Iheringia
Série Zoologia

e-ISSN 1678-4766
www.scielo.br/isz

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Article

Redescription of *Omophoita octoguttata* (Coleoptera: Chrysomelidae) and its immature stages, with notes on life history

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Received 10 September 2020
Accepted 25 May 2021
Published 13 August 2021
DOI 10.1590/1678-4766e2021016

ABSTRACT. Given that many descriptions of Coleoptera were made with only external and superficial characters, an update to the original characterization of species is deemed necessary. This study focuses on updating the know morphological data for the adults of *Omophoita octoguttata* (Fabricius,1775) (Galerucinae, Alticini), a flea beetle native of southern Brazil. We also give insights on the morphology of its immature stages. The adult can be easily recognized by the pale macula at vertex, six large pale maculae, and two smaller in the humeral region at the elytra. The immatures are similar to other know Oedionychina. Eggs oval and orange. Mature larvae present setae bearing scoli, a reddened body, pygopod present, and lacking stemmata, but with curved hook-like tarsal claws. The pupae present slender black setae through its yellowed body, with the elytral and hind wing thecae curved around the body. The eggs are laid in small clutches in the soil and when the larvae eclode they stay in the aerial parts of plants. The mature larvae form a cocoon of soil matter around themselves for their pupal phase. Morphological remarks for larva and pupa of this species when compared to other members of the genus remain limited, demanding further studies with other species.

KEYWORDS. Alticini, egg, larva, Neotropical, Oedionychina, pupa.

Omophoita Chevrolat, 1836 (Galerucinae: Alticini: Oedionychina) is a diverse genus of the neotropical coleopterofauna, containing 89 species, 83 of which are registered in Brazil (Bechyné, 1955, 1959; Sekerka *et al.*, 2020). Often individuals of the genus are sampled in biodiversity studies, but seldom are individuals identified beyond the generic level (Furth & Savini, 1996). The generic determination is not complex, as the main distinctive characters of the genus are the pale macula in the visible vertex, three or more pairs of bristles on the labrum distributed irregularly and the first metatarsomere longer than the adjacent tarsomeres (Bechyné, 1955).

The difficulties arise when specific identification of immature alticines is attempted. Chrysomelidae and Coleoptera as a whole lack data referring to the morphology of larvae or pupae, with immature forms rarely ever being described or even preserved for later research, not withstanding their value for taxonomy research (Lawrence *et al.*, 2011). Alticine larvae are usually characterized as eruciform, with a well-developed head capsule, small antennae, usually shorter than the maxillary palps, and the presence of a pygopod (Lee *et al.* 1998; Lee, 1999; Furth & Lee, 2000).

With these taxonomic problems in mind, this work aims to update the description of *Omophoita octoguttata* (Fabricius, 1775), adding more information on the morphology of adults and immatures, as well as the first account of genital morphological characters in females of this genus.

MATERIAL AND METHODS

Adults. Specimens of *O. octoguttata* were obtained by loans from Museu de Zoologia da Universidade de São Paulo, São Paulo, Brazil (MZUSP, curator Dr. Sonia Casari); Instituto Biológico de São Paulo, São Paulo, Brazil (IBSP, curator Dr. Sérgio Ide), and Coleção Entomológica Pe. J. S. Moure, Departamento de Zoologia, Universidade Federal do Paraná, Curitiba, Brazil (DZUP, curator Dr. Lúcia Massutti de Almeida).

The holotype of *O. octoguttata* was not located, but identification to species level was made through comparisons with the original descriptions, and specimens previously determined by Bechyné available in collections.

Different conservation methods may result in changes to the specimens' coloration. Therefore, the color patterns described here are the ones reported from dry preserved specimens and may differ from those observed in living individuals.

The genitalia were dissected following protocols described by Smith (1979). The morphological pieces were preserved in glycerin, stored in a microtube placed alongside

the original individuals (which were fixed in ethanol 70% after dissection). Only tignum, vaginal palpi, spermatheca (for females) and median lobe (for males) were analyzed, as the other components of the genitalia were much less sclerotized and lost during the dissection process.

The descriptions for adults followed the morphological concepts and nomenclature of Bechyné (1955,1956), Crowson & Crowson (1996), Lingafelter & Konstantinov (1999), Rafael *et al.*(2012) and Morais (2016).

