www.biotaxa.org/rce. ISSN 0718-8994 (online) Revista Chilena de Entomología (2022) 48 (2): 361-367.

Scientific Note

Unusual teratological cases in Scarabaeidae (Coleoptera: Scarabaeoidea): two specimens with multiple malformations

Casos teratológicos inusuales en Scarabaeidae (Coleoptera: Scarabaeoidea): dos especímenes con múltiples malformaciones

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ZooBank: urn:lsid:zoobank.org:pub:529C57D9-9D9C-4CB0-88E8-3F148A078261
https://doi.org/10.35249/rche.48.2.22.18

Abstract. We described two similar teratological cases with multiple malformations and loss of symmetry observed in specimens of *Amithao decemguttatus* (Waterhouse, 1876) (Scarabaeidae: Cetoniinae) and *Megaceras jason* (Fabricius, 1775) (Scarabaeidae: Dynastinae) from Colombia.

Key words: Asymmetry; brachelytry; dystrophy; symphysocery; trematelytry.

Resumen. Se describen dos casos teratológicos similares con múltiples malformaciones y pérdida de simetría observados en especímenes de *Amithao decemguttatus* (Waterhouse, 1876) (Scarabaeidae: Cetoniinae) y *Megaceras jason* (Fabricius, 1775) (Scarabaeidae: Dynastinae) de Colombia.

Palabras clave: Asimetría; braquielitría; distrofia; sinfisoceria; trematoelitría.

Teratology has been defined in entomology as the study of abnormalities on insects (Dallas 1926), or the study of specimens with anatomical peculiarities (Balazuc 1948). In a broader view, it has been defined as the study of malformations and anatomical abnormalities, including its causes, mechanisms, and patterns (Ujházy *et al*. 2012). Balazuc was a pioneer in the classification of malformations on insects, thus his works are the base guide in teratological research (*e.g.*, Balazuc 1948, 1969). As possible causes of these conditions, endogenous or exogenous factors have been reported to produce malformations on insects (Yi *et al*. 2017; Kizub and Leshchenko 2019), including genetic disorders, deficiency of the embryonic development, physical or chemical damage, and biological parasitism (Bunalski and Lubecki 1990; Clark and Belo-Neto 2010; Ghannem *et al*. 2015). Furthermore, reports of teratological cases on insects are infrequent as most malformations go unnoticed and lack taxonomical value (Gasca-Álvarez *et al*. 2017), even when malformed specimens have been described as new taxa (*e.g.*, Coiffait 1965; Dellacasa *et al*. 2001; Wollaston 1867).

The most diverse insect orders also have a high frequency of teratological cases reported (Ortuño and Ramos-Abuín 2008), and Coleoptera has many cases in different family-level groups (*e.g.*, Asiain and Márquez 2009; Lüer 2019; Ortuño and Vique 2007; Verdugo-Páez 2000). Among the most reported groups of scarabs (Scarabaeoidea) with malformed specimens

Received 13 May 2022 / Accepted 3 June 2022 / Published online 30 June 2022
Responsible Editor: José Mondaca E.

are the subfamilies Cetoniinae and Dynastinae (Gasca-Álvarez *et al*. 2017). However, in the Neotropical genus *Amithao* Thomson, 1878 (Scarabaeidae: Cetoniinae), no malformed specimen has been previously reported. In contrast, in the genus *Megaceras* Hope, 1837, two malformed specimens have been previously described: one gynandromorphic specimen of *Megaceras crassum* Prell, 1914 from Peru (Bosia 2013), and one malformed specimen of *Megaceras morpheus* Burmeister, 1847 from Venezuela (Gámez and Acconcia 2020).

Here we describe one malformed specimen of *Amithao decemguttatus* (Waterhouse, 1876) and one of *Megaceras jason* (Fabricius, 1775). The examined malformed specimens are housed in the Entomology Collection of the Instituto de Investigación de Recursos Biológicos Alexander von Humboldt (IAvH-E) (Villa de Leyva, Boyacá, Colombia), additional specimens were examined to compare normal and malformed structures. Additional specimens are also housed at IAvH-E and Museo Laboratorio de Entomología of the Universidad del Tolima (MENT-UT) (Ibagué, Tolima, Colombia).

