# SYSTEMATICS OF THYSANOPTERA, PEAR THRIPS AND OTHER ECONOMIC SPECIES

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## Abstract

The systematics of the Thysanoptera, and several economic species in the United States and Canada (North America) are discussed briefly. Morphological characters to distinguish the six families in North America and the following economic species, pear thrips (*Taeniothrips inconsequens* (Uzel)), basswood thrips (*Thrips calcaratus* Uzel), western flower thrips (*Frankliniella occidentalis* (Pergande)), flower thrips (*Frankliniella tritici* (Fitch)), tobacco thrips (*Frankliniella fusca* (Hinds)), and onion thrips (*Thrips tabaci* Lindeman) are discussed.

## Introduction

The common name for the order Thysanoptera is thrips. Other common names that have been used are bladderfeet and woodlouse. There is also a genus *Thrips*, which is the oldest name in the order. In the United States and Canada (North America), there are about 700 described species of thrips. Mound & Houston (1987) estimate about 4,500 known species worldwide and probably another 4,500, mainly in the tropics, that have not been described.

Most thrips are tiny and barely visible. They usually are 1-2 mm long, the smallest are about 0.5 mm and the largest found in the tropics are about 14 mm (Lewis 1973). They are found in flowers and various parts of the plants, and often pupate or spend part of their life cycle in soil or ground litter. Thrips have elongate bodies, which are often slightly to strongly flatten dorso-ventrally (Figs. 1-2). Antennae are 4- to 9-segmented. The right mandible is vestigial and the left mandible is developed. Two pairs of elongate wings are fringed with long cilia. A bladder is located at the apex of each leg (Fig. 3). The abdomen is 10-segmented.

Currently, there are eight families of thrips in two suborders worldwide. The suborder Tubulifera consists of only one family, Phlaeothripidae, which includes about 350 species in North America. Members of this family (Fig. 1) can be recognized by the tubelike last or tenth abdominal segment, which has terminal setae; the female lacks an ovipositor. Also, the forewings, which lie crossed on the abdomen when at rest, lack veins and setae except at the base, and their surfaces are bare. Foretarsi are always one-segmented. The maxillary stylets are long and inserted inside the head (Fig. 4). Only a few species in this family are of agricultural importance. Many species feed on fungi or fungal spores and several species are predators. The life cycle includes the egg, two larval stages, three pupal stages and adult. The antennae of the larvae are not annulated and the last abdominal segment is tubelike and often sclerotized, and the antennae of the pupae lie along the sides of the head.

In the suborder Terebrantia, there are five families in North America. They differ from the phlaeothripids by having an ovipositor. Also, the forewings, which lie parallel over the abdomen when at rest, have veins with setae, and their surfaces are covered with microtrichia (Fig. 2). Maxillary stylets are short. The life cycle includes the egg, two larval stages, two pupal stages and the adult. The antennae of the larvae are annulated, and the last abdominal segment is variously shaped. Antennae of the prepupa project anteriorly but lie over the head in the pupal stage.

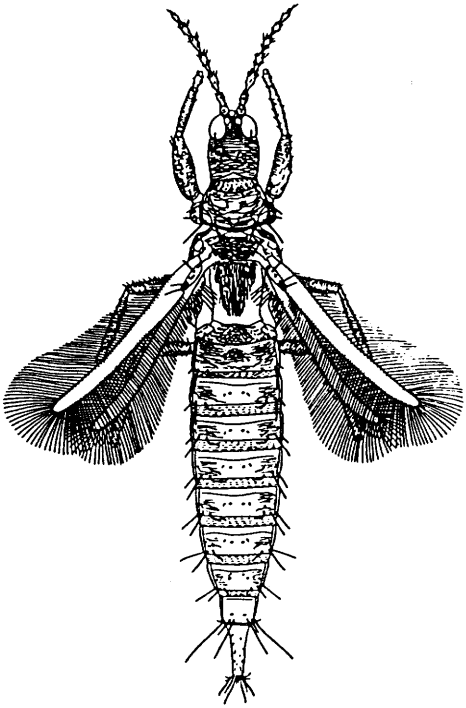

Figure 1. Phlaeothripidae adult (from Stannard 1968).

