

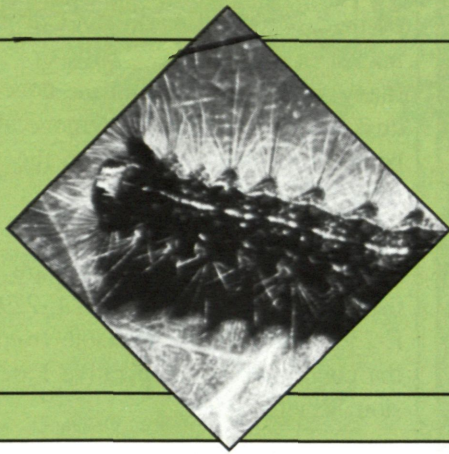
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Gypsy Moth in Michigan Homeowner's Guide
Michigan State University
Cooperative Extension Service
Department of Entomology, MSU, and the Michigan Department of Agriculture
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Gypsy Moth in Michigan HOMEOWNER'S GUIDE

Reprinted April 1992 (First Printing April 1991) ♦ EXTENSION BULLETIN E-2302

Homeowner Techniques for Helping Reduce Damage by the Gypsy Moth

Homeowners' success in helping their trees and shrubs survive attack by the gypsy moth caterpillar increases as their knowledge of the pest grows.

Gypsy moth outbreaks can last two to four years or longer. Why gypsy moth populations skyrocket from time to time is not clear. Outbreaks eventually collapse, usually from natural causes—wildlife that eat the gypsy moth (such as birds or mice), parasites (organisms that live in or on the insect) and diseases.

Until the time of the gypsy moth collapse, however, there are several techniques that homeowners can employ to help control caterpillar damage.

Mechanical Techniques

Sanitation

Keep the yard as clean as possible. Remove discarded items, dead branches (from the ground and out of the trees), stumps, etc., where the gypsy moth female adult is likely to lay eggs. It is very important that homeowners are watchful when obtaining firewood from areas infested by gypsy moths—egg masses could be attached to the wood.

Destroy Egg Masses

One way that homeowners can help reduce the gypsy moth population on their property is to hunt for and destroy egg masses each year.

The female gypsy moth generally lays eggs from mid- to late-July. The female cannot fly, so she will lay the eggs close to the area where she changed from a caterpillar into a moth (pupated).

When the female caterpillar is about to pupate, she will look for a protected area such as a rock crevice, bark flap, leaf litter, woodpile, branch, etc. Once she finds a suitable site, she will attach herself to the surface and weave a thin silken net around her body, transform into a pupa and remain in this state for about two weeks.

Upon emergence, the female gypsy moth is creamy white and has a wingspan of about 2 inches. The brown male's wingspan is somewhat smaller. Both have distinctive black, chevron wing markings.

The adult female will live for about a week. Her sole purpose is to lay eggs. She cannot fly, so she emits a chemical called a pheromone to attract a mate. Mating takes about an hour, after which the female will spend about 24 hours laying a mass of fertilized eggs.

The number of eggs in each mass depends on local environmental conditions and the vigor of the female. It ranges from 50 to 1,000, with an average of about 400 in Michigan.

The egg masses are light reddish brown and from 1/2 to 3/4 inch long, and they are covered by a thick layer of hair from the female's abdomen.

Egg clusters are deposited on tree trunks, stone walls, picnic tables, children's swing sets, eavestroughs, cars, woodpiles, recreational vehicles—on almost anything around the yard. The following year, in May, the larvae begin to hatch, about the time tree buds burst.

Homeowners can search out these egg masses, scrape them from the



Although gypsy moths can cause a great deal of damage to trees, homeowners have ways to combat these pests.

surface to which they are attached and destroy them, either by burning them or burying them about 6 inches deep in heavy soil. Do not leave the scraped egg masses on the ground—many of them will survive the winter.

Egg mass destruction can help protect high value yard trees, but less than 25 percent of the egg clusters on a large tree are within arm's reach. If gypsy moth populations are high, the tree may still be defoliated

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Gypsy Moth Life Cycle



1. Small Larvae—May

1) Small Larvae. This stage lasts for 7–10 days after eggs hatch in early May (or sooner in warmer weather). Larvae are less than 1/2 inch long and usually black. They linger around the egg cluster for several days if the weather is cool or rainy, then climb trees or other objects, trailing silken threads as they move. When the larvae reach the top of the tree, they do not feed but drop on silken threads and are dispersed by the wind.

2) Large Larvae. Feeding at night for 4 to 6 weeks, large larvae generally rest during the day unless populations are very large, then they wander constantly. They grow until they are about 2 inches long.

3) Pupa. During this stationary stage the larvae are changing into moths.



2. Large Larvae—June



4. Adult—Late July–August

This generally occurs from the end of July until early August. After about 10 days in the dark colored pupal cases, the adult moths emerge, leaving the pupal cases behind.

4) Adult. The female moth is creamy white and does not fly but emits a chemical called a pheromone to attract a male moth. The male is brownish and flies in a zigzag pattern looking for the female. A single male can mate with many females. Both sexes have chevron markings



3. Pupa—July



5. Egg Masses—Fall/Winter

(V or notch-shaped marking) on each forewing.

5) Egg masses. The buff colored egg masses contain between 50 and 1,000 eggs. The female deposits the eggs on any convenient surface. The masses are usually covered with hairs from the female's abdomen. The egg masses are quite cold resistant and can survive temperatures as low as -20 degrees F. Egg masses hatch during May.

Homeowner

Continued from page 1

high, the tree may still be defoliated by the larvae (caterpillars) hatching overhead. Even with 100 percent egg mass removal, trees can be defoliated by larvae carried in by wind currents.

Newly hatched caterpillars crawl upwards toward the top of a tree. When they reach the tip of a branch, they may begin feeding or spin downward on silken threads. At this stage of their lives, the caterpillars are black and about 1/4 inch long and are easily blown about on the wind, suspended by the hairs on their bodies and the newly-spun silk. They may be dispersed upwards of a mile, though usually the "flight" is a few hundred yards, depending on local conditions. If the larvae do not land on a tree or shrub, suitable for feeding, they climb upward and disperse again.

