Thysanoptera (Thrips) Within Citrus Orchards in Florida: Species Distribution, Relative and Seasonal Abundance Within Trees, and Species on Vines and Ground Cover Plants

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Thysanoptera (thrips) within citrus orchards in Florida: Species distribution, relative and seasonal abundance within trees, and species on vines and ground cover plants

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Abstract

Seven citrus orchards on reduced to no pesticide spray programs were sampled for Thysanoptera in central and south central Florida. Inner and outer canopy leaves, fruits, twigs, trunk scrapings, vines and ground cover plants were sampled monthly between January 1995 and January 1996. Thirty-six species of thrips were identified from 2,979 specimens collected from within citrus tree canopies and 18,266 specimens from vines and ground cover plants within the seven citrus orchards. The thrips species included seven predators [*Aleurodothrips fasciapennis* (Franklin), *Karnyothrips flavipes* (Jones), *K. melaleucus* (Bagnall), *Leptothrips cassiae* (Watson), *L. macroocellatus* (Watson), *L. pini* (Watson), and *Scolothrips sexmaculatus* (Pergande)] 21 plant feeding species [*Anaphothrips n.* sp., *Arorathrips mexicanus* (Crawford), *Aurantothrips orchidaceous* (Bagnall), *Baileyothrips limbatus* (Hood), *Chaetanaphothrips orchidii* (Moulton), *Danothrips trifasciatus* (Sakimura), *Echinothrips americanus* (Morgan), *Frankliniella bispinosa* (Morgan), *F. cephalica* (Crawford), *F. fusca* (Hinds), *F. gossypiana* (Hood), *Frankliniella* sp. (runneri group), *Haplothrips gowdeyi* (Franklin), *Heliothrips haemorrhoidalis* (Bouché), *Leucothrips piercei* (Morgan), *Microcephalothrips abdominalis* (Crawford), *Neohydatothrips floridanus* (Watson), *N. portoricensis* (Morgan), *Pseudothrips inequalis* (Beach), *Scirtothrips* sp., and *Thrips hawaiiensis* (Morgan)]; and eight fungivorous feeding species [*Adraneothrips decorus* (Hood), *Hoplandrothrips pergandei* (Hinds), *Idolothripinae* sp., *Merothrips floridensis* (Watson), *M. morgani* (Hood), *Neurothrips magnafemoralis* (Hinds), *Stephanothrips occidentalis* Hood and Williams, and *Symphyothrips* sp.]. Only *F. bispinosa*, *C. orchidii*, *D. trifasciatus*, and *H. haemorrhoidalis* have been considered economic pests on Florida citrus. *Scirtothrips* sp. and *T. hawaiiensis* were recovered in low numbers within Florida citrus orchards. Both are potential pest species to citrus and possibly other crops in Florida. The five most abundant thrips species collected within citrus tree canopies were: *A. fasciapennis*, *F. bispinosa*, *C. orchidii*, *K. flavipes*, and *D. trifasciatus*. In comparison, the following five thrips species were most abundant on vines or ground cover plants: *F. bispinosa*, *H. gowdeyi*, *F. cephalica*, *M. abdominalis*, and *F. gossypiana*. Fifty-eight species of vines or ground cover plants in 26 families were infested with one or more of 27 species of thrips.

Keywords: Thrips, Terebrantia, Phlaeothripinae, Idolothripinae, Thripidae, Phlaeothripidae
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Introduction

The Thysanoptera (thrips) exist in a wide array of habitats. Many species are serious economic pests of various crops (Lewis 1997). Several thrips species are important pests of citrus including citrus thrips, *Scirtothrips citri* (Moulton) in California and Arizona and *S. aurantii* Faure in South Africa (Bedford 1943; Talhouk 1975; Tanigoshi and Nishio-Wong 1982). Feeding injury by these species results in scarring of rind tissue in a fairly uniform ring encircling the stem end of the fruit. Navel oranges are a preferred host of citrus thrips in California and subsequent rind blemish injury results in the rejection of fruit for the fresh market. Young twigs, leaves, and leaf buds are also fed upon by citrus thrips resulting in non-economic types of injury to the trees (Jeppson 1989).

Frankliniella bispinosa (Morgan) and *F. kelliae* Sakimura in Florida cause premature flower drop in navel and 'Valencia' oranges as a result of adult and larval feeding during bloom (Childers and Achor 1991; Childers 1992). *Chaetanaphothrips orchidii* (Moulton), *Danothrips trifasciatus* Sakimura, and *Heliothrips haemorrhoidalis* (Bouché) were found to cause rind blemish damage (ring spot) on red grapefruit varieties in Florida (Childers and Frantz 1994).

Eighteen species were identified on citrus flowers and *F. bispinosa* was the prevalent species (Childers et al. 1990, Childers and Beshear 1992). In a later study, 86 species of thrips were collected with sticky card traps that were placed within Florida citrus orchards at several locations (Childers et al. 1998). However, only limited information was available as to which of these species were actual inhabitants of Florida citrus orchards. Development of effective management strategies for thrips pests on Florida citrus requires an understanding of their respective biologies including their relative abundance, associated predators, and distributions within the orchards. Therefore, this study was initiated over a 13-month interval to determine the species complex of Thysanoptera that occur within selected Florida citrus orchards as well as the thrips present on associated vine and ground cover plants within those orchard sites.

Materials and Methods

Seven citrus orchards in Polk, Lake, and DeSoto Counties in Central and South-Central Florida on reduced to no pesticide spray programs were sampled monthly over a 13-month interval between January 1995 and January 1996 for Thysanoptera (Table 1). The Trask, Pollard, and Yarborough orchards were located in the

Table 1. Pesticide spray programs for seven citrus orchards sampled for Thysanopteran species in Florida during 1995–1996.

Orchard	Herbicides	Insecticides/Acaricides	Fungicides
Trask Polk County 'Hamlin' orange	Not applied since 1995	Not applied since 1995	Not applied since 1995
Yarborough Polk County 'Hamlin' orange	Glyphosate 1994, 1995	Petroleum oil + (Mn and Zn) 1994	Copper 1994
Pollard Polk County 'Duncan'/'Marsh' grapefruit	Not applied since 1993	Not applied since 1993	Not applied since 1993
Hart I Lake County 'Ambersweet' orange	Glyphosate 1993, 1995	Ethion + petroleum oil (Summer 1994) Fenbutatin oxide (Spring 1993) Propargite (Fall 1993 and 1994)	Never applied
Hart II Lake County Navel orange	Not applied since 1992	Ethion + petroleum oil (Spring and Summer 1992) Fenbutatin oxide 1992	Aliette 1992 Copper 1992
Mixom I DeSoto County 'Marsh' grapefruit	Glyphosate, norflurazon, simazine, sethoxydin, diuron 1995, 1996	Not applied since 1986	Not applied since 1986
Mixom II DeSoto Co. 'Valencia' orange	Glyphosate, norflurazon, simazine, sethoxydin, diuron 1995, 1996	Not applied since 1988	Not applied since 1988

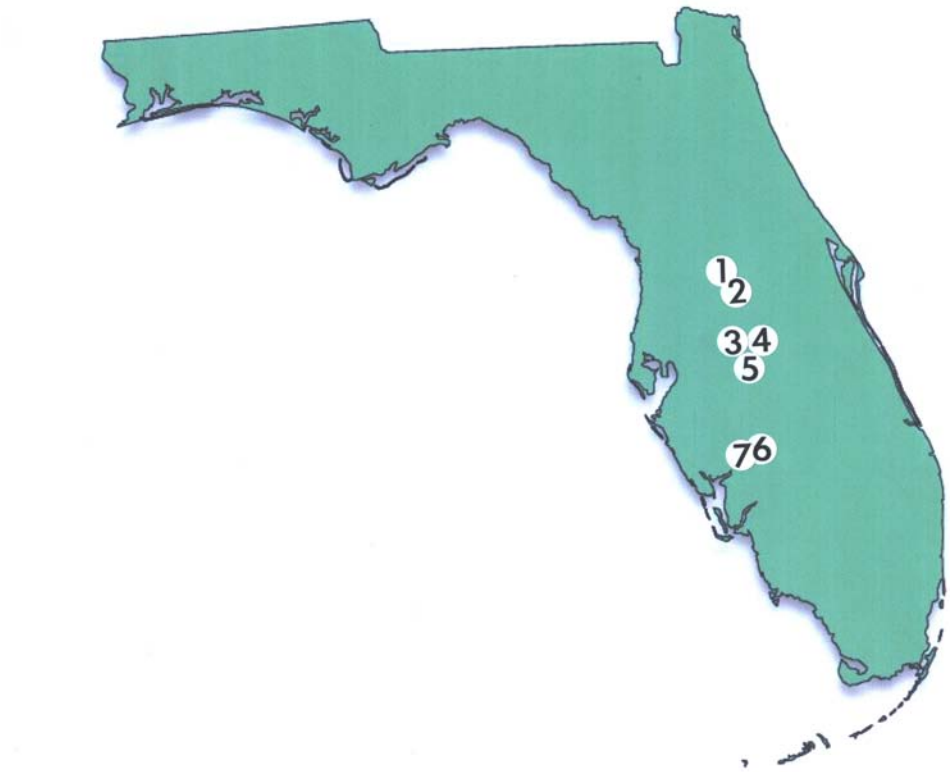

Figure 1. Map of Florida showing the locations of the seven citrus orchard sites: 1 - Hart I, 2 - Hart II, 3 - Pollard, 4 - Trask, 5 - Yarborough, 6 - Mixom I, 7 - Mixom II.

