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First larval description and chaetotaxic analysis of the neotropical whirligig beetle genus *Enhydrus* Laporte (Coleoptera, Gyrinidae)

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ABSTRACT

The larva of the whirligig beetle *Enhydrus sulcatus* (Wiedemann, 1821) is described and illustrated for the first time, including detailed morphometric and chaetotaxic analyses of the cephalic capsule, head appendages and legs. Larvae of *Enhydrus* Laporte, 1834 exhibit the characters traditionally recognized as autapomorphies of the family Gyrinidae: well developed cardo, completely divided prementum, presence of lateral abdominal tracheal gills, and presence of four terminal hooks on the pygopod. The egg bursters located on the parietal, the presence of an additional sensorial plate on the third antennomere, and a well developed lacinia may also represent autapomorphies of the family. *Enhydrus* larvae share with those of the other known Dineutini genera the presence of numerous minute additional setae on the mandible, the presence of additional setae on the cardo, the submedial position of the coxal seta CO12, the absence of the trochanteral seta TR2, and the presence of numerous pore-like additional structures on the ultimate maxillary and labial palpomeres. On the other hand, *Enhydrus* can be distinguished from the other known dineutine genera by the presence of pore-like additional structures on the basal maxillary and labial palpomeres, the presence of ventral spinulae on the pygopod, and the bare tracheal gills, among other characters.

Introduction

Enhydrus Laporte, 1834 is a small gyrinid genus composed of four species (Miller and Bergsten, 2012). It is included in the tribe Dineutini together with the extant genera *Andogyrus* Ochs, 1924, *Dineutus* MacLeay, 1825, *Macrogyrus* Régimbart, 1882 and *Porrorhynchus* Laporte, 1835, and several extinct genera (Gustafson and Miller, 2013). Members of this genus are relatively large (adult length about 20 mm) and occur mainly in South America, with two species (*E. sulcatus* (Wiedemann, 1821) and *E. tibialis* Régimbart, 1877) in Brazil, one species (*E. mirandus* Ochs, 1955) in Venezuela, and the remaining species (*E. atratus* Régimbart, 1877) in Ecuador and Colombia but reaching Panamá and Costa Rica in Central America. The known southern limit of the genus is a record of *E. sulcatus* in the state of Rio Grande do Sul, southern Brazil (Mañko, 1993). The adult members of *Enhydrus* were revised by Brinck (1978).

Enhydrus sulcatus, the type species, inhabits streams that run through hills of preserved gallery forest, and within this habitat the adults can be found, either isolated or in aggregations, in the streams or in small pools formed by the intricate geography of the stream borders, always in shaded places with some current (Mañko, 1997; Alvarenga et al., 2011). This species has been subject of detailed studies on the adult external and internal morphology (Mañko, 1993), morphometry and sexual dimorphism (Alvarenga et al., 2011), pygidial glands (Barth, 1960), and bionomy and habitat (Mañko, 1997). However, the study of the larvae has remained a gap in our knowledge, with this stage being unknown for the genus.

A system of nomenclature for the primary sensilla of larvae of the family Gyrinidae is presently under development (Archangelsky and Michat, 2007; Michat et al., 2010; Michat and Gustafson, 2016). Although incomplete and subject to improvement based on the discovery of more gyrinid larvae, this system provides a descriptive template to which larvae of more genera can be incorporated. In this contribution we study the first-instar larva of *E. sulcatus* to provide, for the first time, a detailed description of the larval morphology and primary chaetotaxy of the genus *Enhydrus*. We also compare the morphological and chaetotaxic

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characters of this genus with those of other gyrinid genera for which the larvae have been described in detail, and discuss remarkable or interesting findings.

Material and methods

Source of material

The description provided in this paper is based on five instar I specimens obtained from eggs laid by adults collected in June 2009 at the following locality: Brazil, Minas Gerais State, Ingaí, 21°20′47″S & 44°59′27″W. Females were kept alive in plastic water tanks and fed with small insects. The oviposition occurred two days after confinement, and the eggs hatched 28 days after oviposition. The larvae could not be successfully reared in the laboratory due to their unknown requirements.

Methods

The larvae were cleared in lactic acid, dissected, and mounted on glass slides in polyvinyl-lacto-glycerol. Microscopic examination at magnifications up to 1000× and drawings were made using an Olympus CX31 compound microscope equipped with a camera lucida. Drawings were scanned and digitally inked using a Genius PenSketch tablet. The material is held in the collections of Y. Alarie (Department of Biology, Laurentian University, Sudbury, Ontario, Canada) and M.C. Michat (Laboratory of Entomology, Buenos Aires University, Argentina).

