Zootaxa 4162 (2): 373–380
http://www.mapress.com/j/zt/

Article

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

http://doi.org/10.11646/zootaxa.4162.2.11
http://zoobank.org/urn:lsid:zoobank.org:pub:B822F49F-3934-426C-8763-673C2E83D365

Uncovering the diversity of the neotropical genus *Elaphopsocus* ('Psocoptera': Psocidae: Amphigerontiinae): from one to ten species

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Abstract

For 75 years, the genus *Elaphopsocus* was considered a monotypic lineage of neotropical psocids. As a result of recent work in South America, this genus presently includes seven species from Brazil and Colombia. We here describe three new species from the East Colombian high Andes.

Key words: taxonomy, Psocodea, 'Psocoptera', Neotropics

Introduction

The neotropical region is proving to house a remarkable variety of undescribed species of Psocidae (González Obando *et al*. 2011; Román-P. *et al.* 2014; Román-P. *et al.* 2015). Recent explorations carried out mainly in Colombia, Brazil and Mexico have helped to understand and uncover many aspects of the family taxonomy (Lienhard & Smithers 2002), systematics and biogeography (Yoshizawa *et al*. 2008; Román-P. *et al.* 2016), but still many species remain unknown to science.

Among the many lineages distributed in the neotropics, the genus *Elaphopsocus* is particularly interesting because of the recent increase in the known species (Román-P. *et al.* 2015). *Elaphopsocus* was described 75 years ago (Roesler 1940), based on a single species from Brazil. Six new species were recently described, opening the possibility of a higher uncovered diversity in the region (Román-P. *et al.* 2015). Recent explorations in the east of the Colombian high Andes have discovered three additional undescribed species. The purpose of this paper is to describe and illustrate them, and assign them to the species groups recognized in the genus.

Material and methods

The four available specimens of *Elaphopsocus* were dissected in 75% ethanol. The head, terminalia, and right wings and legs were mounted on slides in Canada balsam. Measurements (in microns) were taken using an ocular micrometer mounted on a Nikon Eclipse *Ci-L* microscope. Color was recorded by placing whole specimens, before dissection, under a microscope illuminated with cold white light at 40X. The illustrations were made from photographs taken with a Canon EosT5i and processed in Helicon Focus program.

Abbreviations for lengths of parts measured are as follows: right forewing (FW), right hindwing (HW), femur of right hind leg (F); fourth segment of right maxillary palpus (Mx4), flagellomeres 1...n of right antenna (f1...fn), minimum distance between compound eyes in dorsal view of head (IO), antero-posterior diameter and transverse diameter (D and d, respectively), of right compound eye; PO: d/D.

Accepted by L. Mound: 21 Jul. 2016; published: 9 Sept. 2016

Results

Román-P. *et al.* (2015) established three species groups for the species of *Elaphopsocus*; the species described below are best assigned to Group III, that requires to be modified as follows: Hypandrium slightly concave posteriorly or decidedly convex, with postero-lateral corners slightly projected posteriorly, or clearly projected to form slender, acuminate extensions. Phallosome with side struts separate proximally, aedeagal arms stout, of mid length, or slender, elongate.

Elaphopsocus boyacaensis n. sp. Male

(Figs 1–6)

Diagnosis. Belonging in Species Group III (Román-P. *et al.* (2015), as modified above. Hypandrium wide, posteriorly concave, with a heavily sclerotized plate on each side. Phallosome with side struts slender, pointed anteriorly; aedeagal arms stout, club shaped; external parameres slender, bow shaped. Differing from *E. roesleri* in the pattern of the forewing pigmentation, in having the posterior border of the hypandrium concave, with postero-lateral corners slightly projected, and in the clearly different phallosomes (compare Fig. 6 with Fig. 45 in Román-P. *et al.* (2015).

