



## A new species of *Onthophagus* (Scarabaeoidea: Scarabaeinae) from the Mexican Transition Zone, with remarks on its relationships and distribution

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### Abstract

A new American *Onthophagus* of the *chevrolati* species-group is described (*Onthophagus bolivari* sp. nov.), providing also identification keys to the *aztecus* complex. Dorsal habitus and genital structures of the new species are illustrated. The relationships and geographical distribution of the *aztecus* complex are discussed, giving particular attention to the evolutionary history of *O. bolivari*.

**Key words:** Scarabaeinae, *Onthophagus*, Mexico

### Introduction

The New World *Onthophagus* of the *chevrolati* group have been extensively revised by Zunino & Halffter (1988), providing important taxonomic, ecological and biogeographical data to the study of the genus in America. The *chevrolati* group currently numbers 43 species and subspecies distributed from the central United States to the southern territories of the Trans-Mexican Volcanic Belt. The species-group exhibits highest diversity across the mountain ranges of the Mexican Transition Zone, while the northern border of its distribution is represented by a few species associated either to the packrat and gophers’ nests or to cave habitats (*O. coproides* Horn, 1881, *O. brevifrons* Horn, 1881, *O. subtropicus* Howden & Cartwright, 1963 and *O. cavernicollis* Howden & Cartwright, 1963).

According to the shared genital ground-plans (e.g. male endophallic sclerites, ventral sclerotization of the vagina) and external morphological characters (e.g. male frontal carina, pronotal protuberance), three distinct lineages have been delineated within the species-group: *verspertilio* (1 species), *hippopotamus* (9 species) and *chevrolati* (29 species).

The morphological and biogeographical study of the lineage *chevrolati* revealed three main taxonomic subunits, which were further split into several complexes of species Zunino & Halffter (1988). Within the third subunit, three complexes have been recognized, such as *aureofuscus*, *aztecus* and *undulans* (Zunino & Halffter, 1988).

To date, the *aztecus* complex comprises 6 species and subspecies locally distributed in the Sierra Madre del Sur (1 species), as well as across the western and central Trans-Mexican Volcanic Belt. The species of this complex occur primarily in pine-oak woodlands within an altitudinal range of 2000–2400 m a.s.l.

In this study we provide the description of a new *Onthophagus* of the *aztecus* complex recently found in two nearby mountain localities of the Mexican High Plateau (Cerro El Pinal and La Malinche Volcano) pertinent to the Trans-Mexican Volcanic Belt. Identification keys to the *aztecus* complex and illustrations of the dorsal habitus and

genitalia of the new species are provided. Possible phylogenetic relationships with allied species are discussed, with updates to the ecology and biogeography of the complex.

### ***Onthophagus bolivari* sp. nov. Moctezuma, Rossini & Zunino**

**Type locality.** Cerro El Pinal (Rincón Citlaltépetl), state of Puebla, Mexico.

**Description.** Habitus: Major male (Fig. 1). Length 8.3 mm. Maximum width 4.6 mm at the middle of the prothorax. Color black, silky and dull, basal half of pronotum and elytra silky, anterior half of pronotum and head distinctly shiner. Clypeus strongly concave, pentagonal, almost square shaped if seen from above, anterior margin strongly reflexed. Head with lateral margins weakly sinuate in proximity of the clypeo-genal sutures. Genae evenly curved, genal sutures inconspicuous. Clypeal carina absent, frontal carina transverse, strong and slightly sinuated at middle, sometimes almost angulated backward, evanescent on either sides, clypeus with coarse and deep punctures very close and often confluent, frontal surface either smooth or with fine punctures. Pronotum with a feeble depression on the posterior side, posterior margin of pronotum marked by a row of deep punctures. Pronotal prominence triangular and apically obtuse and rounded, intermediate tubercles absent, posterior tubercles strong, transversally developed and situated slightly behind the midline of pronotum, pronotal disc with medium-size and shallow punctures, densely distributed on the anterior half and, finer and scattered posteriorly, pronotal surface with an evident and reticular microsculpture, finer in the posterior half, lateral margins of pronotum almost evenly rounded if seen from above, median angles distinctly reflexed. Elytral striae fine, shiny, with very shallow punctures separated by three diameters, elytral interstriae flat, dull and silky, with very small and scattered punctuation, surface of the elytral intervals with the same microsculpture noticed for the posterior half of pronotum, pygidium dull and silky, with a very fine punctuation evenly distributed, some punctures bearing very short and yellow seta, pygidial surface defined by a distinct microsculpture. Foretibiae long and slender, apically distinctly curved, and slightly wider, apical tooth triangular and covering the insertion point of the apical spur, spur curved ventrally. Parameres and endophallic sclerites as represented in Fig. 4.

