

Biological Control of Pest Mites in Apple (5/11/09)

Natural enemies and environmental factors limit populations of insect and mite pests in natural ecosystems. When natural enemies are killed by man's actions in any habitat or when pests are introduced to new habitats without their natural enemies, natural control often fails and results in pest outbreaks. Biological control of pest species by predators, parasitoids, and pathogens has been a cornerstone of IPM since its inception. It has been difficult to utilize the full potential of biological control in tree fruit and other crops that receive periodic sprays of broadspectrum pesticides and/or have high quality standards. The best pest targets for biological control in tree fruits are generally the secondary foliage-feeding pests that do not cause direct fruit injury (i.e. mites, aphids, & leafminers). Populations of pests that feed directly on the fruit (i.e. codling moth, oriental fruit moth, & plum curculio) generally can not be tolerated at levels high enough for biological control agents to reproduce.

The most successful biological control programs in eastern tree fruits have centered on the conservation of native species of mite predators to control the European red mite and two-spotted spider mite. After 40 years of use, some of these predators have developed resistance to organophosphate insecticides, but are suppressed or eliminated when broadspectrum carbamate and pyrethroid insecticides are used. The use of pheromone mating disruption, horticultural oils and some of the more selective reduced-risk insecticides and miticides will allow a natural increase of predators capable of regulating pest mite populations to tolerable levels without the use of miticides. The potential savings to Pennsylvania apple growers is approximately \$1 million per year and a reduction of almost 1 ton of miticide active ingredient into the environment. Mite control through biological control in apple has the additional advantage of stopping the development of miticide resistance and, once established, is sustainable long-term if the use of certain harmful pesticides is avoided. **The routine use of carbamates and pyrethroids in stone fruits, pears, grapes, and small fruits currently prevents reliable biological mite control, even though many of the same predators found in apple can be present.**

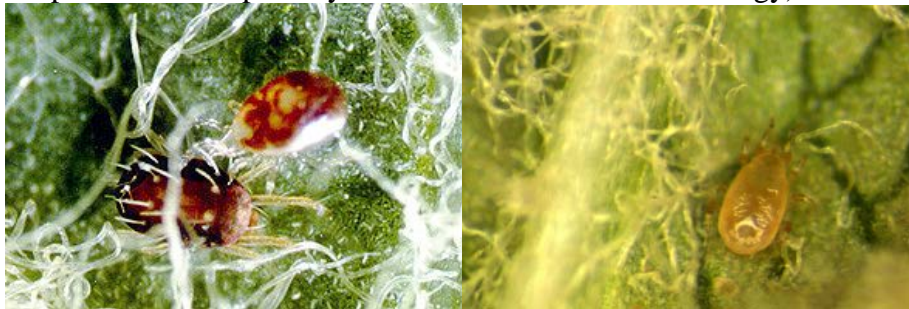
Listed below are descriptions of the main biological mite predators found in Pennsylvania apple orchards:

Typhlodromus pyri (Phytoseiidae)

Discovered in Pennsylvania in 2003, this predatory mite is by far the most reliable and effective mite predator. It is very similar in appearance to *Amblyseius fallacis* (see below) also commonly found in apple orchards, but is an omnivore and more closely associated with its apple host. It is very active and moves very rapidly to consume up to 350 mite prey in a lifespan of about 75 days. Females may lay up to 70 eggs each and have several generations per season. Populations, therefore, can build very rapidly in response to pest mite populations. Most effective in the cooler weather of the spring and fall, *T. pyri* is somewhat less effective in the summer months. It overwinters on the apple tree under the bark where it is less susceptible to dormant oil applications and is very tolerant of Pennsylvania's relatively mild winters.

Able to regulate pest mite populations well below injury thresholds of less than 5 pest mites per leaf, it is able to subsist on harmless apple rust mite populations, pollen or fungal spores

when pest mite populations are low. Well adapted to living in apple, *T. pyri* do not leave the tree during the season and once populations are established, sustainable mite control is virtually ensured when the predator to prey ratio is at least 1:5 and probable at 1:10. This seasonal association with its apple host, however, makes them very susceptible to toxic pesticides. Because they do not disperse quickly, they may take several growing seasons to re-establish after extinction by harmful pesticides unless artificially re-introduced. Once populations are identified or artificially established, conservation is therefore very important and applications of certain pesticides have to be avoided. Natural populations are most likely to be found in grower orchards relying primarily on organophosphate and reduced-risk insecticides and where pheromone mating disruption is being used. Establishment of *T. pyri* into orchards where it is absent is relatively simple and can be accomplished in 1-2 seasons once “donor” orchards with abundant *T. pyri* populations have been identified as a source. Transfers of *T. pyri* from these orchards can be successful by physically moving blossom clusters or shoots in May and June. (See Pennsylvania Fruit Monitoring Guide or PSU Fruit Research & Extension Center website for pesticide susceptibility and orchard transfer methodology).

