Spongy moth in North America

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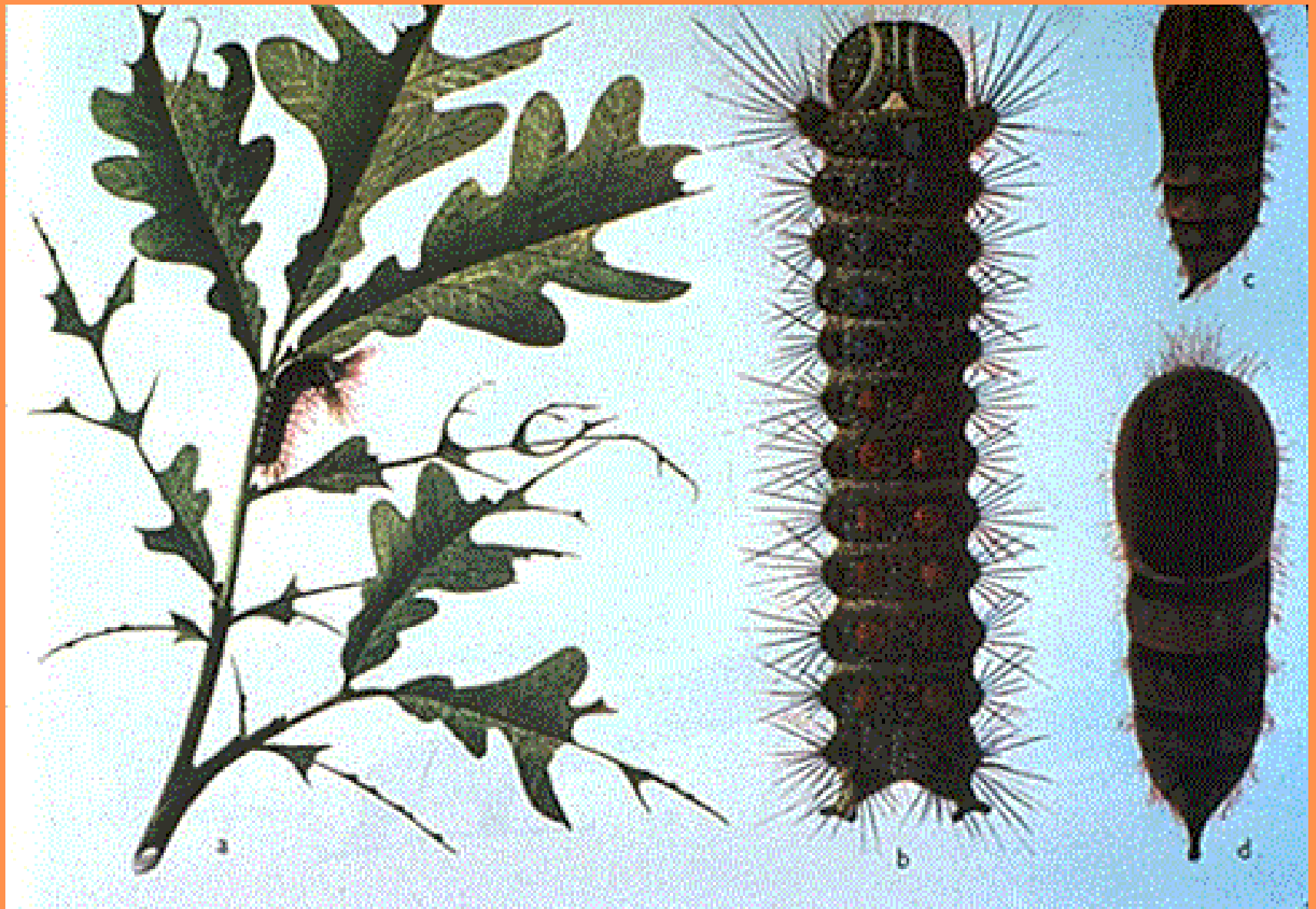