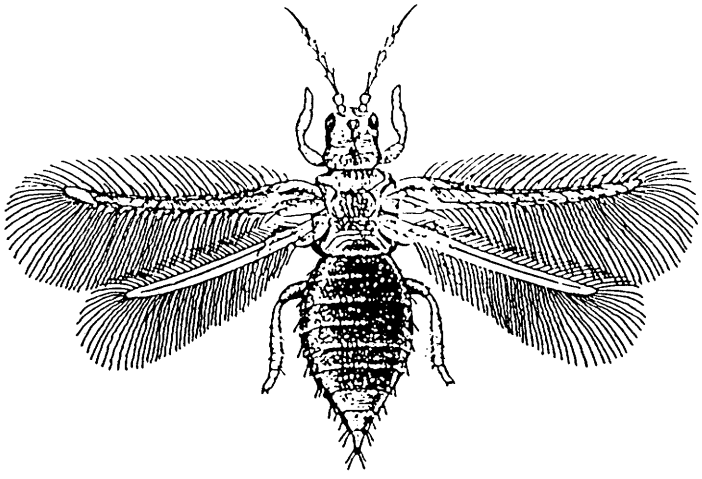

Figure 2. Thripidae adult (from Bailey 1938).

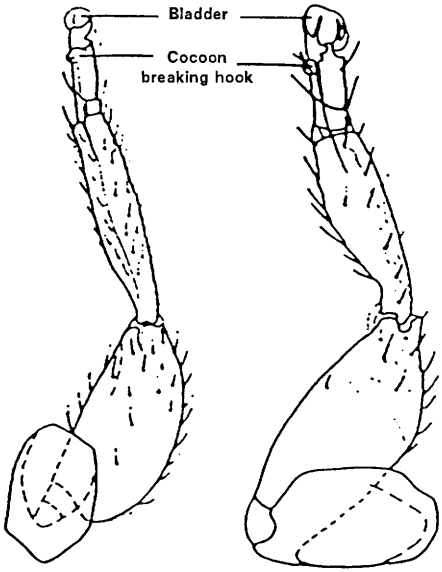


Figure 3. Bladder on the forelegs of Aeolothripidae (from Stannard 1968).

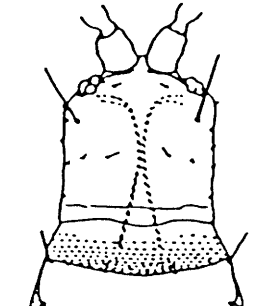

Figure 4. Maxillary stylets in head of Phlaeothripidae adult (from Stannard 1968).

Of the five families, the Adiheterothripidae with one species and Merothripidae with four species are seldom found and are not discussed further. The Heterothripidae (Fig. 5) with 20 species have strongly sclerotized bodies. The sides of the abdomen are reticulated and microtrichia are usually present. Posterior margins of the abdominal segments have a fringe of longer microtrichia. Antennae are 9-segmented with segments III and IV having small sensoria in rows or bands encircling the segments near the apices. Species in this family are found in flowers and on leaves but are not known to be of economic importance. There are about 57 species in the family Aeolothripidae; many are predaceous. They can be recognized by their large size and broad forewings, which are usually banded and their apices are usually broadly rounded (Fig. 6). Further, the antennae are 9-segmented; segments III-V are elongate and parallel sided, and the sensoria on III and IV are flat, linear or oval. The ovipositor is upturned (Fig. 7). None of the other families have upturned ovipositors.

The family Thripidae (Fig. 2) is the largest family in the Terebrantia with about 280 described species in North America. It is recognized by the down-turned ovipositor (Fig. 8), forewings are usually slender with pointed apices, and the sensoria on the antennae III and IV project either as simple or forked (trichome) sense cones. Most of the economic species are found in this family and the morphological characters to identify several of the species are discussed.

## Discussion of Adults

The following structures are some of the morphological characters used to identify thrips (Fig. 9). The antennae are located at the anterior part of the head. Between the compound eyes on the head are usually three ocelli (lens like organs) in a triangular arrangement. A crescent shaped coloration, the ocellar crescent, borders each ocellus. Normally, the crescents are orange to red. Also between the eyes are several setae, the ocellar setae. A pair of these setae in the ocellar area is known as the interocellar setae. The lateral margins of the head posterior to the eyes are referred to as the cheeks.

