

University of Nebraska - Lincoln

DigitalCommons@University of Nebraska - Lincoln

Insecta Mundi

Center for Systematic Entomology, Gainesville,
Florida

5-10-2013

***Sufetula* Walker in Florida (Lepidoptera: Crambidae)**

James E. Hayden

Florida State Collection of Arthropods, James.Hayden@FreshFromFlorida.com

Follow this and additional works at: <https://digitalcommons.unl.edu/insectamundi>

Hayden, James E., "*Sufetula* Walker in Florida (Lepidoptera: Crambidae)" (2013). *Insecta Mundi*. 801.
<https://digitalcommons.unl.edu/insectamundi/801>

This Article is brought to you for free and open access by the Center for Systematic Entomology, Gainesville, Florida at DigitalCommons@University of Nebraska - Lincoln. It has been accepted for inclusion in Insecta Mundi by an authorized administrator of DigitalCommons@University of Nebraska - Lincoln.

INSECTA MUNDI

A Journal of World Insect Systematics

0296

Sufetula Walker in Florida (Lepidoptera: Crambidae)

J.E. Hayden
FDACS, Division of Plant Industry
P.O. Box 147100
Gainesville, FL 32614-7100

Date of Issue: May 10, 2013

J.E. Hayden
Sufetula Walker in Florida (Lepidoptera: Crambidae)
Insecta Mundi 0296: 1-15

ZooBank Registered: urn:lsid:zoobank.org:pub:0986651C-DD2A-41B4-A937-563B5E366536

Published in 2013 by

Center for Systematic Entomology, Inc.
P. O. Box 141874
Gainesville, FL 32614-1874 USA
<http://www.centerforsystematicentomology.org/>

Insecta Mundi is a journal primarily devoted to insect systematics, but articles can be published on any non-marine arthropod. Topics considered for publication include systematics, taxonomy, nomenclature, checklists, faunal works, and natural history. **Insecta Mundi** will not consider works in the applied sciences (i.e. medical entomology, pest control research, etc.), and no longer publishes book reviews or editorials. **Insecta Mundi** publishes original research or discoveries in an inexpensive and timely manner, distributing them free via open access on the internet on the date of publication.

Insecta Mundi is referenced or abstracted by several sources including the Zoological Record, CAB Abstracts, etc. **Insecta Mundi** is published irregularly throughout the year, with completed manuscripts assigned an individual number. Manuscripts must be peer reviewed prior to submission, after which they are reviewed by the editorial board to ensure quality. One author of each submitted manuscript must be a current member of the Center for Systematic Entomology. Manuscript preparation guidelines are available at the CSE website.

Managing editor: Paul E. Skelley, e-mail: insectamundi@gmail.com

Production editor: Michael C. Thomas, Brian Armitage, Ian Stocks

Editorial board: J. H. Frank, M. J. Paulsen

Subject editors: G.B. Edwards, J. Eger, A. Rasmussen, F. Shockley, G. Steck, Ian Stocks, A. Van Pelt, J. Zaspel

Spanish editors: Julieta Brambila, Angélico Asenjo

Printed copies (ISSN 0749-6737) annually deposited in libraries:

CSIRO, Canberra, ACT, Australia
Museu de Zoologia, São Paulo, Brazil
Agriculture and Agrifood Canada, Ottawa, ON, Canada
The Natural History Museum, London, Great Britain
Muzeum i Instytut Zoologiczny PAN, Warsaw, Poland
National Taiwan University, Taipei, Taiwan
California Academy of Sciences, San Francisco, CA, USA
Florida Department of Agriculture and Consumer Services, Gainesville, FL, USA
Field Museum of Natural History, Chicago, IL, USA
National Museum of Natural History, Smithsonian Institution, Washington, DC, USA
Zoological Institute of Russian Academy of Sciences, Saint-Petersburg, Russia

Electronic copies (On-Line ISSN 1942-1354, CDROM ISSN 1942-1362) in PDF format:

Printed CD or DVD mailed to all members at end of year. Archived digitally by Portico.
Florida Virtual Campus: <http://purl.fcla.edu/fcla/insectamundi>
University of Nebraska-Lincoln, Digital Commons: <http://digitalcommons.unl.edu/insectamundi/>
Goethe-Universität, Frankfurt am Main: <http://edocs.ub.uni-frankfurt.de/volltexte/2010/14363/>

Author instructions available on the *Insecta Mundi* page at:

<http://www.centerforsystematicentomology.org/insectamundi/>

Copyright held by the author(s). This is an open access article distributed under the terms of the Creative Commons, Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original author(s) and source are credited. <http://creativecommons.org/licenses/by-nc/3.0/>

Sufetula Walker in Florida (Lepidoptera: Crambidae)

J.E. Hayden

FDACS, Division of Plant Industry

P.O. Box 147100

Gainesville, FL 32614-7100

James.Hayden@FreshFromFlorida.com

Abstract. The two species of *Sufetula* Walker (Lepidoptera: Crambidae) occurring in Florida are reviewed based on adult specimens. *Sufetula carbonalis* n. sp. is described, *Sufetula diminutalis* (Walker) is diagnosed, and they are differentiated from related Caribbean species and similar sympatric Crambidae. Both are occasional root pests of ornamental palms. Unusual structural characters suggest that *Sufetula* is misclassified in Spilomelinae.

Introduction

Sufetula Walker (Lepidoptera: Crambidae) includes 27 previously described species that are distributed globally in tropical and subtropical forests (Nuss et al. 2013). The adults are small, grayish crambids with cryptic habits (Fig. 1–12). The larvae, which have zero or one pair of stemmata and extra non-setigerous pinacula, tunnel in the roots of palms (Genty and Mariau 1975; de Chenon 1975; Mariau et al. 1981; Bonneau et al. 2004) and, less often, other monocots (Sein 1930; Patrick 1994). Of these, *Sufetula diminutalis* (Walker) occurs in Florida, USA and elsewhere in the Caribbean Region, Central America and northern South America.

The presence of a second species in Florida has been known since at least the 1960s, as it was discovered in material sent by C. P. Kimball to E. G. Munroe for identification. Indeed, Kimball (1965:200) lists four species of *Sufetula* in Florida: *S. diminutalis* (Walker), *S. philogelos* Dyar, and two unnamed species, on which he comments as follows:

“5352,1 [S.] SP. This and the next species were erroneously believed to be the two named *Sufetula*, but Munroe has found that they are probably undescribed, and possibly not *Sufetula*.”

“5352,2 [S.] SP. To the unaided eye this bears a strong resemblance to small males of *Synclita oblitalis* (Walker), a resemblance that is immediately dispelled [sic] under magnification.”

Sufetula philogelos is a junior synonym of *Microphyesetica hermeasalis* (Walker) (Fig. 13), a spilomeline of similar size and maculation that has long been confused with *Sufetula* (Dyar 1922). As for *S. diminutalis* and the unnamed species, specimens in the Florida State Collection of Arthropods bearing the first intercalary number (5352,1) cannot be distinguished from the type specimen of *S. diminutalis*, so they are hereby equated. Munroe may have split them from *S. diminutalis* in Kimball’s list because that species was described from Honduras, which calls into question the conspecificity of the Florida population. The 150-year-old lectotype of *S. diminutalis* has no abdomen, so further genitalic or molecular evidence is unlikely to become available. The type’s maculation is identical to Florida specimens, and more recent Central American specimens have the same maculation and genitalia as specimens from Florida. Kimball presumably retained *S. diminutalis per se* in the checklist as a place holder for specimens in other collections that he could not verify. Munroe’s reason for considering a different generic assignment is unknown. In any case, specimens with Kimball’s second intercalary number are certainly a distinct species, described below.

Materials and Methods

Specimens were examined from the following institutions: Canadian National Collection (CNC: Ottawa, ON, Canada); Florida State Collection of Arthropods (FSCA: Gainesville, FL, USA); McGuire Center for Lepidoptera and Biodiversity, Florida Museum of Natural History (MGCL: Gainesville, FL, USA); National Museum of Natural History (NMNH: Washington, D.C.), Terhune S. Dickel Collection

(TSD: Anthony, FL, USA). Additional specimens collected at light or with sugar bait of molasses, beer, yeast and ripe bananas are in my collection (JEH).

Specimens were dissected with standard methods (Winter 2000), stained with Chlorazol Black E and slide-mounted in Euparal. Images were taken with 1) a Microoptics system (Visionary Digital, www.visionarydigital.com) incorporating a Canon EOS 50D camera, Infinity CF4 and Achrovid 10x lenses (www.infinity-usa.com), and Helicon Focus 5.3.7 image stacking software (Helicon Soft Ltd. 2012) (MGCL); 2) an Auto-montage Pro 5.01 system (Synoptics Ltd.) using a JVC digital camera and Leica Z16APO lens (FSCA).

Morphological terms follow Klots (1970), Maes (1985) and Wootton (1979), with forewing $Rs_1...Rs_4$ replacing $R_3...R_5$. Abbreviations: A8 = eighth abdominal segment; AM = antemedial; PM = postmedial; S8 = eighth sternite; T8 = eighth tergite.

Systematics

Sufetula Walker, 1859: 946.

Loetrina Walker, 1863: 132.

Mirobriga Walker, 1863: 131–132.

