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Cabamofa alexsmithi sp. nov., the second species of *Cabamofa* in Costa Rica (Diptera: Bibionomorpha: Sciaroidea *incertae sedis*)

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The genus *Cabamofa* Jaschhof previously contained three species: the type species *C. mira* Jaschhof from Costa Rica, and the Oriental *C. orientalis* Jaschhof & Ševčík from Thailand and *C. vietnamensis* Jaschhof & Levesque-Beaudin from Vietnam (Jaschhof 2005, Jaschhof & Ševčík 2019, Jaschhof *et al.* 2022). Here we describe a further Costa Rican member of the genus, *C. alexsmithi* Jaschhof & Levesque-Beaudin **sp. nov.** We analyzed the morphology of both sexes and obtained the COI barcode for the species. The specimens studied, two males and three females, were collected in the course of the inventory of the arthropod fauna of Área de Conservación Guanacaste, a World Heritage Site, northwestern Costa Rica (Janzen & Hallwachs 2016). The systematic position of *Cabamofa* within the Sciaroidea *incertae sedis* group of genera, recently reviewed by Jaschhof & Ševčík (2019), is not further discussed here since *C. alexsmithi* does not provide us with fresh insights in this respect.

Size and shape of the new species are that of a typical *Cabamofa* (Fig. 1). In terms of adult morphology, *C. alexsmithi* is most similar to *C. mira*, the resemblance being as close as in the species pair from the Oriental region (Jaschhof *et al.* 2022). Positive species-specific distinctions, although still subtle, lie mostly in the genitalic structures of males. Morphological terms used here are in accordance with the overview given by Cumming & Wood (2017). The types of *C. alexsmithi* will be deposited in the Canadian National Collection of Insects, Arachnids, and Nematodes, Ottawa, Ontario, Canada (CNC).

A morphological peculiarity of male *Cabamofa* not adequately addressed in the past is the structure of the two abdominal segments preceding the genitalia (see below the description of *C. alexsmithi*). Of both the seventh and eighth segments, the tergal portions are markedly shorter than the corresponding sternal portions (Fig. 2), giving the genitalia space for an upwards turn (Figs 1–1A), probably during copulation. This peculiarity can be regarded as a generic character of *Cabamofa* and as a further distinction to *Rogambara* Jaschhof, its putative sister group (Jaschhof 2005).

Cabamofa alexsmithi Jaschhof & Levesque-Beaudin sp. nov.

(Figs 1–8)

Differential diagnosis. Adults of the two Neotropical *Cabamofa* differ in vein M_{1+2}, which in *C. alexsmithi* resembles the shape of an U (Fig. 4) whereas in *C. mira* the U has a short stem (Jaschhof 2005: fig. 24). This distinction is stable among all the specimens known of both species (*C. alexsmithi*, n = 5; *C. mira*, n = 3). Also, in some, but not all specimens known of *C. alexsmithi* vein CuA is slightly sinuous (Fig. 4), not straight apically as in *C. mira* (Jaschhof 2005: fig. 24). The two Oriental species of *Cabamofa* have a stemless M_{1+2} and straight CuA (Jaschhof & Ševčík 2019: fig. 2, Jaschhof *et al.* 2022: fig. 2). Otherwise the females of *C. alexsmithi* and *C. mira* are indistinguishable from each other, although the spermathecae of *C. alexsmithi* are partially covered with dense, tiny spikes, a structure not described for *C. mira* (Jaschhof 2005). Females of the Oriental species are unknown. Males of *C. alexsmithi* and *C. mira* differ in genitalic structures, notably the aedeagal apodeme, whose apex is pointed in *C. alexsmithi* (Fig. 7) and furcate in *C. mira* (Amorim & Rindal 2007: fig. 45), and the tegmen, whose posterior edge is markedly incised in *C. alexsmithi* (Fig. 7) and only slightly concave in *C. mira* (Amorim & Rindal 2007: fig. 45). Further possible distinctions in male genitalic structures are discussed below. Males of the two Neotropical *Cabamofa* are abundantly different from males in the Oriental region, for