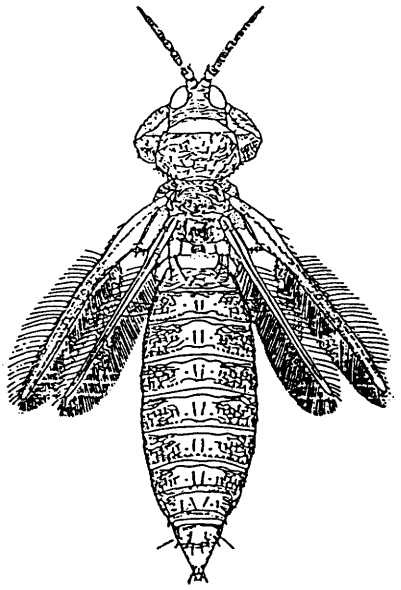

Figure 5. Heterothripidae adult (from Stannard 1968).

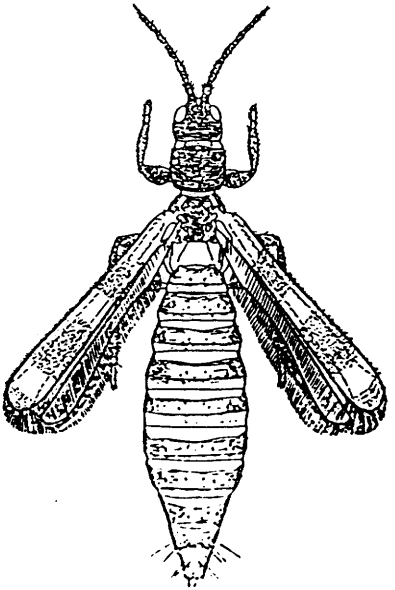

Figure 6. Aeolothripidae adult (from Stannard 1968).

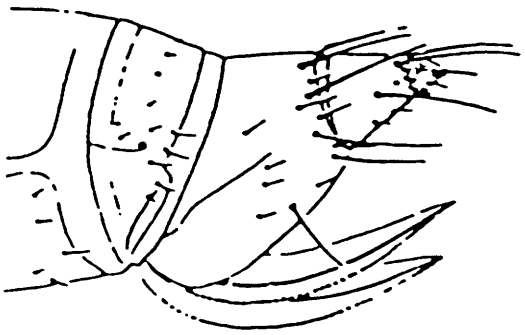

Figure 7. Ovipositor of female Aeolothripidae (from Kono & Papp 1977).

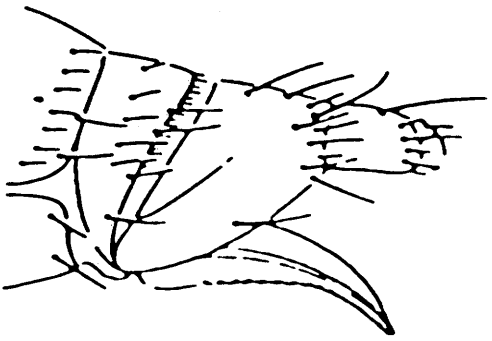

Figure 8. Ovipositor of female Thripidae (from Kono & Papp 1977).

