



Biology of gall inducing arthropods and their associates – Memorial issue for Professor Junichi Yukawa

A new neotropical *Bruggmanniella* Tavares, 1909 (Diptera: Cecidomyiidae) inducing galls on commercial avocado

Carolina de Almeida Garcia¹ · Maria Virginia Urso² · Grazielle Furtado Moreira³ · Alexandre José Ferreira Diniz⁴

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Abstract

Brazil is among the world's leading avocado producers, with cultivation increasingly threatened by gall-inducing midges that damage blossoms and impair fruit development. During surveys in commercial Hass avocado orchards in Minas Gerais, Brazil, a previously unknown species of *Bruggmanniella* Tavares, 1909 (Diptera: Cecidomyiidae) was discovered infesting young fruits. Here, we describe *Bruggmanniella abacate* sp. nov. Garcia and Urso, based on larvae, pupae, males, and females reared from malformed fruit galls. Larvae develop within the ovarian tissue, inducing elongated galls that lead to fruit abortion. This is the first record of a *Bruggmanniella* species associated with *Persea americana* Mill. cv. 'Hass' in Brazil. Our findings reveal previously undocumented diversity of avocado-infesting gall midges and underscore the need for further studies to evaluate their distribution, biology, and potential economic impact on the expanding Brazilian avocado production.

Keywords Asphondyliini · Gall midges · Hass avocado · Lauraceae · Taxonomy

Introduction

Brazil is one of the world's leading avocado producers, currently ranking seventh globally. National production is mainly concentrated in the southeastern and southern regions, in the States of São Paulo, Minas Gerais, Paraná and Espírito Santo (Almeida 2022).

There are several important pest species of avocado crops, two of them belong to the Cecidomyiidae family: *Bruggmanniella perseae* Gagné, 2004, described from Colombia and Costa Rica, and *Asphondylia websteri* Felt, 1917,

recorded in the United States of America. Cecidomyiids are known for their gall-forming habits and have been reported as major pests of avocados in Latin America. Losses in these locations reach 80%. Adults of cecidomyiids, commonly known as “ovary flies”, lay eggs in flowers infesting avocado blossoms and affecting the normal fruit development. The attacked fruits take on an elongated cylindrical shape, which then aborts (Moreira et al. 2024). In Brazil, similar symptoms have been observed in the regions of Alto Paranaíba and southern Minas Gerais, in out-of-season blooms occurring from August to September, that allow a higher prevalence of the insects. The infestation rate of the crop in 2022–2023, the first season in which it was detected, reached 10%. Further studies are still ongoing to determine the rate and speed of the infestation's spread in southeastern Brazil. Managing these pests is still a challenge due to the lack of information on their biology, distribution, and potential economic implications for avocado production.

The genus *Bruggmanniella* Tavares, 1909 is predominantly Neotropical, comprising 23 described species, 12 of which are found in Brazil. Four of these species—*B. maytenuse* Maia, 1992, *B. perseae*, *B. notatae* Rodrigues and Maia, 2020, and *B. sideroxyli* Rodrigues and Maia,

✉ Carolina de Almeida Garcia
dag.carolina@gmail.com

¹ Laboratory of Morphology and Evolution of Diptera, Department of Biology, University of São Paulo, Ribeirão Preto, SP, Brazil

² Laboratory of Systematic of Diptera, Department of Biology, Federal University of São Carlos, Sorocaba, SP, Brazil

³ FG Agricultural Consultancy, Brodowski, SP, Brazil

⁴ Department of Plant Protection, Agricultural Engineering and Soil Science, São Paulo State University “Júlio de Mesquita Filho”, Ilha Solteira, SP, Brazil

2020—are known to induce galls on fruits (Gagné and Jaschhof 2025; Garcia et al. 2020; Rodrigues et al. 2020). This study describes a new species of *Bruggmanniella* Tavares, 1909 (Diptera, Cecidomyiidae) that induces galls on the ovary of *Persea americana* Mill. cv. ‘Hass’ (Lauraceae) in Brazil.