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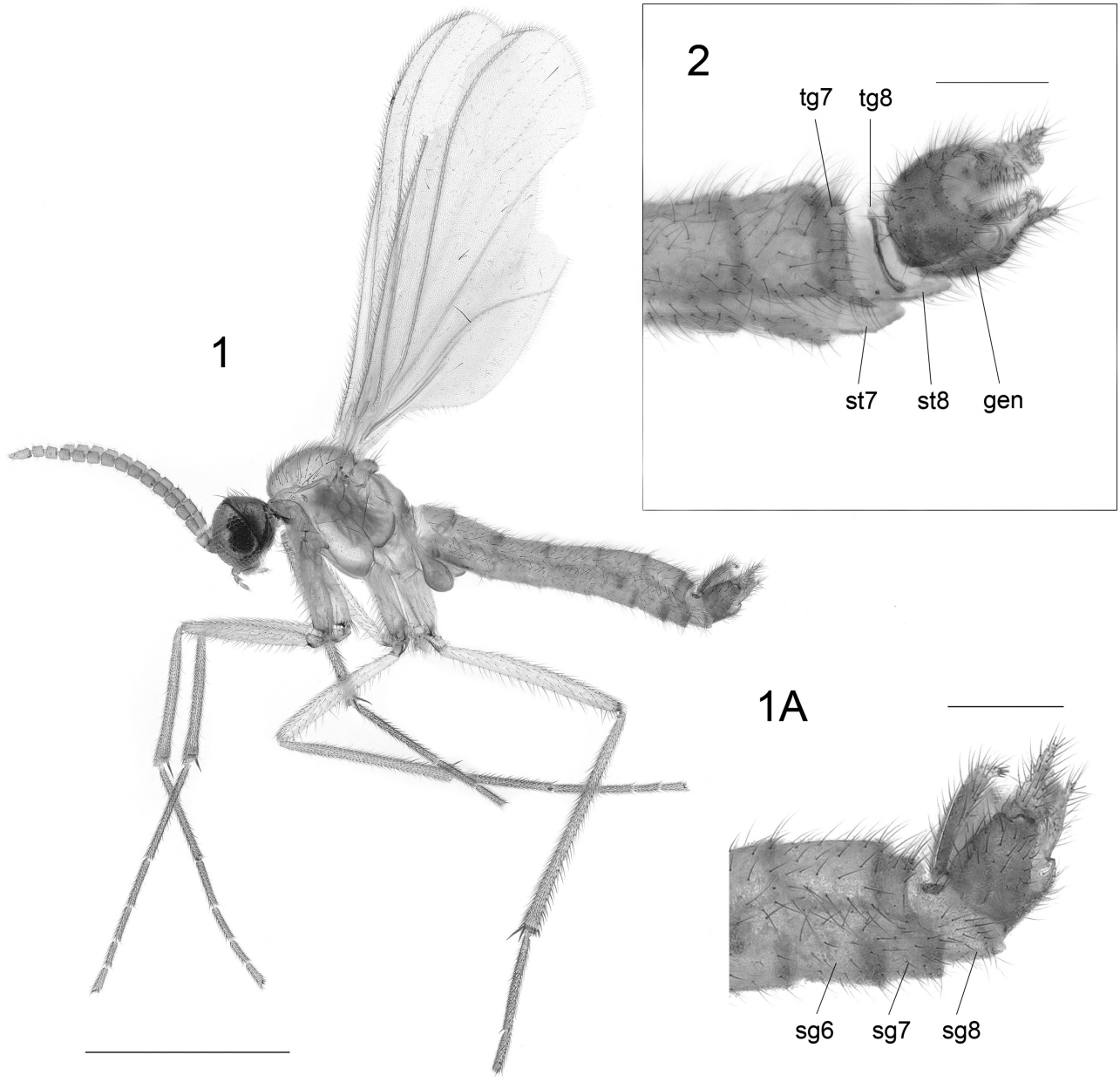
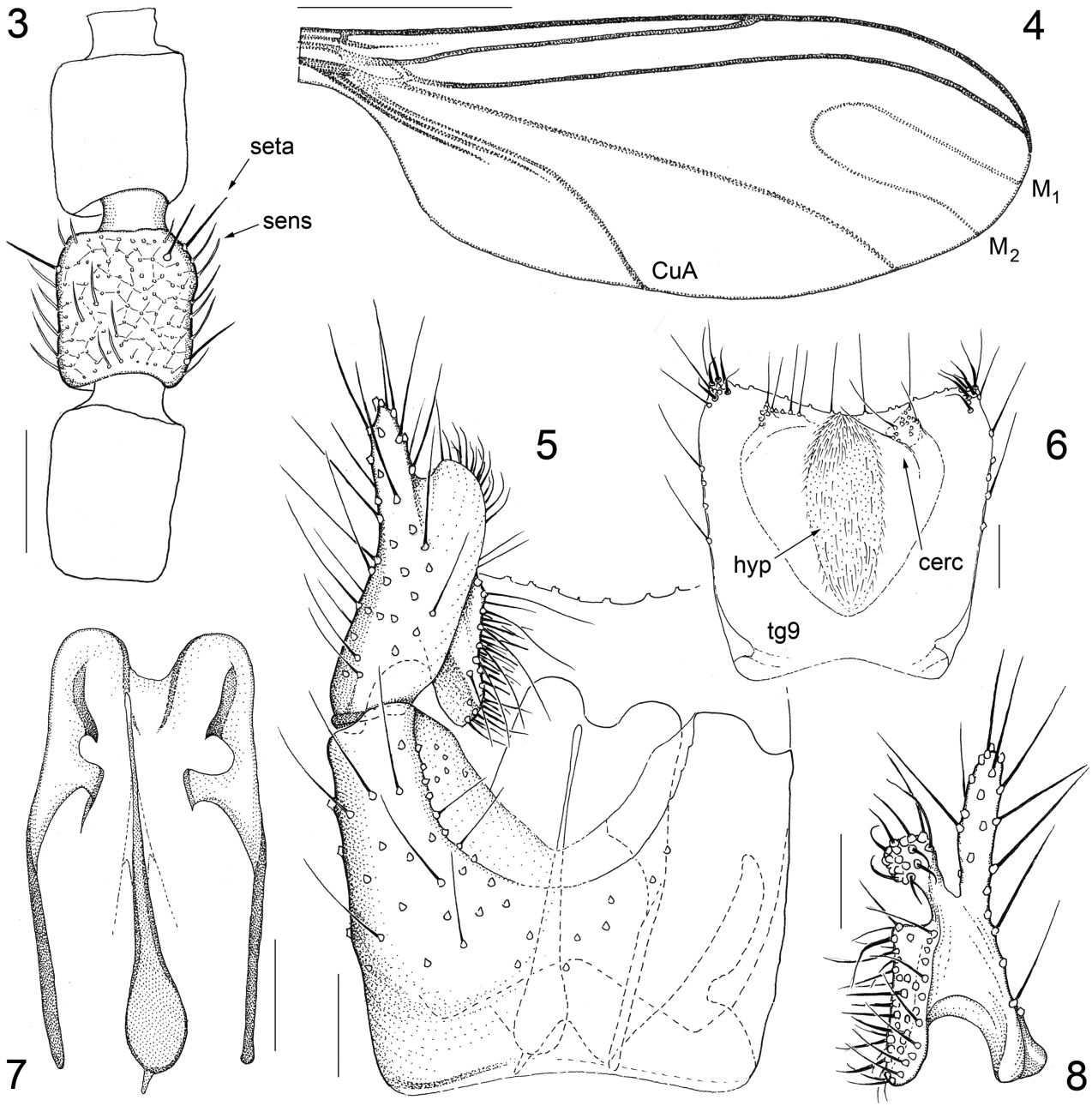
instance in having shorter flagellomeres (Fig. 3 *versus* Jaschhof & Ševčík 2019: fig. 1) and markedly shorter apical palpal segments (Amorim & Rindal 2007: fig. 39 *versus* Jaschhof & Ševčík 2019: fig. 3).