**Variation.** Minor male (Fig. 2). Differs from the major male for its smaller size, clypeus more distinctly trapezoidal, frontal carina reduced, pronotal prominence very weak, foretibiae similar to female.

Female (Fig. 3). In addition to secondary sexual characters the female differs to the minor male by the clypeus curved and clearly sinuated at middle, clypeal carina low, either slightly curved or almost straight, frontal carina regularly curved on both sides. Female genitalia as represented in Fig. 5.

**Material examined.** *Holotype*: major ♂ labeled “México, El Pinal, Puebla, a 0.3 km de Rincón, 2/VII/13, necrotrampa 7n2, x-9753’59.8”W, y-198’55.3”N, veg. arbustiva, 2704 m, Moctezuma J.V.P. Col. 19 paratypes ♂♂♀♀: Synthesis of paratype material collection sites.—MEXICO: State of Puebla: Cerro El Pinal (Rincón Citlaltépetl) at 0.3 km from Rincón Citlaltépetl, 2704–2710 m a.s.l.; Cerro El Pinal (Santa Isabel Tepetzala) at 2.5 km from Rincón de Citlaltépetl, 2543 m a.s.l. MEXICO: State of Tlaxcala: La Malinche Volcano (12.5 km from the Municipality of Chiautempan), 2700–2900 m a.s.l.; La Malinche Volcano (La Malinche Holiday Resort, 26 km from Huamantla), 3300–3500 m a.s.l.; La Malinche Volcano (6.5 km from Ignacio de Zaragoza, Municipality of Hueyutlipan), 2850–2950 m a.s.l.; La Malinche Volcano (La Malinche Research Station, 8.5 km from Ixtenco), 3100–3200 m a.s.l. The paratypes’ labels bear the exact geographic coordinates, as well as general information, such as baits, vegetation type, collection date and collectors.

*Holotype* and 19 paratypes: G. Halffter collection, Xalapa, Ver., Mexico. Other paratypes (387 specimens): Collections of A. Arriaga (Instituto de Ecología, A.C.), Víctor Moctezuma (Puebla, Pue., Mexico); M.A. Morón, (Xalapa, Ver., Mexico); M. Rossini (Urbino, Italy) M. Zunino (Urbino, Italy); Zoology Museum, UNAM (Mexico, DF); Instituto de Ecología, A. C. (Xalapa, Mexico); Laboratoire de Zoogéographie, Université Paul-Valéry (Montpellier); Canadian National Collection (Ottawa).

*Derivatio nominis*: We dedicate this new species to the memory of Cándido Bolívar y Pieltain (1897–1976), one of the great founders of modern entomology in Mexico.



**FIGURE 1.** *Onthophagus bolivari* Habitus of the major male.

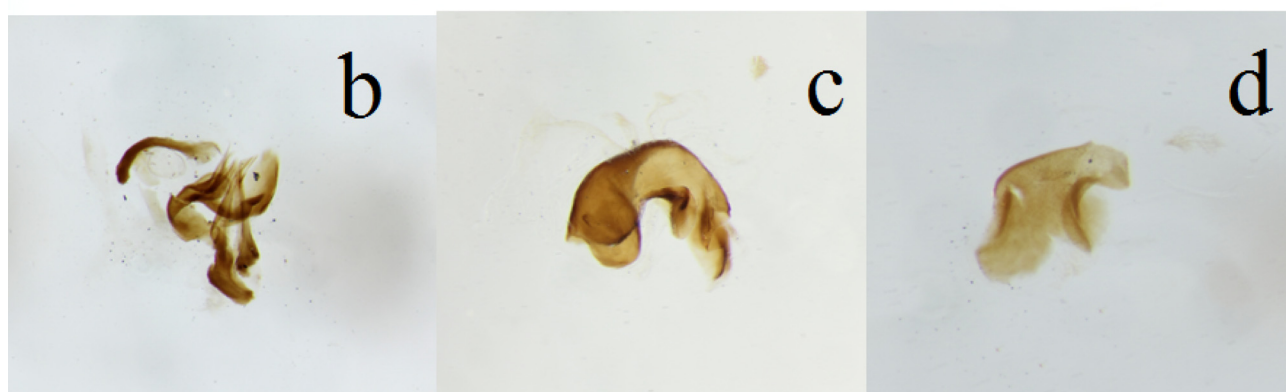


**FIGURE 2.** *Onthophagus bolivari* Habitus of the minor male.



**FIGURE 3.** *Onthophagus bolivari* Habitus of the female.

a



**FIGURE 4.** *Onthophagus bolivari* male genitalia: a) aedeagus, lateral view; b) accessory lamellae, c) *Lamella copulatrix*, d) secondary copulatory lamella.