Color (in 80% ethanol). Body light brown. Compound eyes black, ocelli hyaline, with ochre centripetal crescents. Dark brown banding pattern next to compound eyes. Frontal, fronto-genal, and fronto-clypeal sulci dark brown, postclypeus with brown bands as illustrated (Fig. 1). Genae creamy. Coxae, trochanters, femora and tarsi brown, tibiae white. Forewing pattern (Fig. 3), with dark brown spots on proximal half, basal to the discal cell. Light brown bands over a hyaline background distally. Pterostigma with small brown spots. Veins brown (Fig. 3). Hindwings (Fig. 4), almost hyaline, with cell cup light brown. Abdomen uniformly light brown; hypandrium more strongly pigmented distally.

Morphology. As in diagnosis, plus the following: vertex slightly concave, with compound eyes not reaching the level of the vertex (Fig. 1). Pterostigma acute distally, slightly extended posteriorly towards Rs-M. Cell m wide, almost rectangular, crossvein between areola postica and M long (Fig. 3). Hypandrium broad, with sclerotized plate at each side (Fig. 5), phallosome elongate, with side struts widely separated anteriorly (Fig. 6). Paraprocts elongate, marginally sclerotized, with an elongate anterior "handle", and a posterior stout prong (Fig. 2), sensory fields with 34 trichobothria in penta-lobed basal rosettes. Epiproct broadly semicircular, slightly convex anteriorly, marginally sclerotized, with a distal setal field (Fig. 2). Clunium densely covered with small papillae, more evident on margins.

Measurements (in microns). FW: 4045, HW: 3862, Mx4: 215, f1: 662, f2: 471, f3: 421, IO: 520, D: 235, d: 164, IO/d: 3.17, PO: 0.69.

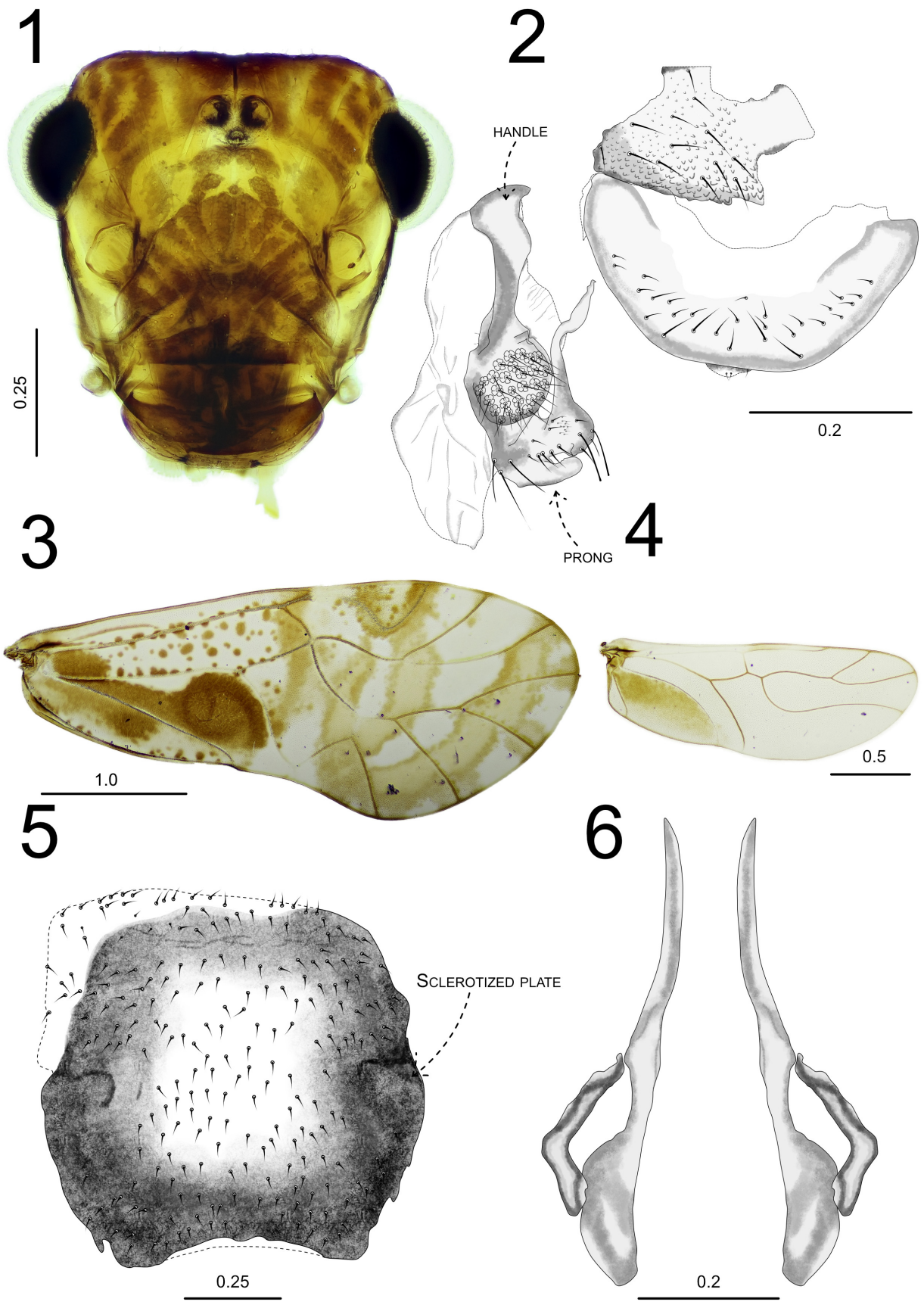
Specimen studied. Holotype male. COLOMBIA. Boyacá. SFF Iguaque, Lagunillas, 05° 25" N: 73° 27' W, 3380 m. Alexander von Humboldt Institute Collection, slide code ME3-1738, Malaise trap. Paratype male. COLOMBIA. Boyacá. SFF Iguaque, Cabaña mamarramos, 05° 25" N: 73° 27' W, 2855 m. 7–21.i.2001, Malaise trap. P. Reina.

