Diflubenzuron: Diflubenzuron (Dimilin®) is an insecticide. When ingested by any instar stage of gypsy moth caterpillars, diflubenzuron disrupts the formation of a new cuticle (outer skin) during molting, resulting in death.

Tebufenozide: Tebufenozide (Mimic®), like diflubenzuron, is an insect growth regulator. Tebufenozide mimics the action of a natural insect hormone, which induces premature molts of the gypsy moth caterpillar, resulting in death. Evaluation of tebufenozide indicates that larvae of Lepidoptera are sensitive, but other insects are much less affected.

Small Area Control

Removing and Destroying the Egg Masses: One of the earliest (1930s) gypsy moth treatments was destroying egg masses. Civilian Conservation Corps workers in New England destroyed egg masses during the fall, winter, and early spring. The technique is labor and time intensive, and therefore impractical for large areas. In a forested area, many more egg masses are present than actually seen and destroyed. The technique may be helpful in urban or suburban areas.

Tree Trunk Bands: Removal and destruction of gypsy moth caterpillars may be useful in localized urban and suburban situations. The habit of caterpillars moving down from the crown and resting in protected areas during the day can be used to collect them. Bands of burlap are placed around the trunks of susceptible trees as resting areas. During an outbreak, the bands must be checked and the larvae removed and killed daily. Caterpillars may remain in the canopy and feed night and day during an outbreak, reducing the effectiveness of this method. Except as a survey tool, use in a forest situation is impractical.

Burlap band trap with caterpillars.

Barriers: Barriers that include a sticky surface are effective and can be made by wrapping the trunk of a susceptible tree with duct tape (to protect the bark and provide a smooth surface) and applying a thin layer of Tanglefoot®. Gaps between the tape and the bark should be filled. Trunk barriers should be in place before gypsy moth eggs hatch in March or April.

Sticky barriers have no effect on caterpillars already in the canopy, so the impact of barriers is usually limited to a 20- to 30-percent reduction in caterpillars, resulting in an average foliage protection rate of about 20 to 30 percent. While trunk barriers provide some benefit, they should never be relied on to protect foliage.

For more information, contact:

Joseph L. Cook
Gypsy Moth SEIS Project Leader
USDA Forest Service
180 Canfield Street
Morgantown, WV 26505
FAX: (304) 285-1505

Images courtesy of USDA Forest Service and APHIS PPQ Archives, *www.invasive.org.*

The USDA is an equal opportunity provider and employer. FS-808c

The Supplemental Environmental Impact Statement [SEIS] augments the analysis and documentation of "Gypsy Moth Management in the United States: a cooperative approach," Final Environmental Impact Statement, 5 vols. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Area State and Private Forestry, November 1995.

National Gypsy Moth SEIS Team
USDA Forest Service
180 Canfield Street
Morgantown, WV 26505

Information Bulletin No. 3

Gypsy Moth

Supplemental Environmental Impact Statement Project

Historic photograph of 1930s Civilian Conservation Corps scouting for gypsy moth.

Gypsy Moth

Natural Control Agents and Treatments

United States Department of Agriculture
Forest Service
Northeastern Area
State and Private Forestry
NA-IN-06-05
www.na.fs.fed.us

The gypsy moth is often controlled by natural agents such as parasites, predators, and fungal pathogens.

Natural Control Agents

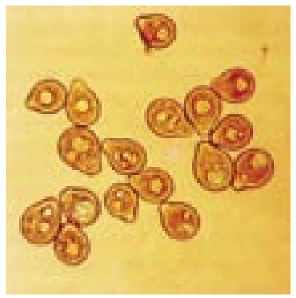
Parasites: Parasites help maintain low-density populations of the gypsy moth, but do not prevent the buildup of already increasing populations. Research of foreign gypsy moth parasitoids started in 1904 and continues today; parasites studied include flies and wasps that attack and kill gypsy moth eggs, larvae, and pupae.

