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Abstract. Sapodilla (*Manilkara zapota* (L.) van Royen) is originally from the Neotropics, and has become one of the most important tropical crops in the last few decades. The major producers include India, Mexico, Sri Lanka, the Philippines, Venezuela and Guatemala. It is also a minor crop in the United States, specifically South Florida. In 2015, it was reported that Florida growers suffered a loss of up to 80% of their production due to lepidopteran pests. We surveyed two sapodilla orchards weekly in South Florida for about six months. We collected 1,070 lepidopteran individuals (i.e., larvae, pupae and adults) belonging to seven families, nine genera and ten species. *Phidotricha erigens* Ragonot (30%), *Banisia argutula* Whalley (22%) and *Holcocera crassicornella* Dietz (13%) were the most frequently collected species. The most abundant months were April, May and June. Florida has records for ten of the sixteen species of lepidopterans associated with sapodilla in the Americas, four of which are newly reported host records. We also recorded one new record on loquat (*Eriobotrya japonica* (Thunb.) Lindl.) and another new record on ficus (*Ficus* sp.). Finally, we found a negative relationship between climate variables and the abundance of Lepidoptera species.

Key words. Pest management, biocontrol, parasitoids, borers, tropical fruits.

Introduction

Sapodilla (*Manilkara zapota* (L.) van Royen) is a desirable Neotropical fruit in the family Sapotaceae. It is indigenous to southern Mexico and Central America, and in 1802 it was introduced to some Caribbean Islands and southern Florida (Morton 1987; Mickelbart 1996; Kamala et al. 2006; Balerdi et al.

2008). It was also introduced to Asia through the Philippines during Spanish colonization, where it has become one of the most important agricultural crops on that continent (Morton 1987; Venkateswara et al. 2014). Currently, the highest production areas worldwide are in India and Mexico followed by Sri Lanka, the Philippines, Venezuela and Guatemala (Morton 1987; Mickelbart 1996; Balerdi et al. 2008). In the United States, this fruit is a specialty crop in southern Florida where the production has been increased markedly throughout the years (currently estimated at 300 acres).

Many insects have been reported to attack sapodilla in Venezuela (Rubio-Espina et al. 1968), India (Butani, 1975) and Puerto Rico (Medina-Gaud et al. 1987). The most important insects associated with sapodilla are Lepidoptera due to the damage they cause to leaves, flowers and fruits. Lepidopteran pests on sapodilla have been reported in Brazil, China, USA, French West Indies, India, Indonesia, Pakistan, Malaysia, Mexico, Philippines and Thailand (Clarke 1954; Bradley 1981; Ibrahim 1990; Witethom and Silawatchananai 1990; Soares-da Silva et al. 2003; Iruegas et al. 2002; Wu and Solovyev 2011; Peiris 2014). Thirty-four species of Lepidoptera have been reported to attack sapodilla, in addition to the four new host records mentioned in this work being *Banisia myrsusalis* Walker (Thyrididae), *Eustalodes achrasella* Bradley (Gelechiidae) and *Nephopteryx eugraphella* (Ragonot) (Pyralidae) the most common pests (Parvathi and Belavadi 1994; Patange et al. 1997; Soares-da Silva et al. 2003) (Table 1).

During 2015, sapodilla growers from southern Florida suffered a loss of up to 80% of their production due to lepidopteran pests. In this paper, we provide the results of our biological observations, including identifications of all lepidopterans observed on sapodilla, and we propose potential biological control agents for these pest species.

Materials and Methods

Study site

From March to August 2015, we surveyed two sapodilla groves weekly. The first site was at the Tropical Research and Education Center, part of the University of Florida, IFAS, which has 105 sapodilla trees. The other site was a private grove (Finca 6 Palmas (F6P)) of a member of the Tropical Fruit Growers of South Florida, Inc., containing 192 sapodilla plants. Both sites are located in Miami-Dade County, Homestead, Florida. The soil at these sites is Krome: a very gravelly sandy loam soil (Noble et al. 1996; Li 2012) soil. The sapodilla cultivars grown include Alano, Brown Sugar, Fruit and Spice Park, Hasya, Makok, Medora, Modello, Molix, Morena, New Sapodilla, Piña, Piña Grande, Prolific, O-2, O-3, O-4, O-B, Seedless Seedling, Simmonds, Tikal and Tom Thers. The sapodillas were surrounded by atemoya (*Annona cherimola* Mill. *x A. squamosa* L. hybrids), soursop (*Annona muricata* L.) sugar apple (*A. squamosa* L.), ackee (*Blighia sapida* Koening), star apple (*Chrysophyllum cainito* L.), wampee (*Clausena lansium* (Lour.) Skeels), longan (*Dimocarpus longan* Lour.), loquat (*Eriobotrya japonica* (Thunb.) Lindl.), lychee (*Litchi chinensis* Sonn.), mamoncillo (*Melicoccus bijugatus* Jacq.), avocado (*Persea americana* Mill.), canistel (*Pouteria campechiana* Baehni), mamey (*Pouteria sapota* (Jacq.) Moore and Stearn) and cattley guava (*Psidium cattleianum* Sab.), Costa Rican guava (*Psidium friedrichsthalianum* (O. Berg) Nied) and biriba (*Rollinia deliciosa* Saff.).

Table 1. Lepidoptera species associated with sapodilla (*M. zapota*) and the countries where they have been observed as a pest or possible pest. Asterisks indicate new host records.

Family	Subfamily	Species	Country
Gracillariidae	Acrocercopinae	*Acrocercops gemoniella* Stainton, 1863	India
		Eucosmophora sp.	Brazil
Praydidae	Praydinae	*Prays citri* (Millière, 1873)	French West Indies
Tortricidae	Chlidanotinae	*Trymalitis margarias* Meyrick, 1905	India

Family	Subfamily	Species	Country
	Olethreutinae	*Cryptophlebia illepida* (Butler, 1882)	India
		Dichrorampha sapodilla Heppner, 1981	USA
Limacodidae	Limacodinae	*Miresa bracteata* Butler, 1880	China
Metarbelidae	Metarbelinae	*Indarbela quadrinotata* Walker, 1856	India
Lycaenidae	Theclinae	*Deudorix isocrates* (Fabricius, 1793)	India
		Electrostrymon angelia (Hewitson, 1874)*	USA
Gelechiidae	Anacampsinae	*Eustalodes achrasella* (Bradley, 1981)	India, Pakistan
	Anacampsinae	*Eustalodes anthivora* Clarke, 1954	The Philippines, India
Elachistidae	Elachistinae	*Stephensia armata* Sruoga, 2003	Belize
Blastobasidae	Blastobasinae	*Holcocera crassicornella* Dietz, 1910*	USA
Cosmopterigidae	Cosmopteriginae	*Pyroderces badia* (Hodges, 1962)*	USA
Thyrididae	Striglininae	*Banisia argutula* Whalley, 1976	USA
		Banisia myrsusalis (Walker, 1889)	USA, Brazil, Australia, India, Sri Lanka, China, Vietnam, Malaysia, Indonesia, Thailand, Madagascar, South Africa
Pyralidae	Epipaschiinae	*Phidotricha erigens* Ragonot, 1888*	USA
	Phycitinae	*Comotia torsicornis* Dyar, 1914	USA
		Mussidia pectinicornella (Hampson, 1896)	Thailand
		Nephopterix piratis (Meyrick, 1887)	Malaysia
		Nephopteryx eugraphella Ragonot, 1978	India
		Phycita erythrolophia Hampson, 1903	India
		Zamagiria dixolophella. Dyar, 1914	Mexico
		Zamagiria laidion (Zeller, 1881)	USA, Brazil
Notodontidae	Dudusinae	*Netria viridescens* Walker, 1855	Malaysia
		Tarsolepis remicauda Butler, 1872	Indonesia
	Stauropinae	*Stauropus alternus* Walker, 1855	India
Erebidae	Lymantriinae	*Olene mendosa* Hübner, 1823	India
	Erebinae	*Achaea mercatoria* (Fabricius, 1775)	India, Malaysia
		Achaea serva (Fabricius, 1775)	India
	Arctiinae	*Barsine* sp.	India
		Mangina syringa (Cramer, 1775)	India
		Robinsonia dewitzi Gundlach, 1881	Mexico
Lasiocampidae	Lasiocampinae	*Metanastria hyrtaca* (Cramer, [1779])	India
		Trabala vishnou (Lefèbvre, 1827)	Thailand
Saturniidae	Arsenurinae	*Copiopteryx jehovah* (Strecker, 1874)	French Guiana
Sphingidae	Macroglossinae	*Erinnyis ello* (Linnaeus, 1758)	USA, Brazil

Study plants

We sampled the trees randomly and attempted to examine 10% of the total plants per month at each planting. We observed 12 plants per week in the University of Florida Tropical Research and Education Center (UF/IFAS TREC) (48/month) and 24 at P6F (96/month) for a time span of 15 minutes per tree. We collected 10 –12 inflorescences per plant. The inflorescences and leaves were placed in plastic bags and taken to the lab for further analysis. All the floral buds and mature flowers were examined for eggs and larvae.

