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Redescription of the genus *Curiades* Pascoe 1880 (Coleoptera: Curculionidae: Entiminae: Naupactini), a potential mimic of Mutillidae from Brazil

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Abstract

The monotypic genus *Curiades* Pascoe 1880 (Curculionidae: Entiminae: Naupactini) is redescribed based on the type species *C. boisduvali* (Boheman 1840), endemic to Río de Janeiro, Brazil. *Curiades boisduvali* shows a characteristic color pattern and vestiture composed of long erect setae that resembles species of *Dasymutilla* Ashmead 1899, a genus of Mutillidae (Hymenoptera) whose wingless females have aposematic colors and painful stings. The similarities between the wasp (model) and the weevil (mimic) suggest a case of Batesian mimicry. The morphological characters of the rostrum and antennae justify a close phylogenetic relationship of *Curiades* and *Platyomus* Sahlberg 1823, even though based on its hairy vestiture the former is superficially more similar to *Trichaptus* Pascoe 1880, another Brazilian naupactine mimic of mutillid wasps. The present contribution includes a redescription of *Curiades* and its only known species, accompanied by habitus photographs, line drawings of genitalia and other diagnostic features.

Keywords: Batesian mimicry, morphology, mutillid wasps, Naupactini, weevils

Introduction

The broad-nosed weevil tribe Naupactini Gistel (Curculionidae: Entiminae) consists of approximately 65 genera (Alonso-Zarazaga & Lyal 1999) with over 500 species distributed mainly in Central and South America (Wibmer & O´Brien 1986). *Curiades* Pascoe (1880: 420) was transferred from Phyllobiini Schoenherr to Naupactini by Kuschel (in Wibmer & O´Brien 1986), along with the related genus *Platyomus* Sahlberg (see del Rio & Lanteri 2010). *Curiades* is a monotypic taxon endemic to Brazil, with the single species *C. boisduvali* (Boheman 1840: 163) distributed along the coastal hills of Rio de Janeiro state at elevations of about 500–700 meters. Adults of this genus resemble wasps of the family Mutillidae, commonly known as "velvet ants" due to their dense pilosity of aposematic colors (red, black, white, silver or gold). They are also known as "cow killers" or "cow ants", in reference to the painful sting of their flightless females.

Curiades most closely mimics species of the genus *Dasymutilla* Ashmead 1899 which are clothed with similar very long and erect hairs. This is probably an example of Batesian mimicry, a form of mimicry in which an unprotected edible species resembles an unpalatable or harmful species and therefore is similarly avoided by predators (Pfennig *et al*. 2001). Another naupactine genus known to mimic mutillid wasps is *Trichaptus* Pascoe 1880, also endemic to Brazil and occurring in Espírito Santo and Minas Gerais states (Lanteri & del Río 2005); however, in this case the weevils resemble species of the genus *Hoplomutilla* Ashmead 1899.

Even though *Curiades* is easily recognized based on its distinct body vestiture, its morphology has not been described in detail. Accordingly, the purpose of this contribution is to redescribe *Curiades*, diagnose its only known species, illustrate the diagnostic features, and to provide some notes on its putative mimicry with Mutillidae.

Curiades boisduvali is poorly represented in entomological collections, and likely is a rare species.

