

Scientific Note: New county records for a tropical fruit-piercing moth, *Eudocima apta* (Walker, 1858), in Florida: A potential agricultural pest (Lepidoptera, Calpinae)

Lawrence E. Reeves^{1*}, Jonathan S. Bremer² and Isaiah J. Hoyer³

¹Entomology and Nematology Department, University of Florida, P.O. Box 110620 Steinmetz Hall, Gainesville, Florida 32611, USA

²McGuire Center for Lepidoptera and Biodiversity, Florida Museum of Natural History, University of Florida, P.O. Box 112710, Gainesville, Florida, 32611, USA

³Florida Medical Entomology Laboratory, University of Florida, 209 9th St. SE, Vero Beach, Florida, 32962, USA

*Corresponding author; E-mail: lereeves@ufl.edu

Abstract: *Eudocima apta* (Walker, [1858]) is a primarily tropical fruit-piercing moth that occurs naturally in Central America, northern South America and the Caribbean. Singleton strays are occasionally collected in North America, as far north as Canada, but established populations are not known from Florida or anywhere else in the USA. Here, we present observations of multiple adult *E. apta* congregated and feeding in a native fig tree at the southernmost point of mainland Florida, and a single individual collected in Miami-Dade County, Florida, representing the first records of this species in Miami-Dade County, and the first published records for Monroe County, Florida.

Keywords: Noctuoidea, Erebidae, Everglades National Park, Miami-Dade County, Monroe County, fruit pest

Eudocima apta (Walker, 1858) is a fruit-piercing moth in the Erebidae subfamily Calpinae. The Calpinae are a lineage of noctuid moths with specialized mouthparts for feeding on the fluids of fruits, mammalian blood, or the tears of mammals, birds and reptiles (Hilgartner *et al.*, 2007). Adult calpine moths have sclerotized probosces, often with barbs, hooks, or cutting ridges used to pierce fruit or mammalian skin (Zaspel *et al.*, 2011). Adult moths can be pests of commercial fruit crops. Damage by fruit-piercing moths makes fruit unmarketable, susceptible to secondary infection by plant pathogens or other insects, or causes early fruit fall in citrus. In Florida, outbreaks of the calpine moth *Gonodonta nutrix* (Cramer, 1780) have seriously damaged citrus crops in the past (Todd, 1959).

The genus *Eudocima* Billberg, 1820 includes 47 species distributed throughout tropical and subtropical regions, with eight described species occurring in the Neotropics (Zilli & Hogenes, 2002). Adult *Eudocima* are polyphagous, feeding from a variety of hard- and soft-skinned fruits (Fig. 1). Some species are serious pests of commercial fruit production. *Eudocima* species have been documented feeding from at least 50 cultivated fruit crops, and are particularly damaging to citrus (Fay, 2002; Davis *et al.*, 2005). In Asia and Australia, loss of citrus crops attributed to *Eudocima* is frequently 10-15%, but may be up to 50-95% when moth abundance is high (Fay & Halfpapp, 2006). Currently, no *Eudocima* species are known to be damaging to fruit production in Florida (J. Hayden, pers. comm. 2016, FDACS-DPI regulatory records), or elsewhere in the United States. However, the United States Department of Agriculture (USDA) has assessed the potential risks of U.S. introduction of *Eudocima phalonia* (L., 1763), published a screening aid for the species, and recommends that any *Eudocima* species encountered be reported to the agency (Davis *et al.*, 2005; Gilligan & Passoa, 2016).



Figure 1. Adult *Eudocima* feed by piercing the skin of fruit with their sclerotized probosces. Fruit can be damaged by feeding, particularly when secondary infections are introduced through the wound made by the proboscis.

