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ADULT *PHYLLOPHAGA EPHILIDA* HOST PLANT FEEDING PREFERENCE

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ABSTRACT

Limited biological information about *Phyllophaga ephilida*, a major sweet potato pest in Louisiana, is available. In 2001 and 2002, a study was conducted in the laboratory to investigate the feeding preference of adult *Phyllophaga ephilida* (Say) (Coleoptera: Scarabaeidae) for the foliage of eight woody plant species: water oak (*Quercus nigra* L.), live oak (*Quercus virginiana* Mill.), red maple (*Acer rubrum* L.), slash pine (*Pinus caribaea* Morelet), pecan (*Carya illinoensis* (Wangenh) K. Koch), sweetgum (*Liquidambar styraciflua* L.), southern magnolia (*Magnolia grandiflora* L.), and American elm (*Ulmus americana* L.). Beetles were placed in an arena with the eight host plants and allowed to feed for 24 h (choice test). Leaf area consumed and change in leaf weight were recorded. In 2001 and 2002, host plant had a significant effect on both leaf area and weight consumed. In 2001, mean leaf area (mm^2) consumed was pecan (504), followed by elm (314), water oak (237), maple (176), live oak (38.0), and sweetgum (4.00). Southern magnolia and slash pine were not consumed. In 2002, mean leaf area (mm^2) consumed was pecan (628), followed by elm (390), water oak (204), maple (75.0), and live oak (30.0). Southern magnolia, sweetgum, and slash pine were not consumed. In 2001, mean leaf consumption (mg) was pecan (8.400), water oak (3.700), maple (3.500), live oak (1.300), elm (0.300), and sweetgum (0.060). Southern magnolia and slash pine were not consumed. In 2002, mean leaf consumption (mg) was pecan (10.00), elm (4.200), water oak (3.200), maple (1.500), and live oak (1.000). Southern magnolia, sweetgum, and slash pine were not consumed. *Phyllophaga ephilida* exhibited a preference for pecan, oak, and elm. They avoided slash pine and southern magnolia.

Key Words: adult feeding, phytophagous, *Phyllophaga ephilida*, sweet potato

RESUMEN

Información biológica sobre *Phyllophaga ephilida,* una plaga principal de batata en el estado de Louisiana es limitada y poca disponible. En 2001 y 2002, un estudio fue realizado en el laboratorio para investigar la preferencia alimenticia de adultos de *Phyllophaga ephilida* (Say) (Coleoptera: Scarabaeidae) para el follaje de ocho especies de plantas leñosas: roble americano (*Quercus nigra* L.), roble de Virginia (*Quercus virginiana* Mill.), arce rojo (*Acer rubrum* L.), pino (*Pinus caribaea* Morelet), pacana (*Carya illinoensis* (Wangenh) K. Koch), ocozol (*Liquidambar styraciflua* L.), magnolio (*Magnolia grandiflora* L.) y olmo americano (*Ulmus americana* L.). Los escarabajos fueron puestos en una arena de ocho plantas hospederas y permitieron alimentarse por 24 h (prueba de escoger). El área de la hoja consumida y el cambio en el peso de la hoja fueron notados. En 2001 y 2002, el hospedero de planta tuvo un efecto significativo en el área y el peso de la hoja consumida. En 2001, el promedio del área de hoja (mm^2) consumida de pacana fue 504, siguido por olmo (314), roble americano (237), arce (176), roble de Virginia (38.0) y ocozol (4.00). El magnolio y el pino no fueron consumidos. En 2002, el promedio del área de hoja (mm^2) consumido fue pacana (628), seguido por olmo (390), roble americano (204), arce (75.0) y roble de Virginia (30.0). El magnolia sureño, olmo y el pino no fueron consumidos. En 2001, el promedio de hoja consumida (mg) fue pacana (8.400), roble americano (3.700), arce (3.500), roble de Virginia (1.300), olmo (0.300) y ocozol (0.060). El magnolio y el pino no fueron consumidos. En 2002, el promedio de hoja consumida (mg) fue pacana (10.00), olmo (4.200), roble americano (3.200), arce (1.500) y roble de Virginia (1.000). El magnolio, ocozol y pino no fueron consumidos. *Phyllophaga ephilida* mostró una preferencia para pacana, roble y olmo. Ellos evitaron el pino y el magnolio.