**Key to the *aztecus* complex (modified from Zunino & Halffter, 1988: 42)**

- Frontal carina distinctly sinuated in the middle, clypeus sub-trapezoidal, pentagonal or rounded . . . . . 1 (Z. & H. : 26)
- Frontal carina like an isosceles regular trapezoid, either straight in the middle or slightly sinuated . . . . . 2
- 1. Dark blue, almost black. Clypeus sub-trapezoidal and very rounded, pronotum of male normal. Elytra with humeral umbones evident. Elytral interstriae with granulose punctures, granules very small. Macropterous. . . . . *O. reyesi* Zunino & Halffter, 1988
- Clypeus either pentagonal or rounded, pronotum with intermediate tubercles distinct or absent . . . . . 3
- 2. Genal sutures evident, frontal carina weak and straight, elytral intervals with a granulose punctuation, body completely black and sericeous. Genitalia as in Fig. 106–107 . . . . . *O. aztecus* Zunino & Halffter, 1988
- Genal sutures inconspicuous, frontal carina slightly sinuated at middle, elytral intervals with a simple and fine punctuation. Body black to dark-brown and sericeous, head and anterior half of pronotum distinctly shiner, elytra clearly more sericeous. Genitalia as in Figs 4–5. . . . . *O. bolivari* **sp. nov.**
- 3. Very dark blue, male with clypeus sub-pentagonal, anterior margin slightly protruded and rounded at middle, intermediate tubercles of pronotum either clearly indicated or absent . . . . . 4

- Dark brown, black, bronze, sericeous and dull, male with clypeus rounded, anterior margin almost truncate, intermediate tubercles of pronotum always absent to slightly indicated . . . . . 5
- 4. Frontal carina of the male slightly angulated in the middle, distinctly carinated. Median tubercles absent. Sericeous-shining . . . . . *O. pseudoundulans howdeni* Zunino & Halffter, 1988
- Frontal carina of male almost imperceptibly carinated, either sides elevated into a small acute tooth directed outward. Median tubercles of the pronotal prominence quite evident. Sericeous-dull. . . . . *O. pseudoundulans pseudoundulans* Zunino & Halffter, 1988
- 5. Dark brown, bronze, sericeous, head and pronotum with strong cupreous or greenish tinges. . . . . *O. tarascus tarascus* Zunino & Halffter, 1988
- Black, dull, sometimes head and pronotum with an indefinite very dark cupreous or greenish dye. . . . . *O. tarascus jaliscensis* Zunino & Halffter, 1988



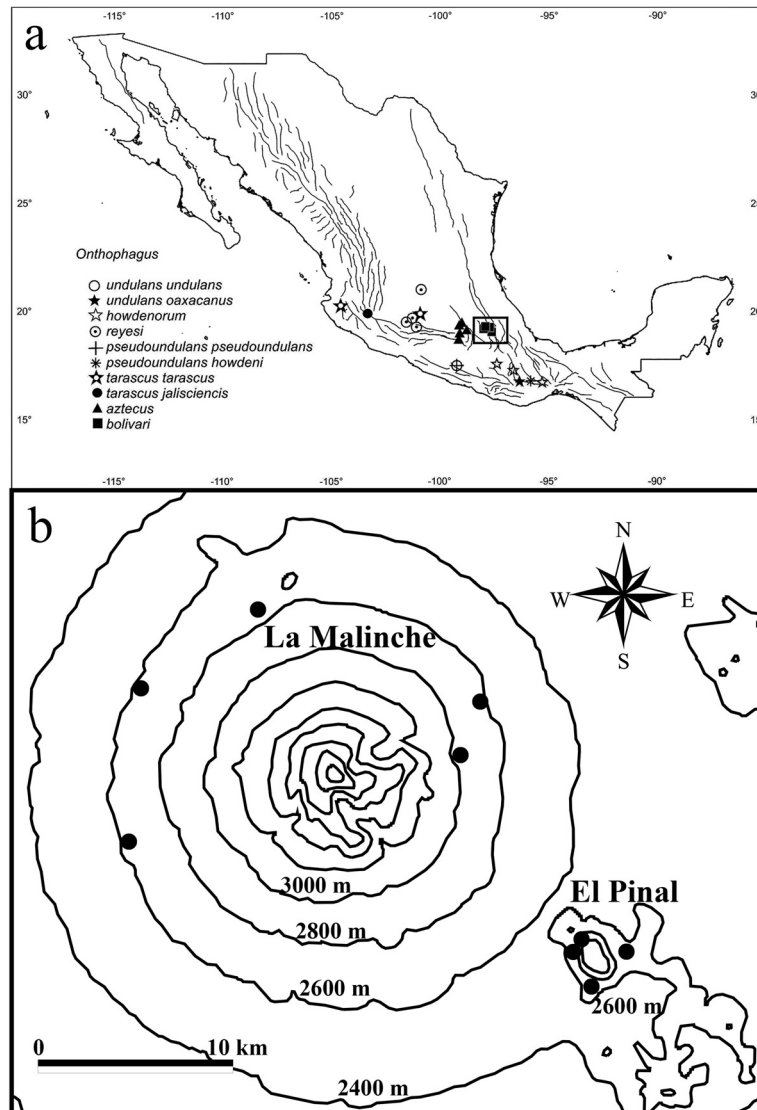
**FIGURE 5.** *O. bolivari* female genitalia.