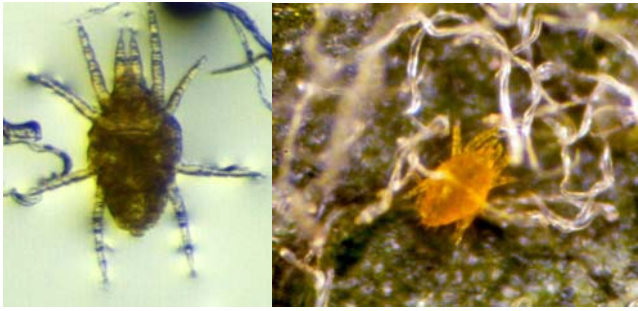


***Amblyseius fallacis* (Phytoseiidae)**

Almost indistinguishable from *T. pyri* except under microscope slide mounts, this predator currently more widespread in distribution in Pennsylvania apple orchards than *T. pyri* due to a higher tolerance for some pesticides and the use of alternative plant hosts. Like *T. pyri*, it is also very active, but is able to build populations 3 times faster during the hotter summer months. It is not as tolerant of cool weather in the spring and fall and is susceptible to winter kill in Pennsylvania. Purely a predator, *A. fallacis* is not able to co-exist on apple trees without pest mite populations to feed on and will often leave the tree to feed on mites in the orchard ground cover. Because its association with the apple host is not nearly as close as that of *T. pyri*, *A. fallacis* populations are often do not build until mid to late summer leaving trees and leave the trees susceptible to early season mite injury. Because it can also survive in the orchard ground cover, however, *A. fallacis* is not as susceptible to extinction in the orchard due to applications of toxic pesticides applied to the tree. The predator to prey ratio of *T. pyri* also applies to *A. fallacis* and distinguishing between the 2 species is not important as long as this ratio is reached.

***Zetzellia mali* (Stigmaeidae)**

An omnivore like *T. pyri* that is able to exist on pollen, fungi and rust mites when spider mite populations are absent, *Z. mali* is very slow and feeds on the eggs of pest mites. Its diamond shape and bright yellow coloration make it easy to distinguish from other predatory mites. Because it is less active, it is able to exist on pest mite populations even lower than *T. pyri*. Like *T. pyri*, it is also more active in the cooler spring and fall months. However, with only a couple of generations each season and a consumption rate of only 2-3 eggs per day, it can not be relied upon to control mite pests alone. It is a valuable supplement to control by other mite predators and is much more tolerant of most pesticides, including pyrethroids.



Stethorus punctum (Coccinellidae)

Once the cornerstone of biological mite control in Pennsylvania apple orchards, this small, black ladybeetle predator has greatly declined in importance over the last 10 years. While tolerant of many organophosphate insecticides, this decline has been mainly due to the greater use of pyrethroids and the introduction of several new neonicotinoid and IGR insecticides which are also toxic. Reproducing only when populations of pest mites exceed 8-10 mites per leaf, relying on this predator alone required the tolerance by growers of some foliar injury. With the registration of newer, more effective miticides in recent years, most growers are not willing to tolerate this injury, despite the high cost of miticides. *S. punctum* is now much less common in orchards and generally in small localized “hot spots” of mites along the borders of orchards. The main advantage now of this predator is its ability to fly and quickly colonize these areas.

Nonchemical Control Methods- Conservation & Augmentation of the predatory mite, *Typhlodromus pyri*.

While a number of mite predators such as *Stethorus punctum*, *Amblyseius fallacis*, and *Zetzellia mali* may contribute to the biological control of European red mite and two-spotted spider mites in apple, only the conservation of native populations of *Typhlodromus pyri* have proven to give consistent, long-term control. Once established, *T. pyri* can almost completely regulate pest mite populations without the need for miticides, if the use of certain toxic pesticides is avoided.

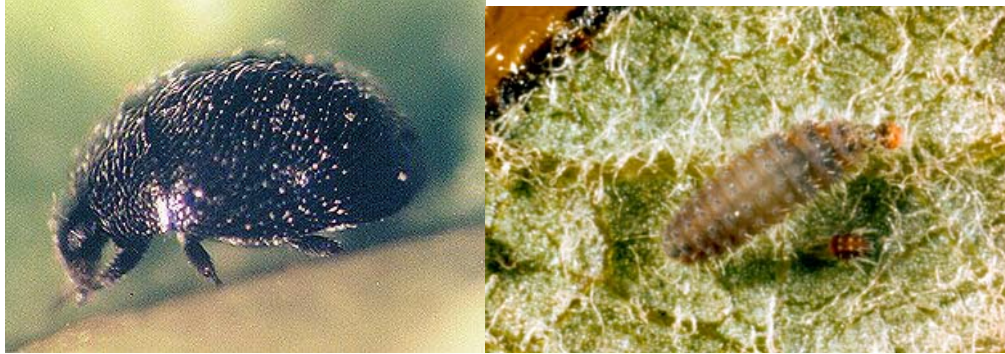
1. The first step for apple growers in establishing mite control with *T. pyri* is to determine if it exists in significant numbers in their orchards.

