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Comparative analysis of Swiss species of *Cyrtopogon* LOEW (Diptera, Asilidae), based on the genitalia of both sexes

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For *Cyrtopogon lateralis* (FALLÉN, 1814), *C. fulvicornis* (MACQUART, 1834), *C. meyerduerii* MIK, 1864, *C. ruficornis* (FABRICIUS, 1794), and *C. platycerus* VILLENEUVE, 1913, descriptions and illustrations of genitalia of both sexes are given. Based on a comparative analysis of the characters, three species groups are recognized, slightly different from the former grouping. *C. platycerus*, earlier considered to belong to the separate genus *Cyclosocerus* BEZZI, is combined with *Cyrtopogon*, and *Cyclosocerus* is sunk as a synonym of *Cyrtopogon*.

Keywords: Asilidae, *Cyrtopogon*, descriptions, genitalia, relationships.

INTRODUCTION

In the genus *Cyrtopogon* sensu BEZZI (1927) some 100 species are known, of which about 30 are Palaearctic and 10 are recorded in Switzerland (WEINBERG & BÄCHLI, 1995). While checking specimens of *Cyrtopogon* in Swiss collections, we took the occasion to make preparations of genitalia of several specimens and to analyze the relationships of the involved species based on genital characters.

In his fundamental revision of *Cyrtopogon* LOEW, 1847, BEZZI (1927) recognized 26 nominal species from the Palaearctic region. Among them, he distinguished several groups of species of which three groups were established as the new subgenera *Cyclosocerus* (one species), *Palamopogon* (one species), and *Lithoeciscus* (six species). In addition, BEZZI (1927) divided the 16 species of the subgenus *Cyrtopogon* s.str. into the species groups *fulvicornis*, *ruficornis*, and *flavimanus*. Later on, *Cyclosocerus* and *Lithoeciscus* as well as *Palamopogon* were given generic rank (cf. LEHR, 1988; WEINBERG & BÄCHLI, 1995, 1998).

As a first result of our analysis, we have shown that *C. flavimanus* and *C. maculipennis*, formerly considered to be synonyms (LEHR, 1988), are valid species, distinguished by several characters of the genitalia (WEINBERG & BÄCHLI, 1993b). After having analyzed the genitalia of *C. longibarbus* LOEW, we have given *Palamopogon* generic rank (WEINBERG & BÄCHLI, 1998). In this paper, we want to show the genitalia of both sexes of additional 6 species from Switzerland. Of *C. culminus* BIGOT, 1885, no extant specimens were available. BEZZI (1927) considered this species to be a synonym of *C. longibarbus* (LOEW). Based on the short and rather ambiguous original description, no better decision can be taken.

MATERIAL AND METHODS

Specimens belonging to the collections of the Natural History Museums of Basel, Genève, Lausanne, Neuchâtel and Zürich have been studied. Details of col-

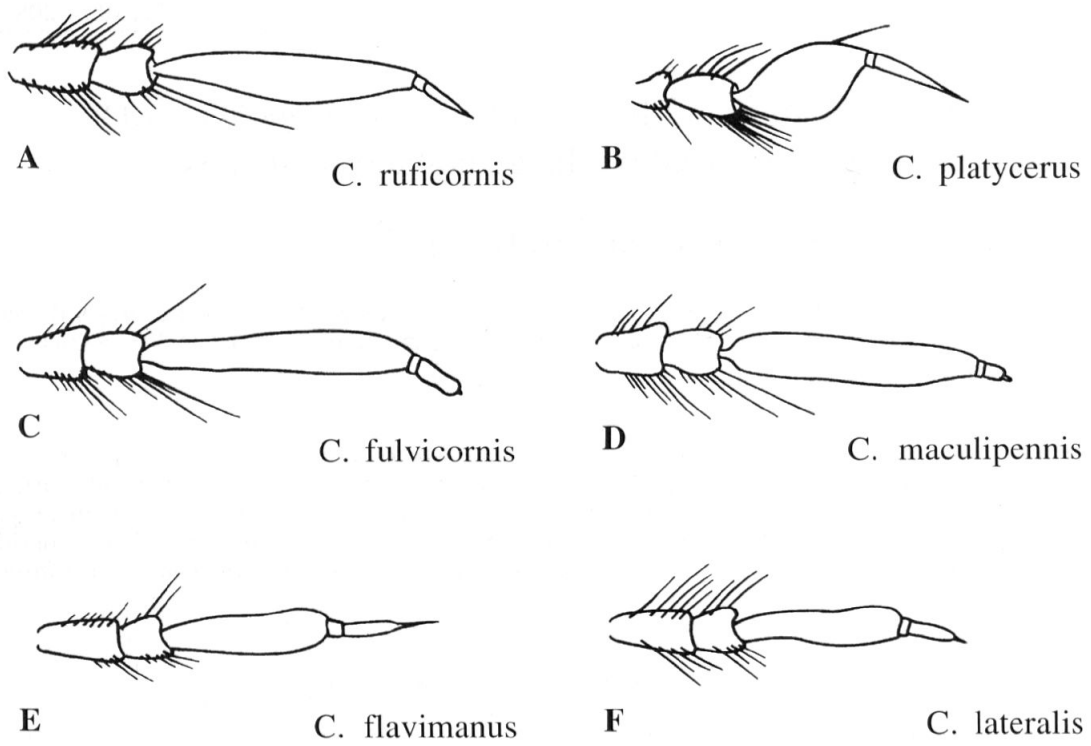

Fig. 1. Antennae of *Cyrtopogon* species (B and C redrawn after BEZZI, 1927).

lection sites are given by BÄCHLI *et al.* (1995) and WEINBERG *et al.* (1993b, 1994, 1995, 1996).

Preparations of genitalia were made and morphological terms are used as mentioned in WEINBERG & BÄCHLI (1993a, 1993b, 1995, 1998).

RESULTS

Diagnostic characters of Cyrtopogon

In addition to many characters of external morphology, e.g. the shape of the antennae (Fig. 1) already mentioned by BEZZI (1927), the species of *Cyrtopogon*, as far as analyzed by us, share the following characters:

– Epandrium longitudinally divided, completely in *C. flavimanus* (WEINBERG & BÄCHLI, 1993b, Fig. 1A) and *C. lateralis* (Fig. 2A), partially in all other species (Figs 4A, 6A, 8A, 10A, and WEINBERG & BÄCHLI, 1993b: Fig. 3A).

– Hypandrium with a median apical projection which shape, as mentioned below, is related to the apex of the aedeagus (Figs 2B, 4B, 6B, 8B, 10B, and WEINBERG & BÄCHLI, 1993b: Figs 1B, 3B).

– Gonopod bisegmented, the basistylus shows specific projections, the dististylus is straight, narrow, according to species (Figs 2D–E, 4D–F, 6D–E, 8D–EF 10D–E, and WEINBERG & BÄCHLI, 1993b: Figs 1D–F, 3D–F).

– Aedeagus:

1) Conical sheath with one or two denticles in the apical part on each side (Fig. 2F, and WEINBERG & BÄCHLI, 1993b: Figs 1G–H); projection of the hypandrium membranous (Fig. 2B, and WEINBERG & BÄCHLI, 1993b: Fig. 1B).

