.1.5
http://zoobank.org/urn:lsid:zoobank.org:pub:92B59468-BDEE-43E7-83B0-24BC0DBE556D

Two new species of *Campsurus* Eaton (Ephemeroptera: Polymitarcyidae) from Colombia

CARLOS MOLINERI[1] & CRISTIAN E. GRANADOS-MARTINEZ[2]

[1]*Instituto de Biodiversidad Neotropical, CONICET (National Council of Scientific Research), Universidad Nacional de Tucumán, Argentina. E-mail: carlosmolineri@gmail.com*
[2]*Grupo de Investigación Ecología, Biodiversidad en Ecosistemas Tropicales (EBET) Universidad de La Guajira. E-mail: biolocristiam@gmail.com*

Abstract

Two new species of *Campsurus* from Colombia are herein described, based on adults of both sexes and eggs. *Campsurus vichada* **sp. nov.** from the albifilum group, is separated from the other species in this group by: abdominal terga shaded slightly darker posteriorly, with a pale median band and pale closed markings, and pedestals short and subquadrate, main lobes of penes very long and slender, among other characters. Its sister relation with *C. homaulus* and *C. gracilipenis* is hypothesized through a cladistic analysis. A key is presented for the six species in the albifilum group of *Campsurus*.

Campsurus cristales **sp. nov.** from the segnis group, closely related to *C. janae*, is diagnosed by: posterior margin of male abdominal sternum IX tri–lobed, pedestal strongly elongated and penes with a strongly expanded dorsal area, among other features.

Key words: *Campsurus albifilum* group, *C. janae*, *C. gracilipenis*, C. *homaulus*, phylogenetic tree, key, Neotropics, South America

Introduction

Campsurus Eaton is the most species–rich group in Polymitarcyidae (Ephemeroptera), 36 South American and 3 North & Central American species have been described (Molineri et al. 2015, Molineri & Salles 2017).

Diagnostic characters of the genus are mainly from the adult stage that has the legs reduced to a small flap attached to the body, with the exception of male fore legs used to grasp the female during copula (Domínguez et al., 2006). Phylogenetic hypotheses have been published for some species groups of the genus (Molineri & Salles 2013), but a global phylogeny for the entire genus is lacking.

We here describe two new species collected in Colombia, both from male and female adults and eggs. One of the species is from the albifilum group, and as a phylogenetic matrix was published recently (Salles & Molineri 2013) we scored the characters of the new species and discuss here its relationships. The other species falls into the more heterogeneous segnis group (Molineri et al. 2015), without a proposed phylogeny yet. Finally, we include or modify published keys to male imagos to include the new species.

Material and methods

Material was fixed and preserved in 96% ethanol. Body parts of some specimens were mounted on slides using Canada Balsam; wings were mounted dry. Male genitalia and female sternum VIII were treated with KOH for 10–15 minutes at 80 ºC, and these structures together with some eggs were mounted in slides as mentioned above. Male and female adults were associated because of shared color pattern, size range, and shape of mesoscutal protuberances. The interpretation of male genitalia sclerites follows Kluge (2004): the styliger plate is reduced and expressed only as the pedestals; the large plate where pedestals are attached is sternum IX. Penes have a complex

 Accepted by F. Salles: 14 Nov. 2018; published: 4 Jan. 2019

penean arm (internal structures), generally with a double articulation (Kluge 2004). Terminology is from Kluge (2004) and Molineri & Salles (2013). Habitus images of preserved specimens were taken using a Zeiss STEMI 2000–C stereomicroscope with an ERC5 digital camera. Study material is deposited in MUSENUV (Museo de la Universidad del Valle, Cali, Colombia); CEBUC (Colección Entomológica del Programa de Biología de la Universidad de Caldas, Caldas, Colombia), and IBN (Instituto de Biodiversidad Neotropical, Tucumán, Argentina).

Phylogenetic study. We added *Campsurus vichada* **sp. nov.** to the matrix published in Molineri & Salles (2013), to study its phylogenetic position in the albifilum group. We corrected the order of the states of character number 10 (Hind margin of male sternum IX) that were erroneously written in the published phylogeny (Molineri & Salles 2013), to: state 0= medially acute, state 1= without a median projection. Other characters and states are identical to original matrix, and can be seen in Appendix 1. Searches were conducted in TNT (Goloboff et al. 2008) under implied weights (with k=3).

Results

***Campsurus vichada* sp. nov.**
(Figs. 1A–C, Figs. 3A–D)
http://zoobank.org/NomenclaturalActs/C6E4D995-4CC1-4B77-91FC-725E7BE84B0F

Diagnosis. *Campsurus vichada* **sp. nov.**, here described from male and female imagos, can be separated from other species of the genus by the characters listed for the albifilum species group (Molineri & Salles 2013) and from the species of this group, by: 1) FW 10.0–11.0 mm (male), 13.5–16.0 (female); 2) dorsum of head shaded black widely, some specimens with Y–shaped pale area between ocelli and extending through occiput (Figs. 3A–B); 3) abdominal terga shaded slightly darker posteriorly, with a pale median band and other markings as in Figs. 3A–B ; 4) pedestals relatively short, subquadrate, main lobes of penes very long and slender, secondary lobe reduced and relatively short (Figs. 3E–D).

