

Cheryle A. O'Donnell(1), Laurence A. Mound(2), and Michael P. Parrella(1) (1)-University of California Davis (2)-CSIRO Brisbane Australia

Any questions or comments regarding the operation of this key should be directed to Cheryle O'Donnell at caodonnell@ucdavis.edu.

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#### Click here to begin

#### <u>Abstract</u>

Thrips that attack flower crops are very small insects and identification of thrips species is often very difficult. At the present time, an inadequate understanding of thrips taxonomy and identification makes practical pest management decisions difficult. Some thrips species are serious pests and damage crops by direct feeding, whereas others are vectors of plant-infecting viruses. However, many species are merely tourists that, despite being present in large numbers, will not cause any damage. Thus, correct identification of thrips species is critical for effective crop monitoring, which is a prerequisite for the development of integrated pest management strategies for thrips.

A simplified, taxonomically correct thrips key is needed by flower growers, extension agents and pest control advisors. The three level, color picture key developed in the present study is interactive and user friendly. Level I is designed for in-field identification, where only a hand lens (and possibly a stereo microscope) is needed. Levels II and III are for more advanced researchers and pest control advisors, and make use of characteristics visible only with a compound microscope. Level III also includes an encyclopedia with information on each species such as host range, type of damage, viruses vectored and crops damaged. The three levels simplify identification of thrips to genus and species level via an interactive, step by step sequence.

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North America

Chaetanaphothrips orchidii Dendrothrips ornatus Dichromothrips corbetti Echinothrips americanus Frankliniella bispinosa Frankliniella fusca Frankliniella intonsa Frankliniella minuta Frankliniella occidentalis Frankliniella schultzei Frankliniella tritici Heliothrips haemorrhoidalis *Liothrips vaneeckei* Liothrips varicornis Parthenothrips dracaenae Thrips australis Thrips hawaiiensis Thrips nigropilosus Thrips palmi Thrips simplex Thrips tabaci

Appendix A: Collecting thrips for identification Appendix B: Microscope slide preparation of thrips Appendix C: Illustration of thrips identification characteristics Appendix D: Female and male characteristic differences Appendix E: Differences in characteristics between adults and larvae References

#### **Introduction**

Thrips are very small insects and distinguishing among species is often very difficult. Recently, taxonomic keys (on CD ROM) have been published to assist in identifying major thrips species in Europe (Mound and Moritz 1999). However, these were developed for the seasoned practitioner, and are of much value to growers. In addition, we felt there was a need to focus on thrips as pests of floriculture crops, with the goal of developing a key that could be used by growers and advanced practitioners. Some thrips species are serious pests and damage crops by direct feeding, whereas others are vectors of plant-infecting viruses. However, many species are merely tourists that, despite being present in large numbers, will not cause any damage. Thus, correct identification of thrips species is critical for effective crop monitoring, which is a prerequisite for the development of integrated pest management strategies for thrips.

Flower growers, extension agents and pest control advisors need a simplified, accurate thrips key. The three level, color picture key developed in the present study is intended to meet that need. The first level is designed for in-field identification where nothing more than a hand lens or low power dissecting microscope is needed. The other two levels are for those with greater understanding of thrips taxonomy, and these levels require the use of a compound microscope. In addition, the last section includes basic information on each species including host range, type of damage, viruses vectored and crops attacked. The three levels simplify identification of thrips to genus and species level via an interactive, step by step sequence. A more detailed description of each level follows:

Section 1. This section displays color photographs of live adult female thrips. The user can refer to the photographs at each couplet to aid them in the identification of their specimen. In this section, thrips are viewed using a hand lens or low power dissecting microscope and are distinguished based on their overall body color.

Section 2. This section uses detailed morphological characteristics to distinguish among species of thrips. Specimens must be mounted on glass microscope slides and viewed with a compound microscope. A point system was developed to assist in the identification process.

<u>Section 3.</u> Here, basic information about thrips commonly found on flower crops in North America is provided as well as a photographic log of taxonomic characters for each species.

Although useful, the body color of thrips as an identifying characteristic can be problematic. Many thrips species vary in color and mature coloration may not develop until some days after an adult has emerged. In addition, in some species males are much paler than females, and several pest species may vary greatly in color between seasons and/or sites at different altitudes. Finally, thrips collected in alcohol will become pale with time. Because of this variability, species in the genera *Thrips* and *Frankliniella* may key out in two or more places in the key.

Wing length and color can also vary among species, and some adult thrips do not develop wings or wings may be vestigial (reduced to a small remnant). This can be confusing when viewing adults together with larvae. Therefore, we concentrated on adults in this key. In addition, because male characteristics may differ greatly from those of the female (differences between male and females are shown in the appendixes), we have chosen to use female thrips in our key because these are collected more frequently than males.

Antennal segments may vary from specimen to specimen. Furthermore, the antennal segment on one side of the thrips could be 7-segmented, whereas that on the other side is 8-segmented. In this key, we counted antennae with the majority of segments.

We recommend referring to the appendixes throughout the key, particularly if you are unfamiliar with thrips characteristics. Every effort has been made to limit the use of technical words in the key, but there are some that could not be avoided. The appendices will be useful for explaining the technical language and thrips body characteristics used within this key. Appendix C folds out so that the characteristics and terminology can be viewed while using the key.

A review of the literature revealed that twenty-one species of thrips are known to be pests of, or to be frequently found on, flower crops in North America (including Hawaii). However, there are more than 700 species of thrips in North America and, while the majority of these have not been recorded on flower crops, there is always the possibility that some of them will turn up in flower samples. Thrips that cannot be identified using this key should be sent to experts in thrips identification.

## Section 1- Identification of adult thrips based on body color.

This section requires the use of a hand lens and/or low power dissecting microscope. To look at thrips, it is best to put them into a small dish with a glass lid, and then place the dish in a refrigerator. The thrips will be slowed down for several minutes and identification can proceed. When they become active again they can be put back into the refrigerator.

Live thrips can also be placed in 70% alcohol to be viewed with a dissecting microscope. Specimens in alcohol should be kept in the dark so they do not lose their natural color.

Where available, the common names of thrips are listed and those marked with an asterik (\*) are approved by the Entomological Society of America (Bosick 1997). We first distinguish adult thrips on the basis of their overall body color\*.

\*Thrips vary in color, wing length and in number of antennal segments. Consult the introduction section on page 6.

#### What is the color of the body of the adult thrips?

A: Is the body bicolored<sup>a</sup> (i.e., yellow with some dark markings or dark with some pale markings)? <sup>a</sup> Bicolored refers to thrips that are not uniformly light or dark in color.



Yes, see <u>Part A</u>, No, see next question.

Is the body almost uniform in color?B: Uniformly yellow in color?C: Uniformly dark in color?



Yes, yellow see Part B.



Yes, dark see Part C.



#### <u>Part A</u>

#### Species with body bicolored

Several of the most important thrips pests are frequently bicolored, including:

Frankliniella occidentalis Frankliniella intonsa Thrips australis Thrips hawaiiensis Thrips nigropilosus Thrips tabaci Western flower thrips\* European flower thrips Eucalyptus flower thrips Hawaiian flower thrips\* Chrysanthemum thrips\* Onion thrips\*

These species are difficult or even impossible to distinguish from each other in the field or greenhouse. You need a powerful hand lens (20x) or dissecting microscope for the next steps:

Are the wings bicolored, dark in color and much lighter only at the base? Are the wings uniformly colored?



Thrips hawaiiensis



Yes

Does the pronotum have long setae on the anterior margin?



*Frankliniella* species These species cannot be distinguished from each other without a compound microscope, see <u>Section 2</u> Microscope slide mounted specimens.

Does the pronotum have long setae only on the posterior margin?



Thrips species

#### Thrips species:

Does the forewing have 2 complete rows of setae on the wing veins? Are the ocelli red? Does the forewing only have a few (2-6) setae on the first vein near the wing tip? Are the wings sometimes very short? Are the ocelli red?



Yes =*Thrips australis* 



Yes =*Thrips nigropilosus* 

Does the forewing only have a few (2-6) setae on the first vein near the wing tip? Are the ocelli grey?



Yes =Thrips tabaci

#### <u>Part B</u> Body uniformly yellow.

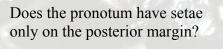
Do the wings have a dark band at the base and middle? Do the antennae have long pointed terminal segments?



Yes =*Chaetanaphothrips orchidii* (See <u>Section 3</u>)

The following species are difficult or even impossible to distinguish from each other in the field. You need a dissecting microscope for the next steps:

Does the pronotum have setae on the anterior and posterior margins?





Yes =Frankliniella species.



Yes = Thrips species.

*Frankliniella species* with yellow body color: The following species can only be distinguished by use of a compound microscope. [See Section 2].

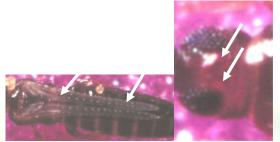
Frankliniella occidentalis Frankliniella intonsa Frankliniella bispinosa Frankliniella tritici

Western flower thrips\* European flower thrips Southern flower thrips Flower thrips\*



#### *Thrips* species with the body yellow:

Does the forewing have a continuous row of setae on the first vein? Are the ocelli red?

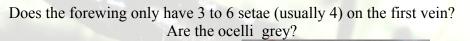


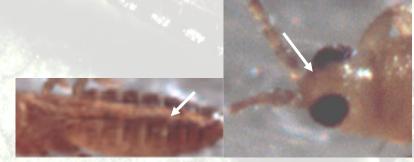
Yes =*Thrips australis* 

Does the forewing have only 3 setae distally on the first vein? Are the ocelli red?



Yes = *Thrips palmi* 





Yes =*Thrips tabaci* 

#### **<u>Part C</u>** Species with body uniformly dark

The following characters can be seen using a low power dissecting microscope.

Is the last abdominal segment tubular? Is the forewing smooth, without setae?



Liothrips species (See Section 3)

Is the last abdominal segment conical? Is the forewing surface rough, usually with long setae?





See next set of characters below.

Does the pronotum have long setae on the anterior margin and does the forewing have two complete rows of setae?



*Frankliniella* species, see next set of characters.

Is the pronotum lacking long setae on the anterior margin and does the forewing lack two complete rows of setae? (Rarely with wings not developed).



See next set of characters on p. 16.

Head without long setae between or behind the eyes, and wings





Yes = Frankliniella minuta

Head with a pair of long setae between the eyes, and wings not fully developed (a wing pad)? (If wings are fully developed they do not extend the full length of the body.)