Adult June beetles are nocturnal defoliators of trees, shrubs, and grasses in diverse ecological regions (Richter 1958; Vallejo et al. 1998). Several reports describe adult *Phyllophaga* spp. feeding on the foliage of woody plants (Davis 1916; McLeod 1986; Potter 1998). However, the host range and feeding preference of adult *Phyllophaga ephilida* have not been investigated. Insects may be classified as monophagous (host range includes plants of one or a few closely related species within a genus), oligophagous (host range includes several genera within a family), or polyphagous (host range includes several families in one or more orders of plants) (Metcalf & Luckman 1975). Often the common traits of the preferred hosts are phytochemical.

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The larvae of *P. ephilida* damage sweet potato roots in Louisiana (Rolston & Barlow 1980). Most commercial sweet potato fields in Louisiana are relatively small (about thirty hectares) and bordered by tree lines or woody areas. These trees may provide food for adults. Knowledge of the host range and feeding preference of adults for the common tree species in south central Louisiana would help in understanding the ecology of the pest and perhaps explain the specific distribution of the pest among grower fields.

The purpose of this study was to investigate the feeding preference of *P. ephilida* adults for the foliage of eight trees common in the sweet potato growing areas of Louisiana.

Materials and Methods

Host preference tests were conducted in an arena constructed from an 11.3-L Rubbermaid® plastic container (40.6 × 28.5 × 27.5 cm) with a snap cover. An opening (10 by 40 cm) was cut in the center of the plastic cover and flexible screen (1.02 mm) was glued to the edges of the opening with a hot glue gun to allow for airflow and to prevent beetles from escaping. A layer of sand (3 cm deep) was placed in the bottom of the container and a styrofoam board (2 cm thick) was placed on top. Cut into the board were circular holes to accommodate 20-ml glass scintillation vials. These vials stood erect in the board and held the host plant stems. Vials were filled with distilled water, the host plant stems inserted into the top, and parafilm was wrapped over the top of the vial to hold the host plant in place. Young leaves from eight species of trees were harvested 1 h before the experiment. The evaluated leaves were: water oak (*Quercus nigra* L., Fagaceae), live oak (*Quercus virginiana* Mill., Fagaceae), red maple (*Acer rubrum* L., Aceraceae), slash pine (*Pinus caribaea* Morelet, Pinaceae), pecan (*Carya illinoensis* (Wangenh) K. Koch, Juglandaceae), sweetgum (*Liquidambar styraciflua* L., Hamamelidaceae), southern magnolia (*Magnolia grandiflora* L., Magnoliaceae), and American elm (*Ulmus americana* L., Ulmacaeae). All eight test plants were randomly assigned a position in a circular arrangement within the arena. In the field, adult beetles were collected in Japanese beetle pheromone traps (Trece® Incorporated). Pheromones traps consisted of 4 mL of methyl ester of L-isoleucine impregnated in a rubber septum. The traps were placed in commercial sweet potato fields in St Landry Parish, LA, on 22 May 2001 and 4 Jun 2002 and inspected weekly. Beetles were kept in the laboratory 24 h before their use in the experiment at 24°C. The photoperiod was maintained at 16:8 (L: D). Twenty adult *P. ephilida* males were placed in the center of the arena and allowed to feed for 24 h. After 24 h, the consumption was determined by measuring the leaves before and after insect feeding with a leaf area reader (Li-Cor®). Leaf area consumption was calculated by subtracting the final leaf area from the initial leaf area. Leaf weight was measured with a Mettler Toledo® scale. Control leaves without beetles were used to adjust for weight loss due to desiccation. The experiment was conducted in 2001 and 2002, with a randomized complete block design with six replicates for each trial. After each bioassay, the genitalia of all beetles were dissected and a species determination made by A. Diagne. Identified adults were sent to Dr. E. R. Woodruff for confirmation (Gainesville, Florida). The voucher specimens were deposited at the Louisiana State University Entomology Museum. A total of six trials were conducted each year. Data were analyzed by SAS General Linear Model (GLM), and Least Significant Difference (LSD) was used for mean separation (SAS Institute 1990).