Other Mechanical Means

In addition to destroying egg masses, homeowners can use a number of other methods to reduce defoliation of their yard trees.

Watch for the small caterpillars early in the spring and simply spray them out of the trees with a garden hose and nozzle. At this stage of their lives, the small caterpillars are very sensitive to sudden changes in temperature and mechanical disturbances and hosing them out of the trees and shrubs will kill them. Adding insecticidal soap to the water increases the effectiveness of this tactic.

Hose attachments for this can usually be purchased from your local hardware or nursery. Be sure to follow label directions on the insecticidal soap container.

Sticky, slippery or fabric bands (sometimes called barrier and hiding bands) can be placed around tree trunks to help curtail, though not necessarily prevent, the caterpillars movement into the tree canopy.

Sticky bands can be purchased or made using a non-porous material that can be wrapped around a tree trunk, then coated with a commercially made sticky material such as Tanglefoot, which traps the caterpillars as they make their daily migration up and down the tree. Don't use



Gypsy moth caterpillars use cloth bands to hide during daylight hours. Scrape the caterpillars into a bucket of soapy water.

substances such as grease, tar or creosote—these can damage the tree bark, particularly on young maples, oaks and fruit trees.

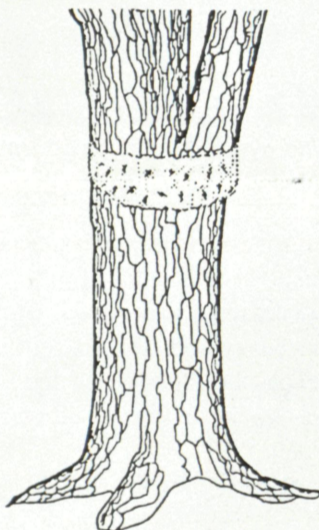
Sticky bands become less effective after a rain and by weathering over time, so the sticky material will have to be reapplied periodically. Bands covered with caterpillars need to be cleaned or replaced.

Slippery bands, which are relatively new on the market, are also intended to prevent the caterpillar from climbing up into the canopy of the tree. The caterpillars cannot cross the bands because they cannot get a grip

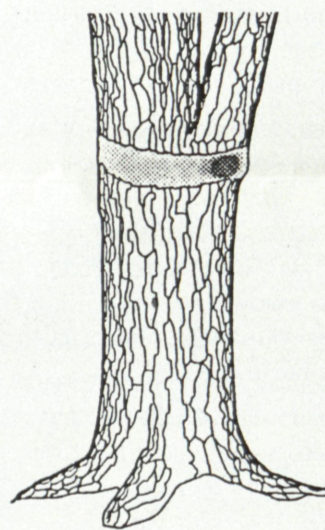
on the slippery surface. Slippery bands may not be completely effective on trees with coarse bark because caterpillars will crawl in the bark crevices under the bands.

Cloth, or hiding bands, can be homemade from medium weight dark cloth about 12 to 18 inches wide and long enough to wrap completely around the tree. Fasten each band at about chest level around a tree with twine, cord or wire about midway from the bottom of the cloth. Then fold the top part of the cloth down over the bottom half.

Some of the caterpillars descending the tree after daybreak in search of a



Sticky bands trap the caterpillars.



Slippery bands keep caterpillars from climbing trees.

Pesticide Safety

This publication contains pesticide recommendations based on research and pesticide regulations. However, changes in pesticide regulations occur constantly. Some pesticides mentioned may no longer be available, and some may no longer be legal. If you have questions about the legality and/or registration status for using pesticides, contact your county Cooperative Extension Service office.

To protect yourself and others and the environment, always read the label before applying any pesticide.

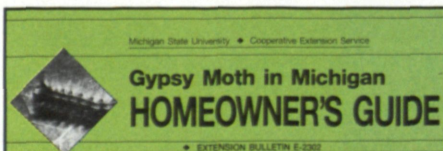
For more information about pesticide safety, see Extension Bulletin E-2215, "Using Pesticides Safely: A Guide for the Applicator."

In Memoriam Gary Simmons, Ph.D.

Professor
MSU Department of Entomology

Aug. 7, 1944–Jan. 24, 1991

*His dedication and excellent talent
were focused upon improving
Michigan's forestlands.*



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For more information about the gypsy moth or other insect pests, contact the Cooperative Extension Service county office nearest you.

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shady daytime resting spot will hide under the flap of the band. These caterpillars must be removed and destroyed (burned or dropped into a bucket of soapy water) daily, or many will climb back up the tree at dusk to feed. Be sure to remove all bands from trees each fall so the trees will not be harmed.

The details of these mechanical means of gypsy moth control are listed in Extension Bulletins E-2299, E-2300 and E-2301, available from the county MSU Cooperative Extension Service office.

Pesticide Techniques

Biological Insecticides

Several biological sprays on the market contain *Bacillus thuringiensis* (B.t.) as an active ingredient. These products (sold under such trade names as Dipel, Thuricide and Bactur) can be applied from the ground or by aerial spraying.

These sprays are quite safe because they kill only caterpillars and do not affect honeybees or natural enemies of the gypsy moth. However, they do kill other moth and butterfly larvae.

To be most effective in preventing defoliation, B.t. must be applied when caterpillars are less than 1 inch long. B.t. has a residual activity of 5 to 10 days, so timing and coverage are important. Two applications are often needed.

Biosafe nematodes (*Steinernema cappocapsae*) sold as Biosis are also effective against gypsy moth as a foliar spray (in the evening or early morning) or by spraying cloth bands affixed to trees. Biosafe nematodes are available in some garden centers.

Chemical Insecticides

A number of chemical insecticides are available through the local hardware or nursery. They include acephate (Orthene), carbaryl (Sevin), malathion (Cythion) and methoxychlor (Marlate).

These sprays need to be used with caution because they will also kill honeybees and a variety of other beneficial insects, including gypsy moth insect parasites and predators.

If you choose to use these chemicals, read and follow label instructions exactly, and remember that adults, children and pets will likely frequent the sprayed area.