2) Shape broadened in the apical part, medially tubular with two lateral, long, basally largely humped projections either with simple pointed tips (WEINBERG & BÄCHLI, 1993b: Figs 3I–H), or forming one or two denticles in the apical part (Figs 4G–H, 6F–G); projection of the hypandrium apically fortified with two strongly sclerotized structures (Figs 4B, 6B).

3) Shape medially tubular, in the apical half with two projections, either straight and pointed, or curved (Figs 8G–H, 10F–G); projection of the hypandrium with two tubes or two rounded prolongations (Figs 8B, 10B).

– Pump chamber rounded, very wide, with very wide apodema head (Figs 2F, 4G–H, 6F–G, 8H, 10F–G).

– Ovipositor short, with 5–7 acanthophorites on each side. Tergite 8 is covered by short hairs medially and by long hairs laterally, and different in the density of the sclerotization (Figs 3A, 5A, 7A, 9A, 11A).

– Hypogyne sclerotized, basally and apically membranous (Figs 3B, 5B, 7B, 9B, 11B).

– Gonapodema in the shape of an inverted **V** (Figs 3D, 7C, 9E) or **U** (Figs 5D, 11D).

– Membrane forming the genital chamber with specific form.

– Hypopygium and ovipositor sclerotized and covered with setae.

Cyrtopogon flavimanus (MEIGEN, 1820)

Genital characters: – Epandrium longitudinally divided, apically rounded, sclerotized and covered with long hairs. – Hypandrium: The median membranous projection is apically rounded, related to the shape of the aedeagus. – Gonopod: Basistylus apically with a distinct concavity. The inner projection is strongly sclerotized, flattened at apex. The dististylus has the same shape as the inner projection of the basistylus but is not strongly sclerotized, and is opposite. – Aedeagus conical, with narrow apical half and two denticles on each side. – Ovipositor sclerotized, with 5 acanthophorites on each side. – Hypogyne wider than long, strongly sclerotized, covered with hairs, apically membranous with two rounded, sclerotized areas which are covered with short hairs. – Gonapodema formed like a large V in anterior view, the three spermathecal ducts arising from the genital chamber, the apex in form of a large, thick, sclerotized spiral with 4–5 turns.

Cyrtopogon lateralis (FALLÉN, 1814)

Genital characters: Epandrium longitudinally divided, apically rounded, sclerotized and covered with hairs (Fig. 2A). – Hypandrium: The median membranous apical projection is apically rounded, related to the shape of the aedeagus (Fig. 2B). – Gonopod: Basistylus apically with a short concavity; the apical sides are sharpened. The inner projection is broadened in the middle and then straightened toward the apex. The dististylus has the same shape as in C. flavimanus and is covered with hairs (Figs 2D–E). – Aedeagus conical, with narrow apical half and with one denticle on each side (Fig. 2F). – Ovipositor sclerotized, with 6 acanthophorites on each side (Fig. 3A). – Hypogyne strongly sclerotized, covered with hairs, apically membranous with two rounded, sclerotized areas which are covered with short hairs

C. lateralis

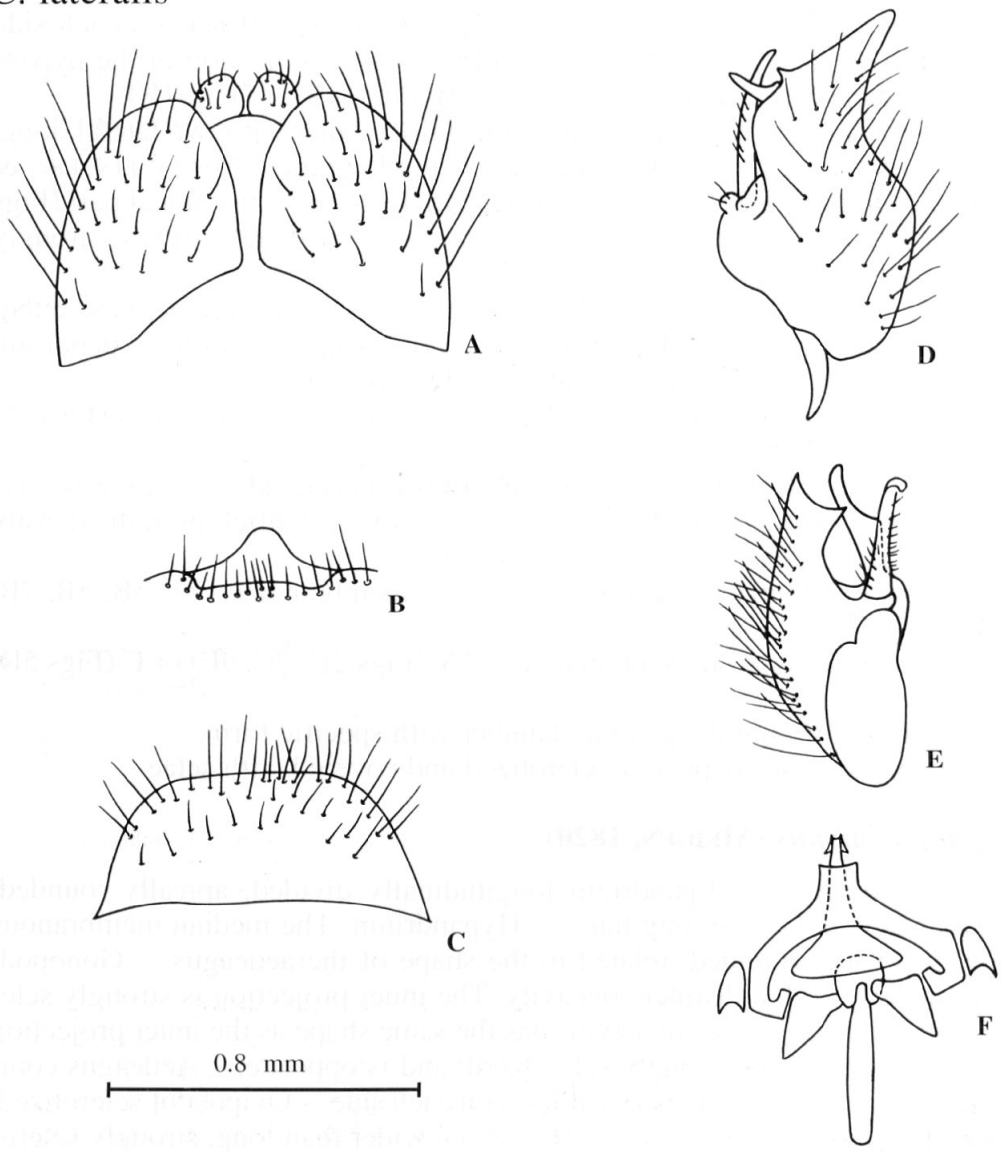

Fig. 2. Male genitalia of *Cyrtopogon lateralis*. A, epandrium and cerci, dorsal view; B, projection of hypandrium; C, hypandrium, dorsal view; D, gonopod, dorsal view; E, gonopod, lateral view; F, aedeagus, dorsal view.

