Zootaxa 5471 (3): 383–390
https://www.mapress.com/zt/

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

https://doi.org/10.11646/zootaxa.5471.3.8
http://zoobank.org/urn:lsid:zoobank.org:pub:0BE427F7-BC46-4BE4-A910-CDAFE76837E6

New World *Orphanostigma* Guenée, 1854, including a new species from Costa Rica (Lepidoptera: Crambidae: Spilomelinae)

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Abstract

Orphanostigma haemorrhoidalis Guenée, 1854, was described from Brazil and introduced worldwide for the biological control of *Lantana camara* L. (Verbenaceae). *Orphanostigma futilalis* (Barnes & McDunnough, 1914), **rev. stat.**, described from south Texas, United States, is removed from synonymy with *O. haemorrhoidalis.* We designate lectotypes for *O. futilalis*, **new lectotype**, and *O. haemorrhoidalis*, **new lectotype**, to stabilize the names of these species. We describe *Orphanostigma eugeniephillipsia* Solis, **sp. nov.**, from Costa Rica and provide adult and genitalia images for all three New World species.

Key words: lantana, biological control, noxious weed, *Orphanostigma abruptalis*, Sri Lanka

Introduction

Lantana camara L. (Verbenaceae), commonly known as lantana, among many other common names, is listed as one of the world's worst invasive alien species (Lowe *et al.* 2000). It is a noxious, allelopathic weed, displacing desirable and indigenous plants in forests, orchards, and pastures (Holm *et al.* 1977), for example, providing understory fuel during forest fires (Berry *et al.* 2011), and toxicity to animals upon ingestion (e.g., Swarbrick *et al.* 1998, Ntalo *et al.* 2022). Many natural enemies have been released for its biological control including *Orphanostigma haemorrhoidalis* Guenée, 1854 (Crambidae: Spilomelinae), but to date only partial success with this species has been achieved in some countries (Day & Zalucki 2009, Winston *et al.* 2024). Populations of *O. haemorrhoidalis* from Florida, Cuba, and Trinidad were released into 14 countries; it has been reported established in seven countries and has spread unassisted to at least six other countries (Winston *et al.* 2024).

Orphanostigma Warren, 1890, a genus in the tribe Spilomelini (Mally *et al.* 2019) with seven species primarily from the Old World (Nuss *et al.* 2003–2024), has never been revised. In a publication about the Crambidae of Aldabra, Shaffer & Munroe (2007) redescribed the genus and type species, *O. abruptalis* (Walker, 1859), from Sri Lanka; an adult, and male and female genitalia were figured. In the remarks about the genus and closely related genera, they transferred *O. haemorrhoidalis*, described from Brazil, from the genus *Salbia* Guenée, 1854, found in the New World pyraloid faunal lists (Munroe 1983, 1995) to *Orphanostigma*; this transfer was overlooked by Scholtens & Solis (2015) in a Nearctic checklist.

Orphanostigma haemorrhoidalis currently has two synonyms, *O. dircealis* (Walker, 1859) described from the Dominican Republic, and *O. futilalis* (Barnes & McDunnough, 1914) described from southern United States. The type of *O. dircealis,* located at the NHMUK, lacks an abdomen, and so it may be difficult to confirm its identity upon future scrutiny. Recently, we investigated the identity of *O. futilalis* that was synonymized over a hundred years

Accepted by B.-K. Byun: 21 May 2024; published: 19 Jun. 2024

ago with *O. haemorrhoidalis* by Dyar (1917). *Orphanostigma haemorrhoidalis* was originally described by Guenée (1854) from a male and a female collected in Brazil, but the location of the type specimens of *O. haemorrhoidalis* was previously unknown. We designate lectotypes for *O. futilalis*, **new lectotype**, and *O. haemorrhoidalis*, **new lectotype,** to stabilize the names of these species. Additionally, we describe a new species of *Orphanostigma* that was discovered initially with an analysis of CO1 barcoded adult moths from the Area de Conservación Guanacaste in Costa Rica. We provide images of the genitalia of the three New World species and the Old World type species, *O. abruptalis*, of the genus.