Life cycle and immatures. Adults of *O. octoguttata* were collected in Itaiacoca, Ponta Grossa, state of Paraná, Brazil, by E. da S. Araújo (October 28, 2019;25°07'03.7"S, 49°56'27.8"W; manual collection; collected flying or resting on top of the leaves of various medium height plants) and transferred to a terrarium in the Laboratório de Genética e Evolução at Universidade Estadual de Ponta Grossa, Paraná, Brazil, so that the adults could mate and oviposit in a controlled environment.

The terrarium was assembled using common household transparent plastic containers (40 cm length, 27 cm width and 23 cm height) covered by tulle fabric, filled with a layer of small rocks, humus soil (approximately 10 cm deep), soil from the beetle's sampled site and live specimens of *Hyptis radicans* (Pohl) (Lamiaceae), also from the collection site as substract, which were observed being eaten by *O. octoguttata* and described by Begossi & Benson (1988) as a possible host plant (Fig. 18). The containers were sprayed with activated charcoal filtered water twice a day. The plants were previously left to grow for two months, being exposed to natural sunlight, until the adult beetles collected in the field were added. The plants were replaced once most of their leaves were eaten by the beetles or dead. We placed ten individuals in the terrarium, forming five couples (sex inferred by their size: females are usually larger than males).

Adults showed a voracious behavior, eating nearly all plants in the terrarium in approximately two weeks, and due to this reason, they were transferred to a different terrarium built with the same aforementioned characteristics. Adults mated and laid eggs on the soil, but the larvae were only first recorded a few days after hatching, before the first larvae appeared we were not able to observe any eggs. Once larvae were recorded for the first time, we observed them daily to monitor the development of the larvae and pupae.

Later on, a clutch of eggs and three instars of larvae were collected by hand, as well as pupae and their cocoons, by searching the soil gently with spoons. The immature specimens were placed in boiling water and later preserved in ethanol 70%. The cocoons were preserved dry. It should be noted that the individuals of other instars were not collected, as the host plants proved to be very sensitive to manipulation, we feared that extensively searching the soil for pupae and larvae could result in the premature death of the plants. This is our first successful rearing experiment with *O. octoguttata* after four unsuccessful attempts, and we chose to not risk the future viability of the experiment over the sampling of more individuals.

Immatures were placed along with their inferred adult parents in the collection of the Laboratório de Genética e Evolução, UEPG, and five samples were donated to Museu de Zoologia, Universidade de São Paulo.

The descriptions for the immatures followed Böving (1929), Kasap & Crowson (1976), Borowiec & Świętojańska (2003) and Kučerová & Stejskal (2008).

Digital images. The images were obtained with a MC170 HD (Leica) camera coupled with a Leica M205 C stereomicroscope, using the LAS 4.8.0 (Leica) software for image capturing. Photos were edited in Adobe Photoshop CC 2019 and vectorized in Adobe Illustrator CC 2015.

RESULTS

Omophoita octoguttata (Fabricius, 1775)

Material examined. Adults: BRAZIL, **Santa Catarina:** Nova Teutônia, ♀, IX.1936, B. Pohl col. (MZSUP 25738); São Bento do Sul, ♂, IV.1949, Dirings col. (MZSP 25613); **Paraná:** Ponta Grossa, 2♀, I.1939, Camargo col. (MZSP 25583); Itaiacoca, 4♀, 6.II.2018, E. Araújo col. (LabGEv); 2♀, ♂, 24.III.2018, E. Araújo col. (LabGEv); **São Paulo:** Barueri, ♂, 30.VII.1960, K. Lenko col. (MZSP 25584); **Minas Gerais:** Pouso Alegre, ♀, ♂, I.1960, Pereira & Madeiros col. (MZSP 25585). Eggs: BRAZIL, **Paraná:** inferred adult parents collected in Itaiacoca, by E. Araújo in 25.XI.2019 (LabGEv); Ponta Grossa, eggs reared in LabGEv, 13.II.2020, B. P. Begha col. (LabGEv). Larvae: BRAZIL, **Paraná**: inferred adult parents collected in Itaiacoca by E. Araújo in 25.XI.2019 (LabGEv); larvae reared in LabGEv, 18.XI.2019, B. P. Begha col. (LabGEv). Pupae: BRAZIL, **Paraná**: inferred adult parents collected in Itaiacoca by E. Araújo in 25.XI.2019 (LabGEv); larvae reared in LabGEv, 16.XII.2019, B. P. Begha col. (LabGEv).

