



This work is licensed under a Creative Commons Attribution 3.0 License.

## Research article

[urn:lsid:zoobank.org:pub:256407D2-64CC-4B3C-8C24-FA7C8CBF50B2](https://zoobank.org/pub:256407D2-64CC-4B3C-8C24-FA7C8CBF50B2)

# The *Chimarra lehibemavo* species-group, new and endemic to Madagascar (Trichoptera, Philopotamidae)

François-Marie GIBON

IRD, Centre de Biologie pour la Gestion des Populations (UMR INRA / IRD / CIRAD / Montpellier Supagro), Campus de Baillarguet, CS 30016, 34988 Montferrier sur Lez Cedex, France.  
E-mail : [Francois-Marie.Gibon@ird.fr](mailto:Francois-Marie.Gibon@ird.fr)

[urn:lsid:zoobank.org:author:C68C830F-626B-42E5-91EC-8147C42E8B03](https://zoobank.org/author:C68C830F-626B-42E5-91EC-8147C42E8B03)

**Abstract.** The *Chimarra lehibemavo* group is described to include thirteen new species: *Chimarra lehibemavo* sp. nov., *C. cebegepi* sp. nov., *C. fenoevo* sp. nov., *C. forcellini* sp. nov., *C. fotobohitra* sp. nov., *C. gattolliati* sp. nov., *C. gensonae* sp. nov., *C. jejyorum* sp. nov., *C. hamatra* sp. nov., *C. makiorum* sp. nov., *C. moramanga* sp. nov., *C. saha* sp. nov. and *C. tamara* sp. nov. The adults are easily recognizable by their large size, yellow colour and the structure of the male genitalia. The membranous tergum IX and the absence of the mesal lobe of tergum X are observed in other lineages, but the strong asymmetrical deformation of the phallosome is apomorphic. The group is monophyletic with unknown affinities, but a preliminary phylogenetic placement is suggested following genetic analysis of two specimens. With one exception, the species have restricted geographical distributions in Madagascar and inhabit rivers in eastern pristine rainforests.

**Keywords.** Caddisflies, Chimarrinae, new species, biogeography, systematics.

Gibon F.-M. 2017. The *Chimarra lehibemavo* species-group, new and endemic to Madagascar (Trichoptera, Philopotamidae). *European Journal of Taxonomy* 319: 1–31. <https://doi.org/10.5852/ejt.2017.319>

## Introduction

The genus *Chimarra* Stephens, 1829 is the largest genus in the Trichoptera (Morse 2015). It is almost cosmopolitan in distribution, only absent from the southernmost areas of South America, New Zealand and many oceanic islands. The Neotropical and Oriental regions harbour the main known diversity. For a long time ignored, the rich Malagasy fauna of *Chimarra* begins to be studied. Ten species are reported to date from the island, but already collected material has permitted to estimate a richness exceeding sixty species (Gibon *et al.* 1999). The morphological diversity offered by this material has revealed the presence of distinct lineages and this was confirmed by the DNA-based phylogenies published by Wahlberg & Johanson (2014) and Kjer *et al.* (2014).

The long-term objective of our studies was to contribute to the conservation of the Malagasy fauna, not only for emblematic, economic or with high touristic value species, but also taking into account little known taxa important for ecosystem functioning. For this purpose, history of settlement, endemism,

vicariance and redundancy are key data, these studies are much more informative at infrageneric levels (Resh & Unzicker 1975).

The genus *Chimarra* is monophyletic and clearly characterized by morphological synapomorphies. Three of the four recognized subgenera are reported only from the New World (mainly the northern part of South America and the Antilles). All the Old World species belong to the nominal subgenus *Chimarra*, which secondarily invaded North America (Ross 1956; Blahnik 1998), an event dated by Wahlberg & Johanson (2014). A few large lineages were considered by Ross (1956) and redescribed by Blahnik *et al.* (2009, 2012). These lineages illustrate the long-term history of the genus. The species group defined here should be included, thereafter, in the great historical lineages, that would require other approaches such as molecular studies or larval morphology.

I have recently described two species belonging to the *minima* species group and widely distributed in the open lowland landscapes of Madagascar (Gibon 2015). By contrast, the *lehibemavo* group includes numerous species which are, with the exception of *Chimarra fenoevo* sp. nov., restricted to the pristine rainforests and microendemic (*sensu* Gibon 2000 and Wilmé *et al.* 2006). The monophyly of the group is inferred from male genital structure, which includes an unique combination of characters and a remarkable apomorphy. No closely relative group could be identified.

## Material and methods

The material was collected during the project “Biodiversité et Biotypologie des eaux continentales malgaches” jointly conducted by the ORSTOM and the CNRE (Antananarivo). The equipment, the sampling method and the study areas were described by Elouard & Gibon (2001). Unless otherwise stated, the material was collected by the author. Some field campaigns benefited from the logistic of the WWF; in those cases, the main results and detailed ecological descriptions of the regions were published (Andringitra: Goodman 1996; Andohahela: Goodman 1999; Marojejy: Goodman 2000). Specimens were captured using a portable light trap, which was composed of a black light and a gas lamp, and subsequently preserved in 75% ethanol. The male genitalia of some specimens were cleared in a solution of potassium hydroxide, studied under the microscope in cedar oil, and mounted on slides in Euparal®. The holotypes, paratypes and other specimens are deposited in the CBGP (Montferrier).

The storage in ethanol (75%) at room temperature is not favourable to the long-term preservation of the DNA (K. Kjer, personal communication during the XV<sup>th</sup> International Symposium on Trichoptera), our colleague Gwenaëlle Genson (INRA/CBGP) managed to obtain sequences from two specimens. The extraction of genomic DNA was performed on whole specimens, using “DNeasy 96 Blood & Tissue extraction (QIAGEN)”, following standard protocol. A primer cocktail described by Cruaud *et al.* (2010) was used to sequence the standard bar-code sequence of the mitochondrial COI gene (cytochrome c oxidase I). Voucher sequenced specimens and their DNA are deposited in the collections of the CBGP.

The terminology used thereafter is that of Blahnik (1998). Schematic ecological profiles of the capture sites were established according to altitude, distance to the source and watershed, their construction, use and limitations were described and discussed by Randriamasimanana & Gibon (2001).

## Acronyms

|        |   |
|--------|---|
| CBGP   | = Centre de Biologie pour la Gestion des Populations (Montferrier, France)    |
| CNRE   | = Centre National de Recherche sur l’Environnement (Antananarivo, Madagascar) |
| INRA   | = Institut National de la Recherche Agronomique (Paris, France)               |
| ORSTOM | = Office de la Recherche Scientifique et Technique Outre-Mer (Paris, France)  |
| WWF    | = World Wide Fund for Nature (Gland, Switzerland)                             |

## Results

### Taxonomy

Class Insecta Linnaeus, 1758  
 Order Trichoptera Kirby, 1813  
 Superfamily Philopotamoidea Stephens, 1829  
 Family Philopotamidae Stephens, 1829  
 Subfamily Chimarrinae Rambur, 1842  
 Genus *Chimarra* Stephens, 1829  
 Subgenus *Chimarra* Stephens, 1829

The *Chimarra lehibemavo* group

### Diagnosis

All the Old World species of the genus belong to the nominal sub-genus *Chimarra* Stephens, 1829, characterized by a curvature of the stem of Rs vein in the forewing. In some groups, as *minuta* and *georgensis*, this curvature is weakly marked. In the *lehibemavo* group, the stem of Rs vein is not curved but clearly angular (Fig. 1). This constitutes an accentuated state of the character. The *lehibemavo* group differs from the large *digitata* lineage by the absence of the median lobe of tergum X and the membranous tergum IX; it differs from the *tsudai* lineage by the undivided lateral lobes of tergum X. These lateral lobes are U-shaped or boomerang-shaped with one dorso-distal and one ventral branch. This is also observed in the *georgensis* species group but species of this latter group have a dorsally membranous tergum X and a reduced but sclerotized tergum IX. Above all, the phallic apparatus is the best characteristic of the group: the phallosome is laterally split in two plates (thereafter named dorsal and ventral lamina); each of these plates is distorted in its own way, making the apparatus asymmetric. This phallosome, associated with a variable internal sclerite and a large phallosomal sclerite, is a remarkable apomorphic character, the best way to identify the group. Each species exhibits specific forms of phallosome and phallic sclerites, making the phallic apparatus the best diagnostic character.

In Madagascar, alive adults of the group are easily identifiable by the combination of the yellow colour and the large size. Most of the Malagasy *Chimarra* are black or brown, but the species of the *minima* and *dybowskina* groups are yellow or pale brown; the forewing length varies from 4 to 6 mm. In Africa, some species from mountain areas are quite large (for exemple 6.2 mm in *Chimarra philipponi* Gibon, 1986 from Guinea or 7.0 mm in *Chimarra calidopectoris* Wahlberg *et al.*, 2014 from Malawi). The

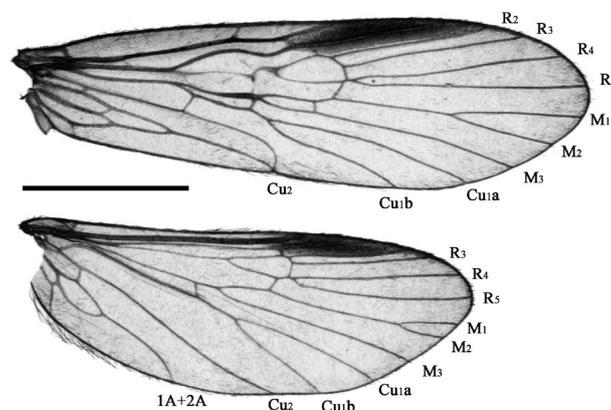


Fig. 1. *Chimarra jejyorum* sp. nov., right wings. Scale bar = 2 mm.

*lehibemavo* group is a little bigger with a range of 5.5–10 mm – forewing length – and a median value of 7.3 mm.

## Description

### Adult

Three ocelli. Labial palps 3-segmented. Maxillary palps 5-segmented, first segment short, second with an apical tuft of setae. Spur formula: 1/4/4. Forewing with forks 1, 2, 3 and 5; stem of R1 sinuous; stem of Rs with an angular bend a little before discoidal cell, node thickened at discal cell; M vein 3-branched (M4 absent), M<sub>1+2</sub> long petiolate. Hind wing with forks 1, 2, 3 and 5; 1A and 2A join to form a loop and reach together wing margin.

Abdominal segment VIII complete, smaller than the VII, sternite VIII with a ventral keel. Sternite IX with a ventral keel and large antero-lateral lobes deeply invaginated in sternite VIII; in lateral view: latero-distal margin convex, sub triangular or rounded. Tergite IX membranous. Tergum X completely divided in two lateral lobes, median part membranous without noticeable median lobe. When viewed laterally, each lateral lobes v- or boomerang-shaped with one dorsal and one ventral branch. Preanal appendages small, simple and generally knoblike. Inferior appendages one-segmented, shape and size variable depending on the species; when viewed laterally, rectangular or triangular with small lobes along the caudal margin, most species having an additional lobe on the inner side (internal lobe, Fig. 4A, C). Phallic apparatus comparatively large, comprising a bulbous base prolonged by a tubular phallosome (structure sometimes described as pistol-shaped), remarkably long (longer than abdominal segments VIII, IX and X). Phallosome sclerotized, distal part split, forming two conspicuous, asymmetrically enlarged or distorted extensions (dorsal and ventral lamina, Fig. 2D–E). Endotheca with: (1) a well developed phallosomal sclerite complex, (2) a large, variable in shape, internal sclerite, usually spiniform but sometimes globular or bullet-shaped.

## Biomolecular data

The CO1 barcoding sequence is known for two specimens only, one male of *C. fenoovo* sp. nov. and one male of *C. tamara* sp. nov. The identification research in the database BOLD (Ratnasingham & Hebert 2007) indicates for *C. fenoovo* sp. nov. a similarity percentage of 95.54 with *C. OF* sp. MG9, an unidentified Malagasy species included in the phylogeny published by Kjer *et al.* (2014, supplementary material). For *C. tamara* sp. nov., the maximum percentage is only 83.31, but again with *C. OF* sp. MG9. In the electronic supplement file of Kjer *et al.* (2014), the nearest relative of *C. OF* sp. MG9 (in a COI based phylogeny) is *C. orumbera* Cartwright, 2002 from Australia. *Chimarra orumbera* is easily distinguished from any species of the *lehibemavo* group by the presence of the dorsal lobe of tergum X (although quite simple and poorly sclerotized), and the absence of distortion of the phallosome. These data will be more useful for future study, when the afrotropical fauna will be better known. For the moment, I would not say that this preliminary result confirms or, at least, does not refute the conclusion of the morphological study: the *lehibemavo* group is not close to any other among the afrotropical species.

*Chimarra lehibemavo* sp. nov.

