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Authors: Buckingham, Gary R., Wineriter, Susan A., Stanley, Jason D., Pratt, Paul D., and Center, Ted D.

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VAGILITY AS A LIABILITY: RISK ASSESSMENT OF THE LEAF-BLOTCHING BUG *EUCEROCORIS SUSPECTUS* (HEMIPTERA: MIRIDAE), A PROSPECTIVE BIOLOGICAL CONTROL AGENT OF THE AUSTRALIAN TREE *MELALEUCA QUINQUENERVIA*

Gary R. Buckingham[1,*], Susan A. Wineriter[1], Jason D. Stanley[2], Paul D. Pratt[3] and Ted D. Center[3]
[1]USDA-ARS Invasive Plants Research Laboratory, P.O. Box 147100, Gainesville, FL 32614-7100

[2]Division of Plant Industry, Florida Department of Agriculture and Consumer Services, P.O. Box 147100, Gainesville, FL 32614-7100

[3]USDA-ARS Invasive Plant Research Laboratory, 3225 College Ave., Fort Lauderdale, FL 33314

*Retired

Abstract

Melaleuca quinquenervia (Cav.) S.T. Blake (Myrtales: Myrtaceae) forms dense monocultures that displace native vegetation in wetlands of southern Florida, USA. Faunal studies in the tree's native Australian range revealed several prospective biological control agents, including the leaf-blotching bug, *Eucerocoris suspectus* Distant (Hemiptera: Miridae). This herbivore was imported into quarantine to assess risk to Florida native and ornamental species after preliminary Australian studies had indicated that it might be useful. Ornamental *Melaleuca* spp. suffered heavy feeding in no-choice adult feeding trials, with moderate feeding on some native Myrtaceae. Native species sustained light to heavy feeding in multi-choice adult feeding trials and in a no-choice nymphal feeding trial. Feeding increased on native species in a large enclosure after *M. quinquenervia* was cut, allowed to dry, and then removed. Nymphs completed development only on *M. quinquenervia* and ornamental bottlebrushes, *Melaleuca* spp. However, inability to fully develop on non-target species is of limited importance as a criterion for release of insects with highly mobile immature stages as compared to less vagile species. Local movement from the host to other plant species could result in unacceptable non-target damage despite seemingly adequate developmental specificity. This insect would clearly harm native and ornamental Myrtaceae and should therefore not be released.

Key Words: Biological control, Hemiptera, *Eucerocoris suspectus*, host range, *Melaleuca quinquenervia*, Miridae, Myrtaceae, risk assessment, weed control

Resumen

Melaleuca quinquenervia (Cav.) S.T. Blake (Myrtales: Myrtaceae) forma monoculturas densas que desplazen la vegetación nativa en las tierras humedas en el sur de la Florida, EEUU. Estudios faunísticas realizados en el rango nativo Australiano del árbol revelan varios agentes de control biológico prospectivos, incluyendo un chinche que mancha las hojas, *Eucerocoris suspectus* Distant (Hemiptera: Miridae). Este herbívoro fue importado al laboratorio de cuarentena para evaluar su riesgo hacia las especies nativas de la Florida y ornamentales después de que estudios preliminares en Australia indicaron que esta especie puede ser útil. Especies ornamentales de *Melaleuca* sufrieron niveles fuertes de alimentación en pruebas sin opción de los adultos, con alimentación moderada en plantas nativas de la familia Myrtaceae. Las especies nativas sostuvieron alimentación leve y fuerte en pruebas de opciones multiples de alimentos para los adultos y en pruebas sin opción de alimentos para las ninfas. La alimentación aumentó sobre las especies nativas en un cercado grande después que la *M. quinquenervia* fue cortada, puesta a secar y quitada. Las ninfas completaron su desarrollo solamente sobre *M. quinquenervia* y especies de *Melaleuca* ornamentales. Sin embargo, la incapacidad para desarrollar completamente sobre especies que no son el enfoque es de importancia limitada como un criterio para la liberación de insectos con estadios de immaduros altamente moviles comparado con especies menos moviles. El movimento local de un hospedero a otras especies de plantas puede resultar en daño no aceptable en plantas que son el enfoque a pesar de que la especificidad del desarrollo parece adecuada. Este insecto claramente dañaría las Myrtaceae nativas y ornamentales y por ello no debe ser liberado.