Adult (Figs 1–15). Diagnosis. Body shape oval; eight pale yellow to light brown maculae almost completely covering the elytra, being six of similar size and shape, and two much narrower, elongated at humeral region; maculae rectangular to rounded. Tegument between maculae dark-brown to black. Head black, with three pale yellow to light brown maculae: one covering most of the vertex and the antennal calli, and two covering the lateral portions of the frontoclypeal region. Ventral area of mesothorax, metathorax, and legs black and covered with short pale hairs.

Males: length 7.41-7.42 mm; width 3.38-3.58 mm.

Females: length 9.00-9.91 mm; width 4.24-4.59mm.

Head (Figs 3, 4). Rounded, black. Vertex at the same level of tegument, with fine punctation. Inconspicuous supraorbital suture, smooth integument. Supraorbital pore with long and erect seta. Eight to ten setae at lateral margin of head macula, near eyes. Twelve setae scattered between antennal insertions. Gena with nearly same width as the eye, bearing several setae. Antennae black, filiform, with eleven antennomeres; scape subcylindrical, antennomere II shorter

than III, antennomere III-X subequal in length, subconical, longer than antennomere XI, which is also subcylindrical, albeit with a narrower, acute apex; antennal insertions ovoid, smaller than the diameter of the eye, interantennal space approximately same size of antennal insertions. Antennae comparatively longer in males. Frontoclypeus subtrapezoid, each side with four setae.

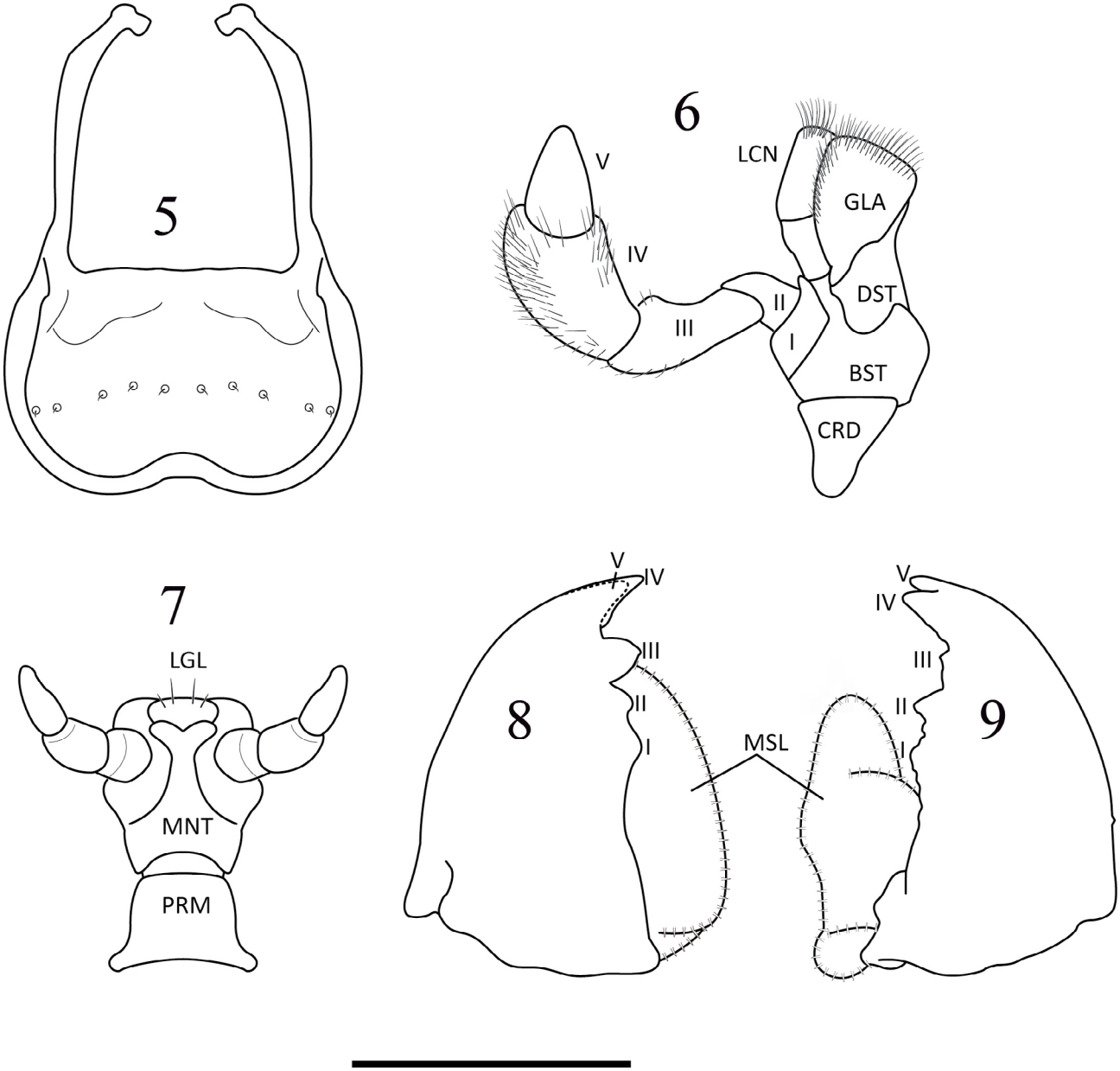
Mouthparts (Figs 5–9). Labrum (Fig. 5) with rounded distal margins, central portion emarginated, with ten long setae. Maxilla (Fig. 6) with narrow cardo in the proximal portion, with margins diverging from the center forming a much wider apex; stipe divided in basistipe and dististipe, the former larger and subtriangular, the latter elongated; galea subcylindrical and digitiform lacinia both with dense bristles at apex; maxillary palpus well developed with five palpomeres; III and IV the longest, IV the widest and V greatly reduced. Labium (Fig. 7) with membranous ligula, not well developed, reaching the base of the apical segment. Labial palpus with three segments, with short and transverse palpifer; palpomere II subcylindrical and slightly longer than wide; apical article narrowing to the apex. Subtrapezoid prementum. Mandibles (Figs 8, 9) nearly symmetrical, subtriangular, with curved outer margin; left mandible with five apical teeth, only three visible teeth on the outer face, IV and V teeth longer and sharper, mola absent; right mandible with five apical teeth, IV and V teeth longer and sharper, while others short and blunt. Well-developed membranous setose ventral lobe on each mandible.