Discussion. There are likely further differences in male genitalic structures that could be used to distinguish *C. alexsmithi* from *C. mira.* For instance, the tegmen of *C. alexsmithi* has two pairs of hooks ventrally, which are largely transparent and thus not as obvious as Fig. 7 might suggest, whereas the tegmen of *C. mira* was illustrated as lacking any substructures (Amorim & Rindal 2007: fig. 45). Also, the ninth tergite of *C. alexsmithi* is not as deeply incised posteriorly (Fig. 6) as that drawn for *C. mira* (Amorim & Rindal 2007: fig. 47), and the two species differ markedly regarding the outline of the hypoproct (Fig. 6 *versus* Amorim & Rindal 2007: fig. 47). Finally, one may expect interspecific differences in the construction and setosity of the gonostylus, although those might be hard to recognize from illustrations; in *C. alexsmithi*, for instance, the three-lobed structure is so complex that different perspectives seem to show completely different gonostyli (Fig. 5 *versus* Fig. 8). Also, one cannot be sure whether the gonostylar setae in *C. mira* are as uniform as illustrated by Amorim & Rindal (2007: fig. 46) or whether this is a result of the drawing technique.



FIGURES 1–2. *Cabamofa alexsmithi* **sp. nov.**, male paratype. **1:** Habitus, lateral (specimen in ethanol after DNA extraction). **1A:** Posterior abdomen including genitalia, enlargement from 1. **2:** Ditto, dorsolateral. Scale for 1, 1.0 mm, for 1A and 2, 0.2 mm. Abbreviations: gen = genitalia, sg6 (–sg8) = sixth segment (–eighth segment), st7 (–st8) = seventh sternite (–eighth sternite), tg7 (–tg8) = seventh tergite (–eighth tergite).



FIGURES 3–8. *Cabamofa alexsmithi* **sp. nov.**, males. **3:** Third to fifth flagellomeres, lateral (paratype). **4:** Wing, dorsal (holotype). **5:** Genitalia, ventral (holotype). **6:** Ninth tergite and adjacent structures, ventral (paratype). **7:** Tegmen and aedeagal apodeme, ventral (holotype). **8:** Gonostylus, dorsal (paratype). Scale for 3 and 5–8, 0.05 mm, for 4, 1.0 mm. Abbreviations: cerc = cercus, hyp = hypoproct, sens = sensillum, tg9 = ninth tergite.

Other characters. Male. Body length 2.7–2.8 mm. **Head.** Clypeus setose. Scape slightly larger than pedicel, both setose, pedicel somewhat lighter in color than scape and flagellum. Fourth flagellomere short-cylindrical, with short neck; node 1.1 times as long as wide, with dense, irregular cover of fine seta-like sensilla, interspersed with very few larger setae arising from sockets, surface with irregular network of tenuous ridges (Fig. 3). Compound eyes touching at vertex, eye bridge 5–6 ommatidia long. Palpus short, with 5 setae-bearing segments, third segment conspicuously swollen, with sensory pit, fifth segment short, only slightly longer than fourth (similar to *C. mira*, Amorim & Rindal 2007: fig. 39). **Legs.** Coxal lengths relative to thoracal height: forecoxa, 0.7, midcoxa, 0.6, hindcoxa, 0.5. Edge of foretibial anteroapical depression with comb of 12 straight, stiff setae; apices of mid- and hindtibia with combs of 4 and 15 setae respectively similar to those on foretibia but those on midtibia more widely spaced. Claws small, strong, crescent-shaped, toothless. Empodia barely claw-long. **Wing** (Fig. 4). Slightly shorter than body, 2.7 times as long as wide. All veins clearly