Highlands City vicinity in Polk County all within 10 km of each other. The two Hart orchards were about 5 km apart and located immediately off County Road 469 about 10 km northwest of Mascotte in Lake County. The two Mixom orchards were located in southeastern Arcadia in DeSoto County about 10 km apart (Figure 1).

Thrips species were collected separately from (1) 100 inner leaves (2) 100 outer leaves, (3) 10–20 twigs, (4) 25-immature fruits, and (5) individual mature fruit samples. Tree trunk scrapings (6) were collected into a 5-liter bucket containing about 250 ml of 80% ethanol. A stiff brush was used to make 15–20 firm, short downward strokes on the surface of the main trunk and scaffold limbs of each citrus tree sampled and scrapings were directed into a bucket placed directly below to collect the arthropods. Loose bark or debris and lichens were also collected from the tree trunks. Each of the six sample types was collected individually and replicated six to eight times. Many thrips species would rapidly leave a disturbed leaf or fruit. Therefore, rapid preservation of the thrips fauna was intended to accurately measure what was present within the sample.

Individual fruit, leaves, and twigs were collected and dropped immediately into a bucket containing about 250 ml of 80% ethanol, and vigorously agitated in the solution. Most of the fruit, leaf, or twig samples were discarded on site and the alcohol wash was transferred into a labeled glass jar and returned to the laboratory for processing.

Ground cover plants or vines were also sampled from five of the seven orchard sites. Selection of plants varied at each location and depended upon their prevalence. The two Mixom sites had been treated with herbicide and lacked ground cover plants for sampling (Table 1). Plant material for each species included leaves, stems, and flowers (when present), and a single sample was taken from one or more plants for each selected plant species present per orchard site on a given date. A sufficient volume of a ground cover plant or vine species was gathered to fill a 473 ml glass jar containing 50–100 ml of 80% ethanol to near

capacity. Each jar containing one plant species was returned to the laboratory for processing. A representative sample of each plant was also collected and placed in a plant press in the field between sheets of newspaper for eventual identification. Plant identifications to species were completed by Kent Perkins at the Herbarium, University of Florida, Gainesville. Collection data were included with samples in both jars and the plant press which included location, date, and code (e.g., weed A, B, C).

Each thrips species in each processed sample was recorded and then placed into a labeled vial containing 80% ethanol. Thrips were later removed, and individually slide-mounted in Hoyer's mounting medium (Krantz 1978) then oven-cured for at least three weeks at 45–47°C. Numerous thrips (more than 500) were present in many of the ground cover plant samples so subsamples from these were taken by proportionally selecting between 30 and 100 representative specimens by color, sex, or larval size.

Results and Discussion

Thrips Species Composition

Thirty-six species of thrips were identified from 2,979 specimens collected within citrus tree canopies and 18,266 specimens from vines or ground cover plants (Tables 2, 3). Ten thrips species were recovered only from within citrus tree canopies and included: *Merothrips floridensis* (Watson), *M. morgani* (Hood), *Frankliniella* sp. (runneri group), *Heliothrips haemorrhoidalis* (Bouché), *Adraneothrips decorus* (Hood), *Hoplandrothrips pergandei* (Hinds), Idolothripinae, *Neurothrips magnafemoralis* (Hinds), *Stephanothrips occidentalis* (Hood and Williams), and *Symphyothrips* sp. Fourteen thrips species were recovered from both citrus tree canopies and vine or ground cover plants and included: *Anaphothrips* n. sp., *Arorathrips mexicanus* (Crawford), *Chaetanaphothrips orchidii* (Moulton), *Danothrips trifasciatus* (Sakimura), *Frankliniella bispinosa* (Morgan), *F. cephalica* (Crawford), *Microcephalothrips abdominalis* (Crawford), *Scirtothrips* sp., *Aleurodothrips fasciapennis* (Franklin), *Haplothrips gowdeyi* (Franklin), *Karnyothrips flavipes* (Jones), *K. melaleucus* (Bagnall), *Leptothrips macroocellatus* (Watson), and *Leucothrips piercei* (Morgan). The remaining twelve species were collected only from either vine or ground cover plants and included: *Aurantothrips orchidaceous* (Bagnall), *Baileyothrips limbatus* (Hood), *Echinothrips americanus* (Morgan), *Frankliniella fusca* (Hinds), *F. gossypiana* (Hood), *Neohydatothrips floridanus* (Watson), *N. portoricensis* (Morgan), *Pseudothrips inequalis* (Beach), *Scolothrips sexmaculatus* (Pergande), *Thrips hawaiiensis* (Morgan), *Leptothrips cassiae* (Watson), and *L. pini* (Watson) (Tables 2,3). Among the 36 thrips species were seven predacious, 21 phytophagous and eight fungal feeding species. Four of the phytophagous species are known pests of Florida citrus: *F. bispinosa, C. orchidii, D. trifasciatus,* and *H. haemorrhoidalis* (Childers 1992, 1999; Childers and Frantz 1994). Two additional phytophagous species, S*cirtothrips* sp. and *T. hawaiiensis* are potential economic pests of Florida citrus that require close monitoring over the coming years. The remaining 23 phytophagous and fungal feeding thrips species are not economic pests of citrus.

Distribution, relative and seasonal abundance of each thrips species on citrus and on vine and ground cover plants within citrus orchards

The five most abundant thrips species found within citrus tree canopies were: *A. fasciapennis* (1,015), *F. bispinosa* (680), *C. orchidii* (360), *K. flavipes* (206), and *D. trifasciatus* (156). In comparison, the five most abundant species found on vines or ground cover plants were: *F. bispinosa* (6,151), *H. gowdeyi* (5,003), *F. cephalica* (Crawford) (4,310), *M. abdominalis* (1,036), and *F. gossypiana* (Hood) (207).

Each of the 36 species is divided into three groups below. Their distributions within citrus trees or from one or more of 58 species of plants, vines, and groundcover representing 26 families are presented. The thrips species associations and dates collected from each of these plants are shown in Table 3.

Predacious species

Aleurodothrips fasciapennis (Franklin)

This species was the most abundant predacious thrips collected within the citrus tree canopy during this study (Tables 2, 3). *A. fasciapennis* was present in all seven orchard sites on leaves, fruit and twigs. This species was more abundant on inner versus outer leaf samples with 495 and 171 individuals, respectively (Table 4).

A. fasciapennis was found during every month

Table 2. Distribution and comparative numbers of Thysanopteran species collected within seven Florida citrus orchards between January 1995 and January 1996.