[urn:lsid:zoobank.org:act:419A1C29-F941-42A7-9663-4FE9CBCF186B](http://urn:lsid:zoobank.org:act:419A1C29-F941-42A7-9663-4FE9CBCF186B)

Figs 2, 16

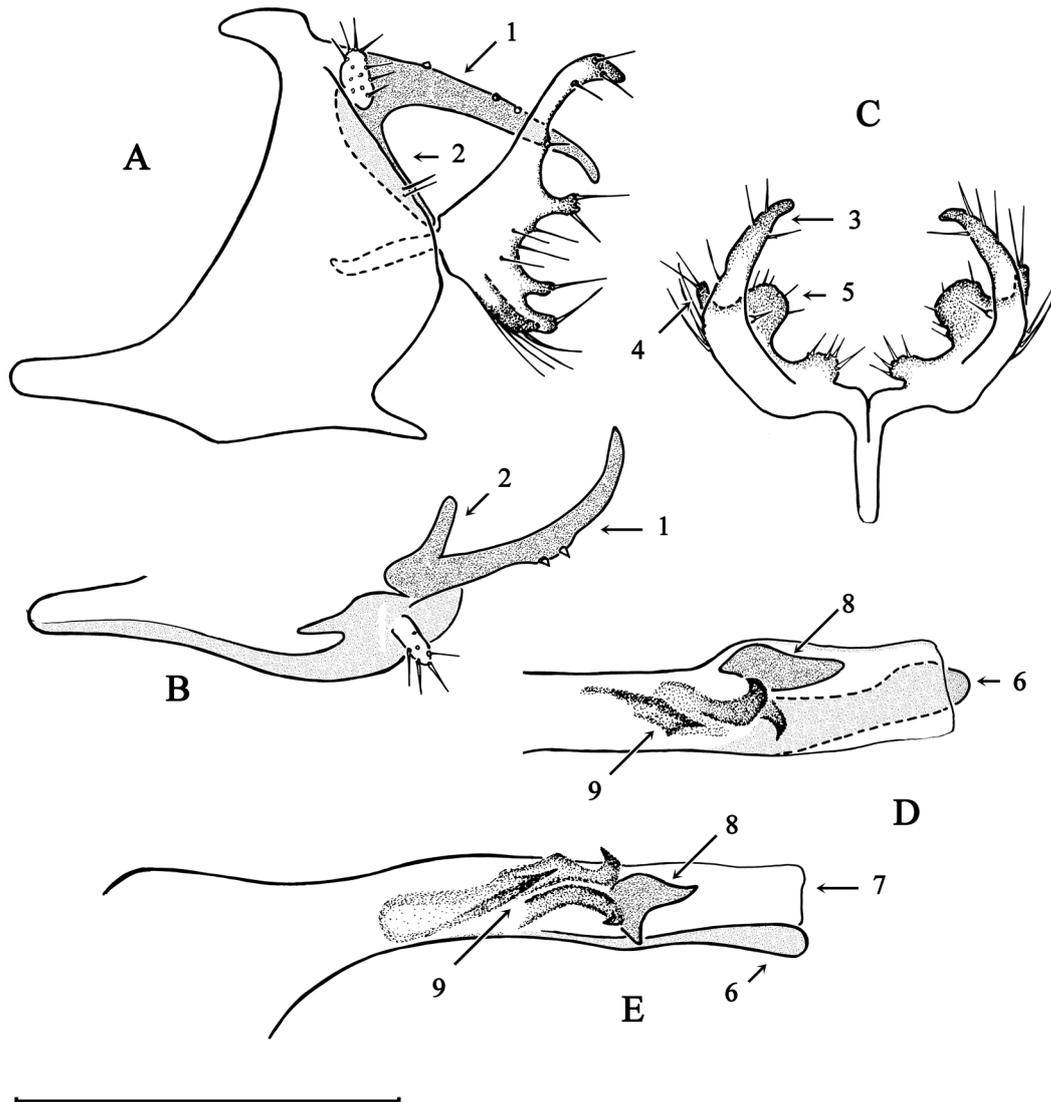
## Diagnosis

*Chimarra lehibemavo* sp. nov. is one of the largest Afrotropical species of the genus. Together with *C. cebegepi* sp. nov. and *C. saha* sp. nov. it forms a sub-group being characteristic in having a long and finger-shaped dorsal branch of tergum X (Fig. 2A1, B1) and a long dorsal branch of the inferior appendage (Fig. 2A, C3). *Chimarra lehibemavo* sp. nov. is characterized by the phallic internal sclerite

which is stout and shorter than the phallosclerite, whereas longer in *Chimarra cebegepi* sp. nov. (Fig. 3D–E) and *Chimarra saha* sp. nov. (Fig. 13D–E).

### Etymology

From the Malagasy ‘lehibe’ (= big) and ‘mavo’ (= yellow), referring to the colour and large size of the species.



**Fig. 2.** *Chimarra lehibemavo* sp. nov. **A–B.** Abdominal segments IX and X. **A.** Lateral view. **B.** Dorsal view (*partim*). **C.** Inferior appendage, dorsal view. **D–E.** Phallic apparatus. **D.** Dorsal view. **E.** Lateral view. 1 = Lateral lobe of tergum X, dorsal branch. 2 = Lateral lobe of tergum X, ventral branch. 3 = Inferior appendage, dorsal branch. 4 = Inferior appendage, ventral branch. 5 = Inferior appendage, internal lobe. 6 = Phallosclerite, ventral lamina. 7 = Phallosclerite, dorsal lamina. 8 = Phallosclerite, internal sclerite. 9 = Phallosclerite, phallosclerite. Scale bar = 0.5 mm.

## Type material

### Holotype

MADAGASCAR: ♂, mounted on 3 slides, remaining parts in alcohol, Andranomifitatra River, camp IV of the WWF expedition to the Marojejy National Park, 14°26'04" S, 49°44'05" E, 1625 m, 12 Nov. 1996, leg. D. Randriamasimanana and J. Legrand.

### Paratypes

MADAGASCAR: 1 ♂, in alcohol, Andranomifitatra River, camp III of the WWF expedition to the Marojejy National Park, 14°26'02" S, 49°44'05" E, 1225 m, 25 Oct. 1996, leg. D. Randriamasimanana and J. Legrand; 3 ♂♂, in alcohol, camp II of the WWF expedition to the Marojejy National Park, 14°26'02" S, 49°45'47" E, 725 m, 16 Oct. 1996, leg. D. Randriamasimanana and J. Legrand; 1 ♂, mounted on 3 slides, remaining parts in alcohol, camp II of the WWF expedition to the Marojejy National Park, 14°26'10" S, 49°45'37" E, 750 m, 14 Oct. 1996, leg. D. Randriamasimanana and J. Legrand; 1 ♂, mounted on 2 slides, remaining parts in alcohol, camp I of the WWF expedition to the Marojejy National Park, 14°25'50" S, 49°46'18" E, 500 m, 12 Oct. 1996, leg. D. Randriamasimanana and J. Legrand.

## Description

SIZE. Forewing 10.0 mm, hind wing 8.0 mm.

TERGUM X. Lateral lobes deeply divided, boomerang-shaped with long dorsal and ventral branches (Fig. 2A).

INFERIOR APPENDAGES. Roughly triangular, anterior margin length about twice the ventral margin length; hypotenuse sinuous; internal lobe small and thumb-shaped on lateral view, wide and sinuous on dorsal view.

PHALLIC APPARATUS. Little modified, ventral lamina separate and forming long digitiform plate (Fig. 2C–D), dorsal lamina wide and sub rectangular; internal sclerite short and stout, bifid lateral view; phallosomal sclerite with one central peaked element and two hook-shaped lateral elements.

## Distribution

Madagascar (endemic), Marojejy National Park.

### *Chimarra cebegepi* sp. nov.

[urn:lsid:zoobank.org:act:F5486868-6EBC-46F2-97C8-9AE3A893C8B7](http://urn:lsid:zoobank.org:act:F5486868-6EBC-46F2-97C8-9AE3A893C8B7)

Figs 3, 17

## Diagnosis

Together with *C. lehibemavo* sp. nov. and *C. saha* sp. nov., *Chimarra cebegepi* sp. nov. forms a sub-group of three closely related species. *C. lehibemavo* sp. nov. is characterized by the short internal sclerite of the phallic apparatus (Fig. 2D–E), this latter is long and apically curved in the other two species. *C. cebegepi* sp. nov. differs from *C. saha* sp. nov. by the distal margin of the inferior appendage slightly concave and regularly rounded in lateral view (Fig. 3A). Moreover *C. saha* sp. nov. is characterized by the lateral deflection of the dorsal lamina of the phallosome (Fig. 13E), which is more developed than in *C. cebegepi* sp. nov. (Fig. 3E).

## Etymology

The name is designed from the acronym of the Centre de Biologie pour la Gestion des Populations.

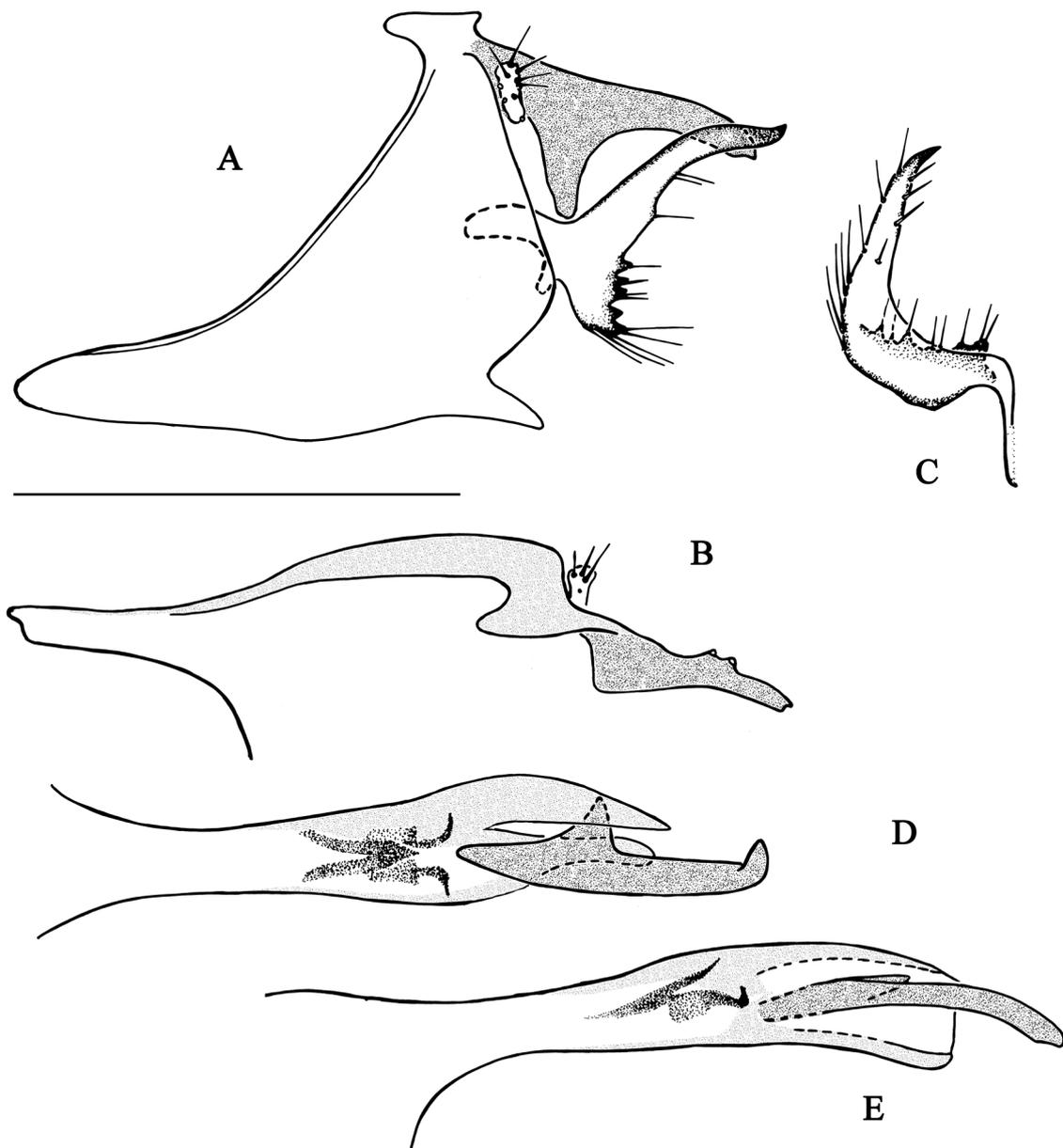
**Type material**

**Holotype**

MADAGASCAR: ♂, mounted on 7 slides, camp I of the WWF expedition to the Marojejy National Park, 14°26'02" S, 49°46'20" E, 450 m, 13 Oct. 1996, leg. D. Randriamasimanana and J. Legrand.

**Paratypes**

MADAGASCAR: 1 ♂, mounted on 3 slides, remaining parts in alcohol, camp II of the WWF expedition to the Marojejy National Park, 14°26'10" S, 49°45'37" E, 750 m, 14 Oct. 1996, leg. D. Randriamasimanana and J. Legrand; 6 ♂♂, in alcohol, camp I of the WWF expedition to the Marojejy National Park, 14°26'13" S, 49°46'17" E, 460 m, 12 Oct. 1996, leg. D. Randriamasimanana and J. Legrand.



**Fig. 3.** *Chimarra cebegepi* sp. nov. **A–B.** Abdominal segments IX and X. **A.** Lateral view. **B.** Dorsal view (partim). **C.** Inferior appendage, dorsal view. **D–E.** Phallic apparatus. **D.** Dorsal view. **E.** Lateral view. Scale bar = 0.5 mm.

## Description

SIZE. Forewing 8.5 mm, hind wing 6.8 mm.

TERGUM X. Lateral lobes not as deeply divided as in *C. lehibemavo* sp. nov., dorsal branch longer than ventral one (lateral view).

INFERIOR APPENDAGES. Dorsal branch elongate, regularly narrowing; ventral branch short; internal lobe constituted by six small indentations (Fig. 3C); distal margin concave and regularly rounded in lateral view (Fig. 3A).

PHALLIC APPARATUS. Phallosome split from mid-length in two asymmetrical laminas of equivalent length; internal sclerite long (longer than the laminas of the phallosome) with curved apex and, before mid-length, short and triangular protuberance (Fig. 3D); phallosomal sclerite present with two lateral, hook-shaped elements.

## Distribution

Madagascar (endemic), Marojejy National Park.

*Chimarra fenoovo* sp. nov.

[urn:lsid:zoobank.org:act:F13971CA-B594-4FDF-9A4D-FB32EDE20E78](https://doi.org/10.21203/rs.3.rs-139711CA-B594-4FDF-9A4D-FB32EDE20E78)

Figs 4, 15

## Diagnosis

*Chimarra fenoovo* sp. nov. is closely related to *C. forcillinii* sp. nov. These two species are characterized by the curved dorsal branches of tergum X (Figs 4B, 5B). They differ by the shape of the inferior appendages: triangular in *C. fenoovo* sp. nov. (Fig. 4A), whereas L-shaped in *C. forcillinii* sp. nov. (Fig. 5A).

## Etymology

The name is that of the nearest city to the type locality.

## Type material

### Holotype

MADAGASCAR: ♂, mounted on 6 slides, tributary of the Manampanihy River near Fenoovo, 24°41'00" S, 46°53'39" E, 72 m, 15 Apr. 1992, leg. J.-M. Elouard.