Melaleuca quinquenervia (Cav.) S. T. Blake is a large tree of Australian origin and one of numerous invasive plants threatening the Florida Everglades. This introduced tree forms expansive monocultures and spreads rapidly from prolific seed production. Its presence and rapid spread hinders restoration of many south Florida ecosystems including sawgrass prairies, hardwood hammocks, and even pine uplands (Bodle 1998; Turner et al. 1998). Invaded habitats are transformed into nearly pure stands of *M. quinquenervia* trees, thereby altering the function and structure of these systems.

A biological control program began in 1986 to curtail the *M. quinquenervia* invasion by inhibiting its reproduction. *Eucerocoris suspectus* Distant (Hemiptera: Miridae) seemed an excellent candidate based upon the injury it caused to young shoots (Fig. 1) in Australia (Burrows & Balciunas 1999). It was introduced into quarantine during 1996 to complete host range evaluations by focusing on native and cultivated Myrtaceae. Herein, we report results of host range studies that led us to reject this species.

Burrows & Balciunas (1999) described the biology and life history of *E. suspectus* as follows. Females insert eggs into the young shoots. Nymphal development progresses through 5 instars and requires about 17 d but is influenced by plant quality. A single female produces up to 163 progeny and adults live up to 72 d. Adults and nymphs feed on the sap of young leaves and shoots causing distinctive brown blotches on the foliage. Their dispersive capacity is unknown but both nymphs and adults are very active, making them difficult to contain, and are readily able to disperse onto nearby vegetation.

Materials and Methods

Laboratory Cultures

Dr. Charles Turner and staff of the USDA-ARS Australian Biological Control of Weeds Laboratory collected *E. suspectus* adults near Brisbane, Australia, during Jul and Aug 1996. A shipment arrived in quarantine at Gainesville, Florida on

Fig. 1. A female *Eucerocoris suspectus* and feeding scars on *Melaleuca quinquenervia*.

12 Jul with 17 of 38 adults alive (5 males and 12 females). A second shipment arrived on 31 Aug, which contained 4 of 75 adults alive (not sexed).

Adults were placed on seed-grown *M. quinquenervia* saplings of varying sizes, usually less than 2 m tall. The saplings were sleeved with fine-mesh netting (100 holes/cm^2) and held in air-conditioned quarantine greenhouses. Plants were fertilized with an encapsulated fertilizer, watered regularly, and occasionally sprayed with a soap-vegetable oil mixture to control insect pests. They were not sprayed after the bugs were added. During rearing, adults and/or nymphs, which preferred new growth, were removed and placed on new saplings, depending upon the amount of damage and the amount of remaining leaf material. They were reared continuously from Jul 1996 to Jun 1997, during which time 5 host range studies, designated I-V, were conducted. Each study consisted of 1 or more separate trials designated A-L.

No-choice Adult Feeding and Oviposition Trials (Study I)

Potted test plants (Table 1) 1-2 m tall bearing new growth on the stem tips (hereafter referred to as shoots) were individually caged in quarantine greenhouses in sleeves of nylon netting. Groups of 5 pairs of adults were randomly assigned to the cages. Most plant species were set up within 2 d of the commencement of the study but 3 species were set up 11-13 d later. Each group of plants (n = 3 groups) was assigned a separate control plant of *M. quinquenervia* to comprise trials A, B, and C (Table 1, Test ID). Adults and nymphs were removed at 7-11-d intervals and placed separately on new plants. Each exposed plant was held to assess further nymphal emergence. Adults were transferred to a new plant of the same species as many as 4 times (Table 1). Adult survival was recorded at each plant change. Nymphs were removed, counted, and placed together on a new plant of the same species. The number of shoots bearing damaged leaves and the number of leaves with feeding blotches were recorded for most species. Damage results were categorized by a three-tiered intensity scale: "+" = not damaged; "++" = moderately damaged; and "+++" = heavily damaged. The presence of eggs was noted at the end of the test. Water-filled vials with bouquets of ex-

TABLE 1. RESULTS OF THE NO-CHOICE ADULT FEEDING AND OVIPOSITION TRIALS WITH POTTED MYRTACEAE AND LYTHRACEAE EXPOSED TO *EUCEROCORIS SUSPECTUS* (STUDY I).