Study lepidopterans

Eggs were placed in individual petri dishes until the eggs hatched. Larvae were separated into three categories: live, dead and parasitized. The live and parasitized larvae were placed in 50 ml plastic vials with wet filter paper at the bottom, to observe species development. Larvae were fed with fresh flowers every third day until they reached the pupal stage, at which point they were transferred to one-liter jars lined with wet tissue paper at the bottom. When the adults emerged, each specimen was pinned, labeled and identified at least to family and often to genus. The dead larvae were placed in hot water and put in glass vials with 75% ethanol and identified through descriptions in the literature (Ragonot 1888; Dyar 1914; Whalley 1976; Pyle 1981; Horak and Brown 1991; Solis 1999). To corroborate identifications, we sent samples to the Florida Department of Agriculture and Consumer Services (FDACS). The parasitoid larvae and pupae were placed in petri dishes until they reached the adult stage and then they were inserted into 1.5ml microvials with 75% ethanol. The parasitoids were identified to family using textbook keys (McGavin and Lewington 1992; Triplehorn and Johnson 2005). In addition, the parasitoids were reviewed further by Communications and Taxonomic Services Unit USDA-ARS-Systematic Entomology Laboratory in Washington, DC,

We also made further observations on the species' natural history and natural control by reviewing selected sapodilla trees for one hour each morning, afternoon and evening. We recorded each sighting of larvae, adults and parasitoids with a Canon EOS Rebel t5i camera (Melville, NY).

All specimens were deposited in the tropical fruit crops lab at UF/IFAS TREC. The following codens are used for additional depositories that are mentioned in the results:

BMNH Natural History Museum, London, United Kingdom.
MLUR Queen Lovisa Ulrika or "Museum Ludovicae Ulricae Reginae". Currently held at the Uppsala Universitet Evolutionsmuseet, Uppsala, Sweden (UUEM).
MNHP Muséum national d'Histoire naturelle-Paris, Paris, France.
USNM National Museum of Natural History, Smithsonian Institution, Washington, DC, USA.

Data analysis

A database for each grove site was developed which recorded the biological characteristics (morphology, behavior and host plant association) of each larva and the type of damage in the flower and leaf buds, mature flowers, leaves and fruits. The relative abundance was obtained by counting the number of specimens per species. We obtained the climate variables from a 66-year historical record of monthly average high, low and overall average temperatures and total monthly precipitation from the nearest weather station to the study area (FCC 2015). To determine if there is a relationship between relative abundances and climate variables we performed multiple linear regression using Statgraphics Centurion XV, version 15.2.06 (Statpoint Technologies, Inc. 2007). In addition, we made an ombrothermic diagram to compare abundances with climate variables, using an Excel file worksheet (Microsoft 2013).

Results

In all, there were 1,070 Lepidoptera larvae, pupae, and adults, representing seven families, nine genera, and ten species, collected during the course of this study (Fig. 1 and 2). A description of each species was made by combining morphological information from the original descriptions with our newly

observed morphology and life history data. In addition, the host range, natural history, observations of plant damage, and control management are listed. Florida is represented by five of the nine species of lepidopterans related with sapodilla that were previously known in the Americas. We recorded four additional species newly associated with this plant, bringing the total number of state records to ten, and the total number of American records to fourteen. We also found a new record for loquat and another for ficus.

Family Lycaenidae

Subfamily Theclinae

Electrostrymon angelia (Hewitson, 1874)

Thecla angelia Hewitson, 1874
Strymon angelia dowi Clench, 1941
Thecla angelia pantoni Comstock and Huntington, 1943
Thecla angelia boyeri Comstock and Huntington, 1943
Callicista angelia (Hewitson, 1874): Lewis, 1974

Electrostrymon angelia was described as *Thecla angelia* by Hewitson (1874) and recorded in H. G. Smith's collections at the BMNH and various publications under several synonyms.

Description. Egg. Green encircled by small white spines. **Larva.** First instar grayish-green with long white setae; second instar with body orange with some purple spots and medium sized black setae; third instar body completely orange and setae small and numerous; fourth instar similar to third except body purple with some orange spots; length is 8.9–9.3 mm (Fig. 1E). **Pre-pupa.** Darker than last instar. **Pupa.** Completely purple with white setae covering whole body. **Adult.** Sexually dimorphic in size, males larger than females. *Wing expanse*: males 21–23.2 mm, females 19.8–21.1 mm. **Wings.** *Dorsal surface*: Forewings dark brown with large reddish-orange triangular markings between inner margin and cell M1; these markings reduced or absent in the female. Hindwings completely dark-brown with two tails; lobe reddish-orange; base of tails with submarginal white line. *Ventral surface*: All wings reddish-brown. Female paler brown than male; submarginal line and outer margin brown; crossed near middle by a dark brown outlined with pale-brown. Hindwings crossed near middle by dark-brown line margined with white spots; lobe surrounded by white margin and the next black spot covered with minute white spots; large black spot between the tails and the next three small spots surrounded by orange; outer margin black, bordered internally with white. **Head.** *Antennae*: Brown, elongate, clubbed with white lines among the flagellum segments; club of antenna with three colors: orange apically, brown in the middle and white basally. *Vertex*: Dark-brown. *Mouthparts*: Labial palp with first segment larger than second and third. **Body.** *Thorax*: Dark-brown above and pale grayish-brown below. *Legs*: Black with horizontal white lines. *Abdomen*: Dark-brown above and pale grayish-brown below; from the mid-ventral area towards tip abdomen orangish-brown (Fig. 2I).

Distribution. *Electrostrymon angelia* has been recorded in the Cayman Islands, Cuba, Haiti, Jamaica, Puerto Rico, the Bahamas and the Virgin Islands (Hewitson 1874; Clench 1941; Comstock and Huntington 1943; Askew 1988; Miller and Miller 1989, 1997; Schwartz 1989; Ramos 1996). It has been recorded in just in two U.S. states: Minnesota and (South) Florida (Anderson 1974; Miller 1978; Calhoun 1997; Powell 1997).

Hosts. *Schinus terebinthifolius* Raddi (Anacardiaceae); *Piscidia piscipula* (L.) Sarg. (Fabaceae); *Salvia misella* Kunth.; *S. micrantha* Vahl. (Lamiaceae) (Pyle 1981; Fernández-Hernández 2007; Allen *et al*. 2005); *Manilkara zapota* (L.) van Royen (Sapotaceae), **new host record**; and *Eriobotrya japonica* (Thunb.) Lindl. (Rosaceae), **new host record**. The two new host records are also the first time *E. angelia* has been found on Sapotaceae and Rosaceae.

Natural history. Adults were observed during most of the dry and rainy season (March–July) in Florida. Females lay eggs in the flower and leaf buds. When the eggs hatch, the caterpillars feed on the entire flower, including branches, leaf buds, mature flowers and leaves, but not on the fruits. The

caterpillars complete development in 22–24 days. When the caterpillars reach the last instar, they pupate on branches or leaves.

Pupa duration is 24–29 days. The adults live for about three or four months feeding on nectar; males also drink water and puddling salts in wet soil.

Damage. This species has been recorded feeding on leaves of *S. terebinthifolius* (Anacardiaceae) by Pyle (1981). However, in southern Florida, it has become a problem in the production of sapodilla, as most caterpillars feed on flower buds and mature flowers. They eat everything except the pedicels in mature flowers and all the flower buds except the branches. It is very difficult to find caterpillars as they are reddish purple, the same color as the flower and the leaf buds.

