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Diptilomiopus floridanus (Acari: Eriophyoidea: Diptilomiopidae): its distribution and relative abundance with other eriophyoid species on dooryard, varietal block, and commercial citrus in Florida

Carl C. Childers[1,], Michael E. Rogers[2], Timothy A. Ebert[2], and Diann S. Achor[1]*

Abstract

We sampled 526 dooryard, 18 varietal block, and 784 commercial citrus trees in Florida between May 2009 and Apr 2014 for eriophyoid mites including *Diptilomiopus floridanus* Craemer & Amrine, *Aceria sheldoni* (Ewing), *Aculops pelekassi* (Keifer), and *Phyllocoptruta oleivora* (Ashmead). In total, 1,423 *D. floridanus* individuals were collected from dooryard citrus trees and 1 each from the lemon cultivar 'Bearss' and sweet lime trees from the Florida Citrus Arboretum in Winter Haven. *Diptilomiopus floridanus* was collected from dooryard citrus in the following counties in Florida: Broward, Collier, Dade, Indian River, Lee, Martin, Palm Beach, Pinellas, Polk, Sarasota, and St. Lucie. The mite was not observed in Charlotte, Hardee, Hendry, Highlands, Manatee, or Okeechobee counties (Florida). Percentages of the eriophyoid mite species collected from dooryard citrus trees and varietal blocks were: *A. pelekassi* 3.2%, *A. sheldoni* 9.1%, *D. floridanus* 17.3%, and *P. oleivora* 84.2%. The 6 counties with the highest percentages of *D. floridanus* on dooryard trees were: Collier 36%, Broward 25%, Indian River 25%, Palm Beach 25%, Martin 23%, and St. Lucie 22%. In commercial citrus, *A. sheldoni* was collected less than 1.0%, *A. pelekassi* 4.0%, and *P. oleivora* 75.5%, of the time. *Diptilomiopus floridanus* was not collected in commercial citrus orchards during this survey. *Diptilomiopus floridanus* had significantly greater infestation rates on lime and lemon trees compared with grapefruit, tangerine, tangelo, sweet orange, and pummelo trees. However, infestation rates on lime and lemon trees were not significantly different from those on sour orange trees.

Key Words: *Aceria sheldoni*; *Aculops pelekassi*; *Phyllocoptruta oleivora*; Eriophyidae

Resumen

Se muestrearon 526 árboles de cítricos residenciales, 18 bloques varietales y 784 árboles de cítricos comerciales en la Florida entre el mayo del 2009 hasta el abril del 2014 para los ácaros eriofioides incluyendo *Diptilomiopus floridanus* Craemer & Amrine, *Aceria sheldoni* (Ewing), *Aculops pelekassi* (Keifer) y *Phyllocoptruta oleivora*. En total, 1.423 individuos de *D. floridanus* fueron recolectados de árboles de cítricos y 1 cada uno de árboles de limón Bearss y lima dulce del Arboreto de Cítricos de Florida en Winter Haven. Se recolectó *Diptilomiopus floridanus* en los siguientes condados: Broward, Collier, Dade, Indian River, Lee, Martin, Palm Beach, Pinellas, Polk, Sarasota y St. Lucie. El ácaro no se observó en los condados de Charlotte, Hardee, Hendry, Highlands, Manatee o Okeechobee. Las frecuencias de las especies de ácaros eriofioides recogidas de los árboles cítricos y bloques varietales fueron: *A. pelekassi* 3,2%, *A. sheldoni* 9,1%, *D. floridanus* 17,3% y *P. oleivora* 84,2%. Los 6 condados con las frecuencias más altas de *D. floridanus* en los árboles residenciales fueron: Collier 36%, Broward 25%, Indian River 25%, Palm Beach 25%, Martin 23% y St. Lucie 22%. En cítricos comerciales, se recogió *A. sheldoni* menos del 1%, *A. pelekassi* 4,0% y *P. oleivora* el 75,5% del tiempo. No se recolectó *Diptilomiopus floridanus* en los huertos comerciales de cítricos durante este sondeo. La frecuencia de la ocurrencia de *Diptilomiopus floridanus* fue significativamente mayor en lima y limón en comparación con toronja, mandarina, tangelo, naranja dulce y pummelo. Sin embargo, las frecuencias sobre la lima y el limón no fueron significativamente diferentes de las de los naranjos amargos.