Type material. Holotype ♂ imago from COLOMBIA, Vichada, rio Tomo, N 5º 34' 38" / W 68º 29' 35"), 119 m, 04.iv.2017, light trap 18–20 hs, C Granados col. (MUSENUV). Paratypes: 52 ♂ (slides IBN800CM, IBN801CM) and 16 ♀ (slide IBN802CM), same data as holotype (10 ♂ and 4 ♀ in MUSENUV, 10 ♂ and 4♀ in CEBUC, 32 ♂ and 8 ♀ in IBN).

Male imago. Length (mm): body, 10.5–11.0; FW, 10.0–11.0; HW, 4.5–4.7; forelegs, 4.9–5.1; cerci, 27.5–28.5. General coloration yellowish white, shaded with grey dorsally. Head (Fig. 3A) shaded dorsally with grey, some males with lighter coloration on medial line and around median ocellus; vertex with grey shading; some specimens with Y–shaped pale area between ocelli and extending through occiput. Antennae whitish shaded with grey, stronger at margins of scape and pedicel. Thorax (Fig. 3A): pronotum hyaline translucent shaded very slightly with grey on anteromedian zone; mesonotum shaded gray on carinae and on posterior scutal protuberances (PSP); metanotum yellowish, shaded slightly with grey medially. Forelegs whitish shaded completely with purplish grey, lighter on tarsi; legs II–III yellowish translucent with apical black dash (Fig. 3D). Wings: veins whitish translucent, shaded with purplish grey at the base of longitudinal veins, shading more extensive on veins (and membrane around them) Sc and R1. Abdomen (Fig. 3A): terga shaded with grey along a median band; tergum I lightest, IX darkest; tergum I with a median mark (not broken by a pale area medially; terga II–VI shaded with gray except on medial pale band and pale subcircular mark at each side of medial band (Fig. 3A); terga VII–VIII similar but more widely pigmented with gray, and with two pairs of pale circular marks; tergum IX widely pigmented, darker medially, a pair of pale circular marks on anteromedian margin. Abdominal sterna pale not shaded. Genitalia (Figs. 1A, 3E–D): yellowish white; pedestals relatively short, with outer corner indented so apical half is directed slightly towards the outer side; main lobes of penes very long and slender, secondary lobe relatively short. Cerci whitish translucent.

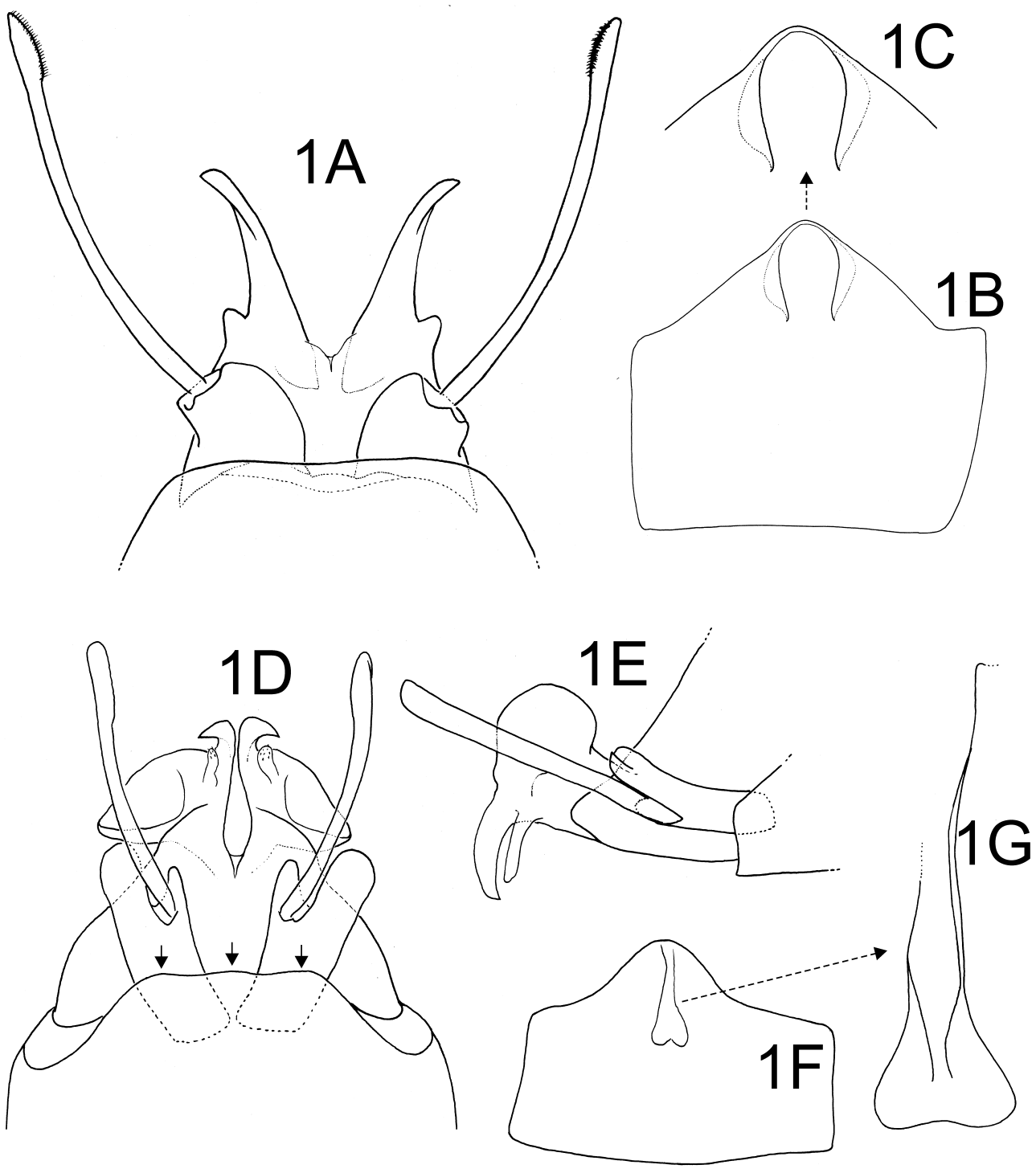
Female imago. Length (mm): body, 13.2–19.3; FW, 13.5– 16.0; HW, 6.1–7.7; forelegs broken; cerci, 5.5–6.0. General coloration yellowish (Fig. 3B). Head with dorsal grey shading except on median zone of vertex (Fig. 3B). Thorax: pronotum shaded grey widely, except some pale areas as in Fig. 3B. Mesonotum as male. Foreleg broken off in all specimens, similar to middle and hind legs in shape. Middle and hind legs with apical black dash as in