		Habitat sample							
Thrips species	**Status**	**Inner leaves**	**Outer leaves**	**Individual fruit***	**25 fruit**	**Twigs**	**Trunk****	**Totals from within tree**	**Totals from ground cover or vines**
Terebrantia	Fungal feeder	0	0	1	0	0	35	36	0
Merothripidae									
Merothrips floridensis (Watson)									
Merothrips morgani (Hood)	Fungal feeder	0	0	0	0	0	3	3	0
Merothrips sp.	Fungal feeder	0	0	0	17	0	1	18	0
Thripidae	Phytophagous	0	0	0	0	1	0	1	3
Anaphothrips n. sp.									
Arorathrips mexicanus (Crawford)	Phytophagous	0	1	0	0	0	0	1	31
Aurantothrips orchidaceous (Bagnall)	Phytophagous	0	0	0	0	0	0	0	1
Baileyothrips limbatus (Hood)	Phytophagous	0	0	0	0	0	0	0	2
Chaetanaphothrips orchidii (Moulton)	Phytophagous***	35	13	33	278	1	0	360	88
Danothrips trifasciatus (Sakimura)	Phytophagous***	6	10	6	134	0	0	156	3
Echinothrips americanus (Morgan)	Phytophagous	0	0	0	0	0	0	0	15
Frankliniella bispinosa (Morgan)	Phytophagous***	120	112	94	60	19	275	680	6,151
Frankliniella cephalica (Crawford)	Phytophagous	0	0	0	1	0	0	1	4,310
Frankliniella fusca (Hinds)	Phytophagous	0	0	0	0	0	0	0	2
Frankliniella gossypiana (Hood)	Phytophagous	0	0	0	0	0	0	0	207
Frankliniella sp. (runneri group)	Phytophagous	0	0	0	1	0	0	1	0
Frankliniella spp.	Phytophagous	5	1	7	1	0	2	16	457
Heliothrips haemorrhoidalis (Bouché)	Phytophagous***	33	14	11	27	0	0	85	0
Microcephalothrips abdominalis (Crawford)	Phytophagous	1	7	0	0	5	0	13	1,036
Neohydatothrips floridanus (Watson)	Phytophagous	0	0	0	0	0	0	0	32
Neohydatothrips portoricensis (Morgan)	Phytophagous	0	0	0	0	0	0	0	4
Neohydatothrips sp.	Phytophagous	0	0	0	0	0	0	0	2
Pseudothrips inequalis (Beach)	Phytophagous	0	0	0	0	0	0	0	2
Scirtothrips sp.	Phytophagous	1	0	1	1	0	0	3	1
Scolothrips sexmaculatus (Pergande)	Predacious	0	0	0	0	0	0	0	6
Scolothrips sp.	Predacious	1	2	1	6	0	0	10	53
Thrips hawaiiensis (Morgan)	Phytophagous	0	0	0	0	0	0	0	2
Thripidae	–	1	0	1	1	0	7	10	50
Tubulifera									
Phlaeothripidae									
Adraneothrips decorus (Hood)	Fungal feeder	0	0	0	2	0	0	2	0
Aleurodothrips fasciapennis (Franklin)	Predacious	495	171	19	253	61	16	1,015	3
Haplothrips gowdeyi (Franklin)	Phytophagous	5	6	0	2	6	0	19	5,003
Hoplandrothrips pergandei (Hinds)	Fungal Feeder	0	0	0	0	1	0	1	0
Idolothripinae	Fungal Feeder	0	0	0	0	1	0	1	0
Karnyothrips flavipes (Jones)	Predacious	5	3	22	129	36	11	206	14
Karnyothrips melaleucus (Bagnall)	Predacious	0	12	1	9	3	3	28	8
Karnyothrips spp.	Predacious	7	0	18	8	11	11	55	0
Leptothrips cassiae (Watson)	Predacious	0	0	0	0	0	0	0	28
Leptothrips macroocellatus (Watson)	Predacious	20	45	5	41	13	3	127	104
Leptothrips pini (Watson)	Predacious	0	0	0	0	0	0	0	20
Leptothrips spp.	Predacious	0	16	2	6	2	0	26	300
Leucothrips piercei (Morgan)	Phytophagous	0	4	1	0	0	0	5	294
Neurothrips magnafemoralis (Hinds)	Fungal feeder	0	0	8	8	0	1	17	0
Stephanothrips occidentalis (Hood and Williams)	Fungal feeder	1	0	1	0	0	0	2	0
Stephanothrips sp.	Fungal feeder	0	1	0	0	0	0	1	0
Symphyothrips sp.	Fungal feeder	0	0	0	0	1	0	1	0
Phlaeothripidae	–	30	17	2	22	3	5	79	34

*Individual fruit (usually mature or over-mature).
**Trunk scrapings
***Pest species on Florida citrus.

Table 3. Thrips species collected from selected vine and ground cover plants within seven Florida citrus orchards between January 1995 and January 1996.

Plant Family, Species [common name]	Thrips species	Months found	Trask	Pollard	Yarborough	Hart I	Hart II
Amaranthaceae							
Amaranthus hybridus L. [common pigweed]	*Frankliniella bispinosa*	Apr					365
	Haplothrips gowdeyi	Apr, Jul			3		147
	Leptothrips sp.	Apr					10
Amaranthus spinosus L. [spiny amaranth]	*Aleurodothrips fasciapennis*	Oct		1			
	Frankliniella bispinosa	Jan, Mar–May, Jul, Oct	291	169		139	
	Frankliniella cephalica	Jan–Feb, Apr Jan–Mar, Jul–Oct		16		9	
	Frankliniella sp.	Jan, Apr	13	13	2		
	Haplothrips gowdeyi	Jan–May, Jul–Sep, Nov	494	380	30	174	
	Karnyothrips flavipes	Apr	13				
	Karnyothrips melaleucus	Feb	3				
	Leptothrips cassiae	Nov				1	
	Leptothrips macroocellatus	Feb, Apr, Aug–Sep	17			1	
	Leptothrips sp.	Feb, Apr, Nov	12	1		1	
	Leucothrips piercei	May, Jul	4			2	
	Phlaeothripidae	Nov	6				
Amaranthus viridis L.	*Frankliniella bispinosa*	May			198		
	Haplothrips gowdeyi	May			77		
Gomphrena serrata L. [globe amaranth]	*Frankliniella sp.*	Nov					1
	Haplothrips gowdeyi	Nov					55
Asclepiadaceae							
Morrenia odorata (Hock and Arn.) Lindl. [milkweed vine]	*Frankliniella cephalica*	Aug	3				
Caryophyllaceae							
Drymaria cordata (L.) Willd. ex. Shultes [West Indian chickweed]	*Echinothrips americanus*	Apr			10		
	Frankliniella bispinosa	Apr			2		
	Haplothrips gowdeyi	Apr, Nov			50		
	Scolothrips sp.	Nov			1		
	Thripidae	Apr			4		
Stellaria media (L.) Cyrillo Vill. [common chickweed]	*Frankliniella bispinosa*	Mar	3				
	Haplothrips gowdeyi	Jan, Mar	7				
Chenopodium album (L.) [pigweed]	*Frankliniella bispinosa*	Jan, Mar, May				1	2,246
	Haplothrips gowdeyi	Jan–Feb, Apr–May		4		12	263
	Scolothrips sp.	May					8
Chenopodium ambrosioides (L.) [Jerusalem oak]	*Chaetanaphothrips orchidii*	May					71
	Frankliniella bispinosa	May, Nov					55
	Haplothrips gowdeyi	Sep–Nov					15
	Leptothrips cassiae	May, Jul					14
	Leptothrips macroocellatus	Oct–Nov					2
	Leptothrips sp.	Jul, Oct					26
	Microcephalothrips abdominalis	Nov					6
	Phlaeothripidae	Oct					2
	Scolothrips sp.	May, Jul					30
	Thripidae	May, Nov					14
Commeliaceae							
Commelina benghalensis L.	*Haplothrips gowdeyi*	Aug		2			
Commelina diffusa Burm. F. [day-flower]	*Frankliniella cephalica*	Sep		1			
	Haplothrips gowdeyi	Aug–Oct	30	57			
	Leucothrips piercei	Oct	4				
Compositae							
Ambrosia artemisifolia L. [hogbrake]	*Frankliniella bispinosa*	May		38			
	Frankliniella cephalica	May		1			
	Frankliniella sp.	May		1			
	Haplothrips gowdeyi	May	2				
	Leptothrips sp.	May	3				
	Neohydatothrips floridanus	May		32			
Bidens alba (L.) DC var. radiata [beggar-tick]	*Chaetanaphothrips orchidii*	Feb, Jul, Oct	7		4	2	
	Frankliniella bispinosa	Jan–May, Jul–Nov	232	439	282	125	593
	Frankliniella cephalica	Jan–Feb, May, Jul–Nov	72	710	120	639	2,498
	Frankliniella gossypiana	Feb					3
	Frankliniella sp.	Jan–Feb, Apr, Jul, Sep–Oct	139	38	44	2	21
	Haplothrips gowdeyi	Jan–May, July–Nov	359	271	220	366	568
	Leptothrips cassiae	Jan, May, Nov			10		
	Leptothrips macroocellatus	Jan, Apr–May, Jul–Sep	13	32	11		5
	Leptothrips sp.	Jan, May, Jul, Sep–Nov	26	5		131	32
	Leucothrips piercei	Jan–Apr, Jul, Sep–Nov	33	36	23	28	13
	Microcephalothrips abdominalis	Jan–Feb, Apr–May, Jul–Nov	14	139	68	213	538
	Phlaeothripidae	Feb, Nov			1	1	
	Thripidae	May, July					2
Conyza canadensis (L.) Conq. var pusilla [Dwarf horseweed]	*Haplothrips gowdeyi*	Jul	2				
	Leptothrips cassiae	Jul	1				
Emilia fosbergii Nicols.	*Frankliniella bispinosa*	May		20			