Materials and methods

Surveys for pests of Hass avocado made by GFM detected deformed fruits in commercial Hass avocado crops in the municipality of São Gotardo, Minas Gerais, Brazil, between 2022 and 2024.

The aborted fruits, approximately 2 cm in diameter, were collected in the orchards and sent to the Laboratory of Biological Control (CONBIO) of the São Paulo State University (UNESP), *campus* Ilha Solteira—UNESP/FEIS, for the rearing of immatures. Adults were obtained by placing fruits in a Marconi® BOD climate chamber (Brazil), adjusted to 25 °C ± 2 °C, 70% RH ± 10% and 14 h photophase in a plastic container of 25 × 17 × 8 cm with an opening for gas exchange and were inspected daily. Specimens of immature and adult stages were preserved in 70% ethanol and subsequently sent to the Laboratory of Systematic of Diptera of the Federal University of São Carlos, *campus* Sorocaba, for identification (Moreira et al. 2024). Although important parts of the specimens are damaged, we believe that the morphology of the male and female terminalia, pupa, and larva that we present allows us to identify this species of economic importance. The specimens were mounted on permanent slides following the method outlined in Gagné (1994). Morphological terminology for adults follows Cumming and Wood (2009) while the terminology for immature stages follows Gagné (1994). Drawings were made with a Nikon Eclipse E200 light microscope (Japan), equipped with a camera lucida. Drawings were vectorized with the aid of Adobe Illustrator® software (USA). The pictures were taken with an optical microscope Olympus SC30 color camera (Japan) attached to an Olympus BX53 light microscope (Japan) and edited with Adobe Photoshop® software (USA).

Types of the new species are deposited at the Zoology Museum of the University of São Paulo, São Paulo, Brazil (MZSP). Voucher specimens of the host plant are housed in the Laboratory of Biological Control (CONBIO)—UNESP/FEIS.

Results

Bruggmanniella Tavares, 1909

Type species: *Bruggmanniella braziliensis* Tavares, 1909, by orig. des.

Diagnosis. Prothoracic larval spatula with 3 or 4 teeth, inner teeth (or tooth) larger than outer ones; pupa with well-developed antennal horns and prothoracic spiracles, absent upper and frontal horns, lack of thickening on pupal cephalic margin; male genitalia with separated gonostylar teeth, parameres absent; cerci-like lobes present on female abdominal segment VIII (Garcia et al. 2020).

Bruggmanniella abacate Garcia and Urso **sp. nov.** (Figs. 1–4).

Diagnosis. Prothoracic larval spatula with four teeth, teeth triangular-shaped, papillae on terminal segment absent; pupal antennal horns with lateral projections from base to middle part; hypoproct bilobed U-shaped, cercus deeply bilobed V-shaped; ovipositor about 4.0 times longer than sternite 7.

Description. Male. Body length: 2.3 mm ($n = 1$). Light yellow. *Head* (Fig. 1A): frons with 14–18 setae; clypeus with 4–5 apical setae; labellum with 6–8 lateral setae each side. Palpus 3-segmented, first segment short, as long as wide, second segment twice as long as the first, third segment 1.5 times longer than the second one. Antenna with 7 flagellomeres remained (broken antenna at the base of the eighth flagellomere); scape twice as long as pedicel, both setose; flagellomeres with wavy circumfila along the flagellomere length (Fig. 1B). *Thorax*: Scutum and scutellum dark brown; scutum with a row of dorsocentral setae; scutellum with scattered setae medially and a row of setae at distal margin; 35–40 notopleural setae; 8–10 anepisternal setae; 31–33 anepimeral setae; other pleural sclerites bare. Legs white; tarsal claw simple, similar in size in all legs; empodium longer than claws, pulvilli absent (Fig. 1D). *Wings* (Fig. 1E). Wings length 2.1 mm and width 1.0 mm ($n = 1$) (Broken wing—it is not possible to specify the veins of the wing). *Abdomen* (Fig. 2A). First through seventh tergites rectangular and sclerotized, with a row of setae on posterior margin of each tergite and scales scattered across the tergites, eighth tergite unsclerotized and bare; first through eighth sternites rectangular and sclerotized, setae and scales scattered across the sternites; tergites and sternites without trichoid sensilla. *Terminalia* (Fig. 2B, C): gonocoxites rectangular-shaped, entirely covered with seta and microsetula; gonostylus rounded; parameres absent; hypoproct slightly longer than cercus, each lobe with one long setae at the apex; each lobe of the cerci rounded apically; aedeagus elongated, shorter than cercus and hypoproct, narrow at base with rounded apex.