On three nights in June 2016, we made observations of an aggregation of adult *E. apta* feeding from the figs of a single *Ficus aurea* Nutt., 1846 tree at Flamingo, Everglades National Park, Monroe County, Florida (25°08'11.1"N, 80°56'26.4"W). We observed 8, 14, and 19 adult moths on the nights of 9, 10, and 14 June 2016, respectively. All observations were made between 23:00 and 02:00. On all three nights, both sexes were present, with the sex ratio approximately equal. Most individuals were observed actively feeding from ripe figs, but several were seen hovering near the tree, apparently in search of figs or landing sites. No instances of mating, or interactions between individuals, were observed. In some cases, multiple individuals were observed within 1 m of each other (Fig. 2). The *F. aurea* tree (Fig. 3) was over 10 m in height. Moths were

observed on the terminal branches that held figs, at heights between the lowest branches, *c.* 2 m from the ground, to the upper canopy. In southern Florida, *F. aurea* trees may produce fruit at any time of the year (Bancroft *et al.*, 2000), and fruiting within populations may be asynchronous (Bronstein & Patel, 1992). In the vicinity of Flamingo, additional mature *F. aurea* trees were abundant, but none had ripe figs, and moths were observed only on the single individual. All specimens appeared in good condition, and none were noticeably worn (Fig. 4). Specimens were not collected, in accordance with U.S. national park regulations. These observations are the first published records of *E. apta* in Monroe County, Florida, but a single individual was observed by the Keys Moth project on Big Pine Key, also in Monroe County, in March of 2016 (Fine, 2016).

