



A Revised Description of the Larva of *Leptocerina pauliani* (Ross 1957) (Trichoptera: Leptoceridae), an Endemic Species of La Réunion Island

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Abstract

Leptocerina is an endemic Afrotropical genus of Trichoptera, with 19 species documented but only five partially described at the larval stage. The first description of *Leptocerina pauliani* (Ross 1957) larva by Marlier & Marlier (1982) included very few illustrations, making comparisons with other species challenging. I present a revised description of the *L. pauliani* larval stage, using specimens collected from the River Marsouins in La Réunion Island. I apply a focus stacking approach for emphasizing coloration patterns and providing a detailed description of larval characters. Criteria for distinguishing *L. pauliani* from the other species of *Leptocerina* already described or partially described for the larval stage are discussed.

Key words: Taxonomy, Larval description, Athripsodini, Mascarene Islands

Introduction

The long-horned caddisfly family (Trichoptera: Leptoceridae) contains over 2254 species distributed across all biogeographic regions (Morse 2020; Morse personal communication). Past classifications of Leptoceridae Leach 1815 (Ulmer 1907a; Morse 1981) were based on morphological characters from adult males, i.e. wing venation, tibial spur formula and genital morphology. The family was divided into two subfamilies: Leptocerinae Leach 1815 and Triplectidinae Ulmer 1906. Malm & Johanson (2011) revised the classification of the family using a molecular approach and, even though their new classification is more-or-less congruent with the morphologically based classification, they proposed modifications such as the elevation of tribes Grumichellini Morse 1981 and Leptorussini Morse 1981 to subfamily status (respectively Grumichellinae and Leptorussinae). Therefore, their new classification now contains four subfamilies of Leptoceridae (Leptocerinae; Triplectidinae Ulmer 1906; Grumichellinae and Leptorussinae). Leptocerinae include nine recognized tribes including Athripsodini, which contains eight genera (*Athripsodes* Billberg 1820; *Axiocerina* Ross 1957; *Ceraclea* Stephens 1829; *Homilia* McLachlan 1877; *Leptecho* Barnard 1934; *Leptoceriella* Schmid 1993; *Leptocerina* Mosely 1932; *Neothripsodes* Holzenthal 1989). *Leptocerina* is restricted to the Afrotropical region, south of the 10° north parallel, and contains 12 continental species, five in Madagascar and two endemic to the Mascarene Islands [*Leptocerina pauliani* (Ross 1957) from La Réunion and *Leptocerina mauritii* (Jacquemart 1963) from Mauritius] (Gibon *et al.* 2001, Gibon & Randriamasimanana 2007).

Even though adult stages of *Leptocerina* are well documented thanks to the work of pioneers like Ulmer (1906, 1907b, 1913), Navás (1930), Mosely (1932, 1939), Kimmins (1955, 1956), Marlier (1956, 1965, 1978), Ross (1957), Jacquemart (1961, 1963), Morse (1984), and Gibon & Randriamasimanana (2007), detailed larval descriptions are still lacking for many species. Larvae of only six species or subspecies have been partially described: *Leptocerina integra* Marlier 1956 by Marlier (1956); *L. pauliani* Ross 1957 by Marlier & Marlier (1982); *Leptocerina ramosa pinheyi* Kimmins 1956, *Leptocerina ramosa trifida* Kimmins 1956, and *Leptocerina ungangana* Ulmer 1931 by Hickin (1956); and *Leptocerina spinigera* Mosely 1932 by de Moor (2002) and de Moor & Scott (2004). Improving descriptions of larval stages is desirable because species identification is often easier with larvae than adults (e.g., *L. ramosa pinheyi* vs *L. ramosa trifida*; Hickin 1956) and because bioassessment studies usually rely on larval stages only.

