The *Chimarra minima* group in West Africa and Madagascar (Trichoptera, Philopotamidae)

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ABSTRACT
Among Afrotropical representatives of the genus *Chimarra* Stephens, 1829 (Trichoptera: Philopotamidae), the minima group is defined to include a number of closely related species that lack the mesal lobe of tergum X, have a membranous tergum IX, and also have characteristic structures of the inferior appendages and phallic apparatus. A preliminary list of the species is proposed. The descriptions of *Chimarra ambaja* Mosely, 1939, *Chimarra callasae* Gibon, 1982*, Chimarra sassandrae* Gibon, 1982 and *Chimarra toubaensis* Gibon, 1985 are supplemented. One synonymy is established *Chimarra petri* Gibbs, 1973 as a junior synonym of *Chimarra minima* Ulmer, 1907. Five new species are described: *Chimarra loffae* n. sp. from Guinea, *Chimarra sanagae* n. sp. and *Chimarra assambae* n. sp. from Cameroon, *Chimarra vulgaris* n. sp. and *Chimarra antsymeloka* n. sp. from Madagascar. New citations for West Africa, Cameroon and Madagascar, new distribution and ecological data are included and analysed.

KEY WORDS
Chimarra,
Biogeography,
new citation,
Ivory Coast,
Mali,
Guinea,
Togo,
Burkina Faso,
Cameroon,
Madagascar,
new synonymy,
new species.

RÉSUMÉ
Le groupe Chimarra minima *en Afrique occidentale et à Madagascar (Trichoptera, Philopotamidae).*
Parmi les espèces afrotropicales de *Chimarra* Stephens, 1829, le groupe *minima* est défini pour des espèces apparentées, dont le dizième tergite ne présente pas de lobe mésal, dont le neuvième tergite est membraneux, et qui possèdent appendices inférieurs et appareil phallique. Une liste préliminaire de ces espèces est proposée. Les descriptions de *Chimarra ambaja* Mosely, 1939, *Chimarra callasae* Gibon, 1982*, Chimarra sassandrae* Gibon, 1982 et *Chimarra toubaensis* Gibon, 1985 sont complétées. Une synonymie est reconnue : *Chimarra petri* Gibbs, 1973 synonyme junior de *Chimarra minima* Ulmer, 1907. Cinq nouvelles espèces sont décrites : *Chimarra loffae* n. sp. de Guinée, *Chimarra sanagae* n. sp. et *Chimarra assambae* n. sp. du Cameroun, *Chimarra vulgaris* n. sp. et *Chimarra antsymeloka* n. sp. de Madagascar. Des signalisations nouvelles pour l'Afrique occidentale, le Cameroun et Madagascar, ainsi que des données nouvelles sur la répartition et l'écologie sont présentées et analysées.

MOTS CLÉS
Chimarra,
Biogéographie,
nouvelle citation,
Côte d'Ivoire,
Mali,
Guinée,
Togo,
Burkina Faso,
Cameroun,
Madagascar
synonymie nouvelle,
espèces nouvelles.

INTRODUCTION

In the Afrotropical region, the richness of the genus *Chimarra* Stephens, 1829 (with a little less than a hundred species) is only surpassed by that of the genus *Cheumatopsyche* Wallengren, 1891 (more than one hundred and ten species). All the species belong to the sub-genus *Chimarra* Stephens, 1829, as defined by Blahnik (1998). In order to make sense of the distributions of these remarkable ecological indicators, a phylogenetic approach would be very useful. It will require the examination of many type specimens, some of which are in poor condition or lost. It will also require a joint study of the Asian fauna, because several colonizations have occurred from this continent (Ross 1956). Meanwhile, in order to facilitate the identifications and the descriptions of new taxa, it is possible to recognize some putative monophyletic lines among new species, defined by hypothesised synapomorphies. In this paper, I describe the *Chimarra minima* group, based on the absence of the mesal lobe of tergum X, presence of a membranous tergum IX and the homogeneity within the group of structures of the inferior appendages and phallic apparatus. A preliminary list of species is also provided. This led to improved descriptions for several described species and also the descriptions of three new species from Western Africa and two from Madagascar. A study of the phylogeny of *Chimarra,* using molecular data, has been recently published (Wahlberg & Johanson 2014). They confirm that the sub-genus *Chimarra* colonized the Afrotropical region from the Oriental region, as proposed by Ross (1956). For the moment, the position of the *C. minima* group in the proposed phylogeny remains hypothetical because some species, particularly the Malagasy ones, are still undescribed. The absence of morphological characters prevents to position the *C. minima* group. Nevertheless, the lineage N6, predominantly Australian and Melanesian, includes a group of African species (*Chimarra calundoensis* Marlier, 1965, *Chimarra lukawei* Jacquemart, 1961) similar to the *C. minima* group, but distinct by characters of the phallic apparatus and of inferior appendages. Future studies are necessary to check the relationship of *C. minima* group with this lineage.

MATERIAL AND METHODS

The continental material was collected during an ecological monitoring carried out for the Onchocerciasis Control Programme in Western Africa (Yaméogo 1994; Yaméogo *et al.* 1988; Resh *et al.* 2005). The Malagasy 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 areas studied were described by Elouard & Gibon (2001). Specimens were captured using a portable light trap which was composed of a black light and a gas lamp. They were subsequently preserved in ethanol (75%). 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 are deposited in the collections of the MNHN (Paris); the paratypes and other specimens are deposited in the CBGP (Montferrier). All the geographic names are ones commonly used but one of them deserves a short explanation. The "Guinean Ridge" or "Loma-Man Ridge" is a line of disjoint heights and mounts, at approximately 250 km from the Atlantic Coast and more or less parallel to it. This line stretches from the eastern foothills of the Fouta Djalon to Mount Tonkoui in the Ivory Coast; it includes Mount Loma and Mount Nimba. The region is a mosaic of environments created by the absence of dominant orographic pattern and the contrast between the northeastern slopes exposed to dry winds (harmattan) and the southwestern slopes exposed to monsoon winds from the Gulf of Guinea. The situation is complicated by deforestation and fires and was described as "situation de confusion et de désordre" (Jaeger & Adam 1947).

Abbreviations

ORSTOM	Institut de recherche pour le développement (IRD), formerly Office de la Recherche scientifique et technique Outre-mer (Paris);
CNRE	Centre national de recherches sur l'Environnement (Antananarivo);
CBGP	Centre de Biologie pour la Gestion des populations (Montferrier);
MNHN	Muséum national d'Histoire naturelle (Paris).

SYSTEMATICS

Family Philopotamidae Stephens, 1829
Subfamily Chimarrinae Rambur, 1842
Genus *Chimarra* Stephens, 1829
Subgenus *Chimarra* Stephens, 1829

The ***Chimarra minima*** group

Preliminary remark

Except for the neotropical region, which has benefited from the studies of Blahnik (1997, 1998 and 2002), the evolutionary history of the genus *Chimarra* is still poorly known and based on the conclusions of Ross (1956). At that time, less than a quarter of the species known today were described and the history of the genus is probably longer and more complicated than Ross proposed. However, he was already able to characterize some major lineages mostly based on structures of the tergum X. In the most primitive forms, tergum X is entire and sclerotized. The following evolutionary steps included the splitting of this tergum into one mesal and two lateral lobes and the transformation of the dorsal lobe, which becomes membranous and subsequently disappears.

Diagnosis. — In the *C. minima* group, the mesal lobe of tergum X has disappeared, the lateral lobes are widely separated and split into two secondary lobes. Furthermore, tergum IX is membranous dorsally: when viewed caudally, the ninth segment is not ring-shaped but U-shaped or horseshoe-shaped (Fig. 1). These characters suggest that the *C. minima* group might be a relative of the *C. tsudai* group. The latter was erected by Ross (1956), who hypothesized that *C. tsudai*

Ross, 1956 was close to the "asiatic ancestor" that initiated one of the colonization movements from Asia to Africa. It was formally described by Blahnik *et al.* (2009), who listed 130 species from Japan to Pakistan (subsequently, Blahnik *et al.* (2012) described five more species from Vietnam). In the *C. tsudai* group, the lateral lobes of tergum X are secondarily subdivided into sclerotized lateral and mesal lobes, and the lateral lobes, and sometimes the mesal lobes, bear numerous sensilla. In the *C. minima* group, the lateral lobes of tergum X are secondarily subdivided into sclerotized dorsal and ventral lobes (subsequently referred to as latero-dorsal and latero-ventral lobes), and the dorsal lobes usually have two sensilla. Moreover, the long inward deformation of the dorso-distal angle of the inferior appendages and the phallotheca ending in two long, lateral and spear-shaped processes are characteristic of the *C. minima* group. Finally, in the *C. tsudai*-group, both veins 2A and 3A of the forewing are looped to 1A, in the *C. minima* group, 2A appears to be Y-shaped apically (Fig. 2).

Description

Adults yellow or pale yellow, wings without patch or pattern. Ocelli 3. Labial palps 3-segmented. Maxillary palps 5-segmented. Spur formula 1/4/4. Forewing (Fig. 2): Rs sinuous, with node before discoidal cell, R1 and stem of M1+2 slightly sinuous; forks 1 and 2 present, sessile; fork 3 present, petiolate; fork 4 absent; fork 5 present; extremity of Cu2 curved and joining wing margin a little beyond 1A; sc-r, r, s, r-m, m, m-cu and cu present. Hindwing (Fig. 2): R1 apparently fused to subcosta, forks 1 and 2 present, sessile; fork 3 present, petiolate; fork 4 absent; fork 5 present; 2A looped to 1A.

Abdominal segment IX distinctly produced anteroventrally, with short posteroventral process, dorsally membranous (U-shaped when viewed caudally). Preanal appendages, short, simple. Inferior appendages bulky, almost rectangular or trapezoidal in lateral view and C-shaped in caudal view; heavily sclerotized, with inward directed elongation of the dorso-distal edge and spine-shaped protuberance or small bump on the inner side. Mesal lobe of tergum X absent. Lateral lobes distally split, over most of their length. Latero-dorsal lobes highly sclerotized, rod, sickle or hook-shaped; latero-ventral rod, plate or sheet-shaped, sometimes absent. Phallotheca tubular, arising from bulbous base, ending in two long, lateral, pointed rods. Endotheca with phallotremal sclerite and one short internal spine, absent in some species.

Remarks

Two subgroups and two isolated species may be distinguished, based on the shape of the latero-ventral lobes of tergum X. In most species, this latero-ventral lobe forms a lateral sheet or a plate along the phallus apparatus (subgroup 1). This plate is sometimes thin, membranous and, for this reason, not visible after clearing in KOH; it is consequently missing from the original descriptions, at least in the case of *C. ambaja* Mosely, 1939, *C. callasae* Gibon, 1982, *C. sassandrae* Gibon, 1982 and *C. toubaensis* Gibon, 1985. I give new figures (lateral view) for the male genitalia of these species (Figs 3E, F; 5G). In some species, the latero-ventral lobe is, like the latero-dorsal lobe, heavily sclerotized, branch or sword-shaped (subgroup 2). In *C. minima*, the latero-ventral lobe is an elongated and narrow plate with a more strongly sclerotized spiny distal thickening. In *C. intexta* Mosely, 1931, the latero-ventral lobe is absent.

