Pest Alert

United States
Department of Agriculture
Forest Service
Northeastern Area
State and Private Forestry
NA–PR–01–12
November 2012

Winter Moth

Winter moth, *Operophtera brumata* L. (Lepidoptera: Geometridae), is a non-native invasive defoliator from Europe that was discovered in Massachusetts in the late 1990s. Winter moth has now been found throughout the eastern half of Massachusetts and into Rhode Island, Connecticut, Long Island (NY), southeastern New Hampshire, and southeastern Maine. It is expected to continue to spread to suitable habitats.

Winter moth has been responsible for widespread and prolonged defoliation in eastern Massachusetts. Winter moth is of particular concern because it feeds on many species and is a pest of deciduous forests, fruit orchards, and ornamental trees and shrubs in its native and exotic ranges. High densities of winter moth can completely defoliate hardwood stands and cause trees to refoliate in the late spring and/or early summer, which may further reduce tree nutrient stores.

Winter moth defoliation has reduced radial growth of oak trees in Massachusetts and has been reported as the causal agent of tree mortality in some stands. Given the early-spring feeding of winter moth and the existence of a well-developed native and exotic defoliator complex, hardwood forests of New England may be subject to multiple defoliators in a single season. Defoliation by winter moth may initiate tree decline that involves secondary pests and decay fungi.

Hosts

Winter moth has a wide host range. In North America, high levels of defoliation have been noted on oak (*Quercus*), maple (*Acer*), birch (*Betula*), apple (*Malus*), and blueberry (*Vaccinium*) species. Winter moth also feeds on ash (*Fraxinus*), basswood (*Tilia*), hazelnut (*Corylus*), beech (*Fagus*), elm (*Ulmus*), and many other genera. In Europe and British Columbia, winter moth also feeds on spruce (*Picea*). Feeding damage largely depends on synchrony between winter moth egg hatch and host tree bud break.

Description

Winter moth is similar in appearance and life history to native insects including fall cankerworm (*Alsophila pometaria*) and Bruce spanworm (*Operophtera bruceata*). Distinguishing winter moth from the native Bruce spanworm is difficult where the two species overlap and typically requires DNA analysis.

Winter moth produces small (0.42 - 0.70 mm), light green, ovoid eggs that change to orange and then dark blue prior to hatching. Winter moth larvae are lime green "inchworm" ("looper") caterpillars with two pairs of ventral prolegs and faint white to creamy-yellow stripes running lengthwise along each side of the body (figure 1). The brown pupa is about 7.0 to 7.6 mm long and features two short spines at the rear (figure 2).

Figure 1.—Winter moth larva.

Figure 2.—Winter moth pupa.

The adult male moth is tan to brown with a wingspan up to 30.0 mm and is capable of flight. The male forewings are fringed and feature bands of black hatch marks (figure 3). The female moth is grayish black and flightless. The vestigial forewings of the female moth are 2.0 to 3.2 mm long and cover the first two to three abdominal segments (figure 4). Winter moth females have longer vestigial forewings than Bruce spanworm females, making this the easiest life stage to distinguish between the two species.

Figure 3.—Adult male winter moth.

Figure 4.—Adult female winter moth.

Life History

In its native European range, winter moth populations are cyclical, with 2- to 3-year outbreaks occurring approximately every 8 to 10 years. In Massachusetts, high densities of winter moth have been consistently observed

for more than a decade. Winter moth feeds at the same time as fall cankerworm and Bruce spanworm, and can hybridize with the latter. In eastern Massachusetts, winter moth has now become the dominant early-spring defoliator.

Winter moth completes one generation per year and overwinters in the egg stage. Eggs typically hatch in April and larvae begin feeding within the expanding buds and later on the foliage for approximately 6 weeks. Winter moth feeding can completely strip trees of foliage (figure 5, left), leaving only the veins. Lighter levels of defoliation can produce tattered leaves with a sieve-like appearance (figure 5, right). Much of the damage occurs inside the bud before the leaves expand. Winter moth early instar larvae disperse in the wind from tree crowns via silken threads in a process known as "ballooning."

Figure 5.—Winter moth feeding damage: heavy (left), lighter (right).