Although detailed illustrations can emphasize some diagnostic features while omitting non-important characters (i.e., tufts of setae), they require uncommon illustrator drafting skills and may omit important information. For instance, the extent of the spinulated area on the head capsule proved to be an important criterion for the discrimination of *Stenophylax* species (Waringer *et al.* 2014), although this distinguishing feature was not represented in the drawings of the larva of *Stenophylax mucronatus* McLachlan 1880 (Frochot & Fotius-Jaboulet 1964).

In this paper, I give a revised description of the larva of *L. pauliani* using a microscope focus stacking approach, which emphasizes coloration patterns and provides detailed photographic illustrations of larval characters. I also discuss criteria for distinguishing *L. pauliani* from the other species of *Leptocerina* already described or partially described for the larval stage.

Material and methods

In order to elaborate a new river bioassessment index that meets the requirements of the European Water Framework Directive (European Commission 2000), an intensive sampling effort (1836 samples in 42 sites; Mérigoux *et al.* 2012) was conducted in rivers of Réunion Island between 2008 and 2011. On 6 November 2009, ten larvae of *L. pauliani* were collected in disconnected pools during the drying phase of the River Marsouins (21°06'47.8"S 55°34'01.1"E, Altitude: 1300 m, Fig. 1A, 1B). I used identification criteria proposed by Marlier & Marlier (1982) and comments by Morse (1984) to identify specimens as *L. pauliani*. Specimens of *Oecetis* sp. and adults of Gyrinidae were collected in the same pools. Specimens have been deposited in the Université Claude Bernard Lyon Zoology, Centre de Ressources pour les Sciences de l'Évolution (UCBLZ–CeReSE) zoology collection (Lyon 1 University, France, n° col.: 2012.7.3.32).



FIGURE 1. Sampling site for *Leptocerina pauliani* (Ross 1957) in a temporary reach of the River Marsouins, La Réunion Island. 1A, dry section; 1B, permanent pools.

Photographs of larvae were taken in the laboratory using a Leica M205C stereomicroscope with a DMC5400 camera, and the stacking process was performed with the LasX software (v. 3.0.11.20652). This process combines images with focus at varying depths into a single detailed image (Montesanto 2015).

Description of last instar larva

The last instar larva of *L. pauliani* inhabits a case that is triangular in cross-section, made of three pieces of leaf attached by their longitudinal edges (Fig. 2A). [Early instars build a cylindrical case made of sand and diverse plant particles (Fig. 2B)].

Body: Last instar larva length ~9.5 mm.

Head: Colouration uniformly brown with light-coloured muscle scars and pale circular areas around eyes (Figs 3A–3C). Head elongate, tapering anteriorly, with antennae longer than half of width of frontoclypeal apotome, but not extending beyond anterior edge of labrum (Figs 3B, 3C). Frontoclypeal apotome narrowly triangular, constricted near mid-length, with pointed posterior apex joining short, asymmetrically curved coronal suture, convex to left (Fig. 3B). Eyes large, dark, simple, surrounded by large, pale, circular areas (Figs 3A, 3B). Pair of subocular ecdysial lines present on head capsule, running under eyes, horizontally reaching posterior part of head and dividing genae into upper and lower parts (Fig. 3A). Labrum yellowish, rectangular, medially indented on anterior edge (Figs 3B, 6A). Mandibles brown, short, shredder-type; left mandible with median short brush, slightly larger than right mandible (Figs 6B, 6C). Anterior ventral apotome forming pear-shaped elongate triangle nearly reaching posteriorly to two small posterior ventral sclerites (Fig. 3C).