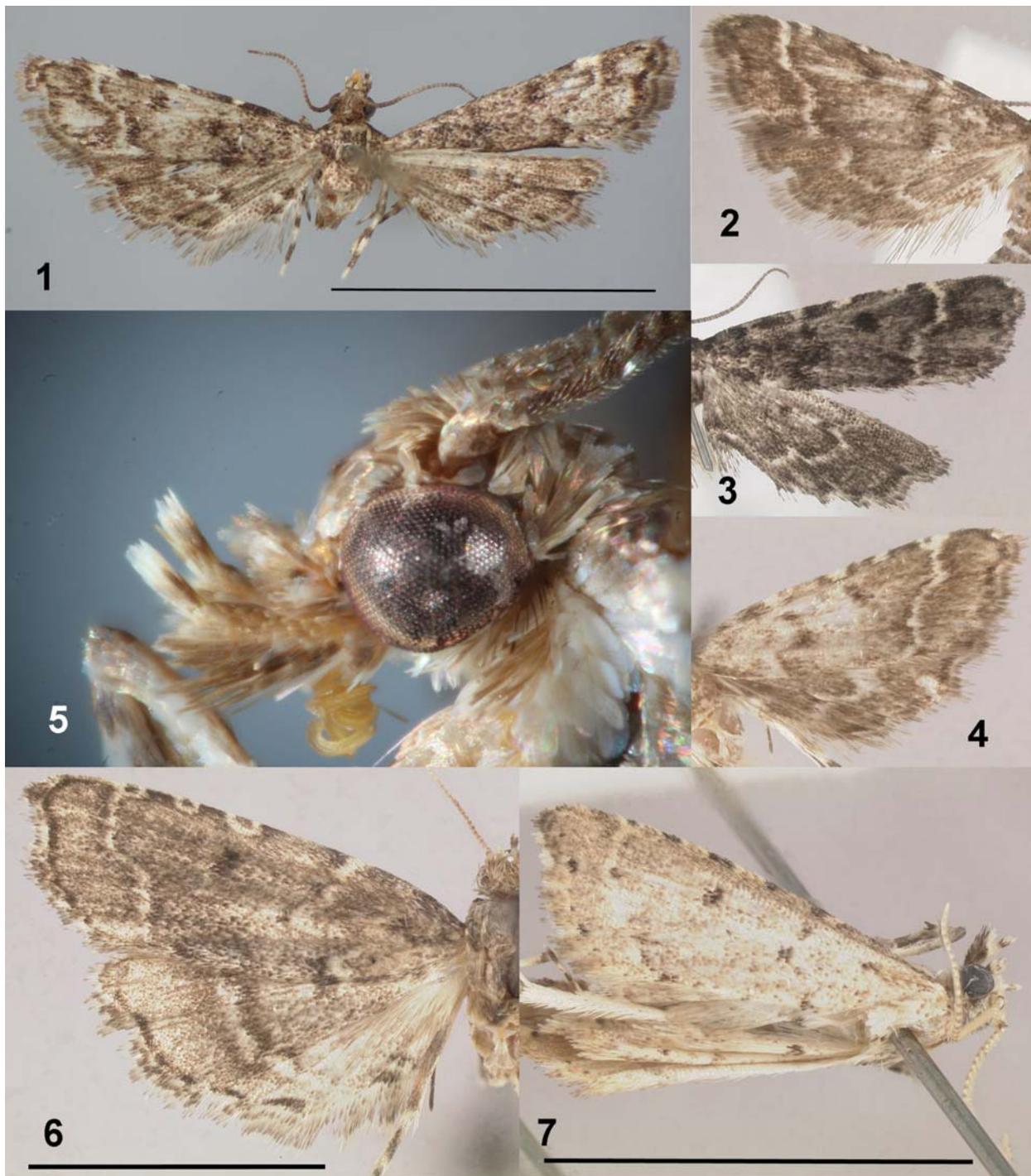
Nannomorpha Turner, 1908: 80.

Perforadix Seín, 1930: 168.

Pseudochoreutes Snellen, 1880: 202.

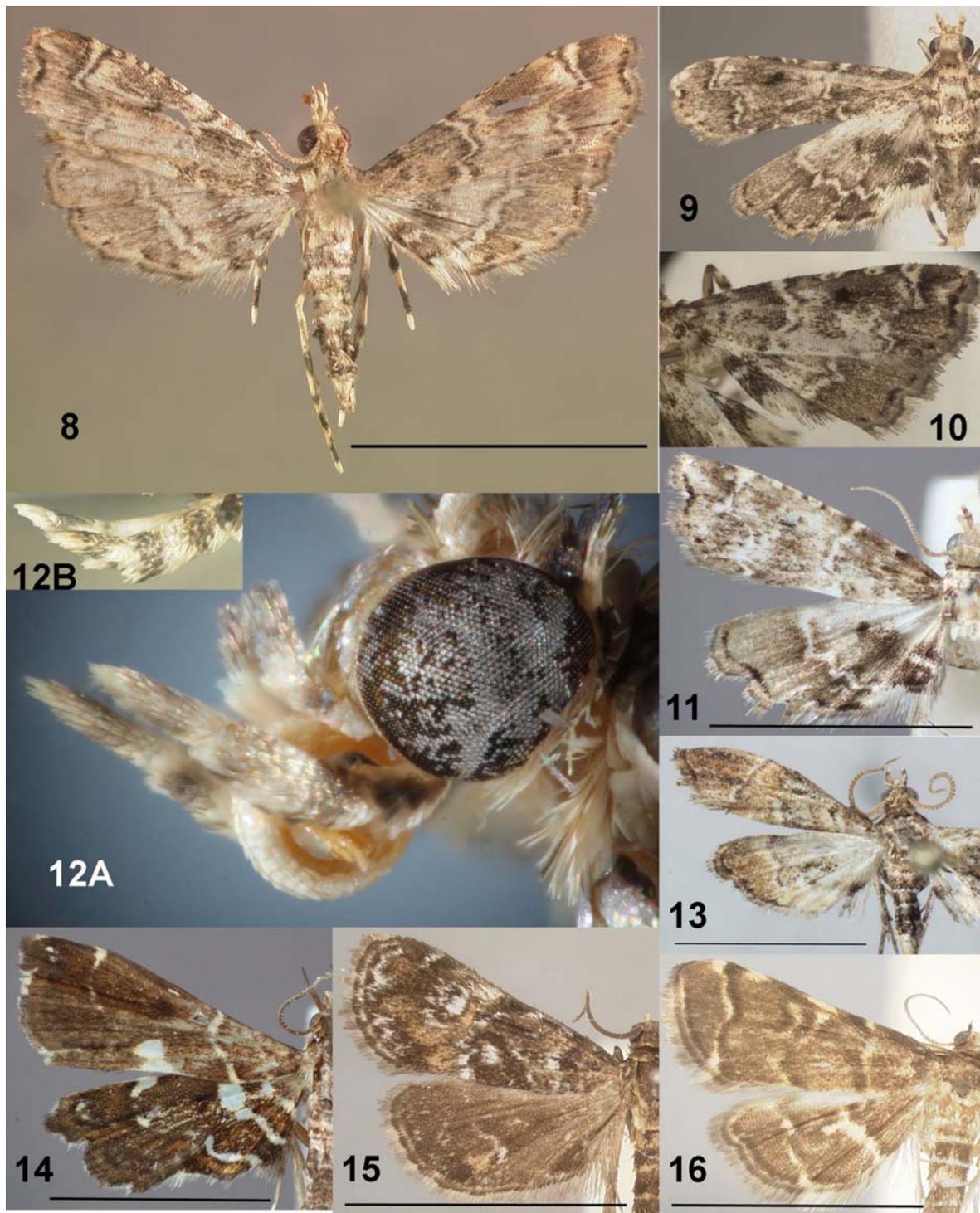
Diagnosis and descriptive notes. All examined specimens of *Sufetula* share similar maculation. The wings are gray or grayish brown with white AM and PM lines. Two or three white spots or lunules are present on the forewing costa between the lines, and there is a dark gray discal spot. The maxillary palpi have four mera and are bushy with scales, and the labial palpi have three mera and are slightly upcurved. The antennae are half the length of the forewings and lack significant modifications. Chaetosemata are absent, and ocelli are present or absent. The male forewing retinacular hook is absent, the male hind wing has one frenular bristle, and the female hind wing has one or two frenular bristles. In the forewing, Rs_4 is connected to the discal cell directly or short-stalked with Rs_{2+3} (sometimes varying intraspecifically: Seín 1930). CuP is present as a tubular vein on the forewing margin, rather than a fold, and it is complete in the hind wing. The tympanal organs are crambiform, and the praecinctorium is a small, unilobate flap. The fornix tympani extends slightly over the venula prima. The bullae tympani are moderately recessed into the body cavity. The depressions posterior of the fornix tympani (hereby homologized with the sacci tympani) are small, narrower than the tympani, opened ventrad and sexually dimorphic (Fig. 18, 19: *pd*). Venulae secundae are present. The male genitalia have a simple, small, membranous uncus without bristles. The gnathos and transtilla are absent without rudiments. The saccus is absent. The valvae are simple, ovate, without projections or processes, except that the ventrodistal margin is membranous and demarcated from the rest of the valva. The valvae extend roughly perpendicularly to the axis of the genitalia or are angled somewhat ventrad, rather than angled dorsad as in most crambids. The valva usually has a demarcated, membranous, labriform margin like a lip or bumper extended along the distal margin and distal half of the ventral margin (Fig. 26: *lb*). The juxta is U- or V-shaped (Fig. 23, 26: *jx*), and the manica (Fig. 26: *ma*) is densely lined with microspinules or less often with larger sclerites. The female genitalia are simple. The papillae anales are fused in a narrow isosceles triangle. The colliculum is present, but it is fused with sclerotization of the antrum in some specimens. The ductus seminalis attaches on the ductus bursae just anterior of the colliculum. Signa are absent or, less often, present as one or two granular areas.