Female. Body length: 2.6 mm ($n = 2$) (ovipositor not extruded). Light yellow. *Head*: Frons with 16 setae; clypeus bare; labellum with nine lateral setae each side. Antenna with 12 flagellomeres, shortened apically (1st—0.18 mm;

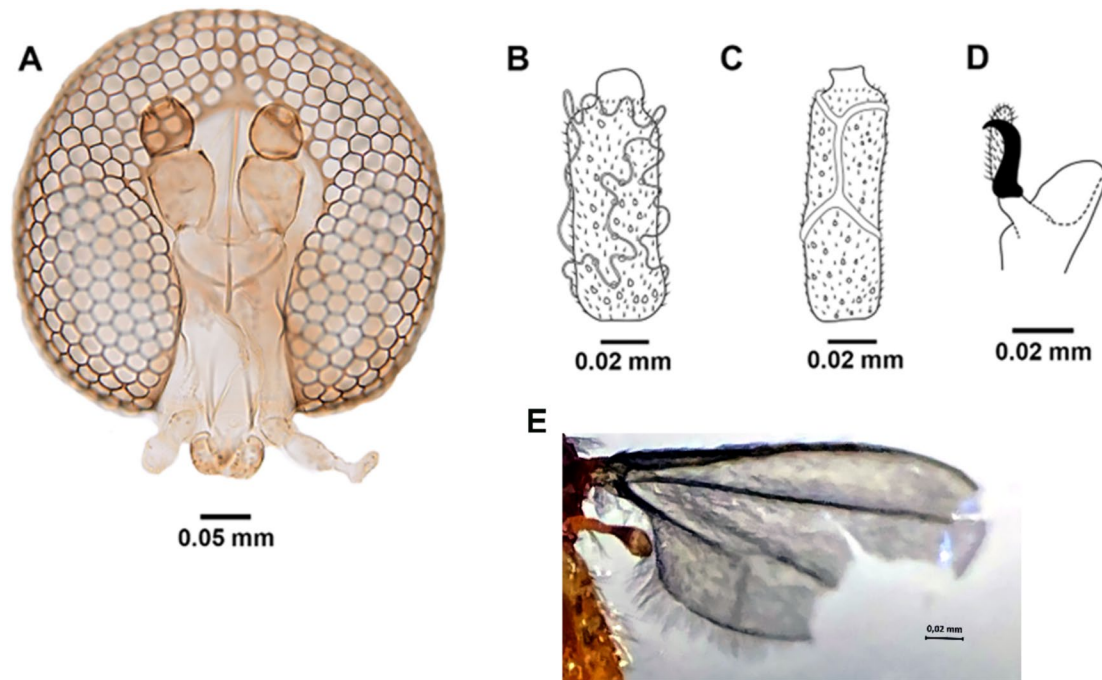


Fig. 1 Adults of *Bruggmanniella abacate* sp. nov. **A** Male head (frontal view). **B** Fifth male flagellomere (frontal view). **C** Fifth female flagellomere (frontal view). **D** Male claw and pulvili (lateral view). **E** Male wing