Abbreviations:

ACG	Area de Conservación Guanacaste, Costa Rica
MNCR-A	National Museum of Costa Rica, San Jose, Costa Rica
NMNH/USNM	National Museum of Natural History, Smithsonian Institution, Washington, D.C., U.S.A.
NHMUK	Natural History Museum, London, United Kingdom

Materials & Methods

Abdomens were soaked in 10% potassium hydroxide and washed in water, stained with Chlorazol black, and slide mounted in Euparal (Robinson 1976). Forewing length was measured from the center of the axillar area to the apex of the forewing. Wing length measurements are based on dry, spread wings. Morphological structures were photographed using a Canon EOS 5DS camera for adults and the Canon EOS 7D Mark II camera for slide mounted structures with the Visionary Digital® imaging system at the NMNH.

The *Orphanostigma* collections in the NHMUK and NMNH were searched for type specimens of *O. haemorrhoidalis* with Guenée labels. The NMNH was searched for the type series of *O. futilalis*; specimens were dissected and photographed. Adults and genitalia of *Orphanostigma,* including those of *O. abruptalis* in the NMNH that were studied and figured in Shaffer & Munroe (2007), were examined. Specimens of *O. haemorrhoidalis* from various Neotropical countries were dissected and examined.

The BOLD analysis for *Orphanostigma* from ACG in Costa Rica was examined (Janzen & Hallwachs 2009, Janzen *et al.* 2009, Ratnasingham & Herbert 2007).

