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(Rubiaceae), an Invasive Weed in Hawaii and Florida**

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**TRACHYAPHTHONA NIGRITA AND TRACHYAPHTHONA SORDIDA
(COLEOPTERA: CHRYSOMELIDAE) REJECTED AS POTENTIAL BIOLOGICAL
CONTROL AGENTS OF PAEDERIA FOETIDA L. (RUBIACEAE), AN INVASIVE
WEED IN HAWAII AND FLORIDA**

ROBERT W. PEMBERTON¹ AND GLORIA L. WITKUS

United States Department of Agriculture, Agricultural Research Service, Invasive Plant Research Laboratory,
3225 College Ave., Ft. Lauderdale, FL 33314

¹Rpemberton5@gmail.com

Skunk vine, *Paederia foetida* L. (Rubiaceae), is an invasive weed native to Asia but a problem in Florida and other areas of the southern USA, and in Hawaii (Pemberton & Pratt 2002). In the southern states of the USA it is mostly a problem in natural areas, whereas in Hawaii the plant is a problem in both natural areas and agriculture. Skunk vine is both a Category I weed (Florida Exotic Pest Plant Committee 2009) and a Florida Noxious Weed (USDA, Natural Resource Conservation Service).

Biological control research began with field surveys in Asia in 1997 (Pemberton & Pratt 2002). A lace bug, *Dulinius conchatus* Distant (Tingidae), and a leaf beetle, *Sphenoraia rutilans* Hope (Chrysomelidae) have undergone host specificity testing but neither demonstrated the narrowness of host range needed in a skunk vine bio-control agent (Pemberton et al. 2005; Pemberton & Witkus unpublished data). Two *Trachyaphthona* spp. flea beetles were identified as promising biological control candidates during surveys in Japan (Pemberton & Pratt 2002). Both species have larvae that feed on roots and adults that consume leaves. The biology and preliminary host ranges of *Trachyaphthona sordida* (Baly) and *T. nigrita* Ohno were studied in Japan (Okamoto et al. 2008).

Adult host range testing on *T. nigrita* was conducted in our Fort Lauderdale quarantine laboratory during 2007 and 2008, with field-collected beetles shipped by Japanese cooperators during each Jun of those years. Adult host range testing on field-collected *T. sordida* beetles was done in 2009 after Japanese cooperators shipped the beetles during Jun of that year. Adults of both species were set up in wooden screened sleeve cages, 50 cm × 50 cm × 53 cm, and fed cut vines of the control plant, *Paederia foetida*, and its invasive relative *Paederia cruddasiana* Pain. *Paederia cruddasiana*, native to Nepal, Burma, China, and Thailand (Puff 1991), is a naturalized weed in Miami-Dade County, Florida. The beetles mated readily and laid eggs throughout the sleeved rearing cages.

The most likely potential non-target plants of these beetles are the many native and economic members of the Rubiaceae in Florida. The host

range testing for *T. nigrita* and *T. sordida* initially concentrated on 3 subfamilies within the Rubiaceae. Test plants were native and ornamental members of this family selected to represent different taxonomic tribes. Host range testing on plants outside of the Rubiaceae consisted of species selected to represent related orders including the Cornales, Gentianales, Lamiales, and the Solanales. In total, 34 species in 7 families and 5 orders were tested.

Host range tests on both beetles were conducted with a no-choice test design, and each individual test plant was exposed to 3 beetles for 1 month. Control plants of *P. foetida* and *P. cruddasiana* were exposed to 3 beetles for 1 month. Because research on *T. nigrita* spanned 2 seasons, each experiment was replicated 5 times. Research on *T. sordida* was conducted for 1 season so each test was replicated 3 times. Host range testing for *T. nigrita* and *T. sordida* was conducted on branches of whole potted plants in the quarantine greenhouse. Clear acrylic tubes, 15.2 cm long × 3.8 cm diameter (6" × 1.5" diameter), each with 2 mesh ventilation holes, were placed on the end of a small branch or stem of each test plant. A slit sponge bung was placed around the base of the stem and up into the bottom of the tube. The stem and bung juncture was wrapped tightly with parafilm. Another bung was used to seal the top of the tube. Due to the saltatory nature of the flea beetles, an aspirator was used to gently transfer 3 tiny beetles through the bung slit and into the tubes and onto each test branch. The 3 beetles consisted of 1 mating pair and another beetle of undetermined gender due to the difficulty in determining gender in this flea beetle. Beetles were monitored for 1 month, and at the end of each week, all leaves with feeding damage were clipped, pressed and then scanned into jpeg files to enable feeding to be measured with SigmaScan® Pro.