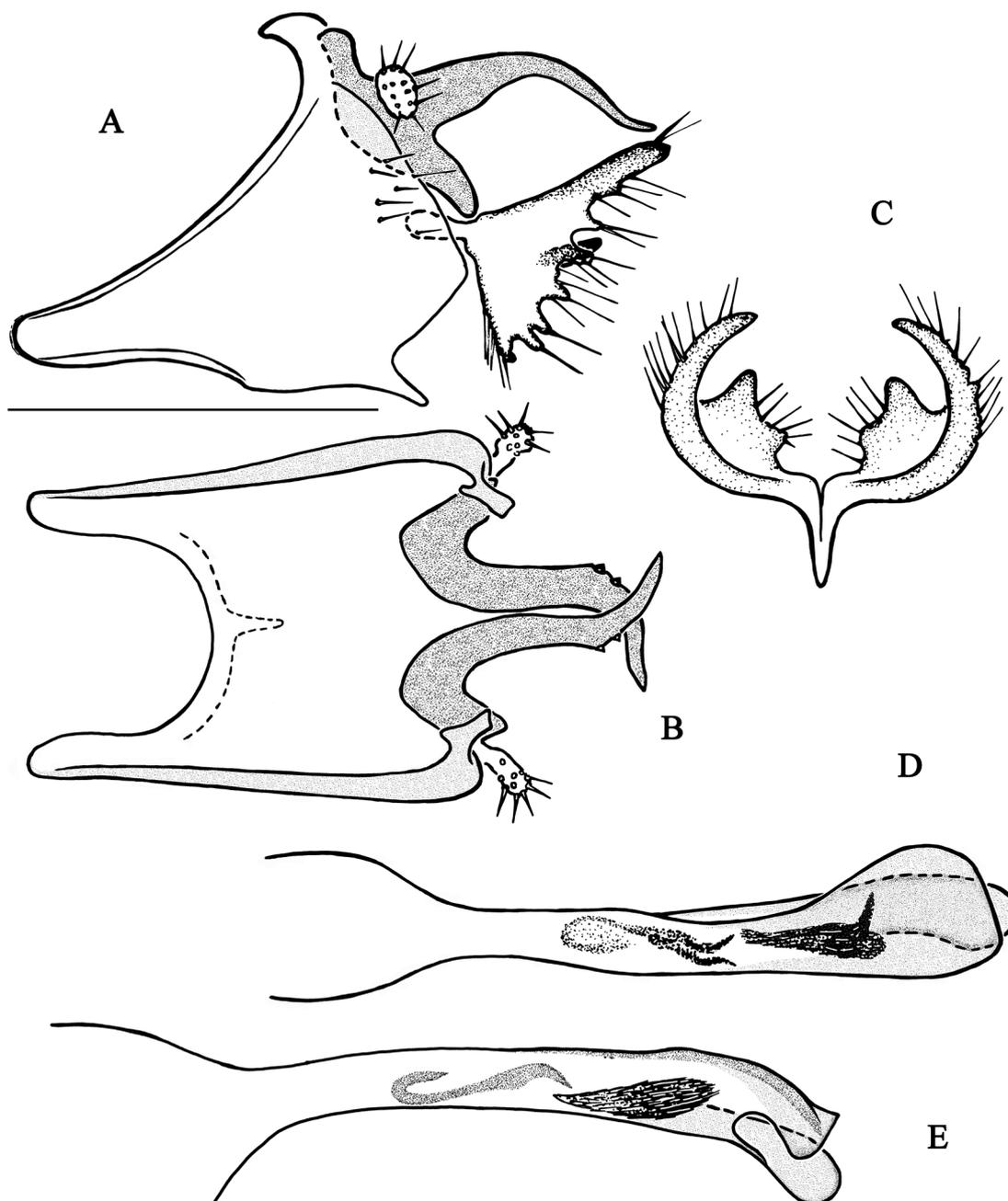
### Paratypes

MADAGASCAR: 1 ♂, mounted on 4 slides, same data as holotype; 3 ♂♂, in alcohol, same data as holotype; 3 ♂♂, Manambolo River, seven kilometres from Berohanga, 24°35'07" S, 46°35'11" E, 440 m, 5 Jun. 1994.

## Other specimens

MADAGASCAR: 1 ♂, tributary of the Rianila River, road to Lakato, 48°21'50" E, 19°03'30" S, 1075 m, 12 Mar. 1993; 1 ♂, Namorona River, Ranomafana, 47°27'18" E, 21°15'37" S, 725 m, 13 Nov. 1993 and 16 Apr. 1994; 1 ♂, tributary of the Namorona River, Ranomafana, 47°25'57" E, 21°15'00" S, 875 m, 14 Nov. 1993; 1 ♂, Ambatoharanana River, Ranomafana, 47°27'34" E, 21°15'15" S, 800 m, 17 Apr. 1994; 1 ♂, Tamara River, 4 km from Ranomafana, 47°25'37" E, 21°14'45" S, 850 m, 17 Apr. 1994; 1 ♂, Ambatandrano River at Ambatandrano, 47°26'32" E, 21°14'45" S, 775 m, 17 Apr. 1994; 1 ♂, tributary of the Namorona River, 47°25'11" E, 21°15'47" S, 1225 m, 18 Apr. 1994; 1 ♂, tributary

of the Betsiboka River, 5 km from Mahatsinjo, 47°00'52" E, 17°46'30" S, 950 m, 1 Dec. 1994; 1 ♂, tributary of the Ankeniheny River, Manjakatampo, 47°18'46" E, 19°21'23" S, 1700 m, 6 Mar. 1995; 1 ♂, Vakoho River, road to Lakato, 48°23'57" E, 19°07'13" S, 820 m, 20 Mar. 1995; 1 ♂, Sahatandra River, Ambodirina, 48°20'28" E, 19°01'32" S, 980 m, 21 Mar. 1995; 1 ♂, tributary of the Rianila River, road to Lakato, 48°21'38" E, 19°03'07" S, 1050 m, 21 Mar. 1995; 1 ♂, Bezavo River, Iloty, 46°36'32" E, 24°38'10" S, 525 m, 06 Jun. 1994; 1 ♂, Bezavo River, Berohanga, 46°36'07" E, 24°38'57" S, 550 m, 6 Jun. 1994; 1 ♂, Tamara River, 4 km from Ranomafana, 47°25'37" E, 21°14'45" S, 850 m, 24 May 1995;



**Fig. 4.** *Chimarra fenoevo* sp. nov. **A–B.** Abdominal segments IX and X. **A.** Lateral view. **B.** Dorsal view. **C.** Inferior appendage, dorsal view. **D–E.** Phallic apparatus. **D.** Dorsal view. **E.** Lateral view. Scale bar = 0.5 mm.

1 ♂, Maintimbahatra, ferry road to Ankarimbelo, 47°19'46" E, 22°07'32" S, 480 m, 20 Jun. 1995; 1 ♂, Sakamalio, Andohahela, 46°40'56" E, 24°32'07" S, 750 m, 2 Feb. 1996; 1 ♂, Manambaroa River, 24 km from Amborompotsy, 46°23'55" E, 20°37'10" S, 1100 m, 24 May 1996; 1 ♂, tributary of the Tsiribihina River, Tambaro, 45°43'10" E, 20°25'40" S, 187 m, 25 May 1996; 1 ♂, Manantenina River, Marojejy Camp I of the WWF expedition to the National Park, 49°46'20" E, 14°26'02" S, 450 m, 4 Oct. 1996; 1 ♂, Tsaratango River, Tsaratango, 47°31'50" E, 21°16'33" S, 585 m, 8 Nov. 1996; 1 ♂, tributary of the Namorona River, near Ranomafana, 47°26'36" E, 21°15'07" S, 780 m, 6 Nov. 1996; 1 ♂, Tsaratango River, 47°31'35" E, 21°16'20" S, 537 m, 13 Nov. 1996; 1 ♂, tributary of the Rianila River, road to Lakato 48°21'48" E, 19°02'40" S, 1050 m, 22 Apr. 1997; 1 ♂, Camp I of the WWF expedition to the Marojejy National Park, 49°46'33" E, 14°26'20" S, 430 m, 17 Oct. 1996.

### Description

SIZE. Forewing 8.3 mm, hind wing 6.6 mm.

TERGUM X. Ventral branch short, directed ventrally; dorsal branch elongated and curved ventrally, apices crossing in dorsal view.

INFERIOR APPENDAGES. Triangular, hypotenuse sinuous, with half a dozen of small lobes (lateral view), internal lobe large, very apparent on the dorsal view (Fig. 4C).

PHALLIC APPARATUS. Distal part of dorsal lamina widened and rounded, ventral lamina digitiform, slightly longer than dorsal lamina; internal sclerite short with a rough surface and a small lateral extension (Fig. 4D); phallotremal sclerite relatively small and thin.

### Distribution

Madagascar (endemic), quite widely distributed.

*Chimarra forcellini* sp. nov.

[urn:lsid:zoobank.org:act:656986B7-7CBD-45A3-B73D-6C12058B2079](http://urn:lsid:zoobank.org:act:656986B7-7CBD-45A3-B73D-6C12058B2079)

Figs 5, 16

### Diagnosis

*Chimarra forcellini* sp. nov. is a close relative of *C. fenoevo* sp. nov. These two species differ by the shape of the inferior appendages (lateral view), L-shaped in *C. forcellini* sp. nov. (Fig. 5A), whereas triangular in *C. fenoevo* sp. nov. (Fig. 4A). Another useful diagnostic character is the maximum width of the phallotheca: that is at the apex in *C. fenoevo* sp. nov. (Fig. 4D), whereas in *C. forcellini* sp. nov. it is in the middle of the tubular part (Fig. 5D).

### Etymology

This species is dedicated to Maxence Forcellini in tribute to his work for the aquatic biomonitoring of La Réunion.

### Type material

#### Holotype

MADAGASCAR: ♂, Sahatandra River near Ambodiriana, 19°01'32" S, 48°20'28" E, 980 m, 4 Apr. 1992, leg. J.-M. Elouard.

### Description

SIZE. Forewing 6.3 mm, hind wing 5.3 mm.

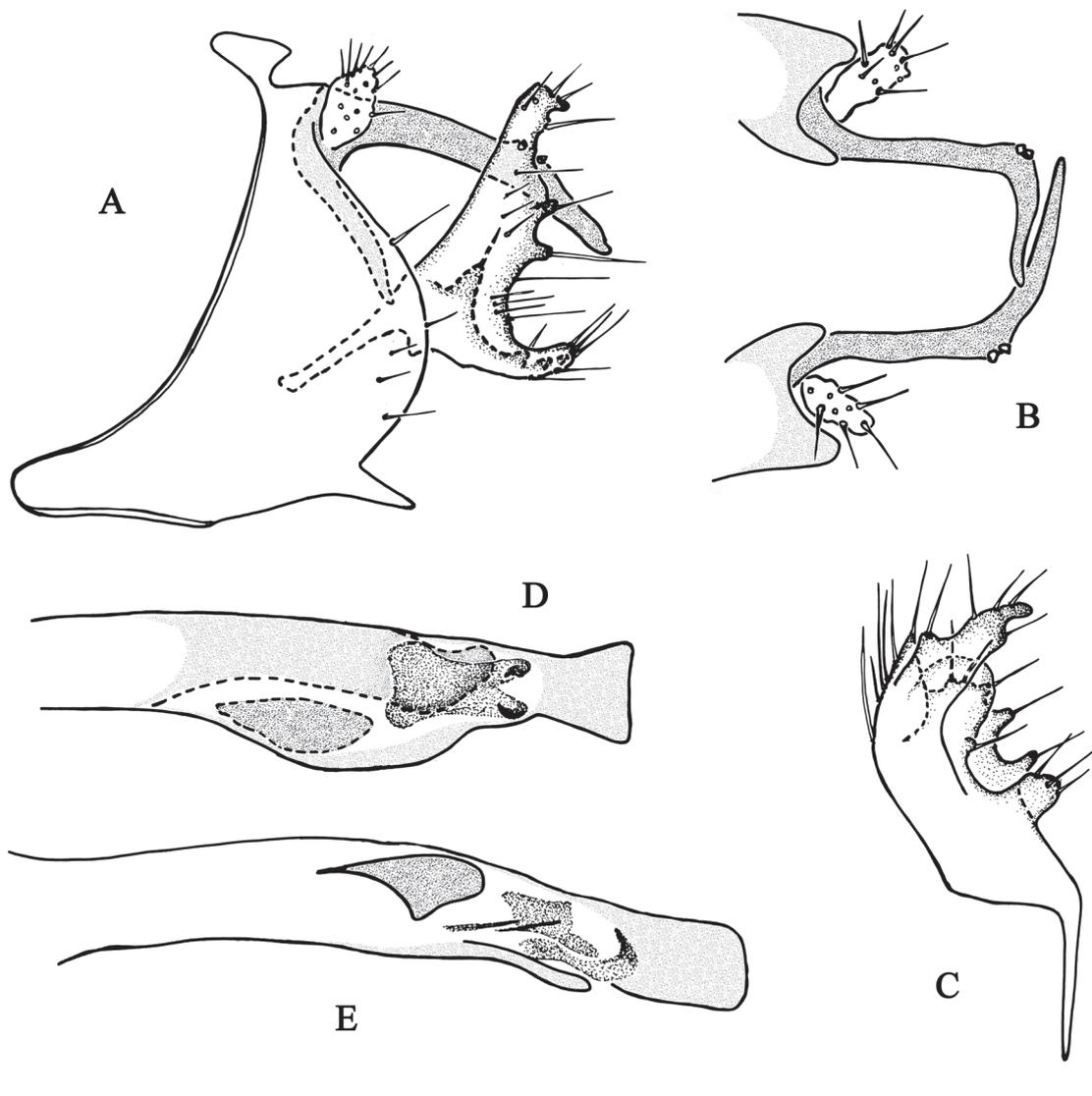
TERGUM X. Both dorsal and ventral branches elongated, ventral branch almost straight, dorsal branch slightly and regularly curved ventrad in lateral view, strongly angled inward in dorsal view (Fig. 5B).

INFERIOR APPENDAGES. L-shaped (lateral view), anterior branch twice as long as ventral one, distal margin sinuous.

PHALLIC APPARATUS. Ventral lamina shorter than dorsal lamina, digitiform (dorsal view); dorsal lamina with prominent median bulge and straight distal edge (Fig. 5D); internal sclerite strong and globular; phallotremal sclerite well developed including an indistinct dorsal element (Fig. 5E) and a broad plate ending in two hooks (Fig. 5D).

### Distribution

Madagascar (endemic), Rianila River basin.



**Fig. 5.** *Chimarra forcellini* sp. nov. **A–B.** Abdominal segments IX and X. **A.** Lateral view. **B.** Dorsal view. **C.** Inferior appendage, dorsal view. **D–E.** Apex of the phallic apparatus. **D.** Dorsal view. **E.** Lateral view. Scale bar = 0.5 mm.