Similar taxa. *Sufetula* shares with other Nearctic Crambidae, but not with Pyralidae (*sensu* Minet [1982]), the crambiform tympanal organs, presence of a praecinctorium and presence of a complete scale ring between the antenna and eye (paralleled in Phycitinae). North American Crambidae that resemble *Sufetula* do not have the combination of undulating terminal wing margins and a CuP vein on the forewing margin. Musotiminae do share an undulating wing outline (Fig. 14), but the forewing CuP vein is absent. In the few musotimine species in Florida, the ocelli and chaetosemata are reduced or absent as



Figures 1–7. *Sufetula* spp. 1–5) *Sufetula carbonalis*, habitus and head. 1) Holotype, abdomen removed. 2) Highlands Co., Archbold Research Station, 2 May 1975 (FSCA). 3) Levy Co., Goethe State Forest, 30 July 2011 (FSCA). 4) Sarasota Co., Siesta Key, 8 April 1953 (FSCA). 5) Lateral aspect of head with large ventral scale tuft (same data as Fig. 2). 6) *Sufetula grumalis*, left wings, Cuba: Santiago, 1925 (NMNH). 7) *Sufetula sacchari*, left wings, Puerto Rico: Rincon, 22 Feb. 1971 (NMNH). Scales = 5 mm.

in *Sufetula*, but the males have a genitalic gnathos and secondary sexual characters: a forewing costal swelling (*Undulambia* Lange) or androconia on the foreleg tibia (*Neomusotima* Yoshiyasu, *Austromusotima* Yen and Solis). The labial palpi of *Undulambia* have an elongate apical meron. Acentropinae such as *Elophila* Hübner (Fig. 15) have ocelli and chaetosemata; where a forewing CuP vein is present, Rs_1 is



Figures 8–16. Florida crambids. **8–11** *Sufetula diminutalis* from Florida. **8**) Male, Levy Co.: Goethe State Forest, 30 Nov. 2009 (TSD). **9**) Same site, 30 July 2011 (FSCA). **10**) Miami-Dade Co.: Homestead, 20 Aug. 2007 (FSCA). **11**) Female, Putnam Co.: Palatka, 10 July 1992 (FSCA). **12**) Females, lateral aspect of head: **A**, with normal labial palpi (Levy Co. Goethe State Forest, 12 Oct. 2012, FSCA); **B**, variation of labial palpi with a few ventrally projected scales (Goethe SF, 9 Dec. 2012, TSD). **13–16**) Similar Floridian crambids. **13**) *Microphysetica hermeasalis*, Picayune State Forest, 2007, J. Vargo (FSCA). **14**) *Undulambia polystichalis*, female, Pinellas Co.: Dunedin, 19 March 1987 (FSCA). **15**) *Elophila obliteralis*, male, Alachua Co.: Gainesville, 1975 (FSCA). **16**) *Anageshna primordialis*, Manatee Co. (FSCA). Scales = 5 mm.

stalked with Rs_{2+3} (which may be fused). Schoenobiinae also usually have a forewing CuP, but the wing margins are straight, chaetosemata and gnathos are present, and the haustellum is reduced. Many small Spilomelinae, such as *Apogeshna* Munroe and *Anageshna* Munroe (Fig. 16), have similar maculation and also lack a well-developed gnathos, but in these, ocelli are present, forewing CuP is absent, and Rs_4 is free. Scopariinae do not have undulating wing margins or forewing CuP, and the ocelli, chaetosemata and gnathos are well-developed. Additional differences are discussed under the species treatments.

In Munroe's key to North American Pyraloidea (Munroe 1972: 12–14), *Sufetula* runs to couplet 11 (Glaphyriinae and Pyraustinae *sensu lato*), requiring a third choice: "hindwing without areas of spatulate setae; praecinctorium simple." In Forbes's key to genera of Pyraustinae, including Spilomelinae (Forbes 1923), *Sufetula* runs to *Blepharomastix stenialis* (Guenée) (p. 542, couplet 1:2), and in the key to Nymphulinae (Acentropinae), it runs to *Geshna* Dyar (p. 574, couplet 1':2'). The species referred to (*Apogeshna stenialis* and *Anageshna primordialis* [Dyar] in current combinations) are remarkably similar to *Sufetula* in size, maculation and conformation of the palpi, but they differ as described above.

Sufetula does not fit easily in Forbes's key to Nearctic subfamilies (Forbes 1923: 524). The intercalation proposed by Seín (1930) for *Perforadix sacchari* Seín is still generally valid: "[insert] another 1 between the first and second to read as follows: '1. Vein 1st A preserved in fore wing; R_5 [Rs_4] stalked with R_3 and R_4 [Rs_2 and Rs_3]; tongue well developed.'" Solis and Shaffer (1999) removed *Perforadix* Seín from Endotrichinae, where Seín had doubtfully placed it, and synonymized it with *Sufetula* in Pyraustinae *sensu lato*.

Sufetula carbonalis Hayden, new species

(Fig. 1–5, 17–19, 23–25)

S. [*Sufetula*] sp. Kimball, 1965: 200 (McDunnough No. 5352,2).

Diagnosis. *Sufetula carbonalis* is both smaller and darker in color than known congeners. Adults of species that are similarly small in size are paler in color. The second meron of the labial palpi is ventrally tufted (Fig. 5). The anterior half of the forewing PM line runs nearly perpendicularly from the costa before turning at a 45° angle (Fig. 1–4). Rs_2 and Rs_3 in the forewing are entirely fused (Fig. 17). The manica of the male genitalia has two pairs of lamellae that are flat, elongate and distally recurved and bifid, like crowbars (Fig. 23: *lm*). The phallus has two small distal cornuti (Fig. 23). In other species of *Sufetula*, the manica is densely spiculose (Fig. 26: *ma*) but without flat plates (although the dense granules may resemble plates when the manica remains with the annellus, e.g. Fig. 32), and the other species lack cornuti or have more than two. The female genitalia of *S. carbonalis* have no sclerotizations of the ductus bursae or corpus bursae; the ostium bursae is wide (Fig. 24: *ob*), the membrane at the junction of the ostium and ductus bursae is thickened, and a rudimentary colliculum is visible as two transverse sclerotizations (Fig. 24: *co*).

Similar species. The sympatric *S. diminutalis* is larger in size and lighter in color. The labial palpi do not have a ventral tuft. The PM line slants slightly distad from the costa to the medial fold, where it sharply turns basad at an angle more nearly parallel to the wing's long axis. Females of *S. diminutalis* have two frenular bristles, a well-developed colliculum and an elongate ductus bursae that is completely and evenly sclerotized along its entire length.

Sufetula carbonalis is closely related to *S. grumalis* Schaus and possibly *S. sacchari* (Seín). *Sufetula grumalis*, described from Cuba, is larger in size, but it has very similar dark gray maculation and a PM line of identical curvature (Fig. 6). The AM line differs in that it extends distad from the costa to the Cu vein, then jaggedly basad on the anal fold, then distad on the anal area. Like *S. carbonalis*, *S. grumalis* has labial palpi with a ventral tuft, the ocelli are absent, and the female has one frenular bristle. The manica has one pair of curved, tridentate sclerites and eight small cornuti (Fig. 30). The colliculum in *S. grumalis* (Fig. 31) is better defined than in *S. carbonalis*, and the ductus bursae is shorter. *Sufetula sacchari*, described from Puerto Rico, is similarly small in size (Fig. 7). The labial palpi are ventrally tufted, and the forewing PM line has similar curvature. It differs from *S. carbonalis* in its pale gray color, conspicuous ocelli, elongate costal lunules that equal the gray interstices in length, manica without

large, discrete, elongate lamellae (Fig. 32), and membranous ductus bursae without sclerotization (Fig. 33).

Among relatively common species in Florida, the most superficially similar are the acentropines *Elophila* (*Synclita*) *obliteralis* (Walker) (Fig. 15) and *E. tinealis* (Munroe). Females have one frenular bristle, like *S. carbonalis*, but differ in having evenly colored palpi and large ocelli and chaetosemata that are situated on a swollen vertex. *Elophila obliteralis* has a white discal spot. Females are larger and paler than *S. carbonalis*. Males are the same size, and although darker than the female, they have forewings with orange scales on the AM and PM areas and also on the hind wing around the anal fold. In *E. tinealis*, the males are even smaller, but females are the same size. The wings have a few irregular white scales, and the ventral body is distinctly white.

Microphysetica hermeasalis (Spilomelinae) is Caribbean in distribution, including southern Florida. Characters shared with *Sufetula* include slightly ascendant labial palpi, relatively large maxillary palpi, rather thick antennae and the absence of chaetosemata and of the male frenular hook. The maculation is similar (Fig. 13), but the PM line is angled out at nearly 45° in the apical half, then directly inward and slightly anteriad up into the cell. The male genitalia (Fig. 29) have dorsally angled valvae with a rounded, transverse fibula, a capitate, spinose uncus and a large, curved cornutus.