Table 1. — Preliminary List Of The *Chimarra minima* Group

Species	Distribution
Subgroup 1	
C. ambaja Mosely, 1939	Democratic Republic of the Congo, Cameroon n. cit.
C. angolensis Marler, 1965	Angola
C. assambae n. sp.	Cameroon
C. bertrandi Scott, 1974	Zimbabwe
C. callasae Gibon, 1982	Mali, Guinea n. cit., Sierra-Leone n. cit.
C. cereris Barnard, 1934	Zimbabwe
C. cognata Kimmins, 1957	Angola, Zimbabwe, Namibia
C. antsymeloka n. sp.	Madagascar
C. loffae n. sp.	Guinea,Cameroon
C. lufirae Jaquemart, 1961	Democratic Republic of the Congo, Zimbabwe, South Africa
C. sassandrae Gibon, 1982	Ivory Coast, Guinea n. cit., Mali n. cit., Togo n. cit., Cameroon n. cit.
C. toubaensis Gibon, 1985	Ivory Coast, Guinea n. cit.
C. vulgaris n. sp.	Madagascar
Subgroup 2	
C. prodhoni Gibon, 1985	Ivory Coast, Burkina Faso n. cit., Guinea n. cit.
C. sanagae n. sp.	Cameroon
Isolated species	
C. intexta Mosely, 1931	Sierra-Leone, Ivory Coast, Guinea n. cit.
C. minima Ulmer, 1907	Togo, Ghana, Ivory Coast, Burkina Faso, Mali n. cit., Guinea n. cit., Benin n. cit., Cameroon n. cit.

Chimarra minima Ulmer, 1907

Chimarra minima Ulmer, 1907: 43-44.

Chimarra petri Gibbs, 1973: 369 **n. syn.**

Chimarra voltae Marlier, 1978: 288 (synonymized by Gibon 1985: 23).

Argumentation

The examination of the holotype of *C. minima* revealed its synonymy with *C. petri*. The genitalia of this specimen are figured for the first time (Fig. 3C-D). Both the latero-dorsal and latero-ventral lobes of tergum X have their distal extremities more sclerotized than their basal parts, which are thinner and difficult to distinguish from each other. Gibbs (1973) already noted the relationship of *C. petri* to *C. intexta, C. cognata* and *C. lufirae.* Besides the differences in tergum X, *C. minima* differs from other species of the group in the absence of a process on the inner face of the inferior appendage and the reticulated appearance of the prolongations of the phallic apparatus.

Chimarra assambae n. sp.
(Fig. 4A-E)

Type Material. — **Holotype**: Cameroon, Assamba River (Sanaga bassin) near Ndjoré, 4°23'59"N, 11°49'11"E, 27.XII.1989, F.-M. Gibon, 1 ♂ (2 slides: genitalia / head and thorax) (MNHN). **Paratypes**: Same data, 1 ♂ (ethanol), 1 ♂ (1 slide) (CBGP).

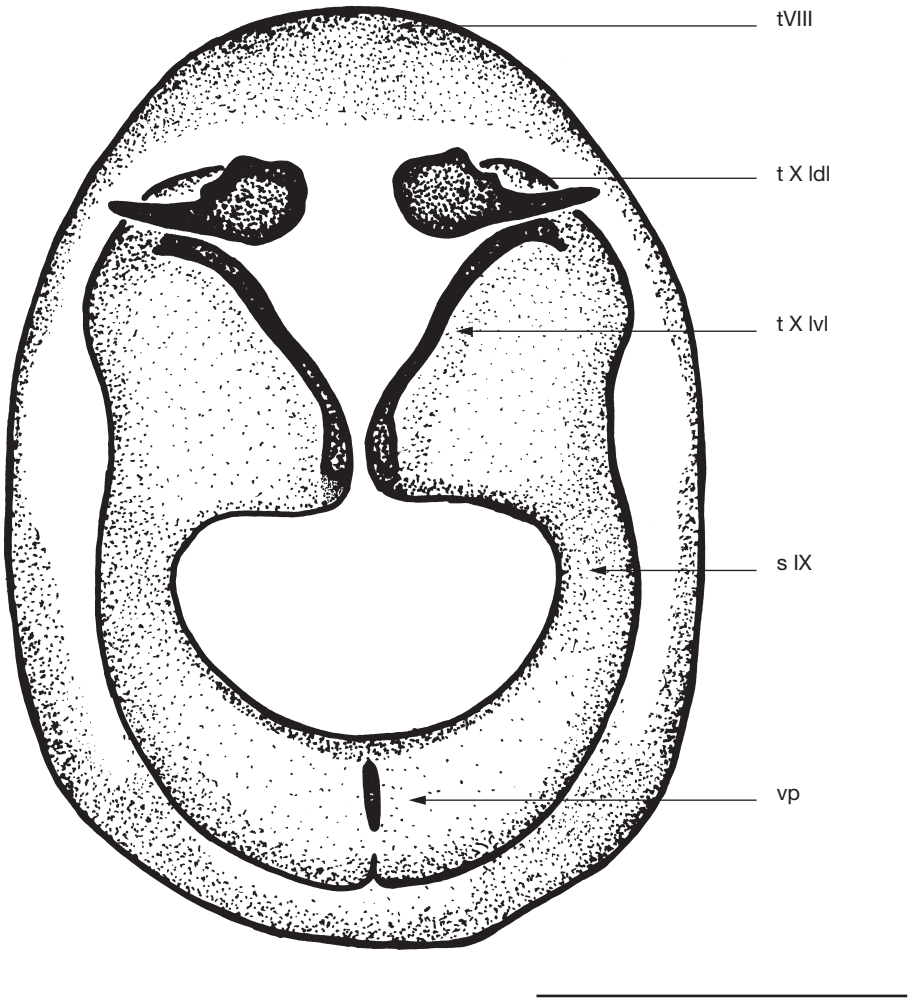

Fig. 1. — *Chimarra antsymeloka* n. sp., abdominal segments VIII, IX and X (without inferior appendages and phallic apparatus), caudal view. Abbreviations: **ldl**, latero-dorsal lobe; **lvl**, latero-ventral lobe; **s**, segment; **t**, tergum; **vp**, ventral process. Scale bar: 0.1 mm

Type locality. — Cameroon, Assamba River (Sanaga bassin) near Ndjoré, 4°23'59"N, 11°49'11"E.

Distribution. — Cameroon. This species is only known from the type locality.

Etymology. — Named after the Assamba River, tributary of the Sanaga.

Diagnosis. — *Chimarra assambae* n. sp. belongs to subgroup 1, with a latero-ventral lobe sheet or leaf-shaped. It is distinguished from most other species (*C. bertrandi, C. loffae* n. sp., *C. lufirae, C. prodhoni* Gibon, 1985*, C. sassandrae, C. toubaensis*) by the absence of the endothecal spine. It is distinguished from *C. callasae* and *C. cereris,* also devoid of an endothecal spine, by its ax-shaped latero-dorsal lobe (hook-shaped in the other species).

Description

Size: forewing 4.3 mm, hindwing 3.5 mm. Preanal appendages small, setose and oval in lateral view. Inferior appendages roughly quadrangular in lateral view, dorsal branch strong and long, ventral protruding process small. Latero-dorsal lobe of tergum X strong, distal part projected ventrad and extended in a characteristic ax-shaped extremity (dorsal view). Latero-ventral lobe of tergum X plate like, long and relatively narrow. Lateral rods of Phallotheca long, thin, distally curved. Endotheca devoid of internal spine; phallotremal sclerite present, reduced.

Chimarra antsymeloka n. sp.
(Fig. 5A-F)

Type Material. — **Holotype**: Madagascar, Ambatandrano River (tributary of the Namorona) at Ambatandrano, 47°26'32"E, 21°14'45"S, 775 m. a.s.l., 17.IV.1994, 1 ♂ (2 slides: Phallic apparatus / abdominal segments VII-X, head and thorax in alcohol) (MNHN).
Paratypes: Same data, 4 ♂ (ethanol). – RN25 between Ranomafana and Ifanadiana on the Namorona, 47°31'46"E, 21°16'40"S, 580 m. a.s.l., 21.IV.1994, 8 ♂ (ethanol) (CBGP).

Type locality. — Madagascar, Ambatandrano River (tributary of the Namorona) at Ambatandrano, 47°26'32"E, 21°14'45"S, 775 m. a.s.l.

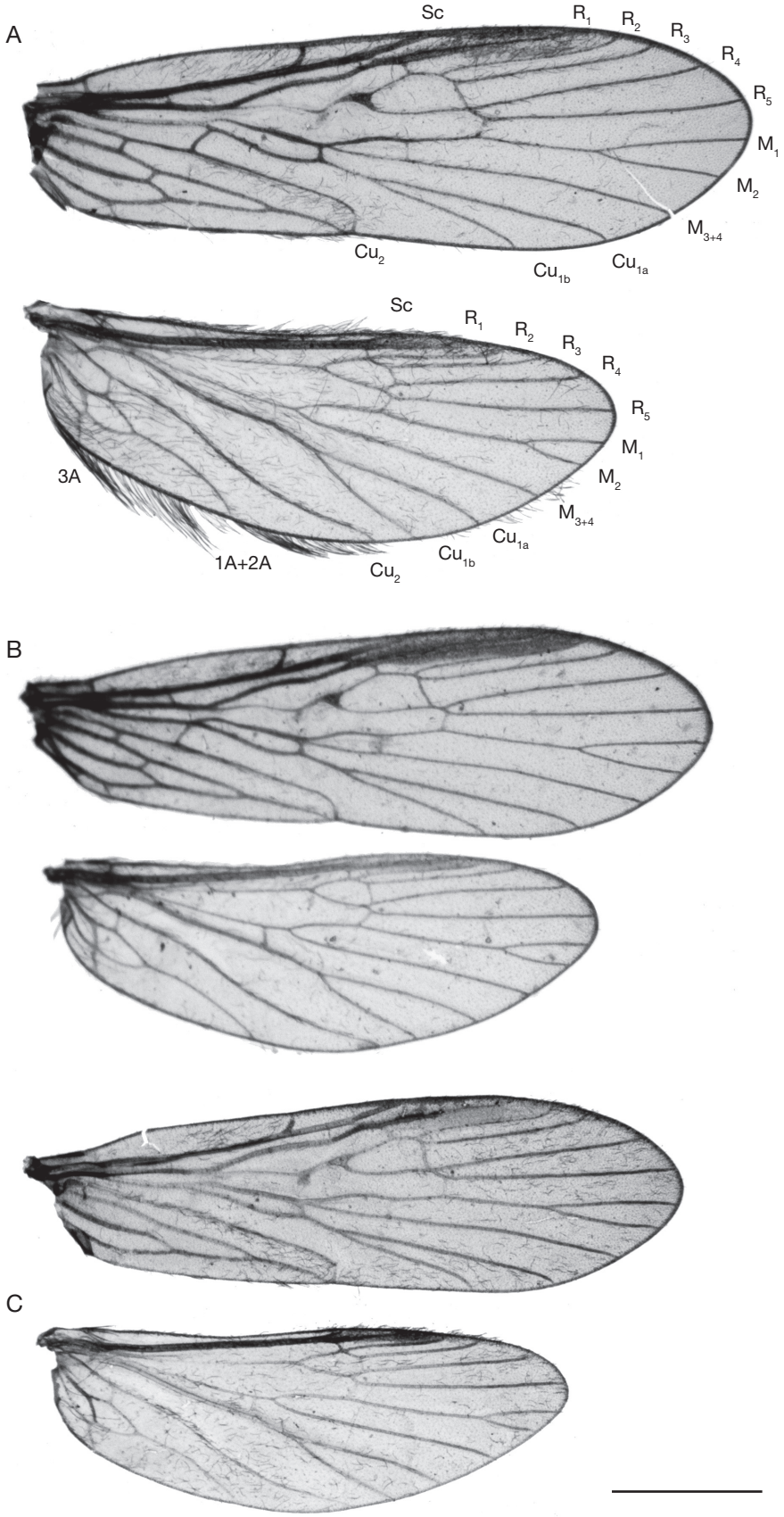

FIG. 2. — **A**-**C**, wings: **A**, *Chimarra vulgaris* n. sp.; **B**, *Chimarra antsymeloka* n. sp.; **C**, *Chimarra assambae* n. sp. Scale bar: 1 mm. Abbreviations: **A**, anal vein; **Cu**, cubitus; **M**, medius; **R**, radius; **Sc**, subcosta.

