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A FLORIDA DEFOLIATOR, *NYSTALEA EBALEA* (LEPIDOPTERA: NOTODONTIDAE), FOUND FEEDING ON BRAZILIAN PEPPERTREE

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The insect fauna associated with the invasive weed Brazilian peppertree (*Schinus terebinthifolia* Raddi; Sapindales: Anacardiaceae; hereafter *Schinus*) in Florida, USA includes 115 species of mostly generalist herbivores, predators, and flower-feeders (Cassani 1986; Cassani et al. 1989). Following these early surveys, one additional species was discovered, namely the fruit-feeding torymid wasp *Megastigmus transvaalensis* (Hussey) that is adventive from South Africa (Habeck et al. 1989; Wheeler et al. 2001; Scheffer & Grissell 2003).

More recently, in 2005 a Neotropical species of Notodontidae, *Nystalea ebalea* Stoll, was discovered feeding on *Schinus* in South Florida (Fig. 1A; shown in color in Suppl. Fig. 1A online in Florida Entomologist 96(3) (2013) at <http://purl.fcla.edu/fcla/entomologist/browse>). This species was previously reported in Florida from a single specimen collected in the 1920s in the Everglades National Park. Such a single report of a rather large and conspicuous insect was suspected of being a temporary establishment, or a 'waif', possibly the result of an extreme weather event (M. G. Pogue, USDA/ARS/SEL, personal communication). Until it was discovered in Florida by the author, this same species was considered as a potential biological control agent of *Schinus* when it was discovered in Argentina and Brazil (Mc Kay et al. 2009). The objectives of this study were to document the

occurrence of this species in south Florida and provide details of its life history.

Individuals were collected as larvae on *Schinus* from several sites in South Florida. Collections occurred from Aug to Nov 2006 at 3 locations in Broward (N 26.083505° W 80.239580°; N 26.045257° W 80.263674°) and Miami Dade (N 25.952163° W 80.430596°) Counties, Florida. Natural populations of larvae continue to appear frequently in our experimental *Schinus* garden at the USDA/ARS Invasive Plant Research Lab in Ft Lauderdale, FL (N 26.084312° W 80.240386°). Larval parasitism was found from two species, *Chetogena* sp. near *scutellaris* Wulp and *Hyphantrophaga sellersi* Sabrosky (Diptera: Tachinidae). A laboratory colony was established under ambient conditions and the larvae were fed bouquets of *Schinus*. Voucher specimens were deposited at the USDA/ARS/IPRL reference collection, Florida State Collection of Arthropods, DPI, FDACS, Gainesville, Florida and the USDA/ARS Systematic Entomology Laboratory, Beltsville, Maryland.

Adults were provided with bouquets of *Schinus* leaflets inserted in floral Aquapics (10 cm; Syndicate Sales Inc., Kokomo, IN, USA) for oviposition. Eggs laid on leaflets were incubated under ambient conditions (27 °C; 12:12 h photoperiod) and monitored for larval emergence. After hatching the larvae were placed individually in Petri dish-

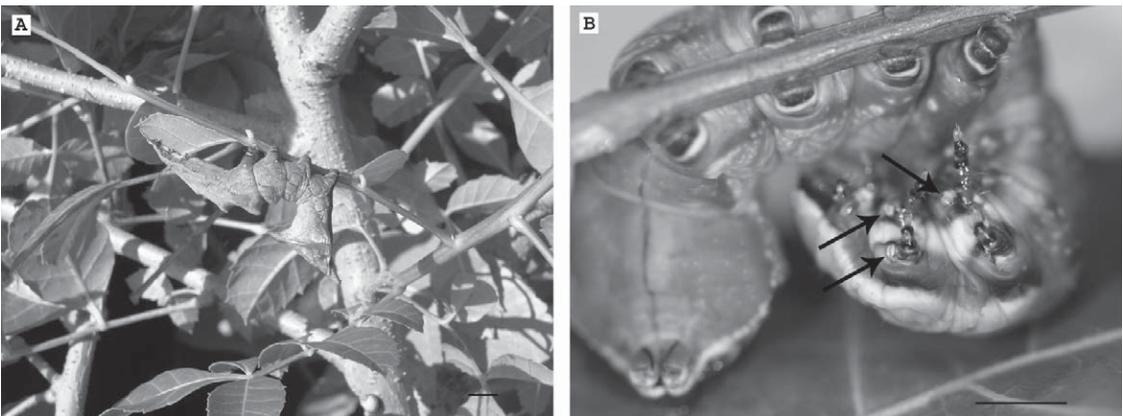


Fig. 1A. Larva of *Nystalea ebalea* feeding on leaflets of *Schinus*, and Fig. 1B coxal yellow glands (arrows) located at the base of each thoracic leg. Scale bar represents 1 cm.

