The Winter Moth

***Operophtera brumata* (L.)**

2010 Preview: This fall 2009, we are seeing increased numbers of winter moth adult moths in most areas of Massachusetts, where winter moth has been a problem in previous years. (Coastal Massachusetts, inland to the Worcester area, Cape Cod, Martha's Vineyard, and Rhode Island.) **It is predicted, that this increase in the numbers of moths suggests that winter moth caterpillars may be quite prevalent once again in those areas during the spring of 2010 and may cause much defoliation damage to untreated trees and other plants.**

Reminder: Next spring (early – mid-April), monitor expanding tree buds and developing leaves for winter moth caterpillars on susceptible trees and manage early, if needed. Those trees that may succumb to heavy defoliation by winter moth caterpillars will be severely stressed. Trees must put out a second flush of growth in order to survive. **Water is critical for trees at that time.** Supplemental watering of trees stressed through defoliation will be necessary throughout the 2010 growing season, if a drought or little rainfall occurs naturally. Fertilizer application is not recommended for trees that have been defoliated.

Massachusetts Winter Moth History: For the past 11 years, many Massachusetts communities have reported millions of moths emerging around Thanksgiving and continuing throughout December. Coincidently, in the spring, these same communities witnessed an astonishing number of small, green caterpillars defoliating maples, oaks and other deciduous trees. The major caterpillar pest thought to be responsible for this foliar destruction was initially thought to be the fall cankerworm. However, in 2003, by collaborative work done by Deborah Swanson, Plymouth County Extension, Robert Childs, UMass Extension, Dr. Joseph Elkinton, UMass, and Dr. David Wagner (UConn) it was discovered that the damage was done by a newly introduced insect called the winter moth (*Operophtera brumata*), a member of the Geometridae family.

Initially, the hardest hit areas were in Eastern Massachusetts, especially southeastern MA, including Cape Cod. The winter moth's known range in Massachusetts and beyond is now much better understood due to the extensive pheromone trapping that has been orchestrated by Dr. Joseph Elkinton at the University of Massachusetts, Amherst. Winter moth is at its heaviest numbers east of Route 495, on the North and South Shores, including Martha's Vineyard and most of Cape Cod, as well as in towns in and around Boston. However, it is also found as far west as Worcester. Winter moth is now established throughout Rhode Island and has been picked up in traps, in southeastern NH, coastal Maine, southeastern CT and out on Long Island, New York. Massachusetts still appears to have the largest and most damaging populations of this pest.

Origin of Winter Moth: Winter moth was initially introduced to North America from Europe in Nova Scotia sometime prior to 1950. It exists throughout Europe but for the most part, it is not a problem there because it has a rich community of predators and parasites that keep it in check. It became a serious pest in parts of eastern Canada (Nova Scotia and Prince Edward Island) in the 1950's and was introduced separately to western Canada around 1970, where it became a problem. It has been a pest in the western region, namely Vancouver, British Columbia.Winter Moth was also found in the Western states of Oregon and Washington where it warranted control measures primarily in commercial blueberries.

Injury and Host Plants: Many different deciduous plants are susceptible. These include: oaks, maples, cherries, basswood, ash, white elm, crabapples, apple, blueberry, and certain spruces such as Sitka spruce (Scotland), and heathers (England). Young larvae (caterpillars) wriggle into buds of apple, blueberry, cherry, crabapple, maples, oaks etc., in the early spring just before or at bud break. Once inside the buds, the tiny caterpillars begin feeding. Delayed bud opening due to cool weather can lead to bud death. Larvae move from bud to bud as they feed. As the larvae grow, they feed in expanding leaf clusters and are capable of creating defoliation in high populations. Research in Canada has shown that four consecutive years of partial defoliation of deciduous hosts can lead to branch mortality while complete defoliation in each of those years leads to tree mortality. In certain regions of Nova Scotia, this pest is responsible for 40% red oak mortality in forested stands. Currently, in Plymouth County and other Southeastern MA areas, many deciduous trees (primarily oak) are displaying signs of serious decline given the multiple consecutive years of defoliation by winter moth in combination with Forest tent caterpillar and gypsy moth in 2004, 2005, and 2006. Within the past three years, many trees have died in SE Massachusetts from the stress of this defoliation coupled with drought and other factors. Several years of defoliation often weakens trees to the point where secondary agents (sometimes known as 'weak invaders') can overcome what is left of a tree's natural defenses (due to repeated defoliation) and kill the tree. Such secondary invaders include: wood borers, bark beetles, *Armillaria* (Shoestring root rots) and others.