Other Precautions to Take

Don't use home remedies to control the gypsy moth. These may be more hazardous to you and the environment than you might suppose.

Don't be misled by people who promise to protect your property from gypsy moth damage with "insurance spray" or other activities.

Be wary of someone who offers to buy trees that have been attacked by the gypsy moth. Consult your county Extension agent, before allowing anyone to cut your trees.

If you think your woodlot needs spraying, ask a professional forester, DNR representative or county agent for advice.

Gypsy Moth Caterpillars Prefer to Chew on Certain Trees

Generally, the gypsy moth caterpillar prefers oak, poplar, birch and willow leaves as its primary sources of food.

These four types of trees are susceptible to defoliation whether growing in a wooded lot or planted in the back yard. To reduce the potential for defoliation, homeowners can plant trees that are not so susceptible to gypsy moth caterpillar damage. The best way to identify those trees is by the genus and species names that appear on the nametags at a nursery or in a catalog, says David Smitley, MSU Cooperative Extension Service entomology specialist, and Curtis Peterson, Extension horticulture specialist.

The following list is divided into categories—I, II, III—that indicate the resistance or susceptibility to gypsy moth caterpillar damage.

Category I—tree species are generally, with some exception, prone to defoliation by the gypsy moth caterpillar.

Category II—species are generally resistant to gypsy moth caterpillar feeding but may experience some damage. Defoliation, however, is unlikely.

Category III—species are generally avoided by the gypsy moth caterpillar.

Homeowners who already have trees in or select trees from Categories II or III should generally have few problems with gypsy moth caterpillar defoliation. Refer to MSU Extension bulletin E-1936, "Selecting Ornamental Plants for Michigan Landscapes," and this table when purchasing trees and shrubs for the yard.

Homeowners who have trees in Category I should maintain the vigor and health of the trees. Obtain MSU Extension bulletin E-1947, "Planting & Care of Ornamental Landscape Plants." Both bulletins are available from the county Cooperative Extension Service office.



Gypsy moth caterpillars prefer to eat leaves of certain tree species, including poplar.

Category I

Oaks (<i>Quercus</i>)	very susceptible
Poplar (<i>Populus</i>)	
<i>P. tremuloides</i>	very susceptible
<i>P. grandidentata</i>	very susceptible
Birch (<i>Betula</i>)	
<i>B. pendula</i> (European white birch)	susceptible
<i>B. populifolia</i>	susceptible
<i>B. papyrifera</i> (paper birch)	susceptible
Willow (<i>Salix</i>)	
<i>S. babylonica</i> (weeping yellow willow)	susceptible
<i>S. spp.</i> (wild types)	variable
Crabapple (<i>Malus</i>)	all susceptible
Maple (<i>Acer</i>)	
<i>A. platanoides</i> 'Royal red' (a red leaf Norway maple)	susceptible
<i>A. platanoides</i> 'Crimson sentry' (a red leaf Norway maple)	susceptible
Plums (<i>Prunus</i>)	
<i>P. cerasifera</i> 'Thundercloud' (Purple leaf plum)	variable susceptible

Category II

Spirea (<i>Spiraea</i>)	resistant
Maple (<i>Acer</i>)	
<i>A. rubrum</i> ('October glory') (0–30% defoliation)	somewhat resistant
<i>A. saccharum</i> (sugar maple)	resistant
<i>A. saccharinum</i> (silver maple)	resistant
<i>A. platanoides</i> 'Deborah' (green leaf Norway maple)	resistant
<i>A. platanoides</i> 'Emerald queen' (green leaf Norway maple)	resistant
Serviceberry (<i>Amelanchier</i>)	resistant
Hickory (<i>Carya</i>)	resistant
Alder (<i>Alnus</i>)	resistant
Basswood (<i>Tilia</i>)	resistant
Ironwood (<i>Ostrya</i>)	resistant
Beech (<i>Fagus</i>)	resistant
Elm (<i>Ulmus</i>)	resistant
White pine (<i>Pinus strobus</i>)	somewhat resistant
Blue spruce (<i>Picea pungens</i>)	somewhat resistant
Sweetgum (<i>Liquidambar</i>)	resistant
Poplar (<i>Populus</i>) <i>P. deltoides</i>	resistant
Birch (<i>Betula</i>)	resistant
<i>B. nigra</i> (river birch)	
<i>B. lutea</i> (yellow birch)	

Category III

Ash (<i>Fraxinus</i>)	usually avoided
Pear (<i>Pyrus</i>)	usually avoided
Honey locust (<i>Gleditsia</i>)	usually avoided
London plane tree (<i>Platanus x acerifolia</i>)	usually avoided
Juniper (<i>Juniperus</i>)	usually avoided
Tulip tree (<i>Liriodendron</i>)	usually avoided
Spruce (<i>Picea</i>)	usually avoided
Yew (<i>Taxus</i>)	usually avoided
Hemlock (<i>Tsuga</i>)	usually avoided
Fir (<i>Abies</i>)	usually avoided
Black Locust (<i>Robinia</i>)	usually avoided
Sycamore (<i>Platanus</i>)	usually avoided
Magnolia (<i>Magnolia</i>)	usually avoided
Lilac (<i>Syringa</i>)	usually avoided
Euonymus (<i>Euonymus</i>)	usually avoided
Dogwood (<i>Cornus</i>)	usually avoided
Catalpa (<i>Catalpa</i>)	usually avoided
Azalea (<i>Azalea</i>)	usually avoided
Arborvitae (<i>Thuja</i>)	usually avoided
Maidenhair tree (<i>Ginkgo</i>)	usually avoided
Black gum (<i>Nyssa</i>)	usually avoided

Tree Care is Important!

The gypsy moth leaves in its wake a lot of weakened trees that may die because they have been stripped of their leaves (defoliated).

Defoliation removes leaf surface area, and this loss in turn reduces the tree's capacity to produce food for itself through photosynthesis. To offset the loss in production, trees must use stored nutrients.