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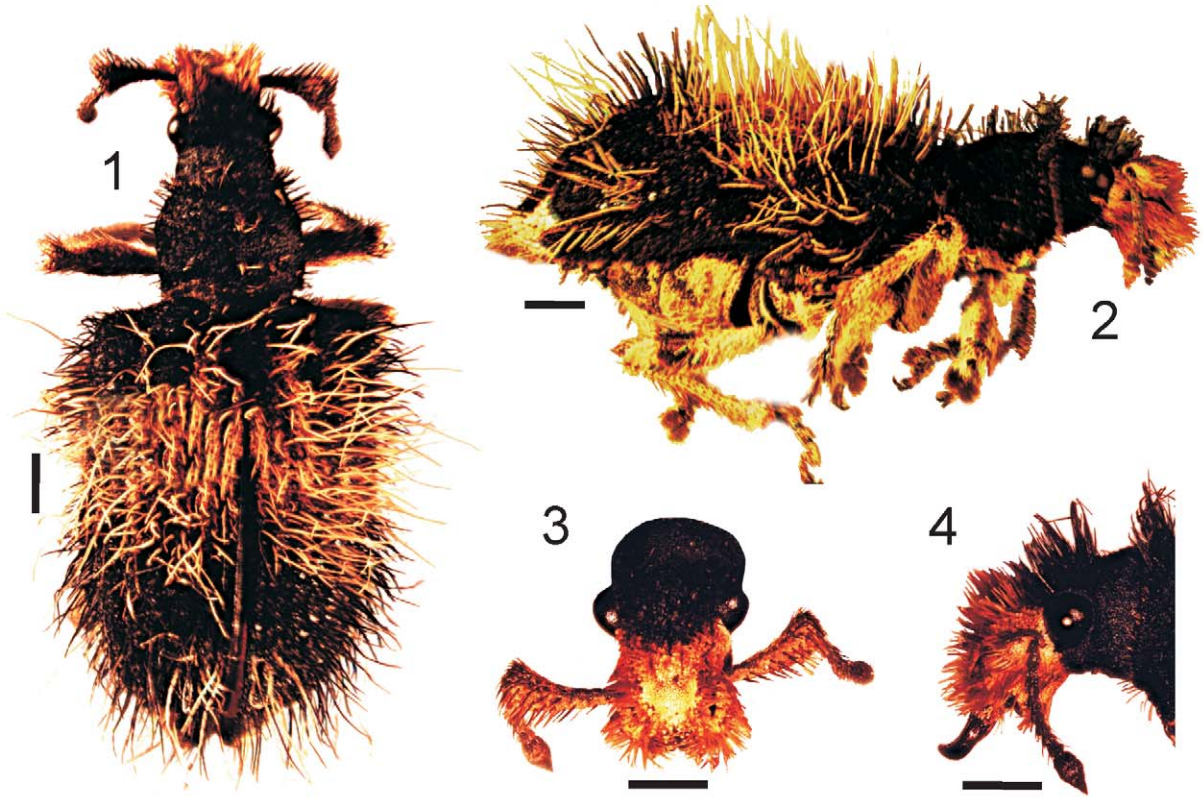
Materials and methods

We have examined specimens from the following institutions:

CWOB	Charles O´Brien Collection, Green Valley, Arizona, USA (Charles W.O´Brien)
MNRJ	Museo Nacional de Río de Janeiro, Rio de Janeiro, Brazil (Miguel Monné).
MZSP	Museu de Zoologia da Universidade de São Paulo, Sao Paulo, Brazil (Sergio Vanin).
NHRS	Naturhistoriska Riksmuseet, Stockholm, Sweden (Bert Vicklund).
USNM	Smithsonian National Museum of Natural History, Washington D.C., USA (Steve Lingafelter)

Dissections of female genitalia were done according to standard entomological techniques. For line drawings we used a camera lucida attached to a Nikon MZ1000 stereomicroscope. Measurements were taken with an ocular micrometer. Abbreviations used in the description are as follows: LB: length of body, measured from apex of rostrum to apex of elytra; WRa: width of rostrum across apex, between external sides; WRb: width of rostrum at base; LR: length of rostrum from anterior margin of eye to apex; LA: maximum length of antenna; WC: maximum width of club; LC: maximum length of club; WP: maximum width of pronotum; LP: maximum length of pronotum; WE: maximum width of elytra; and LE: maximum length of elytra. Gular angle is defined as the angle along the gular suture (Lyal 1995), in lateral view of rostrum and head.



FIGURES 1–4. *Curiades boisduvali*, female: (1) habitus, dorsal; (2) habitus, lateral; (3) head and rostrum, dorsal; (4) head and rostrum, lateral. Scale line: 1 mm.

Curiades Pascoe 1880

Curiades Pascoe 1880: 420. Type species. *Platyomus boisduvali* Boheman in Schoenherr, 1840: 163 (by monotypy).

Diagnosis. Body medium sized (about 9–12 mm), very hairy, with color pattern imitating species of Mutillidae of the genus *Dasymutilla*. Vestiture mostly black, except yellowish apex of rostrum, elytral maculae, legs and venter.