Etymology. The specific name refers to the Colombian Department of Boyacá, from where this species is so far endemic.

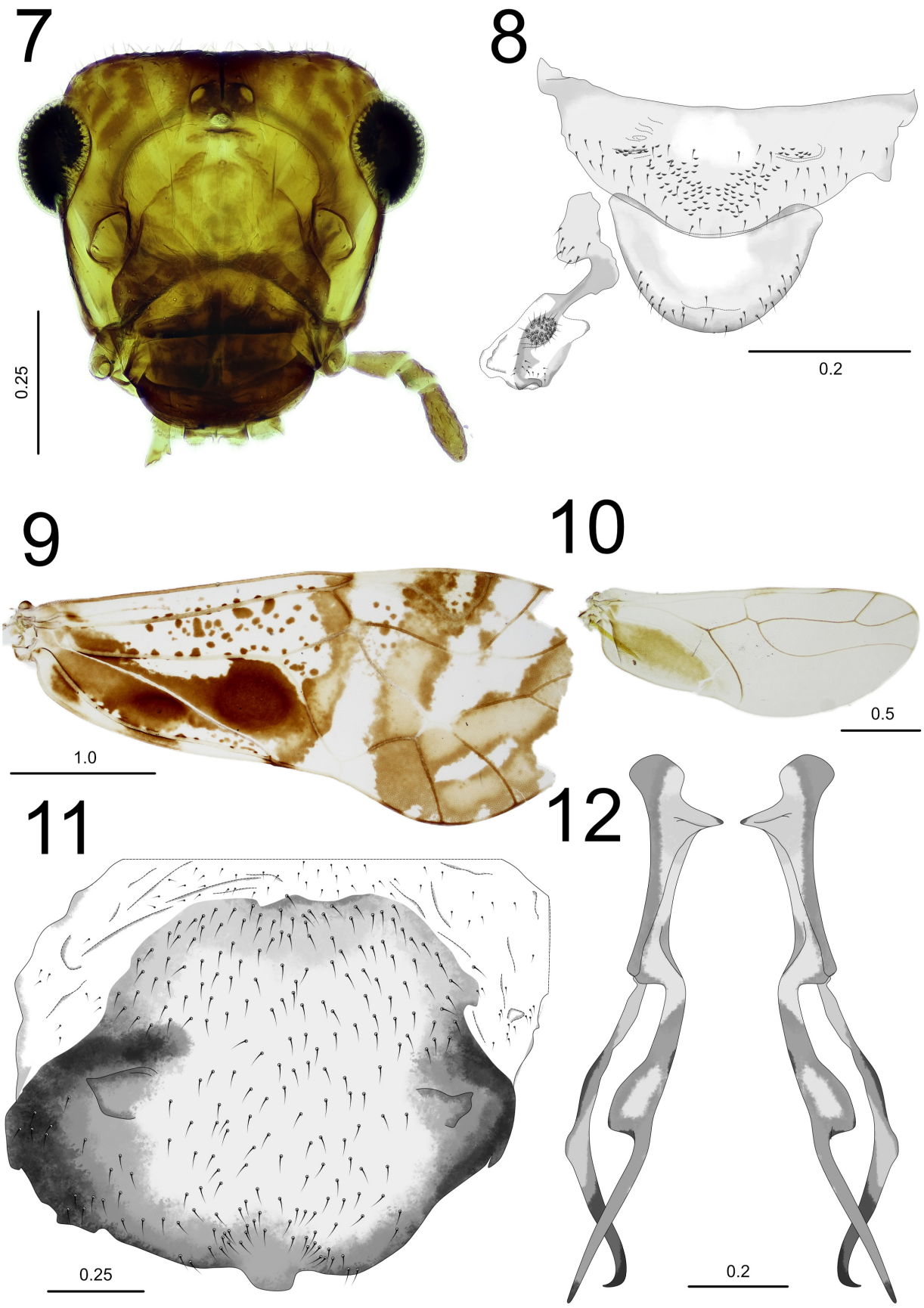
Elaphopsocus cundinamarcaensis n. sp. Male

(Figs 7–12)

Diagnosis. Belonging in Species Group III (Román-P. *et al.* 2015) as modified above. Hypandrium wide, posteriorly convex, ending in a small button-like projection. Phallosome with side struts proximally rounded, each arm bearing proximally a pointed process on inner edge, aedeagal arms long, distally acuminate, dilated medially; external parameres long, slender, bow shaped, distally pointed, curved outwards (Fig. 12). Differing from *E. roesleri* in the forewing pigmentation pattern, and in the structure of the hypandrium and phallosome. Differing from *E. boyacaensis* in having the hypandrium convex, with postero-lateral corners not projected, and in the structure of the phallosome (compare Figs 6 and 12 in this paper).



FIGURES 1–6. *Elaphopsocus boyacaensis* **n. sp.** Male. 1. Front view of head. 2. Paraprocts and epiproct. 3. Forewing. 4. Hindwing. 5. Hypandrium. 6. Phallosome. Scales in mm.



FIGURES 7–12. *Elaphopsocus cundinamarcaensis* **n. sp.** Male. 7. Front view of head. 8. Clunium, left paraproct and epiproct. 9. Forewing. 10. Hindwing. 11. Hypandrium. 12. Phallosome. Scales in mm.