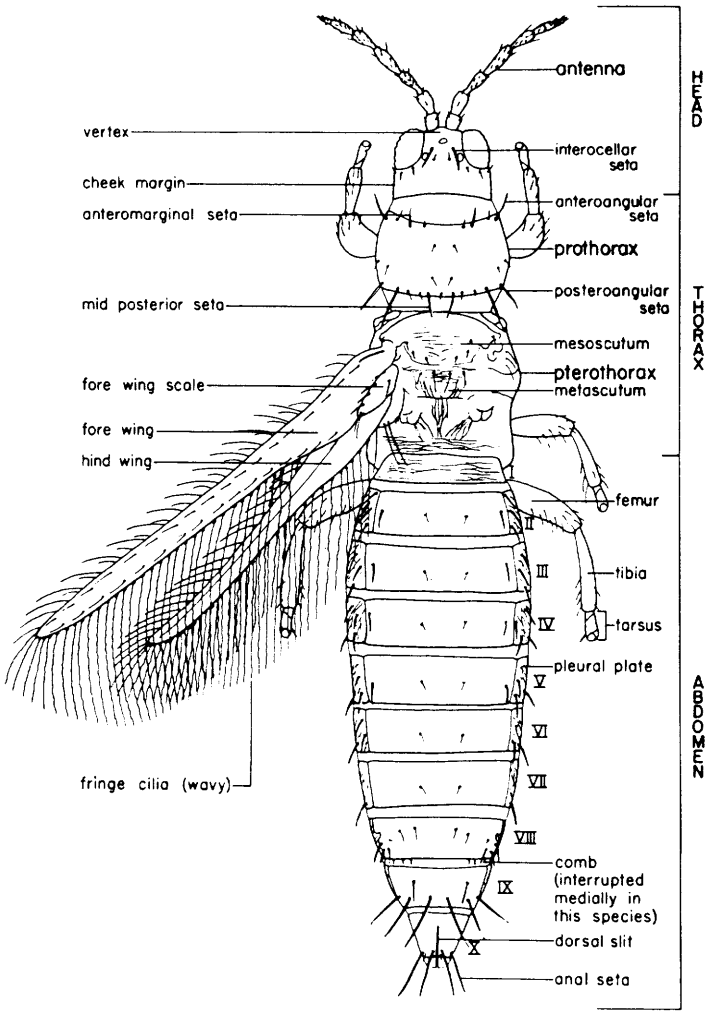


Figure 9. *Frankliniella tritici* (Fitch) (from Stannard 1968).

On the pronotum are various types of setae. One or two pairs of posteroangular setae, when present, are found on the posterior angular parts of the pronotum. Venal setae are present normally on two longitudinal veins on the forewings. The hind vein normally has a complete row of setae. On the forevein, the setae may be in a complete row or only a few irregularly spaced setae are found in the distal one-half. These setae are known as the distal setae. On the abdomen, the posteromarginal comb, which is a row of fine teeth, is found on the posterior margin of tergite VIII. A complete comb has a complete row of fine teeth, an incomplete comb lacks teeth from the median part, or the comb may be absent. Members of several genera such as *Frankliniella* and *Thrips* have a pair of submarginal ctenidia on abdominal tergites V-VIII. The ctenidium is a short row of fine teeth.

**Pear Thrips**

The pear thrips, *Taeniothrips inconsequens* (Uzel) (Fig. 10), is known from Europe, Asia and in North America from British Columbia and Ontario in Canada and from Washington, Oregon, California, Utah, Maryland, Virginia, Pennsylvania, New York, Vermont, Connecticut, Massachusetts, New Hampshire and Maine in the United States. It has been reported from apple, pear, *Prunus* spp., maple and many other trees. This species has one generation per year, and lives most of its life in the soil.

The adult females have brown bodies. Antennae are 8-segmented, and the apical part of segment II and basal part of III are yellow or yellowish brown. Legs are generally brown; the tarsi and bases of tibiae and femora are yellow. Forewings are brown. The head has bulging eyes with the cheeks strongly arched, and two pairs of ocellar setae are present with the interocellar pair long and positioned between the posterior ocelli (Fig. 11). The distinctive feature of this thrips is the apical claw on the foretarsi (Fig. 12), which can be observed usually under the dissecting microscope. The pronotum has two pairs of long, well-developed posteroangular setae. Forewings have normally five to six setae on the distal one-half of the forevein.

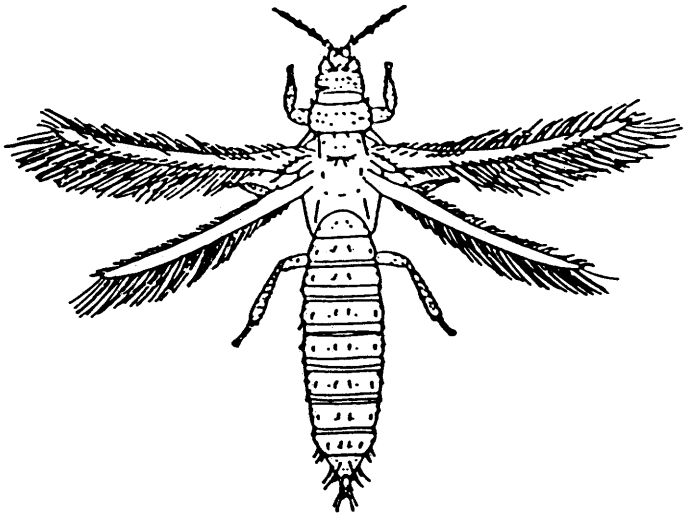

Figure 10. Pear thrips (from Bailey 1944).