Test species[a]	Trial ID[b, c]	No. Plants Tested	Time to 100% Mortality (d)	Feeding Intensity[d]	Nymphs Produced (no.)[e]
Melaleuca citrina (Curtis) Dum. Cours	A	4	27	+++	91
Melaleuca citrina (broad-leaved)	B	4	>42	+++	184
*Melaleuca viminalis (*Sol. ex Gaertn.) Byrnes	A	4	27	+++	181
Melaleuca viminalis 'Little John'	C	4	32	+++	51
Calyptranthes pallens Griseb.*	C	1	9	+	0
*Calyptranthes pallens**	B	1	10	+	0
Calyptranthes zuzygium (L.) Sw.*	C	3	32	++	0
Eugenia axillaris (Sw.) Willd.*	C	1	9	++	0
Eugenia confusa DC.*	B	1	10	+	0
Eugenia foetida Pers.*	C	1	9	++	0
*Eugenia foetida**	B	1	10	++	0
Eugenia uniflora L.	B	2	>10	+++	0
Lagerstroemia indica L. (Lythraceae)	A	1	>25	+	0
Leptospermum scoparium J. R. Forst. & G. Forst.	B	2	20	+	0
Melaleuca quinquenervia (Cav.) Blake	C	4	>42	+++	18[f]
*Melaleuca quinquenervi*a	B	4	>25	+++	401
Melaleuca quinquenervia	A	4	>25	+++	257[g]
Myrcianthes fragrans (Sw.) McVaugh*	B	1	10	++	0
Psidium friedrichsthalianum (O. Berg.) Nied.	C	2	17	+++	0
Psidium cattleianum Sabine	C	3	32	+++	0
Syzygium paniculatum Gaertn.	A	1	10	++	0

[a]Florida natives are indicated with *.
[b]Plants with the same letter had the same *Melaleuca quinquenervia* control plant.
[c]Five pairs of adults on a potted plant covered with mesh sleeve, adults moved weekly to a new plant, old plant was held for nymphal emergence, total plants tested with those adults.
[d]Subjective feeding estimate, compared with feeding on *M. quinquenervia*; at first plant change *M. quinquenervia* reps. had 129-168 leaves with >10 feeding spots.
[e]Total nymphs produced on all plants exposed to that cohort of adults.
[f]Progeny of one female, four of the 5 females were trapped and died in the release vial.
[g]The test ended when all adults were dead on the 3 companion plants. Two females were still alive on *M. quinquenervia*.

cised shoots were tethered to *Melaleuca citrina* (Curtis) Dum.Cours and *Melaleuca viminalis* (Sol. ex Gaertn.) Byrnes at the third and fourth plant changes to provide supplemental food as the original plant material was insufficient following extensive feeding.

No-choice Nymphal Feeding Trials (Study II)

Techniques were similar to those for the previous adult test except that 10 first instars (1.3 to 1.7 mm in length) were placed on the plants instead of adults. Supplemental bouquets of excised shoots in water-filled vials were tethered to test plants that had too few suitable flushing shoots to support the insects after the first week. Four native *Eugenia* spp. were included with *M. quinquenervia* in trial D, and 2 non-target species of *Melaleuca* along with *M. quinquenervia* in trial E (Table 2). Insect survival, the number of adults produced, and the number of leaves attacked were recorded weekly for 28 d. Adults that developed during the test were retained on the plants with the remaining nymphs.

Multi-choice Adult Feeding and Oviposition Trials without *M. quinquenervia* (Study III)

In trial F, 2 bouquets of shoots in water-filled vials of each of 10 test plant species (Table 3) were placed into a glass-topped wooden cage (44.5 x 44.5 × 44.5 cm, l × w × h) in a greenhouse with daily mean temperature 22-24°C (range 19-33°C), and 78-81% RH (range 45-97%). Natural lighting was supplemented with fluorescent lights to maintain a 16L:8D photoperiod. One bouquet of each species was randomized to one of 10 positions in each half of the cage. Ten females and 2 males were released in the cage. Feeding was subjectively estimated on a scale of 0 to 5 from light to heavy after 2 d when the bouquets were replaced and again after 3 d when trial F ended. The plants were examined for eggs at the end of the trial.