Plant Family, Species [common name]	Thrips species	Months found	Trask	Pollard	Yarborough	Hart I	Hart II
	Frankliniella sp.	May		26			
	Haplothrips gowdeyi	May		30			
Eupatorium capillifolium (Lam.) [small dog fennel]	*Frankliniella bispinosa*	Jan, May, Jul, Oct		25			
	Haplothrips gowdeyi	Jan, Oct		5			
	Leptothrips cassiae	May		2			
	Microcephalothrips abdominalis	May, Nov		1		24	
	Thripidae	May				4	
Gnaphalium pensylvanicum Willd. [cudweed]	*Frankliniella bispinosa*	Mar–Apr	114	11	2		80
	Frankliniella sp.	Mar		8	26		
	Haplothrips gowdeyi	Jan, Mar–Apr	32	3	12	21	7
	Leptothrips sp.	Apr	18				2
	Phlaeothripidae	Apr	3				
	Thripidae	Mar	5				
Heterotheca subaxillaris (Lan.) Brit. and Rusby [Camphor weed]	*Frankliniella bispinosa*	Jul					2
	Frankliniella cephalica	Jul					1
	Microcephalothrips abdominalis	Jul					12
Mikania scandens (L.) Willd.	*Haplothrips gowdeyi*	Sep			5		
	Leucothrips piercei	Sep			1		
Sonchus oleraceus L. [milk thistle]	*Frankliniella bispinosa*	Mar		6			
	Frankliniella cephalica	Mar		1			
Taraxacum officinale Wiggers [dandelion]	*Frankliniella cephalica*	Feb		1			
	Leucothrips piercei	Jan	43	21		7	
Youngia japonica (L.) DC [Asiatic hawkweed]	*Frankliniella bispinosa*	Jan				2	
	Frankliniella cephalica	Jan			1		
	Frankliniella fusca	Jan				1	
	Haplothrips gowdeyi	Jan			1		
	Leptothrips sp.	Jan				1	
Convolvulaceae							
Ipomoea coccinea L. [Cypress vine morning glory (vine)]	*Frankliniella bispinosa*	Sep–Nov	1	3			
	Frankliniella cephalica	Oct–Nov	13	1			
	Frankliniella sp.	Oct		10			
	Haptothrips gowdeyi	Oct–Nov	14	1			
Ipomoea hederifolia (L.) [scarlet morning glory (vine)]	*Aurantothrips orchidaceus*	Sep	1				
	Frankliniella bispinosa	Jan		1			
	Frankliniella gossypiana	Jan		1			
	Frankliniella sp.	Jan		2			
	Neohydatothrips portoricensis	Sep	3				
Jacquemontia tamnifolia L. [small flower morning glory]	*Leucothrips piercei*	Jan			8		
Cruciferae							
Barbarea vulgaris R.Br. [yellow rocket]	*Echinothrips americanus*	Jan		1			
Lepidium virginicum L. [Virginia pepper weed]	*Frankliniella bispinosa*	Apr	4				
	Frankliniella sp.	Feb–Mar	3				
	Haplothrips gowdeyi	Jan–Apr	24	7		4	86
	Leptothrips macroocellatus	Apr	1				
	Leucothrips piercei	Jan					1
	Pseudothrips inequalis	Jan					1
Cucurbitaceae							
Momordica charantia L. [wild balsam apple (vine)]	*Haplothrips gowdeyi*	Feb, Sep	3				
	Microcephalothrips abdominalis	Sep	1				
Cyperaceae							
Cyperus retrorsus Chapm.	*Frankliniella bispinosa*	Apr				3	
	Haplothrips gowdeyi	Apr				25	
	Leptothrips sp.	Apr				1	
Euphorbiaceae							
Euphorbia heterophylla L. [Fiddler's spurge]	*Haplothrips gowdeyi*	Sep		20			
Euphorbia hirta (L.) Millsp.	*Frankliniella bispinosa*	Sep		2			
	Frankliniella cephalica	Sep				1	
	Haplothrips gowdeyi	Aug–Sep		80		2	
Euphorbia hyssopifolia (L.) [small eyebane]	*Baileyothrips limbatus*	Oct				2	
	Frankliniella cephalica	Sep				1	
	Frankliniella sp.	Sep				2	
	Haplothrips gowdeyi	Sep–Oct			2	2	
	Leptothrips sp.	Nov				11	
	Thrips hawaiiensis	Sep				1	
Phyllanthus tenellus Roxb.	*Frankliniella bispinosa*	May	2				
	Haplothrips gowdeyi	May	2				
	Scolothrips sp.	May	5				
Fumariaceae							
Fumaria officinalis L. [earth smoke]	*Chaetanaphothrips orchidii*	Jan		1			
	Echinothrips americanus	Mar–Apr			1	1	
	Frankliniella bispinosa	Jan, Mar–Apr		3			
	Frankliniella sp.	Jan, Apr		2	2		
	Haplothrips gowdeyi	Jan–Feb, Apr		5	6		
	Leucothrips piercei	Jan	2				
	Scirtothrips sp.	Apr		1			
Geraniaceae							

Plant Family, Species [common name]	Thrips species	Months found	Trask	Pollard	Yarborough	Hart I	Hart II
Geranium carolinianum L.	*Frankliniella bispinosa*	Mar				1	
	Haplothrips gowdeyi	Mar				2	
Graminae							
Dactyloctenium aegyptium L. Beauv.	*Haplothrips gowdeyi*	Aug				7	
Eleusine indica (L.) Gaertn. [goose grass]	*Arorathrips mexicanus*	Jul	31				
	Frankliniella sp.	Jul	2				
	Haplothrips gowdeyi	Jul	54				
	Karnyothrips melaleucus	Jul	2				
	Phlaeothripidae	Jul	1				
	Scolothrips sp.	Jul	3				
Panicum maximum Jacq. [guinea grass]	*Danothrips trifasciatus*	Apr			3		
	Frankliniella bispinosa	Apr			3		
	Haplothrips gowdeyi	Apr, Jul			8		
Panicum texanum Buckl. [Colorado grass]	*Anaphothrips n. sp.*	May			3		
	Frankliniella bispinosa	May			17		
	Haplothrips gowdeyi	May			105		
Rhynchelytrum repens (Willd.) C.E. Hubb [natal grass]	*Chaetanaphothrips orchidii*	Oct					1
	Haplothrips gowdeyi	Oct					2
Labiatae							
Glechoma hedaracea L. [ground ivy]	*Chaetanaphothrips orchidii*	Jan		1			
	Echinothrips americanum	Jan		1			
	Haplothrips gowdeyi	Jan		2			
	Karnyothrips melaleucus	Jan		3			
Stachys floridana Shuttl. ex. Benth [Florida betony]	*Frankliniella cephalica*	Jan		1			
	Haplothrips gowdeyi	Jan		13			
	Leucothrips piercei	Jan		1			
Leguminosae							
Desmodium tortuosum (Sul.) DC. [Florida beggarweed]	*Echinothrips americanum*	Jul	1				
	Frankliniella bispinosa	Jan			1		
	Haplothrips gowdeyi	Jan			1		
Indigofera hirsuta Harv.	*Frankliniella cephalica*	Oct				16	
	Frankliniella sp.	Oct				1	
	Haplothrips gowdeyi	Jan, Oct				5	11
	Microcephalothrips abdominalis	Oct				5	
Loganiaceae							
Polypremum procumbens L.	*Haplothrips gowdeyi*	Aug				1	
Malvaceae							
Sida acuta Burm.F. [broom weed]	*Haplothrips gowdeyi*	Aug				6	
	Leucothrips piercei	Aug				1	
Sida rhombifolia L. [Indian hemp]	*Haplothrips gowdeyi*	Jul–Aug		1		1	
	Leptothrips macroocellatus	Aug				1	
	Leptothrips sp.	Jul		1			
	Neohydatothrips sp.	Aug				2	
Onagraceae							
Oenothera laciniata J. Hill [cut-leaved evening primrose]	*Haplothrips gowdeyi*	Apr				7	
Oxalidaceae							
Oxalis intermedia A. Rich. [wood sorrel]	*Haplothrips gowdeyi*	Oct–Nov	16		1		
Phytolaccaceae							
Rivinia humilis L.	*Haplothrips gowdeyi*	Sep	1				
Polygonaceae							
Rumex hastatulus Baldw. [hastate-leaved dock]	*Frankliniella bispinosa*	Mar–May				105	6
	Haplothrips gowdeyi	Mar–May				56	85
	Leptothrips sp.	Apr–May				12	
	Thripidae	Apr				24	
Rubiaceae							
Richardia brasiliensis (Meg.) Gomez [Brazilian pusley]	*Aleurodothrips fasciapennis*	Aug					1
	Chaetanaphothrips orchidii	Oct			1		
	Frankliniella bispinosa	Apr–May	9	3	40		
	Haplothrips gowdeyi	Apr–May, Jul–Nov	89	13	115	70	38
	Karnyothrips flavipes	Oct			1		
	Leptothrips macroocellatus	Oct				1	
	Leptothrips sp.	May			3		
	Leucothrips piercei	Oct–Nov			13	6	
Scrophulariaceae							
Scoparia dulcis L.	*Frankliniella bispinosa*	Oct				3	
	Frankliniella cephalica	Oct				1	
	Frankliniella sp.	May				1	
	Haplothrips gowdeyi	Feb, May, Oct				37	
	Leucothrips piercei	Oct				3	
Solanaceae							
Physalis angulata L. [ground cherry]	*Leucothrips piercei*	Jan	3				
Solanum cf. *americanum* L.	*Frankliniella bispinosa*	Mar–May, Jul	78	7	27		34
	Frankliniella cephalica	Mar, Nov		1		187	
	Frankliniella sp.	Mar, Jul, Nov	1	31		21	
	Haplothrips gowdeyi	Jan–Mar, May, Nov	41	3	4	42	4
	Leptothrips macroocellatus	May	4				