male (Fig. 3C). Abdomen similar to male except broader pale medial band on terga II–VII (Fig. 3B). Sternum VIII with a pair of relatively large anteromedian sockets (Fig. 1B–C), sockets partially fused forming a single structure. Caudal filaments whitish translucent.

Eggs. Length, 245–275 µm; width, 200–210 µm. Hemispheric, yellowish, with one whitish polar cap formed by a compound thread (ca. 5.0 mm long) formed by numerous thin filaments tightly braided.

Etymology. Vichada, from the type locality.

Distribution (Fig. 5). Colombia (Vichada).



FIGURES 1A–G. *Campsurus vichada* **sp. nov.**: A, male genitalia, v.v.; B, female sternum VIII, C, same, detail of sockets. *Campsurus cristales* **sp. nov.**: D, male genitalia, v.v.; E, same, l.v.; F, female sternum VIII, G, same, detail of sockets.

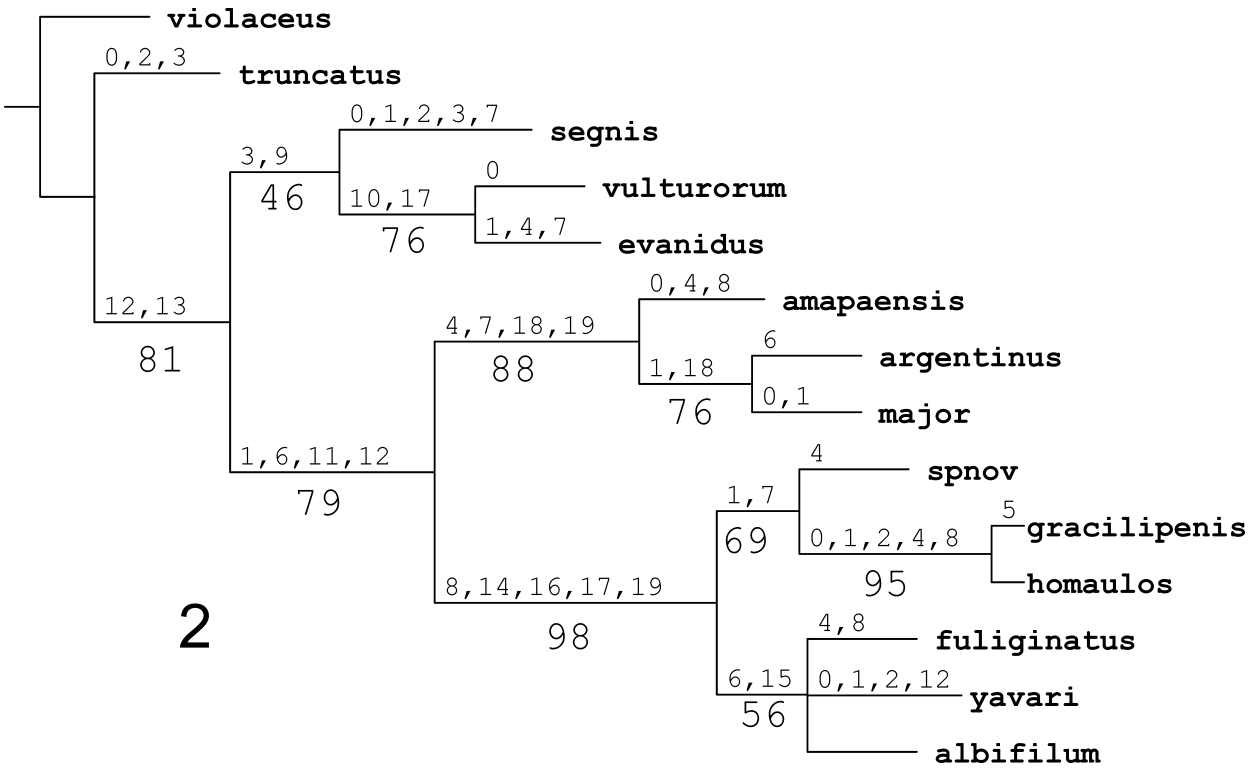


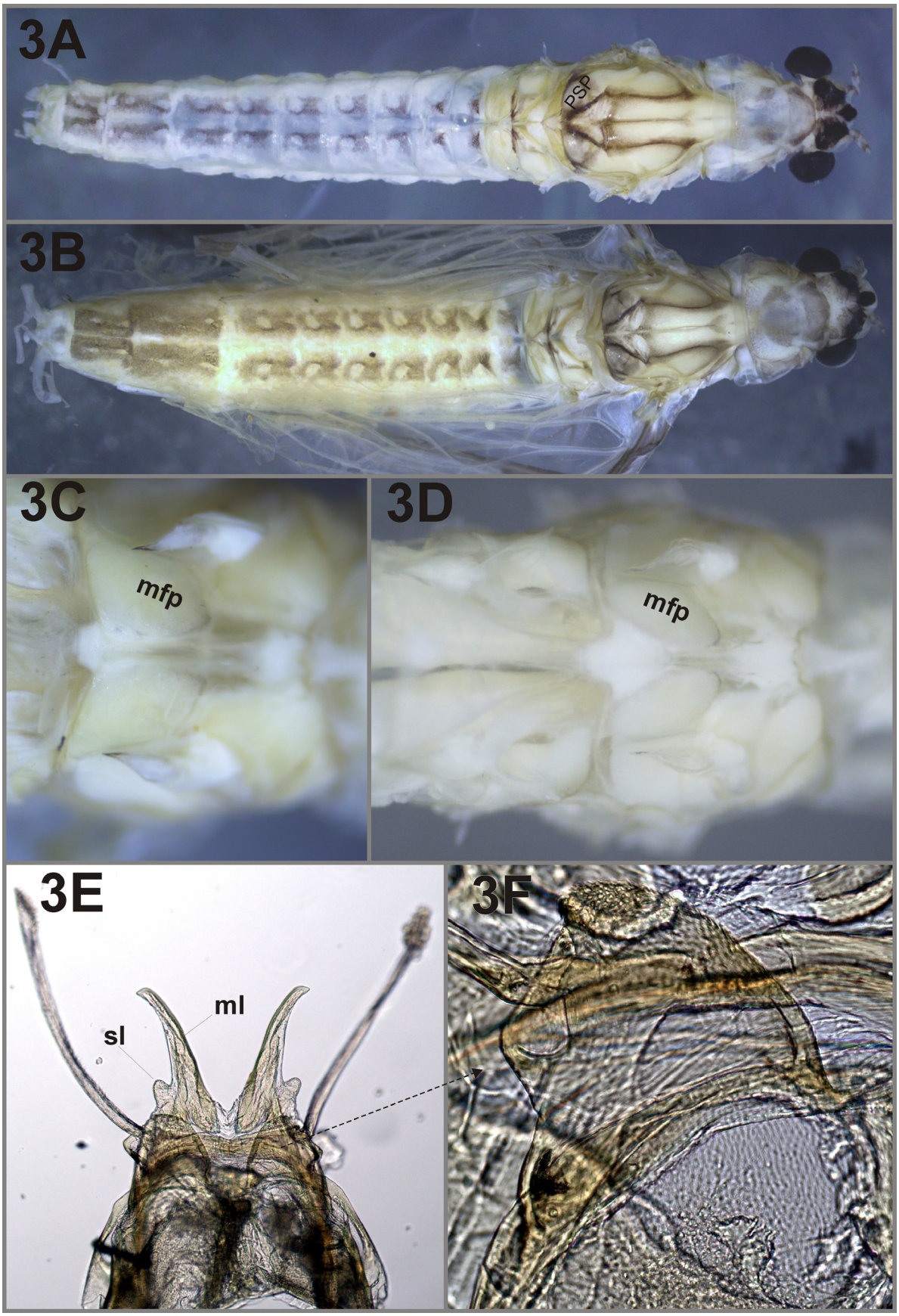
FIGURE 2. Shortest parsimony tree obtained with matrix on Appendix 1, using implied weights. Numbers above nodes indicate character numbers that have changed in this clade or terminal (i.e., apomorphies). Larger numbers below nodes indicate group support (GC differences from 300 replicates of jackknifing).

Discussion. *Campsurus vichada* **sp. nov.** shows characters in common with the two clades in the albifilum group found by Molineri & Salles (2013). The large size of the body and the slightly curved pedestals are shared with *C. albifilum* and *C. fuliginatus*, but the extremely long penes are more similar to *C. gracilipenis* and *C. homaulos*.

We added the new species to the matrix used in Molineri & Salles (2013), and the searches resulted in the same topology shown by these authors, with the new species resulting sister to the pair *C. homaulus* + *C. gracilipenis* (Fig. 2), with good support. The three species share two synapomorphies: 1) a change in continuous character number 1 – Pedestal length/width ratio (from 1.12–1.40 to 1.05), thus the general shape of the pedestal change from subrectangular (plesiomorphy) to subquadrate; and 2) a change in color pattern of abdominal terga (character 7, discrete) from the state 0 (with][–shaped marks) to state 1 (marks closed, forming rectangle or circle).

