# Biology and Management of Balsam Twig Aphid

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MICHIGAN STATE UNIVERSITY EXTENSION

Balsam twig aphid (*Mindarus abietinus* Koch) is a common and important insect pest of true fir trees (Fig. 1). This bulletin is designed to help you recognize and manage balsam twig aphid in Christmas tree plantations. Knowing the biology of this aphid will help you to plan scouting and control activities, evaluate the extent of damage caused by aphid feeding and identify the aphid's natural enemies. Using an integrated management program will help you to control balsam twig aphid efficiently and effectively.

Photo by M. J. Higgins.

Figure 1. Balsam twig aphids on balsam fir.

## Distribution and hosts

Balsam twig aphid is a sap-feeding insect that is native to North America. It follows the distribution of balsam fir north into Canada and occurs on Fraser fir in the Appalachian Mountains and other high elevation areas of the Southeast. This species is also found in Europe and Asia. Balsam twig aphids feed on the current-year foliage of balsam fir (*Abies balsamea*) and Fraser fir (*A. fraseri*). The aphids will also feed on other true firs, including white fir (*A. concolor*) and Canaan fir (*A. balsamea* var. *phanerolepsis*), especially if they are growing near balsam or Fraser fir trees.

## Biology

Balsam twig aphid goes through three generations every year. The aphids overwinter as eggs on needles near the bases of buds. Eggs begin to hatch early in spring, typically around late March to mid-April, depending on temperatures and location within the state. Hatching is completed in one to two weeks. Recent studies in Michigan showed that egg hatch began at roughly 60 to 70 degree-days base 50 degrees F ($DD_{50}$) and continued until approximately 100 $DD_{50}$ (see degree-days discussion under "Timing insecticide sprays" on p. 5).

The newly hatched aphids are very small and difficult to see, but by mid- to late April, at approximately 100 to 140 $DD_{50}$, they have grown enough to be easily visible against a dark background. These first-generation aphids are called "stem mothers." Stem mothers feed on 1-year-old needles or through the bud scales of unopened buds (Fig. 2) but cause little damage.

Stem mothers mature in about three to four weeks, then reproduce. Because all stem mothers are female, no mating occurs. Each stem mother produces 20 to 40 live young, and each daughter is genetically identical to her mother and sisters.

Figure 2. Two stem mothers on a Fraser fir bud.

The second generation of aphids, called “sexuparae”, is the only stage that causes appreciable damage to the tree foliage. The sexuparae aphids first appear at roughly 150 to 200 $DD_{50}$, just after buds break and new needles begin to expand. These aphids will suck sap from the soft, current-year needles for three to four weeks until they mature. When the density of sexuparae aphids is high, the growing needles will become curled, distorted or stunted (Fig. 3).

The sexuparae mature into winged adults. Some may fly to other trees, while other aphids are carried on the wind into new blocks or fields of trees. Mature sexuparae give rise to the final generation of aphids, which includes both males and females. These aphids are very small and do little feeding. After mating, the tiny aphids produce the eggs that will overwinter. The life cycle is completed by late June, and the aphids will not reappear until the next spring.

## Damage

Feeding by the second generation of aphids (the sexuparae) in the swelling buds and expanding needles can affect the growth and appearance of trees. At low aphid densities, some needles on infested shoots will bend or curl slightly, but this rarely causes noticeable damage (Fig. 4). When aphid densities are high, however, current-year needles become distorted and appear to be curled or wrapped around the shoot (Fig. 5). When this level of damage occurs, needle growth may be reduced, causing the current-year shoots to appear stunted. If heavy feeding occurs in consecutive years, tree vigor and growth rates may decline. Balsam twig aphid rarely kills trees, but reduced tree growth and appearance can decrease tree value and reduce profits for growers.

Figure 3. Aphid feeding causes needles to curl tightly.

Figure 4. Light damage caused by low to moderate aphid populations.

Figure 5. Heavy damage caused by high aphid populations.