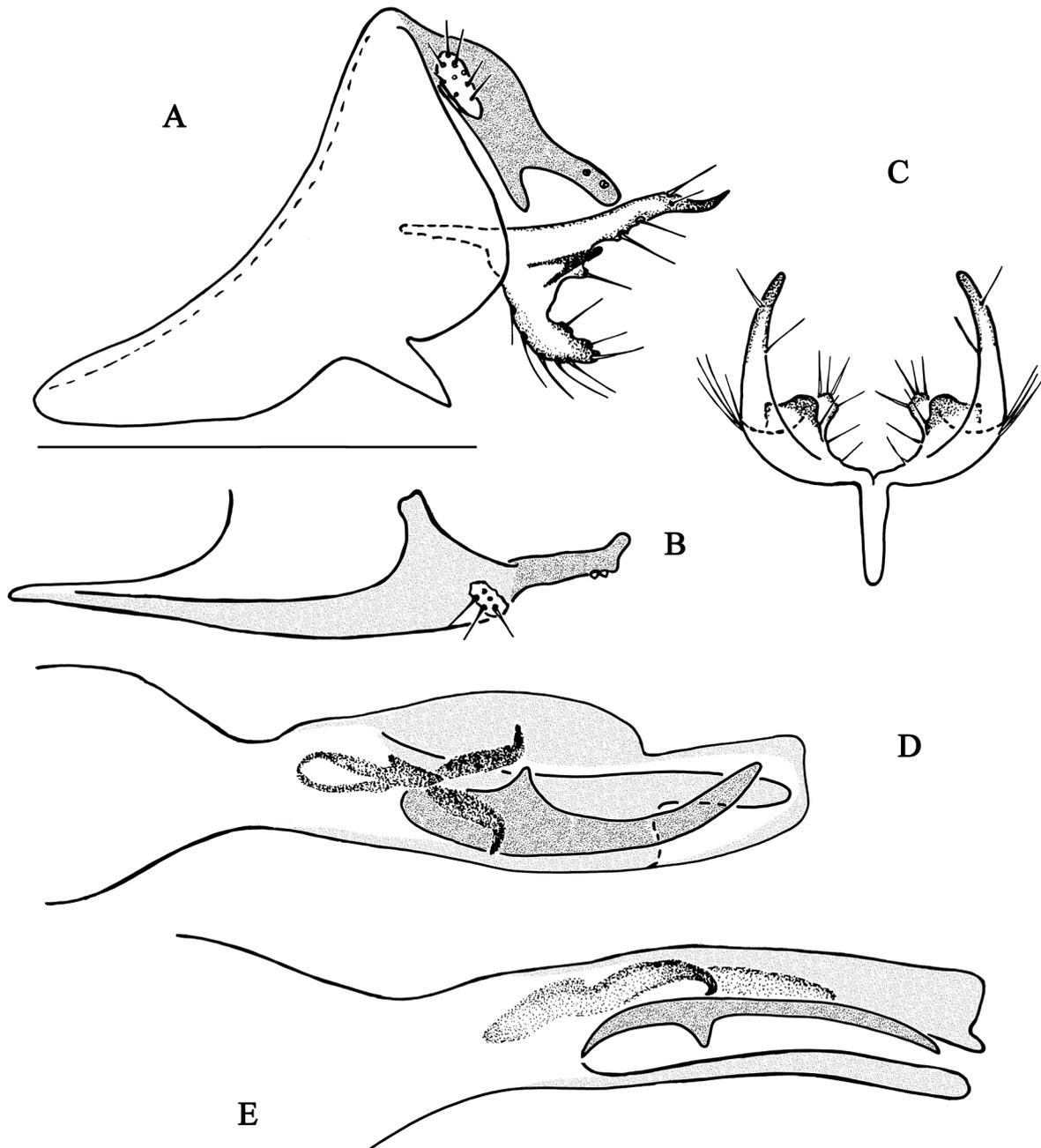
*Chimarra fotobohitra* sp. nov.

[urn:lsid:zoobank.org:act:822F3327-0079-4707-A056-9A5BD6455852](https://doi.org/10.21203/rs.3.rs-1711111/v1)

Figs 6, 17

**Diagnosis**

*Chimarra fotobohitra* sp. nov. differs from the other species of the group by the ventral branch of tergum X, which is short and forms with the dorsal branch an angle of about 20° (Fig. 6A). When it is measurable, this angle is greater than 40°, except in *C. gattolliati* sp. nov. and *C. lehibemavo* sp. nov.,



**Fig. 6.** *Chimarra fotobohitra* sp. nov. **A–B.** Abdominal segments IX and X. **A.** Lateral view. **B.** Dorsal view (partim). **C.** Inferior appendage, dorsal view. **D–E.** Phallic apparatus. **D.** Dorsal view. **E.** Lateral view. Scale bar = 0.5 mm.

where it is around 35° (Fig. 7A, 2A). Another remarkable character of this species is the strong median narrowing of the dorsal lamina (Fig. 6D), also observed in *C. gensonae* sp. nov., but with a different shape (Fig. 8E).

### Etymology

The name is that of the river where the holotype was collected.

### Type material

#### Holotype

MADAGASCAR: ♂, wings and genitalia mounted on 4 slides, remaining parts in alcohol, Fotobohitra River, 11 km from Kianjavato 21°22'39" S, 47°52'00" E, 50 m, 25 May 1995.

### Description

SIZE. Forewing 5.5 mm, hind wing 4.4 mm.

TERGUM X. When viewed laterally, lateral lobe forked after mid-length, ventral branch short, dorsal branch barely longer.

INFERIOR APPENDAGES. L-shaped, dorsal branch twice as long as ventral branch, internal lobe rounded and hump-shaped (Fig. 6C).

PHALLIC APPARATUS. Ventral lamina as long as dorsal lamina, but thinner on the lateral and dorsal views; dorsal lamina with a median narrowing (Fig. 6D); internal sclerite long, nearly as long as ventral lamina, with a little, lateral expansion; phallotremal sclerite with a basal globular part and a distal pair of hooks.

### Distribution

Madagascar (endemic), Mananjary River basin.

#### *Chimarra gattolliati* sp. nov.

[urn:lsid:zoobank.org:act:EB25203C-33C7-4244-A74E-FBD14FB3D215](https://zoobank.org/urn:lsid:zoobank.org:act:EB25203C-33C7-4244-A74E-FBD14FB3D215)

Figs 7, 16

### Diagnosis

*Chimarra gattolliati* sp. nov. is most closely related to *C. jejyorum* sp. nov. In both species, the lateral lobes of tergum X are short, the dorsal branches are small and thumb-shaped. The angle between dorsal and ventral branch is more acute in *C. gattolliati* sp. nov. (Fig. 7A) than in *C. jejyorum* sp. nov. (Fig. 9A). But this is not easy to observe, the two species are more quickly distinguished by the inferior appendages or by the phallic apparatus. In *C. gattolliati* sp. nov., the ventral branch of the inferior appendage is distally protruding, the dorsal branch is thin and arched (Fig. 7A); in *C. jejyorum* sp. nov., the ventral branch is not clearly apparent and the dorsal branch is wide and only curved towards the apex (Fig. 9A). The phallosomes of both species are split, in *C. gattolliati* sp. nov., this splitting occurs after mid-length (Fig. 7D), whereas, in *C. jejyorum* sp. nov., it occurs somewhat after the base (Fig. 9D).

### Etymology

This species is dedicated to Jean-Luc Gattolliat in tribute to his work on the Malagasy may flies.

### Type material

#### Holotype

MADAGASCAR: ♂, mounted on 4 slides, tributary of the Manampanihy River near Fenoevo, 24°41'00" S, 46°53'39" E, 72 m, 15 Apr. 1992, leg. J.-M. Elouard.

**Paratype**

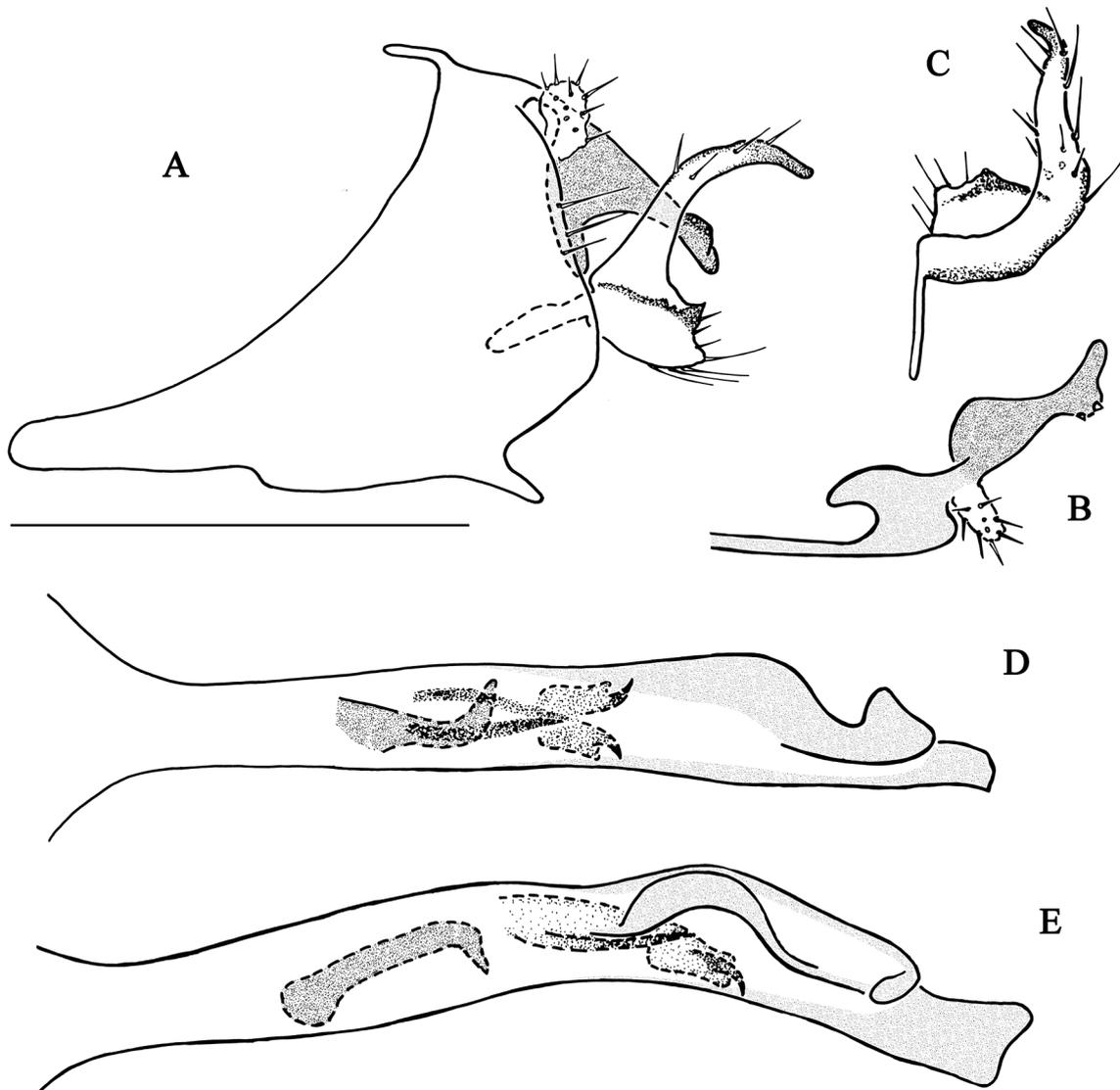
MADAGASCAR: 1 ♂, mounted on 4 slides, remaining parts in alcohol, Andranohela River, camp II of the WWF expedition to the Andohahela National Park, 24°35'33" S, 46°44'19" E, 900 m, 28 Nov. 1995, leg. J.-M. Elouard.

**Description**

SIZE. Forewing 6.6 mm, hind wing 5.5 mm.

TERGUM X. Lateral lobe with wide basal part, short ventral branch and barely longer dorsal branch; when viewed dorsally, dorsal branch angled with, towards the apex, a small protuberance bearing the sensillae.

INFERIOR APPENDAGES. L-shaped (lateral view); ventral branch distally protruding; dorsal branch thin and regularly arched.



**Fig. 7.** *Chimarra gattolliati* sp. nov. **A–B.** Abdominal segments IX and X. **A.** Lateral view. **B.** Dorsal view (partim). **C.** Inferior appendage, dorsal view. **D–E.** Phallic apparatus. **D.** Dorsal view. **E.** Lateral view. Scale bar = 0.5 mm.

PHALLIC APPARATUS. Phallosome split after mid-length; ventral lamina longer than dorsal lamina, dorsal lamina with a lateral fold (Fig. 7E) and an apical curvature (Fig. 7D); phallosomal sclerite with basal part flanked by two indistinct small needles and extended by a pair of hooks; internal sclerite long and stout, with apical curvature, slightly shorter than phallosomal sclerite.

### Distribution

Madagascar (endemic), Andohahela National Park and surrounding areas.

### *Chimarra gensonae* sp. nov.

[urn:lsid:zoobank.org:act:D0D40DA2-B53D-4699-812D-A4BA6B5C80EF](https://doi.org/10.21203/rs.3.rs-10000000)

Figs 8, 18

### Diagnosis

*Chimarra gensonae* sp. nov. is closely related to *C. tamara* sp. nov. When viewed laterally, their tergum X are very similar, characterized by a thick and short dorsal branch and a thin ventral branch (Figs 8A, 14A). The two species differ by the phallosome, short and stout in *C. gensonae* sp. nov. (Fig. 8D–E), long and slim in *C. tamara* sp. nov. (Fig. 14D–E).

### Etymology

It is a pleasure to dedicate this species to my colleague Gwenaëlle Genson in recognition of her efforts for the barcoding of caddisflies.

### Type material

#### Holotype

MADAGASCAR: ♂, mounted on 2 slides, remaining parts in alcohol, Tamara River, 4 km from Ranomafana, 21°14'45" S, 47°25'37" E, 850 m, 24 May 1995.

#### Paratypes

MADAGASCAR: 3 ♂♂, same data as holotype, in alcohol; 1 ♂, Ambatoharanana River near Ranomafana, 21°15'15" S, 47°27'34" E, 850 m, 23 May 1995.

### Other specimens

MADAGASCAR: 1 ♂, mounted on 3 slides, remaining parts in alcohol, Ranomafana National Park, tributary of the Namorona, 21°15'50" S, 47°25'15" E, 1230 m, 7 Nov. 1996.

### Description

SIZE. Forewing 7.6 mm, hind wing 6.0 mm.

TERGUM X. Dorsal branch wide and short, thumb-shaped when viewed laterally, toward the apex a small protuberance with two sensillae; ventral branch thin as long as dorsal branch; dorsal and ventral branches forming an angle of 65°.