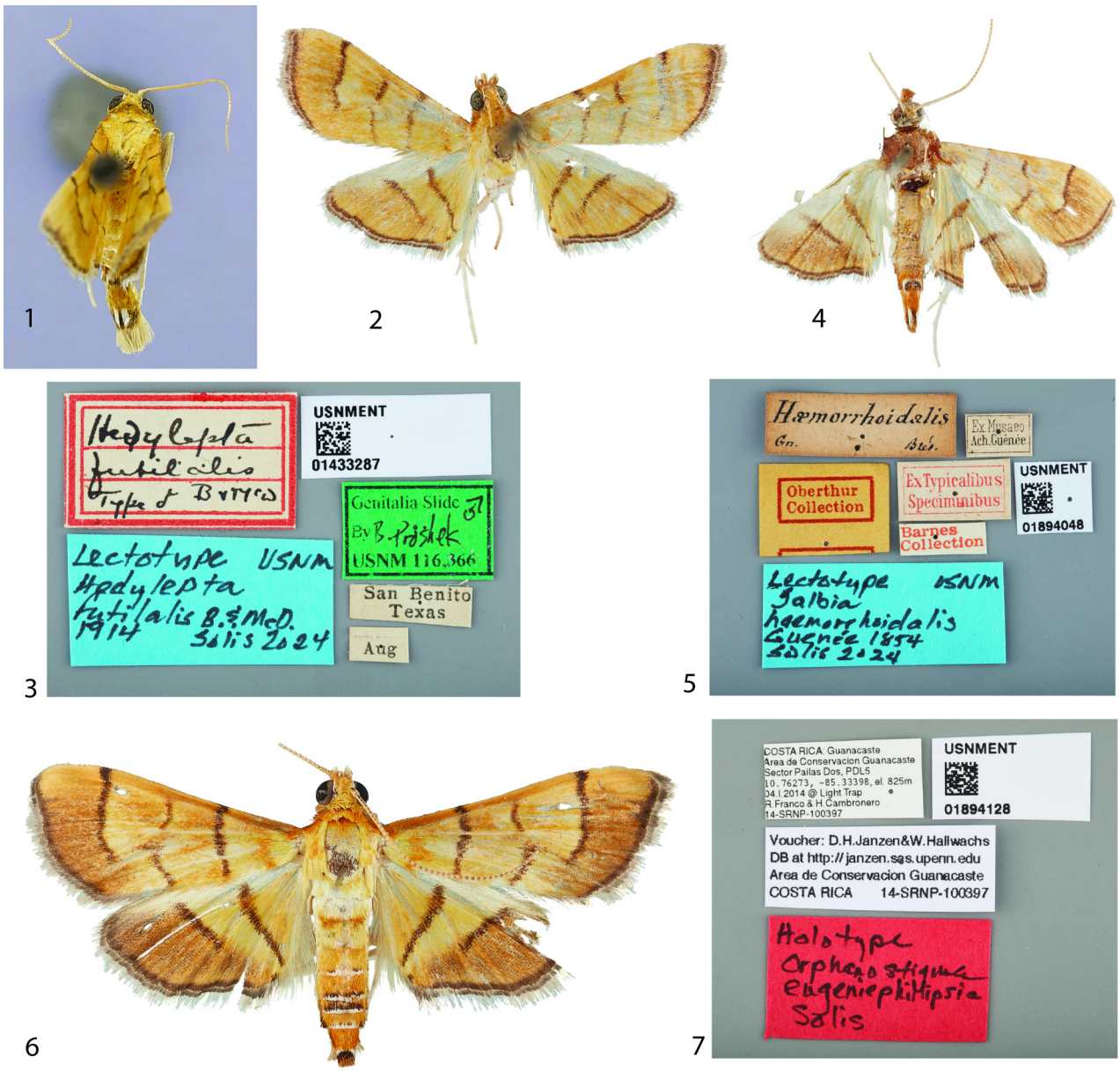
Results and Discussion

We found that *O. futilalis,* **revised status**, is not a synonym of *O. haemorrhoidalis* and we here elevate it to a valid species and discuss diagnostic features below. We located only 3 of the 5 specimens of the *O. futilalis* type series. We designate the specimen (Fig. 1 with abdomen before dissection) with the handwritten word "Type" on the label as the lectotype (Fig. 3), **lectotype designation** (Texas, San Benito, Aug., Hedylepta futilalis, Type, male, B. & McD., genitalia slide USNM #116366, USNMENT01433287), and the other two specimens (Fig. 2, female paralectotype [USNMENT0152197]) with the handwritten word "Cotype" as paralectotypes to stabilize the nomenclature of this species.

Landry (2016) and MJWC were unable to find a Guenée labeled specimen of *O. haemorrhoidalis* at NHMUK, but MAS discovered a specimen of *O. haemorrhoidalis* with a Guenée label at the NMNH and designates the specimen as the lectotype, **lectotype designation,** to stabilize the nomenclature of this species (Label data: Ex Musaeo Ach Guenée, Ex Typicalibus Specimenibus, Haemorrhoidalis, Gn., Brés., Oberthur Collection, Barnes Collection, [USNMENT01894048]) (Figs. 4, 5).

The BOLD analysis for *Orphanostigma* at the ACG included 140 specimens of *O. haemorrhoidalis* with the Barcode Identification Number (BIN) BOLD:AAD3428. At the NMNH 48 males and 52 females (plus 25 unsexed adults in glycerin capsules) were located and examined. Additional specimens of *O. haemorrhoidalis* were present in BOLD: ACE4975 from USA (Georgia and Florida) and Australia (introduced), but this will be discussed in a subsequent paper on the use of *O. haemorrhoidalis* as a biological control agent for lantana. The CO1 barcode

analysis revealed another potential species of *Orphanostigma* from Costa Rica. Five light-caught specimens cluster together in the NJ tree in this BIN apart from the *O. haemorrhoidalis*, but only 4 specimens were located at the NMNH, which now compose the type series. Upon dissection it was found to be morphologically distinct and is described below.



FIGURES 1–7. 1, *Orphanostigma futilalis,* male lectotype, with abdomen before dissection and anal segments pattern visible, San Benito, Texas [USNMENT01433287]. 2, *O. futilalis,* female paralectotype, with wings spread, Brownsville, Texas [USNMENT01521297]. 3, *O. futilalis* lectotype labels. 4, *O. haemorrhoidalis*, male lectotype, Brazil [USNMENT01894048]. 5, *O. haemorrhoidalis* lectotype labels. 6, *Orphanostigma eugeniephillipsia,* **sp. nov.**, female holotype, ACG, Costa Rica [USNMENT01894128], forewing length = 5 mm. 7, *O. eugeniephillipsia,* **sp. nov.**, adult holotype labels.