In trial G, 1 potted plant of each of 4 species was placed in a cloth screen cage (0.6 × 0.6 × 1.2 m, l × w × h) in a greenhouse. The test species included 3 Myrtaceae, pineapple guava (*Feijoa sellowiana* (O. Berg) O. Berg), bay rum tree (*Pimenta racemosa* (Mill.) J. W. Moore), and java plum (*Syzygium cumini* (L.) Skeels), and 1 Rutaceae, lemon (*Citrus limon* (L.) Burm.f. (pro. Sp.) (*medica* × *aurantifolia*)). Three pairs of adults were released in the cage. Two plants with extensive feeding were removed during the second d and the other 2 plants were left until d 11. The plants were checked for eggs and nymphs when the test ended.

Large Enclosure Multi-choice Adult Feeding Trials with and without *M. quinquenervia* (Study IV)

Potted plants, 1-1.5 m tall, were exposed to adults in a large walk-in screen enclosure (1.8 x 1.5 × 1.8 m, l × w × h) in a greenhouse. Plants were randomized to 1 of 9 positions in 3 rows of 3 each, in trials H and I. A *M. quinquenervia* plant was placed next to the test plant in the center of the enclosure at the start of each trial. The 15 test plant species are listed in Table 4. All were Myrtaceae except *Morella cerifera* (L.) Small (Myricales: Myricaceae), which was considered at risk

TABLE 2. NO-CHOICE NYMPHAL FEEDING AND DEVELOPMENT TRIALS ON NATIVE *EUGENIA* SPP. AND EXOTIC *MELALEUCA* SPP. (STUDY II).

Test Plant	Survival (%)[a] after: 7 d	Survival (%)[a] after: 28 d	No. Adults[b]	Leaves attacked (cumulative no.)[c] 7 d	Leaves attacked (cumulative no.)[c] 28 d
Trial D					
Eugenia axillaris	0	0	0	20	—
Eugenia confusa	0	0	0	6	—
Eugenia foetida	0	0	0	28	—
Eugenia rhombea (Berg) Krug & Urb.	30	0	1	34	76
Melaleuca quinquenervia	60	30	5	50+	344+
Trial E					
Melaleuca citrina	100	0	7	50	284+
Melaleuca citrina (broad-leaved)	10	0	0	20	20
Melaleuca viminalis	80	40	4	50+	347+
Melaleuca viminalis 'Little John'	100	70	8	50	459
Melaleuca quinquenervia	80	50	6	50+	446+

[a]Ten small nymphs per plant, new adults were left on the plant with the remaining nymphs.
[b]Some adults died before 28 d when trapped in the folds of the mesh sleeve.
[c]Plants with a "+" were difficult to count accurately so the count is a minimum.

TABLE 3. MULTI-CHOICE ADULT FEEDING AND OVIPOSITION TRIAL ON MYRTACEAE WITHOUT *MELALEUCA QUINQUENERVIA* (STUDY III).

	Feeding intensity[a]				
	Day 2[b]		Day 5[c]		
Test species (Trial F)	Bouquet 1	Bouquet 2	Bouquet 1	Bouquet 2	Eggs
Calyptranthes pallens	1	4	4	5	0
Calyptranthes zuzygium	0	0	0	0	0
Eugenia axillaris	2	1	5	4	6
Eugenia confusa	1	1	3	1	0
Eugenia foetida	0	0	1	1	2
Eugenia uniflora	2	3	2	2	0
Leptospermum scoparium	0	0	0	0	0
Myrcianthes fragrans	1	1	3	1	0
Psidium friedrichsthalianum	2	3	3	5	0
Psidium cattleianum	3	1	5	4	1

[a]Ten ♀♀ and 2 ♂♂ released in the cage. Feeding estimate: 1 = Light, scattered feeding, no large blotches; 2 = Light-medium; 3 = Medium, noticeable feeding, on multiple leaves; 4 = Medium-heavy; 5 = Heavy, some leaves blackened, some abscinded.
[b]Bouquets were randomized in each half of cage and were replaced in d 2.
[c]Test terminated on d 5 when eggs were counted.