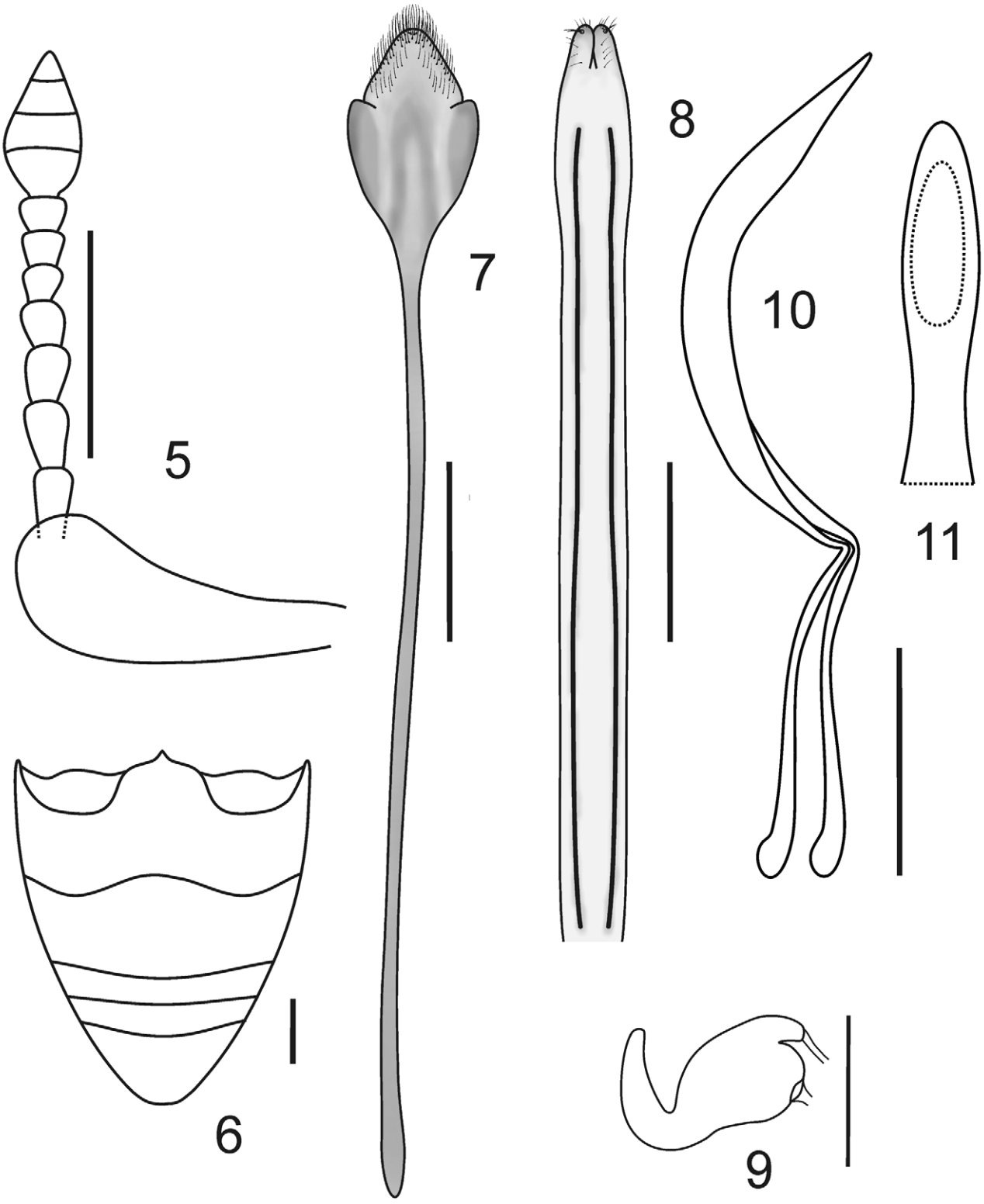
Lateral edges of rostrum strongly thickened and elevated; postocular constriction strong; antennae with very coarse, flattened, clavate, posteriorly curved scape and with short, moniliform funicle; pronotum narrow as compared to broad, strongly bisinuate elytral base; corbels of hind tibiae broad, squamose. *Curiades* and *Platyomus* are similar in the thickened and elevated lateral edges of the rostrum, the shape of the epistome, the dorsally visible apices of the scrobes, and the very coarse, flattened, and posteriorly curved antennal scape, however, the antennae of *Curiades* are much shorter than in *Platyomus* and with a strongly clavate scape. In *Platyomus* the scape is not only longer but also gradually swollen towards the apex.