Plant Family, Species [common name]	Thrips species	Months found	Trask	Pollard	Yarborough	Hart I	Hart II
	Leptothrips sp.	Jul	1				
	Leucothrips piercei	Mar–Apr, Jul	38	2	1		
	Phlaeothripidae	Mar			1		
Solanum sp.	*Leucothrips piercei*	Jan	7				
Umbelliferae							
Spermolepsis divaricata (Walt.) Seringe	*Haplothrips gowdeyi*	Apr					38
Urticaceae							
Parietaria praetermissa Hinton	*Haplothrips gowdeyi*	Jan			3		
Verbenaceae							
Lantana camara L. [common lantana]	*Aleurodothrips fasciapennis*	Aug					1
	Frankliniella bispinosa	Jan–May, Jul, Sep–Nov		1	234		123
	Frankliniella cephalica	Jan, Apr, Jul, Nov					16
	Frankliniella sp.	Mar–May			41		4
	Haplothrips gowdeyi	Jan, Mar–May, Jul, Sep		5	102		27
	Leptothrips macroocellatus	May, Jul, Sep		3	3		9
	Leptothrips pini	Mar–Apr			20		
	Leptothrips sp.	May			3		
	Microcephalothrips abdominalis	May					15
	Scolothrips sp.	May–Jun					6
	Thrips hawaiiensis	Sep		1			
	Thripidae	May					3

sampled and most abundant on inner leaves during the months of March and April 1995 (Table 4). This was similar to results from a previous study by Selhime et al. (1963) who found this species to be most abundant during spring and early summer. *A. fasciapennis* was rarely found on ground cover plants with a total of three adults collected from *Richardia brasiliensis*, and *Lantana camara* in August and on *Amaranthus spinosus* in the Pollard site in October (Table 3).

A. fasciapennis will feed and develop on purple scale, *Lepidosaphes beckii* (Newman), Florida red scale, *Chrysomphalus aonidum* (L.), chaff scale, *Parlatoria pergandii* Comstock, oleander scale, *Aspidiotus nerii* Bouché (Beshear 1975), and mango scale, *Aulacaspis tubercularis* (Newstead) (Labuschagne et al. 1995); cloudy-winged whitefly, *Dialeurodes citrifolii* (Morgan); six-spotted mite, *Eotetranychus sexmaculatus* (Riley), and citrus red mite, *Panonychus citri* (McGregor) (Selhime et al. 1963; Watson et al. 1998). Beattie (1985) found that *A. fasciapennis* played a major role in the suppression of California red scale, *Aonidiella aurantii* (Maskell) on citrus in China.

***Karnyothrips flavipes* (Jones)**
This was the second most abundant predacious thrips species with 94% collected from within citrus tree canopies (Tables 2,3). *K. flavipes* is a predator of several species of pit scales *Asterolecanium* spp., armored scale in *Parlatoria* spp., and *Pseudaonidia duplex* (Cockerell), soft scales (*Saissetia* spp.), whiteflies and mites that infest citrus trees and other plants (Pitkin 1976).

***Karnyothrips melaleucus* (Bagnall)**
This species is a predator of soft scales (Pitkin 1976). Collection data are presented in Tables 2 and 3.

***Karnyothrips* spp**
55 larvae were collected from leaves, fruits, twigs, and trunk scrapings within citrus tree canopies (Table 2). No larvae were collected from vine or ground cover plants.

***Leptothrips cassiae* (Watson)**
This species was collected only from the following ground cover plants: *A. spinosus*, *Chenopodium ambrosioides*, *Bidens alba*, *Conyza canadensis*, and *Eupatorium capillifolium* (Tables 2, 3).

***Leptothrips macroocellatus* (Watson)**
This was the most common species of *Leptothrips* collected from January through May, and July through November (Table 2). Generally, populations were low (1–2) although 11 adults were collected from a fruit sample on May 15. Adult *L. macroocellatus* were collected from *A. spinosus, C. ambrosioides, B. alba, Lepidium virginicum, Sida rhombifolia, R. brasiliensis, Solanum americanum*, and *L. camara* (Table 3).

***Leptothrips pini* (Watson)**
Twenty females were collected from a single sample of *L. camara* in Yarborough on March 30, 1995 (Tables 2, 3). None were collected from within citrus tree canopies.

Leptothrips spp

Adults and larvae of all *Leptothrips* species combined were the second most abundant group of predacious thrips after *A. fasciapennis* (Table 2). Sixty-five percent of the *Leptothrips* larvae collected on ground cover plants were on *B. alba* (Table 3).

Scolothrips sexmaculatus (Pergande)

Both adults and larvae of *S. sexmaculatus* feed on *P. citri, Tetranychus urticae* Koch, *Eotetranychus banksi* (Riley), *Bryobia praetiosa* Koch, and several other spider mite species as well as the citrus rust mite, *Phyllocoptruta oleivora* (Ashmead) (Bailey 1939).

Scolothrips spp

Collection data for *Scolothrips* spp. are given in Table 3. *Scolothrips* spp. occurred on fruit in April and July with a maximum of 6 larvae collected at Hart II in July and from outer leaf samples in May

Table 4. Abundance and distribution of *Aleurodothrips fasciapennis* on Florida citrus trees.

		600 inner leaves			600 outer leaves			150 immature fruit			60 twigs		
Year/Month/Day	Orchard	L*	F*	M*	L	F	M	L	F	M	L	F	M
1995													
Jan 12–19	Trask	13	2	3	0	1	3	3	0	0	0	0	0
	Pollard	5	2	2	1	1	0	6	0	0	0	0	0
	Hart II	1	1	0	3	1	1	0	0	0	0	0	0
	Mixom I	8	6	1	3	3	0	0	0	0	0	0	0
	Mixom II	0	0	0	2	0	0	5	0	0	0	0	0
6-Feb	Trask	3	9	2	1	0	0	0	0	0	0	0	0
	Pollard	8	6	0	1	0	0	3	0	1	0	0	0
	Hart II	1	1	1	2	1	0	0	0	0	0	0	0
	Mixom I	22	11	5	4	2	0	0	0	0	0	0	0
	Mixom II	0	0	0	0	0	0	4	1	0	0	0	0
Mar 15–30	Trask	25	7	9	14	0	0	0	0	0	0	0	0
	Pollard	9	6	5	1	1	0	0	0	0	0	0	0
	Hart II	11	2	2	7	1	1	0	0	0	0	0	0
	Mixom I	38	10	3	20	1	2	0	0	0	0	0	0
	Mixom II	0	0	0	0	1	0	3	0	0	0	0	0
17-Apr	Trask	28	19	12	9	5	7	0	0	0	6	0	1
	Pollard	6	5	0	4	4	2	0	1	0	0	0	0
	Hart II	5	0	2	1	0	0	0	1	0	0	1	0
	Mixom I	27	5	9	2	0	0	0	0	0	1	0	0
	Mixom II	7	2	0	2	0	0	0	0	0	1	1	0
May 17–22	Trask	21	11	7	0	0	1	2	3	0	2	1	3
	Pollard	5	0	1	4	1	1	0	0	0	1	1	1
	Hart II	2	1	1	0	0	0	4	1	1	1	0	1
	Mixom I	3	2	0	2	0	0	6	0	2	2	2	3
	Mixom II	3	1	0	1	0	0	1	0	0	0	0	0
Jul 24–27	Trask	15	2	0	3	0	0	0	0	0	0	0	0
	Pollard	0	0	0	0	1	0	0	0	1	0	0	0
	Hart II	0	1	1	3	2	1	14	5	4	0	0	0
	Mixom I	0	0	0	0	1	0	0	1	1	0	0	2
	Mixom II	0	0	0	0	0	0	0	1	0	0	0	0
28-Aug	Trask	0	1	0	0	0	0	0	1	2	0	0	0
	Pollard	0	0	0	0	0	0	4	5	0	0	0	0
	Hart II	0	1	0	0	0	0	2	5	5	0	0	0
	Mixom I	0	0	0	0	0	0	0	3	1	0	0	0
	Mixom II	0	0	0	0	3	1	1	7	1	0	0	2
Sep 18–20	Trask	0	0	0	0	0	0	0	1	1	0	0	0
	Pollard	1	3	1	2	3	0	0	3	3	0	0	0
	Hart II	0	0	0	0	1	2	0	5	2	0	0	0
	Mixom I	0	0	0	0	0	1	0	3	0	1	1	0
	Mixom II	0	0	1	0	0	0	0	1	1	0	1	0
26-Oct	Trask	0	0	0	0	0	0	0	1	1	0	0	0
	Pollard	2	0	0	0	0	0	0	0	3	0	0	0
	Yarborough	0	0	0	0	0	0	0	1	0	0	0	0
	Hart II	0	0	0	1	0	0	4	2	1	0	0	0
	Mixom I	8	1	1	3	0	0	6	4	2	0	0	0
	Mixom II	0	0	0	0	0	0	0	0	0	0	0	1
Nov 21–30	Trask	3	0	0	0	0	0	3	3	0	1	0	0
	Pollard	0	0	0	0	0	0	8	1	2	0	0	0
	Hart II	1	0	1	0	0	0	10	3	3	2	1	2
	Mixom I	1	0	0	1	2	0	14	4	1	9	1	2
	Mixom II	1	0	0	0	0	0	11	6	2	0	1	1
1996													
18-Jan	Trask	0	0	0	1	0	0	0	0	0	0	0	0
	Pollard	2	1	0	1	1	0	1	1	1	0	0	0
	Hart II	1	0	1	0	1	0	0	0	0	0	1	0
	Mixom I	5	1	0	10	1	0	10	5	6	2	0	0
	Mixom II	1	1	1	0	0	0	1	0	0	0	1	0