Management. This sapodilla pest could be controlled by pesticides, but no trials have been completed. Furthermore, we observed that they are natural prey of some spiders (e.g. Salticidae and *Gasteracantha cancriformis* (Linnaeus)).

Family Blastobasidae

Subfamily Holcocerinae

Holcocera crassicornella Dietz, 1910

Blastobasis eriobotryae Busck, 1915

Holcocera crassicornella was described by W. G. Dietz (1910) from a single specimen found in Florida in the USNM collection.

Description. Egg. Remarkable small size; completely pearly white and turning dark-pink close to emergence. **Larva.** First and second instars dark-yellow, thorax and head dark-brown. Third to seventh instars dark grayish-brown, head nearly black. Last instar length 2.9–3.5 mm (Fig. 1C). **Pre-pupa.** Similar in size to last instar, but body dark grayish-purple; head brown. **Pupa.** Dark-brown; spiracles protruding from the body like spines. **Adult.** Not sexually dimorphic. *Wing expanse*: 4.2–5.1 mm. **Wings.** *Dorsal surface*: Forewings completely gray with overlaid dark-gray scales; a black discal spot; two postdiscal black spots. Hindwings, pale-gray; fringe with very long gray scales. *Ventral surface*: Both wings pale-gray. **Head.** *Antennae*: Filiform; the scape large, flattened and inwardly concave. *Vertex*: Tawny. *Mouthparts*: Labial palpi tawny with second and third segment longer than first. **Body.** *Thorax and abdomen*: Tawny; dorsal view with horizontal row of small spines at the posterior margin of each segment. *Legs*: Similar to labial palpi in coloration (Fig. 2C).

Distribution. Southern Florida (Adamski 1998).

Hosts. *Eriobotrya japonica* (Thunb.) Lindl. (Rosaceae) and *Acer rubrum* L. (Sapindaceae) (Busck 1915; Adamski 1998). *Manilkara sapota* (L.) van Royen, **new host record**.

Natural history. The adults are nocturnal and reach their highest population levels from late spring (June) to early summer (July) in Florida. Females lay their eggs inside the flowers. The larvae develop inside the flowers feeding on everything except the sepals. The larvae produce silk tunnels among flowers to avoid predators. The larval stage lasts 19–23 days depending on the availability of the food resources and can be extended for a longer period of time.

Pupation occurs inside the flowers where the larva rolls up a sepal and makes a silk cocoon. The pupal stage lasts 22–26 days.

Damage. *Holcocera crassicornella* is a serious pest in sapodilla, and during this study it was one of the most aggressive species, after *B. argutula* and *P. erigens*. The damage is very similar to *P. erigens*; we saw many larvae of *H. crassicornella* and to *P. erigens*.

Management. We reared two unidentified parasitoid wasps, a mymarid and a braconid, that parasitized eggs and larvae of *H. crassicornella*.

Family Cosmopterigidae

Subfamily Cosmopteriginae

***Pyroderces badia* (Hodges, 1962)**

Sathrobrota badia Hodges, 1962
Anatrachyntis badia (Hodges, 1962): Zimmerman, 1978

Pyroderces badia was described by R. Hodges (1962) from a specimen from the J. K. Small collection at the USNM.

Description. Egg. Very small size; completely silvery white and changing to snowy white before hatching. **Larva.** First instar is dark-pink, head and last abdominal segment dark-brown, thorax black with silver band in pronotum; Second to fifth instars similar to first, except color soft pink and length 5.8–8.9 mm (Fig. 1I). **Pre-pupa.** Similar in size and color to that of last instar but wider and paler. **Pupa.** Elongate, similar size to last larval instar. **Adult.** Sexually dimorphic, female larger and darker than male. *Wing expanse*: males 3.4–4.7 mm, females 4.9–5.8 mm. **Wings.** *Dorsal surface*: Forewings pale-brown with a series of transverse markings of different color shades ranging from dark-brown to white occasionally overlain with golden-brown or dark-gray scales. Hindwings dark-brown with overlaid with dark-gray or white scales. *Ventral surface*: Both wings dark-brown with overlaid with dark-gray or white scales. **Head.** *Antennae*: Filiform; nearly ¾ length of the body. *Vertex*: Brown. *Mouthparts*: Labial palpi with second and third segment longer than first; lines with different shades present. **Body.** *Thorax and abdomen*: Generally reddish-brown but sometimes pale-brown or brown blended with gray and dark-brown. *Legs*: Similar to labial palps in coloration (Fig. 2E).

Distribution. *Pyroderces badia* is found in the USA, mainly in Florida, but has also been reported in Louisiana, Washington, California, Maryland and Hawaii (Hodges, 1978; Adamski et al. 2006; Bella and Mazzeo 2006). It has also been observed in Costa Rica (Quesada-Jiménez 2013), Cuba (Alonso et al. 2015), Barbados (Bennett and Alam, 1985) and Honduras (Miller et al. 2012). Additionally, *P. badia* has been recorded in nine European countries: France, Greece, Italy, Malta, Netherlands, Portugal, Spain, and the UK (Koster and Sammut 2006; Seguna and Sammut 2007; Huemer and Wieser 2010; Corley et al. 2012; Davis 2012). It was also reported in Australia by Herbison-Evans and Crossley (2014).

Hosts. *Cocos nucifera* L. (Arecaceae); *Brassica oleracea* L. (Brassicaceae); *Ananas comosus* (L.) Merr (Bromeliaceae); *Cycas revoluta* Thunb. and *Cycas circinalis* L. (Cycadaceae); *Cassia occidentalis* L. (Fabaceae); *Punica granatum* L. (Lythraceae); *Musa* ssp. (Musaceae); *Pinus elliottii* Engelm., *P. palustris* Mill., *P. pinaster* Aiton (Pinaceae); *Sorghum bicolor* (L.) Moench (Poaceae); *Eriobotrya japonica* (Thunb.) Lindl., *Prunus persica* (L.) Bastch (Rosaceae); *Citrus* spp. (L.) Swingle (Rutaceae); *Ulmus* spp. (Ulmaceae); *Vitis vinifera* L. (Vitaceae) (Hodges 1962 1978; Heckford and Sterling 2004; White et al. 2005; Adamski et al. 2006; Bella and Mazzeo 2006; Navarro-Campos et al. 2010; Herbison-Evans and Crossley 2014; Quesada-Jiménez 2013). *Manilkara sapota* (L.) van Royen, **new host record** and first record on Sapotaceae.

Natural history. The adults are polyphagous, and feed on many species, but almost all the resources that they consume are organic remains (dead flowers). Therefore, they are not a problem to most of their hosts, but sometimes they feed on some of the healthy flowers close to the dead ones. They were observed eating both healthy and dry flowers of *M. zapota*.

The adults are usually active at night or in the twilight in Florida during summer (June-September). The females lay eggs inside dry or healthy flowers. When the larvae hatch, they start to feed on the organic remains inside the flower. The larval stage lasts about 18–21 days, but if the inserted larvae do not have enough resources, they may enter diapause. Pupation occurs inside the flower usually in a rolled sepal. The pupal stage has a duration of 23–29 days.

Damage. The flowers infected by *P. badia* do not show external damage but turn yellowish brown until desiccated.

Management. We observed an unidentified parasitoid (Braconidae) on *P. badia*. The use of *Bacillus thuringiensis* Berliner, 1915 as a biological control agent has also been reported successfully (Quesada-Jiménez 2013). Chemical control has not been investigated.

Family Pyralidae

Subfamily Epipaschiinae

Phidotricha erigens Ragonot, 1888

Hemimatia atramentalis Lederer, 1863
Pococera atramentalis Hampson, 1896

Ragonot (1888) described *Phidotricha erigens* based in his own specimens of in the MNHP.