Redescription. *Female.* Body medium-sized (11.2–11.8 mm long). *Male.* Body slightly smaller (9.0–9.6 mm long) (Figs. 1–2). *Integument* dark, rugose, with microsculpture. *Vestiture* composed of rounded, imbricate scales and very long, coarse, erect setae on dorsum; color of vestiture mostly black, except yellowish on apex of rostrum, elytral maculae, legs, and venter. *Rostrum* (Figs. 3–4) slightly shorter than wide (LR/WRa: 0.97–0.98; LR/WRb: 0.86–0.89), sides subparallel, thickened and strongly elevated, same as in *Platyomus*; dorsum strongly depressed; median groove deep, narrow, extended up to or slightly exceeding posterior margin of eye; epistome depressed, broad, covered with small creamy scales; scrobe very short, moderately curved, with apex visible from dorsum, ending in front of eye; preocular depression absent. *Head* with frons wide (ca. 2x diameter of eye), strongly depressed; eyes strongly convex; postocular constriction strong; vertex slightly convex; gular angle nearly 110º in lateral view. *Antennae* (Fig. 5) short and robust (LB/LA: 3.27–3.47); scape clavate, flattened, curved backwards, reaching posterior margin of eye; funicle slightly shorter than scape, funicular article 2 slightly (1.5x) longer than article 1, funicular articles 3–7 moniliform; club oval, short (LC/WC: 2–2.11), acuminate. *Mouthparts.* Mandibles covered with creamy appressed scales and coarse setae on external face; prementum subhexagonal, with external surface alveolate, moderately concave and lacking setae. *Pronotum* (Figs. 1–2) moderately transverse (WP/LP: 1.22–1.28), narrow relative to elytra; flanks divergent towards base along anterior third and subparallel along posterior two thirds; disc moderately convex, rugose; median groove indistinct; anterior margin strongly thickened; base bisinuate. *Scutellum* subtriangular, well developed, covered with scarce creamy scales. *Elytra* (Figs. 1–2) broad, widest at humeri (LE/WE: 1.48–1.53), moderately convex; base strongly bisinuate; humeri strongly prominent, slightly constricted behind; subapical callus distinct; striae well defined, punctures deep, medium sized; intervals slightly convex, about 2.5x as wide as striae; apical declivity moderately abrupt; apex subacute. Metathoracic wings present. *Legs* with front coxae contiguous, slightly closer to anterior margin than to posterior margin of prosternum; hind femora slightly wider than pro- and mesofemora; tibiae lacking denticles on internal surface; protibiae with very small mucro; meso- and metatibiae without mucro; metatibial apex widened, with broad corbel plate or outer bevel, densely covered with small creamy scales; dorsal comb about 1.5x longer than apical comb. *Abdomen* (Fig. 6) with intercoxal portion of ventrite 1 slightly narrower (0.9x) than metacoxal cavities; ventrites 1 and 2 subequal, strongly convex in relation to flat ventrites 3–5; ventrite 2 twice as long as ventrites 3 and 4 combined; ventrite 5 conical, posteriorly truncate, mesally elevated near posterior margin. Abdominal tergites strongly sclerotized.

Female terminalia. Sternite VIII (Fig. 7) with subrhomboidal, elongate plate, more sclerotized on lateral angles and basal 2/3 of medial line and with long setae along apical half; apodeme 3.7x longer than plate. Ovipositor (Fig. 8) slender, very long, slightly curved in lateral view, as long as ventrites 1–5; ventral baculi slender, subparallel; coxites slightly sclerotized; styli reduced, minute, directed backwards. Spermatheca (Fig. 9) subcylindrical, with truncate-conical, short nodulus, well developed ramus and short cornu (apex not exceeding the opening of gland). Spermathecal duct about as long as half of ovipositor, very fine and membranous.

Male genitalia. Aedeagus (Figs 10–11) slightly longer than ventrites 1–5; tube longer than apodemes (1.4x), slightly curved in lateral view, with rounded apex and large ostium.