Orphanostigma eugeniephillipsia **Solis, sp. nov.**
http://zoobank.org/urn:lsid:zoobank.org:act:CC7E0169-0AB4-41BF-8417-6FAA5F4CECDA
(Figs. 6–7, 14, 15, 17)

Type material. **Holotype**: ♀, COSTA RICA, Area de Conservación Guanacaste, Sector Pallas Dos, 10.76273, -85.33398, el. 825 m, 04.I.2014, @ light trap, R. Franco & H. Cambronero, 14-SRNP-100397, [USNMENT01894128],

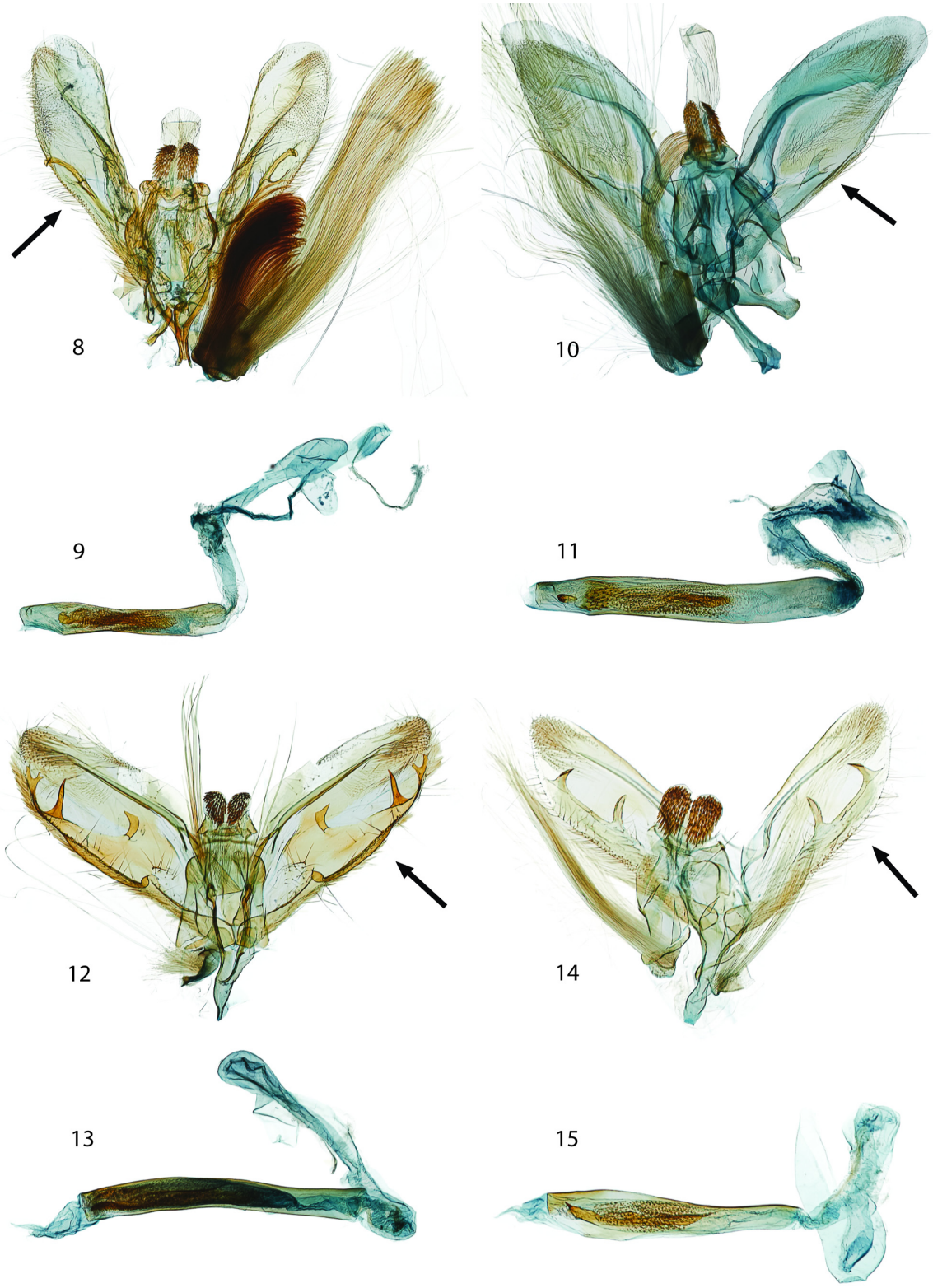
deposited at MNCR-A. **Paratypes**: deposited at NMNH, 1 ♀, COSTA RICA, Area de Conservación Guanacaste, Sector Orosi, Manta Mecate, 10.95415, -85.49155, el. 587 m, 30.II.2011, @ light trap, H. Cambronero & S. Rios, 11-SRNP-104819, USNM slide #116383 [USNMENT01894118]; 1 ♂, COSTA RICA, Area de Conservación Guanacaste, Sector Pailas, Catarata Borinquen, 10.817721, -85.390465, el. 945 m, 01/29/2017, light trap, A. Guadamuz & G. Pereira, 17-SRNP-100299, USNM slide #116382 [USNMENT01894117]; 1 ♀, COSTA RICA, Area de Conservación Guanacaste, Sector Pailas, Catarata Borinquen, 10.817721, -85.390465, el. 945 m, 01/29/2017, light trap, A. Guadamuz & G. Pereira, 17-SRNP-100298, [USNMENT01894091]. The Barcode Identification Number (BIN) for the holotype and paratypes is BOLD:AAA0296.