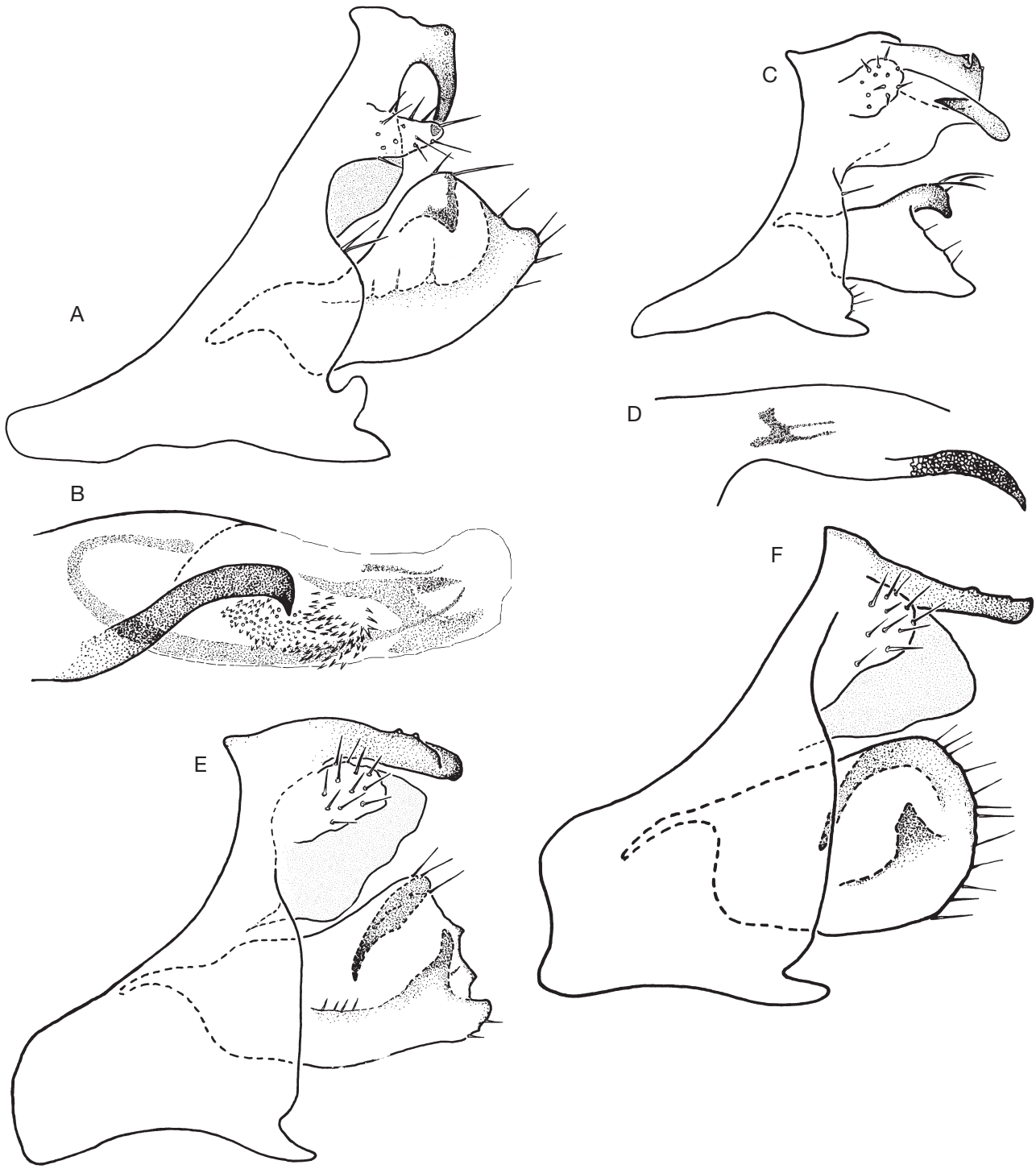

FIG. 3. — **A**, **B**, *Chimarra callasae* Gibon, 1982: **A**, segments IX and X, lateral view; **B**, phallic apparatus, lateral view; **C**, **D**, *Chimarra minima* Ulmer, 1907, holotype male: **C**, segments IX and X, lateral view; **D**, phallic apparatus, lateral view; **E**, *Chimarra sassandrae* Gibon, 1982, segments IX and X, lateral view; **F**, *Chimarra toubaensis* Gibon, 1985, segments IX and X, lateral view. Scale bar: 0.1 mm.

DISTRIBUTION. — Madagascar.

ETYMOLOGY. — Named after the Malagasy words *antsy* = knife and *meloka* = curved, in reference to the shape (sickle) of tergum X in dorsal view.

DIAGNOSIS. — The two Malagasy species, *C. antsymeloka* n. sp. and *C. vulgaris* n. sp., belong to subgroup 1, with a latero-ventral lobe sheet or leaf-shaped. Both have an endothecal spine, straight (not curved as in continental species. The two lateral rods of the phallotheca are smaller than in the other species; they are thick with a wrinkled appearance in *C. antsymeloka* n. sp., thinner and spine-shaped in *C. vulgaris* n. sp. The apex of the latero-dorsal lobes of the tergum X are acute in *C. antsymeloka* n. sp., truncate in *C. vulgaris* n. sp.

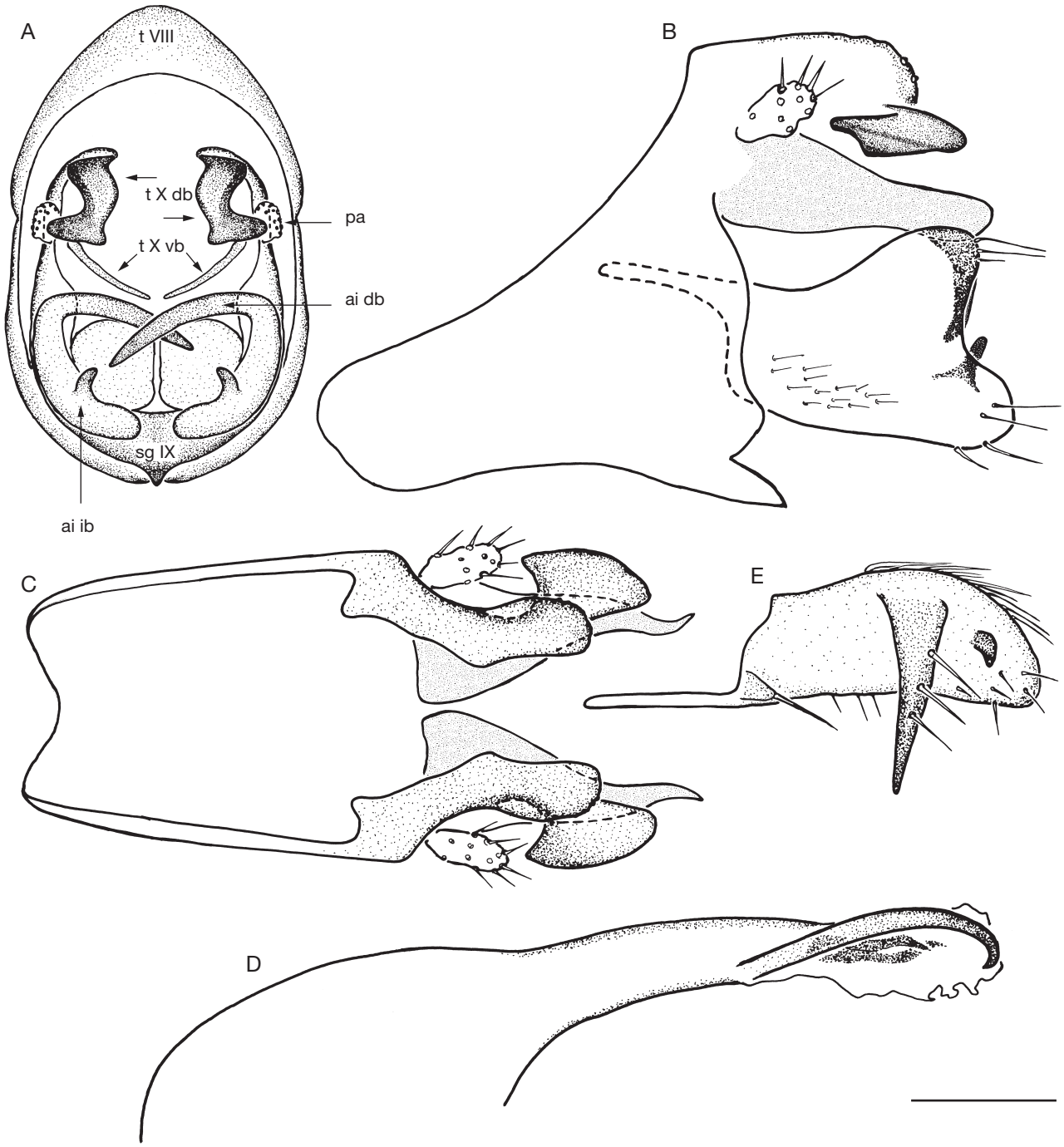

FIG. 4. — *Chimarra assambae* n. sp.: **A**, segments IX and X, caudal view; **B**, segments IX and X, lateral view; **C**, segments IX and X, dorsal view; **D**, phallic apparatus, lateral view ; **E**, inferior appendage, dorsal view. Abbreviations: **ai**, inferior appendage; **db**, dorsal branch; **ib**, inferior branch; **pa**, preanal appendage, **sg**, abdominal segment; **t**, tergite; **vb**, ventral branch. Scale bar: 0.1 mm.