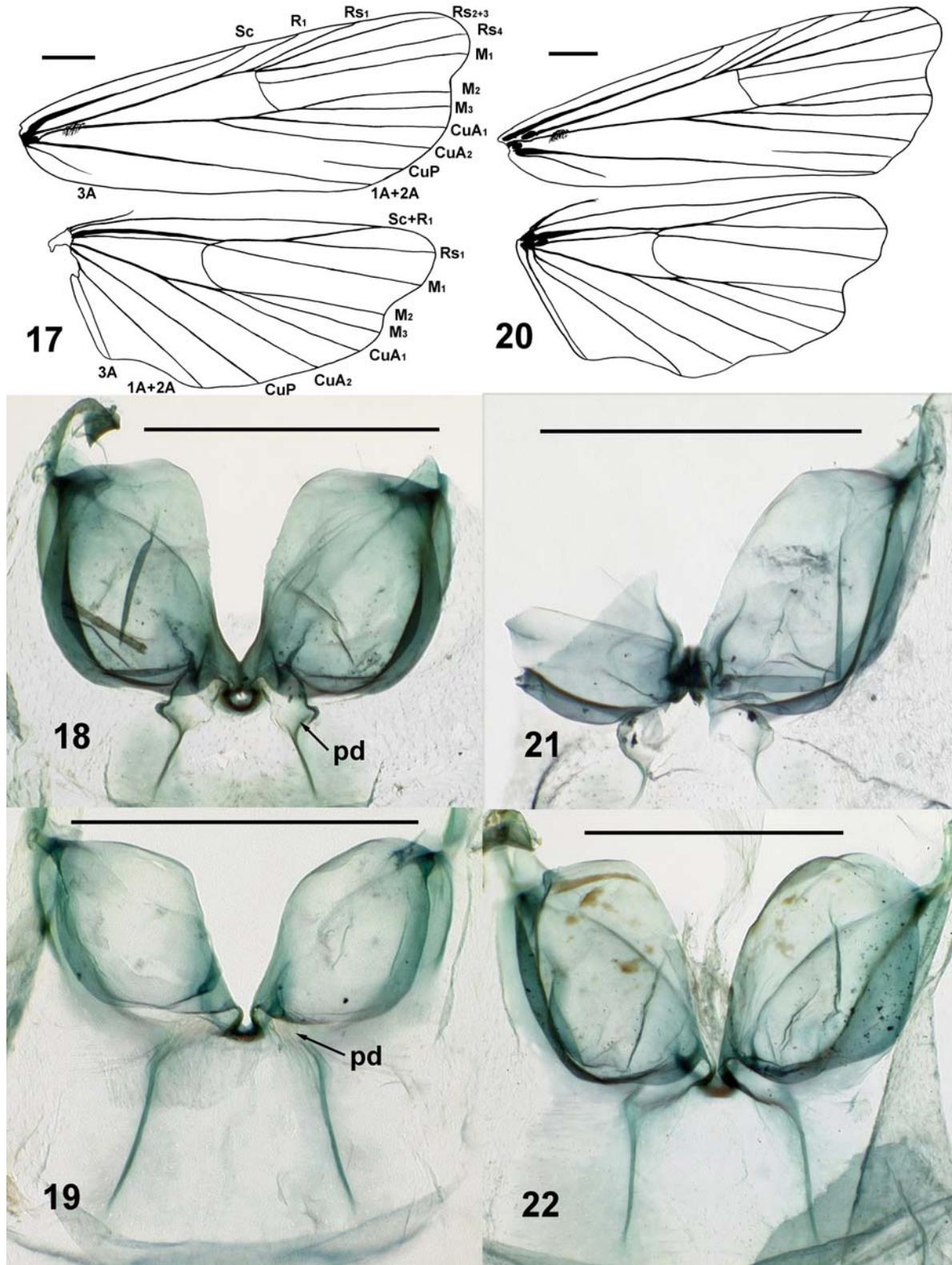
Description. Head (Fig. 5): frons round with appressed, glossy whitish-gray scales; vertex round with dark gray scales directed forward. Chaetosemata absent. Ocelli rudimentary, barely visible posterior of scale tuft. Labial palpi dark gray with mixed white scales; basal meron short; second meron porrect, extended beyond head, ventral side with forward-directed tuft; third meron ascendant at 45° angle. Haustellum well-developed. Antennal scape and pedicel without modifications; flagellum simply scaled, with two rows of scales per meron, lightly ciliate in female, more strongly so in male, with alternating rows directed outward at angle, exposing surface of meron.

Thorax: dorsal side dark gray with mixed white scales; ventral side similar but predominantly white. Legs: epiphysis present; tibial spurs 0, 2, 4, outer spur half length of inner. Robust chaetae not visible on legs. Mera of legs basally white, distally dark gray. Tibiae of hind legs with row of rough, ascendant scales.

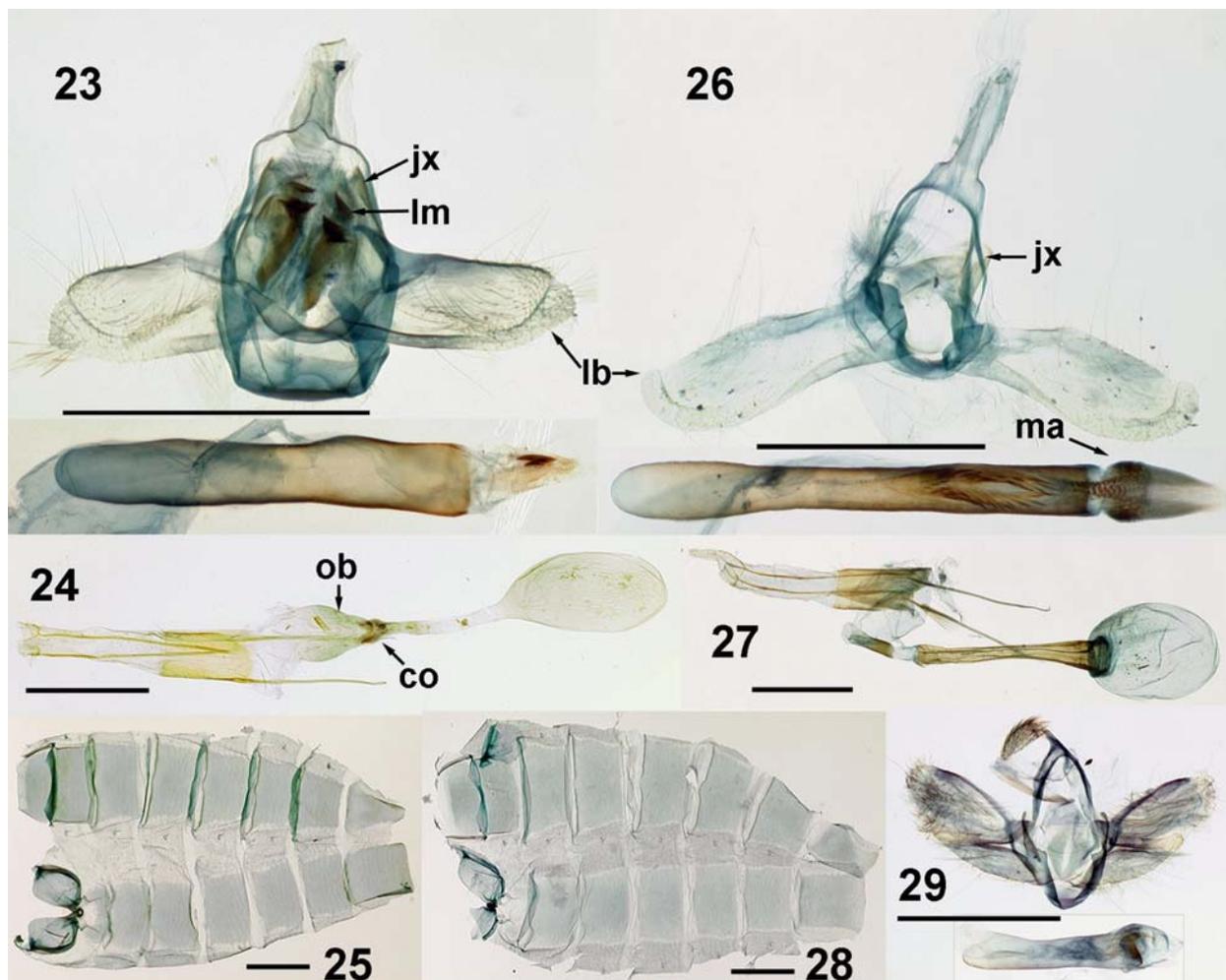
Wings (Fig. 1–4, 17): forewing length (base to apex) 3.5–5.0 mm, mean 4.4 ± 0.3 mm; width (costa to tornus) 1.2–1.7 mm, mean 1.5 ± 0.1 mm (n = 12). Forewing apex rounded, incised on medial fold between M₂ and M₃. Male without retinacular hook. Retinacular hairs in male and female from membrane posterior of base of Cu vein. Female and male both with one frenular bristle in hind wing. Forewing R₁ free, from cell at 0.85 length; Rs₁ free; Rs₂₊₃ fused; Rs₄ from anterior corner of cell or very shortly stalked with Rs₂₊₃; cell closed; discal cross-vein nearly perpendicular to wing axis; M₁ from cross-vein 1/4 distance from anterior corner; M₂ and M₃ short-stalked; CuA₁ and CuA₂ free; CuP present as tubular marginal vein. 1A+2A straight; 3A not tubular, only a faint, straight trace. Hind wing Sc+R1 stalked with Rs₁ 1/3 distance; cell closed; M₁ present; M₂ and M₃ shortly stalked; CuA₁ and CuA₂ free; CuP present from base but weak; 1A+2A strong; 3A present, weak. Forewing color gray to dark gray. AM and PM lines white edged with dark gray; white basal line sometimes visible. Discal spot round, nearly black, in anterior center of wing. Two white spots on costa basal and distal of discal spot, sometimes appearing as lunules with black centers. AM and PM lines expanded slightly on costa and sometimes appearing as lunules. AM line faint and slightly jagged, nearly perpendicular to long axis of wing from costa to posterior margin. PM line nearly perpendicular from costa, bent basad at 45° angle along M veins, then nearly perpendicular to posterior margin, again slightly curved basad on margin. Ventral side like dorsal side, paler. Hind wing gray to dark gray with round, dark gray discal spot. AM line not visible. PM line white, jagged, complete from costa to posterior margin, meeting posterior margin near base. Ventral side similar in color, paler.