Thorax: Pronotum brown, concolorous with head capsule, medially divided and with anterolateral corners delimited by pair of slanting ecdysial lines, each starting from middle of lateral edge to reach submedial one-fifth of anterior edge of respective half sclerite (Figs 3D, 3E). Foretrochantins flat, elongate, and finger-shaped (Figs 3A, 3D). Sclerotised mesonotum medially divided, yellowish with brownish muscle scars and pair of conspicuous dark mesonotal bars characteristic of Athripsodini larvae extending from posterolateral corners to midlength; these mesonotal bars nearly parallel, each branching anteriorly to form fork (Fig. 3E). Metanotum membranous and bearing pair of setal area 1 (*sa1*) setae submesally (best seen in profile in Figs 3D, 4D); pair of small and ill-defined sclerites, each bearing one long and three small setae, present on setal area 3 (*sa3*, Figs 3E, 4F). Pair of dark, transverse intersegmental sclerites between mesosternum and metasternum. Metasternum bearing three pairs of setae, two pairs of *sa3* setae laterally and one pair of *sa2* seta submesally (Fig. 3F, with right submesal seta broken).

Forelegs short and stocky; femora broad and with numerous long setae and row of pale strong spine-like setae on ventral margin; these strong setae also present on tibiae and tarsi; tarsal claws simple, short, curved, with prominent basal spine (Fig. 4A). Midlegs longer than forelegs and also with rows of strong spine-like setae on femora, tibiae, and tarsi, and prominent basal spine on each claw (Fig. 4B). Hind legs long and projected forward; rows of strong setae present on only tibiae (Fig. 4C, black arrow) and tarsi; prominent basal spine present on each claw. Hind femora, tibiae, and tarsi each with two rows of dense, long fringes of swimming setae, one row on each of dorsal and ventral margins (Fig. 4C).

Abdomen: Segment I bearing one dorsal and two lateral humps (Fig. 4D). Pair of long setae located on each side of dorsal hump (Fig. 3E, black arrows). Each lateral hump with patch of very short brownish spines and two long setae anteriorly and darker, slightly sinuous, longitudinal, sclerotized bar posteriorly (Fig. 4E), similar to patch and bar of larvae of other Athripsodini species.

Gills simple (Fig. 4D) and present on abdominal segments II–VII (only two dorsal gills on abdominal segment VII, see Fig. 5A).

Lateral fringe composed of dense, long, and fine setae from abdominal segment III to end of segment VII (Fig. 5A). Continuing along line of lateral fringe on each side, row of short lateral tubercles present on abdominal segment VIII (Fig. 5B).

Two long, dorsomesal upright setae present on abdominal tergite VIII (Fig. 5E). Abdominal tergite IX bearing one dorsomesal sclerite with three pairs of large setae posteriorly; inner pair of setae longer than others and intermediate pair of setae shortest (Figs 5D, 5E); row of two pairs of short, fine, lighter setae inserted between the row of these three pairs of long black setae and posterior edge of this sclerite. Two short lateral setae present on abdominal sternite IX (slightly visible in profile in Fig. 5D).

Anal prolegs short, each with smaller dorsal sclerite and larger sole plate in contact with claw (Figs 5D, 5E). At base of claw insertion, on sole plate, one small and one long seta projecting ventrad (Fig. 5D). Each basal tuft inserted just above claw consisting of four thick and long black setae, mesal seta shorter than other three (Fig. 5D). In ventral view, oblique row of about fifteen upright spines extending from base of claw insertion almost to abdominal sternum IX (Figs 5C, 5F, black arrow). Ventral side of each anal proleg on each side of anus covered with many tight transverse rows of short, flattened spines (Figs 5C, 5F). Anal claws strongly curved and armed apically with three accessory hooks (Figs 5C, 5D).



FIGURE 2. *Leptocerina pauliani* (Ross 1957) larva and its case, habitus, right lateral. 2A, last instar larva; 2B, early instar larva.



FIGURE 3. *Leptocerina pauliani* (Ross 1957). 3A–3C, head: 3A, right lateral; 3B, dorsal; 3C, ventral. 3D–3F, thorax (legs removed to improve visibility): 3D, right lateral; 3E, dorsal, black arrows highlighting pair of long setae on each side of dorsal abdominal hump; 3F, ventral.