Male. Color (in 80% ethanol). Body light brown. Compound eyes black, ocelli hyaline, with ochre centripetal crescents. Dark brown banding pattern next to compound eyes. Frontal, fronto-genal, and fronto-clypeal sulci dark brown, postclypeus with brown bands as illustrated (Fig. 7). Genae creamy. Antennae pale brown, scape unpigmented. Maxillary palpomeres dark brown. Coxae, trochanters, femora and tarsi brown, tibiae white. Forewing pattern (Fig. 9), with dark brown spots proximally, basal to the discal cell. Light brown spots over a hyaline background distally. Pterostigma with small brown spots. Veins brown. Hindwing (Fig. 10) almost hyaline, with cell cup light brown. Abdomen uniformly light brown; hypandrium strongly pigmented in distal half.

Morphology. As in diagnosis, plus the following*:* vertex slightly concave, with compound eyes not reaching the level of the vertex (Fig. 7). Pterostigma slightly extended posteriorly towards Rs-M. Cell m wide, almost rectangular, crossvein between areola postica and M long (Fig. 9). Hypandrium broad (Fig. 11), phallosome pieces long (Fig. 12). Paraprocts elongate, marginally sclerotized, with a long anterior "handle", and a posterior stout prong (Fig. 8), sensory fields with 33 trichobothria in penta-lobed basal rosettes. Epiproct broadly semicircular, slightly convex anteriorly, marginally sclerotized, with a setal field on distal third (Fig. 8). Clunium with small papillae over the central area.

Measurements (in microns). FW: 4312, HW: 3421, Mx4: 205, f1: 670, f2: 477, f3: 405, IO: 524, D: 238, d: 163, IO/d: 3.21, PO: 0.69.

Specimen studied. Holotype male. COLOMBIA. Cundinamarca. National Natural Park Chigaza Charrascales, 04° 31" N: 73° 34' W, 2990 m. 22.V–22.vi.2001. Malaise trap. F. Guzmán.

Etymology. The specific name refers to the Colombian Department of Cundinamarca, where the holotype was collected.

Elaphopsocus roeslerioides n. sp. Male

(Figs 13–18)

Diagnosis. Belonging in Species Group III (Román-P. *et al.* 2015) as modified above. Hypandrium concave, with a pair of heavily sclerotized postero-lateral acuminate projections of mid length. Phallosome with side struts stout, independent; aedeagal arms stout, distally pointed; external parameres long, stout, distally with a pointed projection directed outwards. Related to *E. roesleri*, from which it differs in having the postero-lateral projections of the hypandrium approximately half as long, and in having the aedeagal arms and external parameres stouter (compare Fig. 15 with Fig. 45 in Román-P. *et al.* (2015).