Palabras Clave: *Aceria sheldoni; Aculops pelekassi; Phyllocoptruta oleivor*a; Eriophyidae

Prior to 2008, 3 species of eriophyoid mites were known to occur in commercial citrus in Florida: the citrus rust mite, *Phyllocoptruta oleivora* (Ashmead), the pink citrus rust mite, *Aculops pelekassi* (Keifer), and the citrus bud mite, *Aceria sheldoni* Ewing. All 3 species are in the Eriophyidae, 1 of 3 families within the Eriophyoidea (Lindquist & Amrine 1996). The other 2 families are the Phytoptidae and Diptilomiopidae. The Eriophyoidea is a large and diverse acarine group that includes bud, blister, gall, and rust mites (Baker et al. 1996). Most eriophyoid species are not considered to be economic pests, although they all feed on plant tissues (Baker et al. 1996).

The citrus rust mite has been recognized as a pest on Florida citrus since prior to 1879 (Ashmead 1880). Over 80 years later, *A. pelekassi* was found in Florida citrus orchards (Denmark 1962; Burditt et al. 1963). Researchers actively looked for *A. pelekassi* during the early 1970s without success (Childers 1994). Muma (1975) later stated that *P. oleivora* was the only eriophyoid mite of importance on Florida citrus. *Aculops pelekassi* was found again in sweet orange

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and Murcott, a putative hybrid of *Citrus reticulata* Blanco and *C. sinensis* (L) Osbeck (Hodgson 1967), blocks in Collier, DeSoto, Lake, and Polk counties during 1989 and 1990, and its presence resulted in unexpected economic losses for many growers (Childers 1994). Both species of rust mite, *A. pelekassi* and *P. oleivora,* are capable of causing serious injuries to developing citrus fruits and leaves (Childers & Achor 1999). However, *A. pelekassi* has greater potential destructiveness due to its rapid population increase during Apr to May while citrus fruits are small. Subsequent feeding injury to the fruit resulted in high levels of russeting and subsequent retarded fruit growth (Childers & Achor 1999).

The citrus bud mite was first reported on Florida citrus by Attiah (1959). The mite is not commonly found on fruit, leaf, or twig surfaces, but rather in sheltered places, including under the calyx of fruit, under bud scales, in petiole bases next to buds, in developing blossoms, or in axillary buds (Boyce & Korsmeier 1941; Jeppson et al. 1975). *Aceria sheldoni* currently is not considered an economic problem for Florida citrus growers (Childers & Achor 1999). However, it is a pest of lemons in California where increases in flower and young fruit abscission can occur in the axillary buds of infested lemons (Walker et al. 1992; Phillips & Walker 1997).

During a routine survey of citrus trees on 28 Sep 2008 in the Hollywood, Florida, area, pest survey specialists with the United States Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS), Bureau of Cooperative Agricultural Pest Survey (CAPS), discovered an unusual looking mite on sour orange (*Citrus aurantium* L.; Rutaceae) in John Williams Park (personal communication, K. M. Griffiths and M. E. Meadows, USDA, APHIS, CAPS). The mite was identified as *Diptilomiopus assamica* Keifer (Welbourn 2008). This species was originally described from India and later reported from northern Queensland (Australia) on citrus (Keifer 1959; Knihinicki & Boczek 2002).

Questions were raised about markings on the female genital cover flap of this new species (personal communication, J. W. Amrine, West Virginia University, and C. Craemer, Biosystematics, Agricultural Research Center, Pretoria, South Africa) versus the original description of *D. assamica* by Keifer (1959). Diagrams of *D. assamica* depicted a genital cover flap lacking in markings (Keifer 1959), and this lack of markings was later confirmed by Keifer and Knorr (1978). Additional taxonomic characters differed from the original description by Keifer (1959), and a new species, *D. floridanus* Craemer & Amrine was described (Craemer et al., in press).

Concern about the distribution and abundance of this new rust mite species and its potential impact on commercial citrus in Florida prompted survey efforts from the original collection site outward. In addition, there are no published records of extensive surveys of the statewide mite fauna on dooryard citrus in Florida.

Materials and Methods

During 2009 and 2010, sampling for *Diptilomiopus* and other eriophyoid mites was restricted to the greater Clewiston, Davie, Ft. Lauderdale, Hollywood, Homestead, Loxahatchee, and Plantation areas with multiple collections taken within John Williams Park in Hollywood. The 2 closest commercial orange and grapefruit orchards to the greater Ft. Lauderdale area were in the Southern Gardens Groves, Clewiston, a former citrus grove in Loxahatchee, and commercial and dooryard lime trees were in the Homestead area. Beginning in 2009 and continuing through 2014, sample trees were randomly selected from lists of dooryard citrus locations compiled from multiple sources. Dooryard trees were sampled on the east coast between 2009 and 2012 and on the west coast during 2013. A few trees from both coastal areas were re-sampled during 2014. Because *D. floridanus* was originally found in an eastern coastal habitat, most of the dooryard citrus locations selected for sampling were within 10 to 15 km of either the east or west coasts. After a site was located from the list and sampled, additional citrus trees within a several block radius were searched. Usually 2 or 3 additional locations would be sampled before moving on to another known address having 1 or more dooryard trees. Homeowners were provided with a brief explanation of the project and permission was obtained prior to inspection in all but 6 instances.