Yes = Frankliniella fusca

Head with a pair of long setae between and behind the eyes and wings fully developed?



Yes = F. occidentalis or F. schultzei (See <u>Section 2</u>, Question 9)

#### Wings incompletely developed?

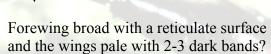


Yes = *Thrips nigropilosus* 

#### Wings fully developed?



Yes = See set of characters, below.





Yes = Parthenothrips dracaenae

Forewing slender, lacking a reticulate surface and wings pale without bands?



See next set of characters.

#### Body dark with yellow legs?

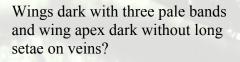


Yes = Heliothrips haemorrhoidalis

Body and legs the same color?



Yes = See set of characters, below.





Yes = *Dendrothrips ornatus* 

Wings different, if banded then setae on veins long?



Yes = See next set of characters.

Wings dark with three pale bands, apex pale and veins with long setae?



Yes = *Echinothrips americanus* 

Wings dark or light, but without bands?



Yes = See next set of characters, below.

#### Is the pronotum lacking long setae?



Yes = *Dichromothrips corbetti* 

Does the pronotum have two pairs of long setae on posterior margin?



Yes = See next set of characters.

Wings dark with pale base?



Yes = *Thrips hawaiiensis* or *Thrips simplex*, see next set of characters, below.

Wings uniform in color, never dark?



Yes = See last set of characters in Section I, Part C.

Middle and hind legs dark brown?



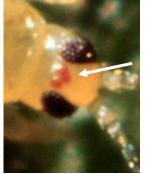
Yes = *Thrips simplex* 

Middle and hind legs brownish yellow?



Yes = Thrips hawaiiensis

#### Ocelli with red pigment?



Yes = Thrips nigropilosus

Ocelli with grey pigment?



Yes = *Thrips tabaci* 



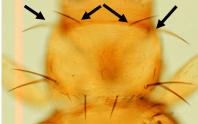
## Section 2- Identifying thrips using a compound microscope

This section requires that thrips be mounted onto microscope slides, and the use of a compound microscope. The best technique for mounting thrips onto slides is described in Appendix B.

In this section a weighted scoring system was developed to assist in identifying thrips species. The questions each have a series of couplets. Tally the points for each couplet and then total the score at the end of the couplet series for each question. The total score will direct you to the next question or to a thrips species.

Note: Thrips vary in color, wing length and in number of antennal segments. Consult the introduction section.

1a. Does the pronotum have two pairs of long setae on the anterior margin?





No = 0 points

Yes = 1 point

**1b.** Does the forewing have two complete rows of setae?

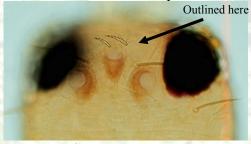


Yes = 1 point

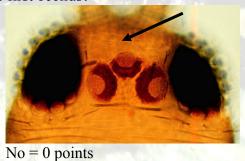


No = 0 points

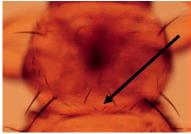
**1c.** Does the head have a pair of setae in front of the first ocellus?



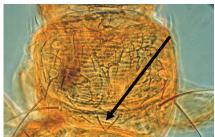




1d. Does the pronotal posterior margin have a pair of minor setae between the posterior median major setae?



Yes = 1 point

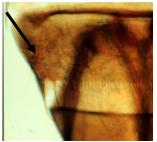


No = 0 points

1e. Do tergites VI and VII have a pair of ctenidia?

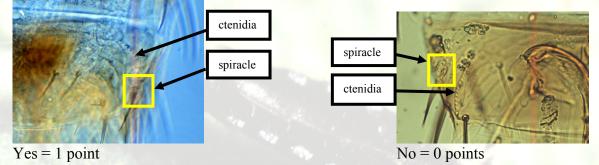


Yes = 1 point



No = 0 points



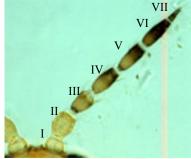


## Question 1, total score:

If the total score is more than 5 If the total score is less than 3

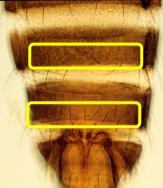
- = *Frankliniella* species (See Question 9)
- = (See Question 2)

**2a.** Is the antenna 7-segmented?



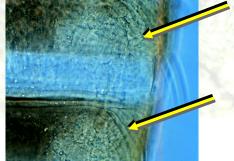
Yes, 7-segmented = 1 point

## **2b.** Are abdominal sternal discal setae present?



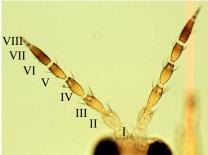
Yes, present = 1 point

**2c.** Do tergites VI and VII have a pair of ctenidia?



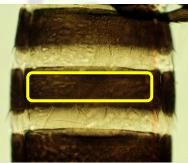
Yes, present = 1 point

#### Is the antenna 8-segmented?

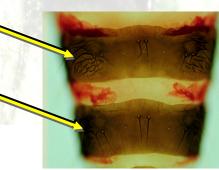


Yes, 8-segmented = 0 points

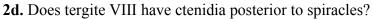
Are abdominal sternal discal setae absent?

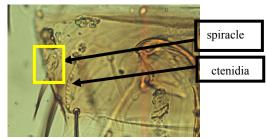


Yes, absent = 0 points

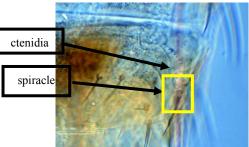


No, absent = 0 points



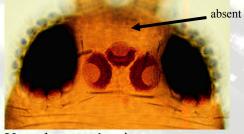


Yes, present = 1 point



No, anterior to spiracles or absent = 0 points

2e. Is ocellar setae pair I absent?



Yes, absent = 1 point

**2f.** Does the forewing have only one complete row of large setae, or are the setae minute?



One complete row of setae, or setae minute = 1 points

## **Question 2 total score:**

If the total score is more than 5 If the total score is less than 3

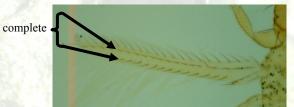
= See Question 15 (*Thrips* species) = See Question 3.



Does the forewing have two complete rows of large setae?

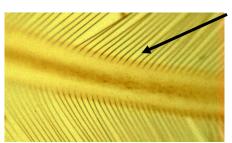
Is ocellar setae pair I present?

Outlined here



Two complete rows of setae = 0 point

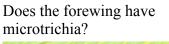
**3a.** Is the forewing smooth?

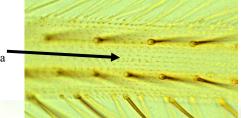


Yes, smooth = 1 point

No michrotrichia

> With Michrotrichia





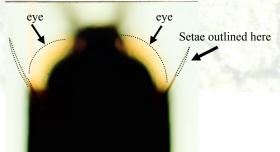
Yes, with michrotrichia = 0 points

**3b.** Is abdominal segment X long and tubular or short and conical?



Yes, tubular = 1 point

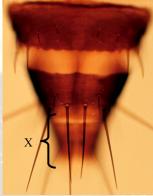
**3c.** Does the head have one pair of long setae behind the eyes?



With one pair of long setae = 1 point

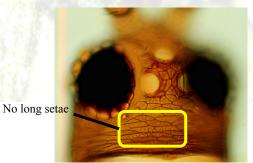
## **Question 3 total score:**

If the total score is 2 or 3= See Section 3. [Phlaeothripidae: Liothrips]If the total score is 0 or 1= See Question 4.



Yes, short and conical = 0 points

Does the head have no long setae behind eyes?



With no pair of setae = 0 points

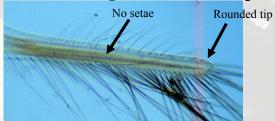
**4.** Do the head and pronotum have strong reticulate sculpture?



Yes, with reticulate sculpture; see Question 5.

#### **Question 5**

5. Is the forewing slender without long setae and with a rounded apex ?



Yes, no long setae; apex rounded = *Heliothrips haemorrhoidalis* 

## **Question** 6

**6.** Is the forewing slender with long setae on the first vein, the wing surface smooth and the apex pointed?



Yes, slender with long setae, surface smooth and apex pointed = *Echinothrips americanus* 

Do the head and pronotum lack reticulate sculpture?



Lacks reticulate sculpture; see Question 7.



No, the forewing has several long setae; apex not rounded = Question 6.

Is the forewing broad with short, stout setae on both veins, the wing surface reticulate and apex rounded?



Yes, broad with short, stout setae, the surface reticulate and the apex rounded = *Parthenothrips dracaenae* 

**7a.** Do the wing veins have only minute setae?



Setae half as long as width

Yes, minute setae = 1 point.

**7b.** Are the middle setae on the tergites long and close together?



Yes, long and close together = 1 point.

#### **Question 7 total score:**

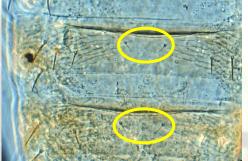
If the total score is 2 If the total score is 0-1 = *Dendrothrips ornatus* = Question 8.

Do the wing veins have setae at least half as long as the wing width?



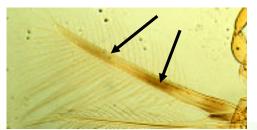
Yes, half as long as wing width = 0 points.

Are the middle setae on the tergites short and widely spaced?



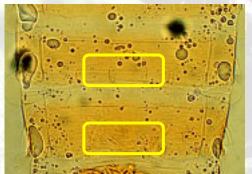
Yes, short and widely spaced = 0 points.

**8a.** Does the forewing have two complete rows of long and widely spaced setae?



Yes, two rows of long and widely spaced setae = 1 point

**8b.** Are the middle setae on the tergites small, fine, light yellow and widely spaced?



Yes, middle setae small, fine, light yellow and widely spaced = 1point

**8c.** Is the forewing dark with one pale band medially?

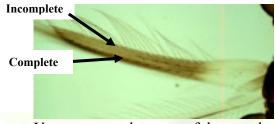


Yes, pale band medially = 1 point

## **Question 8 total score:**

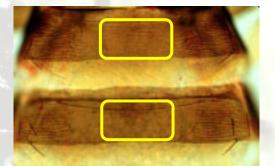
If the total score is 3 If total score is 0-1 = Chaetanaphothrips orchidii = Dichromothrips corbetti

Does the forewing have only one complete row of long and closely spaced setae?