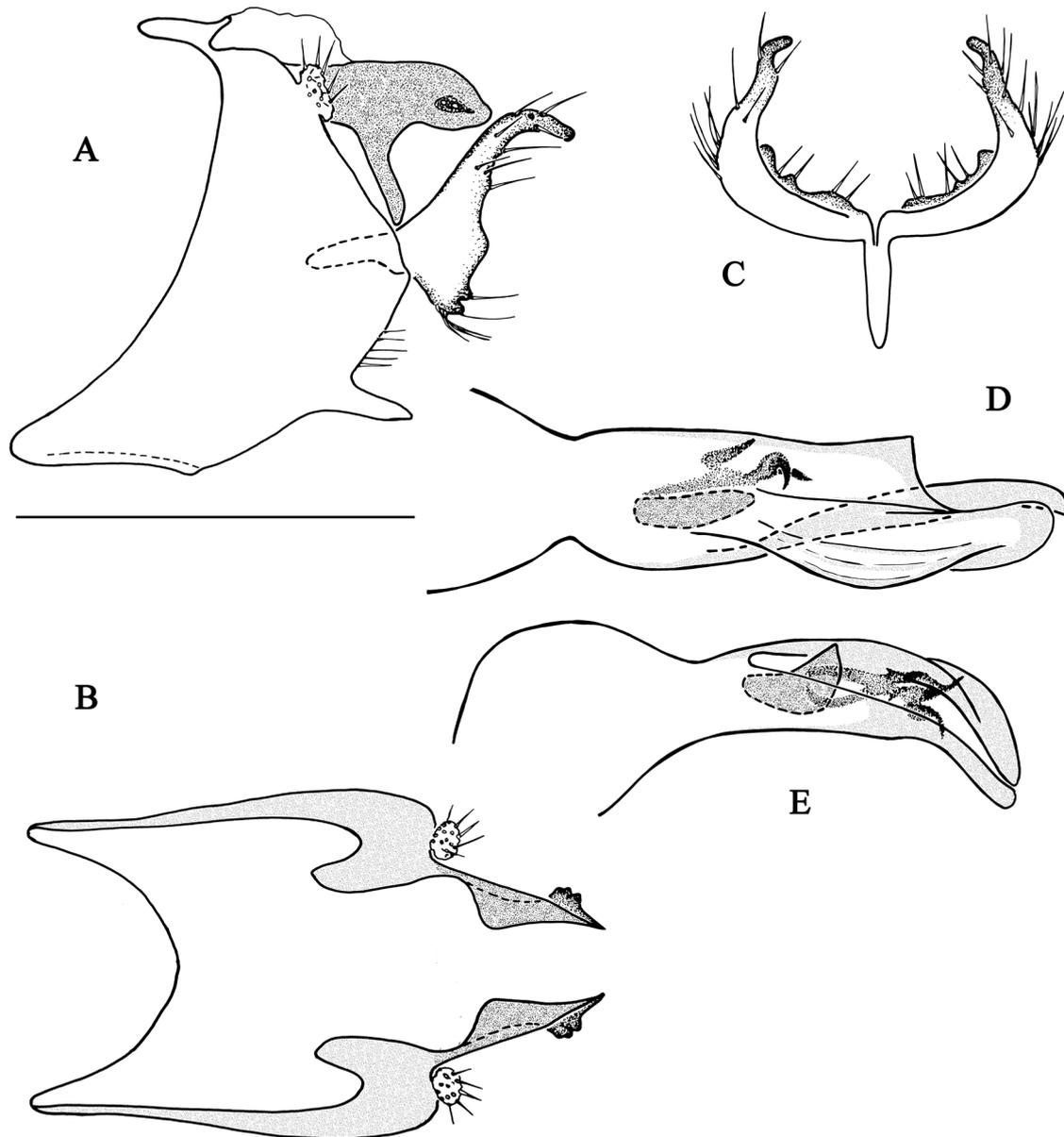
INFERIOR APPENDAGES. Roughly triangular, anterior margin almost twice as long as ventral margin; dorsal part curved distad, inner lobe long, thin, slightly protruding.

PHALLIC APPARATUS. Short compared to other species of the group. Phallosome split nearly from the base; ventral lamina as long as dorsal lamina, thinner and digitiform; when viewed dorsally, dorsal lamina with a lateral fold and a sudden narrowing after mid-length (Fig. 8D); internal sclerite short, stout,

bullet-shaped (Fig. 8E); phallotremal sclerite including an ovoid basal part, a thin spine and a pair of hooks.

### Distribution

Madagascar (endemic), Ranomafana National Park and surroundings areas.



**Fig. 8.** *Chimarra gensonae* sp. nov. **A–B.** Abdominal segments IX and X. **A.** Lateral view. **B.** Dorsal view. **C.** Inferior appendages, dorsal view. **D–E.** Phallic apparatus. **D.** Dorsal view. **E.** Lateral view. Scale bar = 0.5 mm.

*Chimarra jejyorum* sp. nov.

[urn:lsid:zoobank.org:act:714C3E34-8FCB-451E-8A19-10F61A1DF016](https://zoobank.org/act:714C3E34-8FCB-451E-8A19-10F61A1DF016)

Figs 1, 9, 18

**Diagnosis**

*Chimarra jejyorum* sp. nov. is closely related to *C. gattolliati* sp. nov. The two species can be distinguished by the shape of the inferior appendages, as discussed in the diagnosis of *C. gattolliati* sp. nov. or, due to the size of the phallic apparatus, by the phallotheca, split shortly after the base in *C. jejyorum* sp. nov. (Fig. 9D), after mid-length in *C. gattolliati* sp. nov. (Fig. 7D).

**Etymology**

From the Malagasy ‘jejy’ (a traditional musical instrument). It is a reference to the name of the Mountain Marojejy, in translation: where there are many guitars.

**Type material**

**Holotype**

MADAGASCAR: ♂, mounted on 3 slides, remaining parts in alcohol, camp II of the WWF expedition to the Marojejy National Park, 14°26'10" S, 49°45'37" E, 750 m, 14 Oct. 1996, leg. D. Randriamasimanana and J. Legrand.

**Paratypes**

MADAGASCAR: 7 ♂♂, in alcohol, same data as holotype; 1 ♂, camp I of the WWF expedition to the Marojejy National Park, 14°26'02" S, 49°46'20" E, 450 m, 13 Oct. 1996, leg. D. Randriamasimanana and J. Legrand.

**Other specimens**

MADAGASCAR: 1 ♂, mounted on 2 slides, remaining parts in alcohol, Andranomifitatra River, camp III of the WWF expedition to the Marojejy National Park, 14°26'02" S, 49°44'05" E, 1225 m, 25 Oct. 1996, leg. D. Randriamasimanana and J. Legrand.

**Description**

SIZE. Forewing 7.3 mm, hind wing 5.8 mm.

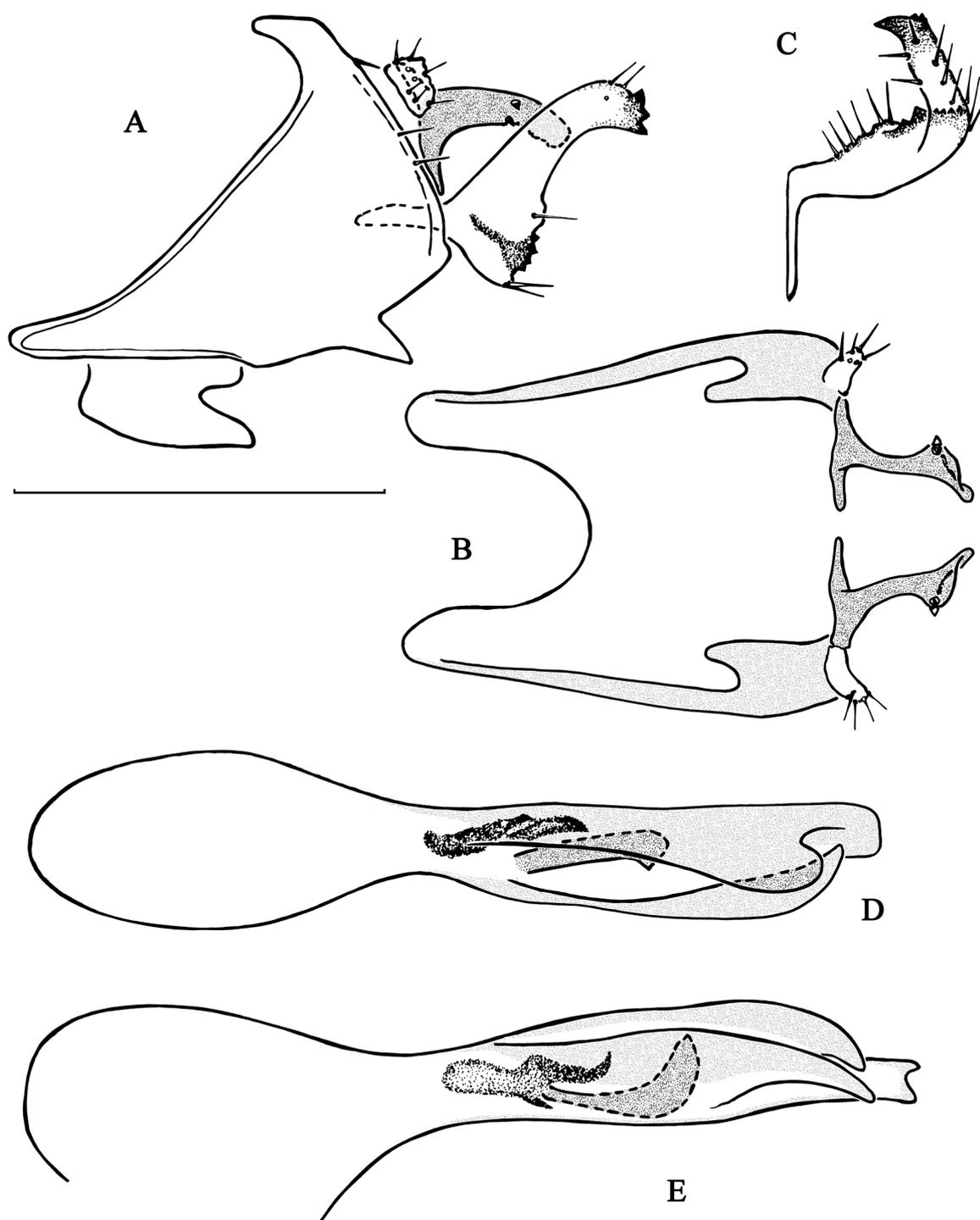
TERGUM X. Ventral branch of lateral lobe short, dorsal branch thumb-shaped, slightly curved ventrad (lateral view), apex contorted with two sensillae (Fig. 9B).

INFERIOR APPENDAGES. Ventral branch reduced, dorsal apex with small denticles.

PHALLIC APPARATUS. Phallotheca split according to a sagittal plane, right lamina large with a big dorso-lateral bump, left lamina nearly as long but thinner (dorsal view); internal sclerite sickle-shaped (lateral view); phallosomal sclerite present, sclerotized but indistinctly shaped.

**Distribution**

Madagascar (endemic), Marojejy National Park.



**Fig. 9.** *Chimarra jejyorum* sp. nov. **A–B.** Abdominal segments IX and X. **A.** Lateral view with ventral margin of sternite VIII. **B.** Dorsal view. **C.** Inferior appendage, dorsal view. **D–E.** Phallic apparatus. **D.** Dorsal view. **E.** Lateral view. Scale bar = 0.5 mm.

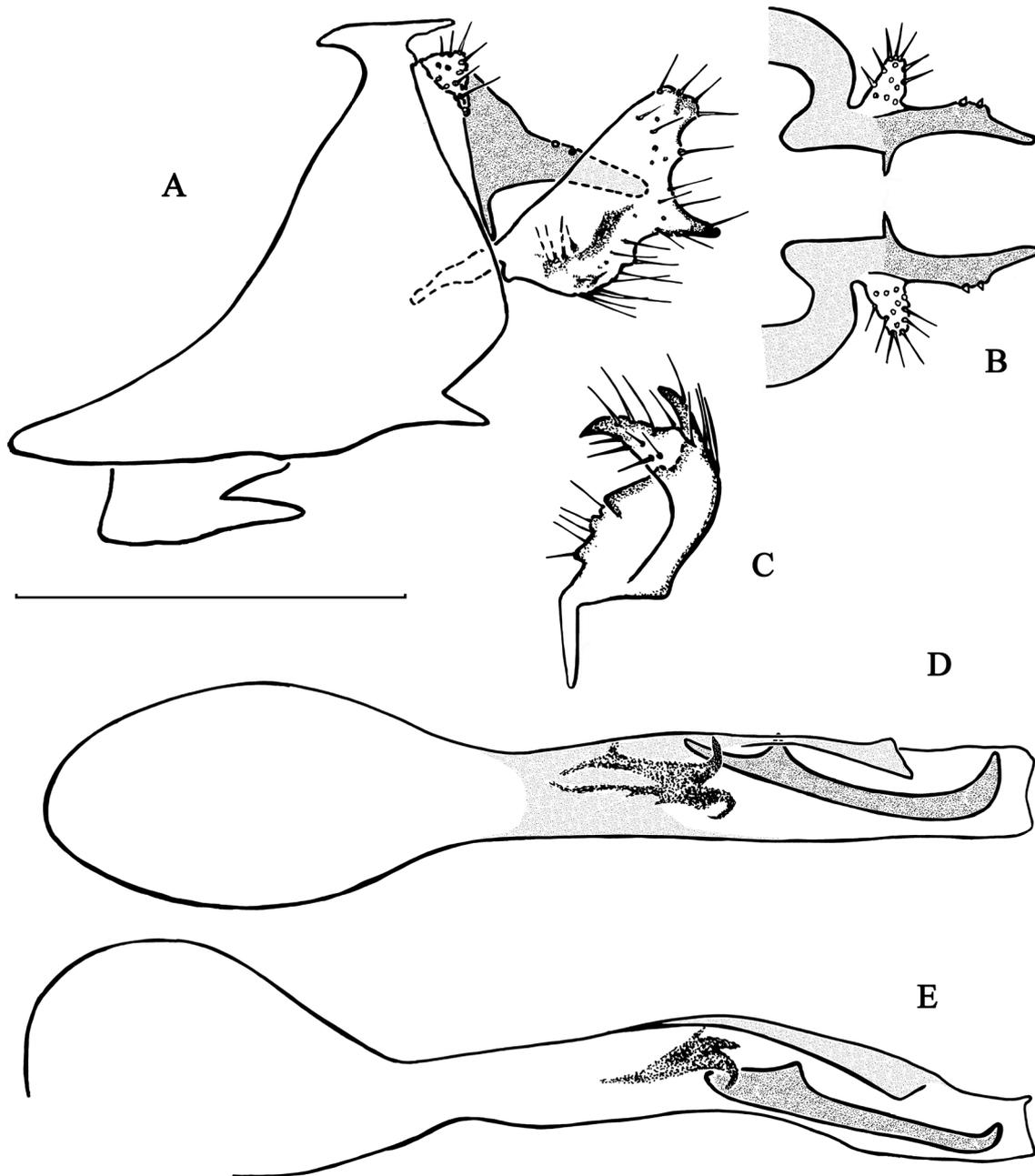
*Chimarra hamatra* sp. nov.