A unique aspect of the interaction between fir trees and the aphids is the ability of trees to outgrow much of the aphid damage. Feeding by the aphids is typically completed by mid- to late June. Current-year needles, however, will continue to grow during the remaining summer months. By autumn, many of the needles will have recovered their form. Studies in Michigan, Wisconsin and North Carolina consistently show that trees outgrow 40 to 50 percent of balsam twig aphid damage by autumn. This means that trees that have moderate or high levels of aphid damage in late June will look much better at harvest time. Some aphid damage can also be removed by clipping off affected shoots when trees are sheared.

The timing of bud break in spring is an important factor affecting the extent of aphid damage. The amount of aphid damage sustained by balsam or Fraser fir often varies considerably, even among the trees within a single block or

field. Trees that break bud relatively late in spring generally sustain less aphid damage than trees that flush early. This probably occurs because late bud-breaking trees provide few feeding sites for the newly hatched sexuparae aphids. In a recent study at Michigan State University, trees that began to break bud after May 7 escaped aphid injury, while trees that broke bud before May 7 were likely to be damaged. Overall growth rates of trees that break bud relatively late are similar to trees that break bud early — the late-flushing trees simply catch up once the new needles begin to grow. In the future, it may be possible to decrease long-term problems with balsam twig aphid by selectively planting fir species or varieties that break bud relatively late.

## Natural enemies

Natural enemies — predators, parasitoids and pathogens — often control populations of damaging plant pests. Insect predators are the most important natural enemy of balsam twig aphid. Recent studies indicate that several groups of insect predators feed on aphids during much of their life cycles.

*Syrphid fly* larvae are voracious predators of balsam twig aphids (Fig. 6a). These larvae live inside the expanding buds and curled needles, where the sexuparae aphids feed. Adult syrphid flies, also called hover flies and flower flies, are black and yellow, feed on nectar and resemble bees (Fig. 6b). The adult syrphid flies tend to hover around the buds and current-year shoots, searching for aphid colonies where they will lay their eggs.

*Brown lacewings* (Fig. 7) are predators of aphids as both adults and larvae. Brown lacewing adults overwinter in the litter layer, emerge early in spring and lay eggs that will hatch about a month later. The small brown lacewing larvae

Figure 6a. Syrphid fly larva.

Figure 6b. Syrphid fly adult.

Photo by A. Gruppe (http://zoologie.forst.tu-muenchen.de/)

Figure 7. Brown lacewing adult.

are difficult to see, but they actively hunt for aphids in the buds and shoots. Adults can be observed preying on aphids or laying eggs once temperatures warm up in the spring. They often “play dead” when disturbed.

*Green lacewing* larvae are small and difficult to see. They are sometimes called “aphid lions” because of their aggressive predatory behavior (Fig. 8a). Adults are frequently observed on or near infested firs (Fig. 8b). Though not all species of green lacewings feed on aphids as adults, those that are common in fir fields are usually aphid predators.

*Ladybird beetles*, also called ladybugs, are common and important predators of balsam twig aphid. Several species of ladybird beetles feed on balsam twig aphids during the spring and summer. One of the most abundant species is *Harmonia axyridis*, the familiar multicolored Asian ladybeetle that often clusters on the sides of houses in fall and winter (Fig. 9a). *Anatis mali* is a large, burgundy-colored ladybeetle that feeds on stem mothers and young sexuparae

Photo by John Davidson.

Figure 8a. Larvae of green lacewings prey primarily on aphids.

Figure 8b. Green lacewing adult.

Figure 9a. *Harmonia axyridis*, the multicolored Asian ladybeetle, is a common predator of balsam twig aphid.

aphids (Fig. 9b). Ladybeetle larvae consume even more aphids than adult ladybeetles. Ladybird beetle larvae vary in color and size, and resemble small, spiny alligators (Fig. 9c).