**Affinities.** Morphological investigation was carried out on a sample of 20 specimens of *Onthophagus bolivari* **sp. nov.** collected in El Pinal (Puebla) and La Malinche Volcano (Tlaxcala). The examination of male and female genitalia, with special emphasis on the internal sclerotized pieces of the aedeagus and ventral sclerotization of the vagina, allowed us to identify putative synapomorphies that *O. bolivari* shares with the species of the *aztecus* complex. As already hypothesized by Gutiérrez (2013), the monophyly of the *aztecus* complex, including the new *O. bolivari*, seems to be supported by a suite of phylogenetically informative characters: apex of the parameres robust, obtuse, forming a right angle with the inferiorly produced apical lobes, *lamella copulatrix* (LC) with median carina strongly developed, right branch of the LC dorsally robust, ventral sclerotization of the vagina well developed.

However, the phylogeny of the *aztecus* complex remains yet unresolved and a more comprehensive cladistics survey is needed in order to explore properly the evolutionary history of these species.

In a recent checklist of the Scarabaeoidea of the Puebla State, Mexico (Morón *et al.*, 2013) the authors mentioned an *Onthophagus*, collected in La Malinche Volcano, that is very similar to *O. aztecus*. We suppose that the *Onthophagus* to which the authors refer to is *O. bolivari*.

**Distribution and ecology of *Onthophagus bolivari*.** To date, *O. bolivari* **sp. nov.** represents the easternmost element of the *aztecus* complex (Map 1). In spite of our intensive sampling efforts, no further specimens of *O. bolivari* have been collected in the two easternmost mountains of the Trans-Mexican Volcanic Belt, that are Pico de Orizaba and Cofre de Perote. To our knowledge, *O. bolivari* appears to be geographically isolated from the remaining species of the same complex. The only two localities where *O. bolivari* has been collected so far are characterized by patch-like vegetation mostly dominated by pine and fir forests, as well as grassland habitats. Furthermore, it is remarkable to say that this new *Onthophagus* is the one within the *aztecus* complex that reaches highest altitudes, occurring at an elevation of approximately 2500–3200 m a.s.l.



**MAP 1.** a) Distribution of the species belonging to the *aztecus* complex, modified from Zunino & Halffter (1988). b) Distribution of *Onthophagus bolivari*.

The geographical range *O. bolivari* is partially interrupted by a cropland of about 10 km wide, intervening between La Malinche Volcano and El Pinal. However, this species appears to be fairly tolerant to different ecological conditions, as it has been found in natural pastures, bunchgrass fields surrounded by seasonal agricultural crops, either in habitats dominated by *Agave* and *Opuntia* cactus species or in scrub fields, as well as in pine-oak-fir, alder and cypress forests.



The wide ecological tolerance of *O. bolivari* appears to be supported also by its trophic features, since it has been collected using pitfall traps baited with human excrements and carrions.

According to the ecology and geographical distribution of *O. bolivari*, a common evolutionary pattern can be suggested for the species included in the *aztecus* complex. As already claimed by Zunino & Halffter (1988), it is likely that climatic fluctuations resulting from Quaternary glaciations (Owen *et al.*, 2003; Lachniet, 2004) may have favored alternating dispersal events, along with the fragmentation of an ancestral biota, which was probably accompanied by vicariant speciation events, particularly evident in the Trans-Mexican Volcanic System (see also Halffter, 2003). In the light of this palaeo-evolutionary scenario, we can suppose that colder climatic conditions than today may have possibly constrained the common ancestor of *O. bolivari* and *O. aztecus* to lower altitudinal zones, such as the foothills of La Malinche Volcano. A subsequent anathermal period may have fragmented this palaeodistribution, triggering the cladogenetic event. The intervention of more recent little ice ages, such as those occurred about 12,000 and 8,000 years ago, could have been responsible for the secondary eastward dispersion (El Pinal) of *O. bolivari*, while the fragmentation of its current geographical range would be a very recent secondary occurrence, possibly related to human activities.

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