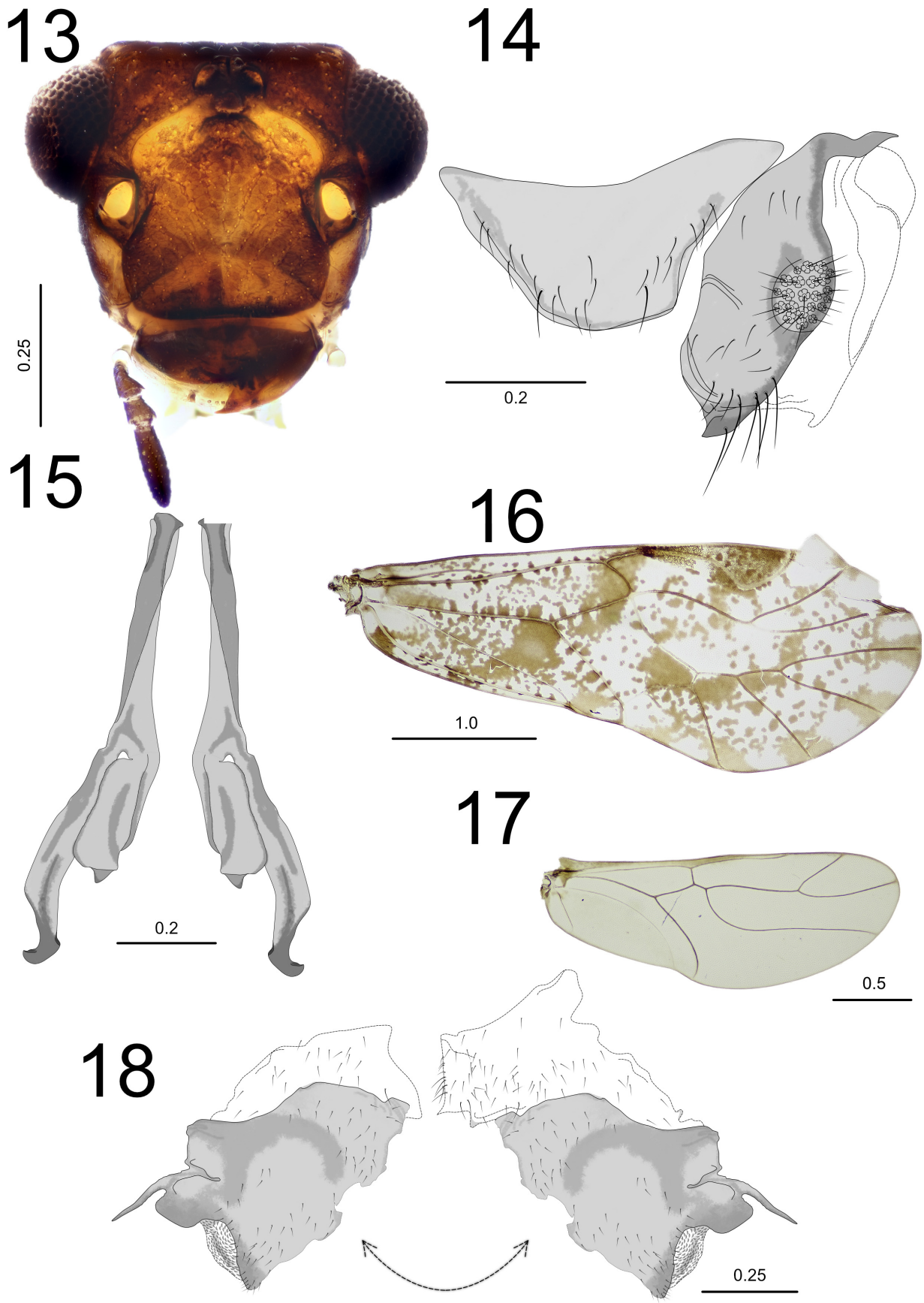
Color (in 80% ethanol). Body light brown. Compound eyes black, ocelli hyaline, with ochre centripetal crescents. Frontal, fronto-genal, and fronto-clypeal sulci dark brown, postclypeus with dark brown bands as illustrated (Fig. 13). Genae creamy with dark colored margins. Antennae pale brown, scape unpigmented. Maxillary palpomeres dark brown. Coxae, trochanters, femora and tarsi brown, tibiae white. Forewing pattern (Fig. 16), with dark brown proximally, basal to the discal cell. Light brown spots over a hyaline background distally. Pterostigma with small brown spots. Veins brown (Fig. 16). Hindwing (Fig. 17), almost hyaline, with cell cup slightly darker. Abdomen uniformly light brown; hypandrium strongly pigmented posteriorly.

Morphology. As in diagnosis, plus the following: vertex straight, with compound eyes not reaching the level of the vertex (Fig. 13). Pterostigma acute distally, slightly extended posteriorly towards Rs-M. Cell m wide, almost rectangular, crossvein between areola postica and M long (Fig. 6). Hypandrium broad (Fig. 18); phallosome elongate, with side struts separated anteriorly (Fig. 15). Paraprocts elongate, marginally sclerotized, with an elongate anterior "handle", and a posterior stout prong (Fig. 14). Sensory fields with 24 trichobothria in penta-lobed basal rosettes. Epiproct trapezoidal, marginally sclerotized, with a marginal field of setae (Fig. 14).