2nd—0.13 mm; 3rd–8th—0.11 mm; 9th—0.1 mm; 10th—0.09 mm; 11th—0.04 mm; 12th—0.02 mm); flagellomeres with appressed circumfila (Fig. 1C). **Thorax:** Scutum and scutellum dark brown; scutum with a row of dorsocentral setae; scutellum only with a row of setae at distal margin; 60–65 notopleural setae; 12–14 anepisternal setae; 16–20 anepimeral setae; other pleural sclerites bare. **Wings.** Wings length 2.3–2.5 mm and 0.9–1.18 mm in width ($n=2$). Wing with C ending near wing apex, R_{4+5} straight and joining C, M_4 and CuA reaching wing apex. **Abdomen.** First through seventh tergites rectangular and sclerotized; first through sixth sternites rectangular and sclerotized with a band of strong setae on posterior margin of each tergite, scales scattered across the tergites, seventh sternite 1.5 times longer than the sixth and strongly sclerotized, setae and scales scattered across the sternites; tergites, and sternites without trichoid sensilla. **Ovipositor** (Fig. 2D): protrusible, needle-like (1.2 mm length), about 4.0 times longer than sternite 7; cerci-like lobes covered with setulae. Otherwise, same as male.

Pupa (Fig. 3A–C). Body length: 2.5–3.0 mm ($n=2$). Light yellow. Integument smooth. Cephalic setae long (0.1 mm). Antennal horns elongate (0.3 mm length and 0.17 width), well-sclerotized, lateral projection from base to middle part of the antennal horn present, outer and inner edges smooth. Upper facial margin thickened, one pair of lower facial papillae, lower lateral papillae absent. Prothoracic spiracles 0.3

mm in length. Wing sheaths reaching the second abdominal segment; leg sheaths reaching the third to fifth abdominal segments. Abdominal tergites of the second through eighth segments with dorsal rows of conspicuous spines mesally positioned and different in size. Eighth tergite with fewer spines than the seventh tergite. Abdominal spiracles present on the second to seventh segments, well-developed and spiniform. Terminal segment of the pupa rounded in males and females.

Larva. Body length 1.5–1.8 mm ($n=2$). Yellow. Prothoracic spatula length 0.6 mm and width 0.2 mm, with four apical teeth, inner teeth longer than the outer ones, triangular-shaped, lateral projection at the base undeveloped (Fig. 3D). Lateral papillae in two groups, one outer and two inner setose papillae; inner pleural papillae setose, present on all thoracic segments and through abdominal segments I to VII; a pair of sternal setose papillae ventrally in all thoracic segment; a pair of sternal setose papillae in abdominal segments I to VII; two sternal setose papillae on sternite VIII. Four dorsal setose papillae on all thoracic and I to VII abdominal segments; abdominal tergite VIII with two setose dorsal papillae. Terminal segment with 0.09 mm length and width, papillae absent. Spiracle present only on first thoracic segment and in abdominal segments I to VIII. Ventral anus in cleft.