The most likely sites are:

- Those that have not received pyrethroid or methomyl applications for several seasons.
- Older orchards with large trees where spray coverage is not complete.
- Abandoned orchards.
- Reduced-risk pesticide orchards or those relying mostly on pheromone mating disruption to control codling moth and Oriental fruit moth.

Sample several trees in each block by examining the underside, mid-veins of 25 leaves/tree for fast-moving tear-drop shaped mites with a hand lens (10-15X). They will appear to be clear or slightly reddish, but not red or bright yellow in color or have spots. (See the PSU Fruit Research & Extension Center website or attached identification sheet). The best time to sample would be mid-season (June or July) or when pest mites are beginning to build. Samples taken early in the spring and in the fall may have relatively low populations that are hard to detect. If detected, bring 25 leaf samples from several trees to the Penn State Fruit Research & Extension

center in Biglerville where they will leaf-brushed in a special machine and slide mounted to distinguish if you have *A. fallacis* or *T. pyri* under a microscope. For the 2006-7 seasons the cost for this service is provided for growers in a Pennsylvania Department of Agriculture grant free of charge.



2. If you have *T. pyri*, do not use pyrethroids or carbamate insecticides after bloom (exception of carbaryl for fruit thinning).

T. pyri begins to emerge from overwintering sites deep in bark crevices at the beginning of bloom, so pre-bloom pesticides have little effect on them. The exception to this is Lorsban, which is toxic if applied past ½ inch green. Dormant & summer oil applications have little effect on *T. pyri*, but help suppress pest mite populations. Applications of pyrethroids and methomyl cause near complete extinction of populations, and may require 2-3 seasons to return naturally. Although toxic at insecticidal rates, the lower rates of carbaryl used for fruit thinning appear to have minimal effect on *T. pyri* populations and 1-2 applications can be made mid-season as a rescue treatment for Japanese beetle control if necessary. Mancozeb fungicides, however, are moderately toxic (depending on the rate) to *T. pyri* eggs if applied past bloom. If a ratio of at least 1 predator to every 10 pest mites is not reached, it may be necessary to suppress the pest populations with a selective miticide (eg. Envidor, Apollo or Savey). Sampling procedures & pesticide safety information for biological control in the PSU Tree Fruit Production Guide & PSU Fruit Research & Extension Center website.

3. If *T. pyri* is not present in particular orchards, they can be introduced from shoots or blossom clusters cut from PSU identified ‘donor’ sites.

Although easiest to cut from other sites on the same farm that have been identified by PSU to have *T. pyri*, in cases where none exist or have been identified, specific sites on the PSU Fruit Research & Extension Center at Biglerville are available to all Pennsylvania apple growers for cutting and transferring shoots (contact David Biddinger at djb134@psu.edu or 717-677-6116 ext. 235). In order to have the best chance of establishing *T. pyri* populations in a single season, transfers of shoots & leaf spurs are best made early season after petal fall (May- June), but before the hot weather of summer (July & August). Transfers after July appear to be less likely to establish populations. Also effective are transfers of flower clusters during bloom when *T. pyri* are concentrated in order to feed on pollen. Transfers should be made at 2 shoots or clusters to every 6th tree in high density plantings and every 3rd tree in normal plantings. Cutting with hand-pruners from a *T. pyri* donor orchard and placing the shoots or flower clusters in the tree canopy of a new orchard takes approximately 1.5 hours per person/acre (exclusive of travel time)

Checklist

Were pyrethroids used post-bloom? Check the PSU Fruit Monitoring Guide for pesticide classifications. (if yes disqualify).

Were carbamate insecticides used post-bloom besides carbaryl for fruit thinning? (methomyl mainly, if yes disqualify)

If mite control was necessary, were selective miticides (Apollo, Savey or Envidor), dormant or summer oils used? (If used non-selective miticides, disqualify).

For growers claiming to already have PSU identified populations of *T. pyri* already established, what is the location and size of the blocks? Transfers of foliage & blossoms are not necessary in these cases, just spray records indicating that they did not use the pesticides restricted in this program.

Size & location of PSU identified apple blocks where *T. pyri* was introduced from foliage or blossoms. (PSU Biglerville lab, commercial orchards, old abandoned blocks, etc.)

Did they follow PSU guidelines for transfers? Document rate.
(2 shoots or clusters every 6th tree for high density plantings, every 3rd tree for normal semi-dwarf plantings.)

How many transfers were made over the life of the contract? Estimated labor cost.

Was biological control of mites achieved? (Did they have to spray miticides?).