The most important finding of the research was the nearly equal or greater feeding by both *Trachyaphthona* species on the native Florida test plant *Diodia virginiana* L. (Table 1). *Trachyaphthona nigrita* adults ate a mean of 3.75 ± 1.1 mm² leaf material of *D. virginiana*, compared to 4.76 ± 1.53 mm² of leaf material on *P. foetida*,

TABLE 1. HOST RANGE TESTING OF *TRACHYAPHTHONA NIGRITA* AND *TRACHYAPHTHONA SORDIDA* ADULT FLEA BEETLES SHOWING PLANTS THAT RECEIVED FEEDING. THREE ADULT BEETLES WERE TESTED FOR 1 MONTH FOR EACH SPECIES. DIFFERENCES IN TOTAL AMOUNTS OF FEEDING ARE DUE TO 5 REPLICATES CONDUCTED OVER 2 SEASONS WITH *T. NIGRITA*, VERSUS 3 REPLICATES WITH *T. SORDIDA*. FLORIDA NATIVES ARE IN BOLD.

Order—Family Tribe	Species	<i>Trachyaphthona nigrita</i>				<i>Trachyaphthona sordida</i>			
		total (mm ²)	mean (mm ²)	SD	SE	total (mm ²)	mean (mm ²)	SD	SE
Cornales – Garryaceae	<i>Acuba japonica</i>	0.01	* ¹	*	*	0.00	0.00	0.00	0.00
Rubiales - Rubiaceae Hedyotideae	<i>Pentas lanceolata</i>	0.03	*	*	*	0.11	0.04	0.04	0.02
Morindeae	<i>Morinda citrifolia</i>	0.11	*	*	*	0.00	0.00	0.00	0.00
Paederieae	<i>Paederia cruddasiana</i>	16.53	3.31	0.57	0.33	4.15	1.38	0.63	0.36
Paederieae	<i>Paederia foetida</i>	23.82	4.76	1.53	0.88	4.84	1.61	0.82	0.47
Paederieae	<i>Serissa foetida</i>	3.33	0.67	0.37	0.22	0.45	0.15	0.21	0.12
Spermacoceae	<i>Diodea virginiana</i>	18.76	3.75	1.10	0.64	9.70	3.23	0.50	0.29
Spermacoceae	<i>Ernodia littoralis</i>	0.02	*	*	*	0.04	0.01	0.01	0.01
Spermacoceae	<i>Mitchella repens</i>	1.15	0.23	0.18	0.10	0.67	0.22	0.28	0.16
Spermacoceae	<i>Spermacoce assurgens</i>	0.01	*	*	*	0.01	*	*	*
Spermacoceae	<i>Spermacoce tetraquetra</i>	2.79	0.56	0.16	0.09	0.12	*	*	*
Spermacoceae	<i>Spermacoce verticillata</i>	0.00	0.00	0.00	0.00	0.06	*	*	*

¹Test feeding was documented in only 1 replicate of each species.

and $3.31 \pm 0.57 \text{ mm}^2$ on *P. cruddasiana*. *Trachyaphthona sordida* adults consumed a mean of $3.23 \pm 0.5 \text{ mm}^2$ leaf material on *D. virginiana*, compared to $1.61 \pm 0.82 \text{ mm}^2$ on *P. foetida*, and $1.38 \pm 0.63 \text{ mm}^2$ on *P. cruddasiana*. Moreover, *D. virginiana* belongs to a taxonomic group within the Rubiaceae different than that of skunk vine, i.e., the tribe Spermacoceae rather than the tribe Paederieae for skunk vine. In addition, *T. nigrita* caused what is considered to be more than test feeding on *Spermacoce tetraquetra* A. Rich., another member of the Spermacoceae. *Trachyaphthona nigrita* adults consumed a mean of $0.56 \pm 0.16 \text{ mm}^2$ of *S. tetraquetra*, compared to $1.61 \pm 0.82 \text{ mm}^2$ on *P. foetida*, and $1.38 \pm 0.63 \text{ mm}^2$ on *P. cruddasiana*. To prevent harm to native and important economic members of the Rubiaceae, the feeding of these flea beetles would need to be limited to plants in the skunk vine tribe, the Paederieae.

It may be possible that the larvae of these beetles could have greater specificity than the adults. Two factors influenced our decision to cease research on these *Trachyaphthona* species and to shift to other candidate insects of skunk vine. Most importantly, we have not successfully reared these univoltine beetles, which are, like many root-feeding flea beetles, difficult to culture in captivity. Secondly, our previous testing with the leaf beetle *Sphenoraia rutilans* found that it could complete its development both on *Diodia virginiana* and *Spermacoce tetraquetra*, indicating that these plants have an attractiveness and vulnerability to some *Paederia* feeding insects.

SUMMARY

Trachyaphthona nigrita and *Trachyaphthona sordida*, 2 potential biological control agents of *Paederia foetida* L. (Rubiaceae), were collected from Japan and brought into quarantine for adult host specificity testing. Testing indicated that they fed significantly on Florida native plants in the tribe Spermacoceae, a different tribe from that to which the target weed *Paederia foetida* be-

longs (*Paederieae*). These beetles, therefore, lack the appropriate level of host specificity, and this eliminates them from further consideration as potential biological controls of *Paederia foetida*, skunk vine.

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