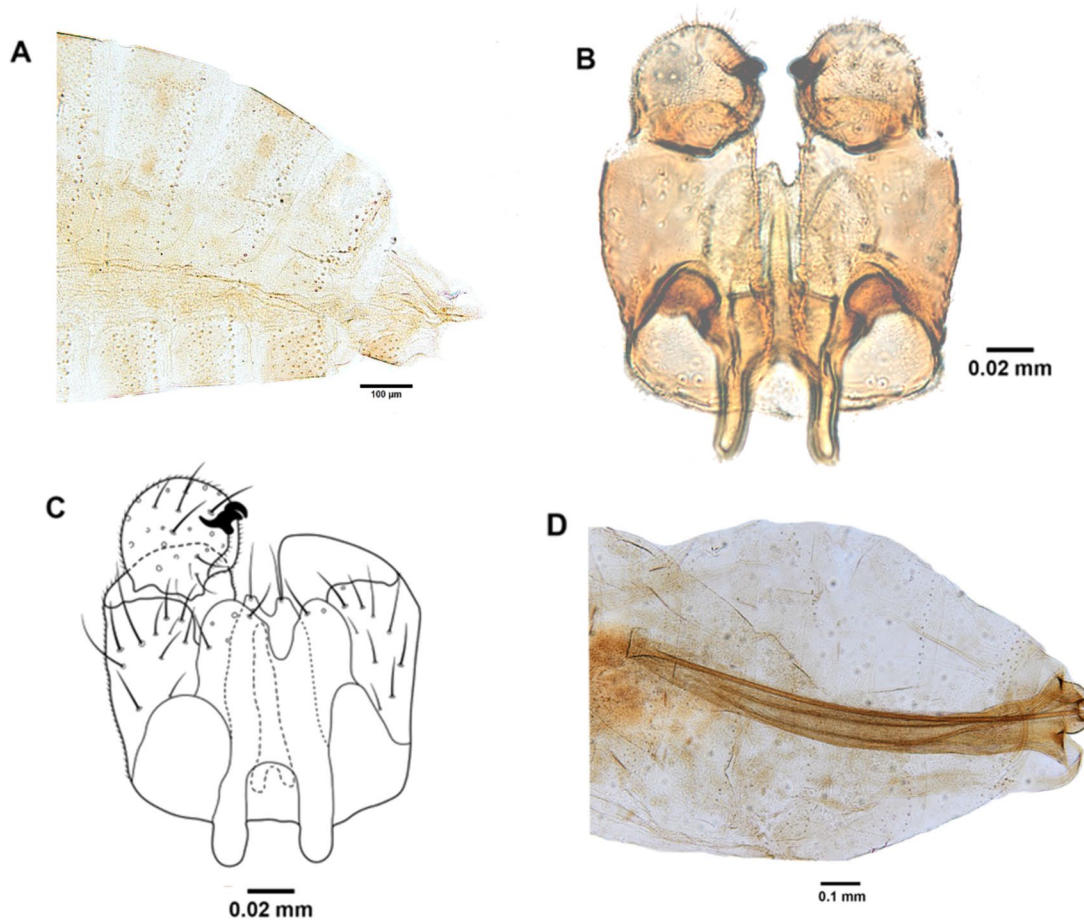


Fig. 2 *Bruggmanniella abacate* sp. nov. **A** Male abdomen (lateral view). **B, C** Male terminalia (ventral view). **D** Female abdomen and ovipositor (lateral view)