The key published in Molineri & Salles (2013) should be modified as follows to include the new species here described. Please note that couplet 5 was also modified to include new data regarding *C. gracilipenis* and *C. homaulus*:

1. Abdominal color pattern pale on terga I–III and very dark on terga IV–IX; secondary lobe of penes short, knoblike (see other characters in Molineri & Salles 2006). . . . . *C. fuliginatus*
- Abdominal color pattern uniform on terga except darker on posterior terga IX or VIII–IX; secondary lobe of penes distinct (Figs. 1A, 3E–D); FW length variable; pedestals variable 2
2. Pedestal subrectangular, length/width ratio = 1.12–1.40; abdominal terga with submedian][–shaped gray mark. 3
- Pedestal subquadrate (Figs. 1A, 3D), length/width ratio = 1.05 or less; abdominal terga more widely pigmented with gray, except small rectangular to ovate pale mark at each side (Fig. 3A).. 4
3. Pedestals very long (length/width ratio > 2.1) and with the apical inner margin strongly projected posteriorly. . . . . *C. yavari*
- Pedestals shorter (length/width ratio > 1.7), inner apical margin broad, not so strongly projected . . . . . *C. albifilum*
4. Body and wings large to medium–sized (FW length >9.5 mm); secondary lobe of penes reduced, short (Figs. 1A, 3D–E) . . . . . *Campsurus vichada* **sp. nov.**
- Body and wings medium to small in size (FW length <9.0 mm); secondary lobe of penes relatively long. 5
5. Penes long and slender (length/width mostly > 0.85); basal inner membrane of penes very short in relation to total length of penean lobe (ratio <0.28) . . . . . *C. gracilipenis*
- Penes shorter (length/width mostly < 0.80); basal inner membrane of penes not so short in relation to total length of penean lobe (ratio >0.32). . . . . *C. homaulos*



FIGURES 3A–D. *Campsurus vichada* **sp. nov.**: A, male imago, dorsal view (PSP= Postero Scutal Protuberances); B, female imago, d.v.; C, female mesosternum; D, male mesosternum (*mfp*= mesofurcasternal plates); E, male genitalia, v.v. (*ml*= main lobe; *sl*= secondary lobe); D, detail of pedestal.

***Campsurus cristales* sp. nov.**
(Figs. 1D–G, 4A–E)
http://zoobank.org/NomenclaturalActs/418316B8-092E-4C03-960C-DF24C22F8EC2

Diagnosis. *Campsurus cristales* **sp. nov.** is described from male and female adults. It can be distinguished from other species of *Campsurus* by: 1) small to medium size (length of male FW 7.0–8.0 mm, female FW 10.7 mm); 2) posterior margin of male abdominal sternum IX tri–lobed (Figs. 1D); 3) pedestal almost touching each other medially at base, strongly elongated, parastylus broadly rounded apically, relatively wide and somewhat projected distally (Fig. 1D, 4D), inner corner rounded and slightly projected (Fig. 1D–4D); 4) penes with a strongly expanded dorsal area (*ea* in Fig. 4E), main lobe sclerotized, long and relatively acute apically, secondary membranous lobe shorter, rounded apically and cylindrical (Figs. 1D–E, 4D–E).

Type material. Holotype ♂ imago from COLOMBIA, Meta, La Macarena, Pailones, Caño Cristales, N 2º 16' 4" / W 73º 46' 59", 257 m, 26.x.2016, light trap 18–20 hs, C Granados col. (MUSENUV). Paratypes: 16 ♂ imagos (1 on slide IBN803CM) and 1 ♀ imago (slide IBN804CM), same data as holotype (8 ♂ and 1♀ in IBN, 4♂ in MUSENUV, 4♂ in CEBUC).

Male imago. Length (mm): body, 7.2–7.7; fore wing, 7.0–8.0; hind wing, 3.5–4.0; fore leg, 3.5–4.2; cerci, 20.0–21.0. General coloration yellowish white, widely shaded with gray (Fig. 4A). Head completely shaded with black dorsally, and on antenna (except for hyaline flagellum), ventrally with gray marks along carinae. Thorax (Fig. 4A, 4C). Pronotum translucent, extensively shaded with black, darker on anterior portion, medial line, and margins; prosternum yellowish white. Mesonotum yellowish, shaded with gray medially on parapsidal sutures, and on a triangle between PSP; pleura and sterna yellowish white, shaded with slightly gray. Metanotum yellowish white, shaded with gray medially. Meso furcasternal plates as in Fig. 4C. Legs. Fore leg completely shaded with gray; middle and hind legs yellowish translucent, shaded completely with gray. Wings. Membrane hyaline, except C and Sc areas shaded with brownish gray, veins hyaline, except C, Sc, and R_1 brownish on basal 2/3. Hind wing hyaline, except base of veins yellowish. Abdomen (Fig. 4A) whitish translucent, extensively shaded with gray on terga, except on small paler dots. Abdominal sterna translucent white, shaded with gray on medial line of sterna VII–IX. Genitalia (Figs. 1D–E, 4D–E)): yellowish white; sternum IX with three slightly marked lobes on hind margin (arrows in Figs. 1D), medial line and hind margin black; pedestal of each side touching basally, with apically rounded parastylus (*mo* in Fig. 4D), round inner corner small, slightly projected (*mi* in Fig. 4D); forceps short and translucent, shaded with gray basally; base of main lobe of penes sclerotized, very expanded dorsally (*ea* in Figs. 4D–E), apical portion narrowing abruptly and finger like, main lobe sclerotized and acute apically, secondary lobe membranous and rounded apically, slender and cylindrical. Caudal filament hyaline translucent.