Photographs of specimens' habitus were taken with a Canon EOS 5D Mark II with a Canon EF 100mm f/2.8 USM macro lens. Affected structures were photographed with a stereomicroscope Leica S8-APO equipped with a camera Leica MC190 HD. Malformation's terminology follows Balazuc (1948) and Ortuño and Vique (2007).

Case 1. Cephalic hemidystrophy and hemibrachelytry in *Amithao decemguttatus* (Waterhouse, 1876) (Scarabaeidae: Cetoniinae) (Figs. 5-8).

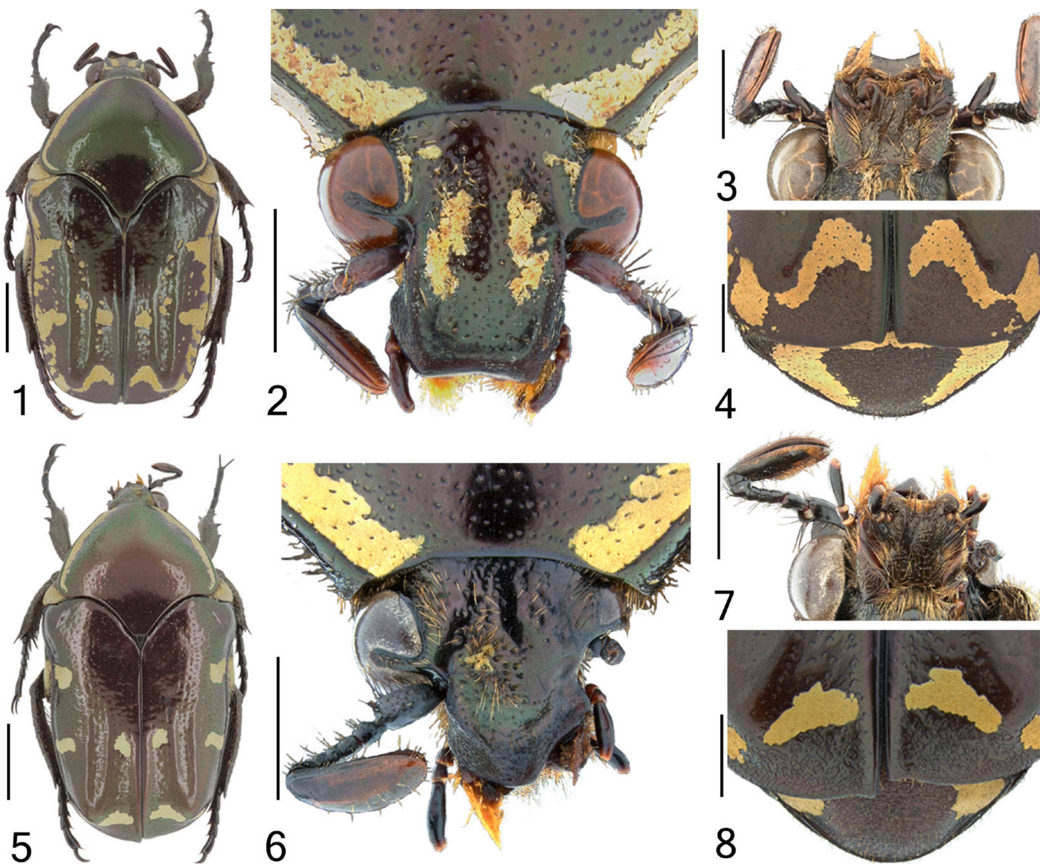
Material examined. COLOMBIA (1 male): BOYACÁ. Otanche, Vereda Las Chincas, Finca Las Quinchas; 05°49'25.5" N, 74°15'47.4" W; 1425 m; 2019.viii.1; captura manual nocturna; García-Cobos D. / IAvH-E-214414. The specimen was collected in a rural area with paddock vegetation without cattle. This specimen was compared with a regular specimen from IAvH-E (Figs. 1-4).