Natural history. *Curiades* is endemic to eastern Brazil, occurring in the state of Río de Janeiro at elevations of about 500–700 meters. Its distributional range corresponds to the Atlantic province *sensu* Cabrera and Willink (1973); or to the Brazilian Atlantic Forest *sensu* Morrone (2006) which includes the eastern slopes of the coastal hills of Brazil which are characterized as tropical forest of trees 30–40 meters high and a lower layer of palms, lianas and epiphytes such as orchids, ferns and bromeliads. This biogeographic province harbors a highly diverse entomofauna with several endemic species and subspecies (da Costa & Lima 2005).



FIGURES 5–11. Antennae, ventrites, female and male terminalia of *Curiades boisduvali*: (5) left antenna; (6) ventrites; (7) sternite VIII; (8) ovipositor, ventral view; (9) spermatheca; (10) aedeagus, lateral view; (11) aedeagus, terminal portion of tube, ventral view. Scale line: 1 mm; spermatheca 0.5 mm.

Remarks

Curiades was described by Pascoe in 1880 based on the type species *Platyomus boisduvali* Boheman. It was originally placed within the tribe Phyllobiini, and later transferred to Naupactini by Kuschel in the checklist of Wibmer and O´Brien (1986), together with *Platyomus* Sahlberg and *Mionarthrus* Kuschel. In a preliminary phylogenetic analysis of the tribe Naupactini (del Río & Lanteri 2010), *Curiades* was recovered within a monophyletic group formed by *Platyomus*, *Aptolemus* Schoenherr, *Saurops* Kuschel, *Megalostylus* Schoenherr and *Megalostylodes* Champion. This group is characterized by the synapomorphic presence of a particular shape of the rostrum, i.e. with thickened and elevated sides and dorsally visible scrobes at the apex. All the aforementioned genera have stouter antennae than in the remaining Naupactini.

The rostrum of *Curiades* is more similar to that of *Platyomus*. Nevertheless, other characteristics, mainly those of the female and male genitalia and the proportions of the antennal segments, justify a monotypic genus separated from *Platyomus* and other related genera.

Trichaptus, the other naupactine genus mimic of Mutillidae, is closely related to *Briarius* [Fischer de Waldheim] (Lanteri & del Río 2003, 2005) and does not belong to the former generic group.

The similarity of *Trichaptus* and *Curiades* is superficial and due mainly to convergent shared color patterns and other characteristics of the body vestiture (e.g., long erect setae), as well as the presence of a narrow pronotum in relation to the width of the anterior margin of the elytra. Most genus-level traits, such as those of the rostrum, antennae and genitalia, differ among the two genera. In *Curiades* the hairs that cover the dorsum of the body are much longer than those of *Trichaptus*, and in each genus they closely resemble those of their putative wasp models (*Dasymutilla* and *Hoplomutilla*, respectively).

Curiades boisduvali (Boheman 1840)

Platyomus boisduvali Boheman in Schoenherr 1840: 163
Curiades boisduvali; Pascoe 1880: 421 (overlooked by Taschenberg in Heyne & Taschenberg 1907: 225)

Type material studied. Holotype female from Brazil ("Brasilia interior"), seen at the type collection of the Naturhistoriska Riksmuseet (NHRS).

Other material examined. Brazil. no loc (MZSP: 2; USNM: 10). Río de Janeiro: Río de Janeiro (CWOB: 1); Corcovado, Río Guanabara, 23-X-1953, Zajeiro col. (MNRJ: 4); 2-XII-1957, Seabra & Alvarenga col (MNRJ: 6); X-1961, Alvarenga & Seabra col. (MNRJ: 1); 18-10-1974, Alvarenga & Seabra col. (MNRJ: 1).