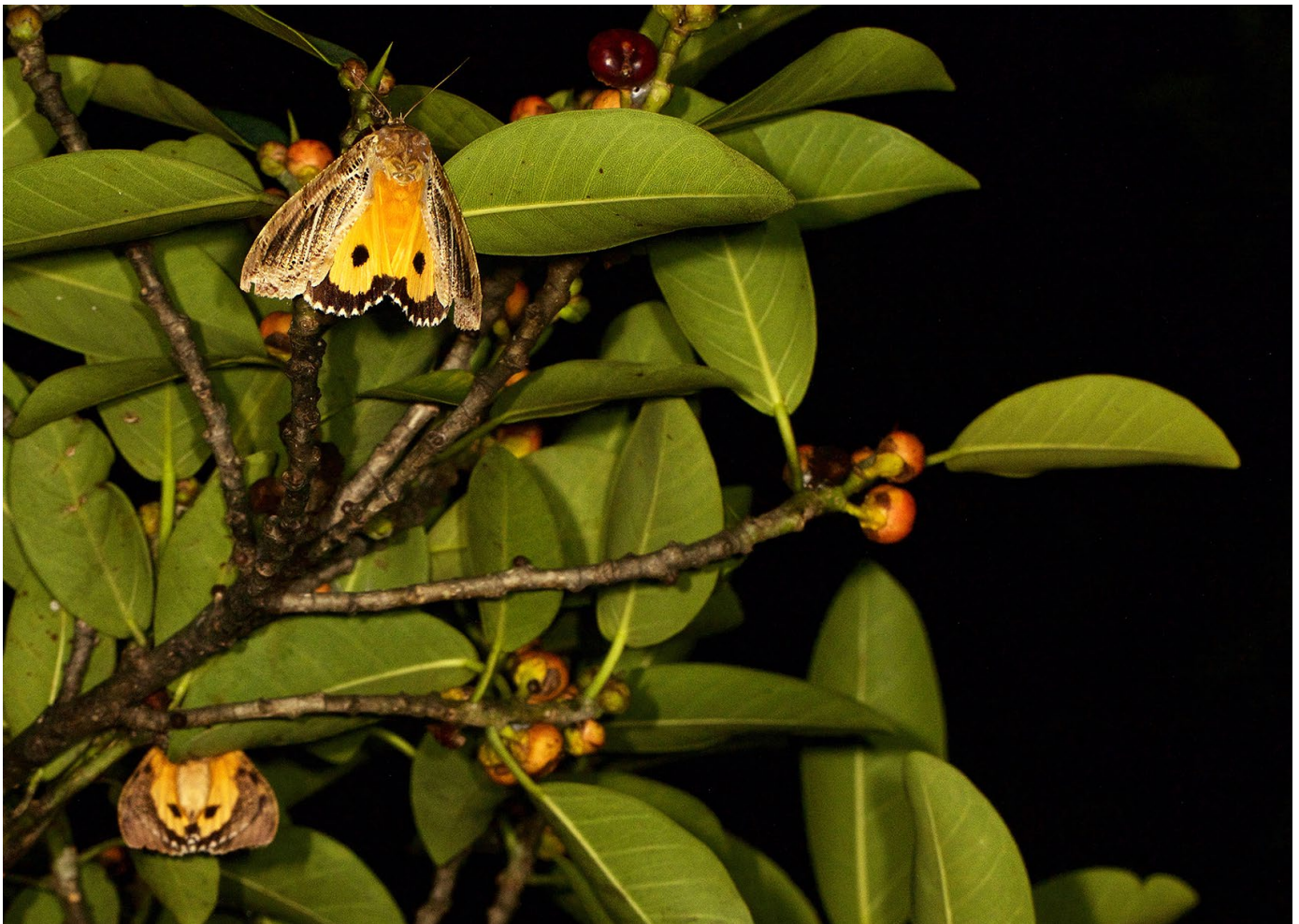


Figure 2. Multiple adult *Eudocima apta* individuals feeding from *Ficus aurea* figs at Flamingo, Monroe County, Florida on 14 June 2016. In many instances, moths were in close proximity to each other. The individual in the foreground is a female.

An additional female was observed by IJH and LER, and collected by IJH, on 13 June 2016 at a roadside *F. aurea* along S.R. 9336 in Miami-Dade County (25°24'29.8"N, 80°31'24.1"W). To our knowledge, this is the first record of this species in Miami-Dade County. Identification was confirmed by James E. Hayden, and the voucher was deposited in the Florida State Collection of Arthropods, Florida Department of Agriculture and Consumer Services, Division of Plant Industry (Hayden, 2016).

Eudocima apta is a Neotropical species that was formerly considered conspecific with *Eudocima materna* (L., 1767), an Old World species (Zilli & Hogenes, 2002). Older records of Neotropical *E. materna* refer to *E. apta*. *Eudocima apta* occupies a distribution that extends from Mexico to northern South America. Four specimens are known from Cuba (Brou & Aguilla, 2013). Specimens of *E. apta* have been collected in North America, as far north as Ontario, Canada. These individuals are believed to represent strays, as established



Figure 3. On several nights in June 2016, adult *Eudocima apta* were observed congregated in this strangler fig, *Ficus aurea*, at the Flamingo Campground in Everglades National Park.

populations are not known in the USA or Canada (Gilligan & Passoa, 2016). Brou *et al.* (2013) reviewed the verified North American records of *E. apta*. In Florida, 12 individuals of both sexes have been collected and verified between 1971 and 2013 in Alachua, Clay, Gadsden, Highlands, Levy, Liberty, Manatee, Palm Beach and Sarasota Counties. Associated collection data suggests that all specimens were collected singly, usually at lights or fruit baits, between March and June (Brou, 2006).

Eudocima larvae feed primarily on vines in the family Menispermaceae de Jussieu, 1789 (Reddy *et al.*, 2005). The

host plants of *E. apta* are not well characterized, but larvae have been collected from two menisperm species: *Disciphania heterophylla* Barneby, 1981 (Menispermaceae) in Costa Rica (Janzen & Hallwachs, 2009), and a species of *Odontocarya* Miers, 1851 (Menispermaceae) in Panama (Van Bael *et al.*, 2004). Powell & Brown (1990) listed *E. apta* as polyphagous in Mexico. Plants in the genus *Erythrina* L., 1753 (Fabaceae Lindl., 1836) produce secondary compounds, particularly tetracyclic alkaloids, similar to many of the menisperm *Eudocima* host plants (Amer *et al.*, 1991). In some areas, *Eudocima phalonia* has expanded its host range to include *Erythrina* where both *Erythrina* and menisperm hosts are present (Fay, 1996; Sands & Chan, 1996). In southern Florida, Menispermaceae is represented by a single, native species, *Cissampelos pareira* L., 1753, a state-listed endangered species that is known from Miami-Dade County, but not Monroe County (FDACS, 2015; Wunderlin *et al.*, 2016). However, *Erythrina herbacea* L., 1753 is present at Flamingo, and the plants are relatively abundant in the area (Seavey & Seavey, 2012). While *E. apta* has not been recorded from *Erythrina* hosts, the plants were readily available to adult moths. We inspected *Erythrina herbacea* plants at the Flamingo campground within 1 km of the fruiting *F. aurea* tree from which moths were feeding and did not find larvae.