(Fig. 3B). – Gonapodema formed like an inverted V (Fig. 3D). The three spermathecal ducts arising from the genital chamber (Fig. 3D), the apex in form of large, thick, sclerotized spiral with 2–3 turns (Fig. 3C).

Cyrtopogon fulvicornis (Macquart, 1834)

Genital characters: Epandrium partially divided, apically rounded, sclerotized and covered with short hairs (Fig. 4A). – Hypandrium with a median membranous apical projection showing two sclerotized lateral areas, related to the shape of the aedeagus (Figs 4B–C). – Gonopod: Basistylus apically narrow and with a small concavity. The inner projection apically with a distinct concavity. Dististylus flattened and pointed at apex, covered with short hairs (Fig. 4D–F). – Aedeagus broadened

C. lateralis

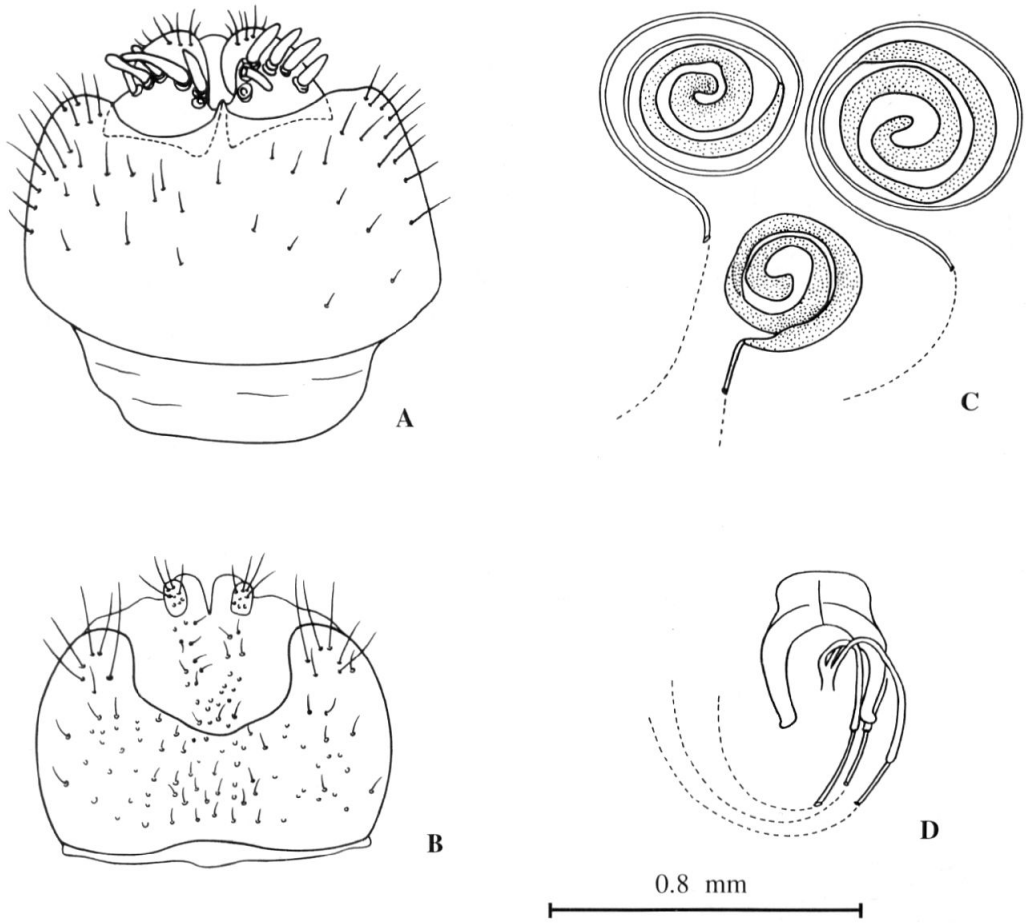

Fig. 3. Female genitalia of *Cyrtopogon lateralis*. A, ovipositor, dorsal view; B, hypogyne, dorsal view; C, terminal spirals of spermathecae; D, gonapodem with basal portion of spermathecae.

in the apical part, medially tubular with two lateral, long, basally largely humped projections, each with one denticle in the apical part (Figs 4G–H). – Ovipositor sclerotized, with 6 acanthophorites on each side (Fig. 5A). – Hypogyne sclerotized, covered with hairs, apically membranous with two rounded, sclerotized areas which are covered with short hairs (Fig. 5B). – Gonapodema formed like a large U (Fig. 5D). The three spermathecal ducts arising from the genital chamber, the apex in form of a thick, sclerotized spiral with 2–3 turns (Fig. 5C).

Cyrtopogon maculipennis (MACQUART, 1834)

Genital characters: Epandrium partially divided, the two parts are triangular with pointed apex. – Hypandrium: The apical projection is hooked at top, related to the shape of the aedeagus. – Gonopod: The apex of the basistylus is straight, the inner projection laterally flattened and pointed at apex. The dististylus shows two apical processes; the shorter one is haired. – Aedeagus broadened in the apical half, medially tubular, basally with two lateral, long, basally largely humped projections with pointed ends. – Ovipositor sclerotized, with 6 acanthophorites on each side. – Hypogyne wider than long, sclerotized and covered with hairs, apically membranous with two rounded, sclerotized areas which are covered with short hairs. – Gonapodema strongly sclerotized and formed like a large V with a rounded, sclerotized