DESCRIPTION

Size: forewing 4.5 mm, hindwing 3.7 mm. Preanal appendages small, setose, wineskin-shaped. Inferior appendages massive in lateral view, dorsal branch strong, short, triangular when viewed dorsally; internal process long and narrow, inserted just below the dorsal branch. Latero-dorsal lobe of tergum X strong, distal part curved, with pointed distal extremity; small pointed projection inserted at mid-length on the outer edge; sickle-shaped when viewed dorsally. Latero-ventral lobe of tergum X sheet like, long, somewhat triangular on lateral view. Lateral rods of Phallotheca short, strong, curved ventrad with a wrinkled appearance. Endothecal spine present small, straight. Phallotremal sclerite large; when dorsally viewed, trident-shaped with two symmetric latero-dorsal branches and one slightly shorter, centro-ventral branch.

FIG. 5. — **A**-**F**, *Chimarra antsymeloka* n. sp.: **A**, inferior appendage, dorsal view; **B**, segments IX and X, lateral view; **C**, tergum X, dorsal view; **D**, *Chimarra antsymeloka* n. sp., specimen from the Efaho River (near Ifarantsa), tergum X, dorsal view; **E**, *Chimarra antsymeloka* n. sp., specimen from the Menarandra River (near Tranoroa), tergum X, dorsal view; **F**, phallic apparatus, lateral view; **G**, *Chimarra ambaja* Mosely, 1939, segments IX and X, lateral view. Scale bar: 0.1 mm.

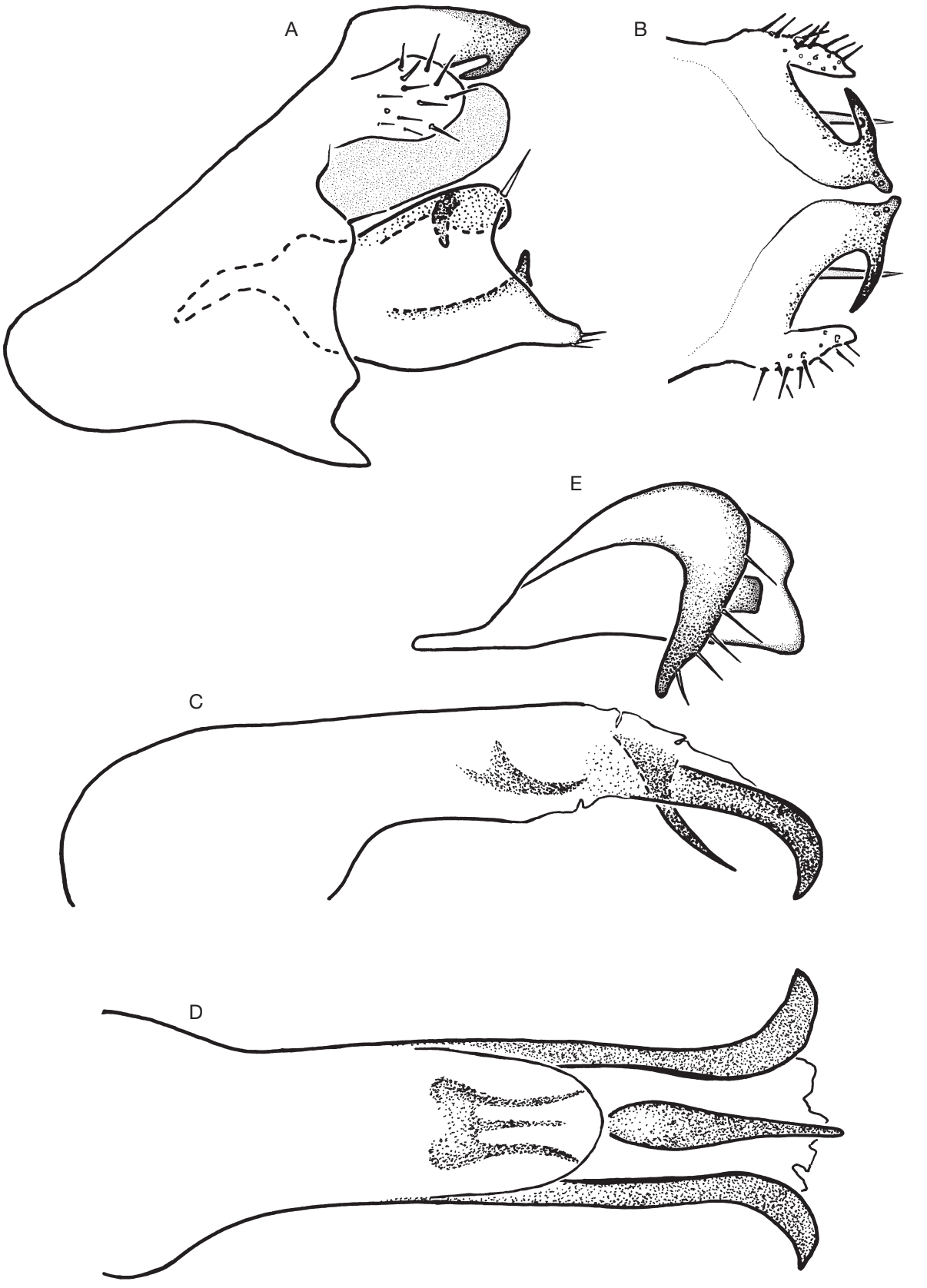

FIG. 6. — **A**-**E**, *Chimarra loffae* n. sp.: **A**, **B**, segments IX and X, lateral view (**A**), dorsal view (**B**); **C**, **D**, phallic apparatus, lateral view (**C**), dorsal view (**D**); **E**, inferior appendage, dorsal view. Scale bar: 0.1 mm.

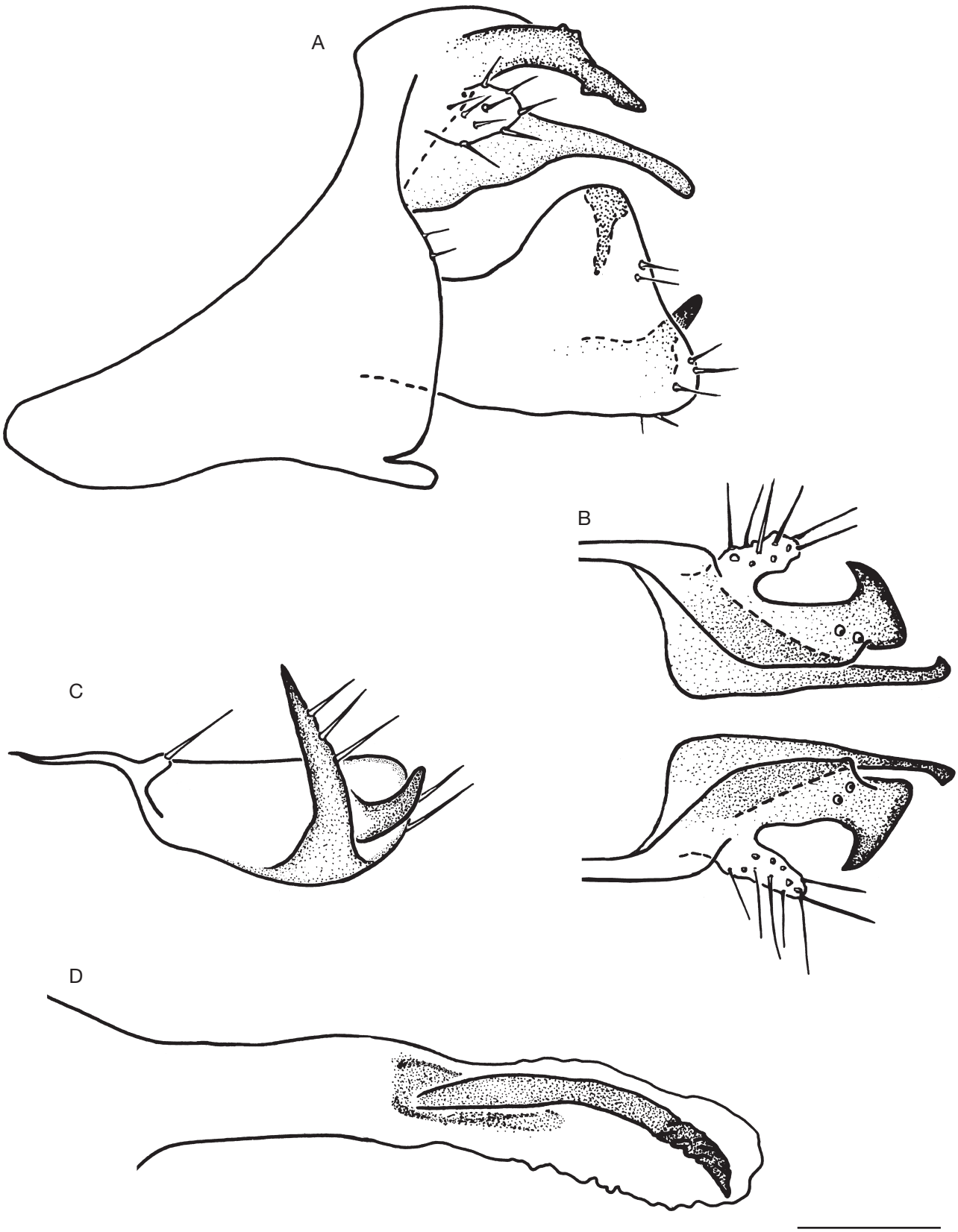

FIG. 7. — **A**-**D**, *Chimarra sanagae* n. sp.: **A**, **B**, segments IX and X, lateral view (**A**), dorsal view (**B**); **C**, inferior appendage, dorsal view; **D**, phallic apparatus, lateral view. Scale bar: 0.1 mm.