because of limited use by other *Melaleuca* herbivores (Wheeler 2005; Pratt et al. 2009). Two specimens of *Eugenia* DC. were placed together at the same position in trial H because they had fewer shoots than the others. Ten pairs of adults were released on the *M. quinquenervia* plant. Damaged leaves were counted daily except for trial H, which was not assessed until the third d. The few damaged leaves on the test plants were removed daily to avoid duplicate counting. Damaged leaves were not removed from *M. quinquenervia* because this would have resulted in total defoliation of the tree. The resultant cumulative counts were therefore underestimates for *M. quinquenervia* inasmuch as most leaves would have been subjected to repeated feeding. The *M. quinquenervia* was cut on the fifth day and the pieces were tied to the trunk to allow the leaves to dry and the bugs to disperse. The dried *M. quinquenervia* was removed on the seventh day and the trial terminated on the tenth day. The plants in trial I were examined for eggs when the test ended.

Melaleuca viminalis and the 2 forms of *M. citrina* were randomized to 9 positions, 3 each, in trial J. Due to a limitation of standard *M. viminalis* plants, 1 *M. viminalis* cultivated variety 'Little John' was also incorporated into the trial. We placed 2 pots together at one position for *M. citrina* and one for *M. viminalis* because they had fewer shoots than the other plants. Eighteen males were released on the ceiling in the center of the cage. Three survivors were removed on the fifth day, but 2 more were found on the seventh day when damaged leaves were counted. Males were used to avoid oviposition in order to preserve the plants for other uses.

No-choice Starvation Trial with Nymphs and Adults (Study V)

Three potted sugarcane plants, *Saccharum officinarum* L. (Cyperales: Poaceae), and 2 potted lemon plants were individually caged in nylon sleeves in the greenhouse (trial K). Three females, 2 males, and 6 medium-sized nymphs were released in each cage where they remained until they died. The number of leaves with feeding spots was counted after all bugs were dead. An additional trial (trial L) was conducted to determine if discoloration observed on the plants in trial K was due to feeding damage. A leaf of a sugarcane plant and a lemon plant was covered with a small net sleeve. One pair of adults and 2 nymphs were released in the small sleeve. Each plant was enclosed in a larger sleeve. All plants in trials K and L were examined for eggs when the test ended.

RESULTS

No-choice Adult Feeding and Oviposition Trials (Study I)

Feeding was moderate to heavy on nearly all plants tested (Table 1). The 2 non-target *Melaleuca* spp., the 2 *Psidium* spp., and *Eugenia uniflora* L. were most heavily attacked. Native Myrtaceae were noticeably damaged but, with the exception of *Calyptranthes zuzygium* (L.) Sw. on which they survived for 32 d, the adult bugs died within 10 d. Nymphs developed and eggs were found only on non-target *Melaleuca* spp. and *M. quinquenervia*. *Lagerstroemia indica* L. suffered only light damage, although some nymphs lived

TABLE 4. WALK-IN ENCLOSURE MULTI-CHOICE ADULT FEEDING TRIALS ON MYRTACEAE WITH AND WITHOUT *MELALEUCA QUINQUENERVIA* (STUDY IV).

	Leaves with feeding blotches, cumulative tally on day				
Test Species	3	5	7	10	Eggs
Trial H. Ten adult pairs, potted plants at 9 positions, *M. quinquenervia* next to central plant					
Calyptranthes pallens	1	1	5	11	
Calyptranthes zuzygium	0	0	0	0	—
Eugenia axillaris	1	3	11	16	—
Eugenia confusa	0	1	14	22	—
Eugenia foetida	8	8	25	36	—
Eugenia rhombea	0	0	4	4	—
Melaleuca quinquenervia	164	293	Drying[a]	Removed[b]	—
Myrcianthes fragrans	2	2	30	36	—
Morella cerifera (L.) Small (Myricaceae)	0	1	1	1	—
Psidium longipes (Berg) McVaugh	0	0	22	22	—
Trial I. Set up same as Trial H but eggs were assessed at the end of evaluation					
Melaleuca citrina					
Melaleuca citrina (broad-leaved)	2	3	13	21	no
Melaleuca viminalis	3	28	104	254	yes
Eucalyptus camaldulensis Dehnh.	0	0	1	1	no
Eucalyptus camaldulensis	4[c]	11[c]	12[c]	23[c]	yes
Leptospermum scoparium	0	0	0	0	no
Melaleuca quinquenervia	258	328	Drying	Removed	—
Psidium friedrichsthalianum	0	0	7	0	no
Psidium cattleianum	0	0	0	0	no
Trial J. Eighteen ♂♂, potted plants at 9 positions, 3 of each species					
Melaleuca citrina	—	—	23[d]		—
Melaleuca citrina (broad-leaved)	—	—	38		—
Melaleuca viminalis	—	—	127		—