Thorax. Pronotum transverse, width twice the length, lateral margins and angles rounded, with a long seta at each angle; anterior angles extending beyond the head insertion; hypomeral lobe inflated, laterally and ventrally distinct; disk lacking any setae or impression, light pink to orange for live specimens, pale yellow to light brown in dry preserved specimens. Prosternum with the same color as the pronotum; prosternal process relatively narrow, widening apically, rounded at apex. Scutellum black, triangular with rounded vertices; procoxal cavities open. Elytra (Figs 1, 2) black with eight pale yellow to light brown maculae, six of which larger, subrectangular with rounded vertices to rounded, and two of which are much narrower, also subrectangular with rounded vertices, located in the humeral region. Epipleura visible laterally in the humeral region. Mesosternum and metasternum black, surface densely covered with pale hairs; metasternum elongated, rectangular; outer margins of the thorax with a higher density of hairs.

Fore and median legs similar, with coxae subcylindrical, slender femur and tibiae; middle legs slightly longer. Surface densely covered with pale setae, pilosity on the metafemur restricted to outer margin. Metafemora thickened due to the metafemoral spring; fusiform shape. Tarsi pseudotetramerous, claws appendiculate; metatarsomere V enlarged, fusiform.

Abdomen black, with five ventrites densely covered with pale hairs: ventrites I-IV subequal in length, pygidium slightly longer than the other ventrites and rounded.

Figs 1–4. *Omophoita octoguttata* (Fabricius, 1775). Dorsal habitus with color pattern variations: 1, female; 2, male. Frontal view of the head: 3, variant with rectangular maculae, female; 4, variant with rounded maculae, male.