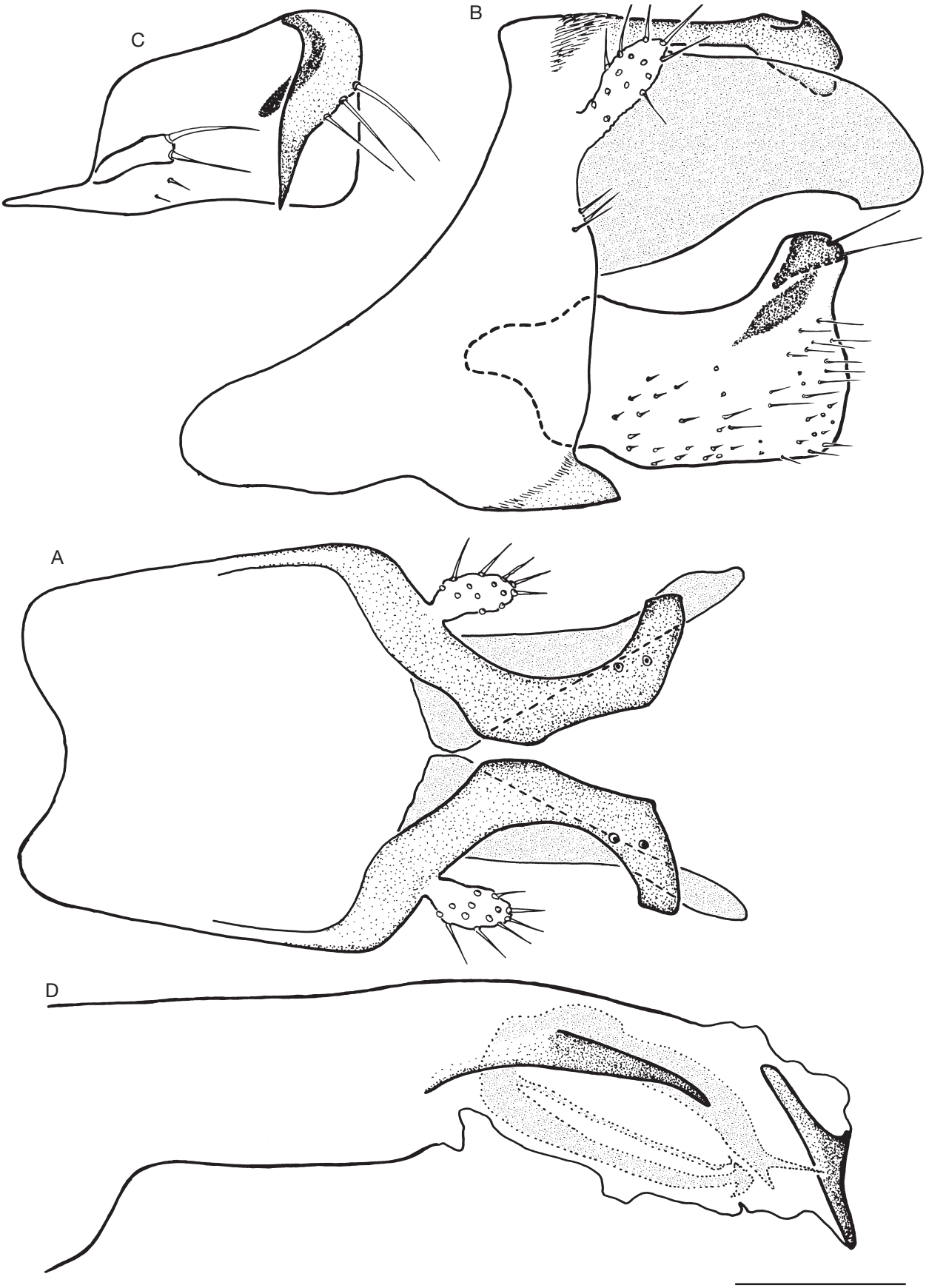

FIG. 8. — **A**-**D**, *Chimarra vulgaris* n. sp.; **A**, **B**, segments IX and X, dorsal view (**A**), lateral view (**B**); **C**, inferior appendage, dorsal view; **D**, phallic apparatus, lateral view. Scale bar: 0.1 mm.

Chimarra loffae n. sp.
(Fig. 6A-E)

Type material. — **Holotype**: Guinea, Loffa River, near Macenta, 8°30'2.62"N, 9°27'27.82"W, 524 m. a.s.l., 20.II.1987, J.-F. Agnèse, 1 ♂ (2 slides: phallic apparatus / abdominal segments VII-X, head and thorax in alcohol) (MNHN).
Paratypes: Same data, 1 ♂ (1 slide), 1 ♂ (1 slide: abdomen, head and thorax in alcohol); Guinea, small tributary of the Saint-Paul River, 22 km North/North-West from Nzérékoré, 7°55'55.18"N, 8°56'32.80"W, 420 m. a.s.l., 30.I.1988, F.-M. Gibon, 1 ♂ (ethanol); Guinea, Makona River at Bofossou, 8°39'23.29"N, 9°40'39.55"W, 21.I.1987, F.-M. Gibon, 2 ♂ (ethanol), 1 ♂ (2 slides: abdomen / head and thorax) (CBGP).

Additional material. — **Cameroon**. Noun River (Sanaga River bassin), a few kilometres upstream from Bafia, 4°47'52"N, 11°16'20"E, 440 m. a.s.l., 21.XII.1989, F.-M. Gibon, 1 ♂ (1 slide), 1 ♂ (2 slides: abdomen / head and thorax), 1 ♂ (2 slides: abdomen / head and thorax), 1 ♂ (alcohol); Sanaga at Nachtigal Falls, 4°20'50.01"N, 11°38'13.26"E, 20.XII.1988. F.-M. Gibon, 1 ♂ (2 slides: wings and genitalia / head and thorax) (CBGP).

Type locality. — Guinea, Loffa River, near Macenta, 8°30'2.62"N, 9°27'27.82"W, 524 m. a.s.l.

Distribution. — Guinea, Cameroon.

Etymology. — Named after the Loffa river (Guinea and Liberia).

Diagnosis. — *Chimarra loffae* n. sp. belongs to the subgroup 1, with a latero-ventral lobe sheet or leaf-shaped. When viewed dorsally, the latero-dorsal lobe of the tergum X are hook-shaped, with strongly curved hooks. This character is shared with *C. prodhoni, C. callasae* and *C. cereris. Chimarra prodhoni* belongs to the subgroup 2 (latero-ventral lobe rod-shaped). *Chimarra callasae* is distinguished by the absence of an endothecal spine, an unusually large phallotremal sclerite and a shorter latero-ventral lobe of tergum X. In *C. cereris,* the hooks are more massive and less curved.

Description
Size: forewing 4.0 mm, hindwing 3.2 mm. Preanal appendages short, setose, fin-shaped. Inferior appendages massive in lateral view, dorsal branch strong, with a line of stout setae; internal process protruding, small, ventrally inserted. Latero-dorsal lobes of tergum X short, hook-shaped, strongly curved latero-ventrad. Latero-ventral lobes of tergum X lightly sclerotized, rounded, almost as long as the latero-dorsal lobes. Lateral rods of phallotheca, long, stout, strongly curved ventrad along the distal third of their length. Terminal endothecal spine short, curved dorsad, with a wide base. Phallotremal sclerite small, trident-shaped when dorsally viewed.

Chimarra sanagae n. sp.
(Fig. 7A-D)

Type material. — **Holotype**: Cameroon, Sanaga River at Sakbayémé, 4°2'3"N, 10°32'44"E, 9.III.1989, F.-M. Gibon, 1 ♂ (2 slides: wings and phallic apparatus / head, thorax and abdomen) (MNHN).
Paratypes: Small tributary of the Sanaga River between Sakbayémé and Song-Loulou, 4°4'42"N, 10°25'20"E, 10.III.1989, F.-M. Gibon, 1 ♂ (3 slides: phallic apparatus / abdomen / head and thorax) (CBGP). - Sanaga at Song-Loulou, 4° 5'20.45"N, 10°27'19.89"E, 6.XII.1989, F.-M. Gibon, 1 ♂ (ethanol) (CBGP).

Type locality. — Cameroon, Sanaga River at Sakbayémé, 4°2'3"N, 10°32'44"E.

Additional material. — Cameroon, Ngoué River near Pouma (Nyong River bassin), 3°61'7.60"N, 10°31'26.35"E, 17.XII.1989, F.-M. Gibon, 8 ♂ (ethanol) (CBGP).

Distribution. — Cameroon.

Etymology. — Named after the Sanaga River (central Cameroon).

Diagnosis. — *Chimarra loffae* n. sp. belongs to the subgroup 1, with a latero-ventral lobe sheet or leaf-shaped. It is distinguished from *C. prodhoni*, the other species of the subgroup, by the wide base of the latero-ventral lobe of tergum X and by the absence of an endothecal spine.

Description.
Size: forewing 3.9 mm, hindwing 3.2 mm. Preanal appendages small, setose with wrinkled aspect. Inferior appendages massive, dorsal branch strong, elongate, with a line of stout setae; internal process protruding, ventrally inserted, small but larger than in *C. loffae* n. sp. Latero-dorsal lobes of tergum X stout, hook-shaped, curved outward, shorter than latero-ventral lobe. Latero-ventral lobes of tergum X: base wide, almost triangular in lateral view, apically extending as a sclerotized, slightly ventrad curved, finger-shaped rod. Lateral rods of phallotheca, long, stout, strongly curved ventrad, distal third with a wrinkled appearance. Endothecal spine absent. Phallotremal sclerite small, with indiscernible structure.

Chimarra vulgaris n. sp.
(Fig. 8A-D)

Type material. — **Holotype**: Madagascar, Marokoto River near Mananara (Mandrare River basin), 46°38'50"E, 24°44'02"S, 275 m. a.s.l., 03.VI.1994, F.-M. Gibon, 1 ♂ (MNHN).
Paratypes: Same data, 10 ♂ (CBGP). – Ankazomanga, tributary of the Sohitay (Mandrare River basin), 46°37'23"E, 24°02'37"S, 430 m. a.s.l., 26.IV.1995, 1 ♂ (4 slides: wings / phallic apparatus and inferior appendages / abdominal segments I-VI / abdominal segments VII-X, head and thorax) (CBGP).

Type locality. — Madagascar, Marokoto River near Mananara 46°38'50"E, 24°44'02"S, 275 m. a.s.l.

Distribution. — Madagascar.

Etymology. — Named after the Latin word *vulgaris* = common.

Diagnosis. — *Chimarra vulgaris* n. sp. is a close relative of *C. antsymeloka* n. sp. The two lateral rods of the phallotheca are smaller than in the continental species; they are thick with a wrinkled appearance in *C. antsymeloka* n. sp., thinner and spine-shaped in *C. vulgaris* n. sp. The latero-dorsal lobes of the tergum X are similar, with an acute extremity in *C. antsymeloka* n. sp., a truncate one in *C. vulgaris* n. sp.

Description
Size: forewing 4.8 mm, hindwing 3.9 mm. Preanal appendages small, setose, wineskin-shaped. Inferior appendages almost quadrangular in lateral view; dorsal branch strong, wide, with an acute apex, when dorsally viewed, as long as the width of the appendage; internal process fold-shaped,

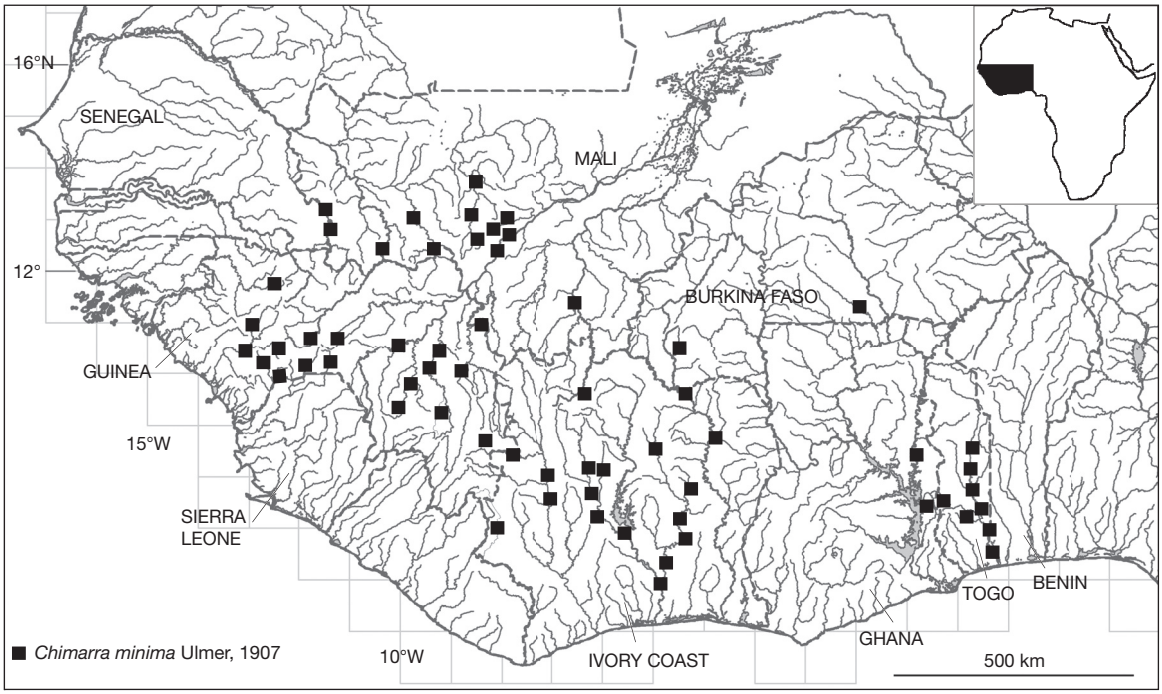

FIG. 9. — *Chimarra minima* Ulmer, 1907, capture sites map in West Africa.

inserted just below the dorsal branch. Latero-dorsal lobe of tergum X strong, curved outward, with truncate apex; boomerang-shaped when viewed dorsally. Latero-ventral lobe of tergum X sheet like, long, wide with rounded extremity. Lateral rods of phallotheca short, slightly curved ventrad. Endothecal spine present small, straight. Phallotremal sclerite large; trident-shaped when viewed dorsally, with two symmetric latero-dorsal branches and one, slightly shorter centro-ventral branch.