Many hardwood trees will produce a new flush of leaves in the same year if they are more than 50 to 75 percent defoliated. The second set of leaves will be smaller and fewer in number, leaving the tree with less capacity to produce the food it needs to survive.

One way to help landscape plants withstand the gypsy moth is to make sure that shrubs and trees have adequate water and nutrients. Watering and fertilizing helps them better

tolerate or recover from gypsy moth defoliation.

The makeup of the soil—its texture, depth and structure—influences the quantities of nutrients and water that are available to trees and shrubs. Homeowners can take samples of the soil under their trees and have the soil sample tested at MSU to determine the level of nutrients available to the plants. The county MSU Cooperative Extension Service has bulletins about soil sampling and using the test results and other helpful information about maintaining healthy shrubs and trees.

Homeowners should fertilize and water landscape plants when soil nutrients and rainfall are not adequate to meet their needs. Trees should be fertilized only according to soil test results. Slow-release formula fertilizers should be used.

Gypsy Moth Glossary of Terms

Bt. *Bacillus thuringiensis*. A bacterium that occurs naturally in the soil and is known to be fatal to gypsy moths. A commercial preparation of B.t. is used as an aerial spray to reduce gypsy moth caterpillar populations. B.t. kills only caterpillars—it is not toxic to humans, fish, wild animals or plants.

Collapse. The drop of a gypsy moth caterpillar population to extremely low levels in a particular area. Lack of food in combination with disease and predators can sometimes cause a collapse of the local gypsy moth population.

Defoliate. Remove leaves from plants, in this case, trees and shrubs. Mature gypsy moth caterpillars will eat several leaves each day.

Egg mass. A cluster of eggs laid by the female gypsy moth. The number of eggs ranges from 50 to about 1,000. The average in Michigan is 400 eggs per cluster. Each cluster will be from 1/2 to 3/4 inch long. The clusters are usually buff colored.

Eradicate. To eliminate an organism from a geographical area. To date, it has been impossible to eradicate the gypsy moth in Michigan.

Frass. Caterpillar droppings.

Instars. Stages of caterpillar growth. Each of the five to six instars roughly corresponds to caterpillar length. For instance, at the 4th through 6th instars, the caterpillars are between 2 and 2 1/2 inches long.

IPM. Integrated pest management (IPM) is the utilization of a variety of ways, including natural controls, to limit insect populations to a tolerable level. It involves taking tree-directed actions, insect-directed actions and no action at various times and places, based on sound ecological, economic and sociological knowledge and on routine monitoring



NPV (wilt disease) is a naturally occurring virus that kills only gypsy moth caterpillars.

of insect populations using pheromone traps, egg mass surveys and defoliation surveys. The aim of IPM is to maintain populations of insects at tolerable levels in ways that are ecologically responsible, cost effective and acceptable to the populace.

Larval stage. The immature form or caterpillar of the gypsy moth. Newly hatched larvae are about 1/4 inch long and usually black. Given dry conditions and temperatures above 40 degrees F, newly hatched caterpillars will crawl upward toward light and foliage.

Molt. As the gypsy moth caterpillar grows, it sheds the outer covering periodically by molting at the end of each instar. Gypsy moth caterpillars generally molt five times before they reach their ultimate length.

Monitoring. Keeping track of the spread of the gypsy moth and the size of the caterpillar population. Gypsy moth traps are used to track the spread of the moth around the state. Surveys of egg masses and defoliation rates are also used.

NPV. Nucleopolyhedrovirus (NPV) occurs naturally in all gypsy moth populations but doesn't become apparent as a cause of mortality until gypsy moth caterpillar populations are high. NPV multiplies in the host caterpillars, eventually killing them. The infection, commonly called "wilt disease," can kill many of the caterpillars in a large gypsy moth population. It is non-toxic to other insects and animals.

Outbreak. This occurs when the population of the gypsy moth caterpillars ranges between 620,000 to 6,200,000 4th instar larvae per acre and causing widespread, severe defoliation. Although outbreaks usually collapse after 2 years, some outbreaks may last considerably longer.

Parasites. Organisms that feed within gypsy moth eggs or invade the gypsy moth caterpillar, feeding inside and killing it.

Pheromone. A scent that the flightless female gypsy moth emits to attract the male gypsy moth so they

can mate. Male gypsy moths are capable of flying long distances.

Predators. Insects and other organisms that eat gypsy moth caterpillars. Among the insects that eat them are adult ground beetles, stinkbugs, spiders, harvestmen and ants. Among the wildlife are mice, robins, crows, starlings, nuthatches and bluejays. The effect of these predators on a gypsy moth population is usually limited when gypsy moth caterpillar populations are high but is greater at low populations.

Pupa. The stage in gypsy moth development when the larva (caterpillar) changes to the adult moth.

Release mode. The rapid increase of a gypsy moth population. This is a transitory state that usually precedes an outbreak.

Refoliate. To produce a new set of leaves after the first set is lost to insects or disease. The new leaves are usually fewer in number and smaller than the original set produced in the spring.

Stress. The effect on plants caused by poor growing conditions or damage by insects, weather or disease. A tree defoliated by gypsy moth caterpillars must draw upon reserves to survive. If reserves are low and cannot be easily restored, the stress of defoliation may kill it.

Suppression spray. A gypsy moth insecticide used in connection with IPM practices to help reduce (suppress) a local population to tolerable levels. These sprays are usually biological and are environmentally safe.

Trap (pheromone). A cardboard structure similar to a small birdhouse in which pheromone is placed. The pheromone attracts the male gypsy moth which is trapped inside. Traps are used to monitor gypsy moth distribution.

Gypsy Moth Predictions Based on Trap Catch Info

Entomologists predict with confidence that the gypsy moth will be defoliating trees in every county in the Lower Peninsula by or before 1997.

One of the tools they use to make this prediction is somewhat more precise than your standard crystal ball. Its full, formal name is the Geographic Information System. Its component parts are a statewide network of insect traps and state-of-the-art technology in computer science, cartography (map making) and entomology.

Playing the role of Merlin in the gypsy moth predictions is Stuart Gage, a Michigan State University entomologist.