[a]*Melaleuca quinquenervia* was cut on d 5 and left in cage to dry slowly.
[b]*Melaleuca quinquenervia* was removed from the cage on d 7.
[c]Number of stems fed upon. Feeding was on stems not on leaves.
[d]Total of the 3 positions, 122 leaves attacked on *C. viminalis* were all on 1 plant.

at least 25 d on it. Damage was usually distributed throughout the plant with over 50% of the shoots attacked on 7 of 10 species. In general, survival on most test plants was quite long (Table 1).

No-choice Nymphal Feeding Trials (Study II)

Small nymphs were dead by d 7 on 3 native *Eugenia* spp. in trial D, but 30% survived on *E. rhombea* Ridl. (Table 2). One became an adult, but it and the remaining nymphs were dead by d 28. Only the newest leaves on *E. rhombea* were attacked but they were heavily damaged and abscinded. Similar feeding and damage was observed on the other *Eugenia* spp., with few leaves attacked due to low nymphal survival but heavy damage levels (Table 2). Older leaves were also attacked on *E. axillaris* (Sw.) Willd., but with little damage. On *M. quinquenervia,* 60% of nymphs survived to d 7 and 50% became adults. Two died after being entrapped in the folds of the cloth sleeve, so survivorship would probably have been somewhat greater.

Survival and feeding on non-target *Melaleuca* spp. in trial E were similar to those on *M. quinquenervia* except on the broad-leaved *M. citrina*. All nymphs were alive on d 7 on *M. citrina* and *M. viminalis* “Little John” and 80% were alive on *M. viminalis* and on *M. quinquenervia*. All were dead on *M. citrina* by d 28, but 40% and 70% were alive on the 2 *M. viminalis* plants and 50% on *M. quinquenervia*. Most surviving nymphs developed to adults on both non-target *Melaleuca* spp. and *M. quinquenervia*, and some adults died before 28 d. Feeding on 2 non-target *Melaleuca* spp. was comparable to that experienced by *M. quinquenervia* (Table 2). Feeding on the test plants was usually distributed throughout the canopy, with most foliage damaged at shoot tips.

Multi-choice Adult Feeding and Oviposition Trials without *M. quinquenervia* (Study III)

All species in trial F except *C. zuzygium* and *Leptospermum scoparium* J. R Forst. & G. Forst. sustained damage, but *Eugenia foetida* Pers. was not damaged until after d 2 (Table 3). Most species had light to medium damage by d 2. Four species showed medium to heavy feeding on one bouquet on d 5 (*Calyptranthes pallens* Griseb., *E. axillaris*, *Psidium friedrichsthalianum* (O. Berg.) Nied., and *P. cattleianum* Sabine). Eggs were found on 3 species: the natives *E. axillaris* and *E. confusa* and the cultivated *P. cattleianum.*

Two of the 4 species in trial G were attacked on d 1. Five of 7 leaves on *P. racemosa* and 4 of 5 leaves on *S. cumini* had more than 5 feeding blotches. The trial ended on d 11, with no feeding on lemon but with 14 leaves damaged on *A. sellowiana*, half of which had more than 5 feeding blotches. No live insects were recovered at the end of trial G. Nymphs only emerged from eggs in the stems of *A. sellowiana*. None emerged from stems of *P. racemosa* or *S. cumini*.

Large Enclosure Multi-choice Adult Feeding Trials With and Without *M. quinquenervia* (Study IV)

With *M. quinquenervia* present in trials H and I, there was little feeding on test plants by d 5 except on one of 2 plants of *M. citrina* and 1 plant of *M. viminalis* (Table 4). However, the feeding on both non-target plants was much less than that on *M. quinquenervia*. Feeding increased on most plants after *M. quinquenervia* was cut, but was still minor except on the 2 plants already mentioned. Feeding on *M. viminalis* on d 10 was similar to that on *M. quinquenervia* on d 3. Eggs were found only on *M. citrina*, *M. viminalis* and *M. quinquenervia* in trial I. There was little feeding on the broad-leaved *M. citrina* in this trial, although it was heavily attacked by adults in no-choice trials. Feeding on plants of other non-target species was not particularly damaging, but was noticeable.

