

NEW HOST PLANT RECORD FOR THE POISON IVY SAWFLY, *ARGE HUMERALIS* (HYMENOPTERA: ARGIDAE), AND ITS PERFORMANCE ON TWO HOST PLANT SPECIES

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ABSTRACT

The poison ivy sawfly, *Arge humeralis* Beauvois, was previously known to feed only on poison ivy, *Toxicodendron radicans* (L.) Kuntze. However, in 2009, larvae were discovered in southern Florida feeding on poisonwood, *Metopium toxiferum* (L.) Krug and Urban. To better characterize the host range of *A. humeralis*, we compared larval performance on *T. radicans* and *M. toxiferum*. Adults oviposited on both plant species, and days to pupation and survival to adulthood were similar. With the exception of longer 1st and 4th stadia on *T. radicans*, stadia were also similar. Most mortality occurred during pupation. The use of *M. toxiferum* by *A. humeralis* indicates a wider range of hosts and of ecosystems than previously known for this insect.

Key Words: *Toxicodendron radicans*, Poisonwood, *Metopium toxiferum*, Anacardiaceae, host range, larval performance

RESUMEN

La única hospedera previamente conocida de la avispa de sierra de la hiedra venenosa, *Arge humeralis* Beauvois, era la hiedra venenosa, *Toxicodendron radicans* (L.) Kuntze. Sin embargo, en 2009, las larvas fueron encontradas en el sur de Florida alimentándose en poisonwood, *Metopium toxiferum* (L.) Krug y Urban. Para caracterizar mejor el rango de los hospederos de *A. humeralis*, comparamos el rendimiento larval en *T. radicans* y *M. toxiferum*. Los adultos ovipositaron en las dos especies, y el tiempo para llegar a la etapa de pupa y la sobrevivencia a la etapa adulta fueron similares. La mayoría de la mortalidad ocurrió durante la pupación. Con la excepción de los estadios primero y cuarto mas largo en *T. radicans*, los estadios tambien fueron similares. El uso de *M. toxiferum* por *A. humeralis* representa un rango más amplio de hospederos y de ecosistemas que los reportados previamente para este insecto.

Translation provided by the authors.

The poison ivy sawfly, *Arge humeralis* (Beauvois) (Hymenoptera: Argidae) was first described in 1809 and ranges throughout eastern North America (Smith 1989; Palisot de Beauvois 1809). Two plant species and one subspecies, all in the genus *Toxicodendron* (Sapindales: Anacardiaceae), have been recorded as hosts: *T. radicans* (L.) Kuntze (poison ivy), *T. radicans* (L.) Kuntze ssp. *eximium* (Greene) Gillis, and *T. vernix* (L.) (poison sumac) (Smith 1989). *Arge humeralis* is the only sawfly in the family Argidae known to feed on Anacardiaceae. This sawfly has been considered for use in biological control of *T. radicans* in Bermuda (Regas-Williams 1979), making its host range of particular interest.

Although *T. radicans* occurs in a wide range of disturbed habitats, *A. humeralis* has previously

been most common in open, disturbed cypress swamps (Smith 1989). Eggs are inserted into the leaf tissue along the leaf margin. Early instars feed gregariously, whereas later instars are usually solitary. Herein, we report the first documented use by *A. humeralis* of poisonwood, *Metopium toxiferum* (L.) Krug and Urban (Sapindales: Anacardiaceae), as a host plant. We also compare the ability of larvae to feed on *T. radicans* and *M. toxiferum*.

MATERIALS AND METHODS

New Host Plant Record

In May 2009, an infestation of *A. humeralis* was discovered on *M. toxiferum* in the Ludlam Pineland Preserve (Miami-Dade County, Florida)

by D. Powell and J. Possley. The preserve is a 4 ha remnant of unaltered pine rockland forest comprised of *Pinus elliottii* Engelm. var. *densa* (Pinales: Pinaceae), some hardwoods, and a shrub layer of saw palmetto, *Serenoa repens* (Bartram) J. K. Small (Arecales: Arecaceae). Due to prescribed burns, *T. radicans* is present at very low densities in the preserve. *Metopium toxiferum* is very common, but the sawfly infestation was concentrated in the western 10% of the preserve.

A cohort of 18 larvae from this infestation was sent to University of Florida, Gainesville on 22 Jun 2009 and reared in the laboratory on potted *M. toxiferum* in clear acrylic cylinders (20 cm diam × 60 cm high). The 8 males and 5 females that survived to adulthood served as the founder population of a laboratory colony. Females laid a total of 203 eggs, 79.8% of which hatched, beginning on 24 Jul 2009. As before, these larvae were placed on potted *M. toxiferum*. Plants and insects were maintained under a 15:9 h L:D photoperiod at 24.8 ± 1.0 °C and $62.4 \pm 5.4\%$ RH. Larvae that had pupated in the soil at the base of the plant were collected and individually placed into 29.6 ml plastic cups with 15 ml of moistened vermiculite until adult emergence.

