GYPSY MOTH IN MINNESOTA: The Early Years

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Arrival of Gypsy Moth in Minnesota

After its introduction from Europe to Massachusetts in 1869, the gypsy moth spread throughout hardwood stands in the northeastern United States. It first appeared in the Lake States in the mid-1950's when moths were collected in Michigan and Wisconsin. In Minnesota, the first verified collection occurred in 1969 when several egg masses and pupal cases were found in Duluth. The first male moth was captured in 1976 in Hennepin County, and, in 1980, 26 male moths were collected in the Twin Cities area. These moths probably entered the state as hitchhikers on outdoor furniture moved from eastern outbreak areas.

The early catches of gypsy moth have resulted in intensified trapping in Minnesota. Moth collections have occurred annually with a statewide total of 196 occurring in 1983 when moths were collected in traps in Anoka, Benton, Dakota, Hennepin, Mower, Olmsted, Ramsey, Rice, Scott, Stearns, Waseca, and Washington counties. Since traps only attract the adult male gypsy moth, trap catches do not necessarily indicate that the insect is established in that area (see Detection, Evaluation and Control). To date, only Benton, Dakota, Hennepin, Ramsey and Washington counties contain isolated areas of potential gypsy moth establishment.

Potential of Gypsy Moth in Minnesota

Over the next few years, the gypsy moth will probably continue to enter and be captured in Minnesota. The locations of introductions will be monitored by the trapping program; and, where isolated areas of infestation are identified, an eradication program (see Eradication vs. Management) will likely be implemented. Reintroductions from infested areas outside of Minnesota, however, may eventually result in the gypsy moth becoming a permanent resident in some portions of our state.

DISTRIBUTION

Gypsy moth eggs are killed when temperatures at the site of the overwintering egg mass drop below –20°F. Based on this and current distribution patterns in North America, the gypsy moth would most likely become established and remain in the southern third of Minnesota. Areas north of a line that roughly extends from northern Washington county to Moorhead in Clay county probably will not experience extensive gypsy moth populations in the near future. However, gypsy moth may be slowly expanding northward in the eastern U.S. While not immediately threatened, northern Minnesota could eventually have infestations of gypsy moth.

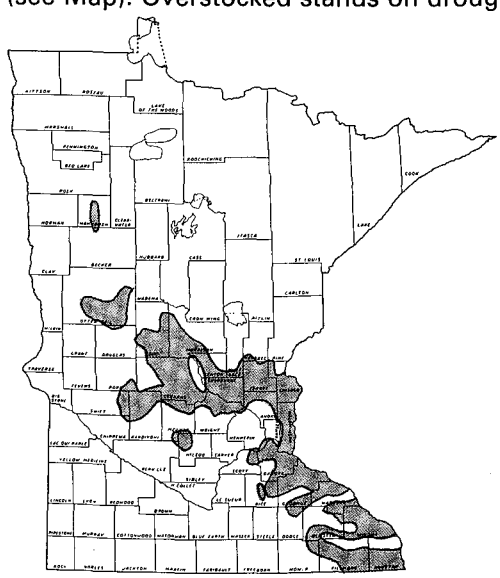
DAMAGE

What can we expect if large numbers of caterpillars build up in an urban or forest area? As a defoliator, the gypsy moth can totally strip the foliage from a wide variety of trees. While oak, aspen and birch are preferred, the gypsy moth will feed on most deciduous trees (except ash and walnut) and even on coniferous trees when hardwood foliage is not available and the caterpillars are in their final development stages.

In urban areas, the decline and death of unhealthy hardwood trees will be accelerated when defoliated for two or more consecutive years. Growth loss in healthy trees will be roughly proportional to the amount of defoliation above 50%. Healthy deciduous trees can enter a period of decline following consecutive years of defoliation. Most coniferous trees will not survive one complete defoliation.

Homeowners and recreationists in infested areas will also have to deal with the considerable annoyance of gypsy moths. In addition to the unappealing appearance of heavily defoliated trees, masses of caterpillars will spin, drop or migrate from heavily infested trees to sidewalks, trails, picnic areas, cars, homes and cabins. Fecal droppings also abound in outbreak areas and the hairy larvae can cause welts and rashes when susceptible individuals come in contact with the larvae. While not dangerous, these allergic reactions add to the annoyance of gypsy moth for some people.

The forest areas most susceptible to gypsy moth defoliation damage are the considerable oak forests found throughout the central and southeast regions of the state (see Map). Overstocked stands on droughty



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soils are the most susceptible to gypsy moth buildup and damage. Mortality of oak species is likely following two or more consecutive years of defoliation as the stressed and declining trees are attacked and killed by root rots, bark beetles and borers. Following severe outbreaks, the oak component will be reduced and replaced by less susceptible species such as ash and maple. It is from preferred hardwood forests that gypsy moth will cycle and in the process periodically reinfest our cities and towns.