Little feeding occurred on either variety of *M. citrina* in trial J. Almost all feeding on *M. viminalis*, 96%, and all on *M. citrina* occurred at one of the 3 positions within the cage. Also, the attacked leaves were on relatively few shoot tips, not widely distributed over the plant (*M. citrina* 3 of 25 tips had feeding, *M. citrina* (broad-leaved), 5 of 10, and *M. viminalis*, 9 of 100).

No-choice Starvation Trial with Nymphs and Adults (Study V)

All insects died on sugarcane plants (n = 3) by the eighth d without feeding in trial K. On lemon plants (n = 2) all insects were dead by the sixth d, but 7 and 8 leaves were damaged on 2 of the plants. This damage was slight, perhaps due to test probing, and all damaged leaves had less than 5 feeding blotches. Brown streaks were observed along the veins on some sugarcane leaves, but when additional insects were confined on new leaves (trial L) to determine if this streaking was symptomatic of feeding damage, none resulted. No eggs were found on any of the test plants.

Discussion

The host range of the *Melaleuca* leaf-blotching bug, *E. suspectus*, may be considered acceptable based on the fact that the insect was able to complete development only on *M. quinquenervia*, other exotic *Melaleuca* spp. and once on *E. rhombea*. However, the vagile nature of this insect would enable it to feed on a wide variety of plants that are not developmental hosts. Feeding damage proved especially troublesome because of the frequency that this insect probed or test fed on non-target plants. Thus, even though *E. suspectus* is stenophagous, it presents a risk to rare endemic plant species such as *E. rhombea* that are sympatric with *M. quinquenervia* in southern Florida. The exact nature of this risk cannot be known without further study but the precautionary principal, which dictates conservative actions, would disqualify release of this insect. We did not test unusually high numbers of insects per cage, for instance, but unacceptably high levels of collateral damage were observed on non-target species in large cage trials. In contrast, and contrary to cage tests, Burrows & Balciunas (1999) observed that adults released on test plants in a shade-house fed and reproduced only on *M. quinquenervia*. Our concerns, however, were confirmed through field observations by personnel at the Brisbane laboratory: damage was observed on mixed Myrtaceae in a garden plot, all stages of *E. suspectus* were found on bottlebrush, *Melaleuca* spp., and damage to guava was severe (Purcell et al. 2000). Bottlebrushes are relatively common ornamentals in Florida and some other states. These were originally placed in the genus *Callistemon* but have since been synonymized with *Melaleuca* (Craven 2006).

These results matched those of Burrows & Balciunas (1999) quite closely in terms of common genera tested in cage tests. They reported noticeable feeding on *Melaleuca* (=*Callistemon*), *Psidium,* and *Syzygium*, as did we. Nymphal survival to adult was 47% on *M. viminalis* in their tests as compared to 50% herein.

Damage from an equal amount of feeding on *Calyptranthes, Eucalyptus, Eugenia*, and *Psidium* was greater than that on *Melaleuca*. The damaged young leaves and young stems dried and abscinded on those genera, as they often did on *Melaleuca*, but there were fewer leaves on non-target plants than on the longer, foliose shoots of the target weed. Thus, an equal number of attacked leaves among test plants resulted in a disproportionate level of damage on non-target hosts as compared to *Melaleuca*. However, this level of non-target damage was limited to a few test species as many more leaves were usually attacked on *Melaleuca*.

The present data also have relevance to experimental protocols for host range testing. Evaluation of an herbivore's host range is an effort to maximize predictive precision within the bounds of practicality. Multiple replicated experiments provide insight to variation in an herbivore's host preferences, but limited financial resources necessitate abandoning continued testing (replication) at early stages of evaluation for herbivores that demonstrate broad host ranges. Although development of *E. suspectus* appears to be confined to *Melaleuca*, non-host feeding by the highly mobile nymphs and adults is too broad and too damaging for this bug to be used for biological control. Therefore, many tests were terminated with few replicates when it became apparent that this insect was not a suitable candidate for release. Continuation of testing for the sake of additional replicates would have wasted time and resources, so testing was curtailed in favor of more suitable candidates.

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