SAMPLING METHODS

Many mite species rapidly leave a disturbed leaf or fruit during sampling. Therefore, rapid preservation of the fauna was required to accurately measure each sample. Dooryard trees that were sampled varied substantially in age and vigor. Most trees showed visual degrees of infection caused by the bacterial disease, citrus greening. In moderate to large citrus trees, 8 to 12 clusters of leaves and associated twigs were clipped from the tree with pruning shears and dropped individually into a 5 L bucket containing approximately 250 mL of 80% ethanol following the protocol of Childers and Ueckermann (2014). In smaller trees, i.e., 2 or 3 year-old trees or trees less than 2 meters in height, 4 to 6 leaf and associated twig samples were taken. Fewer than 15 trees of this smaller size were sampled during the survey. Occasionally, 2 to 4 fruits from a tree were included with the leaf samples or processed separately.

All plant material sampled, including leaves, twigs, and fruit, was vigorously agitated in the alcohol solution and then removed and discarded. The alcohol wash per sample was transferred into a labeled glass jar for processing. Samples from individual trees within each dooryard location were processed separately and placed in individual labeled jars. Random samples of leaves from each tree were collected from the inner and outer canopy areas as well as the middle, high, and low areas inside and outside of the tree canopy. All mites were removed from each sample and multiple numbers of eriophyoid mites were collectively slide-mounted on 1 or more slides in modified Berlese medium (Amrine & Manson 1996).

Sampling of commercial orchard sites in Florida between 2009 and 2012 consisted of 20, 50, or 100 mature spring flush samples, or 20 fruit samples. At Southern Gardens Citrus, 10 leaves were collected from each of 5 randomly selected trees per replicate in each block. Four fruit were collected separately and at random from the same block per replicate. Both leaf and fruit samples were replicated 3 times in each of the 9 blocks of trees at this location. Additional commercial orchards were sampled and varied from 4 to 10 fruit or leaves per tree and replicated 5 times. Numbers of leaves or fruit per tree or numbers of trees sampled during 2012 by independent scouts were not recorded. All samples were immediately washed in 80% ethanol as stated above and placed in individual labeled glass jars.

STATISTICAL ANALYSES

Population dynamics of *D. floridanus* was investigated, including the potential for antixenosis, the inability of a plant to serve as a host, and its effects on distribution. Causes of antixenosis may include lack of a chemical or visual cue recognized by the pest (Kogan & Ortman 1978), and degrees of antixenosis may vary among species of citrus.

To evaluate potential antixenosis, trees were coded 1 for presence of *D. floridanus* and 0 for absence (Excel macro program PooledIn-

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fRate, Biggerstaff 2006) and percent infestation was calculated (95% confidence intervals). If the 95% confidence intervals did not overlap, then our determination was that a significant difference in antixenosis occurred between the citrus species. Generalized linear mixed models with means separation by Tukey honest significant difference (HSD) tests (Proc Glimmix: https://www.sas.com/content/dam/SAS/en_us/doc/other1/editorial-guidelines.pdf ; SAS Institute 2016) were used to determine the degree of antixenosis expressed by each citrus species (lemon, lime, sour orange, tangelo, and sweet orange). Mite counts were square root transformed prior to analysis. Mite counts on different cultivars were log transformed.

Results

Adults and immatures of *D. floridanus* are white to light brown in color, about 160 µm in length with an arched body, and dorsoventrally thicker than the other 3 eriophyoid species found on Florida citrus. The chelicerae of *D. floridanus* are exposed and well developed. This combined with an extended and downward slopping prodorsal shield gives the mite the appearance of having a defined head (Fig. 1). These characters are readily apparent when looking in a dish containing the mites in alcohol with 15 to 20x magnification.