To our knowledge, the observations presented here are the first records of congregations of *E. apta* individuals in the USA. Based on the current information, and without observations of larvae, it is not possible to make conclusions on the status of



Figure 4. An adult male *Eudocima apta* feeding from *Ficus aurea* figs at Flamingo, Monroe County, Florida on 9 June 2016.



Figure 5. Larva of *Eudocima phalonia*. The larvae of *E. apta* are similar in appearance. Both have a blackish body, and two conspicuous eyespots on both the second and third abdominal segments.

E. apta in Florida. However, the presence of individuals of both sexes in a small area, adult food sources, and potential larval host plants raise the possibility that *E. apta* is breeding in southern Florida. On the other hand, Flamingo is located along the coast of Cape Sable, the southernmost point of the mainland United States, and our observations at this site were made within 500 m of Florida Bay. A speculative possibility is that this location is a convenient stopover for migrating moths moving northward from populations on the Yucatán peninsula or Cuba. Further study is required to fully determine the status of *E. apta* as a sporadic stray, seasonal migrant or established resident in southern Florida. Surveys for larvae on potential host plants should be made to determine if reproduction occurs in the state. The larvae of *E. apta*, as in *E. phalonia* (Fig. 5), have a black body, with four prominent dorsal eyespots (two each on the second and third abdominal segments). Images of larvae to aid in the identification of *E. apta* can be found online by searching the database at <http://janzen.sas.upenn.edu> for *Eudocima* (Janzen & Hallwachs, 2009). Visual surveys for adult moths can be made at night by inspecting fruit-bearing trees and fallen fruit with a flashlight, and watching for the eyeshine of feeding moths, or by setting out fermenting fruit baits (Gilligan & Passoa, 2016). Further observations of either adults or larvae should be reported to a regional USDA identifier.

The subtropical climate of southeastern Florida supports an economically important tropical fruit industry. Many of the fruit crops grown in the area are susceptible to attack by fruit-piercing moths, including citrus, mango, papaya, lychee, longan, pineapple, strawberry, and tomato. Considering the close proximity of our observations to this industry, it is important to better understand the status of *E. apta* in southern Florida, and any potential threat it poses to the fruit industry. Further, a potential larval host plant, *Cissampelos pareira* is a state-listed endangered plant that is known in Florida only from Miami-Dade County. The presence of *E. apta*, particularly as a recently established population, may have implications for its conservation.

ACKNOWLEDGEMENTS

We are grateful for the help of Dr. James E. Hayden in examining our specimens and photographs, and to both him and Dr. Jennifer Gillett-Kaufman in reviewing our manuscript and

discussing our observations. We also thank Everglades National Park and P. J. Walker for enabling the fieldwork under which these observations were made.

LITERATURE CITED

- Amer, M. E., Shamma M., Freyer, A. J. 1991. The tetracyclic *Erythrina* alkaloids. *Journal of Natural Products* 54: 329- 363.
- Bancroft, G. T., Bowman, R., Sawicki, R. J. 2000. Rainfall, fruiting phenology, and the nesting season of white-crowned pigeons in the upper Florida Keys. *The Auk* 117: 416-426.
- Brou, V. A. B. 2006. A new U.S. record for the tropical fruit-piercing moth *Eudocima serpentifera* (Walker, [1858]). *Southern Lepidopterists' News* 28: 105-108.
- Brou, V. A. B., Aguila, R. N. 2013. *Eudocima toddi* (Zayas, 1965) (Lepidoptera: Erebidae) a rare and endemic species of Cuba. *Southern Lepidopterists' News* 35: 92-93.
- Brou, V. A. B., Giese, A.R., Miller, D. H. 2013. A new U.S. state record for a tropical fruit-piercing moth in the family Erebidae Leach. *Southern Lepidopterists' News* 35: 27-28.
- Bronstein, J. L., Patel, A. 1992. Causes and consequences of within-tree phenological patterns in the Florida strangling fig, *Ficus aurea* (Moraceae). *American Journal of Botany* 79: 41-48.
- Davis, E. E., French S., Venette, R.C. 2005. *Mini Risk Assessment. Fruit Piercing Moth: Eudocima fullonia Green* (Lepidoptera: Noctuidae). United States Department of Agriculture, Animal and Plant Inspection Service, CAPS PRA, 43 pp.
- Fay, H. A. C. 1996. Evolutionary and taxonomic relationships between fruit-piercing moths and the Menispermaceae. *Australian Systematic Botany* 9: 227-233.
- Fay, H.A. C. 2002. Fruit piercing moths and fruit spotting bugs: Intractable pests of tree fruits in a reduced-insecticide environment. *Acta Horticulturae* 575: 485-493.
- Fay, H. A. C., Halfpapp, K. H. 2006. Fruit maturity and soundness relevant to feeding choice by fruit-piercing moths (Lepidoptera: Noctuidae) in citrus crops in northeast Australia. *International Journal of Pest Management* 52: 317-324.
- Gilligan, T. D., Passoa, S. C. 2016. *Screening Aid. Fruit Piercing Moth: Eudocima phalonia*. United States Department of Agriculture, Animal and Plant Inspection Service, CAPS PRA.
- Hayden, J. E. 2016. *Entomology Section*. Anderson, P. J., Hodges G. S. (Eds). *Triology* 55: 6 (http://www.freshfromflorida.com/content/download/73090/1975659/Triology_July__September_55-3_2016_SM.pdf) (accessed 12 March 2017).
- Hilgartner, R., Raoilison, M., Buttiker, W., Lees, W., Krenn, H. W. 2007. Malagasy birds as host for eye-frequenting moths. *Biology Letters* 3: 117-120.

