



Description of *Cabamofa vietnamensis* sp. nov., the second species of *Cabamofa* in mainland southeast Asia (Diptera: Bibionomorpha: Sciaroidea incertae sedis)

MATHIAS JASCHHOF^{1*}, VALERIE LEVESQUE-BEAUDIN², ADAM BROADLEY³, KAI HELLER⁴,
VU VAN LIEN⁵ & STEFAN SCHMIDT⁶

¹Station Linné, Ölands Skogsby 161, 38693 Färjestaden, Sweden

[✉ mjaschhof@yahoo.de](mailto:mjaschhof@yahoo.de); <https://orcid.org/0000-0003-3447-1620>

²University of Guelph, Centre for Biodiversity Genomics, Guelph, Ontario, Canada. <https://orcid.org/0000-0002-6053-0949>

³Department of Agriculture, Fisheries and Forestry, Science and Surveillance Group, GPO Box 858, Canberra ACT 2601, Australia

<https://orcid.org/0000-0002-4828-7843>

⁴Stückenberg 58, 24226 Heikendorf, Germany. <https://orcid.org/0000-0003-4813-5302>

⁵Vietnam National Museum of Nature, Vietnam Academy of Science and Technology, Hanoi, Vietnam

⁶SNSB-Zoologische Staatssammlung München, Munich, Germany. <https://orcid.org/0000-0001-5751-8706>

*Corresponding author

The genus *Cabamofa* Jaschhof, originally introduced for *C. mira* Jaschhof from Costa Rica (Jaschhof 2005), was recently shown to have a second species, *C. orientalis* Jaschhof & Ševčík, in Thailand (Jaschhof & Ševčík 2019). In the present paper we describe *C. vietnamensis* Jaschhof & Levesque-Beaudin sp. nov. from Vietnam, based on a single male collected by the VIETBIO project. VIETBIO (“Innovative approaches to biodiversity discovery and characterization in Vietnam”) is a bilateral German-Vietnamese research and capacity building project focused on the development and transfer of new methods and technology towards an integrated biodiversity and monitoring system for Vietnam (Duwe *et al.* 2022).

Finds of *Cabamofa* are exceptional events; of the three species now placed in this genus only five specimens in collections are known (Jaschhof & Ševčík 2019). *Cabamofa* shares the quality of rarity with most other Sciaroidea incertae sedis, an evidently polyphyletic grouping of about 20 genera whose familial affiliation has remained unresolved to date (Ševčík *et al.* 2016, Jaschhof 2017; *cf.* Amorim & Rindal (2007) for an alternative phylogenetic hypothesis). Morphological evidence speaks for a sistergroup relationship between *Cabamofa* and *Rogambara*, a monotypic genus found in Costa Rica (Jaschhof 2005, Jaschhof & Ševčík 2019). In terms of male morphology, *C. vietnamensis* fits perfectly in with the generic concept of *Cabamofa* as outlined by Jaschhof (2005) and Jaschhof & Ševčík (2019). As one would expect, the two Oriental species are morphologically more similar, and thus more closely related to each other than to the Neotropical *C. mira* (*cf.* below the diagnosis of *C. vietnamensis*). Since we anticipate further species of Oriental *Cabamofa* to be discovered in the future, and with interspecific distinctions being subtle, the specific diagnosis given below strives to be as exhaustive as possible rather than to highlight only a few randomly chosen key characters.

Morphological terminology used here corresponds with that outlined by Cumming & Wood (2017).

Cabamofa vietnamensis Jaschhof & Levesque-Beaudin sp. nov.

(Figs 1–4)

Diagnosis. The new species, which is largely similar to *C. orientalis*, is distinguished mainly by genitalic characters, as follows (Fig. 4 *versus* Jaschhof & Ševčík 2019: fig. 5). Of the gonostylus, the apex is narrower, lacking the angulate outgrowth found in *C. orientalis*, and the inside bears 2 conspicuously large setae (in Sciaroidea usually referred to as megasetae, arrow-marked in Fig. 4) as opposed to 5 slightly smaller setae found in approximately the same positions in *C. orientalis*. The tegmen is considerably broader and the area of fine aedeagal teeth at the posterior tegminal edge is markedly smaller. The anterior edge of the gonocoxal synsclerite is evenly rounded, not truncate as in *C. orientalis*. Finally, the ninth tergite is longer, and its maximum width is found in the anterior third, not at about the midlength as in *C. orientalis*. Other, minor distinctions concern the wing (Figs 2–3 *versus* Jaschhof & Ševčík 2019: figs 2 and 4): in *C. vietnamensis*, Rs is situated at about the same level as the base of M₄ (not clearly basally of it); R₁ is slightly longer, joining the costa beyond (not before) the midpoint of wing; and the U-shape formed by M₁₊₂ is slightly shorter. See also the remarks on identification given below.