[urn:lsid:zoobank.org:act:EA3CF81A-84AF-4AF0-8997-F48E8E00ADB4](https://doi.org/10.21203/rs.3.rs-10000000/v1)

Figs 10, 17

**Diagnosis**

The closest species to *C. hamatra* sp. nov. is *C. makiorum* sp. nov. The tergum X of these two species are relatively small (as in *C. jejyorum* sp. nov. and in *C. gattolliati* sp. nov.) but, their inferior appendages are roughly rectangular and not triangular or L-shaped as in all the other species of the group. Moreover,



**Fig. 10.** *Chimarra hamatra* sp. nov. **A–B.** Abdominal segments IX and X. **A.** Lateral view with ventral margin of sternite VIII. **B.** Dorsal view. **C.** Inferior appendage, dorsal view. **D–E.** Phallic apparatus. **D.** Dorsal view. **E.** Lateral view. Scale bar = 0.5 mm.

these appendages have a distinct and heavily sclerotized supplementary branch on the distal edge. This branch is inserted at mid-height in *C. hamatra* sp. nov. (Fig. 10A), whereas almost apically in *C. makiorum* sp. nov. (Fig. 11A).

### Etymology

The name is a Malagasy adjective that means ‘uncommon’.

### Type material

#### Holotype

MADAGASCAR: ♂, mounted on three slides, tributary of the Sahatandra River, near Moramanga, 18°56'27" S, 48°29'12" E, 800 m, 28 Apr. 1998, leg. J.-M. Elouard.

### Description

SIZE. Forewing 7.1 mm, hind wing 5.6 mm.

TERGUM X. Lateral lobe reduced; dorsal branch straight (lateral view), relatively short with, at mid-length, a small lateral bump bearing two sensillae; ventral branch short and thin.

INFERIOR APPENDAGES. Wide, roughly rectangular in lateral view; ventral branch weakly developed; median branch protruding, inserted on distal edge (lateral view), making the apex claw-shaped on dorsal view (Fig. 10C).

PHALLIC APPARATUS. Long, distal half of the phallosome poorly sclerotized with the exception of a strip terminated by a triangular tip; internal sclerite long, with a basal triangular extension and curved apex; phallosomal sclerite relatively small, ending in a pair of hooks.

### Distribution

Madagascar (Moramanga area).

*Chimarra makiorum* sp. nov.

[urn:lsid:zoobank.org:act:0874DFCB-4167-488F-8CD8-8F668E4EAE0F](https://zoobank.org/act:0874DFCB-4167-488F-8CD8-8F668E4EAE0F)

Figs 11, 18

### Diagnosis

*Chimarra makiorum* sp. nov. differs from *C. hamatra* sp. nov. by the apical insertion of the median branch of the inferior appendage (at mid-height in *C. makiorum* sp. nov.).

### Etymology

The name is designed from that of the river where the type was collected (Rivière des makis). It is used according to the Latin rules.

### Type material

#### Holotype

MADAGASCAR: ♂, mounted on 3 slides, Montagne d’Ambre, camp I of the WWF expedition to the Park, Makis River, 12°31'40" S, 49°10'09" E, 1075 m, 31 Mar. 1995, leg. J.-M. Elouard.

#### Paratypes

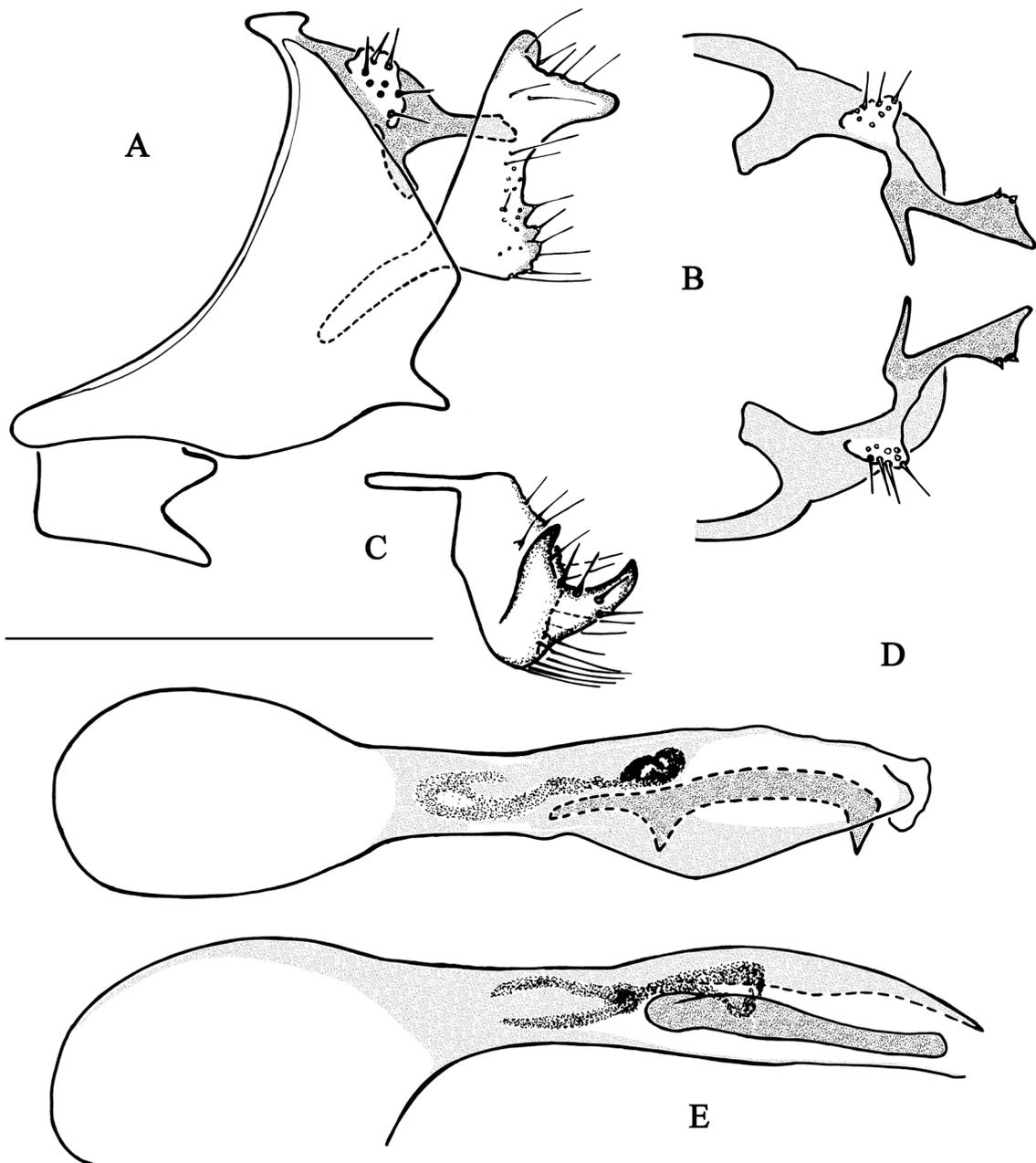
MADAGASCAR: 1 ♂, Montagne d’Ambre, Makis River, 12°29'17" S, 49°10'14" E, 675 m, 2 Apr. 1994, leg. J.-M. Elouard; 2 ♂♂, Montagne d’Ambre, Makis River, 12°31'38" S, 49°10'21" E, 1050 m, leg. J.-M. Elouard.

**Description**

SIZE. Forewing 7.0 mm, hind wing 5.5 mm.

TERGUM X. Lateral lobe with reduced ventral branch and short dorsal branch; dorsal branch straight (lateral and dorsal view), with a lateral bump bearing two sensillae.

INFERIOR APPENDAGES. Wide, roughly rectangular in lateral view; ventral branch weakly developed; median branch protruding, inserted near the apex of distal edge (lateral view), making the apex claw-shaped on dorsal view (Fig. 11C).

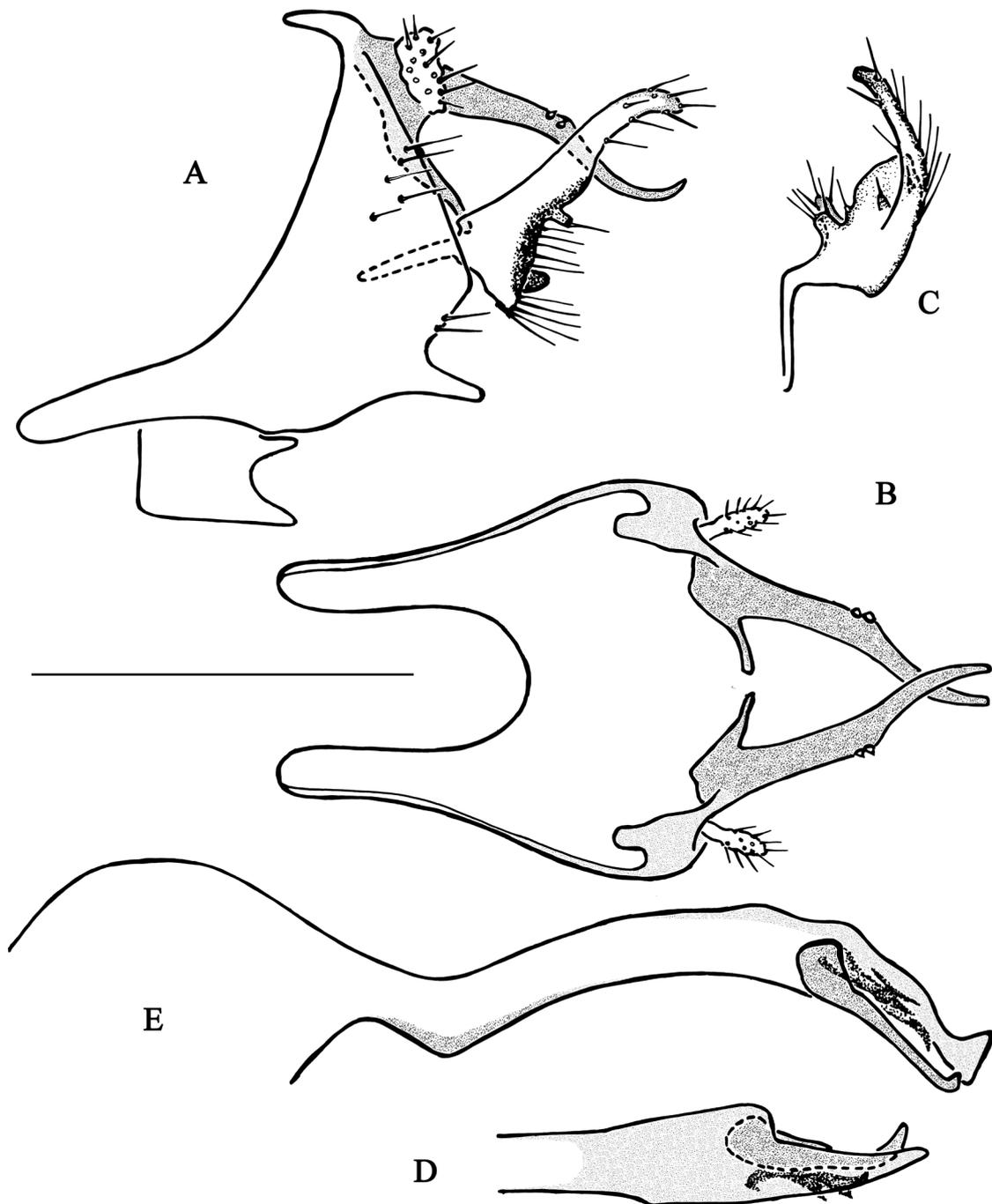


**Fig. 11.** *Chimarra makiorum* sp. nov. **A–B.** Abdominal segments IX and X. **A.** Lateral view with ventral margin of sternite VIII. **B.** Dorsal view (*partim*). **C.** Inferior appendage, dorsal view. **D–E.** Phallic apparatus. **D.** Dorsal view. **E.** Lateral view. Scale bar = 0.5 mm.

PHALLIC APPARATUS. Long, distal half of the phallosome poorly sclerotized with the exception of the dorsal part, whose left edge is laterally extended; internal sclerite long, with a basal triangular extension and curved apex; phallosomal sclerite relatively long (as long as half of the phallosome).

**Distribution**

Madagascar (endemic), Montagne d'Ambre.



**Fig. 12.** *Chimarra moramanga* sp. nov. A–B. Abdominal segments IX and X. A. Lateral view. B. Dorsal view. C. Inferior appendage, dorsal view. D–E. Phallic apparatus. D. Apex, dorsal view. E. Lateral view. Scale bar = 0.5 mm.

*Chimarra moramanga* sp. nov.

[urn:lsid:zoobank.org:act:D6E697EE-4F4D-42EA-A250-0F513A73CB18](https://doi.org/10.3896/BI.2019.66.1.1)

Figs 12, 17

**Diagnosis**

*Chimarra moramanga* sp. nov. differs from the other species of the *lehibemavo* group by the strongly bent base of the tubular part of the phallic apparatus (Fig. 12D).

**Etymology**

The name is that of the nearest city to the type locality.

**Type material**

**Holotype**

MADAGASCAR: ♂, mounted on three slides, tributary of the Sahatandra River, near Moramanga, 18°56'27" S, 48°29'12" E, 800 m, 28 Apr. 1998, leg. J.-M. Elouard.

**Description**

SIZE. Forewing 6.4 mm, hind wing 5.0 mm.

TERGUM X. Dorsal branch of the lateral lobe long (twice as long as the ventral branch), basal part straight, proximal part gently curved dorsad (lateral view), a small bump with two sensillae just before the curvature.

INFERIOR APPENDAGE. Triangular with long anterior margin and short ventral margin, dorsal apex slightly curved distad, inner lobe large and rounded (dorsal view).