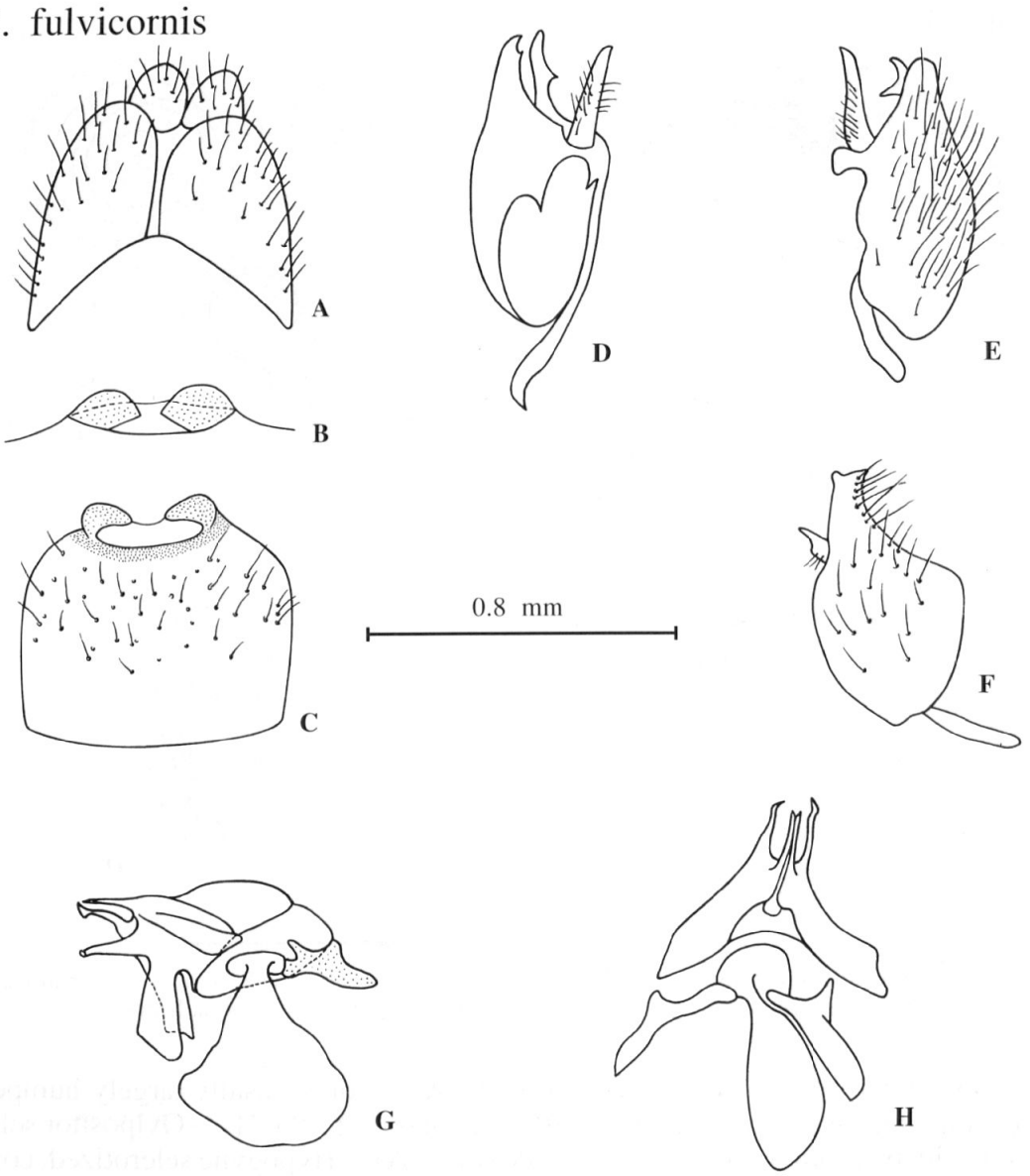

Fig. 4. Male genitalia of *Cyrtopogon fulvicornis*. A, epandrium and cerci, dorsal view; B, projection of hypandrium; C, hypandrium, dorsal view; D, gonopod, latero-ventral view; E, gonopod, lateral-dorsal view; F, gonopod, dorsal view; G, aedeagus, lateral view; H, aedeagus, dorsal view.

area. The three spermathecal ducts arising from the genital chamber, the apex in form of a sclerotized spiral with 4–5 turns.

Cyrtopogon meyerduerii Mik, 1864

Genital characters: Epandrium partially divided, apically rounded, sclerotized and covered with long hairs (Fig. 6A). – Hypandrium with a median membranous apical projection which is medially divided and shows two apical, strongly sclerotized structures, related to the shape of the aedeagus (Fig. 6B). – Gonopod: Basistylus apically rounded and with narrow half. The inner projection strongly sclerotized and apically with a distinct concavity. Dististylus flattened, pointed at apex (Figs 6D–E). – Aedeagus broadened in the apical part, medially tubular with two lateral, long, basally largely humped projections, forming two denticles in the api-

C. fulvicornis

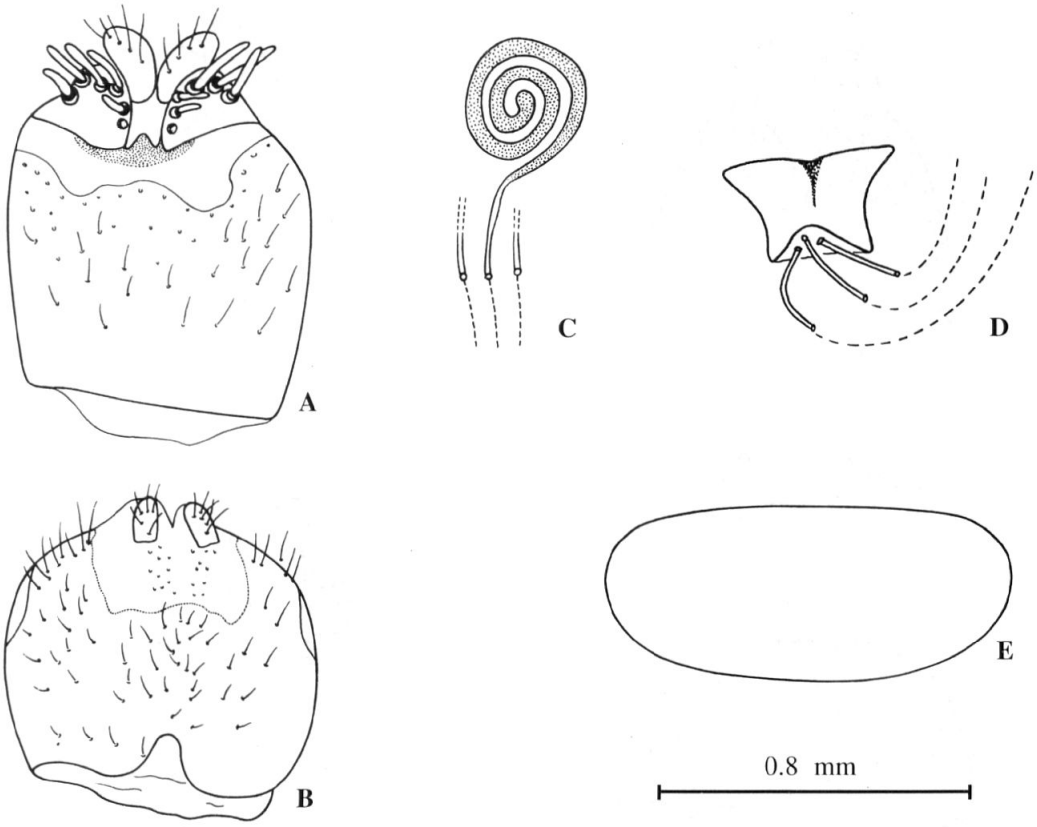

Fig. 5. Female genitalia of *Cyrtopogon fulvicornis*. A, ovipositor, dorsal view; B, hypogyne, dorsal view; C, terminal spirals of spermathecae; D, gonapodem with basal portion of spermathecae; E, egg.

cal part (Figs 6F–G). – Ovipositor sclerotized, with 5 acanthophorites on each side (Fig. 7A). – Hypogyne sclerotized, covered with hairs, apically membranous with two oval long sclerotized areas which are covered with short hairs (Fig. 7B). – Gonapodema formed like an inverted V. The three spermathecal ducts arising from the genital chamber, the apex in form of a large, sclerotized spiral with 3–4 turns (Fig. 7C).