Results and Discussion

Leaf area consumed by male *P. ephilida* was different among the eight host plants in 2001 in trial 1 ($F = 4.09$; $df = 7, 5$; $P < 0.0001$), in trial 2 ($F = 2.24$; $df = 7, 5$; $P < 0.0001$), in trial 3 ($F = 8.62$; $df = 7, 5$; $P < 0.0001$), in trial 4 ($F = 6.39$; $df = 7, 5$; $P < 0.0001$), in trial 5 ($F = 9.85$; $df = 7, 5$; $P < 0.0001$), in trial 6 ($F = 9.85$; $df = 7, 5$; $P < 0.0001$) (Table 1). Leaf area consumed by male *P. ephilida* was significant among the host plants in 2002 in trial 1 ($F = 3.08$; $df = 7, 5$; $P < 0.0001$), in trial 2 ($F = 3.32$; $df = 7, 5$; $P < 0.0001$), in trial 3 ($F = 15.65$; $df = 7, 5$; $P < 0.0001$), in trial 4 ($F = 3.56$; $df = 7, 5$; $P < 0.0001$), in trial 5 ($F = 9.26$; $df = 7, 5$; $P < 0.0001$), in trial 6 ($F = 8.06$; $df = 7, 5$; $P < 0.0001$) (Table 2). No discernible losses in leaf area were detected in the controls, hence adjustment for water loss was not made to leaf area measurements of the treatments. In 2001, mean leaf area consumed by male *P. ephilida* was pecan, 504 mm^2, followed by elm (314 mm^2), water oak (237 mm^2), maple (176 mm^2), live oak (38.0 mm^2), and sweetgum (4.00 mm^2). Southern magnolia and slash pine were not consumed. In 2002, leaf area consumed was pecan, with a mean of 628 mm^2, followed by elm (390 mm^2), water oak (204 mm^2), maple (7.50 mm^2), and live oak (3.00 mm^2). Southern magnolia, sweetgum, and slash pine were not consumed. Leaf area measurement can be a less reliable measurement of beetle feeding than weight due to the variation in leaf density and leaf thickness between plant species. Therefore, consumption (mg) based on fresh weight of foliage consumed also was measured.

The consumption by male *P. ephilida* was different among the eight host plants in 2001 in trial 1 ($F = 4.27$; $df = 7, 5$; $P = 0.0001$), in trial 2 ($F = 2.18$; $df = 7, 5$; $P < 0.0001$), in trial 3 ($F = 7.52$; $df = 7, 5$; $P < 0.0001$), in trial 4 ($F = 3.08$; $df = 7, 5$; $P < 0.0001$), in trial 5 ($F = 12.38$; $df = 7, 5$; $P < 0.0001$), in trial 6 ($F = 5.24$; $df = 7, 5$; $P < 0.0001$)

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TABLE 1. LEAF AREA CONSUMED (MM^2) BY MALE *PHYLLOPHAGA EPHILIDA* (SAY) FROM THE FOLIAGE OF EIGHT PLANT SPECIES IN A CHOICE TEST, 2001.

	Mean area (mm^2) consumed/trial[1]					
Host Plant	1	2	3	4	5	6
Pecan	241 a	836 a	458 a	632 a	723 a	139 b
Elm	137 a	78 b	170 bc	473 ab	236 b	785 a
Maple	140 a	69 b	102 cd	203 bc	0 c	543 a
Live oak	0 b	0 b	8 cd	0 c	0 c	225 b
Water oak	0 b	150 b	329 ab	345 b	53 bc	550 a
Southern magnolia	0 b	0 b	0 d	0 c	0 c	0 c
Sweetgum	0 b	28 b	0 d	0 c	0 c	0 c
Slash pine	0 b	0 b	0 d	0 c	0 c	0 c

[1]Means with the same letter are not significantly different based on LSD test, $P = 0.05$.