## Management

Scouting: Effectively managing balsam twig aphid requires early-season scouting and decision making. One of the first steps in managing balsam twig aphid is to evaluate the amount of damage from the previous year. This can be done in late autumn or in early spring. Walk diagonal transects that zigzag through your field. Check mid- and lower canopies, as well as the upper canopy, for damage. If you find little or no aphid damage, treatment is unlikely to be needed this year. When you observe damage, make notes or draw a map of affected areas so that you can prioritize them for future monitoring or control activities.

Figure 9b. *Anatis mali*, the largest native ladybird beetle, begins feeding on aphids in early spring.

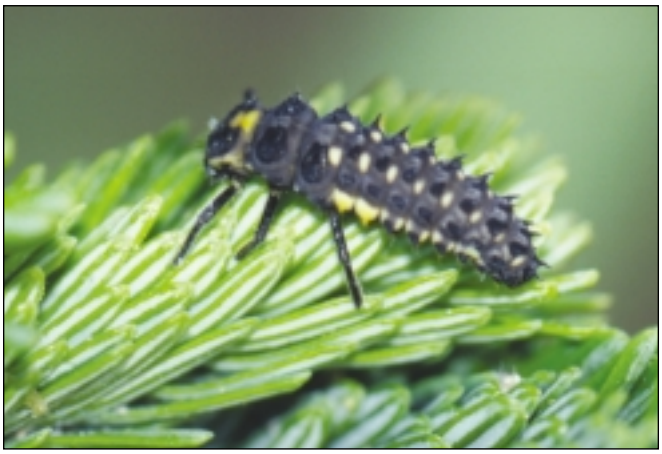

Figure 9c. Ladybird beetle larvae are important predators of balsam twig aphid.

Evaluate damage: If trees did sustain damage last summer, you must evaluate the extent of that damage and determine if it will be cost-effective to apply an insecticide this spring. Results of a recent study showed that customers at a retail choose-and-cut Christmas tree plantation in Michigan did not notice balsam twig aphid damage until at least 30 percent of the shoots had curled, distorted needles. Similarly, the grade assigned to trees destined for wholesale markets was not reduced until 30 percent or more of the shoots had aphid damage. These results indicate that low to moderate aphid populations are not likely to have a measurable effect on tree appearance or value. Applying insecticides, therefore, will be economically appropriate only when aphid populations are relatively high and damage is at intolerable levels.

### *Timing insecticide sprays*

Using degree-days: Monitoring degree-day accumulation will help you estimate when stem mothers are likely to hatch and when the sexuparae aphids will begin feeding. Degree-day accumulation is a way of keeping track of how quickly temperatures warm up in the spring. It is more accurate and reliable to base your scouting and control activities on accumulated degree-days than on the calendar.

Balsam twig aphid, like all insects, is cold-blooded and does not develop at low temperatures. Generally, insect development progresses only if temperatures are at least 50 degrees F. Therefore, degree-day accumulations are usually based on a threshold temperature of 50 degrees F ($DD_{50}$). Accumulated degree-days are calculated weekly by Michigan State University (MSU) and are available from the MSU Agricultural Weather site at www.agweather.geo.msu.edu or your county MSU Extension office.

You can estimate when balsam twig aphid stem mothers and sexuparae will appear by monitoring the accumulation of degree-days in spring. For example, when spring weather is cool, degree-days accumulate at a relatively slow rate and stem mothers may not be present until late April or early May. In contrast, if spring weather is sunny and warm, degree-days accumulate more rapidly and stem mothers may be hatching by late March or early April.

Target the stem mothers: When spraying is necessary, it is critical to apply insecticides at the proper time to prevent damage to current-year foliage. The ideal time to spray is at 100 to 140 $DD_{50}$, after the stem mothers have hatched but before the sexuparae (second generation) aphids are present. Typically at this point, buds are swelling but have not yet broken, and the stem mothers have hatched and are exposed at the ends of the shoots. It is very important to control the stem mothers before they produce the sexuparae. The sexuparae typically feed inside the expanding bud and are well protected from insecticides. Spraying after the sexuparae are present (i.e., after 150 $DD_{50}$) will not prevent damage to the current-year foliage. Late sprays will, however, harm beneficial predatory insects and possibly lead to more pest problems later.