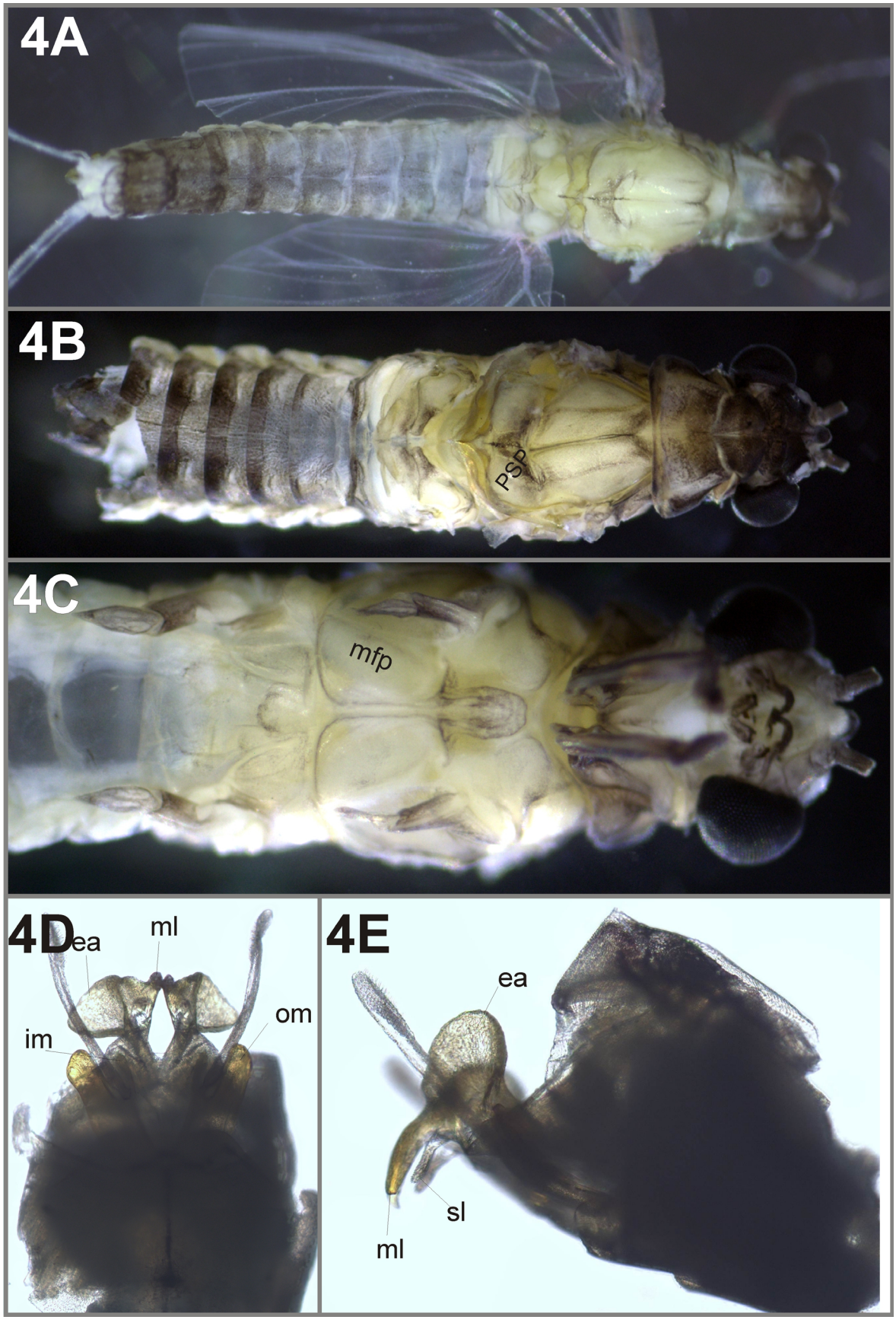
Female adult. Length (mm): body, 8.0; fore wing, 10.7; hind wing, 4.5; fore leg, 1.2; cerci broken. Similar to male imago, except pigmentation more heavily marked (Fig. 4B). Thorax. Pronotum shaded with gray, except pale transverse line between anterior and posterior portions; thin black medial line surrounded by a pale area along anterior portion of pronotum. Mesonotum (Fig. 4B) additionally shaded gray on anterior triangular mark (after mesonotal protuberance). Legs shaded completely with gray. Wing membranes yellowish translucent. Abdomen shaded extensively with black on dorsum (Fig. 4B); sternum VIII with small anteromedian subovate socket (Figs. 1F–G). Caudal filaments translucent whitish.

Egg. Length, 275–300 µm; width, 225–250 µm. Oval, cup–shaped, yellowish with whitish polar cap.

Etymology. The name alludes to the type locality (Caño Cristales).

Distribution (Fig. 5). Colombia (Meta).

Discussion. *Campsurus cristales* **sp. nov.** is very similar to *C. janae* Molineri & Salles, and will key to that species in Molineri & Salles (2017). Nevertheless, the pedestals are broader and parastylus more projected distally in the new species. Also, the penes are even more expanded in a dorsal ovate flat structure (ea in Figs. 4D–E), which is more circular in *C. janae*. Additionally, the main lobe of penes in the new species is longer and apically acute (it is shorter and rounded in *C. janae*). Finally, the tri–lobed hind margin of the sternum IX is unique for the new species.