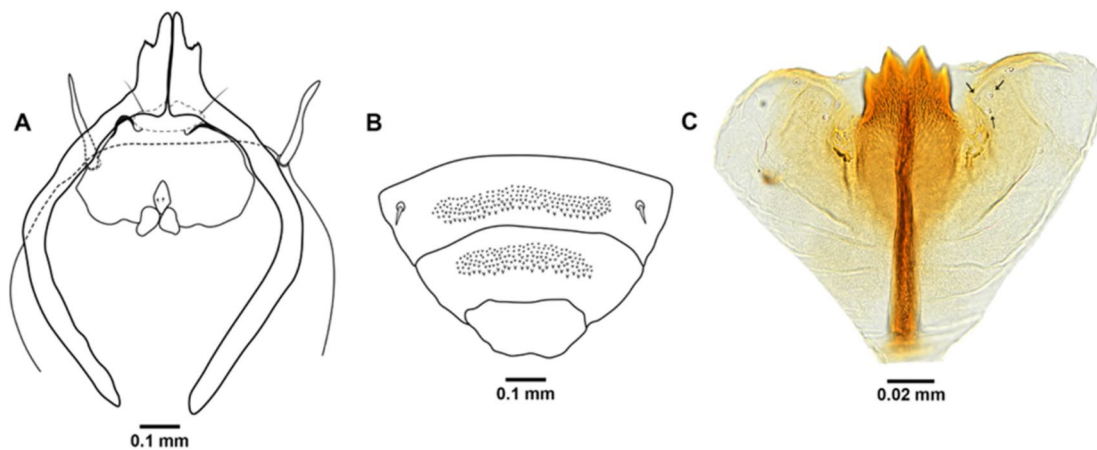
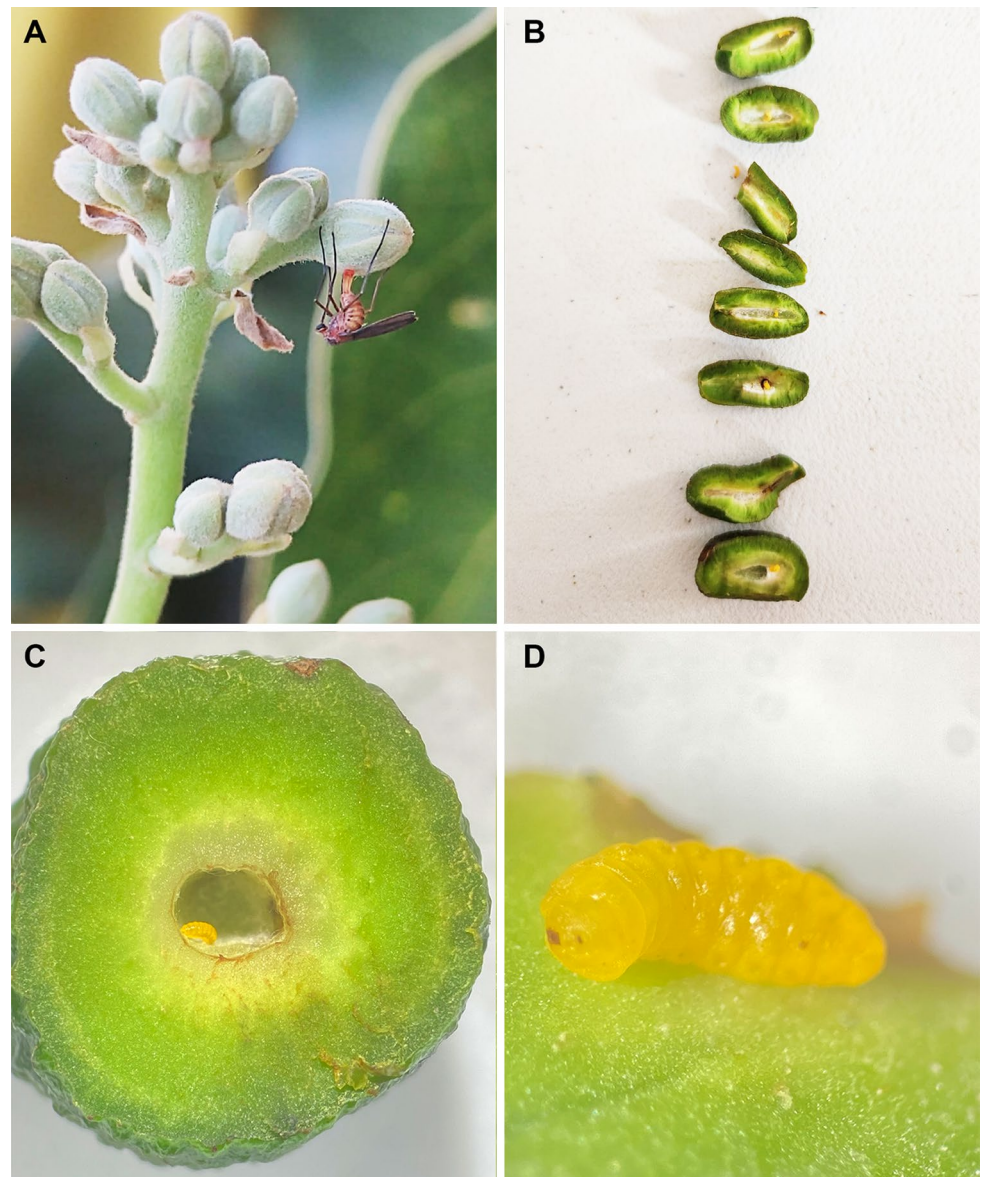


Fig. 3 Immatures of *Bruggmanniella abacate* sp. nov. **A** Pupal antennal horns (ventral view). **B** Sixth to eighth pupal abdominal segments (dorsal view). **C** Larval prothoracic spatula (ventral view). Setae showing the lateral papillae