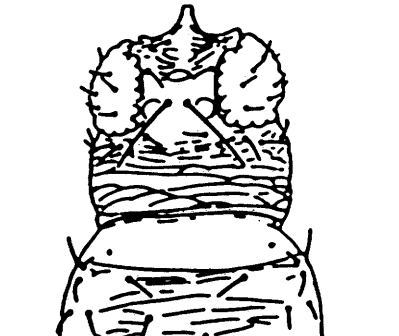

Figure 11. Head and pronotum of the pear thrips (from Mound et al. 1976).

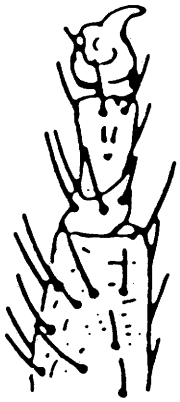

Figure 12. Apical claw on foretarsus of pear thrips (from Mound et al. 1976).

Figure 13. Tooth on foretarsus of *Thrips calcaratus* Uzel (from Mound et al. 1976).

The abdomen lacks ctenidia, tergum VIII has a well-developed posteromarginal comb, and only the median pair of posteromarginal setae on abdominal sternum VII is anterior to the posterior margin. The male has not been found in North America.

*Taeniothrips orionis* Treherne, a native species found in western North America, closely resembles the pear thrips in color and most characters; however, it lacks the apical claw and has three distal setae on the forewings.

**Basswood Thrips**

*Thrips calcaratus* Uzel, the basswood thrips, was also introduced from Europe, and occurs in Ontario and Quebec in Canada and New York, Pennsylvania and Wisconsin in the United States. It infests various species of basswoods and other plants. Its life cycle is similar to that of the pear thrips.

The adult females have brown bodies. Antennae are 7-segmented; segment III, apices of II, and bases of IV and V are yellow. Legs have tarsi that are yellow and the tibiae are yellowish brown in the distal part. Forewings are grayish brown. The head has two pairs of ocellar setae, with the interocellar pair positioned between the anterior and posterior ocelli. The pronotum has two pairs of well-developed posteroangular setae. Instead of an apical claw, it has a distinctive thumb-like tooth on the distal tarsal segment (Fig. 13), which can be observed under the dissecting microscope. Forewings normally have three setae on the distal one-half of the forevein. The abdomen has ctenidia on tergites V-VIII, and tergum VIII has short, irregular spaced teeth on the posterior margin. Abdominal sternites III-VII have accessory setae. The male also has not been found in North America.

Some *Odontothrips* spp. have a small tooth on the foretarsi, but they also have one or two apical teeth or claws on the fore-tibiae, 8-segmented antennae, and lack accessory setae on the abdominal sternites. Most *Odontothrips* spp. feed on legumes.

**Flower Thrips and Tobacco Thrips**

The western flower thrips, *Frankliniella occidentalis* (Pergande), another species of economic importance, is a vector of the tomato spotted wilt virus (TSWV). It varies in coloration from completely yellow to completely brown. The usual color form is yellow with brown blotches or shading on the abdominal tergites, and pale yellow forewings. Antennae are 8-segmented, and the pedicel of segment III is not angulate. The head has three pairs of ocellar setae. The pronotum has a pair of well-developed anteromarginal setae, which are almost as long as the anteroangular setae, and two pairs of posteroangular setae. Forewings have two complete rows of venal setae. Ctenidia are present on abdominal tergites V-VIII, and tergite VIII has a complete posteromarginal comb, which is short and sparse. The flower thrips, *F. tritici*, and several other common *Frankliniella* spp. may be confused with it. The flower thrips (Fig. 9) has a distinctly angulate pedicel III; the anteromarginal setae are usually one-half to two-thirds as long as the anteroangular setae, and the posteromarginal comb on tergum VIII

is incomplete, i.e. teeth are absent medially. The tobacco thrips, *F. fusca* (Hinds), is also a vector of TSWV and has a brown body, pale brown forewings when the wings are developed, and the posteromarginal comb is absent from abdominal tergite VIII. The tobacco thrips has brachypterous and macropterous forms.