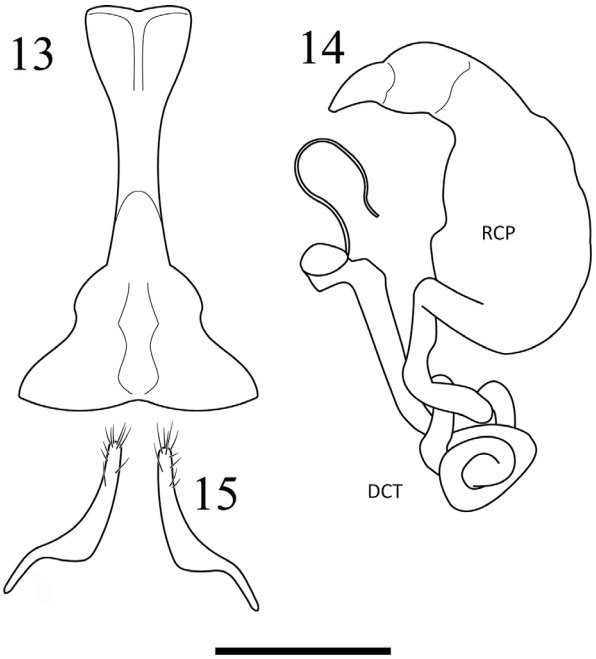


Figs 5–9.*Omophoita octoguttata* (Fabricius, 1775), mouthparts of the adult: 5, labrum, frontal view; 6, left maxilla, dorsal view (I-V, maxillary palpomeres; LCN, lacinia; GLA, galea; BST, basistipe; DST, disistipe; CRD, cardo); 7, labium, ventral view (MNT, mentum; PRM, prementum; LGL, ligula); 8, 9, mandibles, frontal view: 8, right; 9, left (I-V, mandibular teeth; MSL, membranous setose lobe). Scale bar = 500 μm.

Male genitalia (Figs 10–12). Median lobe with parallel lateral margins (Fig. 10), with base slightly wider than apex, short basal hooks (BHS) appearing on the lateral margin near the end of the basal orifice (BOR, Fig. 11), which has a rounded or oval. Apical hood (APH) with nearly parallel lateral margins, diverging to half the length of the flap and folding ventrally to form a semicylinder, straight apical margin. Lateral lobes (LTL, Fig. 12) slightly shorter than the projections of the middle lobe (MDL) which are nearly parallel, diverging at apex.

Female genitalia (Figs 13–15). Membranous *bursa copulatrix*. Tignum goblet-shaped (Fig. 13), with a wide, well-sclerotized apex, with converging margins forming a thinner median portion; parallel margins of the median portion then diverging slightly to the base of tignum, less sclerotized and thinner than the apex. Spermatheca (Fig. 14) simple, with areniform and well-sclerotized receptacle (RCP); spermathecal duct (DCT) long, curled. Vaginal palpi elongated with sigmoid shape (Fig. 15), with a thin base, slightly wider and more sclerotized at the apex, ten setae at the apex.

Figs 10–12. *Omophoita octoguttata* (Fabricius, 1775), male genitalia: 10, median lobe, dorsal view; 11, aedeagus, right lateral view; 12, detail of the apical hood of the median lobe, dorsal view (APH, apical hood; BHS, basal hooks; BOR, basal orifice; LTL, lateral lobes; MDL, middle lobe). Scale = 200 µm.



Figs 13–15. *Omophoita octoguttata* (Fabricius, 1775), female genitalia: 13, tignum; 14, spermatheca; 15, vaginal palpi (RCP, receptacle; DCT, spermathecal duct). Scale = 200 µm.

Eggs (Fig. 18). Egg oblong with round ends, one of extremities wider than the other, with an operculum. Fresh eggs opaque and pale, older eggs orange.

Mature larvae (Figs 19, 20). Larvae eruciform, with many scoli dorsal and laterally, each scolus with two setae. Cephalic capsule black, lacking stemmata. Body reddened orange with hairs organized in punctuations at the sides, ventral area and dorsal area. Younger instars pale, smaller with slightly longer scoli, older instars larger and more reddened. In alcohol, specimens are yellow. Chaetotaxy constant through all instars, with no noticeable difference between older and younger instars; younger instars with longer setae.

Length 10.4-11.73 mm; width 3.38-3.58 mm.