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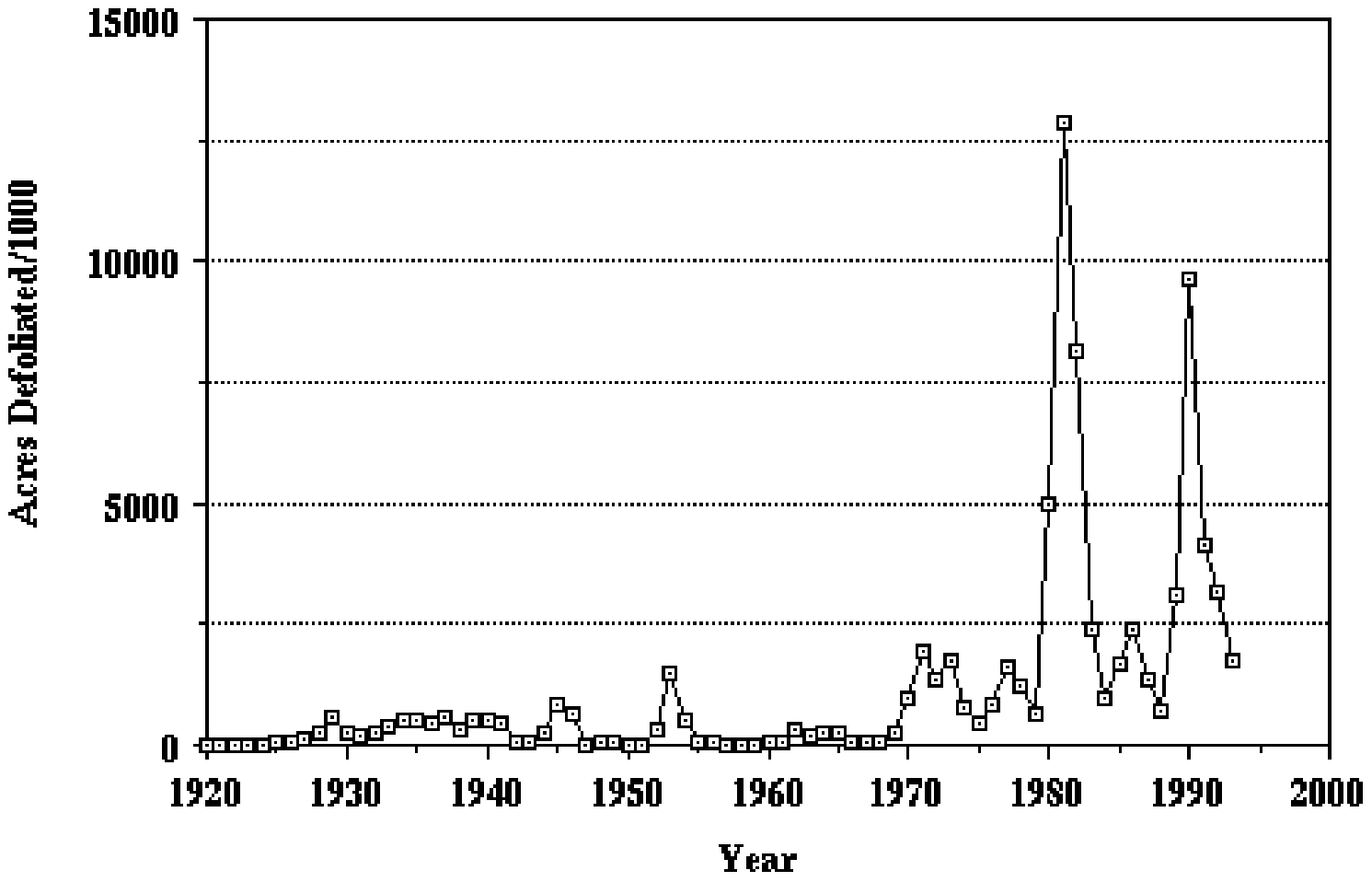

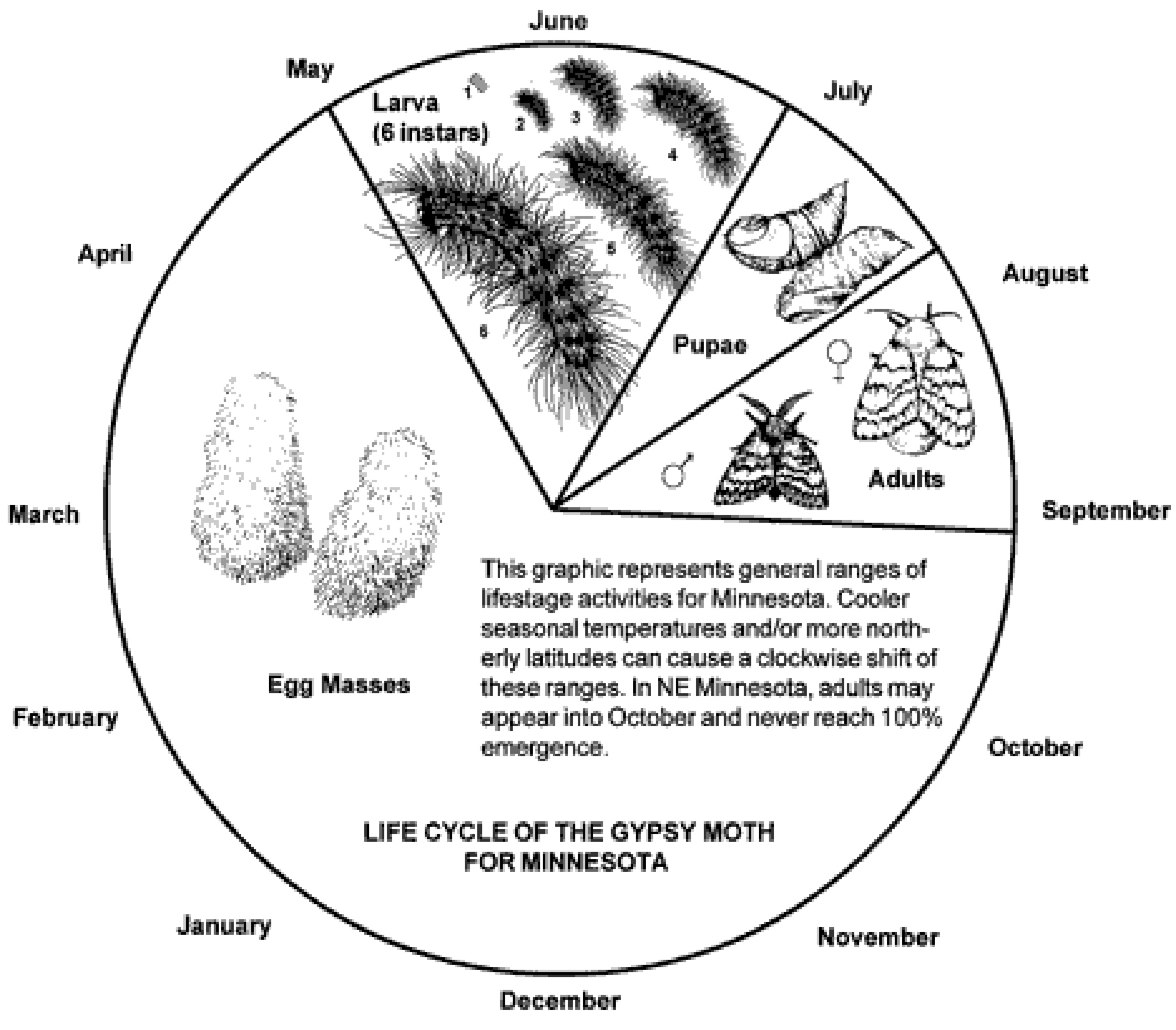
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Larva
(6 instars)
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Pupae
Adults
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Egg Masses
This graphic represents general ranges of lifestage activities for Minnesota. Cooler seasonal temperatures and/or more northerly latitudes can cause a clockwise shift of these ranges. In NE Minnesota, adults may appear into October and never reach 100% emergence.
LIFE CYCLE OF THE GYPSY MOTH
FOR MINNESOTA

