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David W. Boyd, Jr.

USDA-ARS Southern Horticultural Laboratory

David W. Held

Mississippi State University

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ANDROTHRIPS RAMACHANDRAI (THYSANOPTERA: PHLAEOTHIRIPIDAE): AN INTRODUCED THRIPS IN THE UNITED STATES

DAVID W. BOYD, JR.¹ AND DAVID W. HELD²

¹USDA-ARS Southern Horticultural Laboratory P.O. Box 287 Poplarville, MS 39470
e-mail: dboyd@ars.usda.gov

²Mississippi State University Coastal Research and Extension Center 1815 Popps Ferry Road, Biloxi, MS 39532
e-mail: david.held@msstate.edu

ABSTRACT

Androthrips ramachandrai Karny is an exotic thrips, assumed to be predacious, and is associated with gall-inducing thrips. It was first reported in the U.S. from FL, and intercepted in CA from Thailand in 2002. We surveyed *Ficus* spp. with *Gynaikothrips*-induced galls in AL, CA, FL, HI, LA, MS, and TX, and document that *A. ramachandrai* is now established in CA, FL, HI, and TX. It probably has been spread by the ornamental horticulture industry. We outline its biology and compare it to a congener *A. flavipes*, a documented thrips predator. *Androthrips ramachandrai* has the potential to be a beneficial biological control agent and a hindrance to weed biological control.

Key Words: predator, invasive species, *Gynaikothrips*, biotic interference

RESUMEN

Androthrips ramachandrai es un trips exótico, que parece ser un depredador, y esta asociado con trips que producen agallas. El trips fue informado por primera vez en los Estados Unidos en el estado de la Florida, e interceptado en California en el 2002 de Tailandia. Nosotros muestreamos las plantas de *Ficus* spp. con agallas inducidas por *Gynaikothrips* en Alabama, California, Florida, Hawaii, Louisiana, Mississippi, y Texas y documentamos que *A. ramachandrai* esta ahora establecido en California, Florida, Hawai, y Texas. Probablemente el trips ha sido dispersado por la industria de horticultura ornamental. Nosotros también describimos su biología y la comparamos con su congenera *A. flavipes*, un depredador de trips ya documentado. *Androthrips ramachandrai* tiene el potencial para ser un agente de control biológico benéfico y un obstáculo para el control biológico de malezas.

Held et al. (2005) predicted that gall-inhabiting arthropods found in *Gynaikothrips*-induced galls on *Ficus* spp. could be inadvertently transported within the continental U.S. through the ornamental plant industry. *Androthrips ramachandrai* Karny (Thysanoptera: Phlaeothripidae) is known to inhabit the galls of both *Gynaikothrips uzeli* (Zimmermann) and *G. ficorum* (Marchal) (Thysanoptera: Phlaeothripidae) (Takahashi 1934), and is probably being moved throughout the U.S. in shipments of nursery-grown *Ficus*.

The first record of *A. ramachandrai* in the U.S. was of two specimens collected in March 2002, Miami-Dade Co., FL from *Ficus microcarpa* (Moraceae) galled by *G. ficorum* (Nakahara & Edwards 2002). Another collection of *A. ramachandrai* was made from Riverside Co., CA on 02 Aug of the same year (Gaimari 2005). It was intercepted during a federal foreign-quarantine inspection along with *Gigantothrips elegans* Zimmermann (Thysanoptera: Phlaeothripidae) and *Gynaikothrips malabaricus* Ramakrishna on *Ficus* sp. imported from Nong Nooch Tropical Botanical Garden in Thailand (G. Watson, California Department of Food and Agriculture, pers. comm.).

Androthrips ramachandrai was described from India and found in association with the gall thrips *Austrothrips cochinchinensis* Karny (Thysanoptera: Phlaeothripidae) on *Calycopteris* (= *Gentonia*) *floribunda* (Combretaceae) (Karny 1926). Worldwide, *Androthrips* contains 12 species (Mound 2005). *Androthrips flavipes* Schmutz is a known predator of thrips (Ananthakrishnan & Varadarasan 1977; Varadarasan & Ananthakrishnan 1981), and other *Androthrips* species are assumed to be predators, too, but little or nothing is known about their biology.

Androthrips ramachandrai (Fig. 1) is dark brown to black. It can be distinguished from other dark, large phlaeothripids by its large fore femora with a strong, cylindrical tooth near the base followed by a row of small tubercles (Fig. 2). Its tube (abdominal segment X) is almost half the length of *Gynaikothrips* spp., which is easily detectable. It can be separated from other *Androthrips* by the dark middle and hind tibiae (Karny 1926).