**Onion Thrips**

The cosmopolitan onion thrips, *Thrips tabaci* (Fig. 14), is a well known pest and a vector of TSWV. This thrips also varies greatly in color from pale grayish yellow to dark brown. The grayish brown ocellar crescent, which can be observed under the dissecting microscope, will separate it from most species in Thripidae, which have orange to red ocellar crescents. Other diagnostic characters are the 7-segmented antennae, short posteroangular setae present on the pronotum, forewings usually with four to five setae on the distal one-half of the forewings, and the posteromarginal comb on abdominal segment VIII with long, close-set teeth.

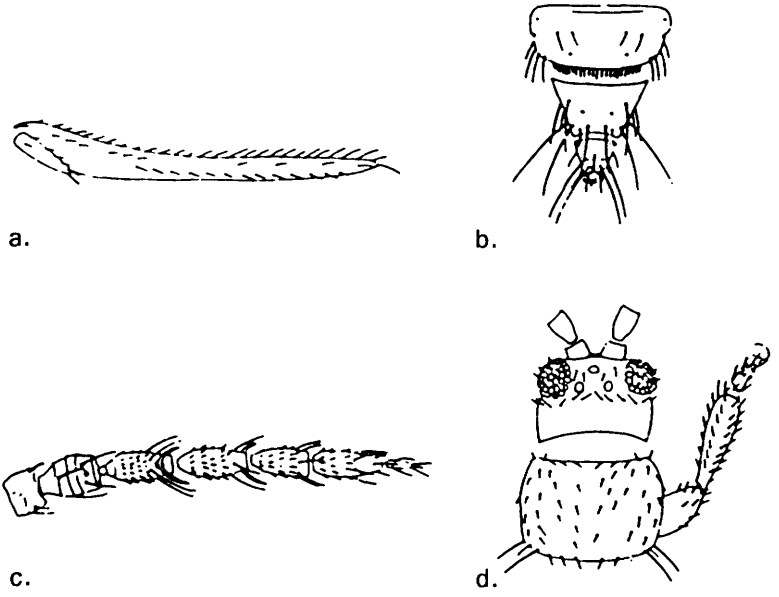


Figure 14. *Thrips tabaci* Lindeman (from Kono & Papp 1977); a. wing, b. abdomen, c. antenna, d. head and thorax.

## Discussion of Immatures

At present, only a few first instars can be identified to species, and pupae can not be identified specifically. Several papers have been published on the second stage larvae and some can be identified to specific or generic level (Speyer & Parr 1941, Vance 1974, Miyazaki & Kudo 1986).

Larvae of the Thripidae have 7-segmented antennae on the head, three thoracic segments with three pairs of legs and a pair of spiracles on the mesothorax, and a 10-segmented abdomen with a pair of spiracles on the second and eighth abdominal segments (Fig. 15). The first stage larvae differ from the second stage larvae by having six pairs of setae on the pronotum and four pairs of setae on abdominal segments III-VII. The second stage larvae have seven pairs of setae on the pronotum and six pairs of setae on abdominal segments III-VII.

The head and body of pear thrips larvae are pale and lack sclerotization except on abdominal segments IX-X. Abdominal segment IX has seven-eight large dorso-lateral teeth on the posterior margin (Fig. 16). The two medial teeth are smaller than the lateral ones. A ventral row of small teeth is present on the posterior margin.

The basswood thrips larvae also do not have sclerotization on the head or body, except on abdominal segment IX and X. Abdominal segment IX has 17-18 large dorso-ventral teeth on the posterior margin. The lateral teeth are larger than those dorsally or ventrally. A ventral row of 8-10 small teeth is present.

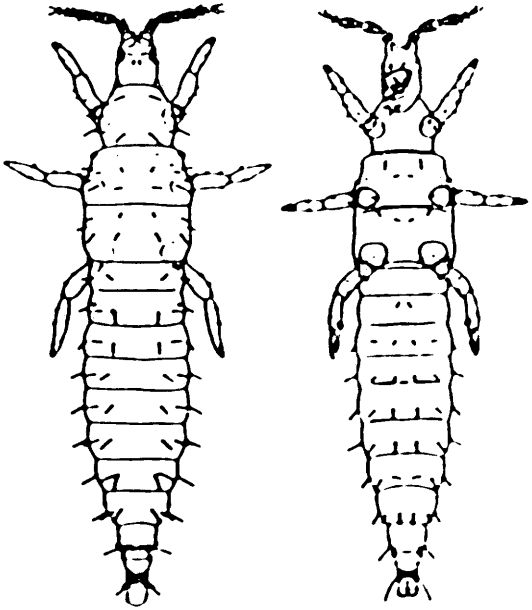

Figure 15. Second instar *Frankliniella intonsa* (Trybom) (from Speyer & Parr 1941).