Galls and biology. In galled fruits of *Persea americana* Mill. cv, ‘Hass’ (Lauraceae). The female of *Bruggmanniella abacate* sp. nov. was observed laying one egg per

ovary (Fig. 4A), as also reported to *B. perseae* Gagné, 2004 (Gagné et al. 2004). The larvae develop within the ovarian tissue (Fig. 4C–D), which inhibits fertilization and leads to

Fig. 4 Galls of *Bruggmanniella abacate* sp. nov. on *Persea americana* Mill. cv. ‘Hass’ (Lauraceae). **A** Female laying eggs on the ovary of *P. americana*. **B** Malformed fruits of *P. americana* with larvae inside. **C, D**. Close-up view of a larva inside the gall



the formation of elongated fruits that measure 2 to 5 cm in size (Fig. 4B). Normally, the malformed fruits detach and fall from the tree shortly after the emergence of the adult. The galls were predominantly observed during the flowering season (February) at altitudes of approximately 900 m in São Gotardo, State of Minas Gerais, Brazil. Nevertheless, infestations of *Bruggmanniella abacate* sp. nov. were occasionally detected in out-of-season blooms occurring from August to September, indicating potential off-season persistence. GFM detected that the infestation rate of the crop in 2022–2023, the first season in which it was detected, reached 10%.

Etymology. The specific name, *abacate*, was named after the term in Portuguese for *avocado*.

Type material. Holotype. 1 male (slide mounted); BRAZIL, Minas Gerais, São Gotardo, collected on 14.vi.2023, Moreira, G.F. leg.; emerged on 13.ix.2024, reared by Moreira, G.F. from fruits of *Persea americana* Mill. cv. ‘Hass’ (Lauraceae). **Paratypes.** 2 females, 2 pupae, 2 larvae (all slide mounted); Brazil, Minas Gerais, São Gotardo, collected on 01.ix.2023, Moreira, G.F. leg.

Discussion

Bruggmanniella abacate sp. nov. exhibits morphological features that distinguish it from its congeners, particularly *B. perseae* Gagné, 2004. The pupal antennal horns of the new species have smooth outer edges with a single basal

projection on each horn, similar to those of *B. bumeliae* Felt, 1907, but contrasting with *B. perseae*, which is characterized by serrate outer edges and a laterally convex shape (Gagné et al. 2004).

The larval prothoracic spatula of the new species is similar to that of *B. sideroxyli* but differs in the relative length of the inner apical teeth, which are significantly longer than the outer teeth (Rodrigues and Maia 2020). In addition, *B. abacate* sp. nov., *B. perseae* and *B. notatae* Rodrigues and Maia, 2020 all have a pigmented area surrounding the spatula, but *B. perseae* and *B. notatae* differ in having teeth of equal size (Rodrigues and Maia 2020, Gagné et al. 2004).

The male of *B. abacate* sp. nov. shares similarities with *B. perseae*. Both species have a deeply bilobed cercus with a V-shaped inner emargination and a bilobed hypoproct with a U-shaped inner emargination. In the new species, however, the cercus is shorter than the hypoproct, whereas the opposite is true for *B. perseae* (Gagné et al. 2004).

These results highlight the unexplored diversity of gall midges associated with *Persea americana* in Brazil and the need for integrated pest management strategies targeting avocado cecidomyiids in the country.

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Author contributions All authors contributed to the study conception and design. Material preparation and analysis were performed by Carolina de Almeida Garcia and Alexandre José Ferreira Diniz. Data collection was performed by Grazielle Furtado Moreira. Pictures were taken by Maria Virginia Urso. The first draft of the manuscript was written by Carolina de Almeida Garcia. All authors commented on previous versions of the manuscript. All authors read and approved of the final manuscript.

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Data availability The data supporting findings are available in the body of this article.

Declarations

Conflict of interest The authors declare that they have no conflicts of interest.

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