Not much is known about the biology of *A. ramachandrai*. It is rare in newly formed galls of *Austrothrips cochinchinensis*. However, as galls mature, *A. ramachandrai* becomes more abun-

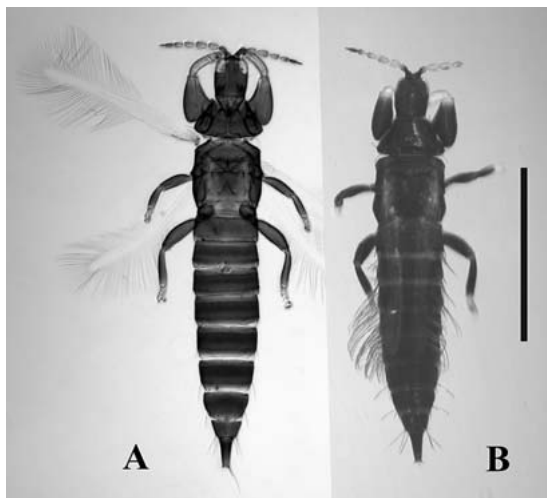


Fig. 1. Dorsal view of *Androthrips ramachandrai* from Riverside Co., CA. (A) Slide mounted, cleared specimen and (B) wet mounted specimen. Scale bar = 1 mm.

dant as the population of *A. cochinchinensis* declines (Ananthakrishnan 1978), which might indicate that *A. ramachandrai* is predacious on the gall-inducing thrips, similar to *A. flavipes* (Ananthakrishnan & Varadarasan 1977).

Currently, *A. ramachandrai* is known from Australia, Costa Rica (L. Mound, pers. comm.), India (Karny 1926), Taiwan (Takahashi 1934), and Thailand (Ananthakrishnan 1978). Herein we report its establishment in the U.S.

The purpose of this paper is to document the currently known distribution of *A. ramachandrai* in the U.S., provide a brief overview from the literature of its biology, and increase the awareness of regulatory and research entomologists in

North American to this thrips, which could become economically and ecologically important.

MATERIALS AND METHODS

We collected and solicited *Gynaikothrips*-induced galls from the following states in the U.S.: AL, CA, FL, HI, LA, MS, and TX. Galls and contents were collected in the field, preserved immediately in 95% ethanol, and taken to the lab for identification of the thrips. Museum records were requested for *A. ramachandrai* from CA (California Department of Agriculture), FL (Florida State Collection of Arthropods), and TX (Texas A & M University).

RESULTS AND DISCUSSION

Ficus galls collected from South Padre Island, Cameron Co., TX by DWH on 24 Aug 2005, from Riverside Co, CA by Chris Hanlon (University of California, Riverside) on 08 Mar 2005, and from Oahu Island, HI by Frank Howarth (Bishop Museum, Honolulu) on 17 Apr 2006 contained specimens of *A. ramachandrai*. Galls from TX were initiated by *G. uzeli* and collected from 7 *Ficus* trees at 2 locations (Table 1). Galls from CA were initiated by *G. ficorum* and collected at 1 location with a total of 258 *G. ficorum* and 21 *A. ramachandrai* (total number of galls not known). Galls from HI were initiated by *G. ficorum* and collected at 1 location with 16 *G. uzeli*. Voucher specimens of *G. ficorum*, *G. uzeli*, and *A. ramachandrai* from CA and TX have been deposited in the USDA, ARS, Systematic Entomology Laboratory, Beltsville, MD; and *A. ramachandrai* from HI have been deposited in the Bishop Museum, Honolulu, HI.

The Florida Department of Plant Industry has at least 44 records of *A. ramachandrai* (2002-2006) from 11 southern counties in Florida (Brevard, Broward, Miami-Dade, Glades, Hillsborough, Lee, Martin, Monroe, Palm Beach, Pinellas, and Sarasota) and from the following plants: *Artocarpus heterophyllus* (Moraceae); *Ficus benjamina* and *F. microcarpa* (Moraceae); *Malvaviscus penduliflorus* (Malvaceae); *Schefflera actinophylla* (Araliaceae); and *Tabebuia heterophylla* (Bignoniaceae).

The California Department of Food and Agriculture has one record of *A. ramachandrai* collected from *F. microcarpa* originating from Irvine Co. and intercepted in Santa Clara Co. on 09 Nov 2004. Galls collected or solicited from AL, LA, and MS did not contain specimens of *A. ramachandrai*, and no further museum records were available for TX.

The 2 records from California are new state records, because the previous record was an intercepted specimen from Thailand (see above). The records from Texas and Hawaii also are new state records.