*L = larvae, F = females, M = males

at two locations. *Scolothrips pallidus* (Beach) has been previously collected from Florida citrus orchards (Childers et al., 1994).

Plant feeders

***Anaphothrips* n. sp**

Collection data are presented in Tables 2 and 3. Nakahara (1995) reported 17 Nearctic species in the genus *Anaphothrips* associated with Gramineae.

***Arorathrips mexicanus* (Crawford)**

A single female was collected on outer leaves at Hart I on October 2, 1995 (Table 2). 25 males, 3 females, and 3 associated larvae were collected from *Eleusine indica* on July 24, 1995 at Trask (Tables 2,3).

***Aurantothrips orchidaceous* (Bagnall)**

A single female was collected from the vine, *Ipoemoea hederifolia* on September 18, 1995 at Trask (Tables 2, 3). This thrips is found on orchids (Sakimura, 1967).

***Baileyothrips limbatus* (Hood)**

Collection data are presented in Tables 2 and 3. This species was collected on *Euphorbia* spp. for the first time in Florida and the continental United States by Frantz (1993) in Palm Beach County during August. Sakimura (1986) collected *B. limbatus* on *Desmodium* sp. in Jamaica.

***Chaetanaphothrips orchidii* (Moulton)**

448 females and immatures were recorded from the seven orchard sites with 360 collected within citrus tree canopies and 88 from vine or ground cover plants (Tables 2, 3). This species was most abundant in two grapefruit orchards (Pollard and Mixom I sites) on fruits and only a few were taken from inner and outer leaves or twigs (Table 4). *Chaetanaphothrips orchidii* was collected from ground cover plants: *B. alba* in February, October, and November; *Glechoma hedaracea* in October; *Fumaria officinalis* in January; *R. braziliensis* in October; *C. ambrosioides* in May and *Rhynchelytrum repens* in October. 71 of the 88 *C. orchidii* were collected from *C. ambrosioides* (Table 4). Other larval host plants included: *Begonia, Emilia, Ephiphyllum, Hemierliodendron, Hypoxis, Musa*, and *Tradescantia* (Morison 1957). Known hosts of *C. orchidii* include: *Alternanthera, Amaranthus, Anthurium androeanum, Bougainvillea, Chrysanthemum, Cereus, Cyclamen, Cyrtandra* sp., *Tradescantia zebrina*, *Zea mays*, *Petroselinum crispum*, *Cryptotaenia japonica, Euph*orbia sp., *Hedytois* sp., *Ipomoea alba, I. congesta, Lycopersicon* sp., *Monstera, Philodendron, Pisonia*, *Rhododendron simsii, Sonchus oleraceus, Spathoglottis plicata*, and *Zingiber zerumbet* (Hara et al. 1987; Mantel and van de Vrie 1988). In addition, adults and larvae have been collected on various grass species including: *Coix lacryma-jobi, Digitaria pruriens, Panicum purpurascens, Paspalum conjugatum, P. orbiculare*, and *Trichachne insularis* in wet areas.

Thompson (1939) first reported *C. orchidii* as a pest on grapefruit in Florida. The orchid thrips is one of three species in Florida that feed where clustered fruit begin to touch, beginning in early May. Mostly red grapefruit varieties, and to a lesser extent white grapefruit, and occasionally round orange varieties such as 'Valencia' or 'Hamlin', are affected by *C. orchidii, D. trifasciatus,* and the greenhouse thrips, *H. haemorrhoidalis*. Damage resulting from their feeding can occur from onset of grapefruit beginning to touch until the fruit are harvested (Childers and Frantz 1994). This survey found 448 *C. orchidii* (65%), 159 *D. trifasciatus* (23%), and 85 *H. haemorrhoidalis* (12 %). *C. orchidii* was present throughout the season in the citrus orchards and most abundant during the fall months of October and November (Figure 2). Re-infestation of maturing clustered citrus fruits can occur with movement of this thrips pest from alternate hosts including many weed species occurring within citrus orchards to maturing clustered fruits throughout the season.

This thrips severely damaged *Anthurium* sp. in a greenhouse in Apopka, Orange County, Florida during December (Osborne 1993) and infested *Maranta leuconeura* var. *erythroneura* in the same area during April (Wilber and Capitano 1998).

***Danothrips trifasciatus* (Sakimura)**

Collection data are presented in Tables 2 and 3. Most specimens were collected in the Pollard orchard on fruit samples with only a few individuals collected on leaves in the Pollard, Hart I, Mixom I and II sites. This species was most abundant during January and February in the citrus orchards and toward the end of harvest for grapefruit varieties in Florida (Fig. 2). This species was collected for the first time within the continental United States during earlier sampling

in south Florida on red grapefruit varieties (Childers and Frantz 1994).

This species feeds on flowers and leaves of various plants including: *P. crispum, Bougainvillea, Z. zerumbet, Alpinia purpurea, Anthurium andreanum, Paspalum orbiculare, P. conjugatum, I. alba, Costus, Melicoccus bijugatus*, young Z. mays leaves, and banana (Sakimura 1975; Bhatti 1980).

***Echinothrips americanus* (Morgan)**

E. americanus (Table 3) is a polyphagous, leaf-feeding thrips found on at least 40 cultivated and 59 native host plant species (Oetting et al. 1993). Frantz and Mellinger (1990) found this thrips species on *Chrysanthemum* during July in Florida between 1986 and 1990. Additional Florida records included coralberry, *Ardisia crenata* in Sorrento, Lake County in November (Murphy 1994) and *Mimosa pudica* in Brooksville, Hernando County in July (Dudley 1994).

***Frankliniella bispinosa* (Morgan)**

680 specimens were collected from inner and outer leaves, fruit, and twigs within citrus canopies in low numbers throughout the year compared with 6,151 collected from 31 vine and ground cover plant species (Tables 2, 3).

Numerous *F. bispinosa* larvae and associated pupae were present on the main trunks and scaffold branches of citrus trees in Florida during February and March (Tables 2, 5). Also, large numbers of second instar larvae drop to the ground and pupate (Childers et al. 1994). Comparable results were shown by Grout et al. (1986) with *S. citri* in citrus orchards in California where a percentage of the population pupated within or near the surface of the soil in leaf litter and a percentage pupated within the citrus trees.

F. bispinosa was the most abundant thrips species recorded on 31 vines and ground cover plant species within 5 of the 7 orchard sites (Table 3). The remaining 2 groves were on herbicide programs and void of ground plant cover (Table 1). Two weed species alone [*Chenopodium album* (L.) and *B. alba* (L.)] accounted for 36% and 27%, respectively, of *F. bispinosa* collected from vines or ground cover plants. This suggests that the composition of ground cover plants within