GEOGRAPHIC DATA

As they were captured during aquatic environment monitoring, informations on the distributions of these species and on the ecological conditions in which they occur are more abondant than the usual knowledge on the African species. These informations are exposed and discussed below.

WEST AFRICA

Described in 1907, *C. minima* is still the smallest species; the other species of the region, described later, are all larger. It is also the most widely distributed (Fig. 9). First recorded from Togo, it is common in the savannahs from the Senegal River (in the Malian part of the watershed) to the Logone River. In Guinea, it is present further upstream on the Niger and Sassandra River than the other savannah species (*C. sassandrae* and *C. callasae)*. In Ivory Coast, it occurs in the North of the Sassandra and the Comoé watersheds. But, in the centre of the country, it is present on almost all the Bandama basin, from the northern tributaries around Korhogo to the region of Tiassalé, not very far from the coastal lagoons. This is probably a consequence of the lower rainfall in this area, known as the "V Baoulé" (Gibon 1985). In Togo, it occurs on all the Mono watershed and is very abundant on the Kara River. In Burkina Faso, it occurs at least on the Nazinon (region of Po) and on the headwaters of the Comoé. It is generally the most abundant species in the transition zones between the forest and the savannah, but is absent from the evergreen forest. Its presence on the headwaters of some coastal basins (Kolenté, Konkouré and Little Scarcies) can be interpreted as an effect of the deforestation that has occurred in these regions. From this ecological point of view, the most atypical capture of this species took place on the Cavally at Lieupleu (Côte d'Ivoire, 3.ii.1988), an assumed consequence of land clearing and intensive cultivation of cacao. The colonization of this area of the Cavally river basin by savannah species, for example *Leptocerus clavatus* Kimmins, 1961 for example has already been reported (Gibon 1992).

Also recorded from the Senegal to the Logone River basins, *Chimarra sassandrae* appears to be more confined to dry regions than *C. minima* (Fig. 10). On the Bandama River basin, we had noticed that it was more abundant than *C. minima* on the small northern tributaries, but scarcer in the forest/savannah transition area around Yamoussoukro and Tiassalé (Gibon & Statzner 1985). On the Niger and Senegal River basins, it is common in the lowland areas, but, upstream, it does not reach the Ridge Loma/Man, or the Fouta-Djalon. In Togo, it occurs on all the Mono River watershed, on the Sio (region of Kati) and on some northern tributaries of the Volta. In Burkina Faso, it has been reported from the Leraba River along the boundary with Ivory Coast.

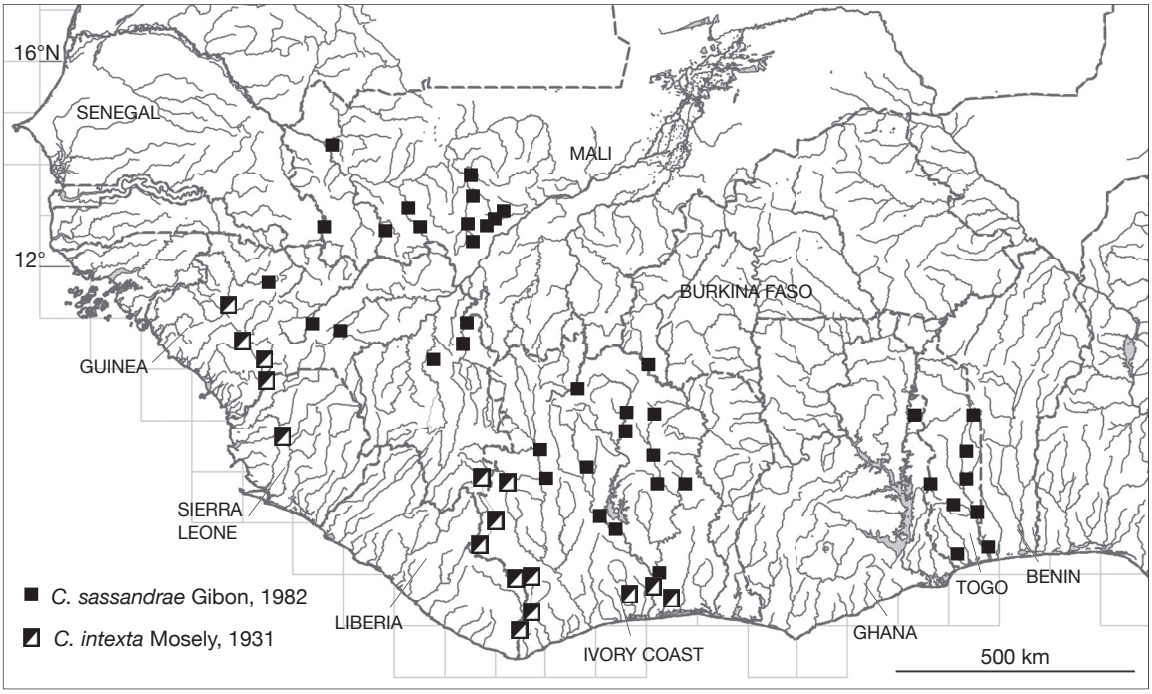

FIG. 10. — *Chimarra sassandrae* Gibon, 1982 and *Chimarra intexta* Mosely, 1931, capture sites map in West Africa.

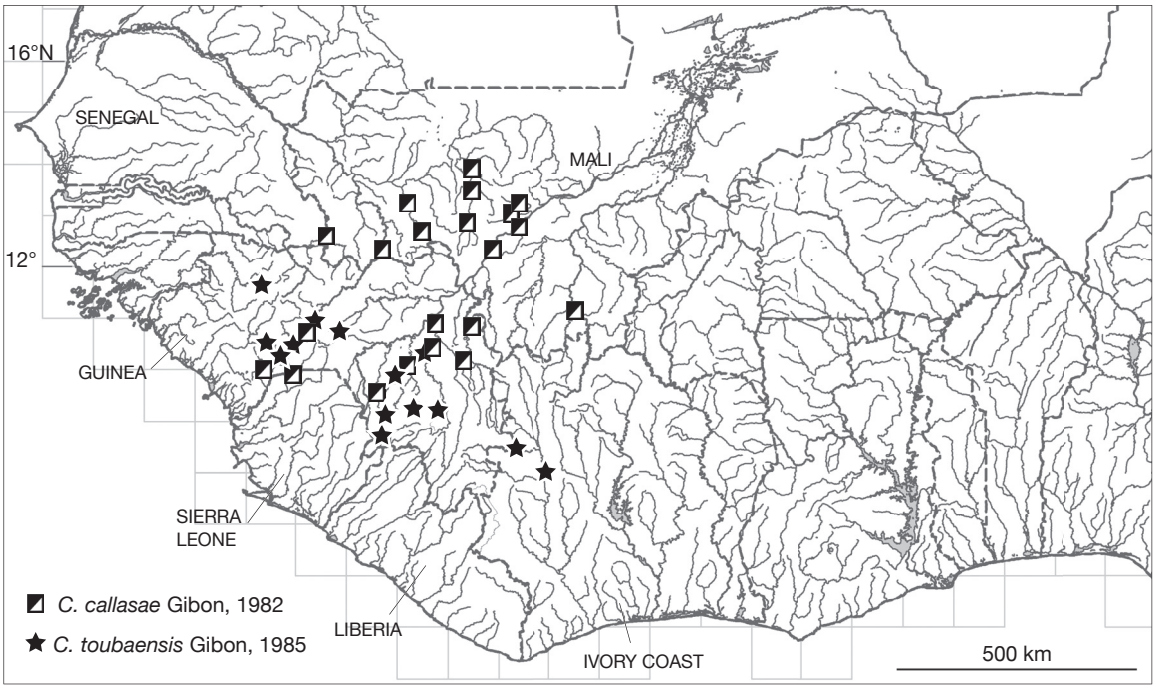

FIG. 11. — *Chimarra callasae* Gibon, 1982, and *Chimarra toubaensis* Gibon, 1985, capture sites map in West Africa.