Comparison of Larval Host Plants

Upon emergence, adults were provided potted *T. radicans* or *M. toxiferum* in clear acrylic cylinders (20 cm diam × 60 cm high) for oviposition. Insects were provided Gatorade® (0.46 mg Na, 0.13 mg P, 0.04 g sucrose, and 0.02 g fructose per mL water) (Perrone et al. 2005) in a 15 ml vial with a cotton wick. When eggs were about to eclose, the leaves containing eggs were removed and kept in Petri dishes (1.5 cm diam × 9 cm high) on moistened filter paper.

Two cohorts of neonates ($N = 30$ per cohort) were placed individually in Petri dishes with 2.5 cm leaf discs of *T. radicans* or *M. toxiferum* on moistened filter paper. Leaf discs were replaced when desiccated or consumed. Mature larvae were transferred to 29.6 ml plastic cups with 15 ml of moistened vermiculite for pupation. The trial was conducted under a 14:10 L:D photoperiod at 26.1 ± 0.0 °C and $70.0 \pm 0.2\%$ RH. The stadium for each instar, age at pupation, and survival were recorded for each larva. An analysis of variance was conducted to detect differences between host plants in the stadium of each instar, larval development time, and pupal stadium (SAS Institute 2010) after verifying variance homogeneity and normality.

RESULTS

New Host Plant Record

The sawflies collected in 2009 ($N = 2$) and 2011 ($N = 7$) were identified as *A. humeralis* by

D. Smith of the Department of Entomology, National Museum of Natural History, Smithsonian Institution, Washington, DC. The mesonota of the specimens were red with black spots on the lateral lobes. The coloration was on the paler end of the range of variation for the species, as is typical of Florida specimens (Smith 1989). Voucher specimens were deposited in the National Museum of Natural History in Washington, DC and in the Florida State Collection of Arthropods in Gainesville, Florida.

Comparison of Larval Host Plants

Females readily oviposited on both *T. radicans* and *M. toxiferum*, and larval development was complete in 17.9 ± 0.6 d ($N = 26$) and 17.8 ± 0.6 d ($N = 22$), respectively (Fig. 1, $F_{1,46} = 0.19985$, $P = 0.6580$). Most mortality occurred during pupation.

Larvae on *T. radicans* had a shorter 1st and 4th stadium ($F_{1,51} = 7.6768$, $P = 0.0078$ and $F_{1,46} = 10.3022$, $P = 0.0024$, respectively) than larvae on *M. toxiferum* (Fig. 2). The other stadia were of similar duration ($P > 0.1$).

The variances of the larval stadia, larval development time, and pupal stadium were homogeneous (Brown-Forsythe test, $P > 0.08$). Histograms showed that the data sets are normally distributed, with one exception. The pupal stadium is bimodal, so the data was stratified to reflect the two distinct groups: a group that emerged within 18-77 d and another that emerged in 120-222 d. Each group was analyzed by ANOVA. The insects in the first group remained in the pupal stage for 45.0 ± 7.2 d and 48.0 ± 13.7 d on *T. radicans* and *M. toxiferum*, respectively ($F_{1,15} = 3.2154$, $P = 0.0931$). The insects in the second group remained in the pupal stage for 148.7 ± 7.8 d and 173.4 ± 10.1 d on *T. radicans* and *M. toxiferum*, respectively ($F_{1,8} = 0.0455$, $P = 0.8365$).

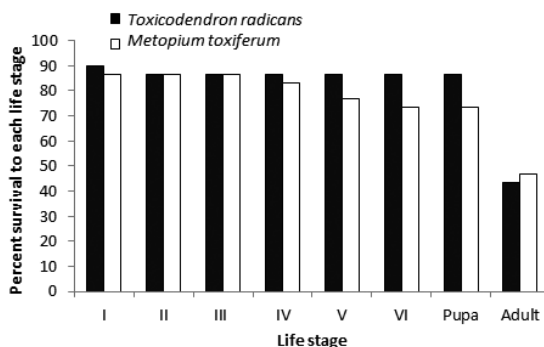


Fig. 1. Percent survival of each life stage of *Arge humeralis* on 2 plant species ($N = 30$ larvae per plant species). The 6th instar is represented by females only, as male *A. humeralis* pupate after 5 instars (Smith 1989).