A total of 526 dooryard, 18 varietal block, and 784 commercial citrus trees representing at least 18 species in the genus *Citrus* which were sampled including the following genera: *Citrus Fortunella* (kumquats) and *Poncirus* (Trifoliate orange) were sampled in 17 central and southern Florida counties between May 2009 and Apr 2014 (Table 1). One or more *D. floridanus* adults and immatures were collected in 11 of these counties (Table 2). Eggs of this species were not found. The 6 counties with the highest infestation rates of *D. floridanus* were Collier 36%, Broward 25%, Indian River 25%, Palm Beach 25%, Martin 23%, and St. Lucie 22%. Collier is the only west coast county among the 6, with the remaining 5 on the east coast. *Diptilomiopus floridanus* was not observed in Charlotte, Hardee, Hendry, Highlands, Manatee, or Okeechobee counties. A total of 1,423 *D. floridanus* were collected from dooryard citrus trees and 1 each from the lemon cultivar 'Bearss' and a sweet lime tree at the Florida Citrus Arboretum in Winter Haven (Florida). This was the 1 instance during the study where *D. floridanus* was collected from known pesticide-treated trees and from an inland county. The spray records for the Fruit and Spice Park (Homestead, Florida) were not available.

Diptilomiopus floridanus was the second most abundant eriophyoid mite collected from dooryard and varietal citrus blocks with 91 of 526 trees infested. Infestation rates of the 4 eriophyoid mites on these trees were as follows: *A. pelekassi* 3.2%, *A. sheldoni* 9.1%, *D. floridanus* 17.3%, and *P. oleivora* 84.2% (Table 1). Thirty-eight percent of lemon, lime, and sour orange trees were infested with 1 or more *Diptilomiopus* on the east coast compared to 27% of the same variet-