Here a parasitic wasp lays eggs on a gypsy moth pupal case. The eggs will hatch into wasp larvae, which will feed on and kill the gypsy moth.

Predators: Gypsy moth predators include about 50 species of birds, 20 species of mammals, and some amphibians, reptiles, insects, and spiders. Once a gypsy moth outbreak begins, predation has no significant effect on gypsy moth densities. Most gypsy moth predators only eat the gypsy moth when their preferred food is scarce. Vertebrate predators, especially the white-footed mouse (*Peromyscus leucopus*), are major sources of late-larval and pupae mortality in low-density gypsy moth populations.

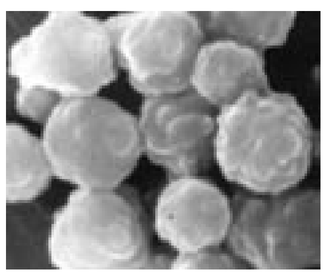
White-footed mice feeding on gypsy moth larvae.

Fungal Pathogen: Outbreaks of *Entomophaga maimaiga* (a fungus that attacks the gypsy moth) occurred in 1989 in the Northeastern United States, the first report of this fungus in North American gypsy moth populations. Unlike the gypsy moth virus, which is associated with high gypsy moth densities, the fungus appears capable of causing mortality to middle- and late-stage gypsy moth caterpillars at low densities. This fungus has spread in the United States, becoming a very important factor in managing gypsy moth outbreaks.



Conidia of Entomophaga maimaiga actively ejected from cadavers cause infection during the same season.

Nucleopolyhedrosis virus (NPV): This virus (NPV) can reach outbreak levels naturally as gypsy moth populations increase. The greater the number of gypsy moth larvae, the more effective the virus. Small caterpillars become infected and die on leaves in tree crowns. Their cadavers disintegrate, dispersing the virus and infecting other gypsy moth caterpillars.



A photograph of gypsy moth virus polyhedra taken with a scanning electron microscope. The polyhedra are about 2 microns in diameter.

The USDA and State and other Federal partners use treatment projects only when natural agents fail to work and the gypsy moth threatens forest resources and human health.

Treatment Projects

USDA gypsy moth treatment projects have most often included the use of *Bacillus thuringiensis* var. *kurstaki* (*B.t.k.*), nucleopolyhedrosis virus (NPV) (Gypchek), mating disruption, or diflubenzuron (Dimilin®). The USDA is proposing the use of tebufenozide (Mimic®) in a supplemental environmental impact statement.

Aerial spraying of a forest for gypsy moth.

Bacillus thuringiensis* var. *kurstaki (B.t.k.): *B.t.k.* is a bacteria that kills caterpillars of moths and butterflies and is found naturally in soil. *B.t.k.* contains a crystalline endotoxin within its spore, which when ingested by caterpillars causes death from the effects of starvation and tissue damage.

Nucleopolyhedrosis virus (NPV) (Gypchek): NPV occurs naturally and is specific to the gypsy moth. Gypchek is an insecticide product made from NPV. Enough Gypchek is produced to treat about 8,000 acres (3,240 hectares) each year. Gypchek infects the gypsy moth caterpillar when ingested. After infection, the virus multiplies rapidly, causing the breakdown of internal tissue, then death. Early instar caterpillars are most susceptible. Dead caterpillars typically hang in an inverted "V" from foliage and branches, releasing more virus to infect additional gypsy moth caterpillars.

Larva killed by the nucleopolyhedrosis virus (NPV), showing typical V-shaped hanging behavior.

Mating Disruption: Mating disruption involves the aerial application of tiny plastic flakes that contain disparlure, the synthetic version of the female gypsy moth sex attractant. The purpose of disparlure is to confuse male moths and prevent them from locating and mating with females.

Historic photo of a worker clipping tips of female gypsy moth abdomens from which sex attractant material was obtained. Today, the synthetic sex attractant disparlure is used.