Beginning in mid- to late-May, larvae stop feeding and drop from tree crowns to the soil to pupate. The pupae form inside cocoons made of silk mixed with soil in the litter beneath trees where larvae fed. Adults emerge from the soil in late fall to early winter, with males dispersing in search of mates. After mating, the flightless females crawl up tree boles and lay eggs singly or in clusters of two to three in bark crevices, on or under lichen, and around the buds of tree branches. A female winter moth produces an average of approximately 150 eggs. Adults are active in the evening, and the male moth can often be seen fluttering around lights, even on cold nights. Because winter moth has a limited potential to disperse naturally, it is likely introduced into new areas through its inadvertent movement in plant material (firewood, ornamental plants, and nursery stock containing soil).

Management and Biological Control

An integrated pest management approach will be needed to manage winter moth where it occurs. It is important to maintain "vigorous" trees and stands through appropriate silvicultural techniques that reduce stress and damage to residual trees. Insecticidal control may be helpful in reducing winter moth populations under certain circumstances, but timing applications with tree phenology is important. Insecticides are only effective during the larval stages and it is critical that application follows host tree bud burst, as early instar larvae are protected when feeding within tree buds.

Currently, biological control may be the most practical tool to manage winter moth populations in forest stands or at larger scales. Previous winter moth invasions in Nova Scotia and British Columbia have been successfully controlled by introducing *Cyzenis albicans*, a parasitoid fly that feeds exclusively on winter moth. Efforts to establish *C. albicans* to manage the burgeoning winter moth population in Massachusetts began in 2005. To date, small populations of this biological control agent have become established at six release sites, and the percent parasitism of winter moth is increasing at some of these sites. Given the high density of winter moth populations throughout eastern Massachusetts, continued release of *C. albicans* is needed to manage this pest.

Photographs:

Figure 1: Milan Zubrik, Forest Research Institute - Slovakia, Bugwood.org

Figure 2: Hannes Lemme, Bugwood.org

Figure 3: Molly Heuss, USDA Forest Service

Figure 4: Molly Heuss, USDA Forest Service

Figure 5 (left): Thomas Lee, University of New Hampshire

Figure 5 (right): Michael Simmons, USDA Forest Service

Pesticide Precautionary Statement

Pesticides used improperly can be injurious to humans, animals, and plants. Follow the directions and heed all precautions on the labels. NOTE: Some States have restrictions on the use of certain pesticides. Check your State and local regulations. Also, because registrations of pesticides are under constant review by the Federal Environmental Protection Agency, consult your county agricultural agent or State extension specialist to be sure the intended use is still registered.

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Published by:
USDA Forest Service
Northeastern Area
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Winter moth in Rhode Island 2014

Winter moth eggs starting hatching in Kingston on April 17 and were 100% hatched by April 24. We monitored eggs by setting up tree wraps last November. Tree wraps halt the wing-less female moths as they climbed up trees in November and December; they then lay a large number of eggs just below the tree wraps. Tree wraps were removed in March and eggs on the trunk circled with a Sharpie so they could easily be found again and watched. Winter moth eggs start out orange, but then turn blue a few days before hatching. Very handy for monitoring egg hatch!

For landscape trees it's not important to control winter moth just when hatching, but for apple and blueberry growers it's very important. Once eggs hatch, winter moth caterpillars wriggle into swollen buds and begin feeding. For apple trees and blueberry bushes, swollen buds are primarily flower buds and once caterpillars are inside buds they are protected from insecticide sprays until just before bloom. By this time many flowers may have been damaged or destroyed, destroying the crop. Landscape trees, on the other hand, can withstand early winter moth feeding damage. To save trees from being defoliated, insecticides can be applied after trees leaf-out, but before excessive feeding damage has occurred.

Winter moth caterpillars continue to feed and grow until around the end of May. Once mature they drop to the ground, dig down a few inches, and pupate. Pupae will remain in the soil until November or December when winter moths emerge as adults. It's male moths that more and more Rhode Islanders are seeing at their porch lights and headlights, especially on warm evenings between Thanksgiving and Christmas. Females are rarely seen because they don't fly.