Diagnosis. Forewing length: 5–6 mm (n=4). Thick band of black and white scales distally on abdominal segments 5-6 and 8th segment with lateral dots of black scales (Fig. 6). Male genitalia valva saccular margin with a medially, dorsally directed thumb-like protrusion, and another more distal dorsally directed protrusion that is broadly curved and distally toothed and sclerotized, both as ½ as long as valva width (Fig. 14); phallus with two flat, sclerotized plates, posterior plate with a sclerotized spine (Fig. 15). Female genitalia with antrum sclerotized with two distal arm-like, lateral projections, bending posteriorly (Fig. 17).

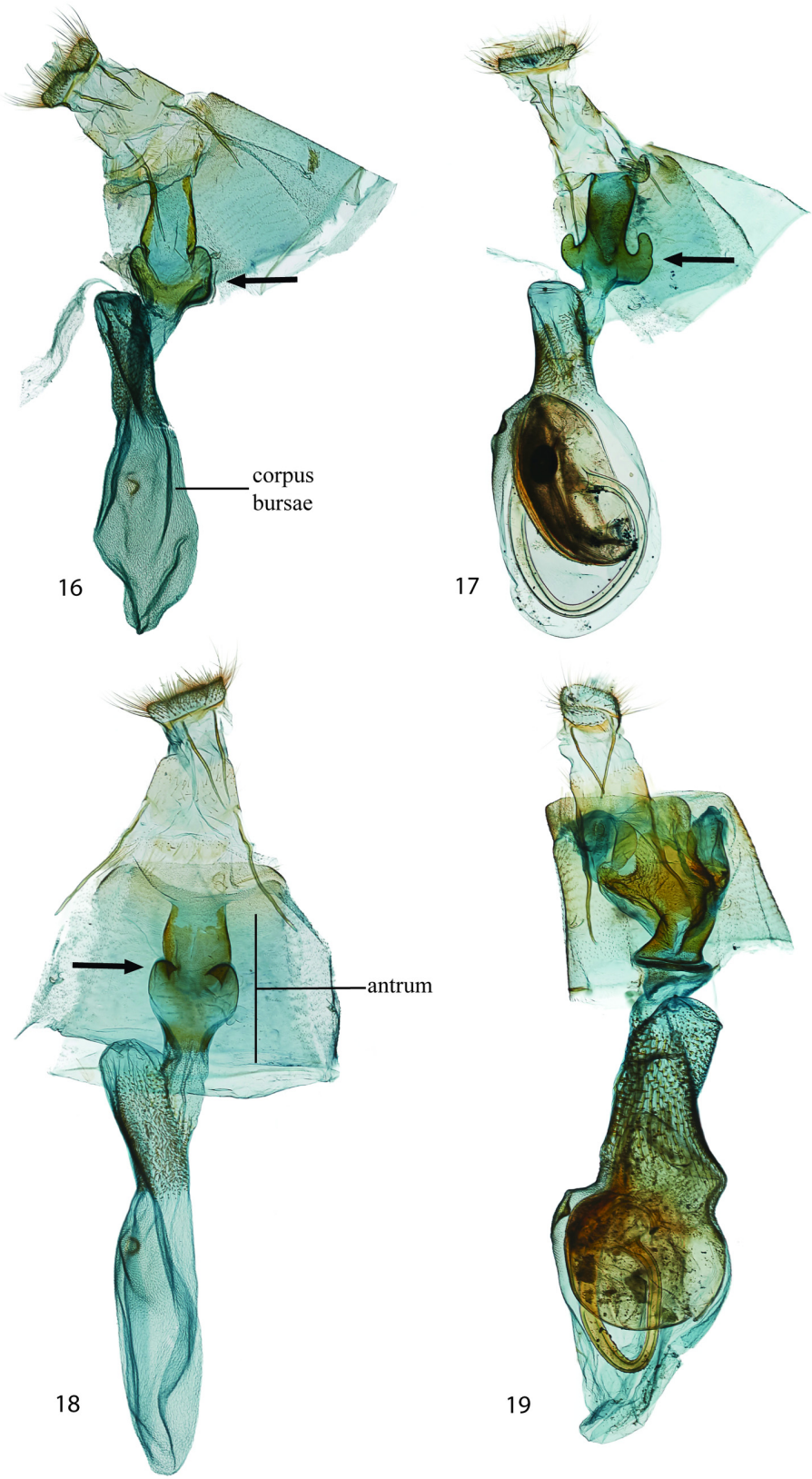
Morphological comparison. Although the best way to confirm identification of these species is with internal genitalia characters, we provide a few external characters of the head and abdomen. The antennae of *O. haemorrhoidalis* and *O. eugeniephillipsia* have an anterior brown line extending onto the shaft, and *O. futilalis* lacks these lines. *Orphanostigma eugeniephillipsia* has a thick band of black and white scales distally on abdominal segments 5–6 and lateral dots with black scales, *O. haemorrhoidalis* has a few black scales on abdominal segments 5–6 and sometimes with a few black scales laterally, and *O. futilalis* has no black scales on these segments. On the dorsum of the 8th abdominal segment of *O. haemorrhoidalis, O. futilalis*, and *O. eugeniephillipsia* the segment is mainly orange yellow in color, but distally it has a white u-shaped line and within it are dark brown scales that can be seen prominently in the lectotype (Fig. 4), but this brown may appear very dark or just as a smudge depending on the condition of the specimen. Wing coloration is not included in the diagnostic characters because, although the specimens of *O. eugeniephillipsia* are dark yellow orange beyond the postmedial line in both wings and only yellow in *O. futilalis*, there is wide variation in *O. haemorrhoidalis* (that *O. eugeniephillipsia* most closely resembles externally) from plain yellow to dark or "deep orange yellow" in this area of the forewing (as in *O. abruptalis*, and as described in Shaffer & Munroe 2007). There are only 4 specimens in the type series of *O. eugeniephillipsia* and only three specimens were found of the type series of *O. futilalis* (2 specimens were not found), so we recommend caution on identifications based only on wing coloration and recommend dissections of the genitalia.