TABLE 2. LEAF AREA CONSUMED (MM^2) BY MALE *PHYLLOPHAGA EPHILIDA* (SAY) FROM THE FOLIAGE OF EIGHT PLANT SPECIES IN A CHOICE TEST, 2002.

	Mean area (mm^2) consumed/trial[1]					
Host Plant	1	2	3	4	5	6
Pecan	220 a	546 a	851 a	564 a	1152 a	439 a
Elm	240 a	364 ab	312 b	440 ab	667 b	324 a
Maple	0 b	0 c	80 c	151 bc	217 c	7 b
Live oak	0 b	36 bc	0 c	54 c	63 c	30 b
Water oak	7 b	272 abc	143 bc	448 ab	270 c	85 b
Southern magnolia	0 b	0 c	0 c	0 c	0 c	0 b
Sweetgum	0 b	0 c	0 c	0 c	0 c	0 b
Slash pine	0 b	0 c	0 c	0 c	0 c	0 b

[1]Means with the same letter are not significantly different based on LSD test, $P = 0.05$.

(Table 3). The consumption by male *P. ephilida* also was significant among the host plants in 2002 in trial 1 ($F = 3.09$; $df = 7, 5$; $P < 0.0001$), in trial 2 ($F = 3.56$; $df = 7, 5$; $P < 0.0001$), in trial 3 ($F = 20.68$; $df = 7, 5$; $P < 0.0001$), in trial 4 ($F = 2.87$; $df = 7, 5$; $P < 0.0001$), in trial 5 ($F = 7.84$; $df = 7, 5$; $P < 0.0001$), in trial 6 ($F = 7.31$; $df = 7, 5$; $P < 0.0001$) (Table 4). No discernible losses in weight were detected in the controls, hence adjustments were not made to the leaf weight measurements. In 2001, mean leaf consumed (mg) was pecan (8.400 mg), water oak (3.700 mg), maple (3.500 mg), live oak (1.300 mg), elm (0.300 mg), and sweetgum (0.06 mg). Southern magnolia and slash pine were not consumed at all. In 2002, mean weight consumed was pecan (10.00 g), elm (4.200 mg), water oak (3.200 mg), maple (1.500 mg), and live oak (1.000 mg). Southern magnolia, sweetgum, and slash pine were not consumed. Within the range of host plants evaluated, *P. ephilida* showed a preference for the foliage of pecan, elm, water oak, and maple. Southern magnolia and slash pine were avoided completely, while sweetgum was barely eaten.

Measurements of leaf area and leaf weight consumed revealed a similar ranking of host plant preference. These results suggest that adult *P. ephilida* will feed on plant species in at least four plant families (Juglandaceae, Ulmaceae, Fagaceae, and Aceraceae) indicating a polyphagous feeding habit. Several reports were made based on observations of adult *Phyllophaga* feeding on leaves of trees (Travis 1939; Sweetman 1931). *Phyllophaga hirticula*, *P. tristis*, and *P. fraterna* were reported feeding on hickory and oak (Davis 1916). Sweetman (1931) reported that *P. implicata*, *P. fusca,* and *P. drakei* selectively feed on woody plants. *Phyllophaga implicata* adults were reported to feed on the foliage of elm, ash, poplar, and willow (Lago et al. 1979; McLeod 1986). Adult *Phyllophaga,* not identified to species, have been observed feeding on walnut, persimmon, birch, elm, poplar, hickory, and oak foliage (Potter 1998). Travis (1939) reported that *P. lanceolata* adults were recorded in Iowa feeding on close to thirty host plants, among them corn, soybean, and potato. Sweetman (1931) reported that *P. anxia* feeds on a broad range of herbaceous plants.