The Insect

The gypsy moth, *Lymantria dispar,* belongs to the insect order Lepidoptera which contains the moths and butterflies. Gypsy moth eggs hatch into caterpillars, feed for several weeks on tree foliage, then form a stationary, non-feeding pupal stage before becoming adult moths. In many ways, gypsy moth is like other defoliating caterpillars but has received notoriety because it is larger than many similar caterpillars, has a voracious appetite, can feed on many different tree and shrub species, has hairs which can cause skin irritation to susceptible people, and has been under federal quarantine for many years. When the insect becomes abundant it can cause extensive defoliation, tree or limb mortality, and irritation and annoyance for people living or visiting the infested areas. The annoyance caused by gypsy moth probably accounts for the greatest pressure to control the gypsy moth in urban and recreational areas.

EGG STAGE

The female gypsy moth (Fig. 1) normally deposits her eggs (Fig. 2) in a well-formed egg mass in mid-July to mid-August. An egg mass contains from 75 to 750 eggs and is covered with a fibrous mat of hairs. At first, it is buff colored but will later bleach with exposure. The gypsy moth overwinters in the egg stage.

Gypsy moth larvae begin emerging from egg masses when weather is favorable, usually sometime in May. The eggs from an individual egg mass will hatch in 3 to 5 days while individual egg masses in an infested area may hatch over a period of 2 to 3 weeks.

LARVAL STAGE

There are several distinct stages of growth (called instars) for gypsy moth larvae. Newly hatched larvae (Fig. 3) are small (3mm), and buff colored but turn black within a few hours after emergence. They remain on or around the egg mass for several days if temperatures are below 40°F or if it is raining.

When conditions are favorable, larvae leave the egg mass and climb trees or other objects continually laying down a trail of silk as they move. When the larvae reach the outer branches or tops of trees, they drop on silken threads that are easily broken by light gusts of wind. Although larvae may be carried for up to a mile by wind, most spread results in redistribution within a small, localized area of up to a few hundred yards.

After dispersing, larvae begin feeding when they encounter acceptable food plants, which include: oak, aspen, birch, apple, basswood, poplar, willow, some maples, cherry, elm, and many other hardwoods. First instar larvae cannot survive on conifer needles. Usually they have 2 or 3 feeding periods during the day chewing small holes within the perimeter of the leaf.

When not feeding, they rest on a mat of silk they have made on the underside of the leaf. Depending on sex, the gypsy moth has 5 or 6 larval stages each lasting from 4 to 10 days.

Second and third stage larvae feed at the leaf margins and characteristically stay in the tree tops, migrating to the undersides of branches and twigs when not feeding. They are hairy, and blackish with several light orange dots on the last half of the back (Fig. 4).

After molting to the fourth stage, larval behavior changes dramatically. Caterpillars are now 1" to 2" long and can be easily recognized as they display 5 pairs of blue spots toward the front and 6 pairs of red spots toward the rear on their upper sides (Fig. 5). Larvae feed during the night, then descend the trees at dawn in search of protective locations where they rest for the remainder of the day. It is during this stage of development that defoliation can be severe enough to be noticed and masses of larvae cause a nuisance as they crawl on lawn furniture, buildings and sidewalks. Last stage larvae stop their daily migration and remain on foliage feeding 24 hours a day. Larvae usually complete their development in late June to mid-July and attach themselves to any surface with strands of silk and transform into pupae.

PUPAL STAGE

The pupa is the transformation stage between caterpillar and adult moth. Pupae have been found

Gypsy Moth Life Cycle

EGG					LARVA		PUPA	ADULTS	EGG			
JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC

Adult Detection Surveys

attached to picnic tables, rocks, lawn furniture, firewood, tents, campers, automobiles, trees, ladders, shutters, trash cans, shrubs, or barbecue grills; the list is endless. Hanging as mahogany-colored cases, the pupae await their change to adult moths (Fig. 6). After about 10 to 14 days, the adult moths emerge leaving the pupal cases behind.

ADULT STAGE

The male moths are dark brown with black markings (Fig. 7), are strong fliers and most active from mid-July—August during daylight hours. They fly in rapid zig-zag patterns searching for female moths. A single male is capable of mating with dozens of females. Females are larger than males, whitish in color with black markings (Fig. 1) and do not fly, but crawl short distances from the place they emerge. They release a potent sex attractant (pheromone) that attracts male moths. Soon after mating, the female deposits her eggs in a single cluster, then dies. Egg masses can be found in any protected location such as on firewood, rocks, picnic tables, automobiles, campers and trees. The gypsy moth has only one generation per year.