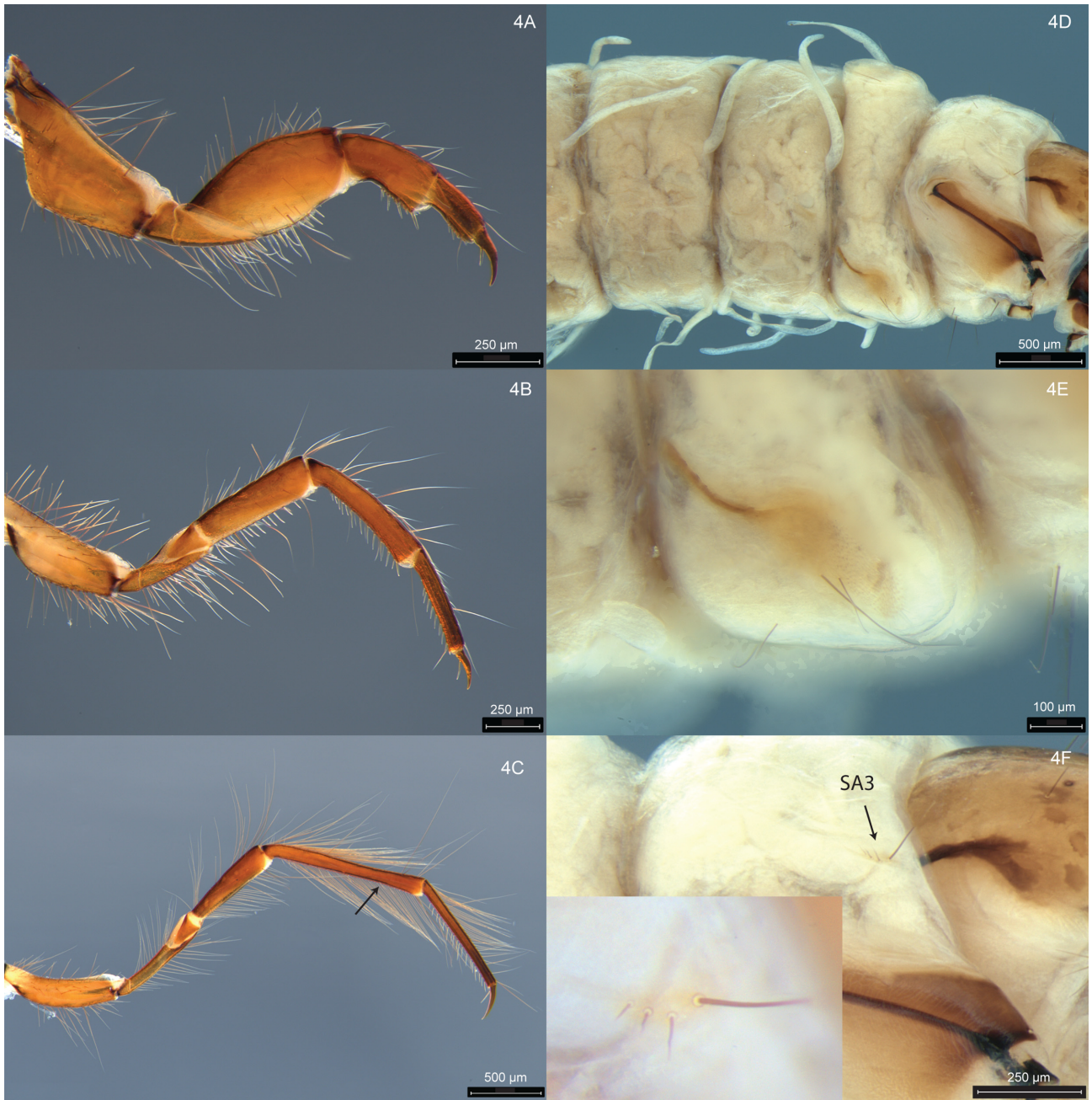


FIGURE 4. *Leptocerina pauliani* (Ross 1957). 4A–4C, left legs, anterior (inner) surfaces: 4A, foreleg (PI); 4B, midleg (PII); 4C, hind leg (PIII). 4D–4F, abdomen: 4D, abdominal segments I–III, right lateral (legs removed to improve visibility); 4E, right lateral hump, right lateral; 4F, metanotum, dorsal [black arrow indicating setal area 3 (SA3); inset = dorsal view of SA3].