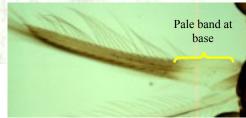
Yes, one complete row of long and closely spaced setae = 0 points

Are the middle setae on the tergites average in length, strongly defined, brown and widely spaced?



Yes, middle setae average in length, strongly defined, brown and widely spaced = 0 points

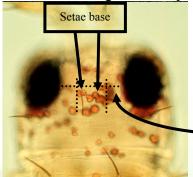
Is the forewing dark with one pale band at the base?



Yes, pale band at base = 0 points

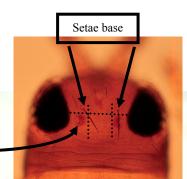
### **<u>Question 9</u>** Frankliniella species:

**9.** Are pair III ocellar setae long with their bases close together, nearly in line between the anterior margins of the posterior ocelli?



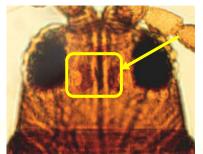
Ocellar anterior (horizontal line) and interior (vertical lines) margins

Yes, setae long with bases close together = Frankliniella schultzei Are pair III ocellar setae bases widely spaced and not in line between the ocelli?



Yes, widely spaced = Question 10.

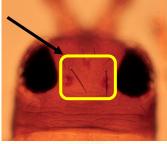
**10a.** Are pair III ocellar setae very short, scarcely longer than one ocellus diameter?



Yes, ocellar setae short = 1 point

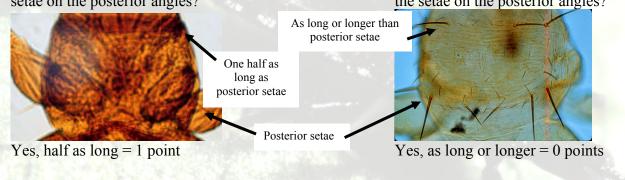
**10b.** Are the setae on the anterior margin of the pronotum less than half as long as setae on the posterior angles?

Are pair III ocellar setae long, more than twice as long as one ocellus diameter?



Yes, ocellar setae long = 0 points

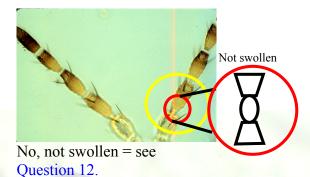
Are the setae on the anterior margin as long or longer than the setae on the posterior angles?



## Question 10 total score:

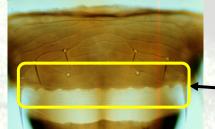
If the total score is 2 If the total score is 0-1 = *Frankliniella minuta* = See Question 11.

**11.** Is antennal segment III pedicel not obviously swollen or angular?



## **Question 12**

**12a.** Does the posterior margin of tergite VIII have a comb represented by broadly rounded lobes? (Comb may not be present in males.)



Slender teeth

Broadly rounded lobes

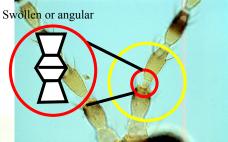
Yes, comb constructed of broadly rounded lobes = 1 point

**12b.** Are the wings shorter than the thorax?



Yes, wings short = 1 point Question 12 total score:

If the total score is 2 If the total score is 0-1 = *Frankliniella fusca* = See Question 13. Is antennal segment III pedicel distinctly swollen or angular?

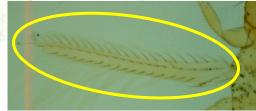


Yes, swollen or angular = see Question 14.

Does the posterior margin of tergite VIII have a comb consisting of slender teeth? (Comb may not be present in males.)

Yes, comb constructed of slender teeth = 0 points

Are the wings fully developed?



Yes, wings fully developed = 0 points

**13a.** Does the metanotum have a pair of pores near the posterior margin?



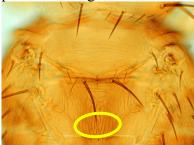
Yes, pores present = 1 point

**13b.** Are the setae behind the eyes long, more than half as long as ocellar setae?



Yes, setae behind the eyes long = 1 point

# Is the metanotum lacking a pair of pores near the posterior margin?



Yes, pores absent = 0 points

Are the setae behind the eyes short, less than half as long as ocellar setae?

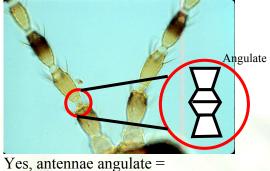


Yes, setae behind the eyes short = 0 points

#### **Question 13 total score:**

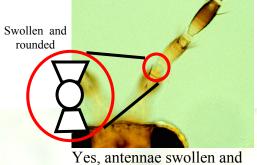
If the total score is 2 If the total score is 0-1 = Frankliniella occidentalis = Frankliniella intonsa

**14.** Is antennal segment III pedicel sharply angulate?



Frankliniella bispinosa

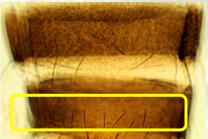
Is antennal segment III pedicel swollen and rounded?



rounded= Frankliniella tritici

## Question 15 Thrips species:

15. Are sternal discal setae absent?

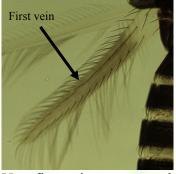


Yes, sternal discal setae present = see Question 16.



No, sternal discal setae absent = see Question 18.

**16a.** Does the first vein of the forewing have a complete row of setae?

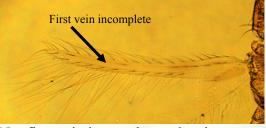


Yes, first vein setae complete = 1 point

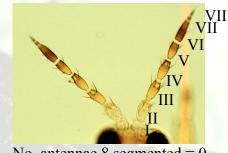
**16b.** Do the antennae have 7 segments?



Yes, antennae 7 segmented = 1 point

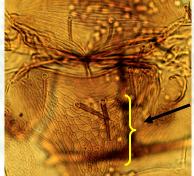


No, first vein incomplete = 0 point



No, antennae 8 segmented = 0 points

16c. Is the metanotum broadly reticulate with setae arising medially?



Yes, metanotum broadly reticulate with setae arising medially = 1 point

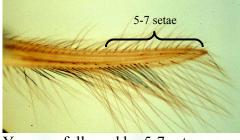
## **Question 16 total score:**



No, metanotum not broadly reticulate with setae arising in anterior margin = 0 points

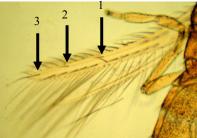
If the total score is 3	= Thrips australis
If the total score is 0-1	= See Question 17.

**17a.** The gap in the setal row on the forewing first vein is followed by 5-7 setae?



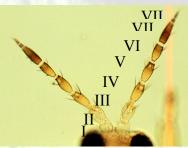
Yes, gap followed by 5-7 setae = 1 point

The gap in the setal row on the forewing first vein is followed by 3 setae?



No, gap followed by 3 setae = 0 points

**17b.** Is the antennae 8-segmented?

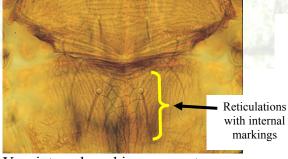


Yes, 8-segmented antennae = 1 point

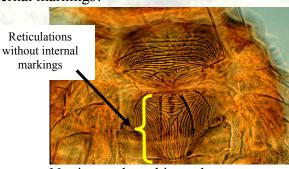


No, 7-segmented = 0 points

#### 17c. Does the metanotal reticulation have internal markings?



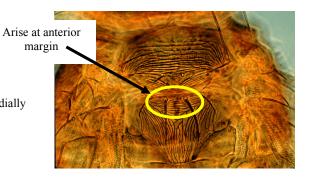
Yes, internal markings present = 1 points



No, internal markings absent = 0 points

# **17d.** Do the metanotal setae arise medially?





Yes, setae arise medially = 1 point

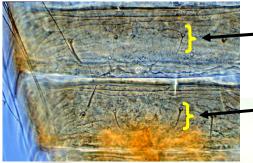
No, setae arise at anterior margin = 0 points

# **Question 17 total score:**

If the total score is 4	= Thrips simplex
If the total score is 0-1	= Thrips hawaiiensis

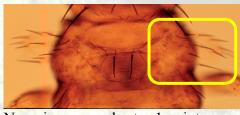
# **Question 18**

**18a.** Are the median setae on each abdominal tergite half as long as the median length of the tergite?



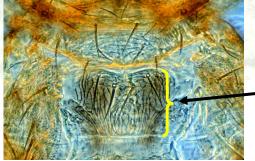
Yes, setae half as long = 1 point

**18b.** Are the forewings very short, scarcely longer than the width of the thorax?



No, wings very short = 1 point

**18c.** Is the metanotum broadly reticulate medially?

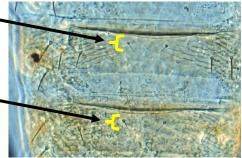


Yes, broadly reticulate = 1 point

# **Question 18 total score:**

If the total score is 2 or 3= Thrips nigropilosusIf the total score is 0= See Question 19.

Are the median setae on each abdominal tergite scarcely one-fourth as long as the median length of the tergite?



Yes, setae scarcely a quarter long = 0 points

Are the forewings fully developed nearly reaching the end of the abdomen?



Yes, wings fully developed = 0 points

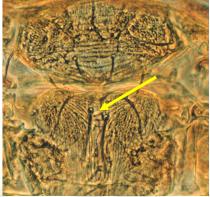
Is the metanotal sculpture striate or longitudinally reticulate medially?



Yes, striate or longitudinally reticulate = 0 points

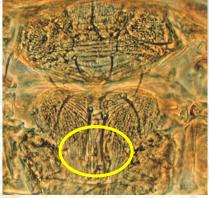
## **Question 19**

**19a.** Does the metanotum have transverse "smiling" lines on anterior third?



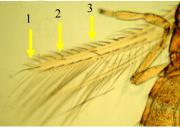
Yes, transverse "smiling" lines points = 1 point

**19b.** Does the metanotum have a pair of pores on posterior third?



Yes, a pair of pores = 1 point

**19c.** Does the forewing first vein have 3 setae on the distal half?

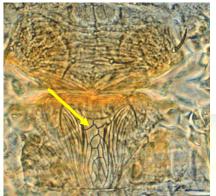


Yes, forewing with 3 setae = 1 point

# **Question 19 total score:**

If the total score is 3= Thrips palmiIf the total score is 0-1= Thrips tabaci

Does the metanotum have irregular longitudinally reticulate lines on the anterior third?



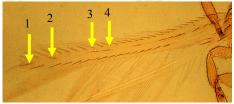
Yes, irregular longitudinally reticulate lines = 0

Is the metanotum lacking a pair of pores on posterior third?