Description. Egg. Yellow with black spots in newly laid eggs and pale-yellow before they hatch. **Larva.** Five instars; first to third instar reddish-orange with a long yellowish-white line dorsally; fourth instar reddish-brown with the same yellowish-white line; the fifth instar is dark-brown with yellowish-orange line. Length 3.8–4.2 mm (Fig. 1F). **Pre-pupa.** Yellowish-orange with a yellowish-white line dorsally. Length as in the last instar, but wider on thoracic segments. **Pupa.** Elongated dark-brown and similar in size to last larval instar. **Adult.** Sexually dimorphic, female larger and darker than male. *Wing expanse*: males 7.9–10.4 mm, females 9.2–14.4 mm. **Wings.** *Dorsal surface:* Forewings pale-gray with black fine scattered scales; postdiscal purplish-brown band; purplish-brown band throughout basal and postbasal area; distinctive transverse lines (first one white, almost straight; second one purplish-gray with a strong angle) on discal and postdiscal area; outer margin gray with a wide broken line between veins; discal black spot; fringe gray. Hindwings pale-gray; dark-gray on outer margin; fringe pale-gray. *Ventral surface*: Forewings dark brownish-gray. Hindwings pale brownish-gray with outer margin dark-gray. **Head.** *Antennae*: Male plumose and female filiform, size ¾ body length. *Vertex*: Mottled gray and dark-gray. *Mouthparts*. Large palps with mottled gray and dark-gray color. **Body.** *Thorax and abdomen*: Gray above and pale-gray below. *Legs*: Mottled gray and dark-gray (Fig. 2F).

Distribution. *Phidotricha erigens* is native to the Neotropical Region and has been recorded in Brazil, Colombia, Cuba, Ecuador, Honduras, Mexico, Peru, Puerto Rico, Trinidad and Tobago, and Venezuela (Ragonot 1888; Kaye and Lamont 1927; Palmer and Pullen 1995; Roque-Álbelo and Landry 2012, Diniz et al. 2009; Velázquez, et al. 2010; Miller et al. 2012). It was also reported as an invasive species in Florida (Solis 1999).

Hosts. *Agave cocui* Trel (Agavaceae); *Mangifera indica* L. (Anacardiaceae); *Araucaria angustifolia* (Bert.) O. Ktze. (Araucariaceae); *Mauritia flexuosa* L. (Arecaceae); *Protium ovatum* Engl. (Burseraceae); *Mammea americana* L. (Calophyllaceae); *Caryocar brasiliense* Camb. (Caryocaraceae); *Salacia crassifolia* (Mart. ex Schult.) G.Don. (Celastraceae); *Benincasa hispida* (Thunb.) Cogn., *Cucumis melo* L. (Cucurbitaceae); *Erythroxylum deciduum* A.St.-Hil. (Erythroxylaceae); *Albizia saman* (Jacq.) F.Muell., *Dimorphandra mollis* Benth., *Mimosa asperata* L., *M. claussenii* Benth, *M. pigra* L., *Phaseolus lunatus* L., *Pterodon pubescens* Benth, *Tamarindus indica* L., *Vigna unguiculata* (L.) Walp. (Fabaceae); *Clerodendrum squamatum* Vahl. (Lamiaceae); *Gossypium hirsutum* L. (Malvaceae), *Averrhoa bilimbi* L. (Oxalidaceae); *Passiflora edulis* Sims (Passifloraceae); *Petiveria alliacea* L. (Phytolaccaceae); *Sorghum bicolor* (L.) Moench, *Zea mays* L. (Poaceae); *Eriobotrya japonica* Lindl. (Rosaceae); *Coffea arabica* L., *Palicourea rigida* Kunth (Rubiaceae); *Citrus* spp. (L.) (Rutaceae); *Lantana camara* L. (Verbenaceae); *Qualea grandiflora* Mart., *Q. parviflora* Mart., *Vochysia thyrsoidea* Pohl (Vochysiaceae) and *Zingiber officinale* Roscoe (Zingiberaceae) (Achten 1995; Palmer and Pullen 1995; Solis 1993, 1999; Diniz and Morais 2002; Matienzo et al. 2003; Nava et al. 2006; Rodovalho et al. 2007; Castilho et al. 2010; Ramos et al. 2010; Carregaro et al. 2009; Diniz et al. 2009; Ferreira et al. 2009; Velázquez, et al. 2010; Bolzan et al. 2012; Cock and Burris 2013; Paiva and Yamamoto 2014). We also found *P. erigens* feeding on *Manilkara zapota* (L.) van Royen, which is a **new host record** for this species.

Natural history. The adults can be observed during the rainy season (late May to late October in southern Florida) and during this time the population explodes. They can also be observed in early spring. They exhibit nocturnal habits but sometimes appear at twilight.

The females lay eggs inside the flower. When the larva hatches, it feeds on petals, sepals and the pistil. When it finishes, it begins to make silk tunnels towards other flowers to stick them together. The larval stage lasts 18–23 days. Pupation occurs inside the flower mainly in the unconsumed sepals. The pupal stage lasts 12–14 days.

Damage. *Phidotricha erigens* is a well-known polyphagous species. It recently became a problem to sapodilla growers, mainly because of the larvae feeding in the flowers, which results in flower desiccation and death. When the population was large, we observed up to 6–12 larvae in a single inflorescence.

Management. We found two parasitoids associated with *P. erigens*: a braconid wasp (*Bracon* sp.) and a bethylid wasp (*Goniozus floridanus* (Ashmead)) feeding on larvae. In Venezuela, other parasitoids (e.g. *Apanteles* sp., *Copidosoma* sp., *Eiphosoma* sp., *Hymenochaonia* sp. and *Euplectrus* sp.) were observed parasitizing *P. erigens* (Velázquez et al. 2010). We also observed a spider (Araneidae: *Eriophora ravilla* (Koch)) feeding on adults. The use of insecticides has not been thoroughly investigated.

Subfamily Phycitinae

Comotia torsicornis Dyar, 1914

Dyar (1914) described *Comotia torsicornis* based on Busck's specimens from the USNM. This species is monotypic by original designation.

Description. Egg. White and flat when fresh, changing to grayish-green when they are close to hatching. **Larva.** First and second instar are white with brown head and prothorax with lateral black spots on each side close to head. Third instar yellowish-orange, with thoracic black spots; head changing to orange with black makings in posterior area and close to stemmata. Fourth and fifth instars greenish-brown with black thoracic spots; head greenish-orange with markings as on third instar. Mature larva length 6.9–7.4mm (Fig. 1B). **Pre-pupa.** Paler and wider than the last instar. **Pupa.** Dark-brown. **Adult.** Sexually dimorphic, male is darker and slightly larger. *Wing expanse*: males 10.9–11.6 mm, females 10.5–11.1 mm. **Wings.** Forewings very narrow and long. *Dorsal surface*: gray, with veins dark-gray; separated discal black spots and matte obscure lines; black spots in outer margin. Hindwings gray with darker veins and outer margin. *Ventral surface*: Both wings pale gray with the veins dark-gray. **Head.** *Antennae*: Elongate, ⅓ body length; male with the basal segment triangular, flagellum with a small spine on exterior angle; second segment of flagellum flat, well developed, excavated behind into a pocket, followed by a line of ridges on the next segments. Female, basal segment with curved projection in mesal area; second segment less developed than male; flagellum simple. *Vertex*: Gray. *Mouthparts*: Labial palp with third segment larger than first and second. **Body.** *Thorax and abdomen*: Gray above and pale-gray below. *Legs*: Gray, male middle tibia with fold containing grayish hairs (Fig. 2B).

Distribution. *Comotia torsicornis* is native to the Neotropical Region and occurs mainly in Central America, part of sapodilla's native range. However, this species was also reported in south Florida (Halbert 2008) and France (Leraut 2008, 2014).

Hosts. *Manilkara zapota* (L.) van Royen, recorded by Halbert (2008).

Natural history. Adults are nocturnal. The highest population was seen during the early spring in March, after that they had a period of decline for two months, but then appeared again in summer (late June) in Florida when the flowers started to emerge. The females lay eggs on sepals and petals of flowers and leaf buds. The eggs hatch after six days and the caterpillar bores into the flowers and floral buds. The caterpillar stays in the flower during all stages of development until they reach the pre-pupal stage at about 16–21 days.

During the pre-pupal stage, the caterpillar, after feeding on the flower or floral buds, finds a leaf, where it pupates. The pupal stage lasts around 18–24 days. When the adult emerges, it can live for around four or five days with water provided; however, there is little information about feeding habits of adults.

Damage. The damage occurs during the larval period when there is boring inside of the flowers and floral buds. The caterpillars feed on all floral parts, even within the pedicels, but do not feed on the sepals. Most of the flower damage is internal and not visible until the infested flowers get soft, at the time when larvae come out to look for another flower.