Measurements (in microns). FW: 4325, HW: 3861, IO: 532, D: 262, d: 154, IO/d: 3.45, Mx4: 200, f1: 670, f2: 480, f3: 400, PO: 0.63.

Specimen studied. Holotype male. COLOMBIA. Huila. Meremberg Nature Reserve, 02° 13' 06.6" N: 76° 07' 01.1" W, 2352 m, 11.ii.2016. MUSENUV slide code 26147, beating branches, R. González.

Etymology. The specific name refers to the similarity of this species with *E. roesleri* Román-P., González & García Aldrete.



FIGURES 13–18. *Elaphopsocus roeslerioides* **n. sp.** Male. 13. Front view of head. 14. Paraprocts and epiproct. 15. Phallosome. 16. Forewing. 17. Hindwing. 18. Hypandrium. Scales in mm.

Discussion

Roesler (1940) described *Elaphopsocus* as the only genus of Psocidae having the areola postica joined to M by a crossvein (Román-P *et al.* 2014; 2015). His description was based on two male specimens from Brazil, which were nominated as *E. glaphyrostigma* Roesler (1940). After a temporal gap of 75 years, six new species were assigned to the genus, sharply increasing its morphological variability (Román-P. *et al.* 2015).

Among the Psocidae, this genus is particularly interesting for having a crossvein connecting the areola postica with M. This character state might represent the most plesiomorphic condition within the family, shared with unrelated lineages as *Eremopsocus* and *Clematoscenea* in Psocinae, besides *Setopsocus, Ptiloneuropsis, Stenopsocus, Graphopsocus, Kodamaius* and *Hemipsocus* from other psocid families (Mockford 1981, 1993; Román-P *et al.* 2014, 2015). The phallosomal structure also supports this hypothesis. The articulated parameres found in *Elaphopsocus* are shared with the subfamily Kaindipsocinae, a lineage that has been considered the least derived within the family (Yoshizawa *et al*. 2011). In summary, morphological features of *Elaphopsocus* suggest that this lineage might correspond to the least derived within Amphigerontiinae. However, the position of this lineage could also be recovered within Kaindipsocinae, as closely related to the *Blaste lunata* species group. Further work should focus in discussing the phylogenetic relations of this genus with other members of the family.

We also pointed out the possibility of paraphyly in the genus due to the heterogeneity of the phallosome structural pattern and the forewing venation, and indicated that it is clearly separable from *Elaphopsocoides* Román- P., García Aldrete & González (2014). The geographic distribution of *Elaphopsocus* is strongly unbalanced, with three species in Brazil and seven species in northern Colombia, suggesting that additional species might be found. Thus a cladistic analysis of the known species might be short lived. The species here described, together with *E. roesleri*, also collected in the Meremberg Nature Reserve, inhabiting forests above 2000 m of altitude, constitute a distinct lineage occurring in the high Andes of South America.

Acknowledgments

The authors thanks Dr. E. L. Mockford (Illinois State University, Normal, Illinois) and Dr. K. Yoshizawa (Hokkaido University, Sapporo, Japan) for corrections. CRP and RGO are grateful to the Departamento de Biología, Facultad de Ciencias Naturales y Exactas, Vicerrectoria de Investigaciones, Universidad del Valle, for research support. ANGA thanks Instituto de Biología, Universidad Nacional Autónoma de México, for continuous research support. CRP thanks A. Valencia-Zuleta for feedback. This work was partially financed by the Programa de Jóvenes Investigadores e Innovadores Virginia Gutiérrez de Pineda, 2015 (COLCIENCIAS) to CRP. Finally, we thank Colciencias for financing the project: "Revisión Taxonómica y Endemismos de los Psócidos (Psocodea: "Psocoptera" de Parques Naturales de Colombia" (Code 1106-659-44236). We thank Claudia Alejandra Medina and the Alexander von Humboldt Institute for giving us access to the Psocoptera in its collections.

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