PHALLIC APPARATUS. Phallosome strongly angled at base, then gently bent ventrad, distal part (one third of the length) poorly sclerotized with the exception of a dorsal strip with triangular apex (lateral view, Fig. 12D); internal sclerite as long as the modified distal part of the phallosome, with enlarged base and curved apex; phallosomal sclerite shorter than the internal sclerite.

**Distribution**

Madagascar (endemic), Moramanga area.

*Chimarra saha* sp. nov.

[urn:lsid:zoobank.org:act:8CED47DC-B04D-4163-9759-F1AE96D400B1](https://doi.org/10.3896/BI.2019.66.1.2)

Figs 13, 17

**Diagnosis**

By most of its characters, *C. saha* sp. nov. is closely related to *C. moramanga* sp. nov. The remarkable structure of the phallic apparatus of this latter prevents any confusion between the two species. Moreover, *C. saha* sp. nov. is characterized by the laterally deflected dorsal lamina of the phallosome. This deflection makes the distal part of the apparatus wider than the median part (dorsal view).

**Etymology**

From the Malagasy 'saha' (= valley), referring to the name of the type-river, used as a noun in apposition.

**Type material**

**Holotype**

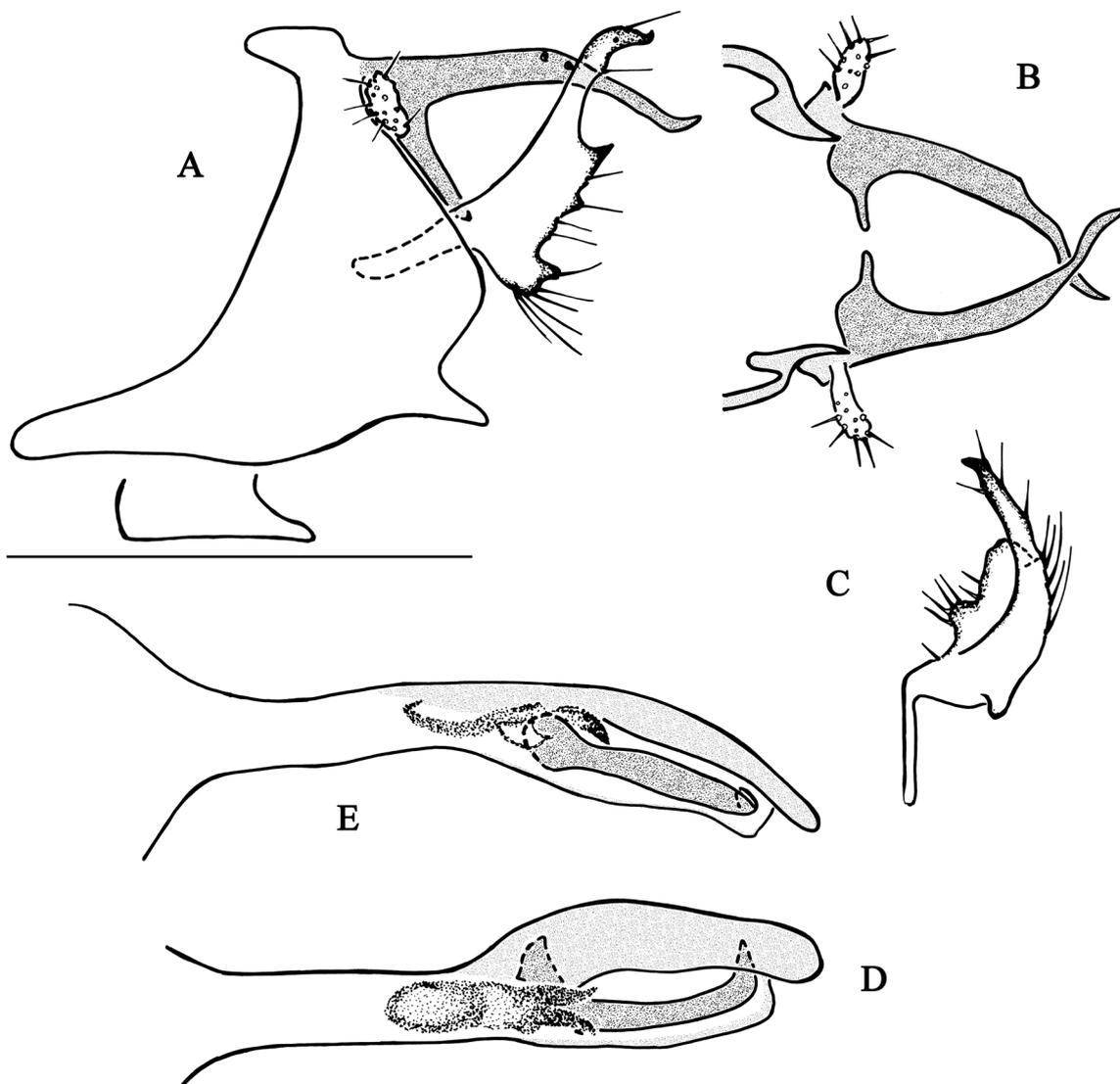
MADAGASCAR: ♂, mounted on 2 slides, remaining parts in alcohol, Sahanivoraky River, 22°13'33"S, 47°00'41" E, 810 m, 19 Nov. 1993.

**Description**

SIZE. Forewing 7.5 mm, hind wing 5.9 mm.

TERGUM X. Dorsal branch of the lateral lobe long (twice as long as the ventral branch), bent ventrad at mid-length with a dorsad curved apex (lateral view).

INFERIOR APPENDAGE. Triangular with long anterior margin, short ventral margin and a small triangular point on distal edge, dorsal apex slightly curved distad, inner lobe large and rounded (dorsal view).



**Fig. 13.** *Chimarra saha* sp. nov. A–B. Abdominal segments IX and X. A. Lateral view with ventral margin of sternite VIII. B. Dorsal view (*partim*). C. Inferior appendage, dorsal view. D–E. Phallic apparatus. D. Dorsal view. E. Lateral view. Scale bar = 0.5 mm.

PHALLIC APPARATUS. Phallosome split at mid-length; dorsal lamina wide, digitiform and laterally deflected; ventral lamina shorter and less sclerotized than dorsal lamina; internal sclerite long; phallosomal sclerite short, with stout pair of hooks.

### Distribution

Madagascar (endemic), Andringitra National Park.

*Chimarra tamara* sp. nov.

[urn:lsid:zoobank.org:act:3C9A5123-F396-4540-8276-6FB2E892DE62](https://doi.org/10.3896/IBID.3C9A5123-F396-4540-8276-6FB2E892DE62)

Figs 14, 16

### Diagnosis

*Chimarra tamara* sp. nov. differs from *C. gensonae* sp. nov. by the long and slim tubular part of the phallic apparatus.

### Etymology

The name is that of the Tamara River, one of those where the species was collected.

### Type material

#### Holotype

MADAGASCAR: ♂, genitalia on 2 slides, remaining parts in alcohol, tributary of the Sahavatoy River, Camp III of the WWF expedition to the Andringitra National Park, 22°12'50" S, 46°58'30" E, 1210 m, 22 Nov. 1993.

#### Paratypes

MADAGASCAR: 2 ♂♂, one mounted on 6 slides, one in alcohol, same data as holotype.

### Other specimens

MADAGASCAR: 2 ♂♂, tributary of the Namorona River near Ranomafana, 21°14'55" S, 47°26'25" E, 800 m, 18 Apr. 1994; 1 ♂, Tamara River, 21°14'45" S, 47°25'37" E, 17 Apr. 1994.

### Description

SIZE. Forewing 7.3 mm, hind wing 5.9 mm.

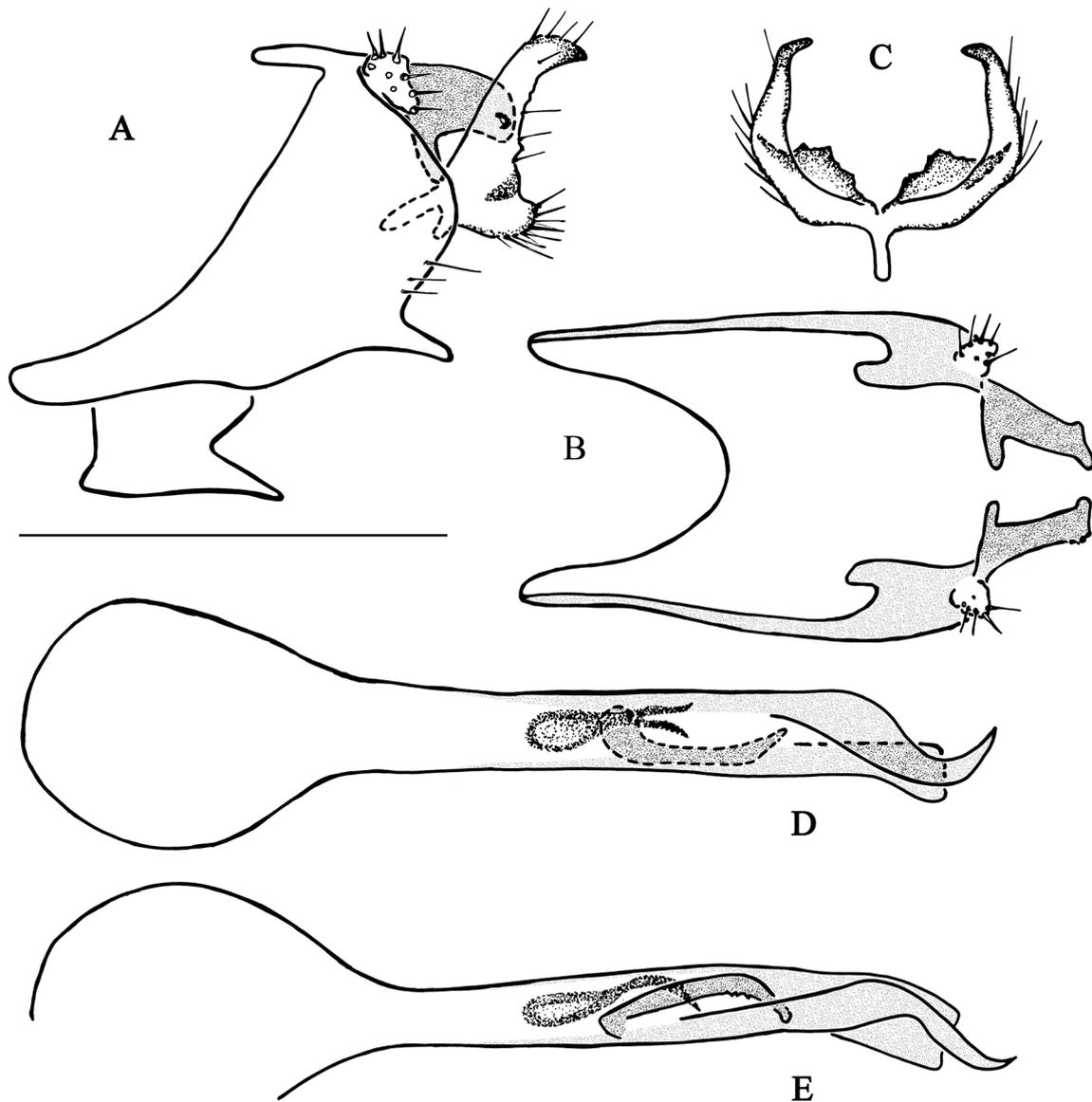
TERGUM X. Ventral branch of lateral lobe small, dorsal branch in direct continuity from the base; when viewed dorsally, apex slightly enlarged, bearing a small protuberance with two sensillae.

INFERIOR APPENDAGE. Dorsal apex curved distad and protruding ventral part (lateral view), inner lobe long forming a serrated big bump on the dorsal view (Fig. 14C).

PHALLIC APPARATUS. Phallosome slim and long, split after mid-length; ventral lamina twisted with acute apex, slightly longer than dorsal lamina; phallosomal and internal sclerites relatively small; internal sclerite slightly longer than phallosomal sclerite, apex curved.

### Distribution

Madagascar (endemic), Andringitra and Namorona National Park.



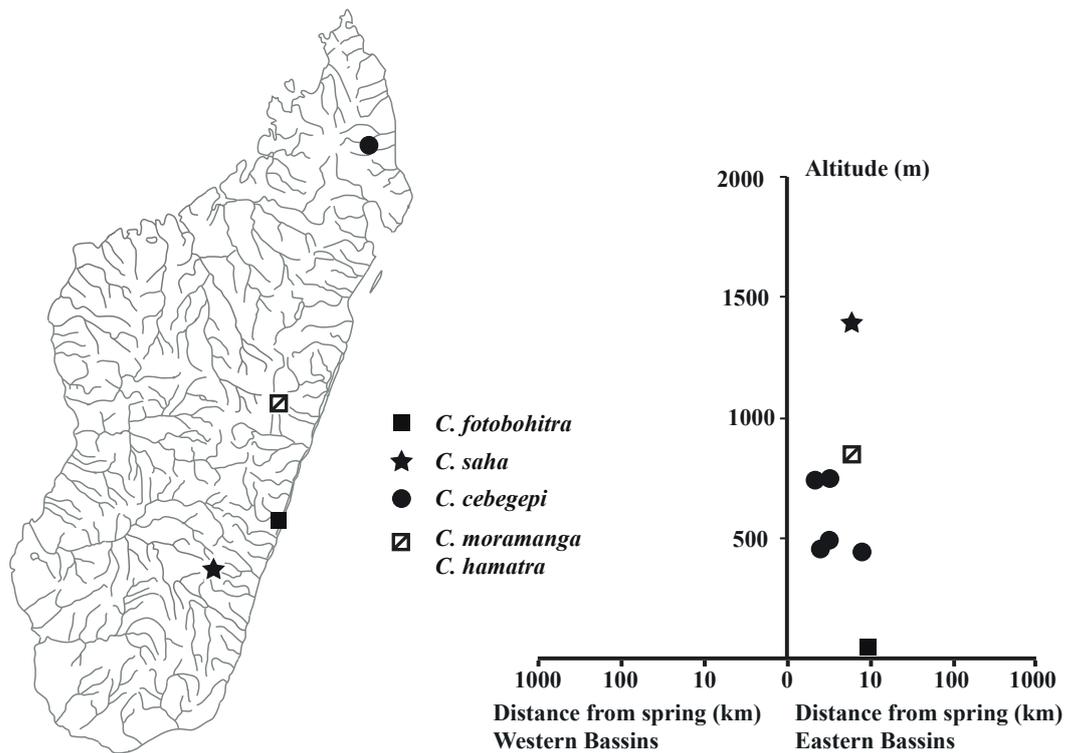
**Fig. 14.** *Chimarra tamara* sp. nov. **A–B.** Abdominal segments IX and X. **A.** Lateral view with ventral margin of sternite VIII. **B.** Dorsal view. **C.** Inferior appendage, dorsal view. **D–E.** Phallic apparatus. **D.** Dorsal view. **E.** Lateral view. Scale bar = 0.5 mm.