Redescription. Body medium-sized (female 11.2–11.8 mm long; male 9.0–9.6 mm long) (Figs. 1–2). *Integument* dark, rugose, with microsculpture. *Vestiture* composed of round, imbricate scales and very long, coarse, erect setae on dorsum; color mostly black except yellow-cream apex of rostrum, legs, elytral maculae and venter. Rostrum covered with yellow scales and very long yellow setae on sides; frons and vertex black, with very long black setae surrounding superior margin of eyes; antennal scape covered with dense yellow scales and stiff brown setae, funicle with cream seta like scales and stiff verticilate setae; pronotum black, with fine medial line of yellow scales on posterior half and very long black setae, mainly on anterior margin; elytra mostly black, with two oblique, subtriangular maculae of yellow scales on anterior half, from suture to 7° interval; elytral setae very long, mostly black, and yellow on subtriangular maculae and on two small yellow spots near apex; legs densely covered with creamy scales, and pale, long, suberect, stiff setae; femora and tibiae with a dark spot on external face; venter mostly covered with dense yellow-creamy scales, and long, suberect, stiff setae; central surface of ventrites 3–5 black, almost lacking setae. Other morphological features as described for the genus (Figs. 1–11). *Morphometrics* (N=6)*: Rostrum*: LR/WRa 0.97–0.98; LR/WRb 0.86–0.89. *Antennae*: LB/LA 3.27–3.47; LC/WC 2–2.11. *Pronotum*: WP/LP 1.22–1.28. *Elytra*: LE/WE 1.48–1.53.

Notes on potential mimicry

Mutillidae are a family of wasps comprising more than 8000 species which mainly occur in dry environments of the tropical and subtropical areas of the world, either on the ground and/or on lower vegetation (Brothers 1995).

All Mutillidae are solitary parasitoids, whose flightless females lay a single egg on each host. They mostly attack mature larvae or pupae of social Hymenoptera, and less frequently, non-feeding stages of Lepidoptera, Coleoptera and Diptera (Brothers *et al.* 2000). The adults possess a wide variety of defensive adaptations such as painful stings, aposematic coloration, hard cuticle and powerful mandibles, reasons why they can serve as models in Batesian mimicry systems (Prudic *et al.* 2007).

Examples of Batesian mimicry are known for Mutillidae and unprotected species of Coleoptera, such as Cerambycidae, Cleridae, Chrysomelidae and Curculionidae (Monné 1980, Mawdsley 1994, Lanteri & del Río 2005), and for Mutillidae and Hymenoptera Formicidae (Wheeler 1983). Ant and wasp mimics are the most frequent among unprotected Coleoptera such as weevils (Hespenheide 1984, 1986). There are also some complex systems of Batesian and Mullerian mimicry, involving several species of beetles (Cerambycidae, Cleridae and baridine Curculionidae), Hymenoptera (Ichneumonidae and Mutillidae), predatory Heteroptera (Reduviidae), Diptera (Tipulidae) and other taxa (Hespenheide 2010). In all the studied examples the protected models are much more frequent that the unprotected mimics (Pfennig *et al.* 2001, Hespenheide 2010).

Curiades bousduvali is the second report of Batesian mimicry between Mutillidae and weevils of the tribe Naupactini, after *Trichaptus* (Lanteri & del Río 2005). Both *Curiades* and *Trichaptus* include a single rare species endemic to eastern Brazil (Espírito Santo, Minas Gerais and Río de Janeiro), each of which resembles a different group of Sphaeropthalminae, a mutillid subfamily of brood-parasites of ground-nesting Hymenoptera (Brothers *et al.* 2000).

Trichaptus shows a distinct pattern of yellow and orange maculae over a black background, similar to that of *Hoplomutilla* species, whereas *Curiades* resembles species of *Dasymutilla* whose wingless females have the appearance of long hairy ants with white, yellow or red pattern on a black background. The overall similarity in color and hairy pattern between mutillids (protected model) and weevils (mimic) is also evident in the morphology of the antennae (short, stout and posteriorly curved).

In the mimicry system including *Trichaptus mutillarius* and *Hoplomutilla*, there are at least other two beetle species involved, *Compsosoma mutillarium* (Klug) and *C. geayi* Gounelle (both Cerambycidae), distributed in northeastern Brazil, Perú (Amazonas) and French Guiana (Monné 1980). The morphology of the three beetle species and the "velvet ant" is strikingly similar. Moreover, it is possible that more than one species of *Dasymutilla* and "true ants" are involved in the mimicry system including *Curiades bousduvali.* Indeed, members of this mutillid genus form large Müllerian mimicry complexes among females and show Batesian mimicry by males (Williams 2012).

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