In collaboration with Joe Elkinton from UMass, we have released a parasitic fly that attacks only winter moth caterpillars. The fly, *Cyzenis albicans*, has successfully controlled winter moth outbreaks in Nova Scotia in the 1950's and the Pacific Northwest in the 1970's. *Cyzenis albicans* lay eggs on leaves of winter moth host plants. When eating leaves, winter moth caterpillars accidentally eat fly eggs too. A fly egg hatches and larva develops inside a caterpillar body. When a parasitized caterpillar drops to pupate, it digs into the soil but instead of a winter moth caterpillar pupating, the fly pupates instead. The fly pupa remains in the soil until the following spring when it emerges as an adult fly at the same time winter moth eggs hatch.

Parasitic flies were released in Goddard State Park in 2011. In 2013, *Cyzenis albicans* were released in Bristol and Jamestown. In 2014, flies were released in Kingston and again in Jamestown (because the 2013 release was deemed insufficient). At the end of May, before many caterpillars drop to the soil, we will collect caterpillars from previous release sites. This year we hope to recover flies for the first time at Goddard Park. It usually takes several years to recover flies and then several more years before seeing a decline in the winter moth population due to parasitism.

Heather Faubert

Figure 1 Tree Banded in Nov.

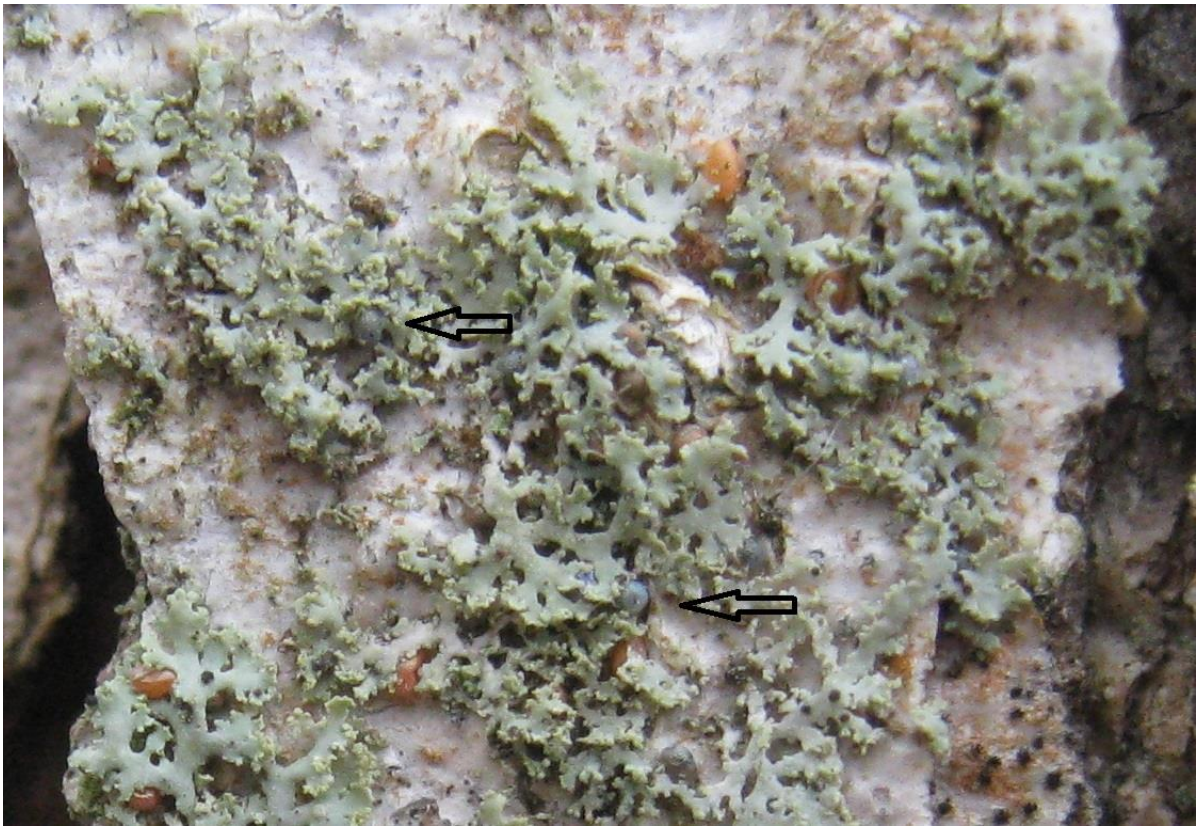

Figure 2 Winter moth eggs showing blue

Figure 3 C albicans

Figure 4 Winter moth eggs circled

Figure 5Release Kingstown