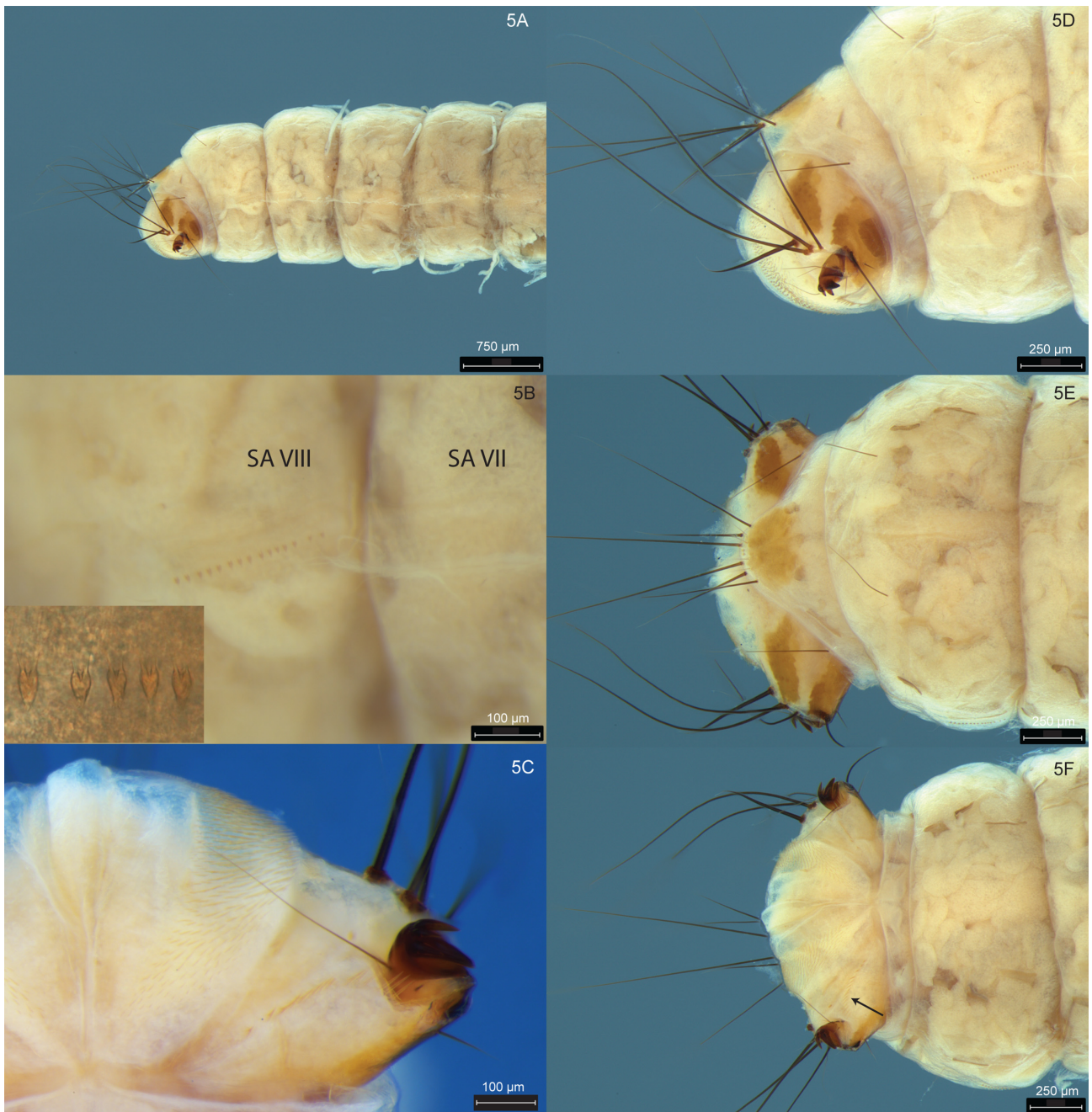


FIGURE 5. *Leptocerina pauliani* (Ross 1957). 5A, abdominal segments IV–IX, right lateral. 5B, row of lateral tubercles on abdominal segment VIII (SA VIII), right lateral; inset = tubercles at X630 magnification. 5C, right anal proleg, ventral. 5D–5F, abdomen extremity: 5D, right lateral; 5E, dorsal; 5F, ventral.



FIGURE 6. *Leptocerina pauliani* (Ross 1957). 6A, labrum, dorsal. 6B, 6C, mandibles: 6B, dorsal; 6C, ventral.

Discussion

In the larval stage, most Leptoceridae share some characters such as long antennae, long hind legs, and the presence of at least two setae on the metasternum (Malm & Johanson 2011). However, there is no single diagnostic character for the Leptocerinae subfamily except perhaps the presence of additional cephalic ecdysial lines on both sides of the anterior part of the cephalic capsule (St Clair 1994). Although Morse (1984) announced that Athripsodini species have mesonotal bars, de Moor (2002, Table 3-4) showed that some (*Athripsodes bergensis* Scott 1958, *Leptecho scirpi* Barnard 1934, and *L. helicothecus* Scott 1958) lack them. Thus, there are currently no criteria specific to the tribe Athripsodini and a thorough comparative study of the larval forms of species belonging to this tribe is desirable. Among the 19 *Leptocerina* species currently recognised, only four (*L. integra*, *L. pauliani*, *L. spinigera*, and *L. ungangana*) and two subspecies for *L. ramosa* (*L. ramosa pinheyi* and *L. ramosa trifida*) are partially described in the larval stage.

Key to the species of already-described *Leptocerina* larva

- 1 Case cylindrical in cross-section (Hickin 1956, figs 8, 13) 2
- Case triangular in cross-section (Figs 1A, 1B) 3