Detection, Evaluation, and Control in Minnesota

Detection efforts to find gypsy moths in Minnesota began in 1969 and continued with limited trapping into the early 1970's. Since that time, detection trapping has been improved and intensified in locations where gypsy moth introductions are most likely.

Eradication efforts began in 1983 when two infested areas, one in St. Paul and one in Woodbury, were successfully treated with aerial applications of the insecticide carbaryl (Sevin^{R}). Whenever new infested areas are identified, they will be evaluated and considered for treatment by the Minnesota Department of Agriculture in an effort to prevent the moth from becoming established in the state (see Eradication vs. Management).

DETECTION

Pheromone traps are used to detect the presence of gypsy moths by attracting and catching adult male moths using a chemical which is a copy of the potent sex attractant (pheromone) produced by the female. Once a male moth enters the trap (Fig. 8), a sticky substance prevents it from leaving.

Detection surveys using pheromone traps are conducted annually from mid-July to September 1st under the direction of the Animal Plant Health Inspection Service of the United States Department of Agriculture. In areas where male moths are caught, the trapping intensity increases the following year depending on how many moths are found in the area. It is generally accepted that potential establishment of gypsy moth is indicated only when more than one male moth is found in a trap, particularly if this occurs in the same location in consecutive years. Single trap catches are not retrapped as intensely since they may be new hitch-hiking introductions or males flying away from a nearby infestation. Areas with multiple moth

1. Female Gypsy Moth
2. Gypsy Moth Egg Mass
3. Newly Hatched Larvae
4. Young Larvae
5. Mature Larvae
6. Gypsy Moth Pupae
7. Male Moth
8. Pheromone Trap for Detection

catches in single traps are more intensely surveyed to determine the extent of any infestation since the possibility exists that an infestation may be present. These areas may also receive intensive ground surveys to check for egg masses or other life stages (larvae, pupae).

In the fall, the ground checking begins and survey entomologists under the direction of the Minnesota Department of Agriculture and USDA, Animal and Plant Health Inspection Service, carefully examine the immediate area searching for viable egg masses or pupal cases. In urban areas, this often means door to door surveys with specific emphasis on locations where people have recently moved from or visited gypsy moth infested areas outside of Minnesota. Not until one or more of these alternate life stages is found in the same year is the area normally considered infested.

EVALUATION AND CONTROL

The location and extent of the infestation are evaluated for a number of control alternatives. Recommended control operations can range from limited ground applications to more extensive aerial applications of an appropriate insecticide. Before control recommendations are finalized by the Minnesota Commissioner of Agriculture, residents in the affected communities are encouraged to participate in the decision making process through public information meetings.

ERADICATION VS. MANAGEMENT

Two approaches are commonly considered when dealing with recently introduced insect pests, eradication and population management. Eradication attempts to completely eliminate the insect from an area so that virtually no individuals remain. Population management attempts to regulate the insect below a level that causes damage. The insect remains in the managed areas.

Eradication is not advisable once a population becomes established and wide-spread. However, eradication can be successful when dealing with low numbers of pests found in relatively small, localized areas. Therefore, a means of locating just a few insects is required for eradication to be considered.

At this time, gypsy moth is a realistic candidate for eradication efforts in Minnesota. The pheromone traps are capable of detecting low level populations and pinpointing the distribution of the insect in an area. At least two control agents (carbaryl and *Bacillus thuringiensis*) are known to be effective in killing the larval stage of gypsy moth. Carbaryl has been used to eradicate gypsy moth in portions of the central U.S. and in St. Paul and Woodbury in Minnesota. A new formulation of *Bacillus thuringiensis*, in combination with mass trapping, has also been used to eradicate gypsy moth. Since gypsy moths are currently introduced into Minnesota by man's movement of various items, introductions are likely to remain localized allowing for early detection and reaction when eradication is still possible.

There are three major benefits of successful eradication efforts. First, the pest insect is prevented from becoming established, and therefore its damage is avoided. Second, pesticide applications are kept to a minimum; it will be unnecessary to routinely treat an area. Third, the monetary cost of eradication will be less than direct cost of routine management programs, the indirect cost of tree damage, and annoyance associated with gypsy moth.

Once the gypsy moth becomes established, Minnesota's approach must switch from eradication to population management. The purpose of population management is to maintain or suppress a pest population below the point where damage becomes significant or unbearable. Gypsy moth "damage" consists of the direct impact on host tree health and vigor via its defoliating habits. In addition, it can cause indirect "damage" by its ability to create unsightly, aesthetically unappealing trees or by creating a nuisance when it moves out of trees to lawns, shrubs, homes, sidewalks, picnic tables, etc. Thus, people will want to reduce both the direct and indirect damage caused by the gypsy moth.