### **Geographic Data**

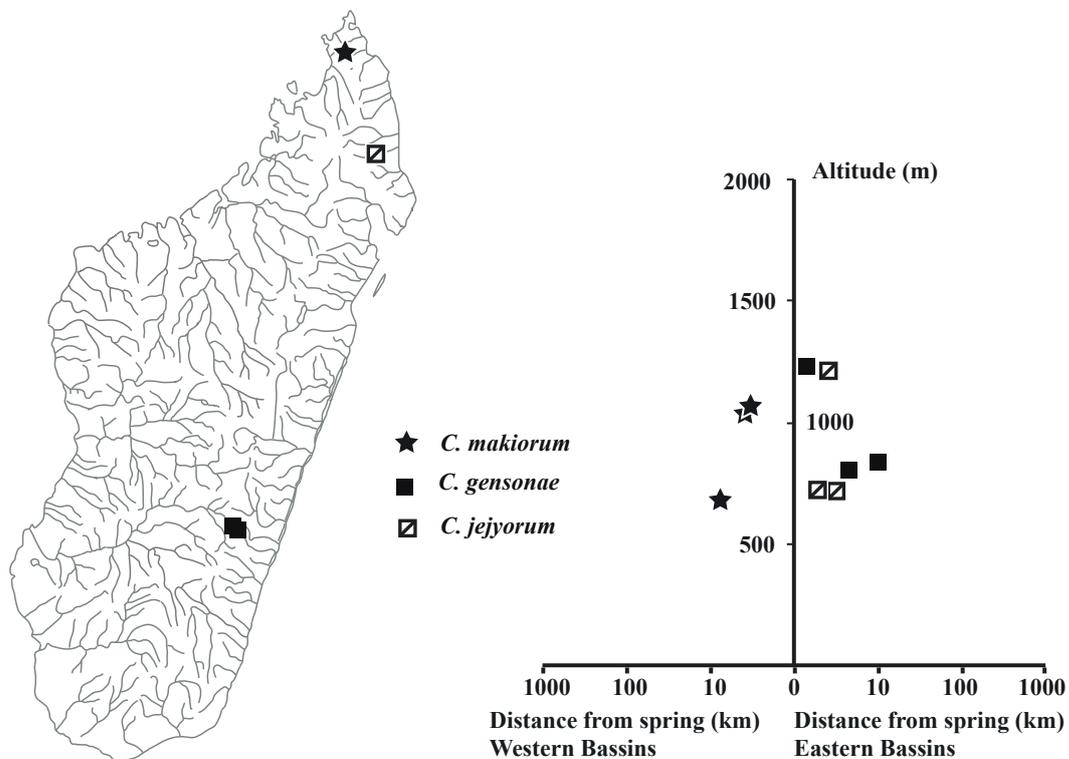
Geographic and ecological information on the *lehibemavo* group are summarized on figures 15 to 18. With one exception discussed thereafter (*C. fenoevo* sp. nov.), the species live in small streams of the oriental rainforests, where they have narrow latitudinal distributions. From the north to the south of the Island, appears a sequence of species or small groups of species:

- Amber Mountain, *C. makiorum* sp. nov.
- Marojejy, *C. cebegepi* sp. nov., *C. jejyorum* sp. nov., *C. lehibemavo* sp. nov.
- Moramanga area, *C. hamatra* sp. nov., *C. moramanga* sp. nov., *C. forcellini* sp. nov.
- Ranomafana, *C. gensonae* sp. nov., *C. tamara* sp. nov.
- Andringitra, *C. saha* sp. nov., *C. tamara* sp. nov.
- Andohahela, *C. gattolliati* sp. nov.





**Fig. 17.** *Chimarra fotobohitra* sp. nov., *Chimarra saha* sp. nov., *Chimarra hamatra* sp. nov., *Chimarra moramanga* sp. nov. and *Chimarra cebegepi* sp. nov., schematic distribution map and ecological profile of the capture sites in Madagascar.



**Fig. 18.** *Chimarra makiorum* sp. nov., *Chimarra gensonae* sp. nov. and *Chimarra jejyorum* sp. nov., schematic distribution map and ecological profile of the capture sites in Madagascar.

Such an eco-geographic pattern was already observed, described and discussed for the Rossinae and for the Philopotaminae (Gibon & Elouard 1996; Gibon 2013, 2014). Compared to the genera *Rossodes* Oezdikmen & Darilmaz, 2008, *Wormaldia* McLachlan, 1865 and *Ranarijaodes* Gibon, 2014, the *lehibemavo* group offers a less extreme situation. One species, *C. tamara* sp. nov., was captured in two adjacent areas (Andringitra and Ranomafana). Moreover, where it can be observed, the altitudinal distributions of the species are wider. In the Marojejy National Park, *C. cebegepi* sp. nov. was collected from 400 to 700 m a.s.l., *C. jejyorum* sp. nov. from 400 to 1200 m a.s.l. and *C. lehibemavo* sp. nov. from 400 to 1600 m a.s.l. In the same area, the six species of *Wormaldia* were strictly restricted to one altitudinal zone (Gibon 2014, table 1). *C. fotobohitra* sp. nov. was collected outside the large area of pristine forest, but on a small stream coming from a forest remnant and is possibly a relic species.

Finally, one species is widely distributed, *C. fenoevo* sp. nov. was collected from the Marojejy in the north to Andohahela in the South, from 70 to 1700 m a.s.l. It was also recorded from the western slope, on headwaters of the Mangoky, Betsiboka and Tsiribihina Rivers. This geographical exception coincides with a different ecological profile. Present on small tributaries, *C. fenoevo* sp. nov. colonizes also broader rivers, further away from the sources, without, however, being a true potamic species (it has never been captured on true large rivers). Another characteristic of this species, compared with other members of the group, is the vegetation of its capture sites. Precisely, the vegetal landscape of the streams (the terrestrial biome *sensu* Ross 1963) and not the riparian vegetation. *Chimarra fenoevo* sp. nov. is the only species of the group that is not associated with the evergreen rainforest. On the eastern slope, it was mainly encountered in the forest transition or in secondary forests; in the Central Highlands, in vestigial or relict gallery forests, above rice field areas.

## Discussion

Species distributions in the *lehibemavo* group are similar to those described for the other subfamilies, Philopotaminae and Rossinae (Gibon 2013, 2014), very different from that described for the *minima* group (Gibon 2015). We can assume that the widely distributed Malagasy species of the *minima* group, morphologically close to their continental relatives, have recently colonized the Island. In comparison, the numerous microendemic species of the *C. lehibemavo* species group possibly belong to a much older fauna. Validation of this hypothesis would require genetic research such as that undertaken by Monaghan *et al.* (2005), who have demonstrated that the Malagasy fauna of Baetidae (Ephemeroptera) is combining archaic and invasive lineages.

## Acknowledgements

I am grateful to all the participants in the program “Biodiversity and Biotypology of the Malagasy continental waters” and to Gwenaëlle Genson for DNA-analysis.

## References

- Blahnik R.J. 1998. A revision of the Neotropical species of the genus *Chimarra*, subgenus *Chimarra* (Trichoptera: Philopotamidae). *Memoirs of the American Entomological Institute* 59: 1–318.
- Blahnik R.J., Holzenthal R.W. & Huisman J. 2009. *Chimarra* of Sabah and Sarawak, northern Borneo (Trichoptera: Philopotamidae). *Tijdschrift voor Entomologie* 152: 109–166.
- Blahnik R.J., Arefina-Armitage T.I. & Armitage B.J. 2012. The genus *Chimarra* Stephens (Trichoptera: Philopotamidae) in Vietnam. *Insecta Mundi* 0229: 1–25.
- Cruaud A., Jabbour-Zahab R., Genson G., Cruaud C., Couloux A., Kjellberg F., van Noort S. & Rasplus J.Y. 2010. Laying the foundations for a new classification of Agaonidae (Hymenoptera: Chalcidoidea),

a multilocus phylogenetic approach. *Cladistics* 26 (4): 359–387. <https://doi.org/10.1111/j.1096-0031.2009.00291.x>

Elouard J.-M. & Gibon F.-M. 2001. *Biodiversité et Biotypologie des eaux continentales de Madagascar*. IRD, Montpellier.

Gibon F.-M. 2000. Biologie de la conservation et singularité des cours d'eau. L'exemple des Philopotamidae malgaches (Insecta, Trichoptera). In: Lourenço W.R. & Goodman S.M. (eds) *Diversité et Endémisme à Madagascar*: 319–330. Société de Biogéographie, Paris.

Gibon F.-M. 2013. Une sous-famille caractéristique des forêts humides primaires malgaches: les Rossodinae (Trichoptera, Philopotamidae). *Zoosystema* 35 (2): 151–174. <https://doi.org/10.5252/z2013n2a2>

Gibon F.-M. 2014. Philopotaminae of Madagascar (Trichoptera: Philopotamidae). *Annales de la Société Entomologique de France (N.S)* 50 (3–4): 382–398. <https://doi.org/10.1080/00379271.2014.982027>

Gibon F.-M. 2015. The *Chimarra minima*-group in West Africa and Madagascar (Trichoptera, Philopotamidae). *Zoosystema* 37 (2): 333–350. <https://doi.org/10.5252/z2015n2a3>

Gibon F.-M. & Elouard J.-M. 1996. Etude préliminaire de la distribution des insectes lotiques à Madagascar (exemples des Trichoptères Philopotamidae et Diptères Simuliidae). In: Lourenço W.R. (ed.) *Biogéographie de Madagascar*: 507–516. ORSTOM, Paris. Available from [http://horizon.documentation.ird.fr/exl-doc/pleins\\_textes/pleins\\_textes\\_6/colloques2/010008490.pdf](http://horizon.documentation.ird.fr/exl-doc/pleins_textes/pleins_textes_6/colloques2/010008490.pdf) [accessed 15 Mar. 2017].

Gibon F.-M., Andriambelo P.Z. & Randriamasimanana D. 1999. A study of the diversity and richness of the Malagasy Trichoptera. In: Chantaramongkol P. & Malicky H. (eds) *Proceedings of the 9th International Symposium on Trichoptera*: 123–124. University of Chiang-Mai, Chiang-Mai. Available from <http://www.documentation.ird.fr/hor/fdi:010021248> [accessed 15 Mar. 2017].

Goodman S.M. (ed.) 1996. A Floral and Faunal Inventory of the Eastern Slopes of the Réserve Naturelle Intégrale d'Andringitra, Madagascar: with reference to elevational variation. *Fieldiana: Zoology (new series)* 85: 1–319.

Goodman S.M. (ed.) 1999. A floral and faunal inventory of the réserve naturelle intégrale d'Andohahela, Madagascar: with reference to elevational variation. *Fieldiana: Zoology (new series)* 94: 1–297.

Goodman S.M. (ed.) 2000. A floral and faunal inventory of the parc national de Marojejy, Madagascar: with reference to elevational variation. *Fieldiana: Zoology (new series)* 97: 1–286.

Kjer K.M., Zhou X., Frandsen P.B., Thomas J.A. & Blahnik R.J. 2014. Moving toward species-level phylogeny using ribosomal DNA and CO1 barcodes: an exemple from the diverse caddisfly genus *Chimarra* (Trichoptera: Philopotamidae). *Arthropods Systematics and Phylogeny* 72 (3): 345–354.

Monaghan M.T., Gattolliat J.-L., Sartori M., Elouard J.-M., James H., Derleth P., Glaizot O., de Moor F., Vogler A.P. 2005. Trans-oceanic and endemic origins of the small minnow mayflies (Ephemeroptera, Baetidae) of Madagascar. *Proceedings of the Royal Society B Biological Sciences* 272 (1574): 1829–1836. <https://doi.org/10.1098/rspb.2005.3139>

Morse J.C. 2015. *Trichoptera World Checklist*. Available from <http://www.clemson.edu/cafls/departments/esps/database/trichopt/index.htm> [accessed 17 Mar. 2017].

Randriamasimanana D. & Gibon F.-M. 2001. Etude systématique, habitat et répartition géographique des *Setodes* (Trichoptera : Leptoceridae) de Madagascar. *Annales de Limnologie – International Journal of Limnology* 37 (2): 125–141. <https://doi.org/10.1051/limn/2001008>

- Ratnasingham S. & Hebert P.D.N. 2007. BOLD: The Barcoding of Life Data System ([www.barcodinglife.org](http://www.barcodinglife.org)). *Molecular Ecology Notes* 7 (3): 355–364. <https://doi.org/10.1111/j.1471-8286.2007.01678.x>
- Resh V.H. & Unzicker J.D. 1975. Water quality monitoring and aquatic organisms: the importance of species identification. *Journal of the Water Pollution Control Federation* 47: 9–19.
- Ross H.H. 1956. *Evolution and classification of the mountain caddisflies*. The University of Illinois Press, Urbana.
- Ross H.H. 1963. Stream communities and terrestrial biome. *Archiv für Hydrobiologie* 59: 235–242.
- Wilmé L., Goodman S.M. & Ganzhorn J.U. 2006. Biogeographic evolution of Madagascar's microendemic biota. *Science* 312: 1063–1065. <https://doi.org/10.1126/science.1122806>
- Wahlberg E. & Johanson K.A. 2014. The age, ancestral distribution and radiation of *Chimarra* (Trichoptera: Philopotamidae) using molecular methods. *Molecular Phylogenetics and Evolution* 79: 433–442. <https://doi.org/10.1016/j.ympev.2014.06.023>

*Manuscript received: 14 April 2016*

*Manuscript accepted: 24 August 2016*

*Published on: 18 May 2017*

*Topic editor: Gavin Broad*

*Desk editor: Kristiaan Hoedemakers*

Printed versions of all papers are also deposited in the libraries of the institutes that are members of the *EJT* consortium: Muséum national d'Histoire naturelle, Paris, France; Botanic Garden Meise, Belgium; Royal Museum for Central Africa, Tervuren, Belgium; Natural History Museum, London, United Kingdom; Royal Belgian Institute of Natural Sciences, Brussels, Belgium; Natural History Museum of Denmark, Copenhagen, Denmark; Naturalis Biodiversity Center, Leiden, the Netherlands; Museo Nacional de Ciencias Naturales-CSIC, Madrid, Spain; Real Jardín Botánico de Madrid CSIC, Spain.