Management. We found an unidentified species of *Bracon* Fabricius parasitizing *C. torsicornis*. We also found a species of spider (*Eriophora ravilla* (Koch)) feeding on *C. torsicornis*. The use of pesticides for this species has not been well studied.

Zamagiria laidion (Zeller, 1881)

Myelois laidion Zeller, 1881
Zamagiria deia Dyar, 1919
Zamagiria striella Dyar, 1919

Zeller (1881) described *Zamagiria laidion* based on a specimen captured by Petersen from Colombia and deposited in the BMNH.

Description. Egg. Whitish-green and flat changing to grayish green just before hatching. **Larva.** First and second instar grayish-green with dark lines throughout the body. Third to fifth instar variable in color; yellowish-green, reddish-brown or brownish-black; the latter color form with grayish mid dorsal line; the head mottled with white dots. Mature larva length, 9.5–11.1 mm (Fig. 1D). **Pre-pupa.** Paler and wider than the last instar. **Pupa.** Greenish-brown and changing to dark-brown before emergence. **Adult.** Sexually dimorphic, males are larger than females. *Wing expanse*: males 20.2–22.9 mm, females 18.2–20.5 mm. **Wings.** Forewings elongated, very narrow posterad and gently extended without a sharp tip. *Dorsal surface*: whitish-gray basally; costal margin mottled with scattered gray scales; two dark-brown transverse curved lines, which are serrated distally (First on postdiscal area and the second on discal area); fold with rough scales from the inner edge to ¾ of the wing width; yellow patch between two dark-brown transverse curved lines; two long dark black bands with a brown patch inside them equidistant from the two transverse lines; whitish line in inner margin along with brown shadows; outer margin with dark line and small square dots; fringe pale brownish-gray anterad and darker posterad. Hindwings glassy; yellowish shimmer along the costal margin gray; anal margin with scattered brown scales. *Ventral surface*: both wings pale-gray, forewings darker than hindwings. **Head.** *Antennae*: Filiform; length extended to middle of body; male with tuft of scales modified at the base. *Vertex*: Grayish-brown. *Mouthparts*: Labial palp marbled in gray and brown; elongated with second segment larger than first and third. **Body.** *Thorax and abdomen*: Grayish-brown dorsally and pale whitish-gray ventrally. *Legs*: Forelegs dark-brown dorsally and pale grayish-brown ventrally; mid-legs and hindlegs uniformly grayish-brown (Fig. 2D).

Distribution. *Zamagiria laidion* has been reported in Neotropical regions especially in Central and South America and some Caribbean Islands (Brazil, Bolivia, Colombia, Cuba, El Salvador, Guana Island, Guatemala, Hispaniola; Panama, Dominican Republic and Venezuela) by Zeller (1881), Rubio-Espina (1968), Marin (1973), Iruegas et al. (2002), Neunzig (2000), Carneiro et al. (2003), Monteiro et al. (2007), Vanegas (2008) and Núñez and Barro (2003). It has also been recorded in the USA (south Florida) by Heppner (2003).

Hosts. *Eriobotyra japonica* Lindl. (Rosaceae); *Manilkara jaimiqui* ssp. *emarginata* (L.) Cronquist, *M. subsericea* (Mart.) Dubard, *M. zapota* (L.) van Royen, *Mimusops elengi* L., (Sapotaceae) (Rubio-Espina 1968; Robinson 1999; Iruegas 2002; Carneiro et al. 2003; Monteiro et al. 2007; Vanegas 2008).

Natural history. Adults are nocturnal and were observed mostly during the summer (late August) to fall (early November) in Florida when there was a considerable increase in population. The population decreased in the winter and increased again in early spring (March-April) but spring populations were still smaller than in the summer. The females commonly oviposit on floral buds, mature flowers, leaf buds, and leaves of sapodilla.

The egg hatches after three to four days and immediately the caterpillar begins boring into the flowers and leaves, which gives the caterpillar a characteristic coloration depending upon what it feeds on.

Individuals that feed on floral parts are reddish green, and those that eat leaf buds are grayish green. The larvae that feed on mature flowers are dark brown with a paler mid-dorsal line and the larvae that feed on leaves are yellowish green. Some larvae stay inside the flower during all development stages (18–24 days) until they reach the pupal stage and others prefer to make a cocoon in the leaves.

The pupal stage is about 19–23 days. The adult life span is seven to nine days feeding only on sugar water. However, we observed some adults feeding on the nectar of sapodilla flowers, but we do not know how this affect the adult life span.

Damage. This species feeds on everything inside the flowers, including sepals and pedicels; these flowers turn reddish green then desiccate and abscise. The entire inflorescence, including leaf buds, is destroyed, with silk tunnels and frass attached to the outside. The larvae also feed on leaves, preferring the new leaves and sometimes eating every part except the midrib.

Management. Some species of parasitic wasps were observed parasitizing *Z. laidion* including *Bracon* sp. and *Goniozus floridanus* (Ashmead). We also found some adults eaten by *Neoscona crucifera* (Lucas). Additionally, some pesticides have been used without a significant result.

Family Sphingidae

Subfamily Macroglossinae

Erinnyis ello (Linnaeus, 1758)

Anceryx ello (Linnaeus, 1758): Walker, 1856
Dilophonota ello (Linnaeus, 1758): Godman and Salvin, 1881
Sphinx cinifera Zikán, 1934
Sphinx omorfia Mooser, 1942

Linnaeus (1758) described *Erinnyis ello* from his own material in the collection of the MLUR.

Description. Egg. Circular and pale green, changing to pale yellow before hatching. **Larva.** All instars usually green, sometimes brown depending on food. The main characteristic of *E. ello* larvae is a big eyespot on the dorsal thorax that is divided by a thin vertical line (Fig. 1J). **Pre-pupa.** Similar to last instar but paler and wider. **Adult.** Sexually dimorphic, male thinner with a black, medial uneven line on forewings extending from basal to apical area, female completely pale-gray, but similar size. *Wing expanse*: 73.9–86.6 mm. **Wings.** Very narrow. *Dorsal surface*: Forewings completely whitish-gray with dark-gray and brown strigiform markings. Hindwings orange with a grayish-black wide line in outer margin. *Ventral surface*: Both wings pale-brown with brown strigiform markings. **Head.** *Antennae*: Whitish-gray; moderately clubbed. *Vertex*: Grayish-brown. *Mouthparts*: Labial palps small. **Body.** *Thorax*: Completely gray, without markings. *Abdomen*: Gray with horizontal black lines and a median gray line dividing those. *Legs*: Pale brown (Fig. 2J).

Distribution. *Erinnyis ello* was incorrectly noted as occurring in India by Linnaeus (1758). This species is native to the Americas. It has been found in the USA, Mexico, Panama, Costa Rica, Dominican Republic, West Indies, French Antilles, Trinidad and Tobago, Ecuador, Argentina, and Brazil (Walker 1856; Godman and Salvin 1881; Zagatti et al. 1995–2006; Lotts and Naberhaus 2015).

Hosts. *Allamanda cathartica* L. (Apocynaceae); *Araujia sericofera* Brot. (Asclepiadaceae); *Carica papaya* L. (Caricaceae); *Cnidoscolus angustidens* Torr., *Euphorbia gymnoclada* Boiss., *E. prostrata* Aiton, *E. pulcherrima* Willd. ex Klotzsch, *E. cyathophora* Murray, *E. heterophylla* L., *E. mesembrianthemifolia* (Jacq.) Dugand, *Hevea brasiliensis* Müll. Arg., *Jatropha gossypiifolia* (Mill.) Müll.Arg., *Manihot esculenta* Crantz, *M. carthaginensis* (Müll.Arg.) Allem, *Ricinus communis* L., *Sebastiana confusa* Lundell and *Sapium aucuparium* Jacq. (Euphorbiaceae); *Arachis hypogaea* L. (Leguminosae); *Gossypium hirsutum* (Malvaceae); *Psidium guajava* L. (Myrtaceae); *Chrysophyllum oliviforme* L., *Manilkara subsericea* (Mart.) Dubard, *M. zapota* (L.) van Royen, *Sideroxylon celastrinum* (Kunth) Penn, *S. salicifolium* (L.) Lam. and *S. tepicense* (Standl.) Penn. (Sapotaceae); *Solanum lycopersicum* L. (Solanaceae) (Bernays and Janzen 1988; Coto et al. 1995; Robinson 1999; Jenkins 2012).