Although the male genitalia of all three New World species have an elongated, sclerotized line from a broad transtilla just below the length of the costal or dorsal margin of the valvae, the armature of the saccular margin of the valva is distinctive in each of the three species (Figs. 8, 10, 14). In *O. eugeniephillipsia* the saccular margin has two dorsally directed protrusions, medially a thumb-like protrusion and distally a broadly curved, distally toothed and sclerotized protrusion (Fig. 14), in *O. haemorrhoidalis* the saccular margin medially has a knife-like elongated ridge, basally with a variously-shaped dorsally directed triangle, i.e., pointed, 1/3 the width of the valva (the shape of the triangle sides can vary and can be difficult to see with some slide preparations) (Fig. 10), and in *O. futilalis* there is a basal, sclerotized ridge near the saccular margin with a ventrally directed, elongate protrusion (almost as long as the dorsal sclerotized ridge), with a square-shaped apex (Fig. 8). The saccular margin of all three New World species varies from that of *O. abruptalis* as shown in Fig. 12. The cornutus of the phallus is also distinctive between the three species: *O. eugeniephillipsia* has a posterior sclerotized spine on a flat plate (Fig. 15), *O. futilalis* has a posterior broad, toothed, and spoon-like shaped sclerotization (Fig. 9), and *O. haemorrhoidalis* has a posterior, sclerotized broad, curved, toothed band (Fig. 11). The phallus of New World species differs from that of *O. abruptalis* that has "numerous minute denticles" (Fig. 13) (Shaffer & Munroe 2007).