Chimarra callasae is a typical savannah species, widely distributed on the Niger and Senegal River basins (Fig. 11). It is also present, but scarce, in the upper reaches of some coastal streams (Kolenté, Rio Corubal, Little Scarcies) and in Sierra-Leone (Seli River at Katik). *Chimarra callasae* has never been captured on the Bandama, Comoé, Sassandra, Mono, Volta or Comoé river basins. Its abundance and its frequency are such that, if present, it could hardly have been missed by Gibbs (1973) during his study of the Trichoptera of Ghana or by Guenda (1986) during his study of the Nasinon (Volta basin). The eastern limit of its known distribution is the River Bagoué (Niger basin), while *C. minima* and *C. sassandrae,* which coexist with *C. callasae* throughout most of its range, reach the basin of Lake Tchad and are probably present further east. These

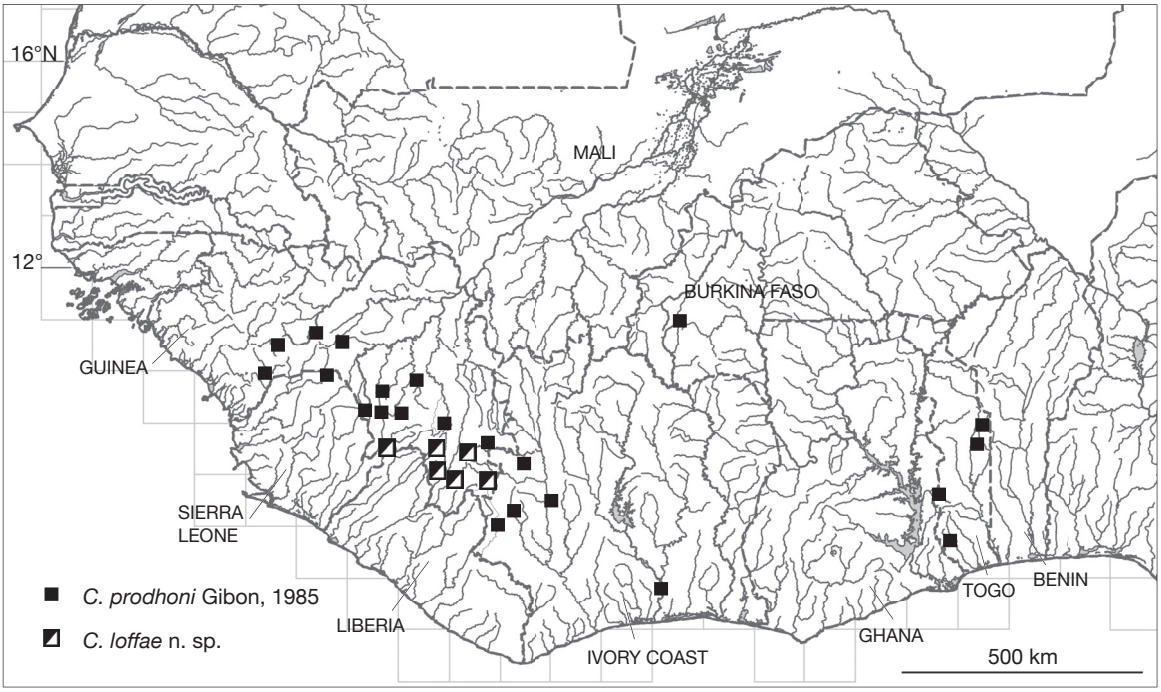

FIG. 12. — *Chimarra prodhoni* Gibon, 1985 and *Chimarra loffae* n. sp., capture sites map in West Africa.

differences are probably not due to ecological factors but to historical ones. They imply that, at least for some species, the limits between hydrographical basins are not easily crossed.

Chimarra prodhoni has been found from Guinea to Cameroon. In Guinea, its distribution includes the Fouta Djalon and the Guinean Ridge (Fig. 12). In Ivory Coast and Togo, *C. prodhoni* is representative of two distinct ecological situations. The first is the typical savannah/forest transition. A good example is the Bandama River, south of Tiassalé, flowing from the savannahs of northern Ivory Coast (mean annual rainfall below 1.200 mm) to the coastal forests (mean annual rainfall above 1.600 mm), *C. prodhoni* is there a potamic species. The second ecological situation is composed of savannah areas, which are more elevated than the surrounding areas. Their vegetation is favoured by increased rainfall and protected by steep slopes, rocky lands or religious beliefs. They constitute small wooded islands. The springs give birth to small brooks, which are clearer and cooler than the streams of the region. The induced faunistic changes are often important. The Plateau of Banfora (region of Bobo-Dioulasso, Burkina Faso), with the headwaters of the Black Volta and those of the Comoé is a good example of these refuges (Gibon *et al.* 1994). Here, *C. prodhoni* is a rhithric species: present near springs, it quickly disappears downstream in the true Sudanese savannahs. Quillévéré (1979) observed similar distribution patterns for *Simulium squamosum*, which is a forest species, but "frequently found in relatively humid, shady savannah areas (such as Bobo-Dioulasso, Natitingou, Lama-Kara)". The distribution of *C. prodhoni* on the Mono River basin is restricted to the headwaters. This is the inverse of its distribution on the Bandama River basin. At this inversion, corresponds

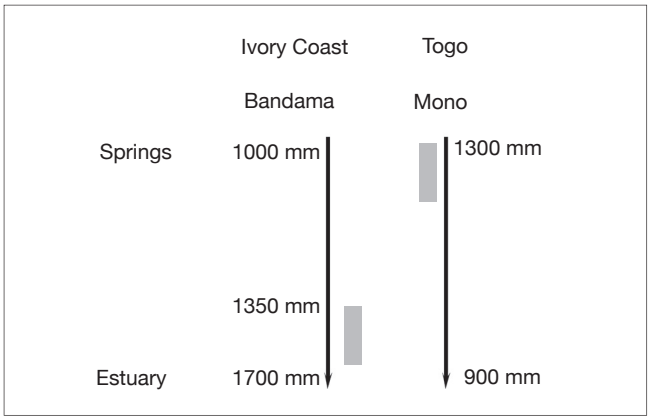

FIG. 13. — Schematic longitudinal position of *Chimarra prodhoni* Gibon, 1985 (Bandama River and Mono River).

the inversion of the rainfalls distribution (Fig. 13). On the Mono, the pluviometry is higher in the North (headwaters area), this is an exception in this area where it is higher in the South, near the Gulf of Guinea (L'Hôte & Mahé 1996). So, the distribution of this species appears more dependant on climate-induced hydrological conditions, than on the longitudinal axis of the stream.

The distribution of *C. toubaensis* is centred on the Guinean Ridge, but does not reach the highest sites (Fig. 11). Like *C. prodhoni, C. toubaensis* is a species of secondary or disturbed forest in the savannah/forest transition zone, but, unlike this latter, it has never been captured in the refuge areas.

The third species of the savannah/forest transition areas, *C. loffae* n. sp. is found at slightly higher altitudes than the other species, which may explain its more restricted distribu-

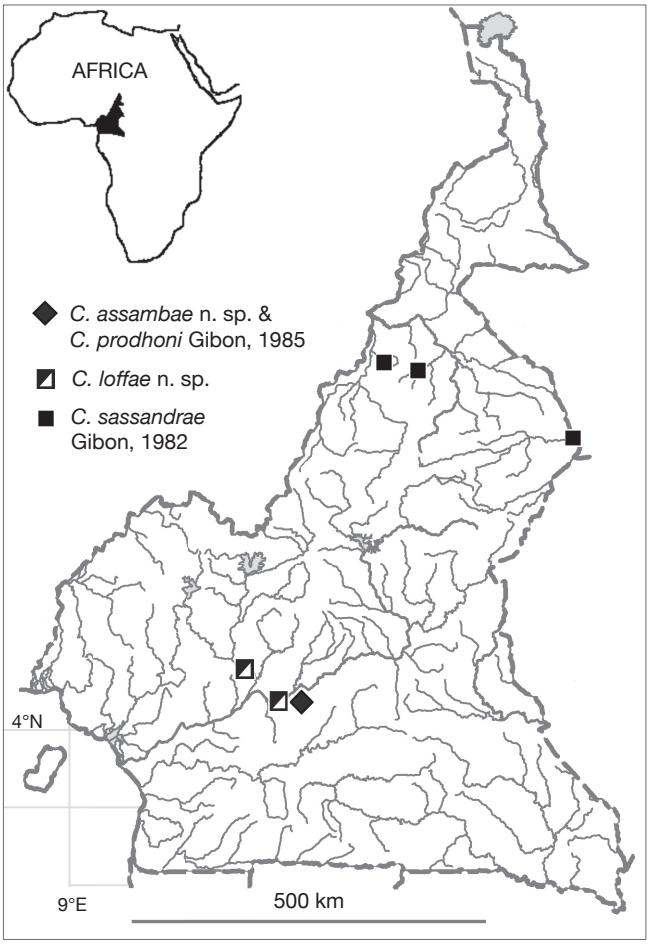

Fig. 14. — Species of the *Chimarra minima* group, capture sites map in Cameroon, part 1.

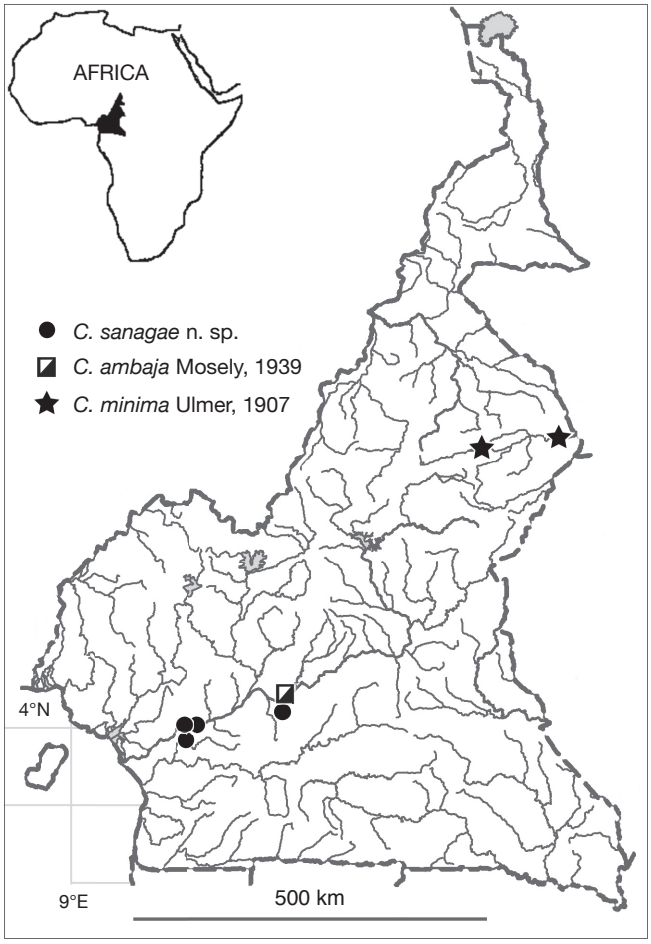

Fig. 15. — Species of the *Chimarra minima* group, capture sites map in Cameroon, part 2.

tion. It was captured on the Upper Cavally, the Saint-Paul, the Moa and the Loffa rivers, i.e. a large part of the south-western slopes of the Guinean Ridge and the most humid area (Fig. 12).

Chimarra intexta was described from Sierra-Leone and reported as a forest species from Ivory Coast (Gibon 1985). It is common in the Cavally River basin where it colonizes small tributaries in the primary forest as well as the main river channel. It is also found on the Bandama, south of Tiassalé, and on the Agneby in secondary or disturbed forest areas. Its presence on the small, coastal basins of Guinea, particularly the Rio Corubal, the Konkouré, and the Kolenté is interesting to note (Fig. 10). *Chimarra intexta* remains in these regions even though severe vegetation changes resulting from human activity have occurred. The mean annual rainfall, however, is over two metres and despite widespread deforestation, the cultivated and secondary vegetation remain dense. This is confirmed by the presence of *C. prodhoni* and *C. toubaensis*, which are characteristic of such situations. However, the sympatric occurrence of *C. intexta* with *C. callasae*, a typical sahelian species, on the Upper Kolenté, is more surprising; in this case, the species richness is due to the global environmental disturbance of the basin.