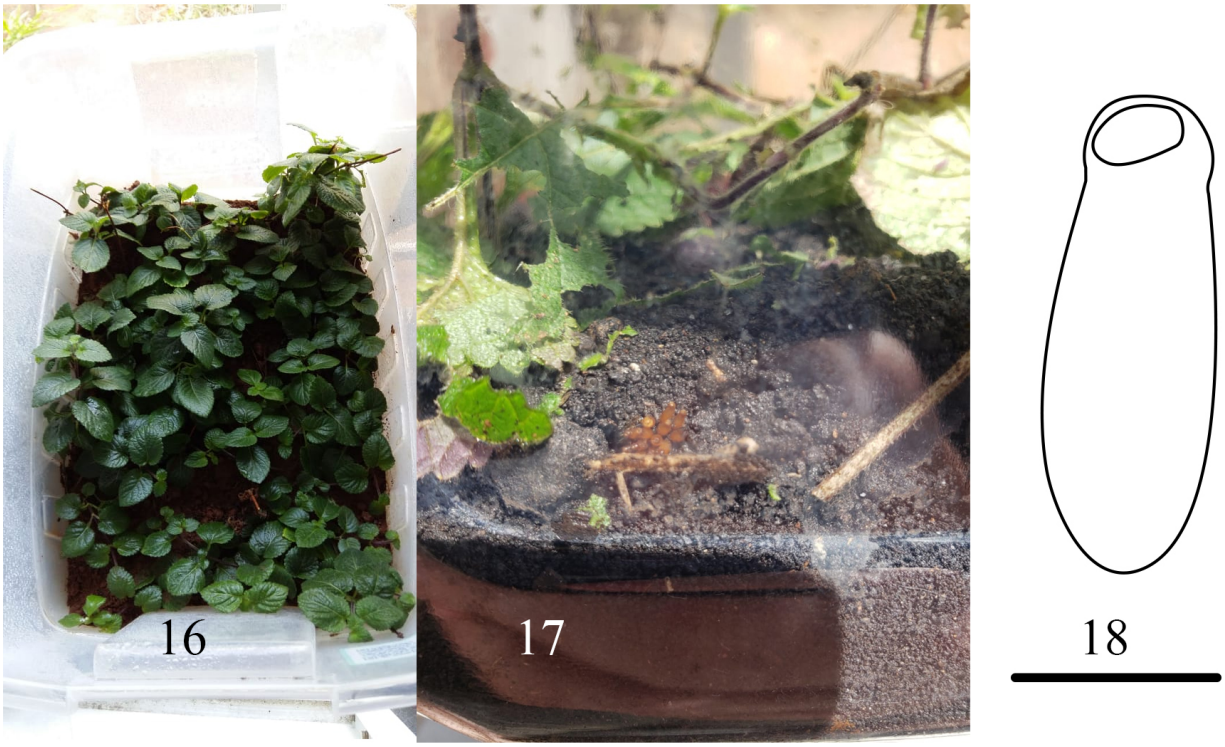
Description. Cephalic capsule (Fig. 19) black, slightly inserted in the thorax; frons, clypeus, labrum, and mandibles black; stemmata absent. Endocarina inconspicuous. Epicranial suture inconspicuous, only the frontal sutures visible, reaching the top of the head capsule, which is partially covered by pronotum. Setae present: four dorsoepicranial (DOS); four paraocellar (POS); two posterofrontal (PFS); two externofrontal (EFS); two anterofrontal (AFS); four externoepicranial (EES). Antennae with three articles, short; antennomere I subtrapezoidal, rounded; antennomeres II and III smaller, conical; antennomere III the smallest. Clypeus lacking setae, subtrapezoid, with a median recess. Labrum horizontally oval, with four setae. Both maxillary and labial palps with four segments.

Front legs slightly shorter than middle and hind legs. All legs with four setae at apex of the femur and four at tibia. Claws simple, curved and hook-like.

Dorsum and abdominal venter with four scoli on each body segment, each scolus with two short setae at apex. Prothorax with one spiracle visible in lateral view; a row of ten setae above the head insertion; eight distinct scoli with setae. Both meso- and metathorax with one long scolus on each side, longer than the scoli in the abdomen. Abdomen with eight pairs of spiracles; segments I-VII with two scoli on each side, close to the spiracle; segment VIII with four scoli. Pygopod present.

Pupa (Figs 21–24). Body shape oval, exarate, adecticous, exarate, pale yellow. Tegument with sparse black setae. Found within cocoons made of dirt and saliva, buried in the soil (Figs 23, 24). Mature pupae with eyes, mandibles, metafemoral spring and claws darkened, sclerotized.

Average length: 7.2 mm; average width: 3.5 mm.