You can effectively scout your trees and determine if the stem mothers have hatched by using a simple sampling device. Find trees that were damaged by aphids last summer — chances are good that they will be infested again. Hold an embroidery hoop covered with black cloth under shoots in the middle part of the tree canopy. Rap the shoots at least three times with a wooden dowel. If the white to greenish stem mothers are present, they will fall onto the black cloth and be readily visible (Fig. 10). Eggs usually hatch first on the southern aspect of trees, so if time permits, sample shoots on both the southern and northern aspects of the trees. This will help you determine when most of the stem mothers have hatched.

Several insecticide products are registered and should effectively control balsam twig aphid if timing and spray coverage are good. Products with the active ingredient imidacloprid (e.g., Provado® 1.6 F) and other systemic products may be more effective than contact insecticides.

## Biological control

Biological control can be an important part of an integrated management program for balsam twig aphid. There are two biological control strategies to consider in your Christmas tree plantation.

Augmentative biological control refers to releasing commercially available natural enemies to increase or augment numbers of predators or other natural enemies in a field. Green lacewing larvae can be purchased commercially and released onto trees that previously experienced heavy amounts of aphid damage or trees with high aphid densities. The lacewing larvae will actively hunt for aphids and are likely to remain on individual trees for their entire larval development period. Recent research at Michigan State University showed that individual lacewing larvae could consume at least 35 aphids per day. Releasing roughly 1 tablespoon of lacewing larvae onto each tree in mid-May

significantly decreased the amount of aphid damage that occurred. Currently, however, this form of biological control is relatively expensive and would likely be most applicable in a small choose-and-cut field or on ornamental trees.

Conservation biological control refers to practices that conserve, protect or enhance populations of natural enemies. Many of these practices can be readily implemented and will be cost-effective in any Christmas tree field. Insect predators that feed on balsam twig aphid (see above) can be a key factor in maintaining aphid populations at low, non-damaging densities. You can conserve these predators by limiting application of broad-spectrum insecticides and using selective products when they are available. For example, spruce spider mites are a common pest problem on fir Christmas trees. One product called Savey® 50 DF (active ingredient hexythyiazox) will provide effective control of spruce spider mites but will not harm populations of predatory insects, mites or other beneficials. In addition, many insect predators require nectar or pollen at some point in their life cycle. Flowering plants along the edges and borders of Christmas tree fields will benefit these predators and help to attract or retain them in your field.

Figure 10. Use an embroidery hoop with black cloth and a dowel to sample aphids.

## Host plant resistance — a long-term management tool?

Genetic factors appear to play a role in the timing of bud break, which affects the extent of aphid damage that fir trees sustain. Many varieties of balsam fir, for example, break bud before Fraser fir trees, even when they are growing side by side. Even within a species, some trees are genetically programmed to break bud relatively late in spring. Identifying the individual trees, varieties or species of fir that break bud late may help reduce aphid damage in the short term as well as the long term. For example, it may be beneficial to harvest trees with early bud break as soon as they reach saleable size. Trees with late bud break are less likely to be affected by aphid feeding and could be retained until they reach a larger size. In the long term, identification and selective propagation of trees that have consistently late bud break may help to reduce balsam twig aphid populations in Christmas tree plantations throughout the state.

## Acknowledgements

We especially appreciate the cooperation and assistance provided by Dr. Mel Koelling, MSU Dept. of Forestry. We also thank Jill O'Donnell, MSU Extension district Christmas tree agent, and the many Michigan Christmas tree growers who provided us with trees and access to their fields. Funding for our project was provided by an MSU Project GREEEN grant. The MSU Christmas Tree Area of Expertise Team provided additional funds to help offset printing costs.



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