Life Cycle: Moths (the adult stage of winter moth) emerge from the soil usually mid-late November and may be active into January whenever the air temperatures are mild (usually above freezing). The male moths are light brown to tan in color and all four wings are fringed with small elongate scales that give the hind margins a hairy or fringed appearance. The male moths are strongly attracted to lights and can often be found flying around outside lamps or holiday lights. The female is gray, almost wingless (brachypterous) and, therefore, cannot fly. She emits a sex pheromone that often attracts clouds of male moths. Females are usually found at the base of trees or scurrying up tree trunks, but can be found almost anywhere. After mating, the female deposits loose eggs on bark, in bark crevices, under bark scales, on lichen, or elsewhere. The adult moths then die and the eggs over-winter. Eggs are green at first, but turn red-orange soon thereafter. In March, just prior to hatching, the eggs turn a bright blue and then a very dark blue-black before hatching. Eggs hatch when temperatures average around 55^{o}F. It is believed that egg hatch in Massachusetts occurs when 20–50 Growing Degree Days (base 50) have accumulated, which can be anywhere from late March into early-mid April, depending on the year. This means that egg hatch occurs just at, or right before, bud break of most of the host plants. Some of the newly hatched larvae crawl up tree trunks and produce a silken strand of silk, which makes them air buoyant. This larval dispersal method is known as "ballooning". In certain situations, given topography and wind patterns, winter moth caterpillars can arrive in areas where they have not been expected to be a problem. After hatching, the larvae wriggle between bud scales of newly swelling buds of such hosts as: maples, oaks, ash, apples, crabapples, blueberry, cherries, etc. and begin feeding.

Caterpillars feed on both flower and foliar buds. Once a bud has been devoured from within, the caterpillar will migrate to other buds and repeat the process. Destruction of the flower buds leads to greatly diminished harvest on fruit crops such as apple and blueberry. After leaf buds open, the small caterpillars can be found within the tight clusters of new leaves during the day. During cool springs, if weather hinders leaf expansion, the winter moth caterpillar can cause high levels of injury to these leaves. Winter moth caterpillars often leave these clusters to become free feeders at night. They may also drop or balloon and begin feeding on plants, like roses and herbaceous perennials that are located beneath or near infested trees. Older larvae feed in

expanding leaf clusters and are capable of defoliating trees and other plants, when abundant. At maturity, the caterpillars will be approximately one inch long, whereupon they drop to the soil for pupation. Pupation occurs from late May into early June.

Winter moth caterpillars are pale green caterpillars with a faint white longitudinal stripe running down both sides of the body. They are "loopers" or "inchworms" and have just two pairs of prolegs. Winter moth caterpillars are often found in association with both the fall and spring cankerworms, as well as Bruce spanworm (*Operophtera bruceata*), which are very similar in appearance and have similar feeding patterns to that of the winter moth caterpillar. Bruce spanworm is native to the Northeast and is rarely a problem. However, the males of this species are attracted to the pheromone used in winter moth traps and thus create a challenge for researchers to discern the difference between the males captured in these traps given their remarkably similar appearance.

Management: Some products are available that act as a barrier to climbing caterpillars or for the climbing adult female moths in late fall to early winter. This method is known as **"**tree banding**".** The products for tree banding are generally heavy weight paper or plastic strips that are covered with a sticky substance that snare climbing caterpillars (or female moths). **However, research <u>does not</u> yet support their effectiveness for reducing winter moth caterpillar populations when in high numbers and they are not recommended for that purpose.** During peak population years, individual bands may fill up with adult moths within an hour. In some cases, it has been witnessed that female moths, upon approaching the barriers, lay their eggs on the tree trunks just below or above the barriers. If utilizing such practices is desired, NEVER place a sticky substance directly onto the bark of the host plant; it may be toxic to the plant. It is also recommended that cotton or polyester fiberfill be wedged under the band in bark furrow areas to prevent the small female moths from going under the band and continuing their climb up the tree.

In the states of Washington and Oregon, as well as Canada, various **natural controls** have been introduced to combat this pest, with varying levels of success. These include parasites such as flies and wasps. Certain native beetles, like carabids (ground beetles) and staphylinids ("oil" beetles) may act as predators of this pest, especially in the pupa stage, in the leaf litter or soil.

Two years of research in Massachusetts by Brenda Whited, a graduate student in Elkinton's lab has shown that the native naturally occurring predators here do cause mortality to winter moth pupae but not enough to prevent outbreaks or defoliation from occurring.

A **dormant oil spray** to the trunks and branches of trees may be helpful to kill the over-wintering eggs before they hatch. However, some eggs are under bark flaps and loose lichen and may be protected from oil sprays. Eggs may also be in other locations on or off the host plant. Caterpillars may also invade host plants by ballooning onto them after treatment has been applied. Oil applications are mostly recommended for blueberry and apple growers and not so much for landscape situations where protecting the flower buds is not as essential as it is for commercial fruit growers. Some growers add a chemical companion, such as Spinosad or Carbaryl, to the oil spray to reach newly hatched caterpillars whose eggs were not covered by the oil. Always check to be certain that any two pesticides are compatible in the spray tank together by reading the label or consulting with the manufacturers of the pesticides.