"My role has been to try to track the gypsy moth over time and space throughout Michigan," he sums up. "The problem has been to do that within reasonable costs and logistics. That's a big task."

When Gage became involved in assessing the spread of the gypsy moth through the state and predicting population densities, the first need was for statewide information on just where the insect was present and in what numbers.

"Up to then, most sampling schemes had followed the gypsy moth around from one outbreak site to another," Gage relates. "This provided information of a sort, but nothing that we could analyze to yield predictions for the next year. What we needed was a uniform, statewide monitoring system."

So he designed one and cooperated with the Michigan Department of Agriculture to put the system in place. It consists of 3,000 pheromone traps (which capture adult male gypsy moths using a bait that imitates the sex attractant that females use to attract mates) distributed uniformly across the entire state.

"Ordinarily, you'd put up traps for an insect only where the habitat is most suitable," he says. "But the gypsy moth can occur in almost any habitat—individual trees, woodlots, etc. So we put traps everywhere, not just in the oak and aspen forests that they prefer. We put two traps in every township in Michigan, and we use the same locations every year, so we get information that we can compare from year to year to see how the insect's numbers are changing."

Staff members from the MDA and other governmental agencies (the Michigan Department of Natural Resources and U.S. Forest Service) put traps up in July, just before the adult moths begin to appear, and take them down around the end of August. Information on the number of moths in each trap enables Gage to calculate their distribution and abundance. These calculations are then extrapolated downward to give

an estimate of gypsy moth male density per square kilometer.

"We have lots of other information at the 1 kilometer grid cell level," Gage explains, "such as forest type distribution, political boundaries, the DNR's maps of defoliation and so on. Using the Geographic Information System, we can combine these to give us maps that show susceptible forests with a high risk of defoliation. We can compare trap catch information from one year to defoliation the next year to see how much we can rely on trap catches to predict defoliation. We've found that they relate fairly closely, so now we have a way of predicting gypsy moth risk that doesn't require counting egg masses in all forests in every square kilometer—an impossible task because of the cost. We can do this only in selected areas."

Gypsy Moth Population Has Built-in Controls

The good news about the gypsy moth in Michigan is that the currently booming population carries within it the seeds of its destruction.

The bad news is that it's still expanding and hasn't yet reached the point of collapse.

"The gypsy moth is new enough to Michigan that it still has tremendous potential to increase its numbers over large geographic areas," says Gary Simmons, Michigan State University forest entomologist. "Michigan has about 10 million acres of Lower Peninsula forests and 3 million acres in the Upper Peninsula where the climate and the tree types provide suitable habitat for the gypsy moth."

In the Eastern U.S., where the gypsy moth became a major pest around the turn of the century, it has fallen

into a natural up and down cycle that lasts for 10 to 15 years. In this cycle, many years of low population are followed by a few years of very high populations. Then the boom turns to bust as natural enemies, disease and starvation wipe out most of the caterpillars, leaving only a few to complete their development into moths and start the cycle anew.

"This pattern of boom and bust is inherent in the gypsy moth population," Simmons says. "We can't prevent populations from increasing and spreading over large areas, and we can't bring about the collapse of those populations. If we tried to take action over a large geographic area, we would only help maintain high populations because anything we did, no matter how many larvae we killed, would still leave hundreds of thousands to mature and reproduce.

But we might succeed in keeping populations below the very high levels where naturally occurring disease organisms begin to take effect."

We can selectively protect valuable trees in limited areas, however, and take action to reduce caterpillar numbers around dwellings and in outdoor recreation areas without interfering with the natural gypsy moth cycle, Simmons says. That's basically the aim of the voluntary gypsy moth suppression program run in Michigan by the Michigan Department of Agriculture: to make it easier to live with the gypsy moth without disrupting the biological control mechanisms that are part of its natural cycle.

Spraying takes place in mid- to late May, when caterpillars are small and most susceptible, and before they

have a chance to do much damage. The material used is a bacterial disease of caterpillars called *Bacillus thuringiensis*, or B.t. for short. Caterpillars that ingest it stop eating almost immediately and die in a few days. B.t. is the safest material available, Simmons explains. It causes disease only in moth and butterfly larvae and is harmless to mammals, birds, predators and parasites of the gypsy moth, other insects, aquatic organisms and humans.

"The gypsy moth has now spread into most of the areas in Michigan where it can survive," Simmons observes. "In the next decade or two, it will reach very high population levels in most of the areas where suitable food trees occur. Then the population boom will go bust, and the gypsy moth will fade from sight—for a while."

Gypsy Moth May Change the Face of Michigan Forests

When gypsy moth numbers are low to moderate, the caterpillars feed almost exclusively on various oak and aspen species. Defoliation is usually localized and scattered. Because the same trees aren't stripped year after year, the feeding of the caterpillars causes little lasting damage to woodlands or individual trees.

When populations are high, food may become scarce and the larger larvae will migrate to less preferred species of trees.

When the pest population is expanding, as it is in Michigan, and the natural controls on its population haven't yet kicked in, the same areas may be defoliated year after year.

"Generally speaking, a deciduous tree that's reasonably healthy can tolerate being defoliated once or maybe even twice," says Gary Simmons, Michigan State University forest entomologist. "After the caterpillars quit feeding in June, the tree taps its

carbohydrate reserves to produce a second crop of leaves in the same growing season. For a tree that's already under stress from drought or lack of soil nutrients or attack by other insects or diseases, the stress of defoliation and refoliation may be the last straw. But healthy trees can usually tolerate one year of heavy defoliation."

A repeat of defoliation and refoliation, however, puts a double whammy on trees. Loss of leaves reduces their ability to manufacture food by photosynthesis and build up carbohydrate reserves, and refoliation draws down the reserves they have. This combination of effects may weaken the tree so much that it can't withstand attack by other insects or diseases. It may die a year or two later or over a period of several years. Other healthy trees may survive even the most intense gypsy moth assault and repeated defoliation.

Given their druthers, gypsy moth larvae would feed almost entirely on

oaks and aspen. Other preferred food trees are birch, willow, apple, basswood, boxelder, hawthorn, alder and witch-hazel.