Spongy moth in North America

SM egg mass

SM larva

SM pupa

SM male moth

SM female moth

Spongy moth in North America

Egg mass

Eggs are laid in a fuzzy, tan-colored mass. The egg mass contains an average of 500 eggs and is about the size of a quarter. Eggs are laid during July and August and hatch the following spring from late April through early May. Egg masses may be laid on living and/or inanimate objects. Such as nursery stock, logs, under eaves on roofs, in wheel wells or an outdoor household article.

Spongy moth in North America

Caterpillars

The caterpillar ranges from 1/8 to 2 1⁄2 inch length depending upon its age. It is dark and hairy. Along its back it has five pairs of blue spots near the head, followed by six pairs of red spots. It actively feeds on plant foliage from early May through early July, when it develops into a pupa.

Spongy moth in North America

Pupae (cocoons)

The pupa is an inactive stage during which the caterpillar becomes an adult moth. Found during July, it is dark reddish-brown and leathery in appearance. It can range in size from 3⁄4 inch to 1 1⁄2 inches long.

Spongy moth in North America

Adult male moth

The adult male moth has feathery (plumed) antennae and can be light beige to dark brown with black jagged bands on its forewings. Its wingspread ranges from 3⁄4 to 1 1⁄2 inches.

Spongy moth in North America

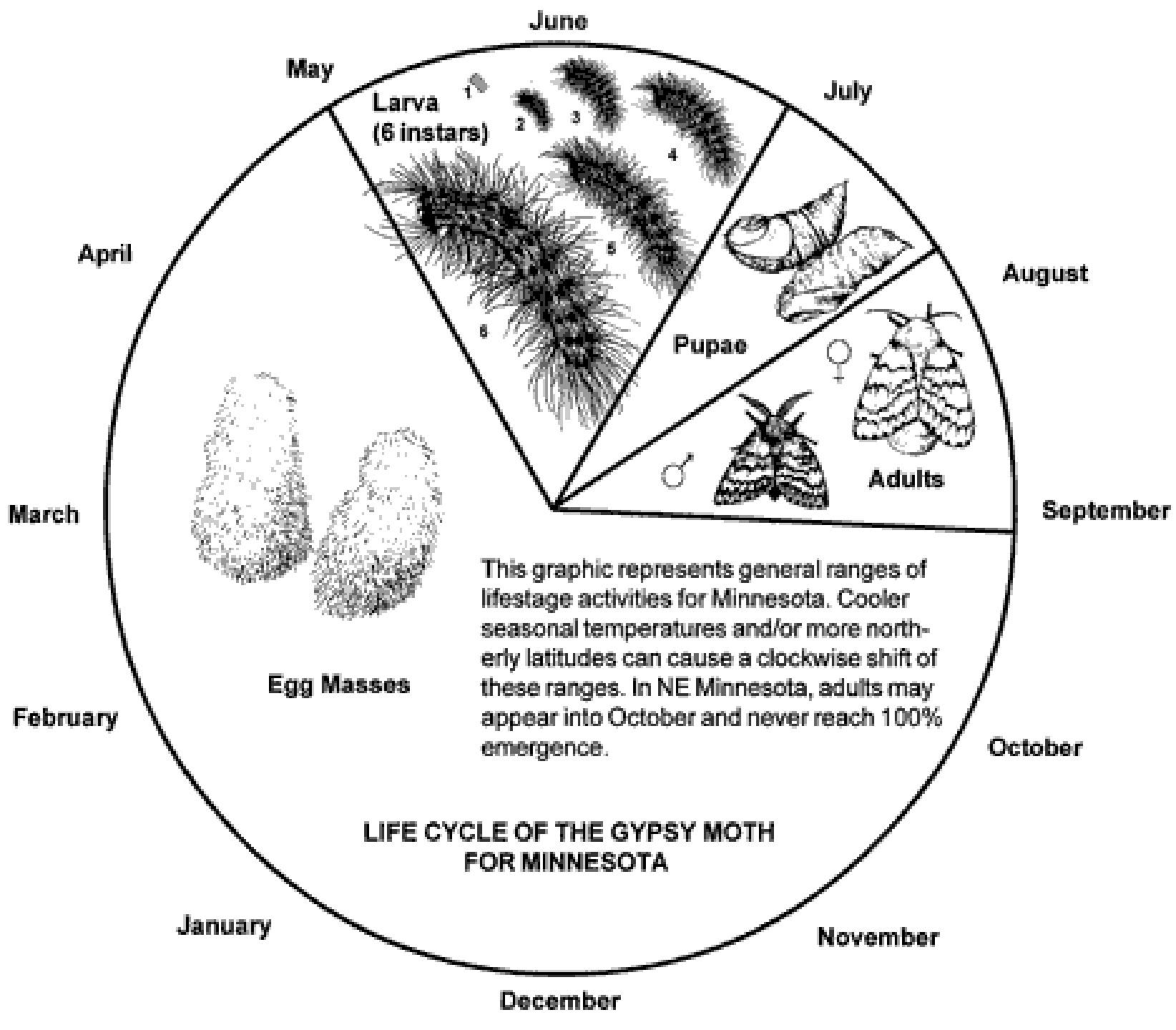
Adult female moth

The adult female moth is white with brown zig-zag markings on her wings and narrow antennae. Its wingspread ranges from 1 to 2 inches. Females cannot fly because their bodies are too large and heavy.

Spongy moth in North America

Adult female moth

Females release a strong sex attractant (pheromone) to attract male moths, which are strong flyers and capable of mating with several females. The female produces one egg mass and dies. Adult moths are typically active from mid-July to early-September.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LIFE CYCLE OF THE GYPSY MOTH
FOR MINNESOTA

Spongy moth in North America

In either 1868 or 1869, the Spongy moth was accidentally introduced near Boston, MA by E. Leopold Trouvelot. About 10 years after this introduction, the first outbreaks began in Trouvelot's neighborhood and in 1890 the State and Federal Government began their attempts to eradicate the Spongy moth.

Spongy moth in North America

His main interest was in identifying native silkworms that might be used for silk production. In the late 1860's he returned from a trip to France with some Spongy moth egg masses. He was apparently culturing them on trees in back of his house when some of the larvae escaped. Trouvelot understood the potential magnitude of this accident and notified local entomologists but no action was taken.

Spongy moth in North America

Trouvelot's interest in silkworm-Spongy moth crosses dimmed and he turned his attention to amateur astronomy.

After 1882 the outbreak on Trouvelot's street continued to grow in size, residents of the Boston area became increasingly alarmed about the Spongy moth problem. In 1889 the Massachusetts State Board of Agriculture began a campaign to eradicate the Spongy moth.