Other male characters. Body length 2.8 mm. **Head.** Clypeus non-setose. Scape slightly larger than pedicel, both setose, lighter in color than flagellum. Fourth flagellomere elongate-cylindrical, with short neck, node 2.5 times as long as wide, with irregular cover of fine setae whose lengths equal the flagellomeral width, interspersed with a few larger setae arising from sockets (similar to *C. orientalis*, Jaschhof & Ševčík 2019: fig. 1). Compound eyes touching at vertex, eye bridge 7–8 ommatidia long. Palpus with 5 setae-bearing segments, third segment conspicuously swollen, with sensory pit, fifth segment conspicuously long and thin (similar to *C. orientalis*, Jaschhof & Ševčík 2019: fig. 3). **Legs.** Coxal lengths relative to thoracal height: forecoxa, 0.75, midcoxa, 0.60, hindcoxa, 0.50. Edge of foretibial anteroapical depression with comb of about 15 straight, stiff setae. Apices of mid- and hind tibia with comb of 8 and 12 setae, respectively, similar to those on foretibia but more widely spaced. Claws small, strong, crescent-shaped, toothless. Empodia small, barely claw-long. **Wing** (Figs 2–3). As long as body, 2.3 times as long as wide. Veins clearly contoured except for Rs which is decidedly pale. **Abdomen.** 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 still shorter. **Genitalia** (Fig. 4). Ninth tergite with setae of various lengths, posterior edge with several large setae pointing inwards (ventrad). Gonocoxal synsclerite with wide, shallow emargination medioposteriorly, below the emargination a more poorly sclerotized, non-setose portion that extends almost to the anterior gonocoxal edge; lateral setae larger than medial setae; dorsal apodemes slender, slightly longer than the distance separating them. Gonostylus with narrow, stem-like base; apical portion broadened into medial lobe of considerable size, covered in numerous thick setae of various lengths, head of lobe with small, blunt-ending, sclerotized tooth largely hidden among the setae. Parameres merged to form a subrectangular, weakly sclerotized plate (tegmen) with convex, weakly contoured posterior edge, lateral edges reinforced by sclerotization. A small, inconspicuous area of fine aedeagal teeth medially at tegminal edge. Ejaculatory apodeme about as long as tegmen, well sclerotized, very slightly broadened towards apex. Cerci small, halfmoon-shaped, setose. Hypoproct conical, non-setose, densely microtrichose.

Female and preimaginal stages are unknown.

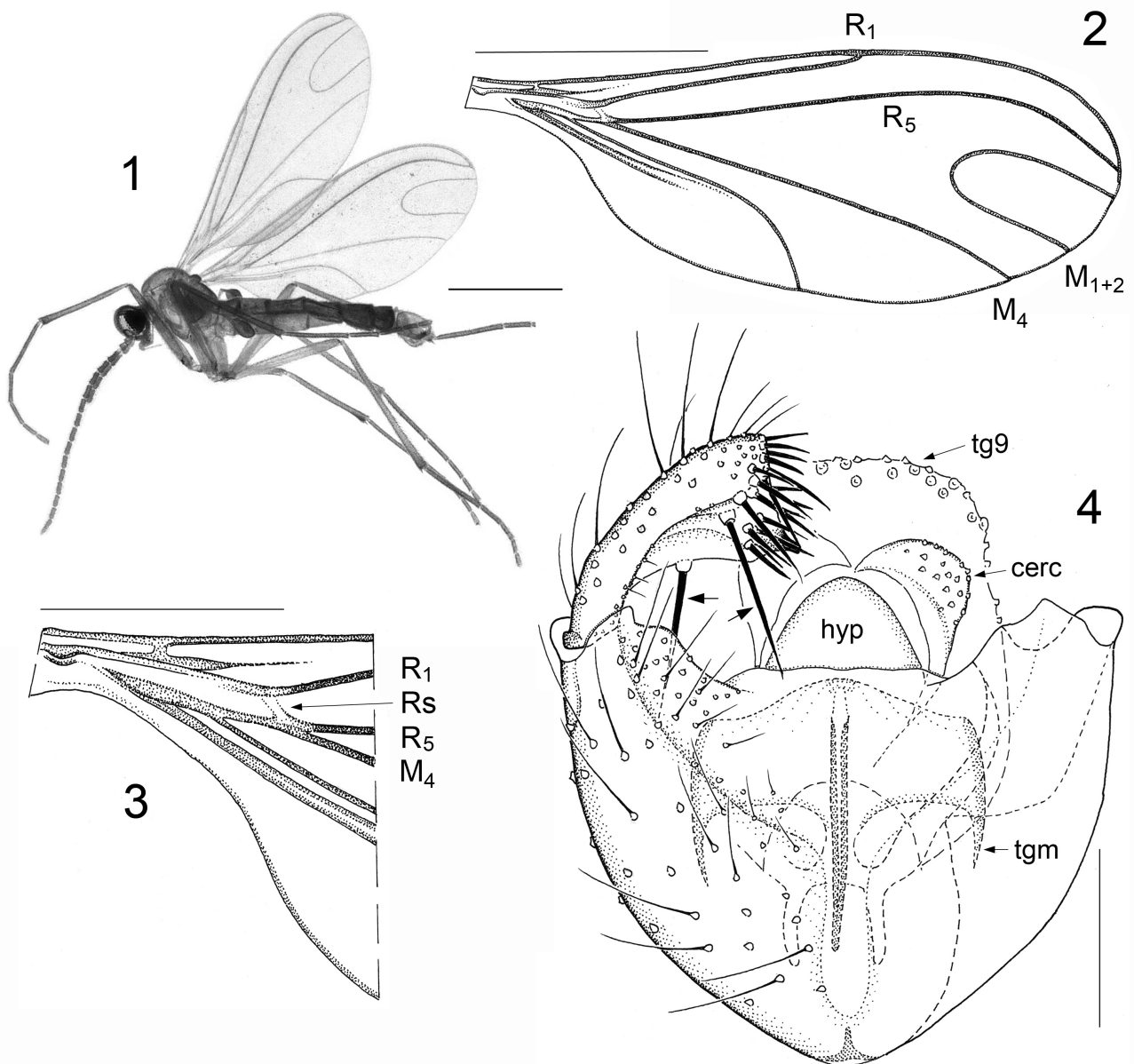
Molecular identification. The COI sequence (651bp) is available on BOLD (<http://boldsystems.org/>): BIN BOLD: AEJ2606, dataset (dx.doi.org/10.5883/DS-CABAMOFA); and on GenBank (accession: OK502254).