- 2 Case made up of vegetable debris arranged transversally; head coloration almost completely black (similar to Hickin 1948, fig. 1) *Leptocerina ramosa trifida*
- Case generally consisting of twig or hollowed stem; head coloration yellowish with dark longitudinal bands (Hickin 1956, fig. 13) *L. ungangana*
- 3 Triangular ventral apotome posteriorly elongate (Fig. 3C) 4
- Triangular ventral apotome wide and not posteriorly elongate (de Moor 2002, fig. 5I; de Moor & Scott 2004, fig. 5.38A) *L. spinigera*
- 4 Hind tarsi with rows of dense, long fringe of swimming setae and ventral row of short, stiff bristles (Fig. 4C) 5
- Hind tarsi with short, stiff bristles but without long fringe of swimming setae (Marlier 1956, fig. 2H) *L. integra*
- 5 Metanotum with well-defined sclerites on setal area 3 (Hickin 1956, fig. 5) *L. ramosa pinheyi*
- Metanotum with ill-defined sclerites on setal area 3 (Figs 3D, 3E) *L. pauliani*

Little is known about the ecology of *Leptocerina* larvae. According to Malaisse (1969), they prefer fast-flowing rivers and according to Marlier (1956), the larva of *L. integra* is found in calm areas of streams with sandy or stony bottoms. This last information is more realistic considering that larvae of some *Leptocerina* species swim using the dense setal fringes on their hind legs. In Zimbabwe, *Leptocerina* are restricted to undisturbed forested sites and may be used as indicators of the structural degradation of water bodies (Chakona *et al.* 2009). More generally, larval descriptions can help identify genera and species and will improve bioassessment in rivers. Further taxonomic work associating larvae of the different species with their identifiable adults and describing those larvae is desirable in the Afrotropical region, including Madagascar and the Mascarene Islands.

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