Natural history. The adults are active all year, especially in spring and summer (March-September). Females lay eggs primarily on leaf buds or leaves. Larvae hatch five days later and feed on leaves. Larval development takes 19–28 days. The pupal stage occurs underground and lasts 27–29 days.

Damage. The larva chews the leaf buds and the leaves at any stage. The damage can be easily detected because this species does not consume the entire leaf. Therefore, the plants attacked by *E. ello* have many chewed leaves similar to other sphingid larvae. Leaf damage can be extensive, weakening the plant.

Management. Control of *E. ello* has been studied for many years. Growers initially used chemical pesticides, but due to uncontrolled use almost all are ineffective today. Currently there are many parasitoids (e.g. *Trichogramma minutum* Riley and *Telenomus dilophonotae* Cameron), predators (e.g. *Polistes canadiensis* (Linnaeus)), nematodes and viruses (e.g. *Baculovirus erinnyis* Bellotti, Reyes, and Arias) used as biological control that have had better results (Bellotti et al. 1992; Da Silva-Carvalho et al. 2015). In addition, some spider species, such as *Nephila clavipes* (Linnaeus), play an important role in its control.

Family Thyrididae

Subfamily Striglininae

Banisia argutula Whalley, 1976

Banisia argutula was described by Whalley (1976) based on Le Moult and Klages specimens in the BMNH. *Banisia argutula* has been confused with *B. myrsusalis* Walker since 1990 in south Florida (Myers et al. 2008). It also looks similar to *B. aldabrana* Fryer, which is found in Africa (Fryer 1912). Both of these other species of *Banisia* can be distinguished from *B. argutula* by their male genitalia (Martinez et al. 2017).

Description. Egg. Conical and reddish orange with white ridges before eclosion, after which they change to orange with horizontal red wine lines. **Larva.** First instar orange with gray spots, and a black band on mesothorax through to the dorsal view and dark brown head. Second instar white with black spots; head brown; mesothoracic band as in first instar. Third and fourth instars yellow with black spots; thorax and head copper. Length 8.2–10.9 mm (Fig. 1H). **Pre-pupa.** Similar to last instar but paler and wider. **Adult.** Sexually dimorphic, the male smaller and darker than the female. *Wing expanse*: males 15.4–17.9 mm, females 18.1–19.3 mm. **Wings.** *Dorsal surface*: Forewings grayish-brown with dark-brown strigiform markings and two translucent elongated spots in postdiscal area, anterior spot larger than posterior, males sometimes without translucent spots. Costal and median areas orangish-brown. Hindwings with black strigiform markings, no translucent areas. *Ventral surface*: Both wings pale-gray with black strigiform markings surrounded by pink lines. **Head.** *Antennae*: Diminutively ciliate. *Vertex*: Grayish-brown. *Mouthparts*: Labial palp copper; third segment smaller than second, with pinkish-purple dot on the tip. **Body.** *Thorax and abdomen*: Grayish-brown above and pale-gray below. *Legs*: Grayish-brown (Fig. 2H).

Distribution. *Banisia argutula* is native to the Neotropics. This moth has been found in French Guiana, Guyana and Suriname (Whalley 1976). Martinez et al. (2017) reported this species from the USA in south Florida based on some specimens previously misidentified as *B. myrsusalis*.

Hosts. *Manilkara zapota* (L.) van Royen (Martinez et al. 2017).

Natural history. Adults are active almost all year, mainly during the rainy season (late May to late October in south Florida). The females lay eggs primarily on the base of the floral buds or open flowers, but will also lay eggs on twigs, leaf buds, and on the fruit. Upon emerging from the egg (after four days), the larva chews a hole in a floral bud, enters the flower, and spins a silk plug covering the entrance hole. While the larva feeds, it covers the walls of flowers or fruits with silk. The larval stage lasts about 12–16 days. Pupation occurs mainly on fruits and flowers. Pupal stage lasts 17–20 days.

Damage. The larva chews holes in the base of floral buds or mature flowers, enters the flower, and consumes everything except the sepals. A single larva is able to join together several flowers and floral buds using silk to avoid exposure to predators. Larvae can also feed on leaves rolling them together as well, or bore into the fruit. It can complete its development in the rolled leaves, damaged flowers or inside of the fruit. When flowers are infested with larvae, they turn reddish brown and larval excrement is evident before drying completely.

Management. Chemical insecticides have not been thoroughly investigated. There are many natural enemies that help to control *B. argutula* (e.g. orb weaver spiders, lizards, birds).

Banisia myrsusalis (Walker, 1889)

Pyralis myrsusalis Walker, 1859
Pyralis elaralis Walker, 1859
Siculodes cinereola Felder, Felder and Rogenhofer, 1875
Siculodes scallula Guenée, 1877
Durdara lobata Moore, 1882
Durdara pyraliata Moore, 1882
Durdara zonula Swinhoe, 1886
Striglina radiata Pagenstecher, 1892

Walker (1859) described *Banisia myrsusalis* from specimens of Tweedie's collection at the BMNH.

Description. Egg. Shiny pink and reddish-brown with white ridges. After hatching, they turn orange as in *B. argutula*. **Larva.** First and second instar are transparent yellow changing to green after feeding; thorax brown. Third and fourth instar as previous, but with two dark-brown lateral patches on thorax. Larva length 6.8–8.9 mm (Fig. 1G). **Pre-pupa.** Similar to the last instar but paler and wider. **Adult.** Sexually dimorphic, male cinereous and slightly smaller than female; female reddish-cinereous. *Wing expanse*: males 19.4–20.1 mm, females 20.8–21.7 mm. **Wings.** *Dorsal surface*: Forewings grayish-brown with strigiform markings and from one to three translucent small spots in postdiscal area, anterior spot larger than posterior, bilateral asymmetry may occur. Males sometimes without translucent spots; costal and median areas ochraceous brown. Hindwings without translucent spots; brownish-black strigiform markings and a thin pink marginal line present. *Ventral surface*: both wings pale-brown with brownish-black strigiform markings surrounded by pale orange. **Head.** *Antennae*: Diminutively ciliate. *Vertex*: Cinereous. *Mouthparts*: Labial palp cinereous with third segment smaller than second. **Body.** *Thorax and abdomen*: Cinereous dorsally and pale-brown ventrally. *Legs*: Pale-brown (Fig. 2G).

Distribution. *Banisia myrsusalis* is a species that it is native to the Neotropical Region, it was introduced to Asia and had been recorded in the USA mainly in Florida USA (Whalley 1976; Martinez et al. 2017), Brazil (Guenée 1877; Soares-da Silva et al. 2003; Monteiro et al. 2007). It has also been reported in the West Indies (Pagenstecher 1892; Whalley 1976; Bendicho-Lopez 1998; Núñez-Águila 2004) and Asia including India, Sri Lanka (Sandhu and Sran 1980; Jhala et al. 1988; Patel et al. 1993; Sathish et al. 2013, 2015), Malaysia (Corbett 1929; Holloway 1970), Hong Kong (Ades and Kendrick 2004), Japan (Hiroshi 1998) Indonesia, Madagascar, Thailand (Whalley 1976) and Vietnam (Konvička et al. 1998). Widely distributed in Africa (Whalley 1976; De Prins and De Prins 2019), Papua New Guinea and Australia (Whalley 1976; Herbison-Evans and Crossley 2014).

Hosts. *Banisia myrsusalis* is an oligophagous moth previously associated only with plants of the Sapotaceae including *Chrysophyllum cainito* L., *C. oliviforme* L., *Madhuca longifolia* (J. Konig) J. F. Macbr., *Manilkara zapota* (L.) van Royen, *M. subsericea* (Mart.) Dubard, *Mimusops elengi* L. and *Pouteria caimito* Radlk.) (Bendicho-Lopez 1998; Robinson 1999; Silva et al. 2003; Monteiro et al. 2007). However, it has also been reported feeding on *Terminalia elliptica* Willd. (Combretaceae) (De Prins and De Prins 2019), and *Ficus* sp. (Moraceae), the latter of which is a **new host record**.

Natural history. The adults are active during late summer (early August in southern Florida), increasing their populations during the rainy season. The females have been observed laying eggs mainly on the twigs, leaf buds, and fruit (Soares-da Silva et al. 2003).