No pores = 0 points

Does the forewing first vein have 4 setae distally?



No, forewing with 4 setae = 0 points

# Section 3- Encyclopedia of flower crop thrips.

In this section we provide further information on each species. The species are listed alphabetically by genus and species name. Where available the common names of thrips are listed and those marked with an asterik (\*) are approved by the Entomological Society of America (Bosick 1997).

This information is intended to supplement Section 1 and/or Section 2 so that you can confirm your identification and read further about the thrips biology, host plants, distribution and damage.

### Chaetanaphothrips orchidii

NAME: Chaetanaphothrips orchidii (Moulton)

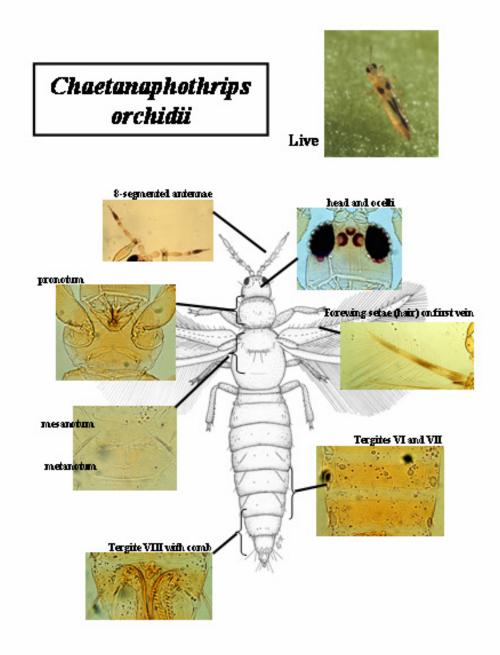
FAMILY: Thripidae: Thripinae

**COMMON NAME:** Orchid thrips

**VARIATION IN BODY COLOR:** Body yellow in color, forewings with dark bands at base and middle.

### **DIAGNOSIS:**

- 1. Ocellar setae, pair I absent.
- 2. Pronotal inner posteroangular and outer posteroangular setae equally long.
- 3. Tergite VIII stippled area surrounding spiracles only.
- 4. Abdominal sternite III and IV without glandular areas.
- **DISTRIBUTION:** Greenhouses in U.S. and Europe, widespread in subtropics including Florida.
- HOST PLANTS: Anthurium, orchids, banana and citrus.
- DAMAGE: Russeted patches 'banana rust' from feeding on banana, leaves, and fruits. White streaks and distortion of young leaves and floral buds on *Anthurium*, orchids and citrus. Thrips feeding will result in scaring of citrus fruit.





### **Dendrothrips ornatus**

NAME: Dendrothrips ornatus (Uzel)

FAMILY: Thripidae: Thripinae

**COMMON NAME:** Privet thrips\*

VARIATION IN BODY COLOR: Body uniformly dark.

### **DIAGNOSIS:**

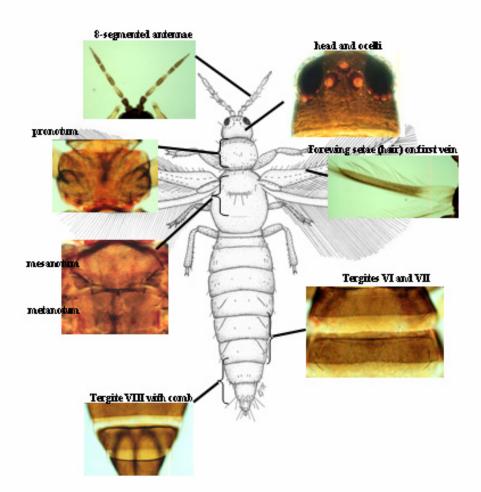
- 1. Head and pronotum without strong reticulate sculpture.
- 2. Wing apex rounded without long setae.
- 3. Median setae on the tergites long and close together.

DISTRIBUTION: North America and Europe.

HOST PLANTS: Ligustrum species and Oleaceae species. (Not necessarily pests)

**DAMAGE:** Leaf feeding creates silvering, speckling, leaves pucker and shed.





### Dichromothrips corbetti

NAME: Dichromothrips corbetti (Priesner)

FAMILY: Thripidae: Thripinae

COMMON NAME: Vanda thrips\*

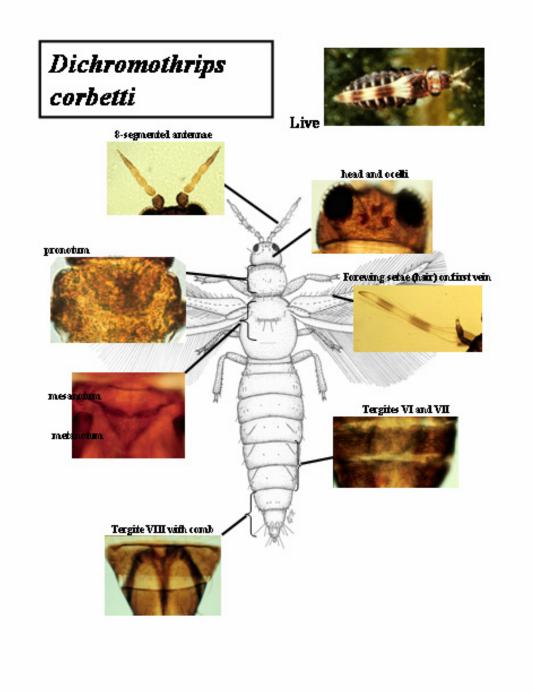
VARIATION IN BODY COLOR: Body uniformly dark.

### **DIAGNOSIS:**

- 1. Ocellar setae I absent.
- 2. No long setae on the pronotum.
- 3. Forewing with one pale band at base.
- 4. Median setae on tergites short and widely spaced.
- 5. Forewing with only one row of complete long and closely spaced setae.
- 6. Lacks a well-developed metathoracic endofurcal spinula.

**DISTRIBUTION:** Mainly in Asia, sometimes in greenhouses in the Northern Hemisphere. **HOST PLANTS:** Orchids.

**DAMAGE:** Bulbs of plant marked with brown patches, silvering on flowers and leaves. **VECTOR OF:** Not known to vector diseases.



### Echinothrips americanus

NAME: Echinothrips americanus (Morgan)

FAMILY: Thripidae: Thripinae

**COMMON NAME:** none

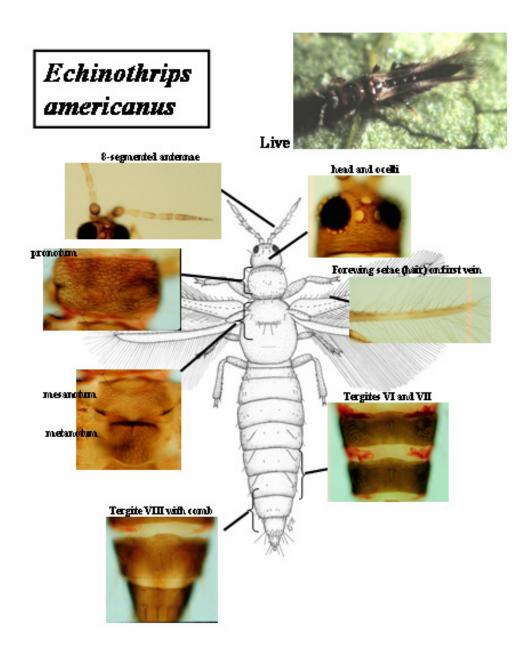
VARIATION IN BODY COLOR: Usually brown with red internal pigment.

#### **DIAGNOSIS:**

- 1. 8-segmented antennae.
- 2. Antennae segment VI long and slender.
- 3. Ocellar setae I present.
- 4. Forewing slender with long setae and the apex pointed.
- 5. Body reticulate. Reticulations forming polygons.

**DISTRIBUTION:** United States and Europe.

HOST PLANTS: Impatiens, Poinsettias and many other greenhouse grown ornamentals. DAMAGE: Leaf feeding by thrips resembles mite damage. Leaves become chlorotic or bleached and the leaf tissue becomes shrunken. Flowers become disfigured from thrips feeding. VECTOR OF: Not known to vector diseases.



# Frankliniella bispinosa

NAME: Frankliniella bispinosa (Morgan)

FAMILY: Thripidae: Thripinae

**COMMON NAME:** Southern flower thrips

VARIATION IN BODY COLOR: Body bicolored, predominantly yellow with brown

blotching on middle thorax and abdomen.

### **DIAGNOSIS:**

- 1. Antennal segment III pedicel sharply angulate.
- 2. Setae behind the eyes long, more than half as long as ocellar setae.
- 3. Metanotum with a pair of pores near the posterior margin.

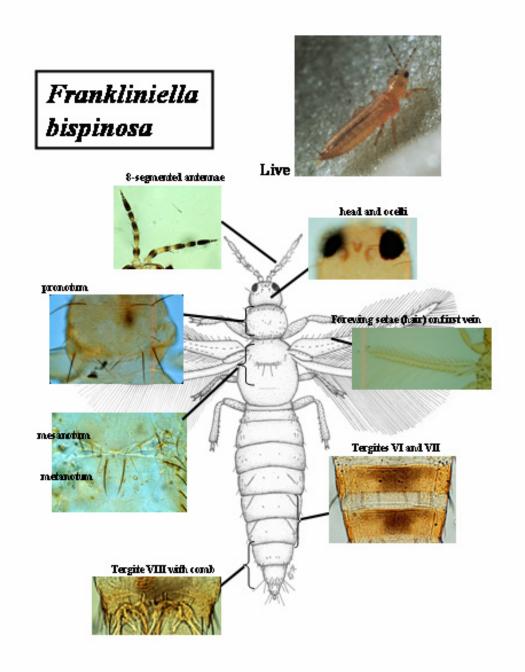
**DISTRIBUTION:** Southeastern United States.

**HOST PLANTS:** Citrus, roses, chrysanthemums, peppers, beans, and native wild flowers. Favors flowers, particularly stamens and pistils.

DAMAGE: Flower discoloration. Fruit scarring on calyx, fruit surface bronzed and silvered.

Leaves crinkled with ragged edges. Brown ring spots on citrus fruit near calyx.

VECTOR OF: Tomato spotted wilt virus (TSWV) (Webb et al. 1997).