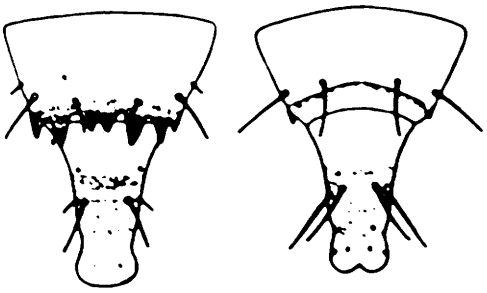

Figure 16. Abdominal segment IX-X of the second instar pear thrips (from Speyer & Parr 1941).

## Preserving and Mounting Specimens

Thrips may be collected and preserved in 60 or 70% ethanol. However, a better solution in which to collect and preserve thrips is AGA. This consists of eight parts of ethanol, five parts of distilled water, and one part each of glacial acetic acid and glycerine. This solution relaxes the wings and legs, which can be spread and aligned easily when the thrips are mounted on a slide. Specimens should not be kept over a year in AGA and should be transferred to 60% ethanol for longer storage.

When quick identifications are needed, temporary slide mounts prepared with Hoyer's or polyvinyl lactophenol may be used. These media will also clear the specimens. For permanent mounts, the specimens should be treated with sodium hydroxide and mounted in Canada balsam or other artificial media.

## Acknowledgment

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**Discussion Period**

Question: How well is coloration maintained in preserved thrips specimens; is pigmentation retained for a long time?

Nakahara: Yes, color loss is not a problem; specimens do not fade after a year or more in solution. Thrips should be collected in AGA solution, but they will not hold up well for a long period of time and should be transferred to 60% ethanol after about a year.

Question: Is there an alternative to glacial acetic acid?

Nakahara: You can use vinegar, which is basically the same thing. One or two drops in a vial of alcohol is plenty. Acetic acid relaxes the thrips appendages which facilitates mounting, reducing the difficulties of spreading the wings.

Question: Is a typical thrips specimen obtained if collected directly from the soil as it emerges and mounted before it feeds on any plant tissue? Is the identifying color characteristics the same as those collected after they have fed on plant tissue?

Nakahara: Slight variation in coloration can occur among thrips. I have noticed colors ranging from yellow to reddish-orange among specimens of the same species. I don't know if this variation in color is a result of the plants they feed upon, but it may be. Thrips that have not yet fed often appear paler than those that have fed on plant tissue. However, the body pigments and basic distinguishing taxonomic features, such as the tarsal and abdominal structures will be present whether they have fed on plant tissue or not.

Question: What is the function of the sense cones, and the bladder on the foretarsi?

Nakahara: I haven't investigated the function of the sense cones, but I assume they are sense receptors of some sort. One theory is that the tarsal bladder is used to hold on to the host, which is a logical thought.

Question: Are you satisfied with the current state of thrips taxonomy, or do you believe that some groups need revision? Is there any work on thrips taxonomy underway presently?

Nakahara: I have just finished writing a manuscript on the Thripidae of North America. The last revision, which included 31 species, was done in 1968. Sixty species are included in my manuscript. It's a matter of the concept of what distinguishes a species. The taxonomy of thrips is evolving. For example, at one time the genus *Thrips* and *Taeniothrips* were only separated by the number of antennal segments, with eight segments in *Taeniothrips* and seven in *Thrips*. The problem that taxonomists faced was that you can get a specimen with seven segments on one antenna and eight segments on the other. Now what are you going to do in that case? Taxonomists now use other characters than the number of antennal segments to separate thrips genera. Therefore of the ten species originally in *Taeniothrips* only two now remain, and the rest have been put in different genera.

Question: Is anyone doing systematic work other than using morphology, such as DNA hybridization?

Nakahara: Not in the United States or Canada. Unfortunately I believe I'm the only person in this country doing systematic work on thrips. I'm glad to see so many people interested in thrips. It's been a long time since I've seen this many gathered together to talk about thrips.

Question: Are the drawings that you showed included in your manuscript, and when will it be published?

Nakahara: Probably in a couple of years, depending on funding. I work for a national agency, and therefore the availability of money is always a problem.