Four or five days after hatching, the larva rolls up in a leaf and chew a small hole where it starts to feed. When the larva finishes feeding within the leaf, it makes a second hole and moves to another leaf. The larval stage lasts 12–15 days. The pupal stage lasts 16–21 days. Pupation occurs mainly inside rolled leaves.

Damage. When leaves are infested with larvae, they are transparent green with many blotch mines. After the larvae emerge from the leaves, the leaves become pale yellowish brown.

Management. Contact pesticides are not effective because the larvae feed inside the leaves. For this reason, control is very difficult. Myers et al. (2008) used pesticides in sapodilla without significant effects. During our investigation we saw many predators that are natural enemies of both *B. myrsusalis* and *B. argutula* (see, *B. argutula* management).

Family Tortricidae

Subfamily Olethreutinae

Dichrorampha sapodilla Heppner, 1981

Hemimene sp., Kimball, 1965

Dichrorampha sapodilla was described by Heppner (1981) along with another new species of *Dichrorampha* Guenée from Florida based on a specimen in the Baranowski collection at the USNM. *D. sapodilla* feeds on sapodilla, while *D. manilkara* Heppner, 1981 feeds on wild dilly (*Manilkara bahamensis* (Baker) Lam. and Meusse). It is a congener of *D. azteca* Walsingham, 1914 and *D. odorata* Brown and Zachariades, 2007.

Description. Egg. Translucent yellow in newly laid eggs and translucent golden-yellow before they hatch. **Larva.** Transparent yellowish-white with head dark-orange from first to fourth instar; fifth instar body not transparent; dark yellowish-white; head dark-orange. Mature larva length 2.9–3.2 mm (Fig. 1A). **Pre-pupa.** The same as the last instar, but thoracic segments wider and body paler. **Pupa.** Yellow except for head, which is brown; some spines present dorsally on abdomen. **Adult.** Not sexually dimorphic. *Wing expanse*: 3.6–4.7 mm. **Wings.** *Dorsal surface*: forewings narrow and long; gray with dark band angled toward apical area from middle of wing to basal third of inner margin; six to seven matte-black strigiform markings in costal area continue diagonally toward tornus, surrounded by orangish-yellow; costal margin with white borders; four apical black strigiform markings surrounded by orangish-yellow through tornus distad acute curve at radius; tornus without orangish-yellow; a large matte-dark spot with orangish-yellow on distal area of spot; speculum with five small dark spots in orangish-yellow area; matte-gray in fringe; hindwings dark-gray; fringe pale-gray. *Ventral surface*: Both wings shiny bronze. **Head.** *Antennae*: Filiform, distally brown and dark-gray, ⅓ body length. *Vertex*: Grayish-brown. *Mouthparts*: Palps small pale brownish-gray. **Body.** *Thorax and abdomen*: Brownish-gray above and pale-gray below. *Legs*: Brownish-gray (Fig. 2A).

Distribution. *Dichrorampha sapodilla* is native to the USA. It has only been found it in south Florida (Heppner 1981; Myers et al. 2008).

Hosts. *Manilkara zapota* (L.) van Royen recorded by Heppner (1981) and Myers et al. (2008).

Natural history. The adults have been observed flying year-round in Florida (Heppner, 1981). Females lay eggs on the petals and sepals of mature flowers. Upon hatching, the neonate larva bores into the flowers and eat the petals and the base of the pistil. The duration of larval development ranges from 12–16 days.

Pupation takes place inside of the sepals where the larva makes a silken cocoon utilizing its excrement. The duration of the pupal stage is close to 15–17 days. Adult moths usually feed on nectar from flowers and also drink water; however, the feeding habits of adult moths of the sapodilla pod borer have not been studied. This species has been observed only in sapodilla (Heppner, 1981).

Damage. The larvae feed on mature flowers only, mainly on the petals and the base of pistil, damaging several flowers until they complete larval development and begin pupation. The petals in damaged flowers turn reddish brown, dry and die. This moth can cause significant losses.

Management. Currently just one parasitoid, an unidentified species of *Bracon*, has been found associated with larvae of the sapodilla pod borer. There are other natural enemies (e.g. *Gasteracantha cancriformis* (Linnaeus)). Potential insecticides for the sapodilla pod borer moth have not been thoroughly investigated (Myers et al. 2008).

Ecological variables

Species abundance data for all observed lepidopterans are provided in Table 2. We found that *Phidotricha erigens* was the most abundant species (30%, 324 individuals), followed by *Banisia argutula* (22%, 236 individuals) and *Holcocera crassicornella* (13%, 138 individuals). The least abundant species were *Pyroderces badia* (2%, 22 individuals) and *Erinnyis ello* (1%, 16 individuals). The months of greatest abundance were April (205 individuals), May (244 individuals) and June (409 individuals), while the fewest were March (46 individuals) and August (43 individuals). Also, a negative relationship (R^2=0.042) was found between climate variables and the abundance of Lepidoptera species, as depicted in the ombrothermic diagram (Fig. 3).

Table 2. Species of Lepidoptera observed during the 2015 sampling period in Florida. Ind. = Number of individuals; % = Percentage of the total individuals collected.

Species	Ind.	%
Banisia argutula Whalley	236	22
Banisia myrsusalis Walker	49	5
Comotia torsicornis Dyar	88	8
Dichrorampha sapodilla Heppner	108	10
Electrostrymon angelia (Hewitson)	30	3
Erinnyis ello (Linnaeus)	16	1
Holcocera crassicornella Dietz	138	13
Phidotricha erigens Ragonot	324	30
Pyroderces badia (Hodges)	22	2
Zamagiria laidion (Zeller)	59	6

Discussion

During this work, we observed that larval damage caused a catastrophic problem with pollination, with most trees not setting fruit. This may be because sapodilla flowers cannot pollinate themselves, but need a second plant in order to be cross-pollinated, even though they produce many flowers. Mickelbart (1996) reported sapodilla trees produce many flowers but only ~39% of the flowers were set. The reduction in the number of flowers per tree by lepidopteran pests could interfere with cross-pollination, thus reducing production.

The species *Holcocera crassicornella* and *Phidotricha erigens* are newly recorded here on sapodilla and these showed to produce more damage in the assessed crops along with *Banisia argutula.* We found that *B. myrsusalis* does not cause flower and fruit damage, as reported by Myers et al. (2008), Crane and Mossler (2013) and Crane et al. (2016) in Florida, but *B. argutula* does (Martinez et al. 2017). *Banisia myrsusalis* found in Florida crops has the same leaf-folding behavior as reported by Patel et al. (1993) and Soares-da Silva et al. (2003).

The species reported as *Zamagiria* sp. by Myers et al. (2008), was identified as *Z. laidion* and was the only species of this genus associated with sapodilla trees, as reported by Heppner (2003).

Many species of spiders were observed during this investigation. However, only *Eriophora ravilla*, *Gasteracantha cancriformis, Nephila clavipes* and *N. crucifera* were directly observed interacting with Lepidoptera at our study sites. These spiders may play an important role as predators of these species and act as a natural pest control in such crops.

Precipitation and temperature did not appear to affect the abundances of these species, similar to what was reported by Roy et al. (2008), who showed that many species of Lepidoptera are not influenced by climate variables. In contrast, Checa et al. (2014) suggest these variables could affect the composition, abundance and phenology of this community, however, those effects were not detected during this investigation.

Conclusions

Banisia argutula had previously been misidentified as *B. myrsusalis*. There is no information about this species in its place of origin, probably because it is not considered a pest.

The species *Electrostrymon angelia*, *Holcocera crassicornella*, *Pyroderces badia*, and *Phidotricha erigens* are newly recorded on sapodilla. *Electrostrymon angelia* and *Banisia myrsusalis* are new records for loquat and ficus, respectively. Remarkably, this is the first time that moths in the families Blastobasidae and Cosmopterigidae have been recorded on Sapotaceae. *Holcocera crassicornella*, *P. erigens* and *B. argutula* were observed to cause the most damage to sapodilla.

We found many potential parasitoid and predator species that could be used as biological control agents. Four were spiders. However, more investigations on their usefulness are warranted. Two families of parasitic wasps (Bethylidae and Braconidae) were observed on larvae of these pests.

Further investigations of the biology of these pests, potential biological control agents, other types of management, are recommended. We also recommend further study as to how environmental and cultural variables could affect this parasite and predator community.