Abdomen: Dorsally gray with white scales on posterior margin of segments, ventrally paler. Praeincinctorium simple. Male T8 and S8 not modified, without membranous areas or scale tufts; T8 a blunt triangle, S8 square (Fig. 25).

Tympanal organs (Fig. 18–19): fornix tympani longer than wide, lateral and posterior margins nearly at right angles, slightly protruded over venula prima. Venulae secundae straight, slightly divergent, longer in female than in male. Posterior depressions small, occupying mesal third of width of



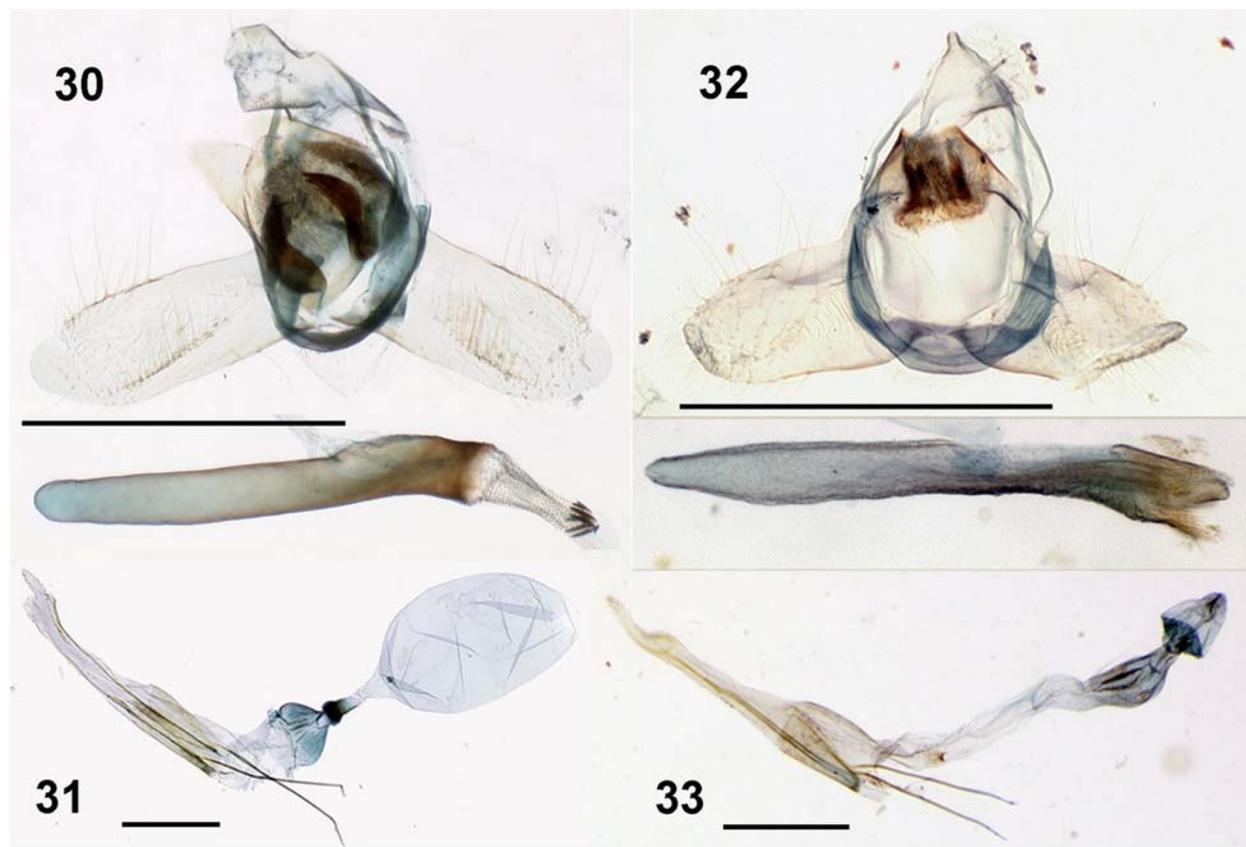
Figures 17–22. *Sufetula* spp. 17–19) *Sufetula carbonalis*. 17) Venation (male, MGCL slide 540). 18) Male tympanal organs (MGCL slide 540). *pd*, posterior depression. 19) Female tympanal organs (JEH slide 1590). *pd*, posterior depression. 20–22) *Sufetula diminutalis*. 20) Venation (female, JEH slide 1439). 21) Male tympanal organs (MGCL slide 96). 22) Female tympanal organs (MGCL slide 578). Scales = 0.5 mm.



Figures 23–29. Genitalia. **23–25**) *Sufetula carbonalis*. **23**) Male genitalia (MGCL slide 98). *jx*, juxta; *lb*, labriform margin; *lm*, lamellae of manica. **24**) Female genitalia (JEH slide 1590). *co*, colliculum; *ob*, ostium bursae. **25**) Male abdominal cuticle (MGCL slide 540). **26–28**) *Sufetula diminutalis*. **26**) Male genitalia (MGCL slide 96). *jx*, juxta; *ma*, manica attached to phallus. **27**) Female genitalia (MGCL slide 578). **28**) Male abdominal cuticle (MGCL slide 96). **29**) *Microphysetica hermeasalis*, Puerto Rico: Maricao State Forest, male genitalia (MGCL slide 670). Scales = 0.5 mm.

tympanal organs; in male, round, pit-like, with emargination lateral of venula secunda (Fig. 18: *pd*); in female, depressions shallow, narrow, transverse, slightly extended onto venula secunda (Fig. 19: *pd*).

Male genitalia (Fig. 23): uncus narrow, membranous, without visible setae, connected to anal tube. Subscaphium larger than uncus. Gnathos and transtilla absent. Tegumen without dorsal ridges. Vinculum round, ventrally nearly flat, without saccus or process. Valvae short, length twice width, of even width, with costal and saccular margins parallel; fibulae and other processes absent but fine setae present; costal margin distally with a few fine, distinct setae perpendicular to margin; distal margin membranous, labriform and distinct from main part of valve, bearing deciduous scales at apex. Juxta (*jx*) represented by pair of narrow, triangular plates with acute apices, extended to upper end of tegumen and laterally framing the manica and phallus. Sclerotization of manica complex, bearing two pairs of overlapping, lanceolate lamellae with distal ends flat and recurved, the complex detaching from phallus in dissection and remaining with genitalic capsule; membrane of manica otherwise spinulose. Phallus straight, length seven times width; caecum penis longer than rest of phallus, inception of ductus ejaculatorius about 1/4 length from apex of phallus; two short, straight cornuti.



Figures 30–33. Genitalia. **30–31** *Sufetula grumalis*. **30**) Male genitalia (Cuba, Santiago de Cuba, JEH slide 1890, NMNH). **31**) Female genitalia (same data, NMNH slide 114765, NMNH). **32–33** *Sufetula sacchari*. **32**) Male genitalia (Puerto Rico, near Rincon, NMNH slide 114756, NMNH). **33**) Female genitalia (Puerto Rico, Res. For. Guajataca, NMNH slide 114762, NMNH). Scales = 0.5 mm.

Female genitalia (Fig. 24): ovipositor elongate and telescoping; anal papillae fused, narrowly pointed. Apophyses thin; posterior apophyses very long, extended to anterior margin of A8; anterior apophyses moderately long. Ostium bursae (*ob*) unarmed, funnel-shaped, nearly as wide as long. Colliculum (*co*) not discretely sclerotized, represented by round, thickened area between antrum and ductus bursae. Ductus bursae twice as long as antrum bursae, straight, not sclerotized. Ductus seminalis from posterior end of ductus bursae just anterior of colliculum. Corpus bursae oval, slightly longer than ductus bursae, twice as long as wide, without signa or appendix.

Types. Holotype: 1F: “Terhune S. Dickel Coll.,” “FLORIDA: Dade County Homestead Fuchs Hammock,” “May 12–13 1980,” “Malaise trap,” (red label) “HOLOTYPE *Sufetula carbonalis* Hayden,” “J.E. Hayden slide no. 1590 F” (TSD, to be deposited in FSCA).