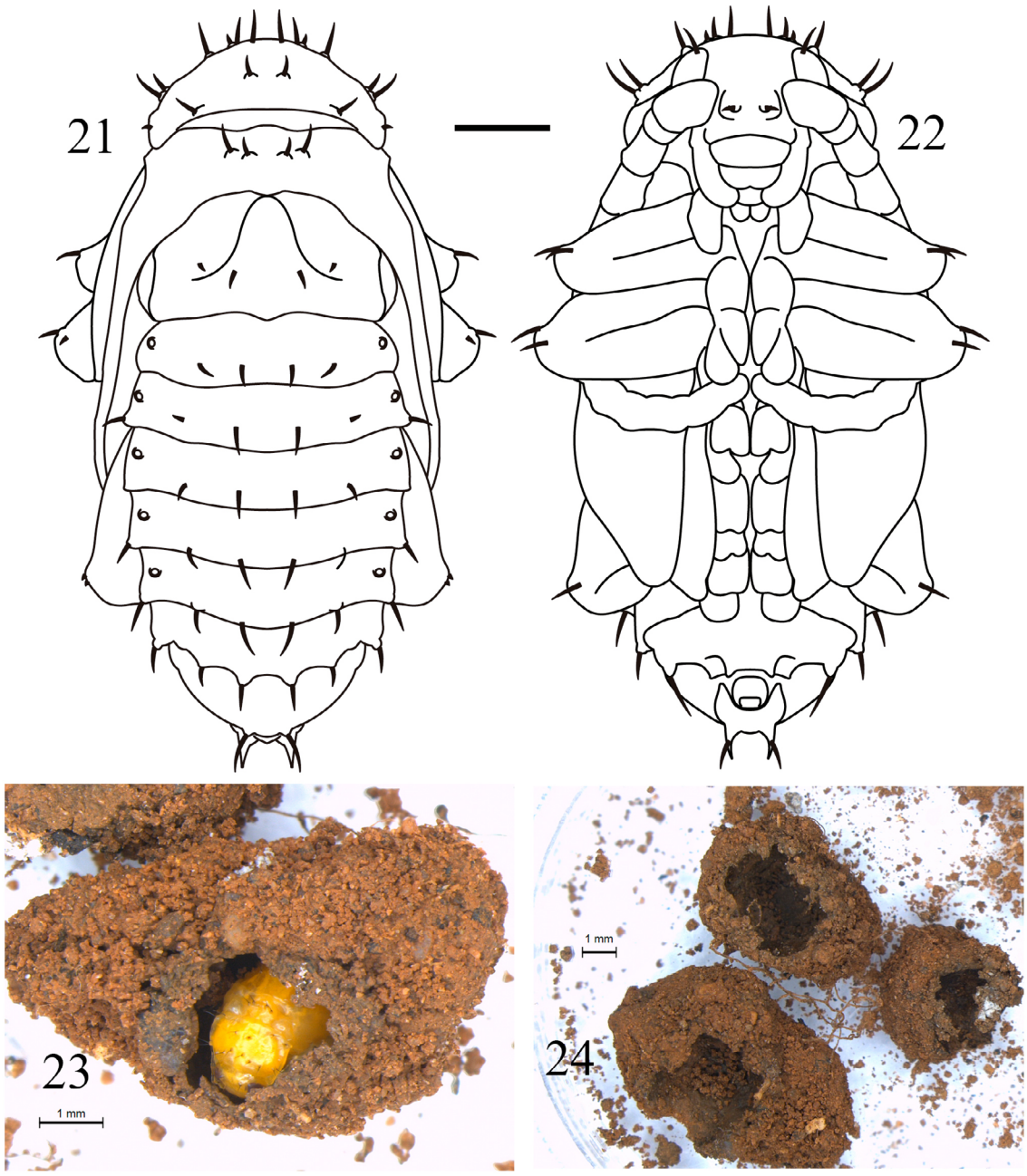
Figs 16–18. *Omophoita octoguttata* (Fabricius, 1775): 16, terrarium used for the rearing; 17, clutch of eggs buried in soil within the terrarium;18, egg. Scale = 1 mm.

Figs 19, 20. *Omophoita octoguttata* (Fabricius, 1775), mature larva: 19, head, frontal view (DOS, dorsoepicranial setae; POS, paraocellar setae; PFS, posterofrontal setae; EFS, externofrontal setae; AFS, anterofrontal setae; EES, externoepicranial setae); 20, lateral habitus. Scale bar = 1 mm.

Description. Head not visible from above, bearing two setae on the eyes, two setae on the frons and two setae on the vertex. Pronotum wider at the base, bearing 16 setae, eight in the median region and eight in the lateral region; one pair of spiracles visible in lateral view. Elytral and hind wing thecae closely appressed, curved ventrally around the body. Mesonotum and metanotum with four setae. All femora with three setae at apex. Abdomen with five pairs of spiracles, visible in dorsal view (Fig. 21); abdominal segments I-VII with six setae; abdominal segment IX with two spine-like urogomphi (Fig. 22).