After exhausting the available food from preferred sources, larger larvae will move to maple, elm, cottonwood, cherry, hemlock, pine, spruce, hickory, beech and serviceberry. They generally avoid feeding on ash, tulip poplar, American holly, cedar, catalpa, sycamore, locust, walnut, butternut, juniper, honeysuckle, rhododendron or dogwood.

Because evergreens can not refoliate, they can not survive even a single defoliation. But because Michigan has many tree species that the caterpillars avoid, their voracious appetite does not mean the end of Michigan forests.

"Over time—a hundred years, perhaps—we will expect to see some long-term changes in the composition of Michigan's forest as a result of devastation by the gypsy moth," Simmons predicts. "We'll probably

see a shift from oak and aspen to more maple, especially red maple, as the forest itself becomes more resistant to the moth. A similar thing happened when chestnut blight virtually wiped out the American chestnut early in this century. It was the dominant species in Eastern forests. Now it's gone. But the forests are still there."

Because trees in much of Michigan have fairly good access to groundwater, Simmons doesn't expect to see trees dying to the extent that the Eastern forests experienced. There, he says, tree deaths seem often to be the result of gypsy moth injury interacting with topography and the availability of water.

"So far in areas in Michigan where we have seen the gypsy moth operating, the trees that have died seem to be the ones that weren't healthy to begin with," he sums up. "Of course, we haven't had 20 or 40 years of this to see what will happen in the long run."

Naturally Occurring Fungus May Prove to be an Effective Gypsy Moth Control

A fungus imported from Japan about 80 years ago may prove to be an effective tool to control the ravages of the gypsy moth in Michigan.

Researchers and Extension specialists at MSU are experimenting with *Entomophaga maimaiga*, a fungus that was brought to the United States by two researchers around 1909. New England scientists Arthur Speare and R. H. Colley believed that their effort to cultivate the fungus which is lethal to the gypsy moth caterpillar, was a failure.

They were wrong.

Speare and Colley released *E. maimaiga* around gypsy moth infested trees in urban Boston during 1910 and 1911. Its effect on the gypsy moth did not show up—or at least was not recognized—until researchers in New England noticed during 1989 and 1990 that huge numbers of gypsy moth caterpillars were dying unexpectedly. Microscopic examination showed that the long-lost fungus was at work.

Heartened by the potential for this naturally occurring enemy of the gypsy moth, research entomologists in the Eastern U.S. and at MSU are attempting to infect gypsy moth caterpillars with *E. maimaiga* in the laboratory. They will then release the infected larvae in woodlands where gypsy moth outbreaks are most severe.

Spearheading the research at MSU is David Smitley, Extension entomologist and researcher, and Leah Bauer, U.S. Forest Service insect pathologist. The MSU Agricultural Experiment Station and the Michigan Department of Agriculture are supporting the project. The North Eastern Area State and Private Forestry provided additional funding in a contribution through the Michigan DNR. If Smitley and Bauer succeed in infecting larvae with *E. maimaiga* in the laboratory, the fungus will be released during May at selected test sites in Roscommon and Wexford counties.

The research will continue for the next two years. If *E. maimaiga* becomes established at the test sites, then samples from those sites will be collected and distributed to other sites around the state, Smitley says.

The researchers are hoping that the fungus becomes widespread in Michigan during the next decade and causes massive gypsy moth caterpillar die-offs. In areas where the fungus is active, costly spray programs may not be necessary.

All this sounds good on paper, but getting *E. maimaiga* established over a wide area will be a complicated task. Some of the scientists who discovered the fungus at work in New England noted that abnormally rainy years provided optimum conditions for fungi to spread.

Therefore, Smitley says, the spread of *E. maimaiga* in Michigan will require many years. Even if it does become established, it will still be only one of the many methods needed to control the gypsy moth.

Commonly Asked Questions about Gypsy Moth

Will county-administered suppression spray programs eradicate this pest?

No. Community suppression spray programs are designed to help homeowners cope with the gypsy moth until natural controls (predators, disease, etc.) cause the population to fall to levels that people can tolerate without spraying.

Once the county begins to spray, will my property have to be treated every year on a permanent basis?

Not likely. Only small blocks of land are sprayed as part of any suppression program. Highly infested, unsprayed blocks bordering these areas are allowed to follow the course of nature. After three or four years of large outbreaks, natural controls such as disease-causing viruses and predators cause populations to “crash” or fall dramatically in these unsprayed areas. When this occurs, properties sprayed in previous years will not require spraying because the population crash will generally extend into these areas as well.

Will the trees in my yard or woodlot die once the leaves are completely chewed off by the gypsy moth?

Most trees survive, but survival depends on the vigor of the tree before defoliation and the species of tree being attacked. Healthy, vigorous trees in your yard or woodlot are generally able to withstand two or three years of heavy feeding by the gypsy moth. Yard trees that are weakened by old age, drought, competition from other trees, or insect and disease problems, however, are at risk and may die after even one defoliation.

In addition, coniferous trees such as pine or spruce can not produce new leaves (needles) after defoliation as do deciduous trees. Consequently, one year’s complete defoliation by the gypsy moth can kill these trees.

What will happen if my neighbors and I choose not to have our properties sprayed as part of a gypsy moth suppression spray program?

Left on their own, gypsy moth populations usually continue to increase in an area until trees are completely stripped of foliage and natural causes, such as predators and virus diseases, reduce the population.

However, during these multi-year outbreaks, the frass (droppings) from the insects falls from trees in large quantities; masses of migrating larvae in search of new food or places to pupate climb on houses and other objects and become such a nuisance that most people (or communities) whose properties qualify for a suppression spray program choose to participate to avoid the many uncomfortable aspects of large gypsy moth outbreaks.

There are tents or webs in the cherry and crabapple trees in my yard. Is that gypsy moth?