- Janzen, D. H., Hallwachs, W.** 2009. *Dynamic database for an inventory of the macrocaterpillar fauna, and its food plants and parasitoids, of Área de Conservación Guanacaste (ACG), northwestern Costa Rica* (<http://janzen.sas.upenn.edu>).
- Fine, D.** 2016. 8543 *Eudocima apta* (<http://www.keysmoths.com/8543-eudocima-apta>) (accessed 17 November 2016).
- Pague, C. A., Brou, V. A. B.** 2013. A second confirmed record of *Eudocima serpentifera* (Walker, [1858]) (Lepidoptera: Erebidae) in the United States. *Southern Lepidopterists' News* 35: 179.
- Powell, J. A., Brown, J. W.** 1990. Concentrations of lowland sphingid and noctuid moths at high mountain passes in eastern Mexico. *Biotropica* 22: 316-319.
- Reddy, G. V. P., Cruz, Z. T., Muniappan, R.** 2006. Attraction of fruit-piercing moth *Eudocima phalonia* (Lepidoptera: Noctuidae) to different fruit baits. *Crop Protection* 26: 664-667.
- Sands, D. P. A., Chan, R. R.** 1996. Survivorship of Australian *Othreis fullonia* on *Erythrina variegata*: hypotheses for development of host plant biotypes in the Pacific. *Entomologia Experimentalis et Applicata* 80: 145-148.
- Seavey, S., Seavey, J.** 2012. *Caloplaca lecanorae* (Teloschistaceae), a new lichenicolous lichen and several additions to the North American lichenized mycota from Everglades National Park. *The Bryologist* 115: 322-328.
- Todd, E. L.** 1959. *The Fruit Piercing Moths of the Genus Gonodonta Hübner*. Agricultural Research Service, Technical Bulletin No. 1201. Washington, D.C., United States Department of Agriculture.
- Van Bael, S. A., Aiello, A., Valderrama, A., Medianero, E., Samaniego, M., Wright, S. J.** 2004. General herbivore outbreak following an El Niño-related drought in a lowland Panamanian forest. *Journal of Tropical Ecology* 20: 625-633.
- Wunderlin, R. P., Hansen, B. F., Franck, A. R., Essig, F. B.** 2016. Atlas of Florida Plants (<http://florida.plantatlas.usf.edu/>). Institute for Systematic Botany, University of South Florida, Tampa, USA.
- Zaspel, J. M., Weller, A. R., Branham, M.A.** 2011. A comparative survey of proboscis morphology and associated structures in fruit-piercing, tear-feeding, and blood-feeding moths in Calpinae (Lepidoptera: Erebidae). *Zoomorphology* 130: 203-225.
- Zilli, A., Hogenes W.** 2002. An annotated list of the fruit piercing moth genus *Eudocima* Billberg, 1820 (*sensu* Poole) with descriptions of four new species (Lepidoptera: Noctuidae, Catocalinae). *Quadrifina* 5: 153-207.