Paratypes: USA, Florida: 1M: “Homestead, Fla. xi-5 1959 D.O. Wolfenbarger” (MGCL slide 99) (FSCA); 1M: “Siesta Key Sarasota Co., Fla. April 8 1953 C.P. Kimball” (MGCL genitalia slide 98, wing slide 541) (FSCA); 1F: “Oneco, Manatee Co., Fla. V-2 1955 Paula Dillman,” “5352.2” (green pen) (FSCA); 1: “FLORIDA: Highlands Co. Archbold Biol. Station 10 mi. S. Lake Placid 2-V-1975,” “at (UV) blacklight,” “J.B. Heppner collector” (FSCA); 1F: “FL: Levy Co. Goethe St. For. Gasline & Beehive Rds. 29°09’38”N, 82°35’55”W. 30-VII-2011. Pine flatwoods, MV. J.E. Hayden,” “J.E. Hayden slide no. 1405 F” (FSCA); 2M: “FLORIDA: Volusia Co. Tomoka State Park 22-25-V-2000 J.B. Heppner” (FSCA); 1F (in alcohol): truck at I-10 Westbound Interdiction Station, Live Oak, Suwannee Co., FL, origin: Gould, FL, on *Phoenix roebelenii*, 9-IV-2012, D. Russell & K. Collins, E2012-2497 (MGCL slide 540) (FSCA); 1M: “FLORIDA: LEVY CO. Goethe State Forest Intersection of North Prong Rd & Middle Rd DEC 9 2012 BAIT Terhune S. Dickel” (TSD); 1 (sex undet., abdomen lost): “Homestead, Fla. xi.13 1958 D.O. Wolfenbarger,” (Munroe’s hand) “5351,” “Database # CNC LEP 00074732”,

(blue label) “Barcode of Life DNA voucher specimen Sample ID: CNCLEP00074732 BOLD Proc. ID: ZYPAN531-10” (CNC); 1F (without head): “Winter Park Fla. 28-VII-39 H.T. Fernald”, “Collected at light”, [large label] “This is probably an undescribed sp. = my 5352,1 or 2. CPK.” (NMNH); 1M: “Siesta Key Sarasota Co., Fla. Nov. 1 1952 C.P. Kimball”, [Munroe’s hand, pencil] “5352” (NMNH); 1F: “FLORIDA: Parker Is., Highlands Co. 4-7 June 1964 R. W. Hodges” (NMNH).

Additional material examined: 1 specimen: Miami-Dade Co., Florida City, at gas station light, 18 Jan. 2013, J. Vargo (J. Vargo Collection).

Distribution. The species is endemic to peninsular Florida, USA, as far north as Volusia and Levy Counties, but most records are from the south and south-central areas of the state.

Phenology. Specimens have been collected in April, May, July, November and December.

Hosts. Larval feeding has not been observed directly and vouchered, but two interceptions by FDACS-DPI agree with the general habit of *Sufetula* species feeding on palm roots. In April 2012, adults were found swarming around potted *Phoenix roebelenii* O’Brien in a truck carrying stock from a nursery in southern Florida. There is an unverifiable earlier record (FDACS-DPI Entomology database no. E2009-1521-1, March 2009) from the same nursery of adults reared from larvae feeding on root balls of *Dypsis lutescens* (H. Wendl.) Beentje & J. Dransf., the specimens of which were identified as “*Synclita* sp.” and discarded.

Etymology. Latin *carbo*, charcoal, in reference to the dark gray maculation.

Remarks. Unlike *S. diminutalis*, *S. carbonalis* is not commonly collected at sugar bait. In Goethe State Forest, T. S. Dickel and I have frequently caught *S. diminutalis* of both sexes but only one male *S. carbonalis* with this method; the other specimen from the forest flew to mercury vapor light early in the evening. It might be overlooked because of its small size and dark color. The possibility of a different flight time should be considered. The Fuchs Hammock holotype was caught in a malaise trap.

The two (or possibly three) pairs of distally curved, crowbar-shaped lamellae are a typical modification of the manica, the pattern of which, like the vesica, varies greatly among *Sufetula* species. The manica may be removed with the phallus or stay with the genitalic capsule in different preparations, so a standardized method of dissection should take advantage of the manica’s diagnostic potential. The sclerites should not be confused with the elongate halves of the juxta.

Sufetula diminutalis (Walker)

(Fig. 8–12, 20–22, 26–28)

Isopteryx diminutalis Walker, 1866: 1315.

Hydrocampa dematralis Druce, 1896: 276, pl. 63 fig. 25.

Sufetula sp.: Kimball, 1965: 200.

Diagnosis. Ocelli are absent. The labial palpi do not have ventral scale tufts or, at most, have a few apically projected scales (Fig. 12A, B). Females have two frenular bristles. The forewing length (base to apex) is 4.5–7.5 mm, mean 5.4 ± 0.3 mm, and width (costa to tornus) is 1.5–2.5 mm, mean 1.9 ± 0.1 mm (n = 20; Fig. 8–11). In the forewing, Rs_2 and Rs_3 are distally separate, and Rs_4 is very short-stalked with their stem (Fig. 20). The forewing PM line is extended slightly distad from the costa to the median fold, then runs nearly parallel to the wing axis between veins M_1 and M_2 . The forewing costa has two distinct white lunules, and the terminal margin between Rs_4 and M_3 is black. The hind wing PM line meets the costa about 3/5 distance from the wing base. In the male tympanal organs (Fig. 21), the posterior depressions are rounded without lateral angulation. The female tympanal organs (Fig. 22) are obliquely elongate, as in *S. carbonalis*. The abdomen is not otherwise modified (Fig. 28). In the male genitalia, the valva is 3.3 to 4 times longer than wide, and the costa is slightly expanded halfway along in a very shallow angle (Fig. 26). The manica (Fig. 26: *ma*) is microspiculose but lacks large spines, plates, or other distinct sclerotizations. The vesica bears a double row of many small cornuti. The uncus is elon-

gate and bears lateral shoulders. In the female (Fig. 27), the ductus bursae is long, narrow, of nearly even width, and sclerotized evenly from just anterior of the ductus seminalis to the corpus bursae, bearing small spines in the far anterior end.

Similar species. Concerning congeners outside of Florida, Dyar (1914) differentiated the Central American *S. hypochiralis* Dyar and *S. hypocharopa* Dyar from *S. diminutalis*; *inter alia*, they have forewings with a broad, white streak on the posterior half of the cell to Cu veins, and a narrower hind wing PM area. *Sufetula hypocharopa* has labial palpi without a ventral tuft, the manica has many dense spinules, the ductus bursae is very long, coiled and unsclerotized, and the signum is a round, granulose field, like the Asian *S. sunidesalis* Walker. *Sufetula dulcinalis* (Snellen) of Colombia also has a narrow hind wing PM area, about 3/4 from the wing base (holotype examined, not dissected).

Sufetula diminutalis is most likely to be confused with *Anageshna primordialis* (Dyar), a common spilomeline. They are the same size and general maculation (Fig. 16). In *Anageshna*, the forewing AM and PM lines are nearly straight across the wing, and the pale costal spots are not surrounded or centrally filled with black. In the genitalia (not shown), males have broad valvae and a capitate uncus similar to *Microphysetica*, and females have a short ovipositor and elongate ductus bursae without an obvious colliculum. The larger, more brightly colored *Apogeshna stenialis* (Guenée) is structurally similar to *A. primordialis*. Other similar Spilomelinae in Florida include species of *Steniodes* Snellen, *Eurrhyarodes* Snellen and *Loxostegopsis* Dyar.

Two musotimines in Florida are similar in size and structure to *S. diminutalis*. *Undulambia polystichalis* Capps has labial palpi with the apical meron long, upturned and acicular. Males are strikingly patterned with orange and white with a radial fovea in the forewing. Females (Fig. 14) are dark brown, and the genitalia have short papillae anales, no colliculum, and the ductus seminalis arising from a small expansion between the corpus and ductus bursae. *Neomusotima conspurcatalis* (Warren), released in Florida to control the Old World climbing fern, *Lygodium microphyllum* (Cav.) R. Br. (Boughton and Pemberton 2009), has palpi similar to those of *S. diminutalis*. In addition to other musotimine characters discussed above, the maculation is mostly brown, lunules are absent on the forewing costa, the PM line is more evenly curved, and the hind wing has terminal black spots. Males have a small androconium around the foreleg epiphysis and robust valvae with a fibula and inflated sacculus, and females have a sclerotized lamella postvaginalis (Solis et al. 2004).

Material examined. Lectotype: (rectangular white label with black underline) “Honduras”, (round green-bordered label) “Type”, (round white label, obverse) “Honduras Limas”, (same, reverse) “61 21”, (typed) “ISOPTERYX? DIMINUTALIS.”, (white label) “Photographed B.M. ~~negative~~” (BMNH).