Etymology. The name refers to the geographical distribution of the new species in Vietnam.

Type material. Holotype (used for DNA extraction, body partly dissected and mounted on microscope slide in Canada balsam): male, Vietnam, Ninh Binh province, Cuc Phuong National Park, near Park Centre, 400 m elevation, 20.351°N:105.594°E, 29.ix.2019, Malaise trap, V.V. Lien (specimen VNMN.IS.CP.00001 in Vietnam National Museum of Nature, Hanoi).

Remarks on identification. *Morphology.* In terms of size and habitus, species of *Cabamofa* can be mistaken for Sciaridae, which usually are plentiful in Malaise trap samples. An eye-catching peculiarity of *Cabamofa* concerns the wing: since the anterior branch of the medial vein (M_{1+2}) lacks the basal (stem) portion, the apical portion (furca) is isolated and forms a perfect U-shape near the wing apex (Figs 1–2). Also, fresh male specimens of *C. vietnamensis* in ethanol show a yellowish thorax that is in contrast with the dark-brown abdomen, the fairly large genitalia being lighter again; the resulting dichromatism differs from the plain-colored black or brown exhibited in most Sciaridae. These two features in combination should raise attention when visually examining sciaroids using a dissecting microscope. To identify *Cabamofa* to species, the genitalic structures of males (Fig. 4) need to be investigated by transmitted-light microscope.

DNA barcoding. The specimen was sequenced for COI. When blasted against the BOLD ID engine, the nearest neighbors (as of early March 2022) were from 13.33% to 14.01% distant and matched a wide range of families: Agromyzidae, Empididae, Limoniidae and Mycetophilidae. When blasted against GenBank, the closest matches were from 13.71% to 14.29% distant and matched again a wide range of families: Culicidae, Empididae, Mycetophilidae and Phoridae. As other unplaced genera from Sciaroidea *incertae sedis* are present on both sequence databases and none are in the top matches, it shows how widely divergent *Cabamofa* really is. While we regard this finding as irrelevant for the actual systematic position of *Cabamofa* within the Sciaroidea, it shows the imperative necessity to perfect the global DNA barcode reference library. For insects, as rarely encountered as most Sciaroidea *incertae sedis* are, it is a hugely challenging task. At this time, it would be almost impossible to correctly identify *Cabamofa* specimens based on COI or discover new species without morphology.



FIGURES 1–4. *Cabamofa vietnamensis* sp. nov., male holotype. **1:** Habitus, lateral (specimen in ethanol after DNA extraction). **2:** Wing, dorsal, setae omitted. **3:** Base of wing, dorsal, setae omitted. **4:** Genitalia, ventral. Scale for 1 and 2, 1.0 mm, for 3, 0.5 mm, and for 4, 0.1 mm. Abbreviations: cerc = cercus, hyp = hypoproct, tgm = tegmen, tg9 = ninth tergite.