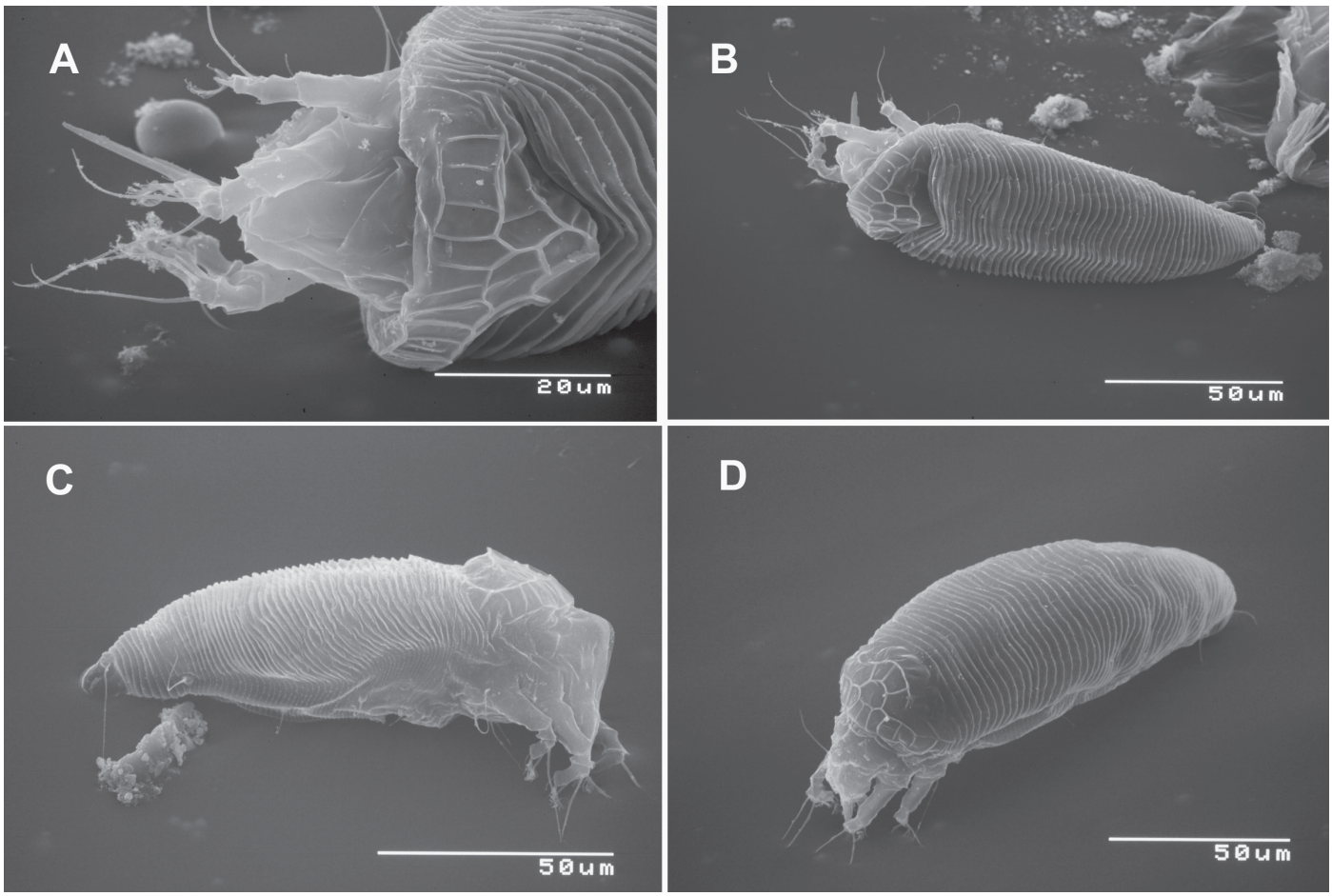


Fig. 1. Photographs taken with a scanning electron microscope of the new species of *Diptilomiopus floridanus* Craemer & Amrine on Florida citrus. (A) Dorsal view of prodorsum, legs, and well developed chelicerae. (B) Dorsal view of the mite. (C) Lateral view of the mite. (D) Dorso–lateral view of the mite with extended, downward gnathosome.

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Table 1. Eriophyoid mites on citrus and related Rutaceae collected from dooryard and varietal collection trees in Florida (2009–2014).

Rutaceae	Common name	Number of trees sampled	Number of trees without eriophyoid mites	*Aceria sheldoni*	*Aculops pelekassi*	*Diptilomiopus floridanus*	*Phyllocoptruta oleivora*
Citrus aurantifolia (Christm.) Swingle	Key lime	34	10	6 (1)[a]	0	148 (9)[a]	1,129 (27)[a]
Citrus aurantium L.	Sour orange	55	10	8 (5)	2 (2)[a]	263 (13)	1,834 (45)
Citrus grandis L. Osbeck	Pummelo	7	0	0	4 (1)	1	414 (7)
Citrus japonica Thunberg.	Kumquat	3	2	0	0	0	35 (1)
Citrus latifolia (Tanaka ex Yu. Tanaka) Tanaka	Lime	44	7	9 (4)	1	190 (16)	1,410 (34)
Citrus latifolia × *C. limon* × *C. sinensis*	Cocktail tree	1	0	0	0	1	4 (1)
Citrus limettioides Tanaka	Sweet lime	2	0	1	0	13 (2)	47 (2)
Citrus limon (L.) Burm. fil.	Lemon	76	8	31 (15)	28 (6)	534 (24)	7,823 (66)
Citrus limon × *C. medica* L.	Ponderosa lemon	10	1	3 (2)	0	12 (2)	488 (9)
Citrus limonia Osbeck	Rangpur lime	1	0	0	0	0	19 (1)
Citrus microcarpa Bunge	Calamondin	1	0	1	0	0	47 (1)
Citrus nobilis Loureira	Temple	2	0	0	0	0	30 (2)
Citrus paradisi MacFadyen	Grapefruit	57	6	4 (2)	0	1	3,956 (51)
Citrus reticulata Blanco	Tangerine	34	2	2 (2)	1	48 (2)	1,357 (32)
Citrus reticulata × *C. paradisi*	Tangelo	44	4	1	5 (1)	44 (3)	2,644 (40)
Citrus sinensis (L.)	Sweet orange	145	15	23 (13)	107 (4)	164 (14)	7,511 (116)
Citrus taitensis Risso	Rough lemon	3	1	0	0	0	70 (2)
Citrus trifoliata L.	Trifoliate orange	1	0	0	1	0	3 (1)
Citrus sp.	Red lime	1	0	0	0	1	20 (1)
Citrus spp.	Unknown species	5	1	1	0	5 (2)	298 (41)
Total		526	67	90 (48)	149 (17)	1,425 (91)	29,139 (443)
Infestation rate				9.1%	3.2%	17.3%	84.2%

[a]The number of mites collected of this species (with the number of trees infested in parentheses).

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Table 2. Number and infestation rate of *Diptilomiopus floridanus* Craemer & Amrine collected from dooryard citrus trees and varietal blocks in Florida (2009–2014).