FIGURES 4A–E. *Campsurus cristales* **sp. nov.**: A, male imago, d.v.; B, female imago, d.v. (PSP= Postero Scutal Protuberances); C, male imago, v.v. (*mfp*= mesofurcasternal plates); D, male genitalia, v.v.; E, same, l.v. (*ea* ear–like projection; *im*= inner projected margin of pedestal; *ml*= main lobe; *om*= outer projected margin of pedestal; *sl*= secondary lobe.

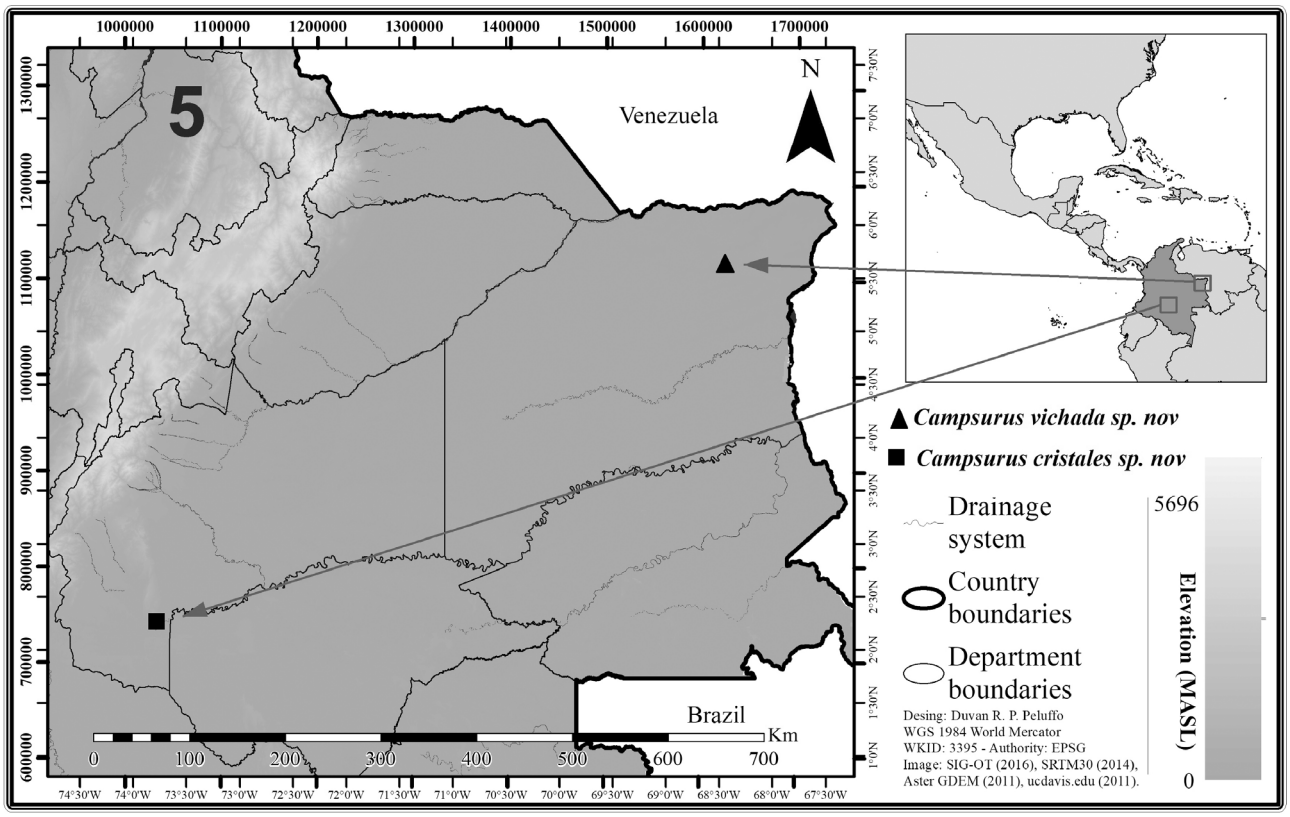


FIGURE 5. Map indicating the distributional records of the new species.

Acknowledgements

The Willi Hennig Society made TNT software freely available. CM thanks CONICET for financial support (PIP845, P–UE099). We also thank to the Macarena-Cormacarena Special Management Area Sustainable Development Corporation and the Alexander von Humboldt-IAvH Biological Resources Research Institute that carried-out studies on the fauna from Caño Cristales. We are very grateful to the *Expedición Colombia Bio - Vichada, Río Tomo and Caño Terecay* for helping with field work. Comments from Inês Gonçalves, Frederico Salles and an anonymous reviewer are greatly acknowledged.

References

Domínguez, E., Molineri, C., Pescador, M., Hubbard, M.D. & Nieto, C. (2006) *Ephemeroptera of South America. Aquatic Biodiversity in Latin America. (ABLA Series. Vol. 2*. Pensoft, Sofia-Moscow, 646 pp.