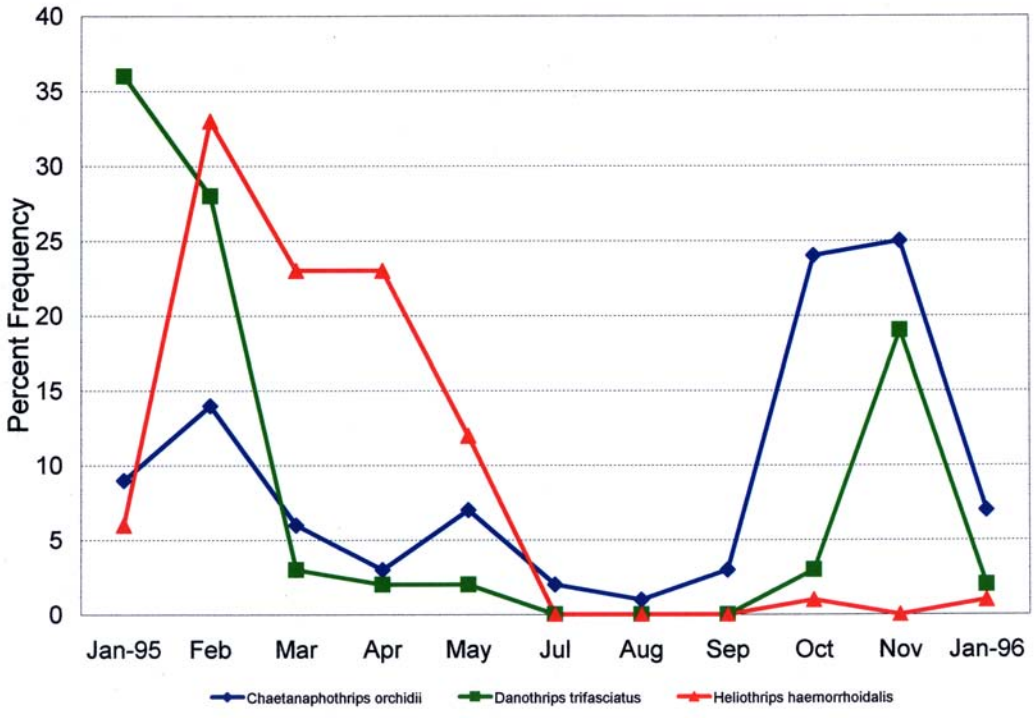

Figure 2. Seasonal frequency distributions of three phytophagous pest thrips species on Florida citrus in seven citrus orchard sites in central and south-central Florida during 1995–1996.

Table 5. Seasonal distribution of *Frankliniella bispinosa* within trees in three central Florida citrus orchards during 1995–1996.

Orchard	Date	Inner leaves*	Outer leaves*	Twigs*	Trunk scrapings*	Fruit*
Trask	19-Jan	0	0	0	0	0
	6-Feb	1P, 2A	6A	0	0	0
	30-Mar	32L, 5P, 2A	25L, 2A	0	62L, 61P, 12A	19L, 7A
	17-Apr	0	1L, 4A	1A	0	10A
	17-May	0	0	0	0	0
	22-Jul	0	0	0	0	0
	28-Aug	0	0	0	0	0
	18-Sep	0	0	1A	0	0
	26-Oct	0	0	0	0	0
	21-Nov	0	0	0	0	0
	18-Jan	0	0	0	0	0
Pollard	12-Jan	0	0	0	0	0
	6-Feb	0	0	0	0	0
	30-Mar	8L, 1A	5L, 17A	0	19L, 2P, 12A	18L, 2P, 10A
	17-Apr	0	2A	2A	0	18A
	22-May	1A	1A	0	0	3A
	24-Jul	0	0	0	0	0
	28-Aug	0	0	0	0	0
	20-Sep	0	0	0	0	0
	26-Oct	0	0	0	0	0
	21-Nov	0	0	1A	0	6A
	18-Jan	0	0	0	0	1P
Yarborough	12-Jan	0	0	0	0	0
	6-Feb	0	1A	0	0	1L
	30-Mar	38L, 1P, 6A	24L	0	38L, 21P, 4A	22L, 1A
	27-Apr	1A	0	2A	0	6A
	17-May	0	1A	0	0	0
	22-Jul	0	0	0	0	0
	28-Aug	0	5A	0	0	1A
	20-Sep	0	0	0	0	0
	26-Oct	0	0	0	0	0
	21-Nov	0	0	0	0	0
	18-Jan	0	0	0	0	0

*L = larvae, P = pupae, A = adults.

different citrus orchards could contribute to grove population differences of this pest thrips species. *F. bispinosa* was present every month of the year on one or more vine or ground cover plants sampled between January 1995 and January 1996 (Table 6) with general trends of higher larval and adult thrips populations occurring during April and again in November. Multiple, overlapping generations occur within vines and ground cover plants as well as within citrus tree canopies throughout the year. These hosts combined with a larger, more diverse host plant range demonstrates why *F. bispinosa* occurs in such abundance throughout Florida and how it has the potential to become such a localized pest on several different crops of agricultural or horticultural importance.

Adults and larvae of *F. bispinosa* have been recorded in numbers as high as 200 per open citrus flower of 'Rhode Red' Valencia and 'Murcott' oranges during the major bloom period between February and April each year (Childers, unpublished). Generally, a few to 100 *F. bispinosa* can be found in the flowers of various citrus varieties during the major blooming period that occurs between February and April (Childers 1999). This species is an important pest of citrus in Florida that causes pre-mature flower drop and reduced yields of navel and Valencia oranges (Childers and Achor 1991; Childers 1992, 1999). Adults and larvae feed on the ovary, style, nectary, petals, and anthers of both swollen buds and open citrus flowers between February and April. Feeding injury results in cellular evacuation, necrosis, plasmolysis, and cellular collapse of floral or bud tissue extending 1 to 5 cells deep. Stress ethylene production occurs resulting in premature flower or bud abortion and reduced fruit set. Preliminary observations indicate that *F. bispinosa* can produce rind blemish injuries on developing Murcott, a tangor variety (M. E. Rogers and C. C. Childers, unpublished).

It is also a pest on other crops in Florida including the flowers of Hibiscus, chrysanthemum, snapdragon, bell pepper, black-eyed peas, blueberry, eggplant, corn, cucumber, peanut, watermelon, and juniper; avocado fruits, tomato fruits; and fruit and flowers of strawberry, avocado, and passion fruit (Watson 1922; Fisher and Davenport 1989; Frantz and Mellinger 1990; Mead 1991a, b, c, 1992; 1993). Frantz and Mellinger (1990) found *F. bispinosa* on numerous

plants including vegetables, ornamentals, trees, and ground cover weed species between February and December in Florida from 1986 to 1990.

***Frankliniella cephalica* (Crawford)**
A single female was collected from a fruit sample in Trask in October compared with 4,310 specimens collected from ground cover plants (Tables 2, 3, and 6). This species was the third most abundant species found in association with Florida citrus orchards (Table 3). Frantz and Mellinger (1990) recorded *F. cephalica* on *Bidens pilosa*, tomato, and mangrove from March through June between 1986 and 1990 in Florida. It is not a pest on Florida citrus and is clearly more of a ground cover inhabitant associated with *B. alba* (Childers et al. 1990; Childers and Beshear 1992; Childers et al. 1994).

***Frankliniella fusca* (Hinds)**
This species was collected only from ground cover plants in Hart I. A single larva was collected from *Youngia japonica* on May 15, 1995 and one female from *Spermolepsis divaricata* on April 19, 1995 in Hart I. Frantz and Mellinger (1990) collected *F. fusca* adults on *B. pilosa*, Chrysanthemum, *Lippia* sp., cucumber, lettuce, grasses, parsley, peanut, pepper, tomato, and hyacinth in Florida between 1986 and 1990.

***Frankliniella gossypiana* (Hood)**
207 adults and associated larvae of this species were collected in 5 of the orchard sites but only on ground cover plants during January through April and July through November (Table 3).

***Frankliniella* sp. (runneri group)**
A single male was collected on a 'Hamlin' orange fruit on April 17, 1995 in Trask (Table 3).

***Frankliniella* spp**
16 larvae were collected from citrus leaf and fruit samples compared with 457 larvae from vine or ground cover plants (Tables 2, 3).

***Haplothrips gowdeyi* (Franklin)**
5022 *H. gowdeyi* were collected during this survey. There were 19 adults and larvae collected from within citrus tree canopies compared with 5,022 adults and larvae from 50 vine or ground cover plants (Tables 2, 3). This was the second most abundant thrips found on ground cover plants. *Gnaphilium pensylvanicum* was infested with adults and larvae between January and March. Other infested plants included *Stellaria media* with females only in March, *R. brasilensis* with females and larvae in April, May, July, and August through November at the 5 orchard sites not receiving multiple herbicide applications (Tables 1,3). *H. gowdeyi* is considered a general flower feeder (Nakahara and Hilburn 1989).

***Heliothrips haemorrhoidalis* (Bouché)**
85 specimens were collected only from citrus fruits, and inner and outer leaf samples during January through May in Trask, Pollard, Yarborough, and the two Mixom sites (Table 2). The number of thrips per sample was generally low with one or two individuals. No specimens were collected on ground cover plants. This species has a wide host range (Denmark 1985). In

Table 6. Seasonal and relative abundance of *Frankliniella bispinosa* and *F. Cephalic* stages on 12 selected ground cover plants* in five citrus orchard sites in central and south-central Florida during January 1995–January 1996.