County	Number of trees sampled	Number of trees with *Diptilomiopus*	Number of *Diptilomiopus* collected	Percentage of infested trees
Collier	22	8	81	36%
Broward	114	29	474	25%
Indian River	8	2	2	25%
Palm Beach	69	17	250	25%
Martin	40	9	182	23%
St. Lucie	18	4	13	22%
Dade	18	3	20	17%
Lee	39	6	86	15%
Sarasota	68	8	75	12%
Polk	30	2	2	7%
Pinellas	61	3	240	5%
Charlotte	21	0	0	0%
Hardee	0	0	0	0%
Hendry	0	0	0	0%
Highlands	0	0	0	0%
Manatee	18	0	0	0%
Okeechobee	0	0	0	0%
Total	526	91	1,425	17%

ies on the west coast. *Diptilomiopus floridanus* was most commonly found along coastal areas within 10 to 15 km of the ocean on dooryard citrus trees. A total of 238 *D. floridanus* and 889 *P. oleivora* were collected from 1 lemon tree in the community of Redington Shores, Pinellas county (Florida) on 19 Jun 2013. The tree was less than 1 km from the ocean and the northern most coastal collection site for this new mite species on either coast. Twenty-five of the 91 trees infested with *D. floridanus* had higher numbers of this species versus *P. oleivora* and included 9 cultivar 'Tahiti' lime, 5 Key lime, 1 sweet lime, 4 lemon, 3 sour orange, and 3 sweet orange trees.

Lime and lemon trees had significantly greater infestation rates of *D floridanus* compared with infestation on grapefruit, tangerine, tangelo, sweet orange, and pummelo trees. However, infestation rates were not significantly different from those on sour orange (Table 3). The infestation rate of the mite on sour orange was not significantly different from infestation on pummelo trees. In situations where species of citrus trees occurred together with 1 or more lime, lemon, or sour orange trees, then they were removed from a second analysis and different results were obtained (Table 4). However, the analysis of infestation rates of lime, lemon, and sour orange remained unchanged from the other citrus species.

The numbers of *D. floridanus* occurring were compared between the major citrus species (Table 5). Sufficient degrees of freedom were available to compare numbers of mites only on sweet orange, lemon, lime, tangelo, and sour orange trees, and no significant differences were found with this analysis.

Table 3. Comparative infestation rates of *Diptilomiopus floridanus* Craemer & Amrine on the major citrus species sampled in Florida between 2009 and 2014.

Citrus common name	Sampling location[a]	Number of trees infested	Number of trees without *D. floridanus*	Infestation rate (%)[b]	Lower 95% confidence interval	Upper 95% confidence interval
Grapefruit	DV	1	56	1.75 a	0.10	8.17
	C	0	2	0.00	0.00	65.76
Tangerine	DV	2	32	5.88ab	1.07	17.86
	C	0	1	0.00	0.00	65.76
Tangelo	DV	3	41	6.82ab	1.83	17.29
	C	0	12	0.00	0.00	24.25
Sweet orange	DV	14	131	9.66ab	5.62	15.29
	C	0	71	0.00	0.00	5.13
Pummelo	DV	1	6	14.29abc	0.85	51.51
	C	0	0	0.00	0.00	100.00
Sour orange	DV	13	42	23.64bc	13.88	36.09
	C	0	0	0.00	0.00	100.00
Lemon	DV	26	63	29.21c	20.51	39.24
	C	0	12	0.00	0.00	24.25
Lime	DV	28	53	34.57c	24.86	45.36
	C	0	36	0.00	0.00	9.64

[a]Location sampled = Dooryard + Varietal (DV) and Commercial trees (C).
[b]Means followed by the same letter are not significantly different ($P > 0.05$ using the Tukey HSD test).

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Table 4. Comparative infestation rates of *Diptilomiopus floridanus* Craemer & Amrine where positive trees were removed from the analysis if they were from multi-tree dooryard locations having lemon, lime, or sour orange present.

Citrus common name	Infestation rate (%)[a]	Lower 95% confidence limit	Upper 95% confidence limit
Tangerine	0.00a	0.00	10.72
Grapefruit	0.00a	0.00	6.42
Sweet orange	4.38a	1.81	8.85
Tangelo	4.65ab	0.84	14.34
Pummelo	14.29abc	0.85	51.51
Sour orange	23.64bc	13.88	36.09
Lemon	29.21c	20.51	39.24
Lime	34.57c	24.86	45.36

[a]Means followed by the same letter are not significantly different ($P > 0.05$) using the Tukey HSD test).

Diptilomiopus floridanus was not found among the 784 commercial citrus trees sampled in Dade, Hardee, Hendry, Highlands, Indian River, Okeechobee, Palm Beach, Polk, or St. Lucie counties between 2009 and 2012 (Table 6). A total of 120 commercial citrus orchards were surveyed for eriophyoid mites between 1986 and 1999 and *D. floridanus* was not found among the 64,887 mites identified (Childers & Achor 1999). That survey included at least 26 commercial citrus orchard sites within 50 km or less of coastal areas in Florida. However, dooryard citrus trees were not sampled in that survey.