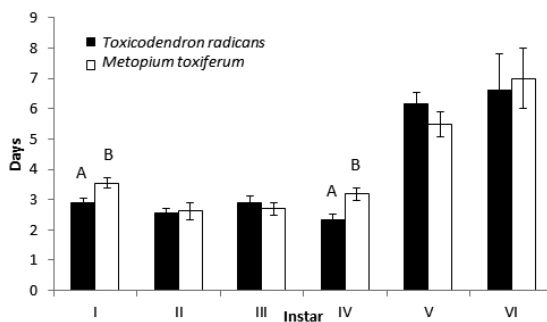


Fig. 2. The mean stadium ($\pm$ SE) for each instar of *Arge humeralis* on 2 plant species ($N = 30$ larvae per plant species). Only durations of completed instars are included in the calculation of means, i.e., if a larva died before molting to the next instar, that last duration was not included. Bars with different letters above them are significantly different within an instar, using analysis of variance. The 6th instar is represented by females only, as male *A. humeralis* pupate after 5 instars (Smith 1989)

CONCLUSIONS

Our results suggest that both *T. radicans* and *M. toxiferum* are equally suitable food sources. Total larval durations, stadia, and numbers of emerged adults were similar on the two plant species, with the exception of the 1st and 4th stadia. Additional fitness measures such as adult weight and fecundity would be helpful to compare host suitability of these 2 plant species. Research on the mating and oviposition behavior of *A. humeralis* is also needed to understand how these behaviors might influence host selection.

The development time to pupation on *T. radicans* is consistent with that reported by Regas-Williams and Habeck (1979). The pattern observed of increasing stadia durations with each successive instar on *T. radicans* is also consistent with their report, although their values were slightly larger. In contrast, pupal duration was much shorter in the older study (10.3–10.6 d on *T. radicans*), suggesting the insects entered a seasonal or laboratory-induced diapause in the current study. The insects in the 1979 study hatched 2 mos earlier in the year than most of ours.

Our discovery of *A. humeralis* feeding on *M. toxiferum* in both 2009 and 2011 represents a new host record and not an aberrant case. This new record indicates a wider range of hosts and of ecosystems than originally known for this insect. Both *T. radicans* and *M. toxiferum* are found in hammocks and other woodlands, but *M. toxiferum* is also found as a shrub in coastal sand dunes (Small 1933) and generally in drier habitats than *T. radicans*. It is unknown how long *M. toxiferum* has been used a host, but the native ranges of *A. humeralis* (Taeger 2010) and both plant species (Wunderlin 1998; Tomlinson 1980) all overlap in

southern Florida. Use of *M. toxiferum* as a host expands the possible native range of *A. humeralis* to the Caribbean, where this sawfly was once considered for release as a biocontrol agent of the introduced *T. radicans* (Regas-Williams and Habeck 1979).

Both *T. radicans* and *M. toxiferum* are in the Anacardiaceae subfamily of the Anacardiaceae (Mitchell 2006). Both contain oily organic compounds called urushiols (also known as pentadecylcatechols) which can cause contact dermatitis in humans (Pell 2011). Further investigation into the chemistry of these plants and other anacards may help explain the hosts used by *A. humeralis*, and predict other potential or unnoticed hosts.

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REFERENCES CITED

- MITCHELL, J. D., DALY, D. C., PELL, S. K., AND RANDRIANA-SOLO, A. 2006. *Poupartioptis* gen. nov. and its context in Anacardiaceae classification. Syst. Bot. 31: 337–348.
- PALISOT DE BEAUVOIS, A. M. F. J. 1809. pp. 89–100 In A. M. F. J. Palisot De Beauvois and J. G. A. Serville, Insectes recueilles en Afrique et en Amérique, dans les Royaumes d'Oware et de Benin, A Saint-Dominique et Dans les États-Unis, Pendant les Années 1786–1797 Schoell and Cie., Paris, France.
- PELL, S., MITCHELL, J., MILLER, A., AND LOBOVA, T. 2011. Anacardiaceae, Vol. 10: pp. 7–50 In K. Kubitzki [ed.], Flowering Plants, Eudicots: Sapindales, Cucurbitales, Myrtaceae. Springer-Verlag, Berlin Heidelberg.
- PERRONE, C., LAITANO, O. AND MEYER, F. 2005. Effect of carbohydrate ingestion on the glycemic response of type 1 diabetic adolescents during exercise. Diabetes Care 28: 2537–2538.
- REGAS-WILLIAMS, K. A., AND HABECK, D. H. 1979. Life history of a poison-ivy sawfly *Arge humeralis* (Beauvois) (Hymenoptera: Argidae). Florida Entomol. 62: 356–363.
- SAS INSTITUTE. 2010. JMP Version 9, Cary, NC.
- SMALL, J. K. 1933. Manual of the Southeastern flora. The University of North Carolina Press, Chapel Hill, NC.
- SMITH, D. R. 1989. The Sawfly Genus *Arge* (Hymenoptera: Argidae) in the Western Hemisphere. Trans. Am. Entomol. Soc. 115: 83–198.
- TAAGER, A., BLANK, S. M., AND LISTON, A. D. 2010. World Catalog of Symphyta (Hymenoptera) - Abstract, additions and corrections. Beiträge Entomol. 60: 300.
- TOMLINSON, P. B. 1980. The biology of trees native to tropical Florida. Harvard University Printing Office. Allston, MA.
- WUNDERLIN, R. 1998. Guide to the vascular plants of Florida. University Press of Florida, Gainesville, FL.