The male of *A. decemguttatus* presents a lack of symmetry in the head and the elytra (Fig. 5). In the head it has cephalic hemidystrophy in which the frons and the clypeus are deformed and reduced on the left side, thus deforming almost all of the head surface (Fig. 6). It also has unilateral dystrophy on the left canthus and eye, both being strongly reduced and almost monophthalmic (absence of one eye) (Fig. 6). The antennae show unilateral dystrophy in which the left antenna has all the segments strongly reduced and fused, except the basal two (Fig. 6). Also, the left maxillary palp suffers dystrophy with all segments being shorter than in the right palp and the left mandible is dystrophic too, being shorter than the right (Fig. 7). In the elytra, it presents hemibrachelytry with the right elytron shorter than the left (Fig. 8).

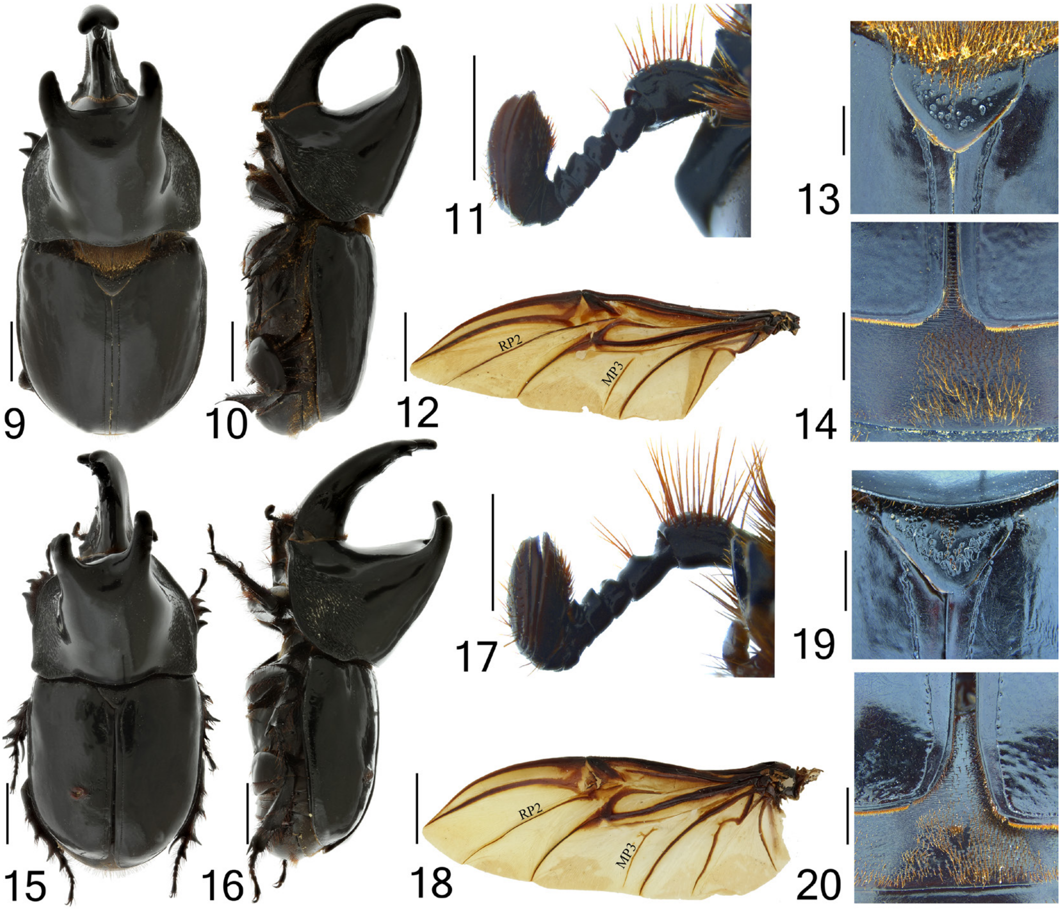
Case 2. Hemidystrophy of cephalic and pronotal horns, and scutellum, unilateral antennal symphysocery, malformed sutural stria, hemibrachelytry, and unilateral trematelytry in *Megaceras jason* (Fabricius, 1775) (Scarabaeidae: Dynastinae) (Figs. 15-20).