Cameroon

Four species of *Chimarra* are described from Cameroon: *C. camerunensis* Marlier, 1980, *C. cara* Mosely, 1936, *C. fallax* Ulmer, 1912 and *C. leta* Mosely, 1936. They all belong to other species-groups. However, a few environmental studies conducted in 1989 have allowed the discovery of seven species of the *C. minima* group in Cameroon, including two new species described above (Figs 14; 15). *Chimarra sassandrae* is the only species reported from the north of the country (Mayo Boki and Mayo Ilou). It is also present on the North Vina River, on the northern edge of the Adamaoua, where we also encountered *C. minima* (near Vogzom and Touboro). The geographical distribution of these two savannah species extends from Senegal to north Cameroon and probably more eastward. *Chimarra sanagae* n. sp. is the only species reported from the south western forests and particularly from the lower reaches of the Sanaga River. The four remaining species were captured in the centre of the country, around Yaoundé. A gently undulating region covered by a mosaic of cultivated land, plantations and secondary forests, whose climate and landscape recall the Guinean Ridge. The presence of *C. prodhoni* on the Assamba River (tributary of the Sanaga), and that of *C. loffae* n. sp.

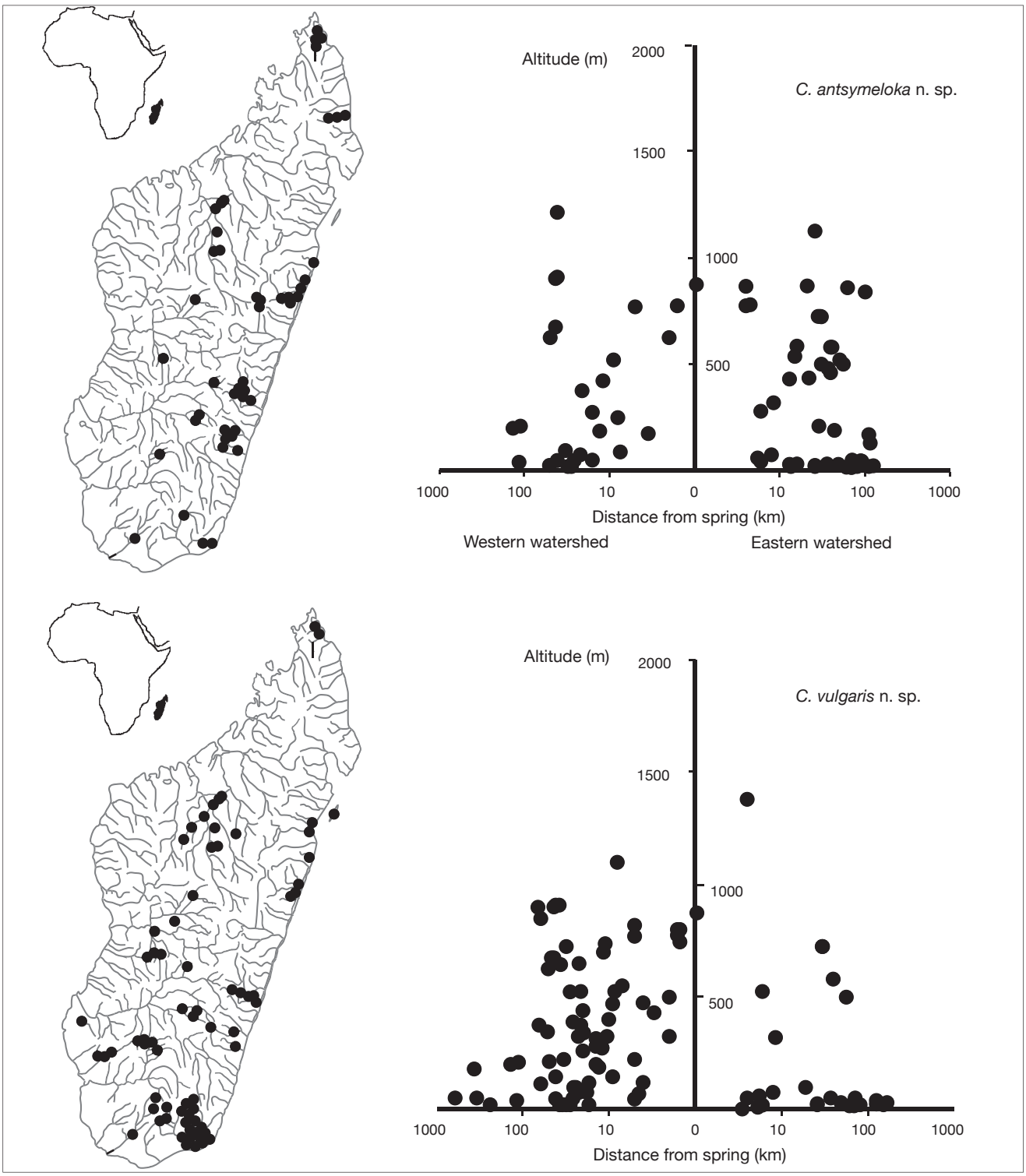

FIG. 16. — *Chimarra vulgaris* n. sp. and *Chimarra antsymeloka* n. sp., schematic distribution map and ecological profile of the capture sites in Madagascar.

on the Noun and on the Sanaga (Nachtigal falls) confirm the ecological requirements of these species. *Chimarra assambae* n. sp. is only known from the type locality on the Assamba and *C. ambaja* described from Congo was captured on the Sanaga.

MADAGASCAR

Chimarra vulgaris n. sp. is present throughout the island, below one thousand meters a.s.l. and outside forest and heavily wooded areas, on both large rivers and small streams (Fig. 16). It is scarce near the western coast. In this region, watercourses

are slow or heavily loaded with sediments, frequently intermittent and generally unfavourable to rheophilic insects.
Chimarra antsymeloka n. sp. has an ecological profile and a distribution map very similar to those of *C. vulgaris* n. sp. *Chimarra antsymeloka* n. sp. is more common on the eastern watersheds (two thirds of the capture sites) than on the western ones (one third of the sites) (Fig. 16). The ratio is reverse for *C. vulgaris,* more frequent on the western watersheds. Climatic contrast between these two regions (Chaperon *et al.* 1993) explains this difference and indicates that *C. vulgaris* n. sp. might be better adapted to aridity.

CONCLUSION

There are still many species of Philopotamidae to be discovered in western Africa, particularly at higher elevations and in evergreen primary forests. The results of Kjaerandsen (2005) indicate that they offer higher diversity and richness than lowlands and savannahs. The information available today indicates that this mountain fauna belongs to other lineages than the *C. minima* species-group (for example *C. philipponi* Gibon, 1986*, C. dioni* Gibon, 1986 and *C. beylaensis* Gibon, 1986 in Guinea; *C. divergena* Gibbs, 1973 and *C. bispinosa* Gibbs, 1973 in Ghana; *C. togoana* Ulmer, 1907 in Togo, *C. leta* and *C. cara* in Cameroon). The *C. minima* group is particularly diverse in the forest transitions. It includes the only species of *Chimarra* commonly present in the Sahel (outside refuges and springs areas). In Madagascar, the group is absent from the forests and from the transition areas. These lower taxonomic and ecological diversities could result from a colonization from Africa to Madagascar.

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REFERENCES

Blahnik R. J. 1997. — Systematics of *Chimarrita*, a new subgenus of *Chimarra* (Trichoptera: Philopotamidae). *Systematic Entomology* 22: 199-243.
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: vi+1-318.
Blahnik R. J. 2002. — Systematics of *Otarrha,* a new Neotropical subgenus of *Chimarra* (Trichoptera: Philopotamidae). *Systematic Entomology* 27: 65-130.
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* 229: 1-25.
Chaperon P., Danloux J. & Ferry L. 1993. — *Fleuves et rivières de Madagascar.* ORSTOM, Paris, 873 p.
Elouard J.-M. & Gibon F.-M. 2001. — *Biodiversité et Biotypologie des eaux continentales de Madagascar.* IRD, Montpellier, 447 p.
Gibbs D. G. 1973. — The Trichoptera of Ghana. *Deutsche entomologishe Zeitung* 20 (4,5): 363-424.
Gibon, F.-M. 1985. — Recherches sur les Trichoptères d'Afrique occidentale. 3 – Philopotamidae de Côte d'Ivoire. *Revue d'Hydrobiologie tropicale* 18 (1): 23-30.
Gibon F.-M. 1992. — Trichoptères d'Afrique occidentale et du Cameroun. Le genre *Leptocerus. Annales de la Société entomologique de France* 28 (3): 221-240.
Gibon F.-M. & Statzner B. 1985. — Longitudinal zonation of lotic insects in the Bandama River System (Ivory Coast). *Hydrobiologia* 122: 61-64.
Gibon F.-M., Guenda W. & Coulibaly B. 1994. — Observations sur la zonation dans les cours d'eau des savanes ouest-africaines: Trichoptères du Sud-Ouest du Burkina Faso. *Annales de Limnologie* 30 (2): 101-121.
Guenda W. 1986. — Évaluation de la toxicité de l'Abate sur les macroinvertébrés benthiques de la Volta rouge (Burkina Faso). *Bulletin de l'I.F.A.N. ser. A* 46 (3,4): 333-349.
Jaeger P. & Adam G. 1947. Aperçu sommaire sur la végétation de la région occidentale de la dorsale Loma-Man. *Bulletin de la Société botanique de France* 94 (7-8): 323-337.
Kjaerandsen J. 2005. — Species assemblages and community structure of adult caddisflies along a headwater stream in southeastern Ghana (Insecta: Trichoptera). *Biodiversity and Conservation* 14: 1-43.
L'Hôte Y. & Mahé G. 1996. — Afrique de l'Ouest et centrale: précipitations moyennes annuelles (période 1951-1989). ORSTOM, Paris.
Marlier G. 1978. — Sur une collection de Trichoptères d'Afrique occidentale. *Revue de Zoologie et de Botanique africaine* 92: 238-302.
Quillévéré D. 1979. — Contribution à l'étude des caractéristiques taxonomiques, bioécologiques et vectrices des membres du complexe *Simulium damnosum* présents en Côte d'Ivoire. *Travaux et Documents de l'ORSTOM* 109, 304 p.
Resh V. H., Statzner B., Gibon F.-M. & Yameogo L. 2005. — Trichoptera, Biomonitoring and the Onchocerciasis (River Blindness) Control Programme in West Africa, *in* Tanida K. & Rossiter A. (eds), *Proceedings of the 11th International Symposium on Trichoptera*, Tokai University Press, Kanagawa: 363-369.
Ross (H. H.) 1956. — Évolution and classification of the mountain caddisflies. The University of Illinois Press, Urbana, 213 p.
Ulmer G. 1907. – Neue Trichopteren: 1 Exotisches Material. *Notes from the Leyden Museum* 29: 1-53.
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.
Yaméogo L. 1994. — *Impact sur les entomocénoses aquatiques des insecticides utilisés pour contrôler les stades larvaires de* Simulium damnosum *Théobald (Diptera: Simuliidae), vecteur de l'onchocercose humaine en Afrique de l'Ouest.* Travaux et Documents microfichés 123. Ed. Orstom, Paris, 297 p.
Yaméogo L., Lévèque C., Traore K. & Fairhurst C. P. 1988. — Dix ans de surveillance de la faune aquatique des rivières d'Afrique de l'Ouest traitées contre les Simulies (Diptera, Simuliidae), agents vecteurs de l'Onchocercose humaine. *Le Naturaliste canadien* 115: 287-298.

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