Goloboff, P.A., Farris, J.S. & Nixon, K. (2008) TNT, a free program for phylogenetic analysis. *Cladistics*, 24, 774–786. https://doi.org/10.1111/j.1096-0031.2008.00217.x

Kluge, N.J. (2004) *The phylogenetic system of Ephemeroptera*. Kluwer Academic Publishers, Dordrecht, 442 pp. https://doi.org/10.1007/978-94-007-0872-3

Molineri, C. & Salles, F.F. (2013) Phylogeny and biogeography of the ephemeral *Campsurus* (Ephemeroptera, Polymitarcyidae). *Systematic Entomology*, 38 (2), 265–267. https://doi.org/10.1111/j.1365-3113.2012.00656.x

Molineri, C. & Salles, F.F. (2017) Review of selected species of *Campsurus* Eaton 1868 (Ephemeroptera: Polymitarcyidae), with description of eleven new species and a key to male imagos of the genus. *Zootaxa*, 4300 (3), 301–354. https://doi.org/10.11646/zootaxa.4300.3.1

Molineri, C., Salles, F.F. & Emmerich, D. (2015) Revision of *Campsurus violaceus* species group (Ephemeroptera: Polymitarcyidae) with new synonymies and nomina dubia in *Campsurus* Eaton, 1868. *Zootaxa*, 3920 (1), 51–68. https://doi.org/10.11646/zootaxa.3920.1.3

APPENDIX 1. Matrix modified from Molineri & Salles (2013)

```
nstates cont ;
xread
'Campsurus albifilum–major'
20 14
&[continuous]
violaceus 10.300–12.000 3.000 0.384 0.895 ? ? 0.165–0.176
truncatus 12.250–12.490 1.930–2.057 0.594 0.667 ? ? 0.162–0.175
segnis 7.000 3.100 0.563 0.963 0.746 ? 0.163–0.165
evanidus 10.000–12.500 1.124–1.199 0.438 0.930 0.572 ? 0.150–0.155
vulturorum 15.900–20.500 1.462–1.484 0.490–0.499 0.957 0.711–0.736 ? 0.153–0.158
major 12.000–14.200 0.491–0.553 ? ? 0.853 ? 0.150–0.153
argentinus 9.500–10.300 0.792 ? ? 0.840 ? 0.140–0.145
amapaensis 9.000–9.800 1.120–1.367 0.329 0.765–0.824 0.857–0.872 ? 0.150–0.158
albifilum 10.200–14.000 0.840–1.667 0.342–0.625 0.570–0.836 0.685–0.874 0.402–0.605 0.120–0.150
yavari 9.200–9.500 2.102–2.115 0.715–0.764 0.685–0.691 0.736–0.753 0.429–0.458 0.135–0.142
fuliginatus 10.100–13.500 1.000–1.400 0.453–0.670 0.566–0.862 0.543–0.702 0.366–0.605 0.130–0.143
homaulos 6.200–9.000 0.645–0.830 0.312–0.379 0.766–0.828 0.760–0.840 0.320–0.360 0.145–0.160
gracilipenis 7.200–8.900 0.591–0.750 0.255–0.321 0.804–0.952 0.750–0.805 0.250–0.282 0.154–0.160
vichada 10.000–11.000 1.050–1.053 0.392–0.420 0.824–0.880 0.341–0.405 0.310–0.330 0.135–0.145
&[numeric]
violaceus 0000000000001
truncatus 0000000000001
segnis 3010011000001
evanidus 40110110?0101
vulturorum 00110110?0101
major 2000121000020
argentinus 2000121000020
amapaensis 2300121000010
albifilum 0100121111102
yavari 0100131111102
fuliginatus 0300121111102
homaulos 1200121101102
gracilipenis 1200121101102
vichada 1100121101102
;
cc - 7.11 13.17;
cc + 0.6 12 18.19;
;
cn {7 Abdominal_terga,_color_pattern with_][_marks_on_2_or_3-7 these_marks_are_closed,_forming_rectangle_or_circle
widely_pigmented,_only_with_pale_transv_dash_at_each_side widely_pigmented median_bells;
{8 Abdominal_terga,_color_pattern,_pale_median_band absent
Wide_pale_median_band_extending_from_2_to_7,_then_narrow
Wide_pale_median_band_extending_from_2_to_6,_then_narrow
Wide_pale_median_band_extending_from_2_to_3,_then_narrow;
{9 Female_sternum_8,_sockets single double;
{10 Hind_margin_of_male_sternum_9 medially_acute without_a_median_projection;
{11 Pedestal,_shape cylindrical_or_other flat;
{12 Pedestals,_inner_apical_margin tongue-like not projected broadly_convex,_slightly_projected same_but_strongly
projected;
{13 Penes,_structure single_lobe large_and_smaller_lobes;
{14 Penes,_curvature ventrally_curved not_curved,_in_the_same_plane_as_forceps;
{15 Penean_arm,_articulation_with_pedestals slightly_differentiated strongly_projected_ventrally;
{16 Penes,_piramidal_base,_outer_margin differentiated,_marked_lateral_indentation,_sometimes_protruding
not_marked,_outter_margin_continue_throug_apex of_penean_lobes;
{17 Penes,_gonopore large_and_openning_medially indistinct;
{18 Penes,_large_lobe not_twisted moderately_twisted strongly_twisted;
{19 Penes,_shape_of_larger_lobe hammer-shaped finger-like subtriangular,_straight_inner_margin, thinner apically;
;
proc /;
```