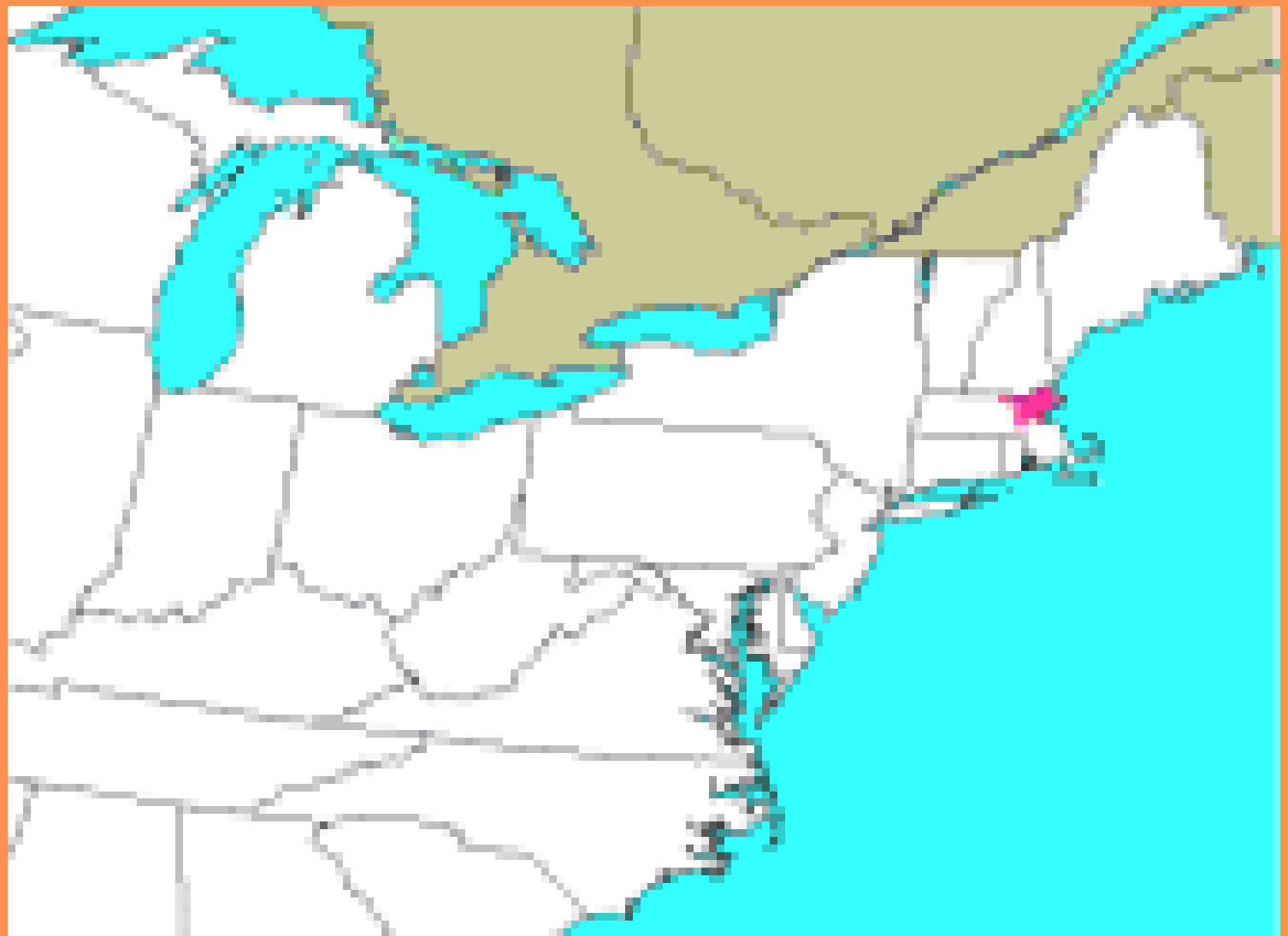
Spongy moth in North America

Picking egg masses from oaks in 1882.