Cyrtopogon ruficornis (Fabricius, 1794)

Genital characters: Epandrium partially divided, apically rounded, sclerotized and covered with long hairs (Fig. 8A). – Hypandrium apically with two tubular projections, related to the shape of the aedeagus (Figs 8B–C). – Gonopod: Basistylus apically narrow with rounded apex. The inner projection is strongly sclerotized and has apically two processes; the inner one is short. Dististylus flattened and pointed at apex (Figs 8D–F). – Aedeagus medially tubular with two straight and pointed projections (Figs 8G–H). – Ovipositor sclerotized, with 6 acanthophorites on each side (Fig. 9A). – Hypogyne sclerotized, covered with hairs, apically membranous with two rounded, sclerotized areas which are covered with short hairs (Fig. 9B). – Gonapodema formed like a large, inverted V (Fig. 9E). The three spermathecal ducts arising from the genital chamber, the apex in form of a sclerotized spiral with 3 turns (Figs 9C–D).

C. meyerduerii

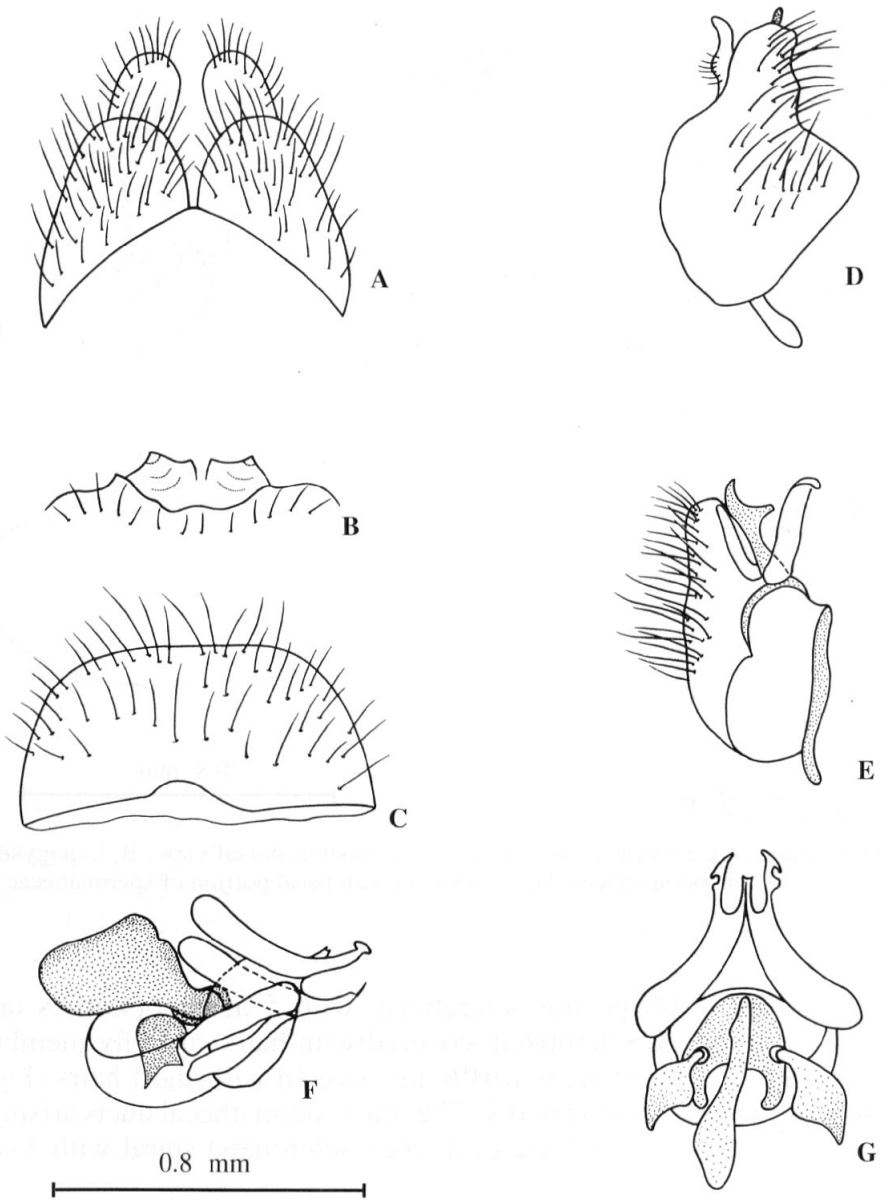

Fig. 6. Male genitalia of *Cyrtopogon meyerduerii*. A, epandrium and cerci, dorsal view; B, projection of hypandrium; C, hypandrium, dorsal view; D, gonopod, dorsal view; E, gonopod, ventral view; F, aedeagus, lateral view; G, aedeagus, dorsal view.

Cyrtopogon platycerus Villeneuve, 1913

Genital characters: Epandrium partially divided, apically rounded, sclerotized and covered with long hairs (Fig. 10A). – Hypandrium medially with two rounded prolongations, related to the shape of the aedeagus (Fig. 10B–C). – Gonopod: Basistylus apically rounded. The inner projection is strongly sclerotized and has apically two processes; the inner one is short. Dististylus flattened and rounded at apex, covered with hairs (Figs 10D–E). – Aedeagus medially tubular with two curved pro-