Acknowledgements

The study was supported by the German Federal Ministry of Education and Research (Bundesministerium für Bildung und Forschung, Berlin, Germany, project “Innovative approaches to biodiversity discovery and characterization” (VIETBIO), grant 01DP17052). The Malaise trap in Cuc Phuong National Park was operated as part of the Global Malaise Program (<https://biodiversitygenomics.net/projects/gmp/>; Centre for Biodiversity Genomics, Guelph, Canada). Collection and sequencing of specimens was supported by a “SNSB Innovativ” grant from the SNSB-Zoologische Staatssammlung München to Stefan Schmidt. Sequencing was done at the Canadian Centre for DNA barcoding (<https://ccdb.ca/>). The sequence analyses for this study were supported, in part, by Genome Canada through the Ontario Genomics Institute, while informatics support was provided through a grant from the Ontario Ministry of Research and Innovation. The support by the Directorial Board and staff of the Cuc Phuong National Park is greatly appreciated. We also would like to thank all Vietnamese and German colleagues of the VIETBIO team for their support during the field courses. The manuscript was reviewed by Peter Chandler, Melksham, UK, and Jan Ševčík, Ostrava, Czech Republic.

References

- Amorim, D.S. & Rindal, E. (2007) Phylogeny of the Mycetophiliformia, with proposal of the subfamilies Heterotrichinae, Ohakuneinae, and Chiletrichinae for the Rangomaramidae (Diptera, Bibionomorpha). *Zootaxa*, 1535 (1), 1–92.
<https://doi.org/10.11646/zootaxa.1535.1.1>
- Cumming, J.M. & Wood, D.M. (2017) 3. Adult morphology and terminology. In Kirk-Spriggs, A.H. & Sinclair, B.J. (Eds), Manual of Afrotropical Diptera. Volume 1. Introductory chapters and keys to Diptera families. *Suricata*, 4, South African National Biodiversity Institute, Pretoria, pp. 89–133.
- Duwe, V.K., Vu, L.V., von Rintelen, T., von Raab-Straube, E., Schmidt, S., Nguyen, S.V., Vu, T.D., Do, T.V., Luu, T.H., Truong, V.B., Vincenzo, V.D., Schmidt, O., Glöckler, F., Jahn, R., Lücking, R., von Oheimb, K. C.M., Heinze, S., Abarca, N., Bollenдорff, S., Borsch, Thomas, Buenaventura, E., Dang, H.T.T., Dinh, T.D., Do, H.T., Ehlers, S., Freyhof, J., Hayden, S., Hein, P., Hoang, T.A., Hoang, D.M., Hoang, S.G., Kürschner, H., Kusber, W.-H., Le, H.N., Le, T.Q., Linde, M., Mey, W., Nguyen, H.D., Nguyen, M.T., Nguyen, D.V., Nguyen, T.V., Nguyen, V.D.H., Nguyen, D.Q., Ohl, M., Parolly, G., Pham, T.N., Pham, P.V., Rabe, K., Schurian, B., Skibbe, O., Sulikowska-Drozd, A., To, Q.V., Truong, T.Q., Zimmermann, J. & Häuser, C. (2022) [Editorial.] Contributions to the biodiversity of Vietnam – Results of VIETBIO inventory work and field training in Cuc Phuong National Park. *Biodiversity Data Journal*, 10, e77025.
<https://doi.org/10.3897/BDJ.10.e77025>
- Jaschhof, M. (2005) *Rogambara* and *Cabamofa*, two new genera of enigmatic sciaroids from Costa Rica (Insecta: Diptera: Sciaroidea). *Bonner zoologische Beiträge*, 53 (3/4), 323–332.
- Jaschhof, M. (2017) 23. *Heterotricha*-group (Sciaroidea, unassigned to family). In Kirk-Spriggs, A.H. & Sinclair, B.J. (Eds), Manual of Afrotropical Diptera, Volume 2, Nematocerous Diptera and lower Brachycera. *Suricata* 5, South African National Biodiversity Institute, Pretoria, pp. 601–605.
- Jaschhof, M. & Ševčík, J. (2019) *Cabamofa orientalis* sp. nov. from Thailand, congeneric with *C. mira* Jaschhof from Costa Rica (Diptera: Bibionomorpha: Sciaroidea *incertae sedis*). *Zootaxa*, 4576 (2), 392–394.
<https://doi.org/10.11646/zootaxa.4576.2.12>
- Ševčík, J., Kaspřák, D., Mantič, M., Fitzgerald, S., Ševčíkova, T., Tóthová, A. & Jaschhof, M. (2016) Molecular phylogeny of the megadiverse insect infraorder Bibionomorpha *sensu lato* (Diptera). *PeerJ*, 4, e2563.
<https://doi.org/10.7717/peerj.2563>