### Frankliniella fusca

NAME: Frankliniella fusca (Hinds)

FAMILY: Thripidae: Thripinae

**COMMON NAME:** Tobacco thrips\*

**VARIATION IN BODY COLOR:** Body color brown or pale (usually males) (Mound and Marullo, 1996).

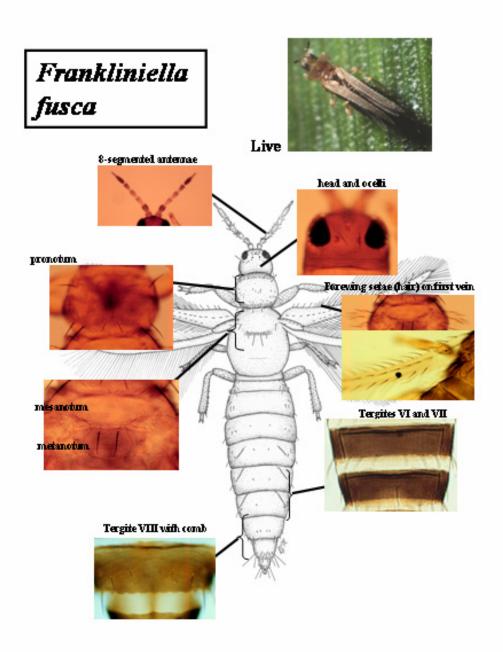
#### **DIAGNOSIS:**

- 1. Wings frequently shorter than the thorax.
- 2. Comb on tergite VIII represented by broadly based lobes, incomplete medially.
- 3. Head with ocellar setae III widely spaced and arising in front of posterior ocelli.

**DISTRIBUTION:** Widespread in North America (Mound, 1997).

HOST PLANTS: Has been found on *Amaryllis* bulbs, peanuts, tobacco, cotton and groundnut.
DAMAGE: Leaves become discolored (silvered) from thrips feeding. Flowers, buds and young leaves become distorted and sometimes blackened. Transmission of TSWV causes necrotic rings on young leaves, bent stem apex, stunted and uneven growth. In addition leaf veins thicken, bronze rings appear on fruit and leaves. Fruit may have pale irregular ringed mottles.

**VECTOR OF:** (TSWV) (Sakimura, 1963).



### Frankliniella intonsa

NAME: Frankliniella intonsa (Trybom)

**FAMILY:** Thripidae: Thripinae

**COMMON NAME:** European flower thrips

VARIATION IN BODY COLOR: Light to dark brown.

### **DIAGNOSIS:**

- 1. Pores absent from posterior half of the metanotum
- 2. Setae behind the eyes short, less than half as long as ocellar setae.
- 3. Comb on tergite VIII constructed of slender teeth.

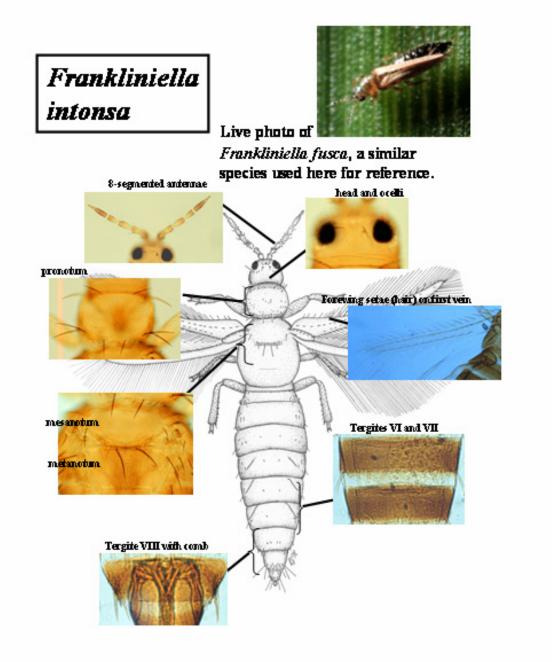
DISTRIBUTION: Swarms in dense clouds in Europe. Common in North America and Asia.

HOST PLANTS: Polyphagous.

DAMAGE: Deforms buds, scars flowers and fruit.

**VECTOR OF:** TSWV, Tomato chlorotic spot virus (TCSV), Groundnut ringspot virus

(GRSV) (Wijkamp et al. 1995 a).



### Frankliniella minuta

NAME: Frankliniella minuta (Moulton)

FAMILY: Thripidae: Thripinae

**COMMON NAME:** none

VARIATION IN BODY COLOR: Dark grayish brown.

#### **DIAGNOSIS:**

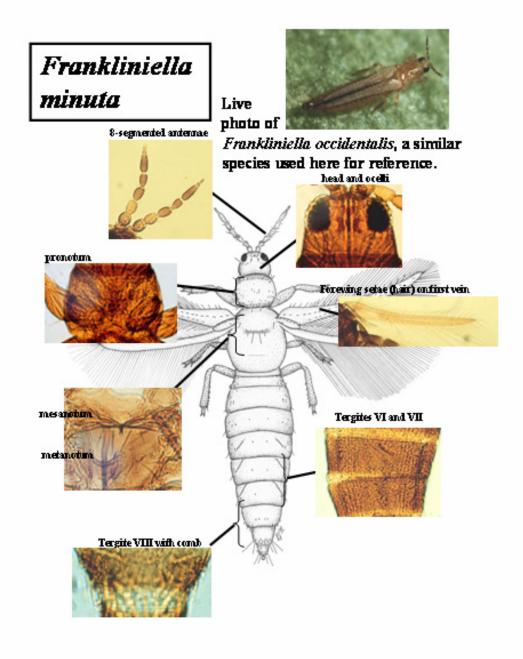
- 1. Ocellar setae very short, scarcely as long as one ocellus diameter.
- 2. Setae on anterior margin of pronotum less than half as long as setae on posterior angles.
- 3. Several tergites before VIII with shallow scallops along hind margin.

DISTRIBUTION: Western North America, South America (e.g. Peru), Guatemala, Panama,

(Sakimura and O'Neill, 1979).

HOST PLANTS: Polyphagous.

**DAMAGE:** Distortion of young leaves and flowers. Silvering of leaves. Adults have been found under the bark of trees.



### Frankliniella occidentalis

NAME: Frankliniella occidentalis (Pergande)

FAMILY: Thripidae: Thripinae

**COMMON NAME:** Western Flower Thrips\*

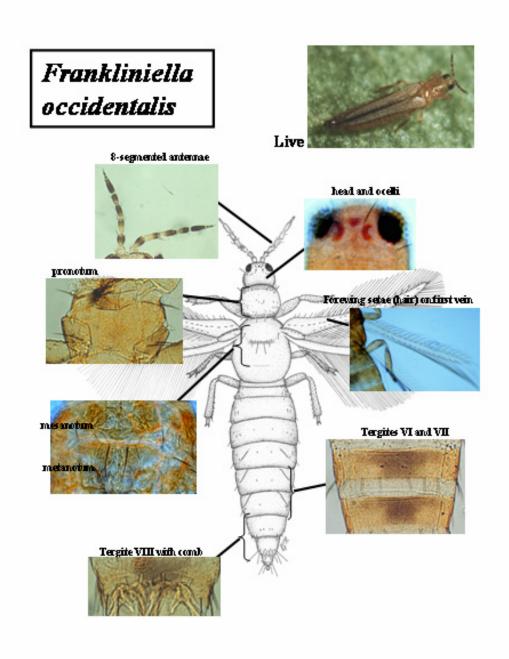
**VARIATION IN BODY COLOR:** Most abundant in bicolored form: dark with light markings or light with dark markings. Dark forms are found in colder seasons and in higher elevations. Light yellow forms are found in warm season and in lower elevations.

#### **DIAGNOSIS:**

- 1. Setae behind the eyes long, more than half as long as ocellar setae.
- 2. Ocelli red.
- 3. Comb on tergite VIII consisting of irregular slender teeth.
- 4. Metanotum with a pair of pores near the posterior margin.
- **DISTRIBUTION:** Widespread in North America, Europe, South America, Asia, Africa and Australia (Mound, 1997).
- **HOST PLANTS:** Polyphagous, seed crops, cut flowers, potted flowering plants and nursery stock.
- **DAMAGE:** Deformation of young seedlings and fruit. Discoloration, silvering and turning white, of leaves, flowers and fruit. Fruits scarred very early in development causing disfigurement as fruit develops.

**BENEFICIAL FOR:** Feeds on mite eggs.

VECTOR OF: TSWV (Gardner et al. 1935; Allen and Broadbent 1986; Cho et al. 1986), *Impatiens necrotic spot virus* (INSV) (DeAngelis et al. 1993; Wijkamp and Peters 1993; Wijkamp et al. 1995a,b), GRSV (Wijkamp et al. 1995a,b), TCSV (Wijkamp et al. 1995a,b). Also known to transmit *Fusarium moniliforme* (a fungus that causes ear rot of corn) (Farrar and Davis 1991) and *Erwinia amylovora* (fire blight bacteria) (Bailey, 1935).



### Frankliniella schultzei

NAME: Frankliniella schultzei (Trybom)

FAMILY: Thripidae: Thripinae

COMMON NAME: Common blossom or cotton bud thrips

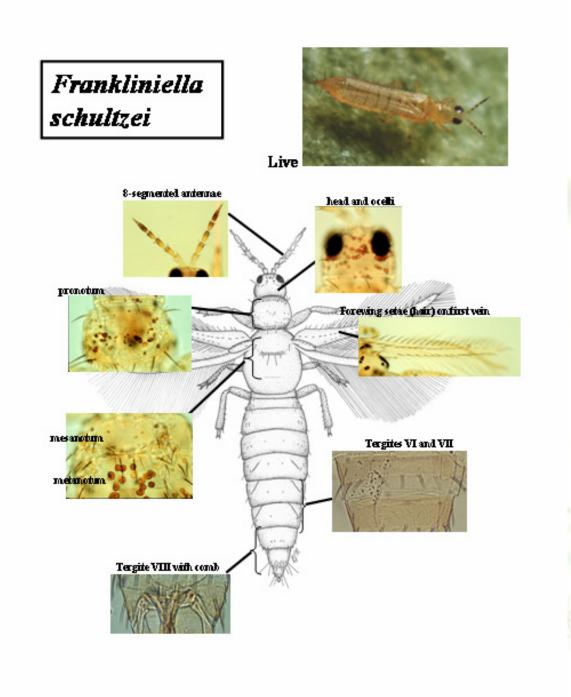
**VARIATION IN BODY COLOR:** Exists as two color forms; dark brown is the most common, but in the tropics the body color is often yellow.