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TABLE 3. CONSUMPTION (MG) BY MALE *PHYLLOPHAGA EPHILIDA* (SAY) FROM THE FOLIAGE OF EIGHT PLANT SPECIES IN A CHOICE TEST, 2001.

	Mean weight (mg) consumed/trial[1]					
Host Plant	1	2	3	4	5	6
Pecan	4.0 a	14.0 a	7.6 a	10.5 a	12.0 a	2.3 bc
Elm	1.4 bc	0.8 b	1.8 b	5.1 b	2.5 b	8.5 a
Maple	2.8 ab	1.4 b	2.1 b	4.1 b	0 b	11.1 a
Live oak	0 c	0 b	0.2 b	0 c	0 b	7.5 ab
Water oak	0 c	2.3 b	5.2 a	5.4 b	0.8 b	9.7 a
Southern magnolia	0 c	0 b	0 b	0 c	0 b	0 c
Sweetgum	0 c	0.4 b	0 b	0 c	0 b	0 c
Slash pine	0 c	0 b	0 b	0 c	0 b	0 c

[1]Means with the same letter are not significantly different based on LSD test, $P = 0.05$.

TABLE 4. CONSUMPTION (MG) BY MALE *PHYLLOPHAGA EPHILIDA* (SAY) FROM THE FOLIAGE OF EIGHT PLANT SPECIES IN A CHOICE TEST, 2002.

	Mean weight (mg) consumed/trial[1]					
Host Plant	1	2	3	4	5	6
Pecan	3.5 a	8.7 a	13.6 a	9.0 a	18.4 a	7.0 a
Elm	2.6 a	3.9 b	3.4 b	4.7 abc	7.2 b	3.5 b
Maple	0 b	0 b	1.6 bc	3.1 bc	4.4 bc	0.1 c
Live oak	0 b	1.2 b	0 c	1.8 bc	2.2 bc	0.9 bc
Water oak	0.1 b	4.3 ab	2.2 bc	7.1 ab	4.2 bc	1.3 bc
Southern magnolia	0 b	0 b	0 c	0 c	0 c	0 c
Sweetgum	0 b	0 b	0 c	0 c	0 c	0 c
Slash pine	0 b	0 b	0 c	0 c	0 c	0 c

[1]Means with the same letter are not significantly different based on LSD test, $P = 0.05$.

There is no observation that *P. ephilida* feeds on the foliage of host plants other than woody plants.

The underlying determinant of the host range of *P. ephilida* is likely to be the presence of phytochemicals and/or volatile compounds acting as an attractant or phagostimulant to the beetle. Sweetman (1931) suggested that the odor of plants can influence the direction of flight in some species of *Phyllophaga. Phyllophaga implicita* is attracted to willow twigs, particularly when its foliage has been bruised (Sweetman 1931). The chemical ecology of *P. ephilida* has not been studied. Insects feeding on plants may induce the production of toxins and digestability reducers (Dicke 1999). Constitutive secondary plant chemicals have similar effects on several herbivore species, with only specialist species able to overcome the negative effects of the chemicals. It is probable that secondary compounds are present in the host plants evaluated in this study, and their presence could contribute to the preferences shown by *P. ephilida*. The phenological stage of the host plant is accompanied by changes in the quality or quantity of secondary compounds, water, and oil content, and can affect the feeding behavior of insects. In our study, only the new growth leaves were used so as to keep their age relatively constant.

Phyllophaga ephilida exhibited preference for pecan, oak, and elm. These species commonly are found in tree lines along the edges of commercial sweet potato fields in Louisiana. Their proximity to sweet potato production areas helps explain the abundance of both adult *P. ephilida* that are captured in blacklight traps and pheromone traps, and the presence of damaging populations of larvae in the fields. The feeding sites also are mating sites for the beetles. Therefore, a feeding site can be a good choice for the placement of pheromones for mating disruption of beetle around sweet potato fields. The determination of the nutritional components of the preferred host plants can provide a foundation for a specific diet that will allow further biological studies on *P. ephilida.*

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