C. meyerduerii

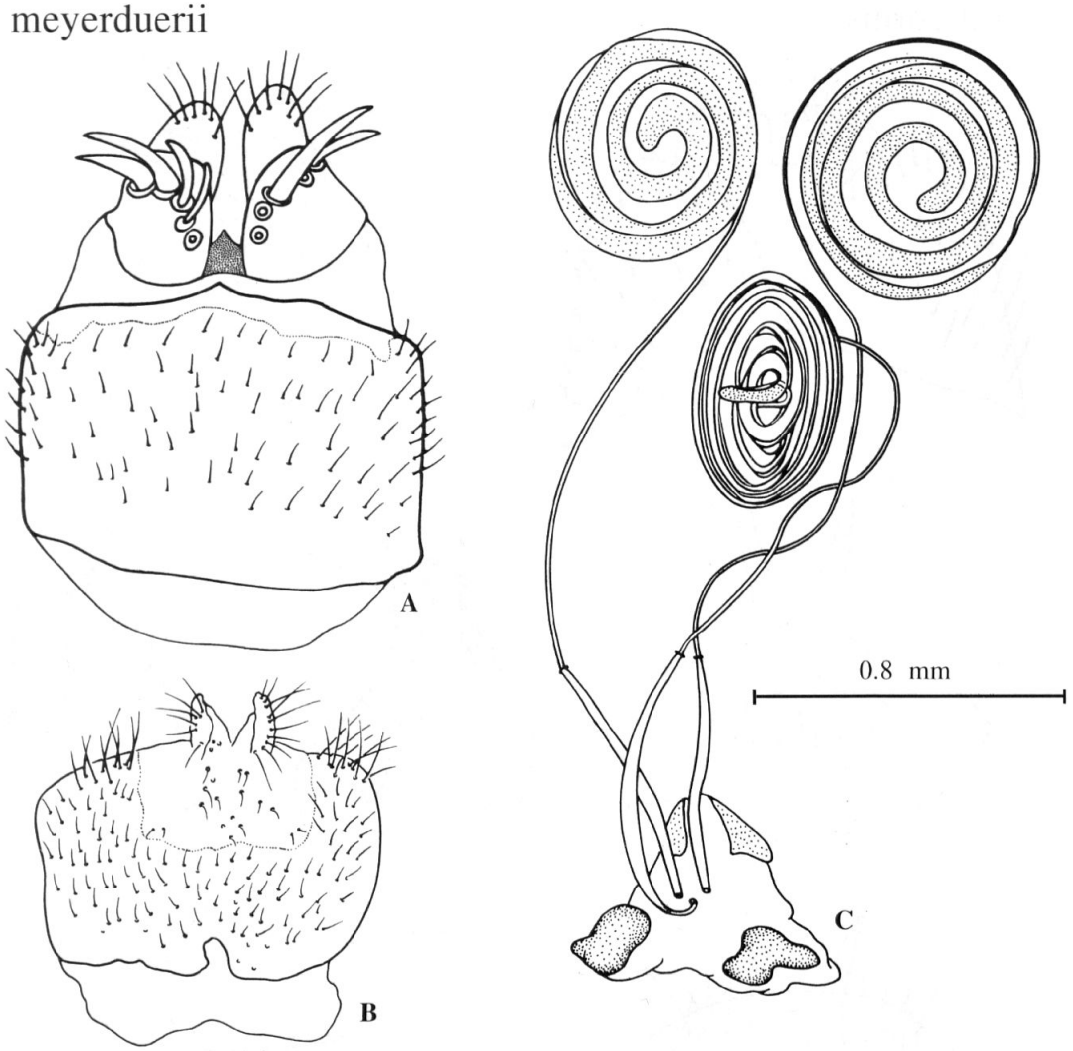

Fig. 7. Female genitalia of *Cyrtopogon meyerduerii*. A, ovipositor, dorsal view; B, hypogyne, dorsal view; C, gonapodem with spermathecae.

jections (Figs 10F–G). – Ovipositor sclerotized, with 6 acanthophorites on each side (Fig. 11A). – Hypogyne sclerotized, covered with hairs, apically membranous with two rounded, sclerotized areas which are covered with short hairs (Fig. 11B). – Gonapodema formed like a large U (Fig. 11D). The three spermathecal ducts arising from a rounded, sclerotized area of the genital chamber (Fig. 11D), the apex in form of a sclerotized spiral with 2–3 turns (Fig. 11C).

RELATIONSHIPS

Based on the genitalia as well as on external characters, we propose the following three groups:

1. *flavimanus* species group: *C. flavimanus*, *C. lateralis*

The aedeagus has a conical sheath with lateral denticles. The projection of the hypandrium is membranous. The arista shows a skittle shape; the postpedicel is more or less parallel-sided (Figs 1E–F).

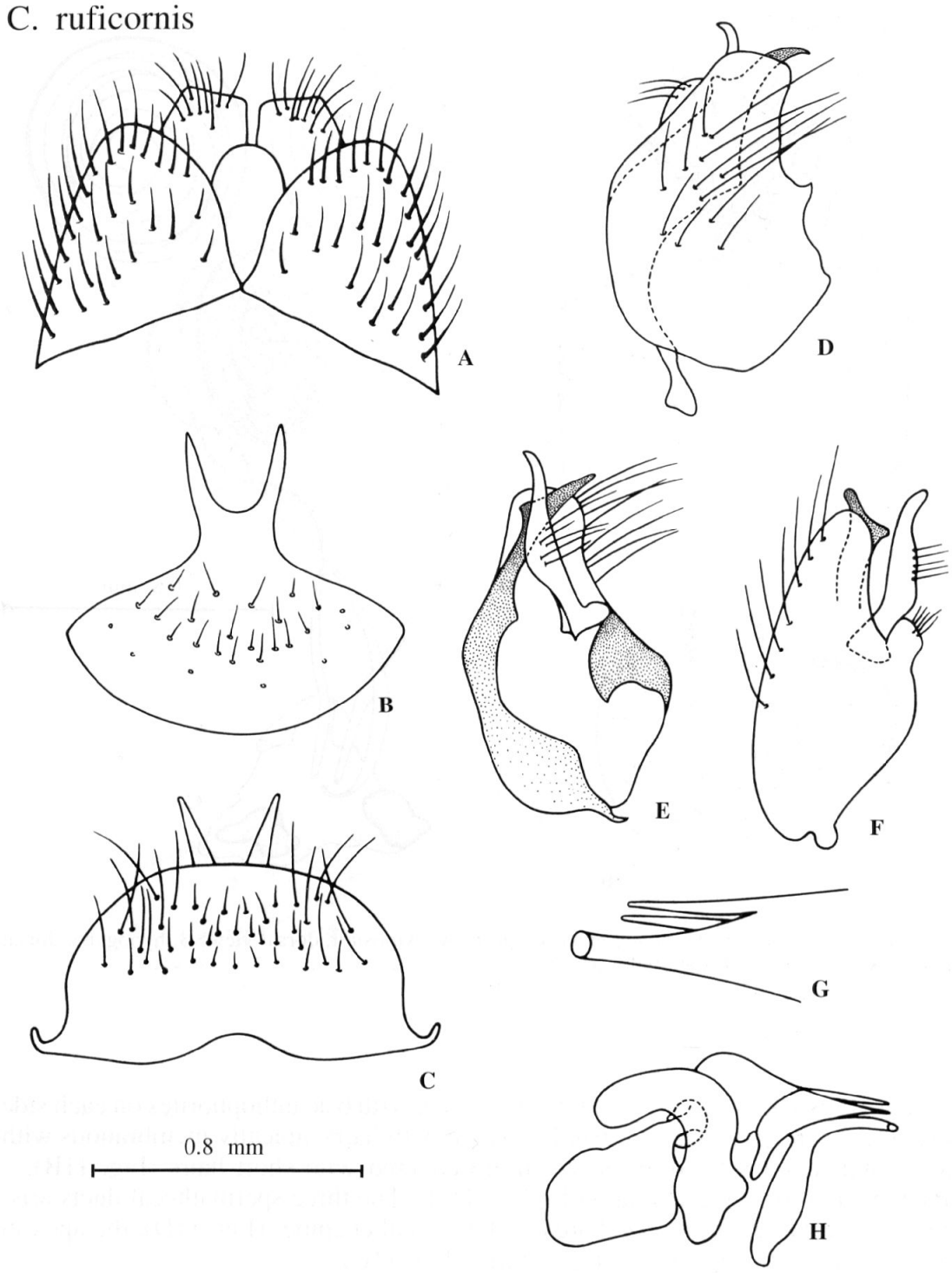

Fig. 8. Male genitalia of *Cyrtopogon ruficornis*. A, epandrium and cerci, dorsal view; B, projection of hypandrium; C, hypandrium, dorsal view; D, gonopod, dorsal view; E, gonopod, ventral view; F, gonopod, lateral view; G, tip of aedeagus, lateral view; H, aedeagus, lateral view.