es (9 cm diam) and observed daily until pupation. Leaflets were replaced, filter paper was changed and frass was removed as needed. Larvae were moved to larger (15 cm diam) Petri dishes in the 4th instar. Upon pupation, pupae were moved to circular plastic containers (11.4 × 5 cm) to allow room for adult emergence. Pupae were sexed by examining the location and shape of the genital pore (Oleiro et al. 2010). Additionally, the head capsule widths of a cohort of 18 neonates were measured after each molt under magnification (40-X). A one-way ANOVA was conducted with SAS/PC to determine if gender influenced development time (SAS Institute 2008).

Larvae were examined for the location of exocrine gland openings which is a characteristic of this insect family (Weatherson et al. 1986). Solitary bright yellow coxal exocrine glands were found at the base of each thoracic leg (Fig. 1B; shown in color in Suppl. Fig. 1B online in Florida Entomologist 96(3) (2013) at <http://purl.fcla.edu/fcla/entomologist/browse>). These glands were seen to swell and contract when provoked by light tapping of the larvae.

Eggs were laid on the leaflet surface and required 3-5 days for larval emergence. Generally there were 5 instars (one larva required 6) that ranged in stadial length from 3.8 days during the first, to 5.2 days during the last instar (Table 1). In general agreement with Dyar's rule (Dyar 1890), each successive head capsule width increased about 1.5 × from the previous instar, except for the single larva that required 6 instars. Total larval development time to the pupa stage was 20-22 days and was not influenced by insect gender. Pupation occurred inside a retreat consisting of plant leaflets glued together with silk by the last instar larva.

Surveys for biological control agents of *Schinus* have been conducted in South America since the 1950s and have continued to the present (Hight et al. 2002; Mc Kay et al. 2009; Wheeler unpublished data). An important extension of these surveys is to compare the species found associ-

ated with the plant in its native range with those found in the introduced range. The discovery of *N. ebalea* in Florida allowed researchers to cancel consideration of this species and focus resources on other potential biological control agents with greater potential for impacting the target weed.

SUMMARY

A species of Notodontidae, *Nystalea ebalea* was discovered feeding on leaflets of the invasive weed *Schinus terebinthifolia* Raddi (Sapindales: Anacardiaceae) in south Florida. The larvae of this species generally have 5 instars and require 20-22 days to reach the pupal stage. Discovery of wild populations of this Neotropical species in the weed's invasive range precluded its consideration as a classical biological control agent.

Key Words: *Schinus terebinthifolia*, biological control of weeds, life history, exocrine glands

RESUMEN

Una especie de Notodontidae, *Nystalea ebalea* fue descubierta alimentándose en hojas de la especie invasiva *Schinus terebinthifolia* Raddi (Sapindales: Anacardiaceae) en el sur de la Florida. Las larvas de esta especie generalmente tienen 5 estadios y requieren 20-22 días para alcanzar el estado pupa. El decubrimiento de poblaciones silvestres de esta especie Neotropical en el rango de la maleza invasiva, impedido su consideración como un agente para el control biológico clásico.

Palabras Clave: *Schinus terebinthifolia*, control biológico de malezas, historia de vida, glándula exocrina

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TABLE 1. MEAN (\pm SE) *NYSTALEA EBALEA* LARVAL HEAD CAPSULE WIDTHS AND INSTAR DURATION WHEN FED *SCHINUS* LEAFLETS. ONLY ONE INDIVIDUAL REQUIRED A 6TH INSTAR.

	Instar	N	Head capsule width (mm)	No. days	\pm SEM
	1	18	0.7	3.9	0.1
	2	18	1.1	3.8	0.1
	3	18	1.7	3.8	0.2
	4	18	2.5	4.3	0.4
	5	18	3.8	5.2	0.2
	6	1	4.0	5.0	.
Total	Males	9		20.2 ¹	0.8
	Females	8		22.0	1.0

¹Development time to the pupal stage was not influenced by gender ($F = 1.9$; $df = 1, 14$; $P > 0.1$)

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