Discussion

Insecticide fogging for mosquito control in John Williams Park (Hollywood, Florida) occurred prior to some of the sampling dates. The insecticides used and dates of application were not available. Mosquito problems were quite evident in the park. However, they were not a problem during 1 or 2 sampling dates. We suspect presence or complete absence of motile stages of this mite at this location were due to the mosquito fogging.

Two *D. floridanus* were collected on lime and lemon trees at the Citrus Arboretum in Winter Haven (Florida) on 11 Jul 2012. The following pesticides were applied to those trees during 2012: 30 Mar – Danitol® (Valent USA Corp., Walnut Creek, California) + Citru-film® (Helena Holding Co., Wilmington, Delaware); 10 May – Kocide® (E. I. DuPont de Nemours & Co., Inc., Wilmington, Delaware); and 11 Jun – Danitol® + Citru-film®. The ability of this mite to survive after pesticide treatments raises concerns about pesticide resistance and the potential of the mite becoming established in commercial citrus orchards in Florida. This could be especially important in lime and lemon cultivars if and when numbers of pesticide applications can be reduced for controlling the Asian citrus psyllid (Rogers & Dewdney 2015). Multiple insecticide and acaricide applications are currently applied to control the insect vector of citrus greening, as well as to suppress eriophyoid mite pests in commercial citrus orchards. Some of the dooryard tree locations appeared to have been sprayed with pesticides based on the condition of the trees and presence of clean fruit, and foliage. Other dooryard trees had varying numbers of predacious mites, especially Phytoseiidae.

Whether *D. floridanus* is a long-established or a more recent introduction into Florida citrus remains unknown. There are no published area-wide survey reports on dooryard citrus. Citrus preference (lemon, lime, and sour orange) and coastal distribution may have played a role in delaying detection. Additionally, more extensive surveys of dooryard and commercial citrus in neighboring countries in the Caribbean should be conducted to determine the extent of this mite species distribution. Species within the genus *Diptilomiopus* have been reported as lower leaf surface feeders occurring in low numbers with no apparent injury to their host plants (Chen et al. 2004; Huang 2005; Huang & Chen 2005; Song et al. 2008). However, extensive samplings of these species are lacking.

Chakrabarti and Mondal (1983) reported that *Diptilomiopus bengalensis* Chakrabarti and Mondal caused yellowing to browning of leaves, and normal leaf growth was affected with heavy infestations on *Gardenia jasminoides* J. Ellis (Rubiaciae). Furthermore, Mohanasundarum (1981) reported that *Diptilomiopus artocarpae* Mohanasundarum caused drying of the twigs of *Artocarpus integer* (Thunb.) Merr. (Moraceae). Both reports are based on anecdotal observations. *Diptilomiopus* species have not been reported as economic pests on citrus or other crops. Essentially, all research conducted so far has dealt with descriptions of species. Information on feeding injury, host susceptibility, and effects of population density are lacking. Future studies should focus on developing culturing methods for this species to determine potential feeding injury and resultant economic impact on difference citrus species.

Table 5. Results of statistical analysis testing differences in *Diptilomiopus floridanus* Craemer & Amrine abundance on different citrus cultivars using the model Host = log(abundance). Zero values were excluded in the analysis.

Source	DF	SS	*F* value	Pr > *F*
Model	4.00	2.52	0.28	0.89
Error	79.00	177.45		
Corrected total	83.00	179.97		

Citrus common name	LS mean	Lower 95% confidence limit	Higher 95% confidence limit
Sweet orange	13	0	29
Lemon	20	9	32
Lime	13	1	24
Tangelo	15	0	50
Sour orange	20	3	37

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Table 6. Eriophyoid mites collected from commercial or research center citrus orchards in Florida (2009–2012).