2. *fulvicornis* species group; *C. fulvicornis*, *C. maculipennis*, *C. meyerduerii*

The aedeagus is broadened in the apical part, with two lateral humped projections. The projection of the hypandrium is apically sclerotized. The arista is cylindrical and truncate, the postpedicel is more or less parallel-sided (Figs 1C–D).

C. ruficornis

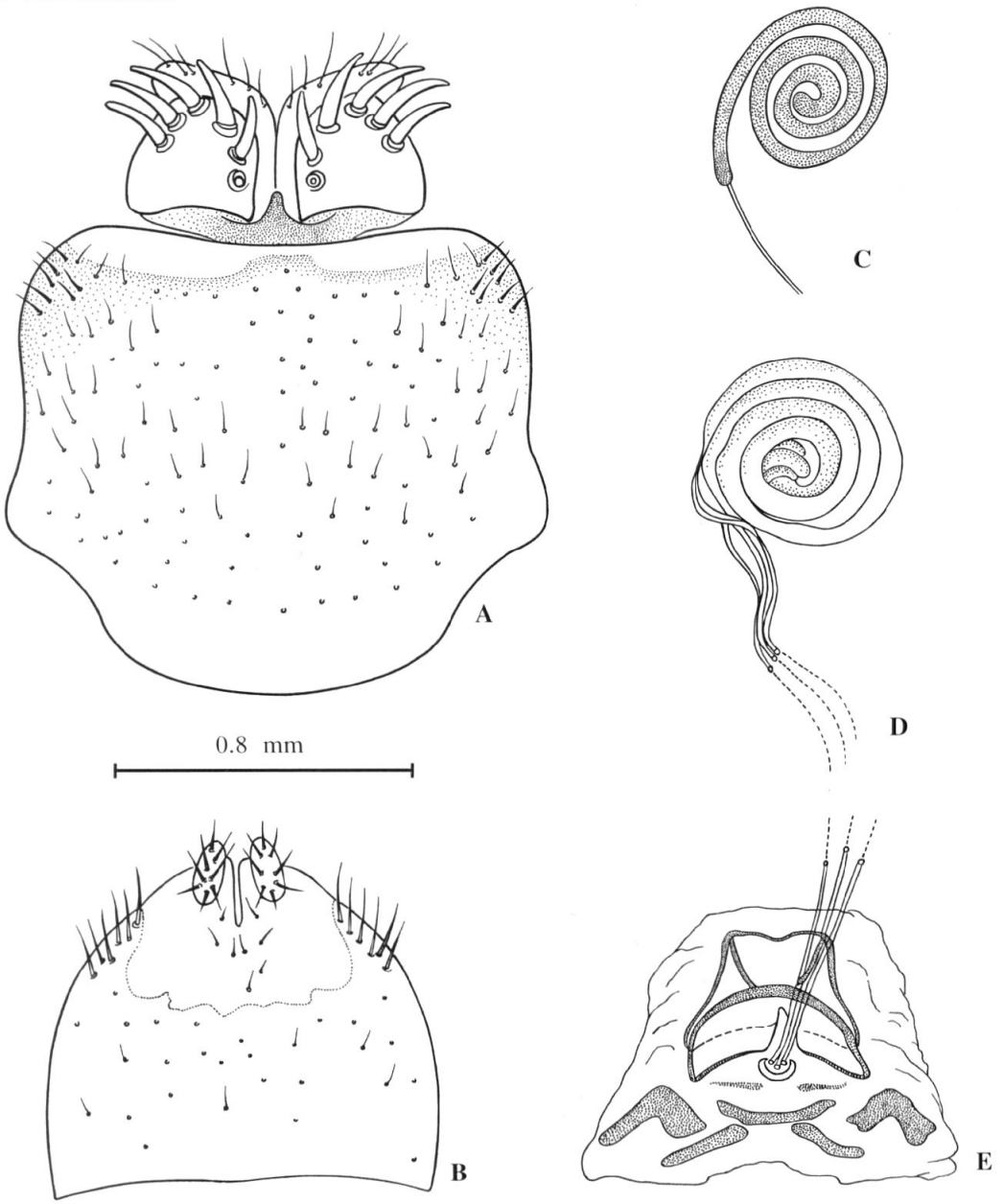

Fig. 9. Female genitalia of *Cyrtopogon ruficornis*. A, ovipositor, dorsal view; B, hypogyne, dorsal view; C, terminal spiral of spermatheca; D, spermathecae; E, gonapodem with basal portion of spermathecae.

3. *ruficornis* species group: *C. ruficornis*, *C. platycerus*

The aedeagus has a tubular structure with two pointed ot curved projections. The projection of the hypandrium is a tubular or rounded double structure. The arista is conical, the postpedicel is more or less enlarged (Figs 1A–B).

As a consequence of this grouping, the species *C. platycerus* is re-combined with *Cyrtopogon*, as originally proposed by BEZZI (1927), and, therefore, the genus *Cyclosocerus* BEZZI, as treated by LEHR (1988), is sunk as a synonym of *Cyrtopogon*.