No. The gypsy moth does not spin webs or tents as it feeds. Silken tents in the crotches of trees are made by the eastern tent caterpillar, which is often mistaken for gypsy moth. This insect feeds primarily on fruit trees such as cherries and apples and the ornamental varieties of these species. Because this insect’s hosts are more limited, the eastern tent caterpillar is not considered as threatening as the gypsy moth. Outbreaks of eastern tent caterpillars occur periodically and, after a few years, “crash” or decline once predators and other natural diseases build up in the population.

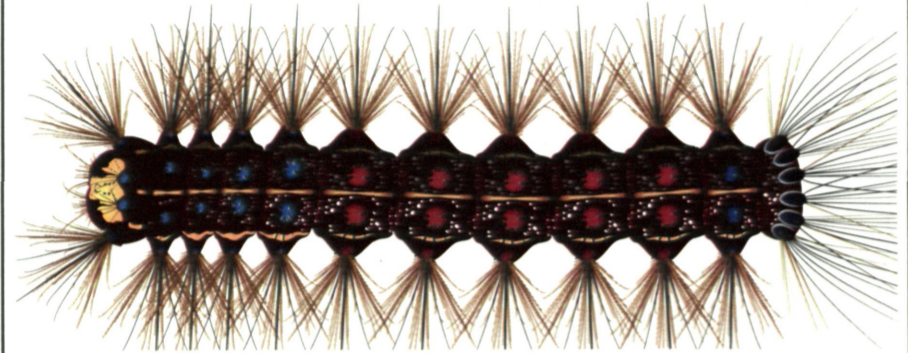
Is there anything that I can do around my home to control gypsy moth without using pesticides?

Homeowners can use several non-pesticide methods that are effective, to some degree, in coping with the gypsy moth. For example, physical barriers can be placed around tree trunks. These include sticky bands that trap gypsy moth larvae or folded fabric bands that attract larvae which can then be easily destroyed. Scraping egg masses off trees and manmade objects before they hatch is another way to help. Some measure of control can also be accomplished by spraying newly hatched larvae with a weak solution of dishwashing soap mixed with water (1–2 fl. oz. per 1 gal. of water).

In addition, spray materials such as insecticidal soaps (similar to the dishwashing detergent mentioned) or *Bacillus thuringiensis*, a bacterial dis-

A Comparison of the Gypsy Moth, Eastern Tent, and Forest Tent Caterpillars

The identity of three common caterpillars that may be present early each year could be confusing. The following illustrations will help identify which of these caterpillars is feeding on your trees.



Gypsy Moth Caterpillar



Eastern Tent Caterpillar



Forest Tent Caterpillar

P. Carrington

ease of caterpillars (tradenames: B.t., Dipel, Biotrol, and others) is also very effective in controlling gypsy moth when larva are about 1 inch long. B.t. is non-toxic to animals and people. It is only lethal to the larvae of insects in the moth and butterfly

family. This material has a low impact on the environment.

How much does a caterpillar eat?

During the caterpillar stage, the gypsy moth eats about one square meter of foliage.

Education is One Key to Coping with Gypsy Moth

When gypsy moth caterpillars are very abundant, their fecal pellets (frass) rain down from the trees, as trees are stripped of their leaves. Caterpillars looking for food may wander through yards and across roads, blanketing surfaces with their hairy bodies.

It’s no wonder that people exposed to high populations of gypsy moth larvae experience emotions ranging from anger and feelings of helplessness to hysteria.

“Homeowners aren’t helpless—there are things they can do to help protect their trees,” says Cora Gorsuch, gypsy moth education coordinator for the Cooperative Extension Service. She brings to that job a background in forest entomology and secondary education. She is quick to agree that people have a right to be concerned about the gypsy moth and equally quick to offer suggestions for dealing with caterpillars that give people some

feeling of control over what’s happening in their backyards.

Much of the Extension educational program for homeowners and business people has been intended to foster peace of mind through education. It has dealt with the biology of the gypsy moth—particularly its boom and bust population cycle—what people can do on their own, and what they can expect from the Michigan Department of Agriculture’s gypsy moth suppression program.

“A problem with the program when it was established in 1985 was that people expected spraying to eliminate the gypsy moth in Michigan,” Gorsuch explains. “Even though homeowners were seeing a significant reduction in the numbers of caterpillars, a lot of people were not satisfied because some caterpillars were remaining. That’s where education comes in—we need to help people understand what to expect from the spray program and other control measures used against the gypsy moth.”

At the other end of the spectrum from the “wipe-em-out!” folks are the people who don’t want the MDA or anyone else to spray their property. Assuring them that any property owner could decline treatment was also part of the gypsy moth educational program.

Extension education has been crucial in helping people understand the aims and methods of the spray program,” says MDA’s Ron Priest. “Until Extension became involved, people had a very irrational lack of understanding of what we were trying to do.”

Gorsuch has put the word out to homeowners through displays, meetings, media interviews and fact sheets. An instructional video for distribution through county Extension offices and video stores in infested areas has been completed. She has also helped counties form the gypsy moth task forces that are the first step in getting involved in the MDA’s spray program.

Humans Have Allies Against Gypsy Moth

In the battle against the gypsy moth, we are not alone. A number of significant parasites, predators and diseases take their toll on the hairy caterpillars.

Among parasites, the foremost is a tiny wasp (*Ooencyrtus kuvanae*) that lays its eggs in gypsy moth eggs. Attracted, apparently, by chemical scents given off by a mass of eggs or an egg-laying female, it is often present even as the female moth is laying the eggs. It is active well into fall and also in the spring, before gypsy moth eggs hatch. When the wasp eggs hatch, the larvae feed on the developing caterpillars and then pupate inside the hollowed-out shells. A few days later, they emerge as adult wasps and start looking for mates and for gypsy moth eggs to lay their eggs in.

An assessment by Cora Gorsuch, MSU graduate entomology student and gypsy moth education agent headquartered in Isabella County, showed that 35 percent of the eggs in any given egg mass may be parasitized.

So why are there still so many healthy, hungry gypsy moth caterpillars?

Gary Simmons, Extension forest entomologist at Michigan State University, explains that gypsy moths simply lay too many eggs for the wasps to get them all.