Material examined. COLOMBIA (1 male): PUTUMAYO. Orito, caserío Churuyaco; Flanco E río Churuyaco; 00°28'25.84" N, 77°5'56.43" W; 363 m; 2019.vii.22; captura manual nocturna en luz doméstica; Cifuentes-Acevedo S. / IAvH-E-214413. The locality is close to the Churuyaco River (on east side) and characterized by a matrix of riparian forests and paddocks without cattle. This specimen was compared with a regular specimen from the MENT-UT (Figs. 9-14).

The male of *M. jason* has deformations in the cephalic horn, pronotum, scutellum, elytra, wings, and abdomen (Figs. 15-16). In the head, the bifurcated cephalic horn is hemidystrophic, thus is inclined to the left side, and the left apex of the apical bifurcation is shorter than the right (Fig. 15). The surface of the cephalic horn on the posterior face at the apical third has two short dentiform projections and an additional projection is also present near to the basal third on the left-lateral face (Figs. 15-16). In addition, the specimen has unilateral antennal symphysocery in which segments five to seven of the left antenna are partially fused (Fig. 17). The pronotal bifurcated horn is hemidystrophic with the left apex shorter, but wider than the right (Figs. 15-16). The scutellum is also hemidystrophic, being larger on the left side of longitudinal axis (Fig. 19). In the elytra, the sutural stria of left elytron is atypically sinuous, especially at its apical third (Figs. 15, 19-20). The specimen exhibits a unilateral trematelytry, in which the left elytron has an irregular perforation close to apical declivity (Fig. 15). A unilateral hemibrachelytry is also present, thus the left elytron is shorter than the right (Fig. 20). The left wing is also perforated (Fig. 18); the radio posterior 2 vein is discontinuous at the perforation level, and the median posterior 3 vein is bifurcated near to the base. In the abdomen, the propygidium is hemidystrophic, therefore the stridulatory area is malformed on the left side of longitudinal axis (Fig. 20).



Figures 1-8. *Amithao decemguttatus* (Waterhouse). **1.** Normal specimen, dorsal view. **2-3.** Head of normal specimen, dorsal and ventral views. **4.** Elytral apex of normal specimen. **5.** Malformed specimen, dorsal view. **6-7.** Head of malformed specimen, dorsal and ventral views. **8.** Elytral apex of malformed specimen. Scale bars for figures 1 and 5 = 5 mm; for figures 2, 3, 4, 6, 7 and 8 = 2 mm. / **1.** Espécimen normal, vista dorsal. **2-3.** Cabeza de espécimen normal, vistas dorsal y ventral. **4.** Ápice elitral de espécimen normal. **5.** Espécimen malformado, vista dorsal. **6-7.** Cabeza de espécimen malformado, vistas dorsal y ventral. **8.** Ápice elitral de espécimen malformado. Barras de escala para las figuras 1 y 5 = 5 mm; para las figuras 2, 3, 4, 6, 7 y 8 = 2 mm.



Figures 9-20. *Megaceras jason* (Fabricius). **9-10.** Normal specimen, dorsal and lateral views. **11.** Antenna of normal specimen. **12.** Wing of normal specimen. **13.** Scutellum of normal specimen. **14.** Elytral apex and stridulatory area of normal specimen. **15.** Malformed specimen, dorsal view. **16.** Malformed specimen, lateral view. **17.** Antenna of malformed specimen. **18.** Wing of malformed specimen. **19.** Scutellum of malformed specimen. **20.** Elytral apex and stridulatory area of malformed specimen. Scale bars for figures 9, 10, 12, 15, 16 and 18 = 10 mm; for figures 11, 13, 14, 17, 19 and 20 = 2 mm. / **9.** Espécimen normal, vistas dorsal y lateral. **11.** Antena de espécimen normal. **12.** Ala de espécimen normal. **13.** Escutelo de espécimen normal. **14.** Ápice del élitro y área estriduladora de espécimen normal. **15-16.** Espécimen malformado, vistas dorsal y lateral. **17.** Antena de espécimen malformado. **18.** Ala de espécimen malformado. **19.** Escutelo de espécimen malformado. **20.** Ápice elitral y área estriduladora de espécimen malformado. Barras de escala para las figuras 9, 10, 12, 15, 16 y 18 = 10 mm; para las figuras 11, 13, 14, 17, 19 y 20 = 2 mm.