#### **DIAGNOSIS:**

- 1. Ocellar setae III long with their bases close together, nearly in line between the anterior margins of the posterior ocelli.
- 2. Comb on tergite VIII nearly absent.
- 3. Antennal segment VI with a large base to sense comb.
- **DISTRIBUTION:** Worldwide. North America, South America, Africa, Australia and Asia (Mound, 1997).
- **HOST PLANTS:** Compositae crops. Polyphagous and flower-living. Weeds are a good source for breeding populations.

**DAMAGE:** Young leaves within the meristematic bud.

**VECTOR OF:** TSWV (Samuel et al. 1930, Sakimura 1969, Cho et al. 1988), TCSV (Wijkamp et al. 1995a,b), GRSV (Wijkamp et al. 1995a,b). May carry spores of downy mildews, rusts and other fungi (Palmer et al. 1989).



## Frankliniella tritici

NAME: Frankliniella tritici (Fitch)

FAMILY: Thripidae: Thripinae

**COMMON NAME:** Flower thrips\*

VARIATION IN BODY COLOR: Pale yellow or darker with brown markings.

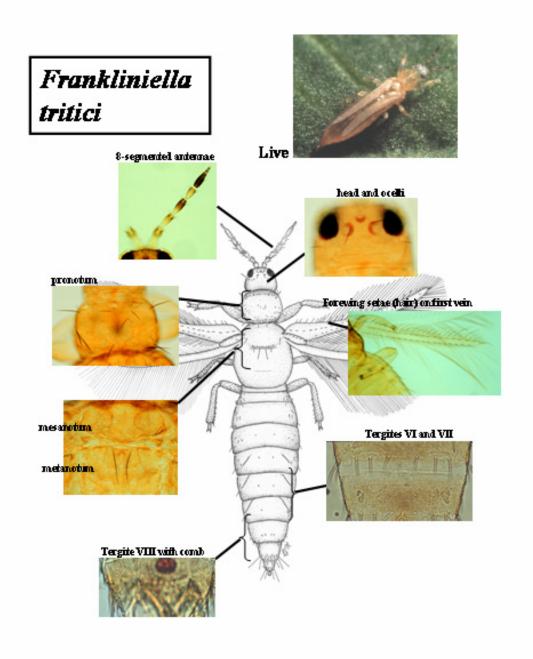
### **DIAGNOSIS:**

- 1. Ocellar setae III situated near anterior margin of posterior ocelli.
- 2. Comb on tergite VIII incomplete and consisting of broad based teeth laterally.
- 3. Antennal segment III pedicel swollen and rounded.

DISTRIBUTION: Widespread in North America (Mound, 1997).

HOST PLANTS: Polyphagous, flowers, fruits. Comparable to Frankliniella occidentalis.

**DAMAGE:** Discoloration and distortion of flowers and buds. Silvered surface blemishes on fruit. Leaves crinkled, with ragged edges.



### Heliothrips haemorrhoidalis

NAME: Heliothrips haemorrhoidalis (Bouch)

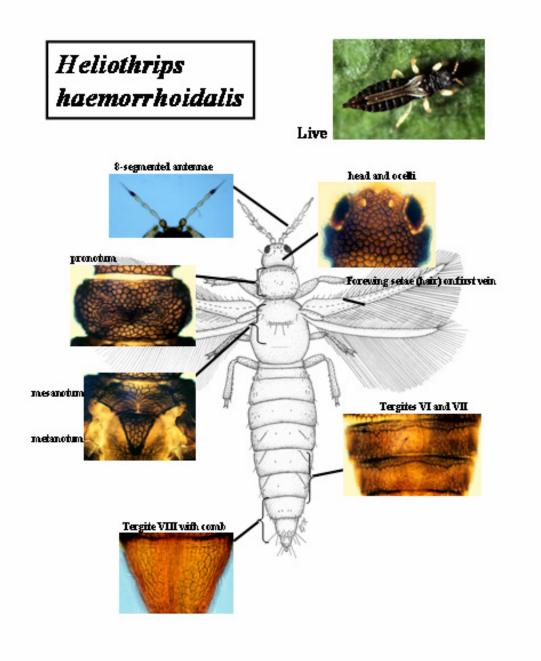
FAMILY: Thripidae: Panchaetothripinae

COMMON NAME: Greenhouse thrips\*

VARIATION IN BODY COLOR: Dark brown, pale legs, abdomen golden brown when mature.

#### **DIAGNOSIS:**

- 1. Body with heavy reticulate sculpture.
- 2. Forewing slender with no long setae and apex round.
- 3. Body dark with pale legs.
- **DISTRIBUTION:** Widespread in Europe, North America, South America, Australia, Africa and Asia (Mound, 1997).
- **HOST PLANTS:** Breeding on the leaves of a wide range of plants in the greenhouse and landscape, but not on herbs or soft leaves. Primarily feeds on the underside of leaves.
- **DAMAGE:** Leaves become distorted, curled under, silvered and turn brown. Plants become stunted, flowers become discolored. Fruit surfaces become bronzed.



### Liothrips vaneeckei

NAME: Liothrips vaneeckei (Priesner)

FAMILY: Phlaeothripidae: Phlaeothripinae

COMMON NAME: Lily bulb thrips\*

VARIATION IN BODY COLOR: Uniformly dark.

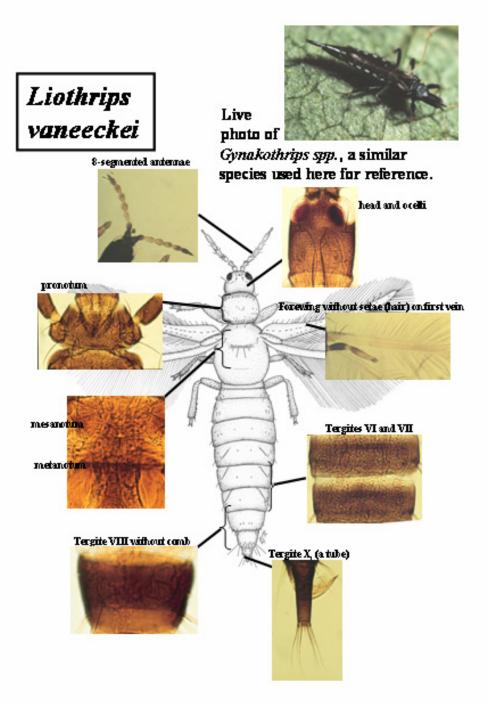
### **DIAGNOSIS:**

- 1. Forewings smooth without veins or setae.
- 2. Last abdominal segment a tube.
- 3. Abdominal tergites with two pairs of wing-retaining setae.
- 4. Pronotum with five pairs of setae.

**DISTRIBUTION:** North America.

HOST PLANTS: Lily bulbs and orchid plants.

**DAMAGE:** Rust colored shrunken areas at base of leaves on lily bulbs and orchid plants. Cause leaf rolls.



### Liothrips varicornis

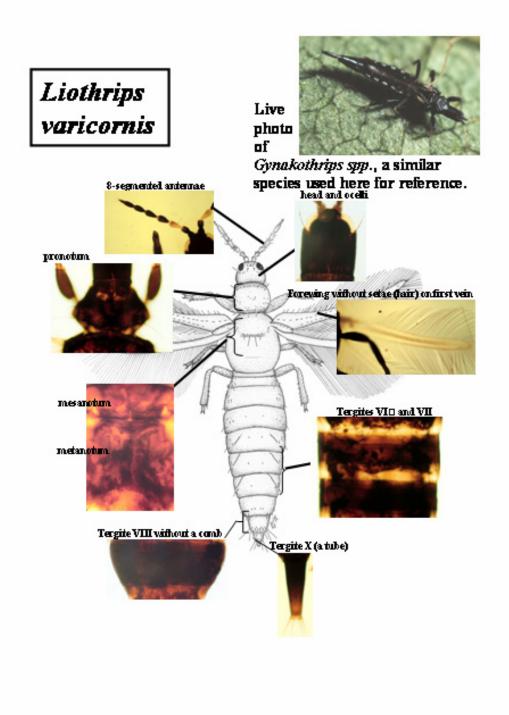
NAME: *Liothrips varicornis* (Hood) FAMILY: Phlaeothripidae: Phlaeothripinae COMMON NAME: Hollyhock thrips VARIATION IN BODY COLOR: Uniformly dark. DIAGNOSIS:

- 1. Forewings smooth without veins or setae.
- 2. Last abdominal segment a tube.
- 3. Abdominal tergites with two pairs of wing-retaining setae.
- 4. Pronotum with five pairs of setae.

**DISTRIBUTION:** North America.

HOST PLANTS: Hollyhocks.

DAMAGE: Cause leaf rolls on hollyhock.



### Parthenothrips dracaenae

NAME: Parthenothrips dracaenae (Heeger)
FAMILY: Thripidae: Panchaetothripinae
COMMON NAME: Palm tree thrips or Dracaena thrips.
VARIATION IN BODY COLOR: Golden brown.
DIAGNOSIS:

Forewings distinctive, broad with reticulate surface.

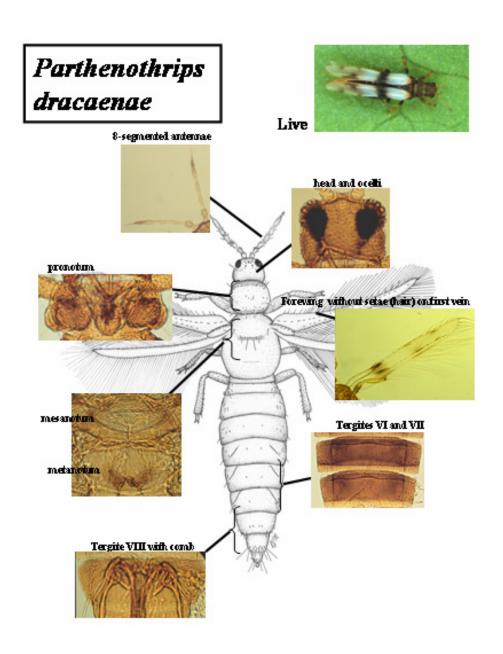
- 2. Body with heavy reticulate sculpture.
- 3. Antennal segments III and IV with simple sense cones (not forked).
- 4. Head wider than long.

**DISTRIBUTION:** Widespread throughout the tropics and subtropics.

HOST PLANTS: Breeds commonly on the Parlour palm, Chamaedorea, greenhouse

ornamental monocots, Gladiolus spp., Freesia and Iris.

DAMAGE: Leaves silvered, browned and scarred.