Fig. 2. Fore femur of *Androthrips ramachandrai* from Riverside Co., CA. (A) Wet mounted, right ventral fore femur and (B) slide mounted, cleared left fore femur. The white arrow is pointing to the strong, cylindrical tooth near the base and black arrow to the row of small tubercles. Scale bars = 250 μ m.

TABLE 1. GALL INHABITANTS BY SPECIES COLLECTED FROM SOUTH PADRE ISLAND, CAMERON CO., TX, AUGUST 2005.

	No. galls	<i>Gynaikothrips uzeli</i>	<i>Androthrips ramachandrai</i>	<i>Montandoniola moraguesi</i>
Site 1				
Plant 1	3	15	9	0
Plant 2	3	25	14	0
Plant 3	3	73	3	3 nymphs
Total	9	113	26	3 nymphs
Site 2				
Plant 1	4	5	34	0
Plant 2	3	12	1	0
Plant 3	3	24	3	0
Plant 4	4	38	0	0
Total	14	79	38	0

Galls were randomly collected from each site, where site 1 was the Convention Center (large landscape plants) and site 2 a local restaurant (containerized plants) on the island.

Our findings from TX (Table 1) might indicate that *Gynaikothrips* populations decline during an increased presence of *A. ramachandrai*. However, further data is needed to substantiate this claim. The trend is consistent with a pattern found by Ananthakrishnan (1978) in which populations of *Austrothrips cochinchinensis* decreased as *A. ramachandrai* progressively increased.

Montandoniola moraguesi (Puton) (Hemiptera: Anthocoridae) was present in the galls from TX and HI. This anthocorid is known to feed on gall-inducing thrips and also on *A. ramachandrai* and *A. flavipes* (Dobbs & Boyd 2006). What impact this anthocorid might have on the effectiveness of *A. ramachandrai* in reducing pest thrips populations is not known. Another natural enemy of *Gynaikothrips* is the wasp *Thripastichus gentilei* (del Guercio) (Hymenoptera: Eulophidae), which parasitizes species of *Androthrips* (Loomans et al. 1997). What quantitative impact these 3 natural enemies (individually or together) have on pest-thrips populations and on each other remains unassessed.

Nothing is known about the ecology of *A. ramachandrai*, but some information may be inferred from the better-studied congener *A. flavipes*. When adults of *A. flavipes* enter mature galls of *Arrhenothrips ramakrishnae* Hood (Thysanoptera: Phlaeothripidae), they feed on about 10% of the available prey and deposit eggs in galls near their prey eggs. After hatching, the larvae consume most of the remaining prey and resort to cannibalism. This behavior can occur whether prey is abundant or not and is a limiting factor to its own population growth (Varadarasan & Ananthakrishnan 1981). Typically they feed on the eggs and larvae, but not adults. By the time the larvae pupate, they have devoured almost 80% of

available prey (Sureshkumar & Ananthakrishnan 1987). *Androthrips flavipes* develops faster than the galling thrips, which enables the predator to complete its life cycle more quickly than the prey (Varadarasan & Ananthakrishnan 1982). Strangely, the enlarged fore femora of adult *A. flavipes* are not used in subduing prey (Varadarasan & Ananthakrishnan 1982; Sureshkumar & Ananthakrishnan 1987).

Because *A. ramachandrai* feeds primarily on the immature stages of thrips in galls, this does not preclude it from attacking the immature stages of surface feeding thrips. In a laboratory trial, *A. flavipes* readily consumed thrips prey in a Petri dish (Varadarasan & Ananthakrishnan 1981). In FL, where *A. ramachandrai* is well established, there may be possible biotic interference (Reimer 1988) with thrips, particularly phlaeothripids such as *Pseudophilothrips ichini* (Hood) (Thysanoptera: Phlaeothripidae), used for biological control of invasive peppertrees (Cuda et al. 2005). The effectiveness of the weed biocontrol *Liothrips urichi* Karny (Thysanoptera: Phlaeothripidae) released for biocontrol of the weed, *Cleome hirta* (Melastomataceae), in HI has been reduced by generalist predators (Reimer 1988).

Androthrips ramachandrai is now established in 3 continental U.S. states and HI, but very little is known about its biology or ecology. It is assumed to be predacious and could potentially have an impact on thrips populations, including pests and weed biological control agents. Its presence could cause biotic interference (Reimer 1988) or it could prove to be a successful natural enemy against *Gynaikothrips* spp. on ornamental *Ficus*. We intend this information to increase the awareness of regulatory agents and facilitate the identification of this potentially important thrips.

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