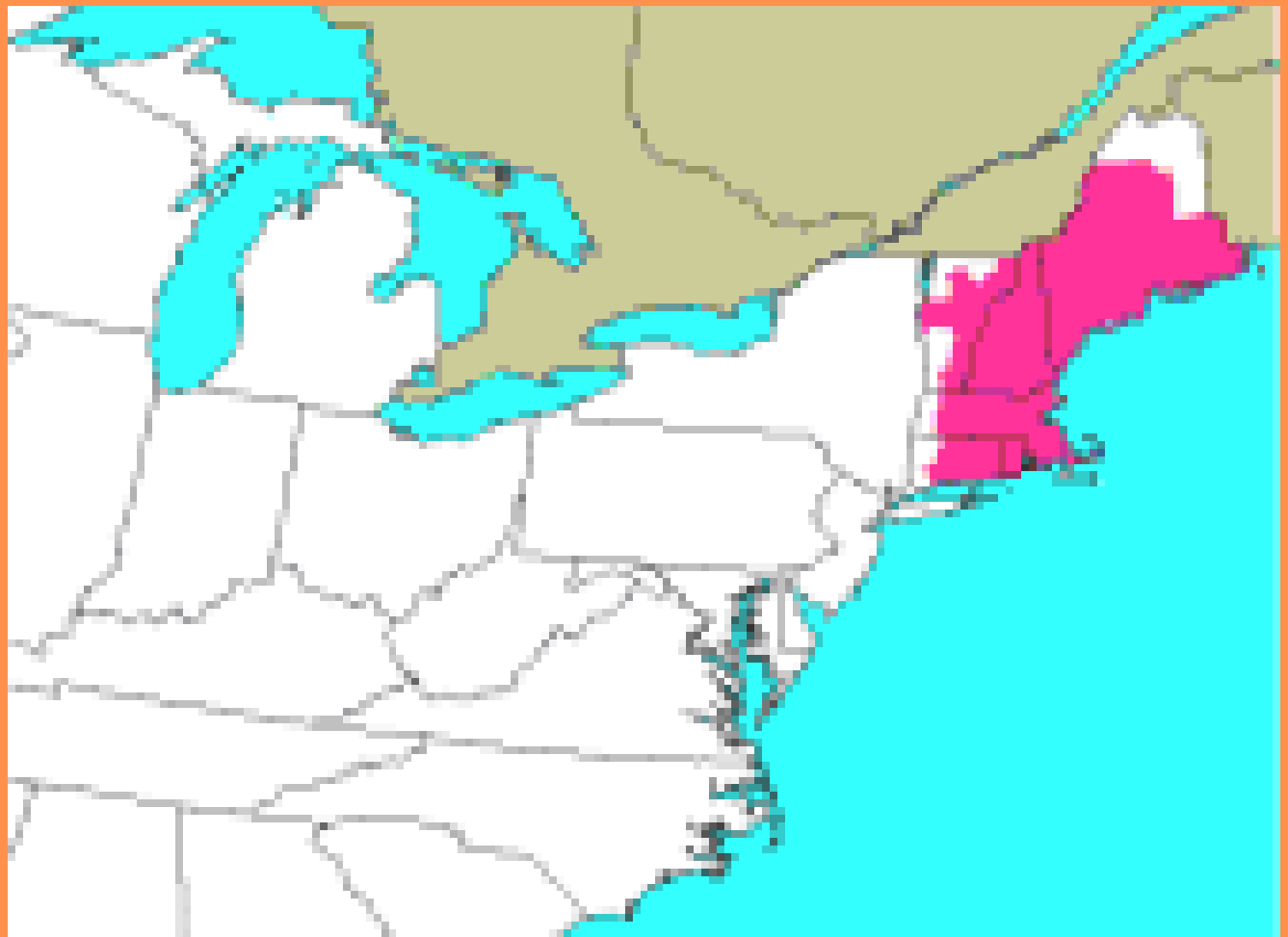
Spongy moth in North America

The methods used during the program ranged from manual removal of egg masses, burning infested forests and application of primitive insecticides. Despite the expenditure of considerable money and effort, the Spongy moth infestation continued to expand in size and by 1900 the effort to eradicate this insect was abandoned.