### Thrips australis

NAME: Thrips australis (Bagnall)

FAMILY: Thripidae: Thripinae

COMMON NAME: Eucalyptus flower thrips or gum tree thrips

VARIATION IN BODY COLOR: Variable, bicolored yellow and brown. Head yellow,

thorax brown and yellow, legs yellowish brown or yellow and abdomen yellow.

#### **DIAGNOSIS:**

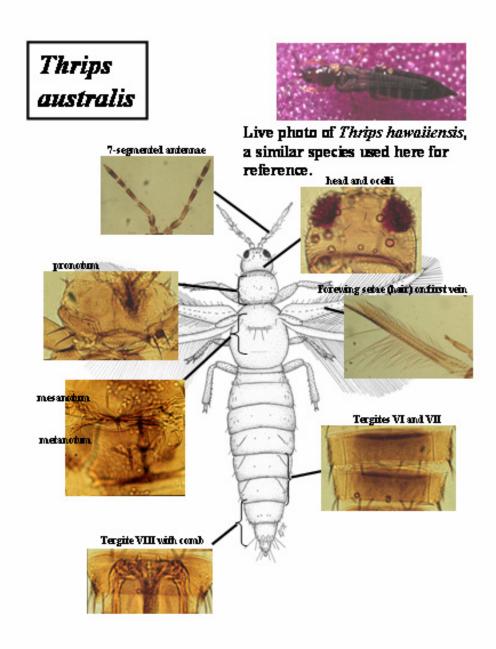
- 1. Head broader than long.
- 2. Antennae 7-segmented.
- 3. Metanotum broadly reticulate with setae arising medially.

**DISTRIBUTION:** Originally from Australia, now spread throughout the U.S.

HOST PLANTS: Polyphagous, common where Eucalyptus is grown. Feeds in flowers of many

Eucalyptus, Myrtaceae and may spill over into ornamental nursery crops.

**DAMAGE:** Little evidence of damage.





## Thrips hawaiiensis

NAME: Thrips hawaiiensis (Morgan)

FAMILY: Thripidae: Thripinae

COMMON NAME: Hawaiian flower thrips\*

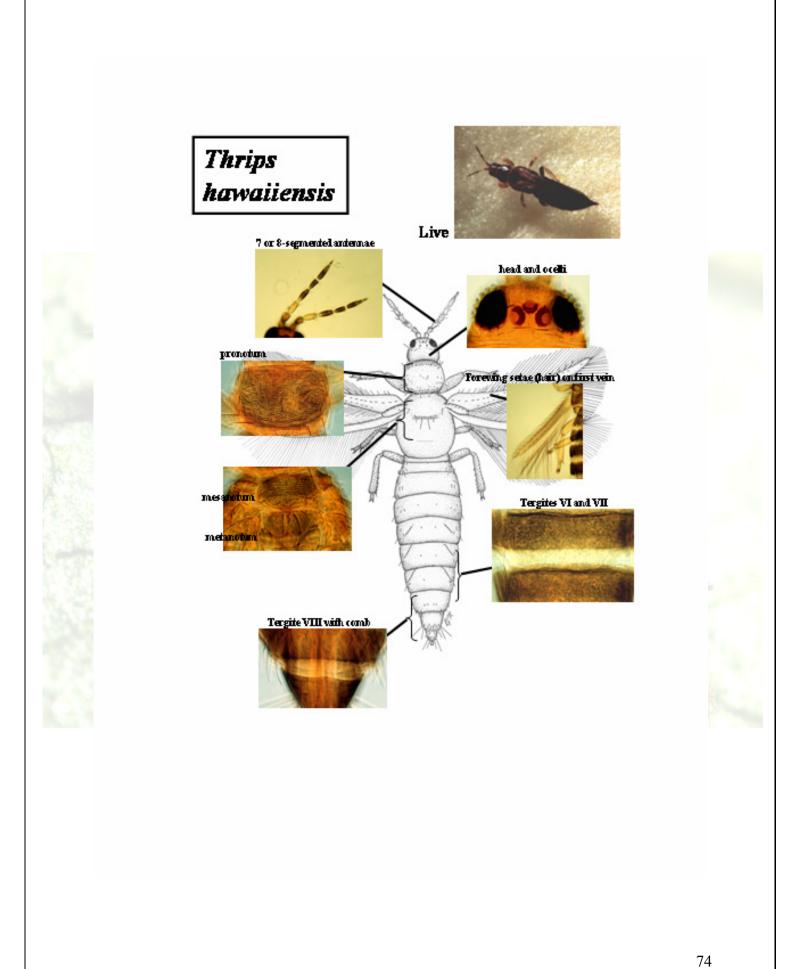
VARIATION IN BODY COLOR: Pale or dark brown. Head and thorax yellow to orange brown. Abdomen brown. Legs yellow to brown.

#### **DIAGNOSIS:**

- 1. Forewings with a gap in the setal row of the first vein followed by 3 setae.
- 2. Antennae 7 or 8-segmented.
- 3. Metanotal reticulation without internal markings.
- 4. Metanotal setae arise at the anterior margin.

**DISTRIBUTION:** North America, South America, Africa, Australia and Asia (Mound, 1997). **HOST PLANTS:** Polyphagous.

**DAMAGE:** Flowers slightly discolored, distorted and marked with spots, young fruit distorted. **VECTOR OF:** Not known to vector diseases.



## Thrips nigropilosus

NAME: *Thrips nigropilosus* (Uzel)

FAMILY: Thripidae: Thripinae

COMMON NAME: Chrysanthemum thrips\*

VARIATION IN BODY COLOR: Uniformly yellow.

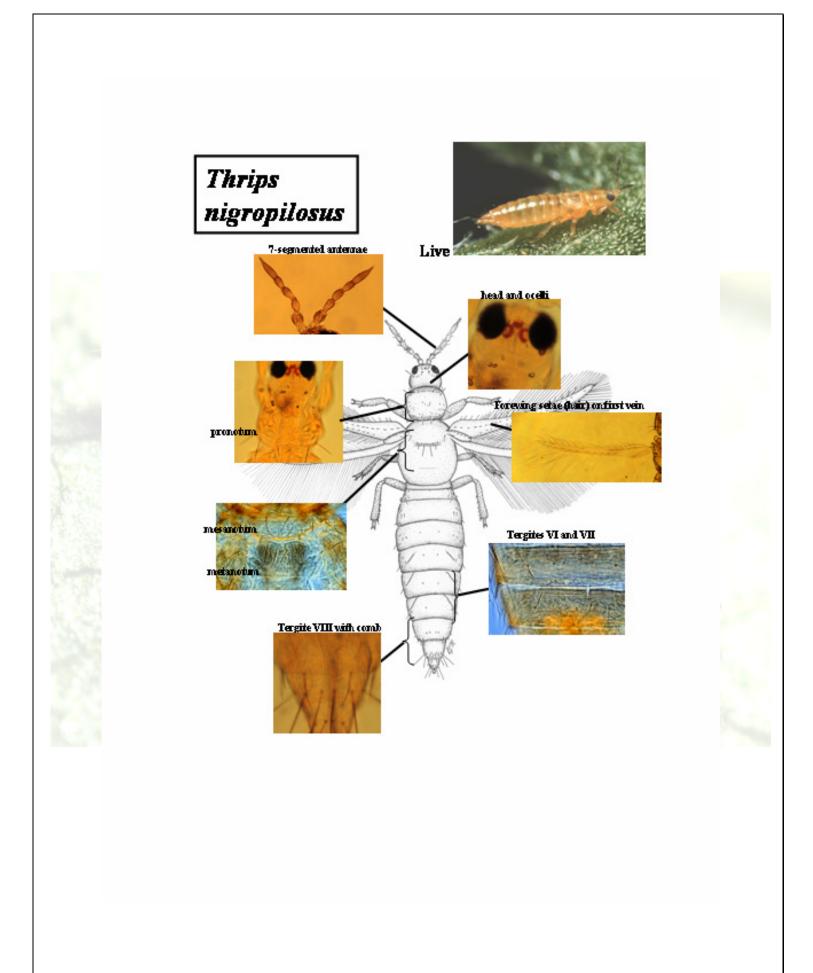
#### **DIAGNOSIS:**

- 1. Median setae on each abdominal tergite half as long as the median length of the tergite.
- 2. Forewings sometimes very short, scarcely longer than the width of the thorax.
- 3. Metanotum broadly reticulate medially.
- 4. Sensilla absent on metanotum.

**DISTRIBUTION:** Widespread throughout northern temperate regions.

**HOST PLANTS:** Foliage feeders of chrysanthemums, gloxinia, eggplant, tomatoes, cucurbits, flax, wheat, onions and lettuce.

DAMAGE: Silvering of leaves, flowers and leaves become discolored, distorted and necrotic.
VECTOR OF: *Thrips nigropilosus* feeding on *Chrysanthemum cinerariaefolium* (Bullock, 1963) flowers is associated with secondary infections of *Alternaria gossypina* and *Cladosporium sp.* (Childers, 1997).

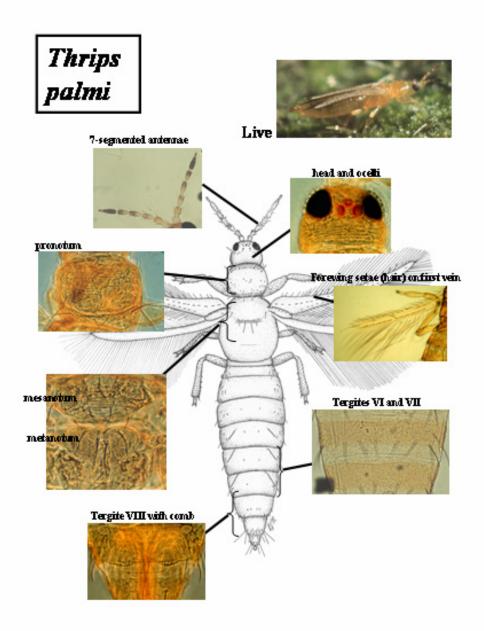


### Thrips palmi

NAME: *Thrips palmi* (Karny)
FAMILY: Thripidae: Thripinae
COMMON NAME: Melon thrips
VARIATION IN BODY COLOR: Pale, yellow to white.
DIAGNOSIS:

Body uniformly yellow.