Morphometric analysis

We employed the terms used in previous papers dealing with the larval morphology of Gyrinidae (Archangelsky and Michat, 2007; Michat et al., 2010). The following measurements were taken (with abbreviations shown in parentheses). Total length (excluding terminal tracheal gills) (TL); maximum width (excluding tracheal gills) (MW); head length (HL) (total head length including the frontoclypeus, measured medially along the epicranial stem); maximum head width (HW); length of frontoclypeus (from anterior margin to the joint of frontal and coronal sutures) (FRL); occipital foramen width (maximum width measured along dorsal margin of occipital foramen) (OCW); coronal suture length (COL); length of mandible (MNL) (measured from laterobasal angle to apex); width of mandible (MNW) (maximum width measured at base); length of maxillary palpifer (PPF); length of galea (GA). Length of antenna (A), maxillary (MP) and labial (LP) palpi were derived by adding the lengths of the individual segments; each segment is denoted by the corresponding letter(s) followed by a number (e.g., A1, first antennomere). The maxillary palpus was considered as being composed of three segments united to the stipes through a palpifer (Archangelsky and Michat, 2007). Length of leg, including the longest claw (CL), was derived by adding the lengths of the individual segments; each leg is denoted by the letter L followed by a number (e.g., L1, prothoracic leg); the length of trochanter includes only the proximal portion, considered from the base to the beginning of the femur; the leg was considered as being composed of six segments (Lawrence, 1991). Length of terminal hooks of abdominal segment X, separated in medial hook (MH) and lateral hook (LH). These measurements were used to calculate several ratios that characterize body shape.

Chaetotaxic analysis

Primary setae and pores were distinguished on the cephalic capsule, head appendages and legs. Sensilla were coded by two capital letters, in most cases corresponding to the first two letters of the name of the structure on which they are located, and a number (setae) or a lower case letter (pores). The following abbreviations were used: AN, antenna; CO, coxa; FE, femur; FR, frontoclypeus; LA, labium; MN, mandible; MX, maxilla; PA, parietal; PT, pretarsus; TA, tarsus; TI, tibia; TR, trochanter. Setae and pores present in the first-instar larva of *E. sulcatus* were labeled by comparison with previous papers dealing with the primary chaetotaxy of members of the family Gyrinidae (Archangelsky and Michat, 2007; Michat et al., 2010). Homologies were recognized using the criterion of similarity of position (Wiley, 1981). Setae located at the apices of the maxillary and labial palpi were extremely difficult to distinguish due to their position and small size. Accordingly, they are not well represented in the drawings.

Results

Description of the first-instar larva of Enhydrus sulcatus *(Wiedemann, 1821)*

Diagnosis

Larvae of *Enhydrus* can be distinguished from those of other known gyrinid genera by the following combination of characters: cephalic capsule constricted at level of occipital region (Figs. 2, 4 and 5); occipital suture present (Figs. 2 and 4); coronal suture short; medial lobe of FR with four very inconspicuous teeth (Figs. 2 and 4); lacinia not dentate on posterior margin, indented apically (Figs. 9 and 10); claws lacking basoventral spinulae (Figs. 13 and 14); tracheal gills lacking spinulae (Fig. 3); terminal hooks subequal in length (Figs. 3 and 15); seta FR3 short, hair-like (Fig. 4); seta PA6 short, hair-like (Fig. 4); MN with additional setae (Fig. 8); cardo with some very short additional setae (Fig. 10); pore MXg proximal on MP2 (Fig. 10); pore MXj medial on MP3 (Fig. 9); MP1, MP2 and LP1 with minute pore-like additional structures (Figs. 9–12); pore LAc medial on LP2 (Fig. 11); seta CO12 medial (Fig. 14); additional setae on CO present (Figs. 13 and 14); seta TR2 absent (Fig. 13); seta TR5 short (Fig. 14); abdominal segment X with ventral spinulae (Fig. 15).

Description

Color (Figs. 1–3). Cephalic capsule and mandibles brown, antennae, maxillae and labium testaceous to light brown; thoracic sclerites light brown, rest of thorax and legs testaceous; abdomen testaceous except terminal hooks brown.

Body (Fig. 1). Elongate, parallel sided, head and pronotum strongly sclerotized, rest of thorax and abdomen soft. Measurements and ratios that characterize the body shape are shown in Table 1.

Head (Fig. 2). *Cephalic capsule* (Figs. 4 and 5). Subrectangular, longer than broad, parallel-sided with distinct narrow neck; occipital foramen slightly emarginate both dorsally and ventrally; occipital suture present; coronal suture short; frontal sutures U-shaped, extending to antennal bases; posterior tentorial pits visible ventromedially; area near occipital suture with reticulation; FR elongate, anterior margin with three weakly delimited lobes; medial lobe slightly produced anteriorly, with four very inconspicuous teeth; lateral lobes weakly developed, truncate, not projected beyond medial lobe; PA with egg bursters formed by a single cuticular spine on each posterolateral surface, and six stemmata at each side, four dorsal and two ventral (not shown in Figs. 4 and 5 because they could not be recognized after the clearing process). *Antenna* (Figs. 6 and 7). Moderately long, slender, shorter than HW, composed of four antennomeres; A1 shortest, A2, A3 and A4 longest, subequal in length; A3 with two minute structures (probably spinulae) on ventrodistal surface, and two subapical flat plates on inner margin, distal one interpreted as the sensorium (A3′) which does