In the female genitalia, all three species have a broad ostium bursae, almost the width of the segment, the antrum is sclerotized and variously shaped, half as long as the corpus bursae, corpus bursae with very short spines, the corpus bursae posterior is 1/3 less broad than the anterior 2/3rd that is broadly rounded, with a small round indentation from the corpus bursae wall or signum, and a ductus seminalis from the flat, square-like posterior edge of corpus bursae. The antrum consists of anterior and posterior sections, the shape is distinctive in the three species: *O. eugeniephillipsia* has two arm-like, lateral projections bending posteriorly originating from the anterior section (Fig. 17), but in *O. haemorrhoidalis* and *O. futilalis* the lateral projections from the anterior section are short and stubby (Figs 16, 18). The lateral projections originate dorsolaterally in *O. futilalis* (Fig. 16, black arrow),



FIGURES 8–15. 8, *Orphanostigma futilalis* lectotype male genitalia, San Benito, Texas, USNM slide #116366. 9, *O. futilalis* phallus, USNM slide #116366. 10, *O. haemorrhoidalis* male genitalia**,** ACG, Costa Rica, USNM slide #116402 [USNMENT01894170]. 11, *O. haemorrhoidalis* phallus, USNM slide #116363. 12, *O. abruptalis* male genitalia, Sri Lanka, USNM slide #116379 [USNMENT01894037]. 13, *O. abruptalis* phallus, USNM slide #116379. 14, *O. eugeniephillipsia,* **sp. nov.**, paratype male genitalia, ACG, Costa Rica, USNM slide #116382 [USNMENT01894117]. 15, *O. eugeniephillipsia,* **sp. nov.**, paratype phallus, USNM slide #116382. [black arrows indicate the saccular margin and species-specific ornamentation on the valva]



FIGURES 16–19. 16, *Orphanostigma futilalis* paralectotype female genitalia, Brownsville, Texas, USNM slide #116,365 [USNMENT01521289]. 17, *O. eugeniephillipsia,* **sp. nov.**, paratype, ACG, Costa Rica, USNM slide #116383 [USNMENT01894118]. 18, *O. haemorrhoidalis*, ACG, Costa Rica, USNM slide #116403 [USNMENT01894170]. 19, *O. abruptalis,* Sri Lanka, USNM slide #116380 [USNMENT01894185]. [black arrows indicate projections from anterior section of antrum]

and ventrally in *O. haemorrhoidalis* (Fig. 18, black arrow). The antrum of *O. abruptalis* lacks distinctive lateral projections, and the antrum is broader than New World species with a strap-like sclerotization anteriorly that is lacking in New World species (Fig. 19).

Distribution. Known only from the Area de Conservación Guanacaste, Costa Rica.

Remarks. The four light-caught specimens of the type series were not reared, although its host plant is predicted to be in the Verbenaceae because most of the *O. haemorrhoidalis* specimens from the ACG, Costa Rica were found feeding on species in this plant family (Janzen & Hallwachs 2009). Most were reared on *Lantana camara*, and a much fewer number were found feeding on *Lantana trifolia* L., and additionally on Verbenaceae, one specimen each was reared on *Lippia berlandieri* Schauer and *L. oxyphyllaria* (Donn. Sm.) Standl.

Etymology. This species is named in honor of Dr. Eugenie Phillips of San Jose, Costa Rica in recognition of her decades of dedicated attention to the taxonomy of Costa Rican microlepidoptera, and especially her efforts to the integration of Costa Rican biodiversity with social processes for widespread public understanding of the importance of the survival of Costa Rica's wildland and its biodiversity.

Acknowledgements

We thank Ben Proshek, Systematic Entomology Laboratory (SEL, USDA), for dissection and photography of specimens. We especially thank the ACG/GDFCF parataxonomist team that reared all of the ACG specimens and collected them from the light traps. We also thank reviewers who provided insightful comments and suggestions. Matthew J. W. Cock receives technical and logistic support from CABI, an international intergovernmental organization, and gratefully acknowledges the core financial support from the member countries (See https://www.cabi.org/about-cabi/who-we-work-with/key-donors/ for full details). Mention of trade names or commercial products in this publication is solely for the purpose of providing specific information and does not imply recommendation or endorsement by USDA. USDA is an equal opportunity provider and employer.

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