Control strategies will then include foliage protection and population reductions. It will likely require routine attention by land managers, homeowners, resort operators, and municipalities in areas where it is established. In this sense, gypsy moth will become similar to the cankerworm (inchworm) in the Twin Cities and the forest tent caterpillar ("armyworm") in Duluth.

Agency and Citizen Responsibilities

Agencies of federal, state and local governments are cooperating in efforts to detect, monitor, control and provide information about the gypsy moth in Minnesota. It is helpful to know what the responsibilities of the agencies are. In addition, citizens and other groups in Minnesota can contribute to a successful program.

CITIZEN INPUT

Early detection is the key to success of the current gypsy moth program. Therefore, an informed citizenry able to identify the various life stages of gypsy moth can be helpful. People can look for gypsy moth and then contact an appropriate agency (listed below) if gypsy moths are suspected in an area.

People moving to Minnesota from gypsy moth infested areas may unknowingly introduce it here. Public awareness of gypsy moth transportation by people can help to avoid this type of introduction.

Organized groups can assist in the detection and monitoring of gypsy moth. Input is most effective

when supervised by the two agencies responsible for detection (MDA and APHIS).

ANIMAL AND PLANT HEALTH INSPECTION SERVICE, UNITED STATES DEPARTMENT OF AGRICULTURE

The United States Department of Agriculture, Animal and Plant Health Inspection Service (APHIS) provides technical assistance and is the primary agency providing funds for detecting and eliminating infestations in states such as Minnesota that are remote from the generally infested areas. APHIS is currently cooperating with the Minnesota Department of Agriculture to help detect gypsy moth and to provide technical assistance in determining control strategies. In addition, APHIS is conducting an inspection and certification program as part of its gypsy moth quarantine efforts. Under the program, all outdoor household items moved from high risk areas into or through non-infested areas are inspected and must be free of all gypsy moth life stages. The contact person is John T. Hayward, Officer in Charge; USDA, APHIS, PPQ; Room 472, Federal Building; 110 South 4th Street; Minneapolis, MN 55401 (612-725-2302).

MINNESOTA DEPARTMENT OF AGRICULTURE

The Minnesota Department of Agriculture (MDA) is responsible in cooperation with APHIS for detection, survey, and eradication of gypsy moth in Minnesota. The Commissioner of Agriculture makes the final decision on control strategies based on input from local government, experts, and citizens. MDA also provides a portion of the money necessary to conduct these control programs. The contact person is Arthur H. Mason, Division of Plant Industry; 90 W. Plato Blvd.; St. Paul, MN 55107 (612-296-8328).

AGRICULTURAL EXTENSION SERVICE, UNIVERSITY OF MINNESOTA

Each county has an Extension agent who can be contacted for educational materials or information about gypsy moth. The Extension Specialist housed on the St. Paul campus of the University of Minnesota contributes insect information to aid in decision-making, develops educational materials on gypsy moth and provides information backup for the county agent. Consult the phone directory under your county for the number of your local extension office.

MINNESOTA DEPARTMENT OF NATURAL RESOURCES

The Department of Natural Resources (DNR) is responsible for developing a long range management plan for gypsy moth on state, county and private forest lands. When gypsy moth becomes established and is no longer a candidate for eradication, DNR is responsible for management programs in forested areas. DNR personnel may also contribute information to aid MDA in determining control strategies for gypsy moth. The contact person is S. Olin Phillips, Supervisor; Forest Insect and Disease Unit, Division of Forestry; Minnesota Department of Natural Resources; Box 44, 658 Cedar Street; St. Paul, MN 55155 (612-296-5965).

FOREST SERVICE, UNITED STATES DEPARTMENT OF AGRICULTURE

When an introduced forest pest such as gypsy moth is declared established and no longer a candidate for eradication, Forest Pest Management entomologists are authorized to assist in the management effort. The Forest Service is also responsible for gypsy moth management operations on federal lands. The contact person is James B. Hanson, USDA Forest Service; 1992 Folwell Ave.; St. Paul, MN 55108 (612-642-5324).

MUNICIPAL FORESTERS AND LOCAL GOVERNMENTS

Local governments and municipal foresters can cooperate with concerned federal, state, and local authorities. Cooperation could include supplying personnel for inspection, distributing information flyers to affected neighborhoods, and assisting in any spraying efforts deemed necessary. Once the gypsy moth becomes established in a community, local ordinances for inspection, education and control would be considered.

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