DISCUSSION

Adults of *O. octoguttata* remain unique among alticine, noticeably for its characteristic maculae pattern on the head and the elytra. It would be possible to confuse a specimen of *O. octoguttata* with *Alagoasa areata* (Germar, 1823) for its strikingly similar elytral pattern, but *Omophoita* remains distinct from *Alagoasa* for bearing the pale maculae on the head and slender metafemoral, and fusiform metatarsomere V (Bechyné,1955). The structures of the median lobe on males and tignum on females can prove to be very useful on



Figs 21–24. *Omophoita octoguttata* (Fabricius, 1775), pupa, habitus: 21, dorsal; 22, ventral; 23, cocoons made from soil matter with pupa; 24, interior of the cocoon, pupa removed. Scale bar = 1 mm.

future studies on the delimitation of species of *Omophoita*, until now no detailed description was made that illustrated the complexity present in this genus (Furth, 1985). Another paper is being developed related to the morphological characteristics of other species of *Omophoita*, which has shown that female genitalia are just as useful as male genitalia to define and separate species, and in the absence of males can be used for identification purposes (in preparation).

The larvae of *O. octoguttata* follow the typical morphology of leaf-eating Oedionychina, characteristic for their prominent setae, body tubercles with setae, short antennae and lack of stemmata (Duckett & Swigoňová, 2002). Even when compared to *O. aequinoctialis* (Linnaeus, 1758), the only member of its genus with described larva, a noticeable difference being the shape of the tarsal claws, which are curved and hook-like in *O. octoguttata* and spine-like in *O. aequinoctialis* (Takizawa, 2005). While chaetotaxy and habitus seem very similar between the two species, we still lack information to draw any generical patterns.

Notes on life cycle and biology. Adult specimens of *O. octoguttata* were collected in an environment of mixed rain forests composed mostly of evergreen subtropical moist

forests (Nascimento *et al.*, 2001; Roderjan *et al.*, 2002), and were found resting on leaves of shrubbery or flying between forest openings.

In laboratory, the beetles were left to mate, and females laid eggs near the host plant, *Hyptis radicans* (some specimens deposited in the Universidade Estadual de Ponta Grossa herbarium). The eggs were arranged in clutches of about twelve eggs, usually buried but sometimes exposed. After eggs hatched (the incubation period varies between five to seven days), the first instar larvae fed both on the roots and the leaves of the host plant. Three instars were observed, and the mature larva built a cocoon around itself composed of soil matter and its saliva, where it entered the pupa stage. After the development period, the adult beetle emerges from the cocoon. Unfortunately, as the immatures remain mostly buried in the soil, we were unable to observe the development between instars and determine each stage's duration, as we avoided extensively searching the soil for pupae and larvae, fearing that it could result in the premature death of the host plants. The breeding period happened in the period of spring and summer in Brazil. Most adult females died few days (seven to ten days) after laying eggs.

The period from egg to the emerging of adults was of approximately 50 days. *Omophoita octoguttata* shows a peak of the population of adults in the spring and summer, that decays in the next few months, until fall and winter, when we found very few individuals or none. Presumably, the eggs of the flea beetles undergo a period of diapause during low-temperature periods, as observed in other Chrysomelidae (Xue *et al.*, 2002; Meiners *et al.*, 2006), allowing the species to persist in the environment during the entire year, but this has not yet been verified for this species. Current data still does not confirm this, but the lineages from this work are at the moment of the production of this manuscript alive in the lab, and going to their third generation before fall, starting at the end of March, in the southern hemisphere.

Acknowledgements. We would like to thank Erica da Silva Araújo and Miguel Airton de Carvalho for helping with the specimens sampling and Rafaela Lopes Falaschi for assisting with translations; for CAPES (Coordenação de Aperfeiçoamento de Pessoal de Nível Superior) for providing the financial support for the producing of this paper; the MZUSP, IB, and DZUP for loan of specimens; UEPG (Universidade Estadual de Ponta Grossa), LabGEv (Laboratório de Genética e Evolução) and PPG-BioEvol (Programa de Pós-Graduação em Biologia Evolutiva) for providing the necessary work infrastructure.

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