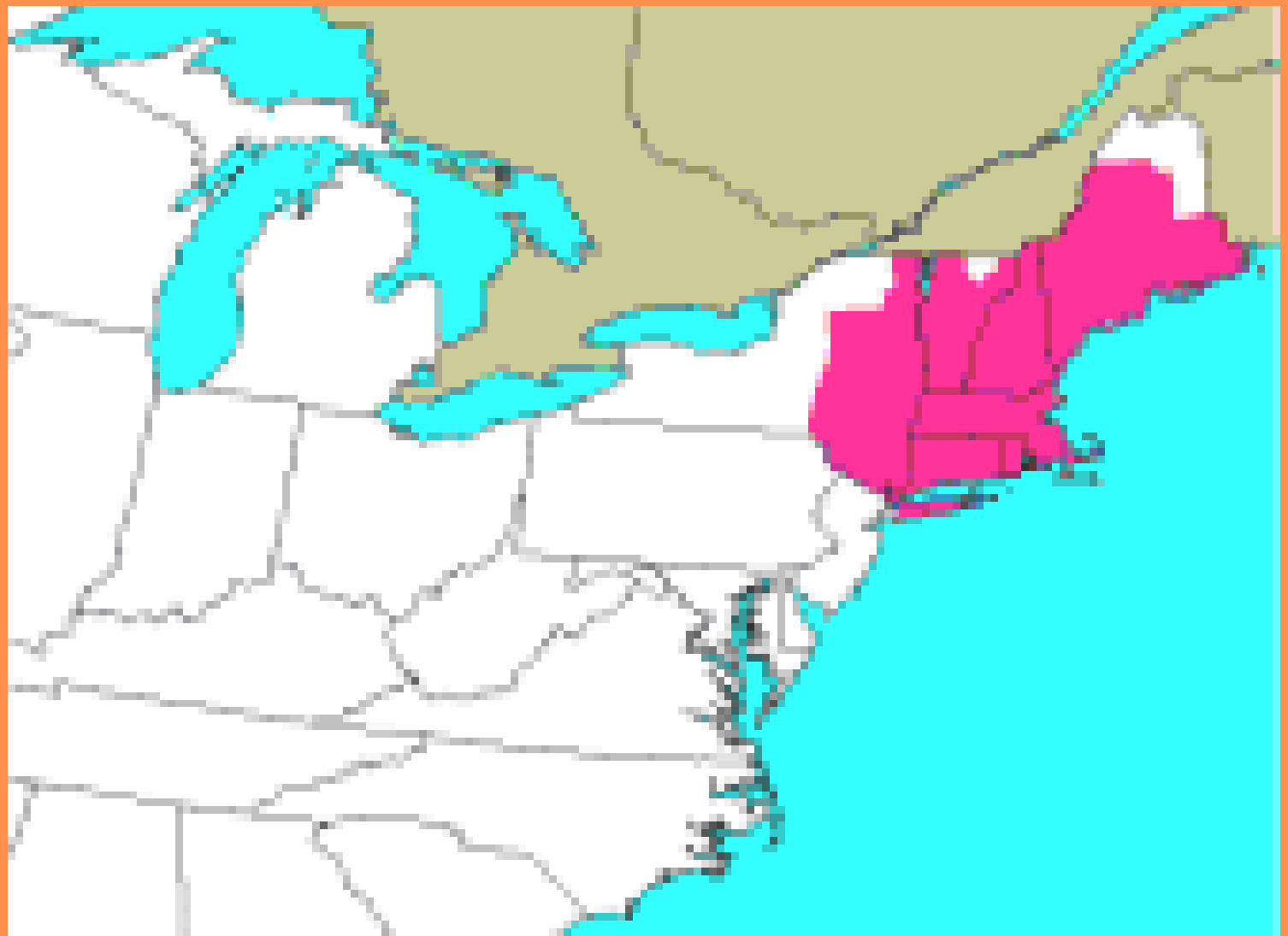
Spongy moth in North America 1900



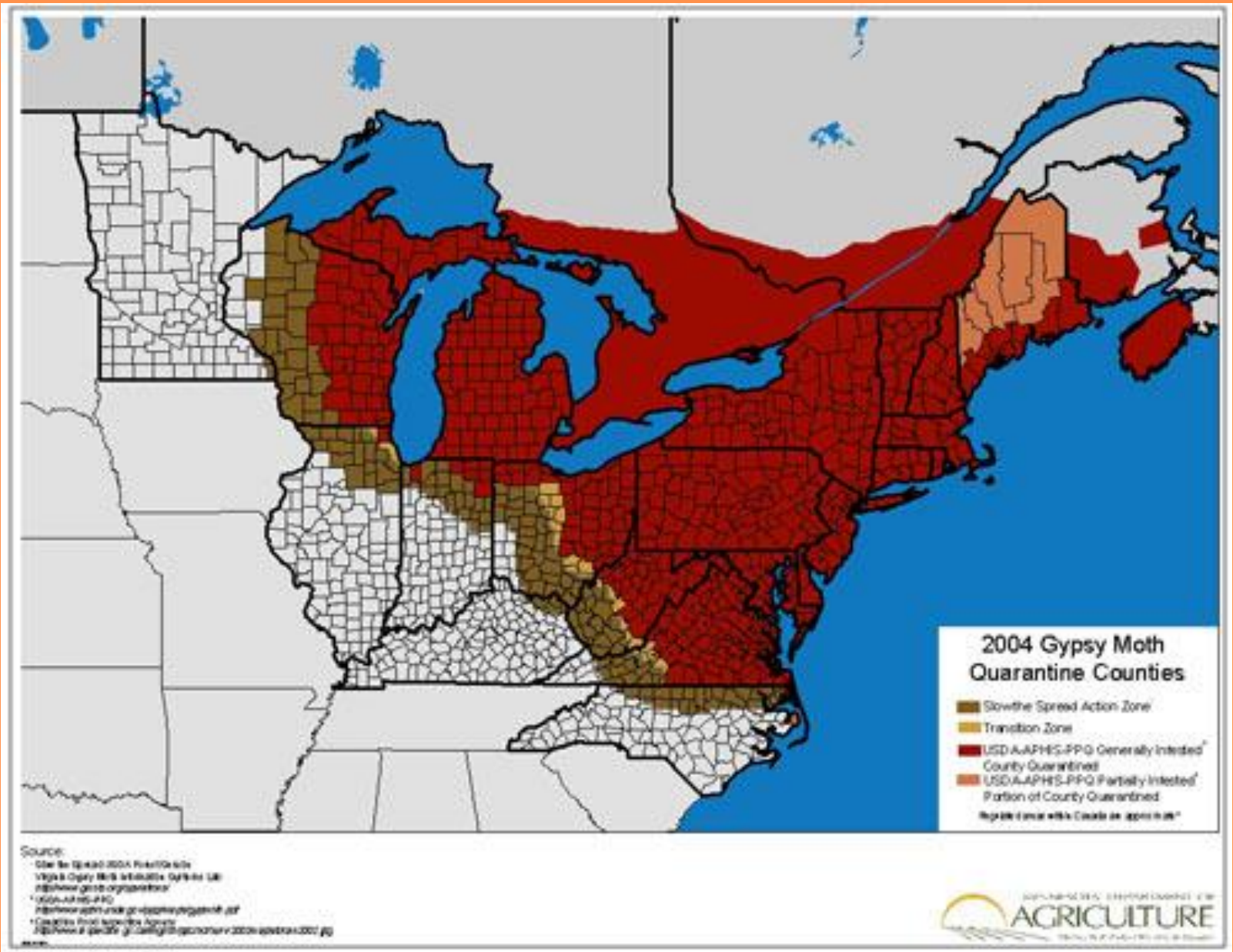
Spongy moth in North America 1935



Spongy moth in North America 1965



2004 Spongy moth infested quarantine counties



Spongy moth in North America

Female Spongy moths cannot fly and have the habit of depositing their eggs on objects near the trees on which they were feeding as caterpillars.

These objects might be picnic tables, car wheel wells, grills or any outdoor household article or lawn ornaments. When these objects are moved from an infested area, the Spongy moth eggs “hitchhike” into other areas, hence the name Spongy moth.

Spongy moth in North America

The United States government realized early on that this insect would be a serious problem.

In the early 1900s, a federal quarantine was placed on all trees in the infested area. Nurseries wanting to transplant trees from the quarantined area had to conduct a careful inspection to ensure the moth wasn’t hitching a ride. Since the female moth cannot fly and the larvae can only move a few miles on the wind, the quarantine kept the moth isolated to the northeast United States for decades.