contoured, although some (M_{1+2}, Rs) are weaker than others. **Abdomen** (Figs 1–2). Segments 1–6 normal size, tergite and sternite of a particular segment ending on same level; segment 7 considerably shorter than anterior segments, sternite twice as long as tergite; segment 8 similar to 7 but tergite still shorter and almost non-setose. **Genitalia.** Ninth tergite (Fig. 6) large, subquadratic, outside with large setae, posterior edge with lateral tufts of short megasetae pointing inwards (ventrad). Gonocoxal synsclerite (Fig. 5) with deep, U-shaped emargination ventroposteriorly, around the emargination setae of various sizes, a large non-setose portion ventroanteriorly; dorsal apodemes small, subtriangular; medial bridges densely setose (not illustrated). Gonostylus (Figs 5, 8) with 3 lobes of different size, outline and setosity; apical lobe finger-shaped, with long setae; middle lobe roundish, its outside almost non-setose, inside densely setose, setae mostly strongly bent and relatively short; mediobasal lobe elongate, very densely covered in setae of various sizes, setae either bent or straight, all directed inwards (mediad). Tegmen (Fig. 7) 1.8 times as long as broad, broadest at the midlength; parameral apodemes long and thin. Ejaculatory apodeme (Fig. 7) nearly as long as tegmen, moderately sclerotized, markedly swollen subbasally. Cerci (Fig. 6) small, halfmoon-shaped, with large setae. Hypoproct large, elongate-oviform, non-setose, densely microtrichose.

Female. Body length 3.2–3.8 mm. Other characters are as in the corresponding males or indistinguishable from *C. mira*.

Molecular identification. COI sequences were obtained for all five specimens through the Canadian Centre for DNA Barcoding (CCDB: https://ccdb.ca/). Sequence lengths varied between 652–654bp and collectively are publicly available in BIN: BOLD:AEL9580 (Ratnasingham & Hebert 2013) for the Barcode of Life Data System (BOLD: http://boldsystems.org/). This BIN and its barcodes are widely divergent from everything else on BOLD with the nearest neighbor being about 14% distant and matching the family Mycetophilidae (BIN: BOLD:ADV0335). This emphasizes the uniqueness of *Cabamofa* among Sciaroidea. Even within *Cabamofa* the divergence is wide, with a 19% distance to *C. vietnamensis*, the only other DNA barcode (BOLD) available for that genus. This suggests that the Neotropical species might be a different lineage than the Oriental species.

All data is publicly available on BOLD, its public dataset (dx.doi.org/10.5883/DS-CABAMOCR), and GenBank (https://www.ncbi.nlm.nih.gov/genbank/; accession: OM782492-OM782496).

Etymology. *Cabomofa alexsmithi* was collected by a Malaise trap at 1200 m elevation in cloud forest on the Pacific slope of Volcan Cacao of Área de Conservación Guanacaste. It is named in honor of Dr. M. Alex Smith of the Department of Integrative Biology of the University of Guelph, Guelph, Canada, in recognition of his many years of intense documentation of the upper elevation ecology of the entomofauna of this volcano.

Type material. *Holotype*: male, Costa Rica, Área de Conservación Guanacaste, Guanacaste province, Sector Cacao, Derrumbe, 1220 m elevation, 10.929°N:85.464°W, cloud forest, 03.xii.2015, Malaise trap, D. Janzen & W. Hallwachs leg. (sample ID: BIOUG71158-F10, museum ID: CNC1156197). *Paratypes*: 1 male, same data as for the holotype but 02.vi.2016 (sample ID: BIOUG70056-B09, museum ID: CNC1156198); 3 females, same data as for the holotype but 17.xii.2015, 05.v.2016 and 19.v.2016, respectively (sample ID / museum ID: BIOUG68329-G11 / CNC1156199, BIOUG71132-G03 / CNC1156200, BIOUG71841-C09 / CNC1156201).

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