Discussion

Some malformations described here have been frequently reported in beetles, as symphysoceries (*e.g.*, Ortuño *et al*. 1998; Verdugo-Páez 2000; Guzmán-Vásquez *et al*. 2020). Despite that other malformations are considered relatively rare, have been already reported in literature. Some examples are the cephalic hemidystrophy affecting mandible, maxillary palp, and antenna of one side of head (Chalumeau and Brochier 2007), unilateral ocular dystrophy (Lüer 2019) or total monophthalmy accompanied with the absence of one antenna (Caruso and Savini 2012), scutellum hemidistrophy (Balazuc 1948), and even the malformation of the hindwings, in few cases, also involving the absence of wing venation (Abdullah and Abdullah 1969). In addition, we present a malformation on the stridulatory area at the propygidial segment of *M. jason*, which was not included by Balazuc and we were unable to find other reports in literature. All these rare malformations highlight the necessity of continuous reporting and description of teratological cases in order to understand morphological malformations in beetles and insects.

The presence of several malformations resulting in a loss of symmetry on many corporal segments and appendages has previously been considered uncommon in Coleoptera, despite the previous malformation reports in different families. Specimens of Carabidae, Cerambycidae, Chrysomelidae, and Staphylinidae have been reported with combined malformations of the head, pronotum, elytra, and/or some appendages (Asiain and Márquez 2009; Clark and Belo-Neto 2010; Ghandi and Herms 2008; Vitali 2007). Other Scarabaeoidea species have individual reports of some of the malformations reported here (Chalumeau and Brochier 2007; Gasca-Álvarez *et al*. 2017; Guzmán-Vásquez *et al*. 2020), but none of previously reported cases document the number of malformations in a specimen of the superfamily (Scarabaeoidae) described here. The only exception is one specimen of the dynastine beetle *Oryctes nasicornis* (Linnaeus, 1758), presenting malformations on pronotum surface, sutural stria of one elytron, hemidystrophic scutellum, and hemibrachelytry (Jeremías 2004). This is congruent with the estimation of Dallas about the frequency of finding a specimen of the same species with more than one malformation being lower than finding an individual with only one malformation (Jeremías 2004).

We cannot identify the origin of the malformations. However, we did not test for teratogens. We think that the most probable cause for the abnormalities we observed is likely environmental contaminants or conditions. An idea supported by reports on mutagenic capacity of contaminants on insects (*e.g*., Goretti *et al*. 2020; Kheirallah and El-Samad 2019; Shulman *et al*. 2017). More detailed sampling is needed to confirm our observation. We may further be able to explain the origin of teratologies with breeding assays and transcriptomic studies, leading us to a better understanding of the phenomenon (Yi *et al*. 2017).

Although no additional malformed specimens from both species were found in the entomological collections revised, occurrence of teratological cases in insects is still relatively undocumented and is likely subestimated in the literature (Jeremías 2004). Only a few reports of teratological specimens from Colombia have been documented, but the majority are of scarabs (Coleoptera: Scarabaeoidea) from the subfamilies Cetoniinae and Rutelinae (Gasca-Álvarez *et al*. 2017; Taboada-Verona *et al*. 2016). We suggest conducting future studies exploring the occurrence of malformations on a determinate taxon at a geographic boundary as a useful tool to understand teratologies and its possible causes.

Acknowledgments

The authors are grateful to Daniela García-Cobos and Sebastián Cifuentes-Acevedo for collect and share the specimens and by the comments about both localities. We thank Zuania Colon and Will Bayfield-Farrell for comments on previous drafts and the revision of the English version of this manuscript. Also, we thank to the anonymous reviewers for their comments that also helped us to improve previous versions of this manuscript. This study was partially financed by the Boyacá Bio project, with funds from the General System of Royalties of Colombia that were administered by the National Planning Department (BPIN 20170000100009), executed by the Government of Boyacá and operated by the Instituto de Investigación de Recursos Biológicos Alexander von Humboldt (cooperation agreement No. 17170).

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