Additional material examined: USA, Florida: 1M: “FLORIDA: LEVY CO. Goethe State Forest Intersection of North Prong Road & Middle Rd OCT 10 2010 MV/BL Terhune S. Dickel” (TSD); 5M, 6F: same data except at bait, Dec. 2, 9 and 15, 2012 (TSD); 1M: Goethe St. For. 30-XI-2009 (TSD); 1F: Goethe St. For. 7-XII-2009 (TSD); 1M: “FL: Levy Co. Goethe St. For. Gasline & Beehive Rds. 29°09'38"N, 82°35'55"W. 23-VII-2011. Pine flatwoods, beer-fruit bait. J. Hayden, T. Paris, M. McCowan” (FSCA); 1F: same data with “J.E. Hayden slide 1404 F”; 1F: same data except “30-VII-2011”; 1F: same data except “6-VIII-2011” (JEH wing slide 1439); 1F: same data except “12-X-2012”; 1M: same data except “12-I-2013” (MGCL body slide 918, wing slide 919) (FSCA); 2M, 2F: “USA, FL: St. Lucie Co. A & L Agricultural Labs, with Rhapsis sp. 14-VIII-2007 R. Murray via L. Buss. E2007-6805” (FSCA); 1M, 3F: “FL: Dade Co. Homestead 07-6183 20 Aug 2007 H. Mayer ex *Rapis excelsa*”, [one] “*Anageshna primordialis* (Dyar) det. J.B. Heppner '07” (MGCL slides 96, 97) (FSCA); 1F: “FL: Putnam Co. Palatka At MV/UV light”, “10-VII-1992 Leg. H.D. Baggett” (MGCL slide 273) (FSCA); 1: “Homestead, Fla. V.8 1959 D.O. Wolfenbarger”, “C.P. Kimball det. 1959”, [pencil] “5351” (FSCA); 1M: “Oneco, Manatee Co., Fla. V.5 1953 Paula Dillman”, “*Sufetula diminutalis* Wlk. Det. E.G. Munroe”, “5351” (FSCA); 1M: “FLORIDA: Collier Co. Collier Seminole State Park 26 Jan 1986 Linwood C. Dow”, “*Sufetula diminutalis*” (FSCA); 1F: “FLORIDA: Alachua Co., Austin Carey Forest, 10 mi. NE Gainesville 19-26-VIII-75”, “collected by malaise trap”, “T. E. Rogers coll.” (FSCA); 1F and larvae (alcohol vial): FLORIDA: Dade Co. Miami R. Quinones coll. ex *Ravena rivularis*, 25-IV-2006, FSCA # E2006-2032 (MGCL slide 566) (FSCA); 1F (alcohol vial): FL: Miami-Dade Co. Homestead, 25.491612°N 80.363512°W in Red palm weevil trap, 25-VI-2012, A. Derksen,

FSCA #E2012-4847 (MGCL slide 578) (FSCA); 1M, 1F (alcohol vial): FL: Miami-Dade Co. Homestead, 25.51987°N 80.379904°W in Palm weevil trap, 18-I-2013, J.M. Torres, FSCA #E2013-0457 (FSCA); 3F: FL: Glades Co. Palmdale, Fisheating Creek Campground, US Rte. 27, on Jackson trap with cue [tephritid] lure. 29-I-2013 M. Terrell. E2013-0688 (FSCA); 1M: "Homestead, Fla. x.9 1959 D.O. Wolfenbarger", (Munroe's hand) "5351", "Database # CNC LEP 00097601" (CNC); 1M: same data except "xi.4 1959", "CNC LEP 00097602" (CNC); 2M: same data except "iv.10 1959", one with "CNC LEP 00097603", "J.E. Hayden slide No. 1851 M", another with "CNC LEP 00074731", (blue label) "Barcode of Life DNA voucher specimen Simple ID: CNCLEP00074731 BOLD Proc. ID: ZYPAN530-10" (CNC); 1M: "USA: FL: Port Everglades CBP via Dominican Republic ex fruit of *Cocos nicifera* [sic] 06.VII.2011: R. Singam Int # APMFL111875562001", [green label] "[male] gen slide By MA Metz USNM 114,581", "*Sufetula diminutalis* Walker Det. M.A. Solis" (NMNH); 1M: "Apr. 1-7", "Everglade Florida", [red-rimmed label] "*Dematralis* Druce x T in Berl. M. Ju[illeg.]", [large label] "Is this actually a synonym of *S. diminutalis*? CPK." (NMNH); 1F: "FLORIDA Vero Beach July 1941 J.R. Malloch" (NMNH); 1M, 7F: "Stemper, Fla.", "Barnes Collection", May 24-31, June 1-7, July 1-7, July 8-15, one with large label "The Stemper lot are all *S. dematralis*" Druce. CPK." (NMNH). **COSTA RICA:** 1F: Sixola R. March. Collection Wm. Schaus; 1M, 1F: Heredia, La Selva Field Sta. near Puerto Viejo, 21-28 March 1988, W.E. Steiner et al. (NMNH). **CUBA:** 1M, 1F: Baracoa, Oct. Coll. Wm. Schaus (NMNH). **DOMINICAN REPUBLIC:** 1M: Santo Domingo, San Francisco Mts. Sept. 1905, Aug. Busck (NMNH). **JAMAICA:** 1M: Trelawny Parish, 1150ft. Mr. & Mrs. E.L. Bell. "9" (NMNH). **PANAMA:** 1M: Alajuelo, April [19]11, August Busck; 1F: Cabima, May [19]11, August Busck (NMNH). **VENEZUELA:** 1F: Aragua, Rancho Grande, 1100m, 11-15 July 1981 cloud forest, J. Heppner (NMNH).

Distribution. The type locality is Lima, Honduras. It is distributed in the Caribbean, southern Central America and northern South America; in addition to records above, it is recorded from Colombia, Peru and Bermuda (Genty and Mariau 1975; Ferguson et al. 1991). Florida counties include Alachua, Collier, Levy, Manatee, Miami-Dade and Putnam. The species is probably distributed throughout peninsular Florida as far north as Gainesville (Alachua County) and Palatka (Putnam County).

Phenology. Specimens have been collected in Florida all months except February, March and September. They have been collected at bait from dusk to well past midnight. Genty and Mariau (1975) stated that adults are active in the early morning and at dusk.

Remarks. The diagnosis suffices to differentiate *S. diminutalis* from *S. carbonalis*. Most species of *Sufetula* were described from one or few specimens, without explicitly comparative diagnoses and without descriptions of genitalia. The only previously published genitalic illustrations are of *S. sacchari* (Seín 1930). Females may be the same size as males or up to 33% larger, as shown by a series taken at one site in Goethe State Forest in December 2012.

Genty and Mariau (1975) studied the larval behavior of *S. diminutalis* as pests of palm roots in South America. They described methods of rearing and control, and they gave general (albeit non-comparative) descriptions of the life stages. Occasional infestations of ornamental palms in Florida are consistent with these accounts, where larvae bore into the growing tips of roots. *Sufetula diminutalis* has been recorded very recently in Germany, based on specimens caught in an enclosed exhibit area stocked with exotic plants (Richard Mally, pers. comm. 2012).

Sufetula diminutalis is attracted to sugar bait of molasses, bananas and beer, reliably although in small numbers, equally by sex. This was discovered through the efforts of T. S. Dickel in Goethe State Forest in pine flatwoods habitat carpeted with saw palmetto, *Serenoa repens* [Bartram] Small. I have consistently attracted the species at bait, but not at light, at one of the same localities. Specimens have also been attracted to molasses-baited palm weevil traps in Homestead, Florida, and this behavior may be more general among related species (Muus 2008). Flight-intercept or malaise traps yielded the German specimens, one from Austin Carey Forest (Gainesville), and the holotype of *S. carbonalis*.

Lack of diapause may explain the northern limit of the distribution of the species. Genty and Mariau (1975) indicated that the life cycle is about one month from egg to eclosion, so adults should be encountered year-round. The association with palms is another explanation for the distribution.

Discussion. The classification of *Sufetula* is problematic. The genus is undoubtedly a crambid, as evinced by the praecinctorium, tympanal structure and chaetotaxy (Seín 1930; Hayden unpubl.). The genus traditionally has been placed in Pyraustinae (Hampson 1899), specifically in Spilomelini or Spilomelinae where specified (Munroe in Hodges 1983). Although none of the authors have explicitly stated reasons for this classification, *Sufetula* shares with Spilomelinae the absence of four structures: chaetosemata, the male frenulum hook, an obvious gnathos and a rhomboidal signum (Munroe 1976; Minet [1982]). However, other evidence challenges this placement. The tubular forewing CuP vein is not present in Spilomelinae: it is present only in Schoenobiinae, some Acentropinae and some outgroup Pyralidae (Forbes 1926; Lange 1956). The small, ventrally directed posterior depressions of the tympanal organs are unlike the invaginated sacculi and puteoli of most spilomelines, and likewise the laterally projected fornix tympani is unlike the ventrally projected condition in Spilomelinae (Minet [1982]). The non-bilobed praecinctorium is present only in a minority of Spilomelinae. A strongly spiculose manica is shared with Scopariinae, Schoenobiinae and Midilinae (Hayden 2012: Fig. 5F). Although a male frenulum hook is absent in observed specimens of *Sufetula* (*contra* Forbes 1926), it is in fact present in a few other genera that otherwise share many characters, such as *Leechia* South and *Neobanepa* Hampson. The larvae of *S. diminutalis* and *S. saccharalis* possess two subventral setae on the eighth abdominal segment (Seín 1930; *pers. obs.*), elsewhere known only in Pyralidae *sensu stricto* and Cybalomiinae (Hasenfuss 1960; Nel et al. 2004). Finally, subterranean or internal feeding in monocotyledonous plants is uncommon in Spilomelinae but very common in certain other subfamilies (Crambinae, Schoenobiinae, Midilinae, some Scopariinae). However, the absence of characters shared uniquely with any one other subfamily prevents a satisfactory placement.