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Figure 1. Larvae of Lepidoptera pests of sapodilla. **A)** *Dichrorampha sapodilla* Heppner. **B)** *Comotia torsicornis* Dyar. **C)** *Holcocera crassicornella* Dietz. **D)** *Zamagiria laidion* (Zeller). **E)** *Electrostrymon angelia* (Hewitson). **F)** *Phidotricha erigens* Ragonot. **G)** *Banisia myrsusalis* Walker. **H)** *Banisia argutula* Whalley. **I)** *Pyroderces badia* (Hodges). **J)** *Erinnyis ello* (Linnaeus).

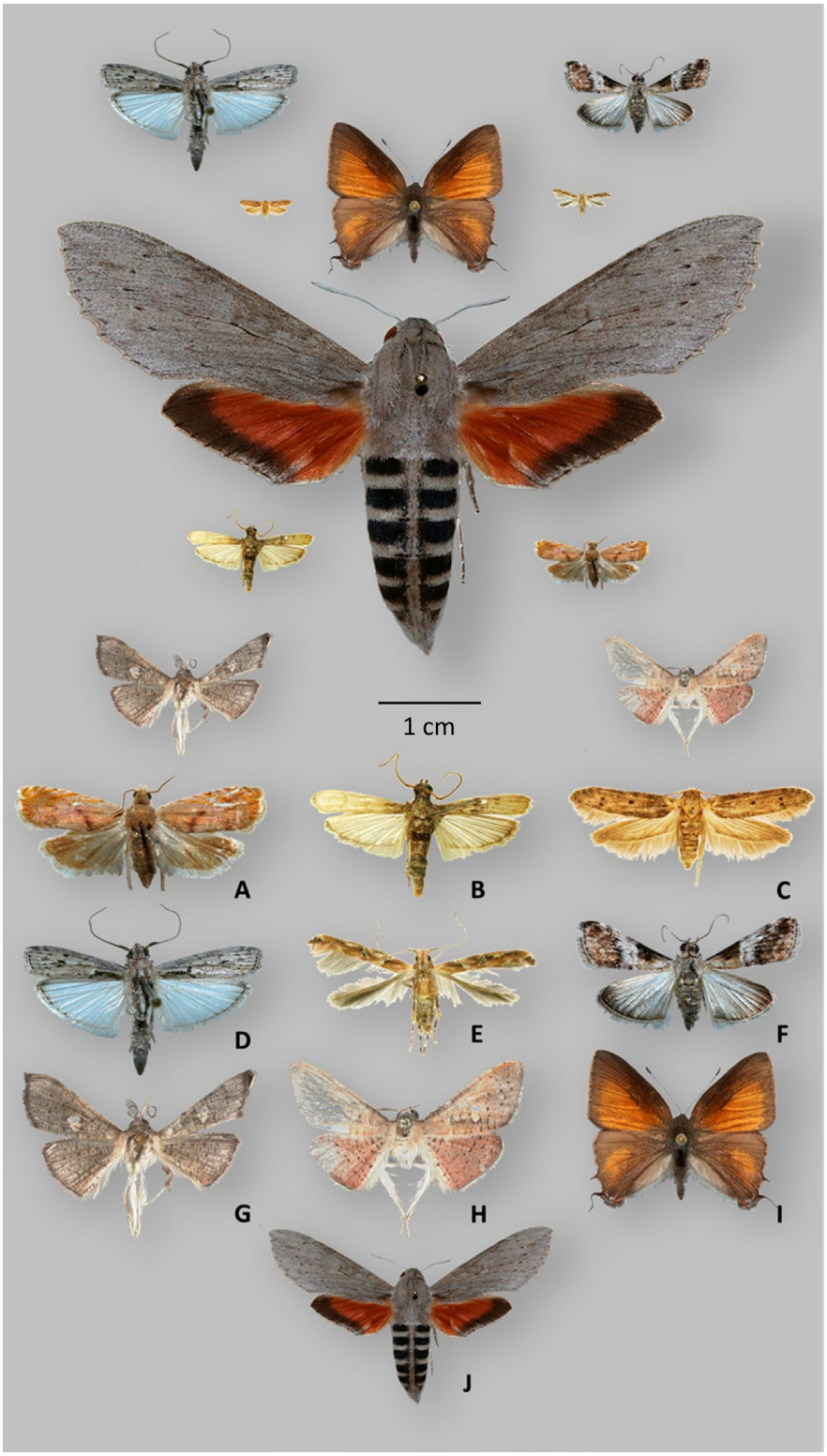

Figure 2. Adults of Lepidoptera pests of sapodilla. The unlabeled images in the top half of the figure are to scale, whereas the labeled images in the bottom half of the figure have been resized. **A)** *Dichrorampha sapodilla* Heppner. **B)** *Comotia torsicornis* Dyar. **C)** *Holcocera crassicornella* Dietz. **D)** *Zamagiria laidion* (Zeller). **E)** *Pyroderces badia* (Hodges). **F)** *Phidotricha erigens* Ragonot. **G)** *Banisia myrsusalis* Walker. **H)** *Banisia argutula* Whalley. **I)** *Electrostrymon angelia* (Hewitson). **J)** *Erinnyis ello* (Linnaeus).

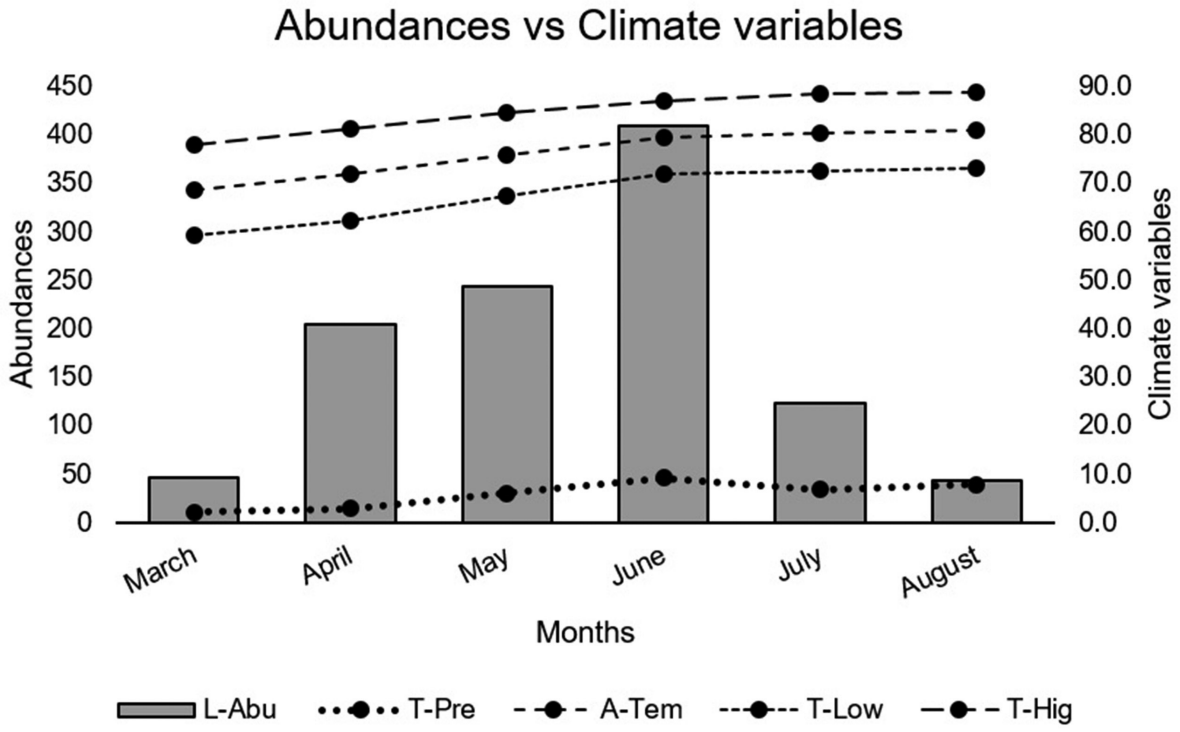

Figure 3. Ombrothermic diagram comparing abundances of species and climate variables. L-Abu= Lepidoptera abundances; T-Pre= Total monthly precipitation; A-Tem= Monthly average temperatures; T-Low= Monthly average low temperatures; T-Hig= Monthly average high temperatures.