"The number of eggs laid by a single female moth can range from about 50 to more than 1,000," he said. "In a healthy, rising population—like the one in Michigan—the average is about 400 per female. If you have a million caterpillars per acre and the wasp and other natural controls kill off 90 percent of them, the ones that are left can build the population back in one generation."

This is not to say that the work done by the wasps has no value.

"If you think we have gypsy moth problems now, just think what it would be like if *Ooencyrtus* hadn't been here," Simmons quips.

The wasp was brought into Michigan some years ago by the Michigan



White-footed mice are a predator of gypsy moth caterpillars.

Department of Agriculture, Simmons notes, in anticipation of a gypsy moth outbreak. It has taken hold and done very well.

"The best part is, it's on our side and it works for free," Simmons points out.

Our other allies include a host of predators. At the top of the list is the white-footed or deer mouse. In studies in New York state, researchers found that these attractive brown and white mice were responsible for about one-third of the mortality of large larvae and pupae. Somehow, the mice were more attracted to female than male pupae, so their selective munching had an even greater effect on the gypsy moth population than merely random dining. Scientists concluded that predation by deer mice was a major factor in keeping gypsy moth populations at low levels in certain areas.

"This begins to explain why gypsy moth is often a greater problem in wooded residential areas or the edges of woods near homes than deeper in the woods," Simmons says. "Homeowners don't tolerate the mice—they keep cats and set traps to eliminate them. In doing so, they may eliminate one significant check on the gypsy moth population."

Other gypsy moth predators include shrews, ground beetles, ants, stinkbugs and other predaceous insects, birds and mammals.

Though the gypsy moth has many natural enemies, parasites and predators just can't keep up with a gypsy moth population explosion, Simmons explains. Their numbers build more slowly.

In a declining population, however, parasites and predators can accelerate the decline. Their numbers are still high, so they can take a proportionately bigger bite out of the remaining caterpillar population. A population on the decline produces fewer and smaller egg masses, he notes, and the rate of parasitism is usually higher.

The major factor in sending a population into decline is not a predator or a parasite but a pathogen—a disease organism. It's a virus that kills larvae, and it's probably the most significant factor in causing a gypsy moth population to crash.

"The problem with it, from the human point of view, is that populations have to get much higher than people are comfortable with before the virus kicks in," Simmons observes. "It's hard to sit back and let nature take its course when caterpillars are so thick in the trees around your house that you can't go outside without an umbrella to ward off their droppings. But the more caterpillars we kill off, the longer it takes the population to build to the point where the virus can cut in."

The virus is always present in the gypsy moth population, Simmons

says. The females pass it along to the next generation when they lay their eggs. The hatching larvae ingest it as they chew their way out. It's also likely that *Ooencyrtus* spreads virus particles from egg to egg and egg mass to egg mass.

Outbreaks of disease from the virus occur twice: when larvae are very young and later, in nearly grown caterpillars.

"If we kill off too many of the young gypsy moth larvae, the first virus 'bloom' doesn't happen and so the second doesn't," Simmons explains. "By reducing the numbers of larvae somewhat, we make conditions better for the surviving caterpillars—more space, more food, less crowding and so on. So they're healthier and less stressed than caterpillars that are running out of food and must travel greater distances, as is true when populations are at very high levels. There's speculation that the concentration of large numbers of caterpillars enhances the transmission of the virus, and the stress of high population levels makes them more susceptible to it."

Gypsy moth populations can go along for years at low levels, with parasites and predators keeping numbers down to the point that the virus disease plays little or no part in population control. Then something happens—some combination of weather and food availability and easing of natural controls, for whatever reason—and the population explodes.

Then, for several years, high population density is the rule. Eventually, caterpillars are so abundant that the virus becomes a factor, and the population crashes.

This cycle of boom and bust, already established in the eastern United States, is what the gypsy moth is building toward in Michigan, Simmons says. For much of the state, the worst is yet to come—before it can get better, the gypsy moth problem must get worse.

But at least we're not up against the caterpillars alone.

Be Careful about Quick Fixes for Your Gypsy Moth Problem

Struggling with the effects of the gypsy moth can be frustrating enough without unscrupulous people trying to take advantage of the homeowner by offering quick fixes.

There are no quick fixes, declares Russell Kidd, MSU Cooperative Extension Service district forestry agent in Roscommon County.

He advises homeowners to be wary of products or services that promise or imply they can end gypsy moth problems in the backyard or woodlot.

Be careful of salespeople who want to spray your trees with chemicals that are "guaranteed" to control the gypsy moth. In some cases, these

may be worthless or even dangerous.

Homeowners should ask what chemical is to be used, its hazard, what its effect will be and what precautions will be taken to minimize spray drift to nearby objects.

Homeowners should also ask to see proof that the company and the individual are certified and licensed to apply such a material. Michigan law requires that commercial pesticide spraying companies be certified and licensed by the Michigan Department of Agriculture.

Remember that chemical sprays are effective only during the caterpillar stage of the gypsy moth. Spraying trees before the eggs hatch or after

the caterpillars have pupated or emerged as adult moths is worthless. (See the gypsy moth life cycle chart on page 1.)

Be wary of unrealistic claims about products or techniques to rid your property of the gypsy moth by themselves.

Some products, such as sticky bands, are indeed useful, but they will not control the gypsy moth completely, especially when used alone. Only a combination of control treatments, used diligently by the homeowner, will achieve satisfactory control of the gypsy moth.

Other products may not do what their names imply. Take, for instance, the gypsy moth trap. The purpose of the trap is to attract and capture the adult male gypsy moth. Traps are used to monitor gypsy moth populations. They will not control or elimi-

nate next year's gypsy moth problem in your yard because one adult male moth can mate with many female moths and one or two traps will not capture enough males to interfere with mating or cause the population to decline significantly next year.

Be very careful about timber buyers who offer to buy standing trees that have been defoliated. Unscrupulous timber buyers may use gypsy moth infestations in an area as a scare tactic to persuade people to sell valuable timber at low prices before the trees die.

Timber owners should always consult with professional foresters before they decide to sell any standing timber.

Your county MSU Cooperative Extension Service office can provide the names of professional foresters in your area.