- 2. Metanotum with transverse "smiling" lines.
- 3. Metanotum with a pair of pores on posterior third.
- 4. Forewing first vein with 3 setae on the distal half.
- 5. Ocellar setae III rising laterally of anterior ocellus.
- **DISTRIBUTION:** North America (Pacific US. and Florida), South America, Africa, Australia and Asia (Mound, 1997).
- **HOST PLANTS:** Cucurbitaceae, Leguminosae, Solanaceae, chrysanthemum, cyclamen, dahlia, morning glory, carnation, citron, various orchids.
- **DAMAGE:** Leaves become silvered, brown, curl and become necrotic. Flowers discolored, distorted and drop prior to fruit development. Terminal shoots distorted and stunted. Fruits scarred by feeding during fruit development.
- **VECTOR OF:** *Watermelon silver mottle virus* (WSMV) (Iwaki et al 1984: Kameya-Iwaki et al. 1988) and *Ground nut bud necrosis virus* (GBNV) (Lakshmi et al. 1995).

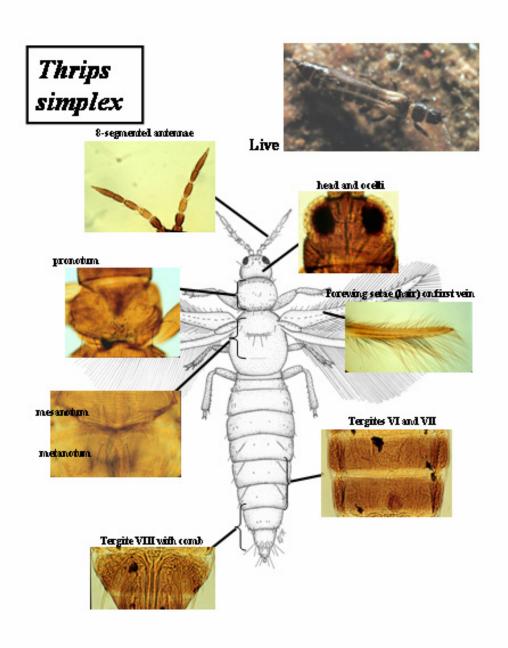


### Thrips simplex

NAME: *Thrips simplex* (Morison) FAMILY: Thripidae: Thripinae COMMON NAME: Gladiolus thrips\* VARIATION IN BODY COLOR: Uniformly dark. DIAGNOSIS:

- 1. Brown body, brown forewings with pale bases.
- 2. Gap on the forewing first vein is followed by 5-7 setae.
- 3. Antennae are 8-segmented.
- 4. Metanotal reticulations have internal markings present.
- 5. Metanotal setae arise medially.
- **DISTRIBUTION:** Almost cosmopolitan, Europe, North America, South America, Africa, Australia and Asia (Mound, 1997).
- **HOST PLANTS:** Flowers and corms of gladiolus and lily bulbs, can also be found on *Dianthus* and *Ornithogalum* species.
- **DAMAGE:** Rust-colored sunken lesions near base of bulb leaves. Leaves, stems and flowers become discolored, distorted and die.

VECTOR OF: Not known to vector diseases.



### Thrips tabaci

NAME: Thrips tabaci (Lindeman)

FAMILY: Thripidae: Thripinae

**COMMON NAME:** Onion thrips\*

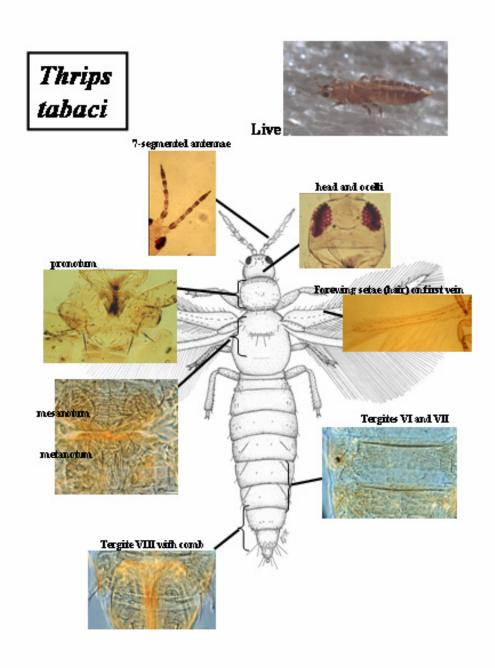
VARIATION IN BODY COLOR: Variable, pale yellow to brown.

#### **DIAGNOSIS:**

- 1. Ocellar crescents are pale, grayish, brown.
- 2. Metanotum has irregular transverse lines on the anterior third.
- 3. Metanotum without pores on the posterior third.
- 4. Forewings with four to six distal setae on the first vein.
- 5. Males rarely found.
- **DISTRIBUTION:** Europe, North America, South America, Africa, Australia and the Orient, however not in the wet tropics (Mound, 1997).

HOST PLANTS: Allium, carnations, polyphagous (Bailey, 1938).

- DAMAGE: Flowers and leaves silvered, distorted and turn brown. Fruits become distorted. Shoot tips distorted.
- **VECTOR OF:** TSWV (Pittman 1972; Linford 1932; Sakimura 1940,1963), and *Iris yellow spotted virus* (IYSV) (Cortes et al. 1998). *Thrips tabaci* feeding damage has also been associated with powdery mildew (Yarwood 1943).



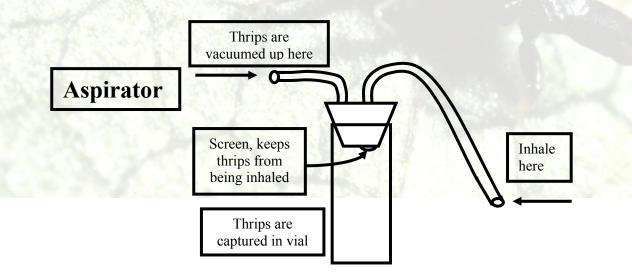
## Appendix A: Collecting thrips for identification.

#### **Collecting live thrips**:

Live thrips are best collected directly from plant material with an aspirator\* (shown below). They should then be transferred to a petri dish and placed in the refrigerator or freezer for a few minutes to slow their activity. Thrips can then be viewed under a dissecting microscope for identification. Should they become active again, they can be returned to the refrigerator or freezer.

#### **Alcohol preservation of thrips:**

For preservation and subsequent study, thrips are best collected live directly from plant material using an aspirator, or by beating the plant over a small plastic tray to dislodge thrips onto the plastic surface. Thrips can then be picked from the tray using a small brush dipped in alcohol. They should be placed into 60% ethanol in a small vial. High concentrations of alcohol cause specimens to become stiff and to lose their color. Thrips collected and preserved in this way can be placed into a small petri dish and viewed with a dissecting microscope. They can also be placed on microscope slides for more detailed examination, as discussed in Appendix B.

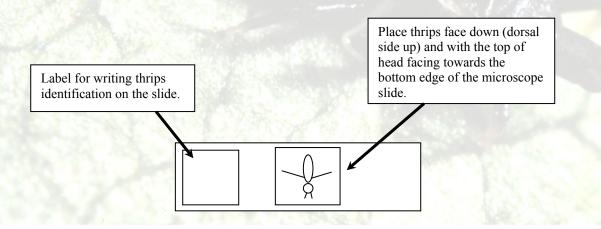


\* Aspirators can be purchased from a local biological supply house.

## **Appendix B: Microscope slide preparation of thrips.**

The objective is to mount a thrips specimen on a glass microscope slide with its wings, legs and antennae spread but without losing the original body shape or coloration. These idealized requirements are difficult to achieve and usually require some compromise. The method that is simplest and usually gives the best results is as follows:

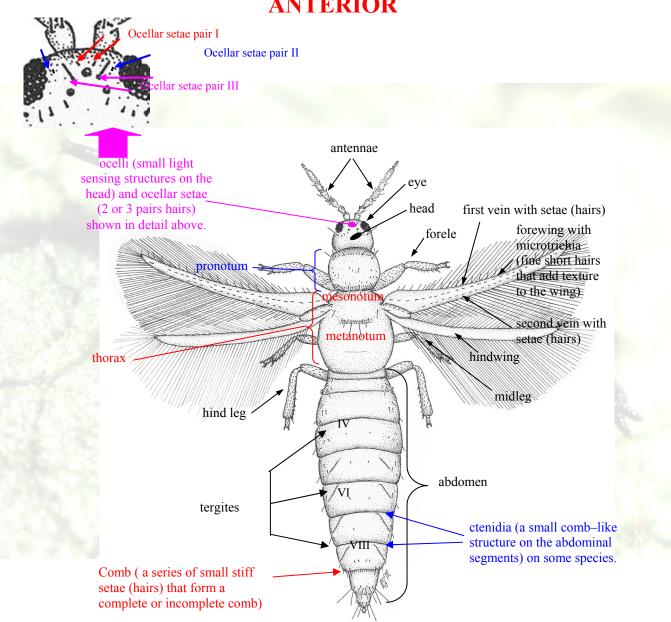
- Place a single thrips specimen alive, or freshly killed in 60% ethanol, into a small drop of water-soluble mountant\* in the center of a microscope slide\*.
- Spread the wings, legs and antennae using a fine needle or straight pin, and place a cover slip\* over the specimen.
- 3. Place the slide on a hotplate at 45° C for at least 2 hours (in the first few minutes, many specimens may collapse, but they will slowly re-expand after an hour).
- 4. Label the slide with the relevant data immediately. If the slide is to be retained, it should be heated in an oven at 45°C for two weeks, and then sealed with a ring of nail polish.



\*Microscope slides, cover slips and a mounting media can be purchased from a local biological supply house.

## **Appendix C:**

Illustration of thrips identification characteristics used in this key.



## **ANTERIOR**

## **POSTERIOR**

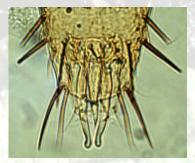
# Appendix D: Female and male characteristic differences.



Differences in the size, shape, coloration of tergite VIII.

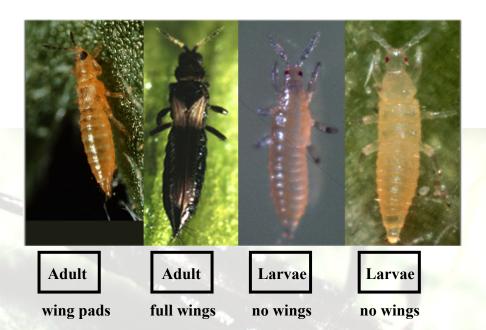


Female genitalia



Male genitalia

<u>Appendix E:</u> <u>Differences in characteristics between adults and larvae.</u>



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