Grower No.	Nearest city/town – County	Date sampled	Number of blocks sampled	Citrus common name or cultivar	Sample type and method	Number of trees sampled[a]	*Aceria sheldoni*	*Aculops pelekassi*	*Diptilomiopus floridanus*	*Phyllocoptruta oleivora*
1	Homestead, Tropical Research and Education Center – Dade	7 Jun 2011	1	'Tahiti' lime	10 leaves per tree	5	0	0	0	161
					2 fruit per tree	5	0	0	0	53
	Homestead, Tropical Research and Education Center – Dade	16 May 2002	1	'Tahiti' lime	10 outer leaves per tree	10	0	7	0	310
					10 inner leaves per tree	10	0	0	0	14
2	Loxahatchee – Palm Beach	10 May 2009	5	Minneola tangelo	10 leaves per tree	50	0	0	0	18
				Grapefruit	10 leaves per tree	50	0	0	0	23
				Minneola tangelo	4 fruit per tree	20	0	0	0	31
				Grapefruit	4 fruit per tree	20	0	0	0	160
	Loxahatchee – Palm Beach	11 May 2010	5	Minneola tangelo	10 leaves per tree	50	0	0	0	356
			5	Grapefruit	10 leaves per tree	50	0	0	0	278
	Loxahatchee – Palm Beach	16 Aug 2010	4	Minneola tangelo	20 leaves per tree	20	0	0	0	3
			4	Grapefruit	4 fruit per tree	20	0	0	0	31
			1	Grapefruit	4 fruit per tree	5	0	0	0	0
3	Fort Pierce – St. Lucie	12 Jun 2012	1	Lemon	Leaves, twigs	5	0	13	0	48
					4 fruit per tree	5	0	0	0	141
					20 leaves per tree	10	0	2	0	310
4	Fort Pierce – St. Lucie	3 Aug 2012	1	'Valencia' orange	Fruit, leaves		0	0	0	67
5	Fort Pierce – St. Lucie	12 Jul 2012	1	'Star Ruby' grapefruit	Fruit, leaves		0	0	0	39
6	Fort Pierce – St. Lucie	12 Jul 2012	1	'Valencia' orange	Fruit, leaves		0	0	0	0
7	Fort Pierce – St. Lucie	6 Jul 2012	1	'Valencia' orange	Fruit, leaves		0	0	0	21
8	Fort Pierce – St. Lucie	7 Jun 2012	1	'Valencia' orange	Fruit, leaves		0	0	0	319
9	Fort Pierce – Indian River	13 Jun 2012	1	'Valencia' orange	Fruit, leaves		0	0	0	0
			1	'Hamlin' orange	Fruit, leaves		0	0	0	43
			1	'Pineapple' orange	Fruit, leaves		0	0	0	18
10	Lake Alfred, Citrus Research and Education Center – Polk	14 May 2010	1	'Hamlin' orange	10 leaves per tree	30	0	0	0	32
					10 fruit per tree	10	0	0	0	0
11	Lake Wales – Polk	4 Jun 2012	1	'Valencia' orange	Fruit, leaves		0	0	0	119
	Lake Wales – Polk	18 May 2012	2	'Valencia' orange	Fruit, leaves		0	1	0	295
	Dundee – Polk	4 Jun 2012	2	'Ambersweet' tangerine	Fruit, leaves		0	0	0	11
	Lake Wales – Polk	4 Jun 2012	1	'Valencia' orange	Fruit, leaves		0	0	0	31
12	Bowling Green – Hardee	12 May 2010	1	Navel orange	10 leaves per tree	30	0	0	0	161
			1	'Hamlin' orange	10 leaves per tree	30	0	0	0	0
13	Sebring – Highlands	25 Aug 2009	1	Citrus sp.	20 fruit		0	0	0	21
14	Sebring – Highlands	2 Jul 2012	1	Orlando tangelo	Fruit, leaves		0	0	0	69
	Sebring – Highlands	2 Jul 2012	1	'Pineapple' orange	Fruit, leaves		0	0	0	62
	Sebring – Highlands	10 Jul 2012	1	'Valencia' orange	Fruit, leaves		0	0	0	14

[a]Number of trees or sample size were not recorded by independent scouts (at least 19 trees were sampled).

Table 6. (Continued) Eriophyoid mites collected from commercial or research center citrus orchards in Florida (2009–2012).

Grower No.	Nearest city/town – County	Date sampled	Number of blocks sampled	Citrus common name or cultivar	Sample type and method	Number of trees sampled[a]	*Aceria sheldoni*	*Aculops pelekassi*	*Diptilomiopus floridanus*	*Phyllocoptruta oleivora*
15	Clewiston – Hendry	14–15 Aug 2010	13	'Hamlin' orange	4 fruit per tree	105	0	0	0	775
					10 leaves per tree	105	0	0	0	390
			3	'Valencia' orange	4 fruit per tree	15	0	0	0	20
					10 leaves per tree	15	0	0	0	52
			3	'Rhode Red Valencia'	10 leaves per tree	35	0	0	0	42
	Clewiston – Hendry	11 May 2011	13	'Hamlin' orange	10 leaves per tree	65	2	0	0	166
16	Grassy Island – Okeechobee	13 Jun 2012	1	Murcott tangerine	Fruit, leaves		0	0	0	2
			1	'Valencia' orange	Fruit, leaves		0	0	0	5
			1	Navel orange	Fruit, leaves		0	0	0	0
					Total	784	2	23	0	3,093

[a]Number of trees or sample size were not recorded by independent scouts (at least 19 trees were sampled).

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