	Trask		Pollard		Yarborough		Hart I		Hart II	
Month	**F.b.**	**F.c.**	**F.b.**	**F.c.**	**F.b.**	**F.c.**	**F.b.**	**F.c.**	**F.b.**	**F.c.**
January, 1995	0	0	0	50L 84A	4A	40A	3A	66A	21A	185A
February	6A	73A	0	159L, 195A	1A	12A	14A	1A	37A	25A
March	74L, 49A	0	41A	1A	43L, 251A	0	2A	0	7A	0
April	150 L, 265A	0	20L, 111A	0	14A	1A	78L, 173A	0	1,666L, 1,395A	0
May	24L 49A	4A	88L, 166A	2A	26L, 192A	0	11A	0	2L, 17P, 160A	5A
July	67A	0	5A	0	1A	1A	0	0	2L 11A	46L, 76A
August	1A	8A	5A	5A	0	4A	0	0	1A	5A
September	0	1L, 23A	5A	9L, 42A	2A	2A	0	45L, 22A	0	155A
October	37A	7L, 6A	2A	108L, 161A	0	7A	0	0	1A	2A
November	1A	6A	3L 2A	130L, 125A	0	6L, 39A	19A	326A	93A	895A
January, 1996	0		1A	0	0	0	0	0	0	0

*The following plants were used to tabulate *F. bispinosa counts: Bidens alba, Gnaphalium pensylvanicum, Solanum americanum, Amaranthus spinosus, Ambrosia artemisiifolia, Emilia fosbergii, Lantana camara, Rumex hastatulus, Chenopodium album, Chenopodium ambrosioides*.
F. cephalica was found on *B. alba, S. americanum, A. spinosus, A. artemisiifolia,* and *L. camara*.
F.b.-- *F. bispinosa*
F.c.-- *F. cephalic*

Italy, it overwinters in the egg stage but is capable of surviving mild winters (Del Bene et al. 1998). Four generations were produced on Viburnum or myrtle leaves. This is a pest of citrus and capable of causing rind blemish damage on clustered fruit of red grapefruit varieties in Florida (Childers and Stansly, 2005).

***Leucothrips piercei* (Morgan)**
This species was collected from outer leaves or Hamlin orange fruit in January, March, and April and from 14 ground cover plants throughout the year except the month of August (Tables 2, 3). Frantz and Mellinger (1990) collected *L. piercei* from Bok choi in November in Florida.

***Microcephalothrips abdominalis* (Crawford)**
13 males and females were recovered from inner and outer leaves and twigs between July and November in the Hart I, Hart II, and Mixom II sites compared with 1,036 individuals collected from vine and ground cover plants (Tables 2,3). This species was found in greatest abundance on *B. alba*. Frantz and Mellinger (1990) collected specimens on *B. pilosa*, Chrysanthemum, *Coreopsis*, Leguminosae, ragweed, and tomato between February and November in Florida from 1986 to 1990. This species was commonly found on Chrysanthemum and *B. pilosa* between January and May in Florida. It is a cosmopolitan species that feeds and develops on flowers of Compositae (Bailey 1937).

***Neohydatothrips floridanus* (Watson)**
This species was collected only from *Ambrosia artemisiifolia* on May 22, 1995 in Pollard (Table 3). It occurs throughout Florida and is not known as a pest.

***Neohydatothrips portoricensis* (Morgan)**
This species was collected only from *Ipomoea hederifolia* in September at Trask (Table 3). This species has been collected from *I. batatas* and *Allium cepa* (Nakahara and Hilburn 1989). Its preferred host is *Ipomoea* spp.

***Neohydatothrips* sp**
Two larvae were collected from *S. rhombifolia* at Hart I during August (Tables 2,3).

***Pseudothrips inequalis* (Beach)**
Two males were collected only from *L. virginicum* in January at Hart II (Table 3). Other host plants include: *Aster* sp., *Senecio* sp., *Salix nigra*, *Chionanthus virginica*, wild begonia, *Monotrope uniflora*, and *Sparta patens* (Jacot-Guillarmod 1974).

***Scirtothrips* sp**
One female was collected on a fruit of 'Marsh' grapefruit in April at Mixom I. One larva each was recovered from inner leaves and fruit in February at Mixom II and one larva from *F. officinalis* in April at Pollard (Tables 2, 3). One male was collected from an emergence cage in a navel orange orchard in Polk County on March 25, 199l (Childers et al. 1994). Four *Scirtothrips* specimens were collected on Mark V Krome Kote white sticky cards placed in navel orange orchards in southwest Florida between February 9 and May 2, 1990. One female *Scirtothrips* was recovered from a Mark V Krome Kote white sticky card in Polk County on March 22, 1993 and another female from a Chromolux metallic mother-of-pearl M05 card on April 9 from the same site (Childers et al. 1998). *Scirtothrips* specimens were never collected from citrus flowers or buds during various experiments between 1988 and 2003 (Childers, unpublished). This species occurred in low numbers in different citrus orchards throughout south and central Florida. An extensive survey of more than 45 vegetable, ornamental, and associated weed plant species was completed between 1986 and 1990 in south Florida by Frantz and Mellinger (1990) and no *Scirtothrips* were collected.

At least four species of *Scirtothrips* (i.e., *S. citri* (Moulton), *S. aurantii* Faure, *S. dorsalis* Hood, and *S. dobroskyi* (Moulton) have been collected elsewhere on citrus (Lewis et al. 1997; Hoddle and Mound 2003). The first three species are economic pests of citrus. The species collected in Florida closely resembles *S. citri* which was reported in 1986 to occur on grapes in northern Florida (Flowers 1989). However, the species identity remains questionable based on morphological comparisons between series of specimens from Florida and *S. citri* from California. Given the importance of some species within this genus, as pests of citrus worldwide, continued close attention to possible future changes in population densities should be given.

***Thrips hawaiiensis* (Morgan)**
One larva and one female were collected separately from *L. camara* in September at Pollard and from *Chamaesyce hyssopifolia* in

September at Hart I, respectively (Tables 2,3). *T. hawaiiensis* was first reported in Florida, Georgia, and South Carolina after 1967 (Sakimura 1986). This thrips feeds on numerous crops of economic importance worldwide (Sakimura and Nishida 1944; Miyazaki and Kudo 1988; Nakahara and Hilburn 1989). Usually, adults and larvae feed on pollen and cell sap of developing flowers resulting in bud malformation and poor fruit set (Palmer and Wetton 1987). Frantz and Mellinger (1990) recorded this species on cucumber during April between 1986 and 1990 in Florida.

One adult was collected from a Mark V Krome Kote white sticky trap in a navel orange orchard in central Florida during 1991 (Childers et al. 1998). One female was collected from an Olson blue sticky trap (Olson Products, Inc., Medina, Ohio) on March 22, 1993 (Childers et al. 1998). Three females were collected from navel orange flowers in January in Polk County, Florida and one male was collected on catkins of *Salix caroliniana* in Polk County on February 9, 1990 (Childers et al. 1990). This species feeds primarily on the inflorescence of various plants and has been intercepted frequently on cut flowers at United States ports-of-entry (Nakahara 1985).

T. hawaiiensis is a serious pest of gladiolus flowers in Taiwan (Chen and Lo 1987). Srivastava and Bhullar (1980) reported *T. hawaiiensis* as a pest on citrus flowers in India. Both larvae and adults reportedly fed on developing flowers with heavily infested blooms failing to set fruit. This species poses a potential future problem for Florida citrus based on such information and continued assessment of its relative abundance and distribution within citrus orchards and ornamental plants is warranted.

Fungal feeders

***Adraneothrips decorus* Hood**
Two males were collected from an orange fruit in October at Yarborough (Table 3). 16 specimens were collected from emergence cages in citrus orchards between March 12 and 22 in an earlier study in Florida (Childers et al. 1994). Sakimura (1986) found *A. decorus* to be abundant on *Sporobolus indicus*.

***Hoplandrothrips pergandei* Hinds**
A single female was collected from a Valencia orange fruit on May 26, 1995 in Mixom II (Table 2).

Idolothripinae
A single larva was collected from citrus twigs on September 19 at Hart I (Table 2).

***Merothrips floridensis* Watson**
This species was collected from trunk scrapings in Trask, Pollard, and Yarborough between January and March 1995 (Table 2). A single female was collected from a fruit of 'Marsh' grapefruit on May 22, 1995 in Pollard.

***Merothrips morgani* Hood**
This species was collected from trunk scrapings in February (Table 2).

***Neurothrips magnafemoralis* Hinds**
This species was collected from citrus fruit between January and March, May, July, and November in Trask, Hart I, Hart II, and Mixom II (Table 2). One adult was collected from trunk scrapings at Hart I in March (Table 2).

***Stephanothrips occidentalis* Hood and Williams**
One female each was collected from inner leaves at Yarborough and from Valencia orange fruit at Mixom II during May, 1995 (Table 2). One *Stephanothrips* sp. larva was collected from outer leaves in January, 1995 at Trask.

***Symphyothrips* sp**
One female was collected from citrus twigs on September 19, 1995 at Hart I (Table 2).

Notes

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