Sufetula is closely related to the Old World genus *Diplopestis* Meyrick. One species, *D. perieresalis* (Walker), has been examined recently in connection with its spread in the nursery trade in Western Europe (Speidel et al. 2007). The authors referred it to Spilomelinae for similar reasons as for *Sufetula*. The species is associated with sedges (Patrick 1994) and palms (Gaedike 2010), and it tolerates temperate and even subantarctic-oceanic climate (Patrick 1994). If it were to be imported accidentally into North America on nursery stock, it would presumably spread over a broader range than the two species treated above. *Diplopestis* is also attracted to sugar bait (Muus 2008). It can be distinguished from native Florida *Sufetula* species by its smoothly curved forewing PM line, short valvae, absence of manica lamellae, and the elongate, unsclerotized ductus bursae.

Acknowledgments

I thank Thomas Simonsen (BMNH) and Richard Mally (SNS Dresden) for photographing the lectotype of *S. diminutalis*, and likewise thank Alma Solis and Mark Metz (USDA-ARS) for the photographs of the type of *S. grumalis* and slides of *S. sacchari*. Jean-François Landry and Vazrick Nazari (CNC) kindly loaned material, including the sequenced specimens. Andrew Jansen and Kurt Ahlmark (FDACS-DPI) took photographs for the figures. Several plant inspectors with FDACS-DPI helped acquire specimens: Andrew Derksen and Juan Menendez Torres (FDACS-DPI) submitted by-catch from palm weevil traps, Dyrana Russell secured a *S. carbonalis* specimen from a truck interdiction, and Rosamaria Quinones traced and vouchered a 2006 interdiction of *S. diminutalis* that yielded adults and larvae. Lyle Buss (University of Florida IFAS) located another lot of adults and larvae. Several people assisted collecting in Goethe State Forest: Thomson Paris, Mike McCowan, Cassandra Romero, Gaeun Lee and Francesca Ponce. Matthias Nuss (SNS Dresden), Debbie Matthews (FLMNH), Michelle DaCosta (FDACS-DPI), and Ian Stocks (FDACS-DPI) provided many constructive criticisms of the paper. Finally, I thank Capt. Terhune S. Dickel for discovering the Goethe population, providing insightful comments on the manuscript, and for disabusing me of the notions that pyraloids do not fly to bait and that winters in north-central Florida are not productive for collecting. This is Entomology Contribution No. 1233 of the Florida Department of Agriculture and Consumer Services, Division of Plant Industry.

Literature Cited

- Bonneau, X., M. Husni, R. Philippe, N. Somchit, C. Jourdan, and N. Lubis. 2004.** Discovery of a factor limiting yields in a coconut plantation on peat: the insect pest *Sufetula* spp. *Experimental Agriculture* 40: 53–64.
- Boughton, A. J., and R. W. Pemberton. 2009.** Establishment of an imported natural enemy, *Neomusotima conspurcatalis* (Lepidoptera: Crambidae) against an invasive weed, Old World climbing fern, *Lygodium microphyllum*, in Florida. *Biocontrol Science and Technology* 19: 769–772.
- de Chenon, R. D. 1975.** Présence en Indonésie et Malaisie d'un lépidoptère mineur des racines du palmier à huile, *Sufetula sunidesalis* Walker det relations avec les attaques de *Ganoderma*. *Oléagineux* 30: 449–456.
- Dyar, H. G. 1914.** Report on the Lepidoptera of the Smithsonian Biological Survey of the Panama Canal Zone. *Proceedings of the United States National Museum* 47: 139–350.
- Dyar, H. G. 1922.** New American moths and notes. *Insecutor Inscitiae Menstruus* 10: 8–18.
- Ferguson, D. C., D. J. Hilburn, and B. Wright. 1991.** The Lepidoptera of Bermuda: their food plants, biogeography, and means of dispersal. *Memoirs of the Entomological Society of Canada* 123(158): 1–105.
- Forbes, W. T. M. 1923.** The Lepidoptera of New York and Neighboring States. Primitive Forms, Microlepidoptera, Pyraloids, Bombyces. Cornell University Agricultural Experiment Station Memoir 68. 729 p.
- Forbes, W. T. M. 1926.** The relationships of some aberrant pyralids (Lep.). *Journal of the New York Entomological Society* 34: 331–338, pl. 25.
- Gaedike, R. 2010.** Nachtrag 2009 zum Verzeichnis der Schmetterlinge Deutschlands (Microlepidoptera). *Entomologische Nachrichten und Berichte* 54: 109–122.
- Genty, P., and D. Mariau. 1975.** Morphologie et biologie du Pyralidae des racines de l'*Elais*, *Sufetula diminutalis*. *Oléagineux* 30: 147–152.
- Hampson, G. F. 1899.** A revision of the moths of the subfamily Pyraustinae and family Pyralidae. Part I. *Proceedings of the Zoological Society of London* 1898: 590–761, pl. 49–50.
- Hasenfuss, I. 1960.** Die Larvalsystematik der Zünsler (Pyralidae). *Abhandlungen zur Larvalsystematik der Insekten* 5. Akademie-Verlag; Berlin. 263 p.
- Hayden, J. E. 2012.** Revision of *Odilla noralis* Schaus and transfer of Erupini to Midilinae (Lepidoptera: Crambidae). *Annals of Carnegie Museum* 80: 309–322.
- Kimball, C. P. 1965.** The Lepidoptera of Florida, an annotated checklist. *Arthropods of Florida and Neighboring Land Areas*. Vol. 1: i-v, 1-363.
- Klots, A. B. 1970.** Lepidoptera. p. 115-130. *In*: S.L. Tuxen (ed.). *Taxonomist's glossary of genitalia in insects*. Munksgaard; Copenhagen, Denmark. 283 p.
- Lange, W. H. 1956.** A generic revision of the aquatic moths of North America: [sic] (Lepidoptera: Pyralidae, Nymphulinae). *The Wasmann Journal of Biology* 14: 59–144.
- Maes, K. 1985.** A comparative study of the abdominal tympanal organs in Pyralidae (Lepidoptera). I. Description, terminology, preparation technique. *Nota Lepidopterologica* 8: 341–350.
- Mariau, D., R. D. de Chenon, J. F. Julia, and R. Philippe. 1981.** Les ravageurs du palmier à huile et du cocotier en Afrique occidentale. *Oléagineux* 36: 170–217.
- Minet, J. 1981 [1982].** Les Pyraloidea et leur principales divisions systématiques (Lep. Ditrysia). *Bulletin de la Société Entomologique de France* 86: 262–280.
- Munroe, E. G. 1972.** *In*: R. B. Dominick, et al. (eds.). *The moths of America north of Mexico, fascicle 13.1A, Pyraloidea (Pyralidae), comprising subfamilies Scopariinae, Nymphulinae*. E.W. Classey; London.
- Munroe, E. G. 1976.** Pyraloidea, Pyralidae (Part). *In*: R. B. Dominick, et al. (eds.). *The moths of America north of Mexico, Fascicle 13.2A*. E. W. Classey and The Wedge Entomological Research Foundation; London.
- Munroe, E. G. 1983.** Pyralidae (except Crambinae). p. 67–76, 78–85. *In*: R. W. Hodges, et al. (eds.). *Check list of the Lepidoptera of America north of Mexico including Greenland*. E. W. Classey Ltd. and the Wedge Entomological Research Foundation; London. xxiv+284 p.

- Muus, T. 2008.** *Diplopseustis perieresalis* voor de tweede maal in Nederland (Lepidoptera: Crambidae: Spilomelinae). Entomologische Berichten 68: 69.
- Nel, J., G. C. Luquet, and J. Minet. 2004.** Redécouverte de *Krombia venturalis* Luquet & Minet, 1982, au Mont Ventoux (Vaucluse). Alexanor 22: 429–442.
- Nuss, M. and contributors. 2013.** Global information system on Pyraloidea. Senckenberg Collection of Natural History, Museum of Zoology, Dresden. www.pyraloidea.org (accessed 24 January 2013).
- Patrick, B. 1994.** Antipodes Island Lepidoptera. Journal of the Royal Society of New Zealand 24: 91–116.
- Seín, F. 1930.** The sugar cane root caterpillar and other new root pests in Puerto Rico. The Journal of the Department of Agriculture of Puerto Rico 14: 167–191, pl. 20–29.
- Solis, M.A., and M. Shaffer. 1999.** Contribution towards the study of the Pyralinae (Pyralidae): historical review, morphology, and nomenclature. Journal of the Lepidopterists' Society 53: 1–10.
- Solis, M. A., S.-H. Yen, and J. H. Goolsby. 2004.** Species of *Lygomusotima* New Genus and *Neomusotima* Yoshiyasu (Lepidoptera: Crambidae) from Australia and Southeastern Asia feeding on *Lygodium microphyllum* (Schizaeaceae). Annals of the Entomological Society of America 97: 64–76.
- Speidel, W., E. J. van Nieuwerkerken, M. R. Honey, and S. J. C. Koster. 2007.** The exotic pyraloid moth *Diplopseustis perieresalis* (Walker) expanding in the West Palaearctic Region (Crambidae: Spilomelinae). Nota Lepidopterologica 29: 185–192.
- Winter, W. D. Jr. 2000.** Basic techniques for observing and studying moths and butterflies. Memoirs of the Lepidopterists' Society No. 5: 1-444.
- Wootton, R. J. 1979.** Function, homology and terminology in insect wings. Systematic Entomology 4: 81-93.

Received March 13, 2013; Accepted April 13, 2013.

Subject edited by J. Zaspel.