***Bacillus thuringiensis* Kurstaki** (B.t. (kurstaki), which is a bacterium and specific to caterpillars of butterflies and moths, works very well on the younger larvae of both winter moth and cankerworms **while they are feeding** on the foliage. B.t. is **not effective when the caterpillars are feeding in the buds.** Bear in mind, if foliage is treated with B.t while it is expanding from the bud, then the newly emerging foliage will not have B.t. on it**. B.t. has to be**

ingested by the caterpillar to be effective. Also, it is known that B.t. works best on younger caterpillars and it is generally known when it is too late to apply this product for many caterpillars, like Gypsy moth or Forest tent caterpillars. **However, no work has been done to discern when it is too late to apply B.t. for winter moth. Therefore, it is best to apply B.t for winter moth soon after the foliage has opened completely and the caterpillars are still relatively young.**

Spinosad, which is available to licensed pesticide applicators as well as homeowners, is another biorational compound that works well against winter moth and most other caterpillars. Two of the homeowner products are labeled as "Bulls Eye Bio-Insecticide" and "Monterey Garden Insect Spray". One of the commercial labels (for licensed applicators) is Conserve SC (Dow AgroSciences). Spinosad is fairly gentle to other organisms, such as the parasites and predators that we want to encourage. However, the label does state that Spinosad is "highly toxic to honey bees at the time of application" and, therefore, great care should be taken to protect honeybees during application. An example would be to **NOT** spray for winter moth when crabapples, or other flowering trees, are in bloom and bees are foraging. Once an application of Spinosad has dried, the threat to bees drops significantly.

Tebufenozide (e.g. Confirm^{tm} is an insect growth regulator (IGR) that works well on most lepidopteran caterpillars. It is **only** available to licensed pesticide applicators; no homeowner version is yet available.

Insecticidal soap may be effective against the younger caterpillars but only when they are exposed on the host plant. Use of this product for winter moth, especially on larger plants, most likely will not yield the desired results.

Chemical insecticides. Many compounds, such as Carbaryl (e.g. Sevin) and Malathion are labeled for winter moths when they are exposed. Many of the Pyrethroids are also labeled for caterpillars on deciduous plants. In general, these chemical products tend to be much harsher on the beneficial organisms and should be used thoughtfully. **These products are also toxic to bees. Always consult your local supplier and always read, understand and follow all label directions for pesticide products.**

Cyzenis albicans is a Tachinid fly that parasitizes winter moth; in fact, winter moth is the only insect that it attacks. This important parasitoid was introduced into Nova Scotia through the 1950's for winter moth and is now the controlling factor for this serious pest. It was also released in the western United States for winter moth there and showed great success. *Cyzenis* has now been brought to Massachusetts and a small initial release was performed in May of 2005 in Plymouth County. Following the 2005 release, *Cyzenis albicans* was released in increasing numbers each year in the following Massachusetts towns: Wenham, MA (2006); Falmouth, MA (2007),Wellesley, Seekonk and Barnstable in 2008 and again in Wellesley in 2009. Several years of releases will be necessary before any measurable effects are seen. The number of release sites is limited each year and at least 1000 flies are released at each site to maximize the chance of successful establishment. Production of flies for release has been augmented by the development of mass rearing techniques in the laboratory for both the fly and its winter moth host. We have also increased our Cyzenis collection efforts in British Columbia, Several thousand of these parasitic flies now await release in 2010 in Massachusetts. This work is being performed by Dr. Joseph Elkinton's lab group at UMass, Amherst. It is made possible thanks to funding from the USDA Forest Service, USDA, APHIS, the Mass. Dept of Conservation and Recreation and the Massachusetts State Legislature.

Current Update: Researchers from the University of Massachusetts, the MA Department of Conservation and Recreation and Plymouth County Extension are now in their sixth year of studying this pest in the Northeast, establishing its range, and actively working to implement a successful means of biological control (i.e. *Cyzenis albicans*). Trunk banding to measure the population sizes of adult winter moth in the highest density areas has now been performed for five years. The findings have been sobering. It is roughly estimated that there were between 1000 – 2000 female moths per tree in those research areas and each female produces about 150 eggs, on average, which translates into a minimum of 150,000 eggs per tree. Now, due to the pheromone trapping and DNA analysis of the captured males, it is apparent that winter moth is now well beyond the initial area of outbreak (Plymouth County, MA). The identification of winter moth and its' distinction from Bruce Spanworm has been confirmed with DNA tests conducted at UMass, Amherst.

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