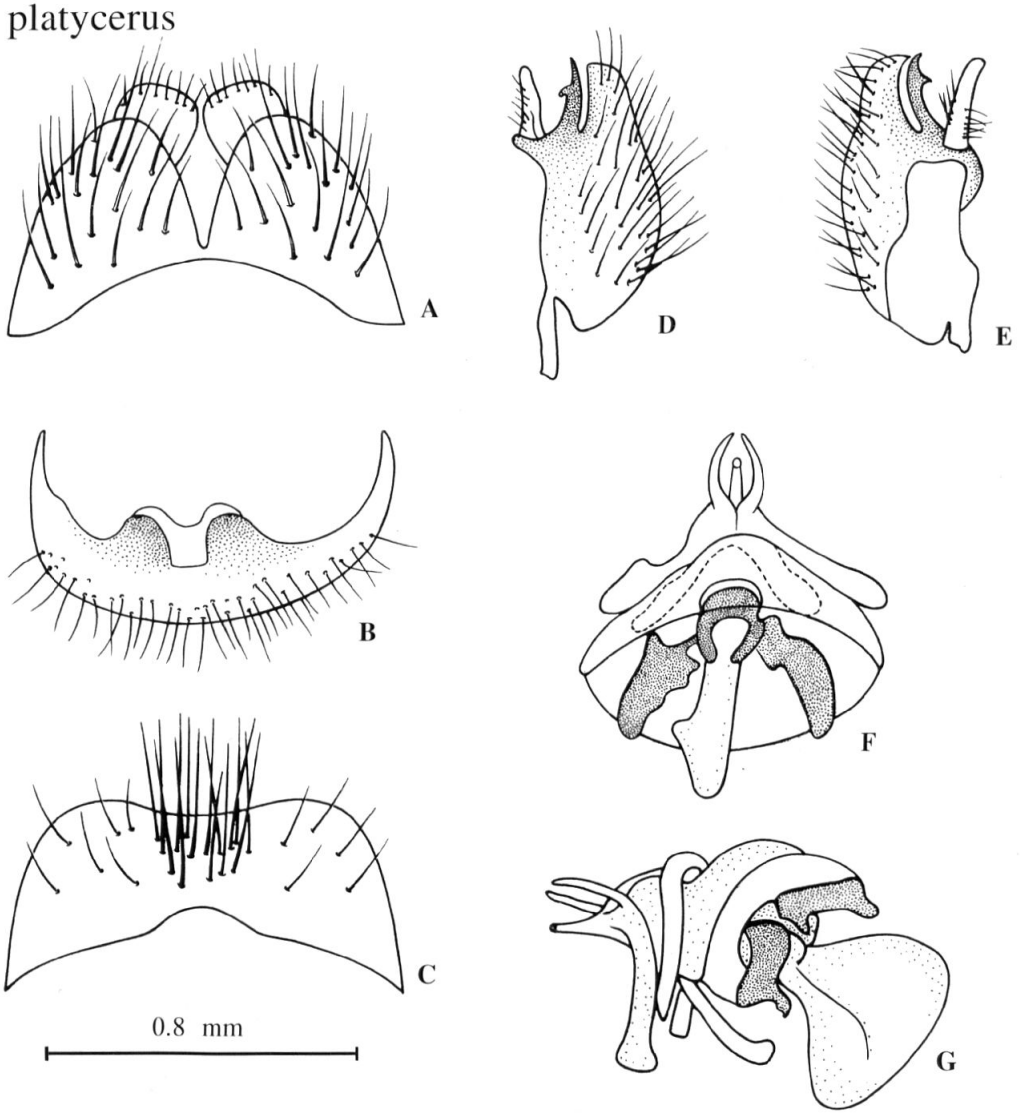

Fig. 10. Male genitalia of *Cyrtopogon platycerus*. A, epandrium and cerci, dorsal view; B, projection of hypandrium; C, hypandrium, dorsal view; D, gonopod, lateral view; E, gonopod, ventral view; F, aedeagus, dorsal view; G, aedeagus, lateral view.

In our opinion, the three species groups have (at least) subgeneric rank which, as we hope, will be confirmed by the analysis of additional *Cyrtopogon* species or by a revison of the whole genus.

DISCUSSION

Within *Cyrtopogon* s.str., BEZZI (1927) established the species groups *fulvicornis*, *ruficornis*, and *flavimanus*, respectively, without expressively giving any group characters, but obviously based on external characters. Therefore, we are unable to discuss the differences in the two proposed groupings.

The structures of the genitalia show important characters which make it possible to assess the systematic position with more accuracy. In his study of the genus *Stenopogon*, LEHR (1963) mentioned that the apical part of the hypandrium shows

C. platycerus

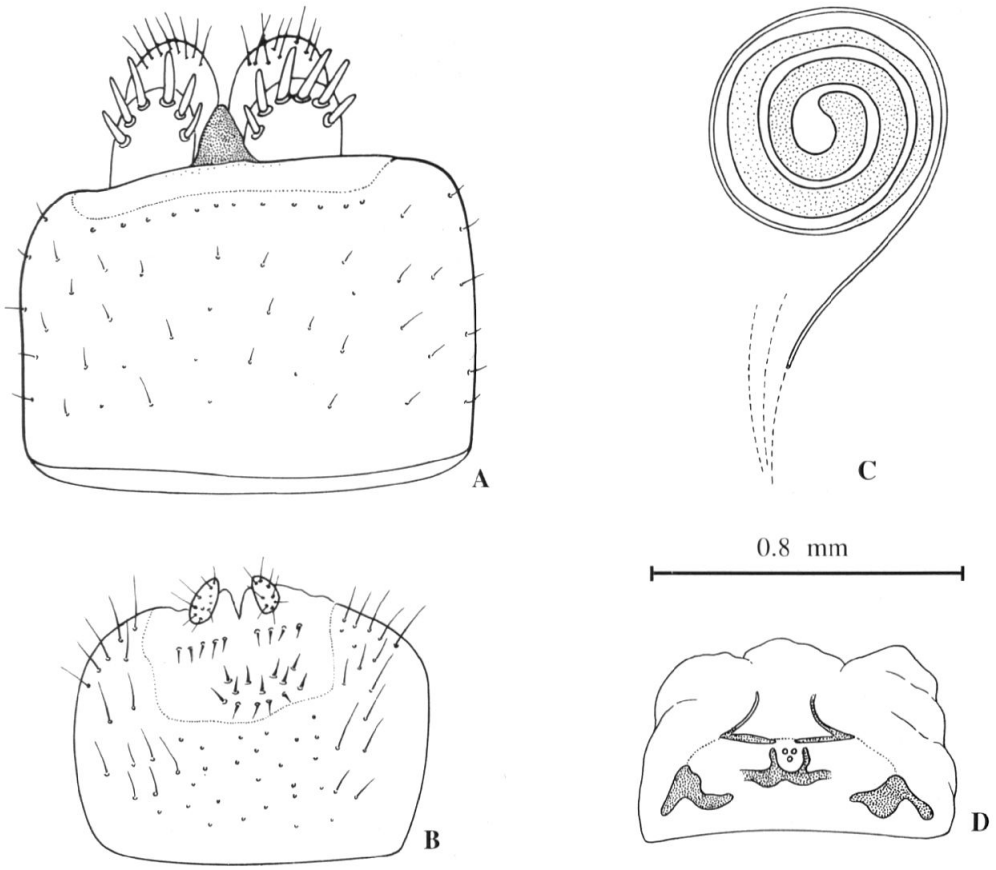

Fig. 11. Female genitalia of *Cyrtopogon platycerus*. A, ovipositor, dorsal view; B, hypogyne, dorsal view; C, terminal spiral of spermatheca; D, gonapodem.

specific details which, in spite of some variability found among larger series of specimens, do not exceed the general plan of the shape of hypandrium. As shown above, we can corroborate this statement; genitalia, especially of the male, should always be used in the discrimination and taxonomic analysis of asilid species.

There are already a few publications giving descriptions and/or illustrations of *Cyrtopogon* species. KARL (1959) made a verbal comparison of the epandrium, the gonopods, and the hypandrium of *C. flavimanus*, *C. lateralis*, *C. maculipennis*, and *C. ruficornis* with species of some other genera, without giving illustrations. He stated that in these species the epandrium is incompletely divided. As shown above, this statement is partially wrong. HULL (1962) illustrated the genitalia of both sexes of *C. ruficornis*, the type species of *Cyrtopogon*, on undissected specimens. These drawings do not reveal any internal sclerites.

THEODOR (1976) illustrated the aedeagus and gonapodema with spermathecae of *C. lateralis* and *C. ruficornis*. As far as we can see, only minor differences exist between our drawings and those of THEODOR (1976). LAVIGNE & BULLINGTON (1981) described a new species of *Cyrtopogon* from Wyoming and illustrated the genitalia of both sexes, but without clearly showing the apical median projection of the hypandrium. ARTIGAS & PAPAVERO (1991) illustrated the position of the sperma-

theca, the gonapodema and one spermatheca of *Cyrtopogon basingeri* WILCOX & MARTIN.

In the study of *C. flavimanus*, we used for the first time the median projection of the hypandrium as a descriptive character (WEINBERG & BÄCHLI, 1993b). That this is an important character, is now clearly established.

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