Spongy moth in North America

But with a helping hand from people, the moth has expanded its territory in recent years, from western Pennsylvania all the way through Ohio, Michigan and Illinois, and into central Wisconsin. Because of the way the moth deposits eggs, people camping in infested areas during prime egg-laying periods (July through mid-August) are particularly susceptible to carrying the pest home on camping gear or even in the wheel wells of their cars. Fortunately, the moth has not arrived en masse in Minnesota - yet.

Spongy moth in North America

One caterpillar can eat up to one square meter of vegetation during its development. They can eat all the leaves on an adult tree in a matter of days. The tree is then weak and susceptible to diseases and other insects. In northeastern states, Spongy moth have been known to defoliate entire forests. When Spongy moth becomes established, property values can decrease, large sums of money are spent by state and federal governments to control it. Much of the beauty of the natural forested landscape is threatened or lost.

Spongy moth in North America

Spongy moth larvae can defoliate entire trees and forests.

Spongy moth in North America

Minnesota Department of Agriculture, in cooperation with the USDA, has had an annual Spongy moth trapping program in place since 1973. This program is designed to protect Minnesota's forests from this tree pest already established in Wisconsin and other eastern states.

Spongy moth in North America

Each summer, MDA workers fan out across the state to set about 16,000 Spongy moth traps. Known as Delta traps, they are triangular, 5 x 6 inch pup tent-shaped pieces of cardboard that are stapled or tied to trees and poles.

Each trap contains a pheromone designed to lure adult male Spongy moths. These pheromones are nontoxic to humans or animals. Once inside, the moth becomes entangled in a sticky substance coating the trap's interior.

Spongy moth in North America

Delta traps attract male Spongy moths with the pheromone of the female. The trap has been opened and laid flat to show the male moths.

Spongy moth in North America

To detect new infestations, traps are placed at a rate of either one trap every 1500 meters or one trap every 3 kilometers, depending on the risk of introduction.

They are placed at higher rates in areas where male moths were caught in previous years. Traps are placed on public property, public rights of way and private property.

Spongy moth in North America

Depending on the number of moths caught in a location, the MDA moves in to combat the pest with chemical and behavioral management techniques.

So far, these spot treatments have kept the moth from getting a foothold in Minnesota.

Spongy moth in North America

The MDA follows up the treatments with a mass trapping effort. This means 36 or more delta traps are set per square mile to determine if the population was eradicated. If no additional moths are caught, the treatment is considered successful.

The MDA will continue to monitor the site with heavy trapping for two years following a treatment. If traps remain empty for those two years, the MDA goes back to regular trapping.

Spongy moth chemical management

Spongy moth in North America

Chemical management

- ***Bacillus thuringiensis*** **var. *kurstaki*: only affects lepidoptera, conserves beneficial insects; Kills larvae by lysing gut with protein crystal; not toxic to mammals**

- **Green plastic flakes containing female pheromone: Disparlure; distributed by plane; 3-4 flakes per foot Disrupt mating; males can not locate females.**

Spongy moth in North America

Chemical management

- **Dimilin, IGR (insect growth regulator) prevents SM larvae from molting. Can cause mortality to aquatic insects, do not spray near water.**

Bacillus thuringiensis var. kurstaki **(Btk)**
Dipel
Thuricide
Protein crystal

Mode of action: Naturally-occurring microorganism that is a stomach poison to moths and butterflies. Feeding ceases and then death occurs.

Duration: No more than 1 week

Caution: Will kill some other butterflies and moths.

diflubenzuron
(not available for homeowner use)
Dimilin
IGR

Mode of action: Stops insect growth and development.

When to apply: When eggs have hatched and leaves are expanded. Apply when young caterpillars are present.

Duration: 3 months on foliage

diflubenzuron
(not available for homeowner use)
Dimilin
IGR

Caution: Cannot be applied over water courses or ponds. Will affect any animals that produce chitin (e.g., crawfish and insects).

tebufenozide
Mimic
IGR

Mode of action: Stops insect growth and development.

When to apply: When eggs have hatched and leaves are expanded. Apply when young caterpillars are present.

Duration: 3 months on foliage

cyfluthrin
Tempo
pyrethroid

Mode of action: Stomach and contact insecticide.

When to apply: When eggs have hatched and leaves are expanded. Apply when young caterpillars are present.

Duration: 2-3 weeks

Caution: Highly toxic to honey bees. Also toxic to many other insects and aquatic organisms.

azadirachtin
Neemix
botanical

Mode of action: Growth regulator.

Duration: No more than 1 week

Caution: Will kill some other butterflies and moths.

acephate
Orthene
organophosphate

Mode of action: Stomach poison. Broad spectrum insecticide. Cholinesterase inhibitor.

When to apply: When eggs have hatched and leaves are expanded. Apply when young caterpillars are present.

Duration: 1-1.5 weeks

Caution: Toxic to birds, bees. Do not apply over water.

Spongy moth in North America

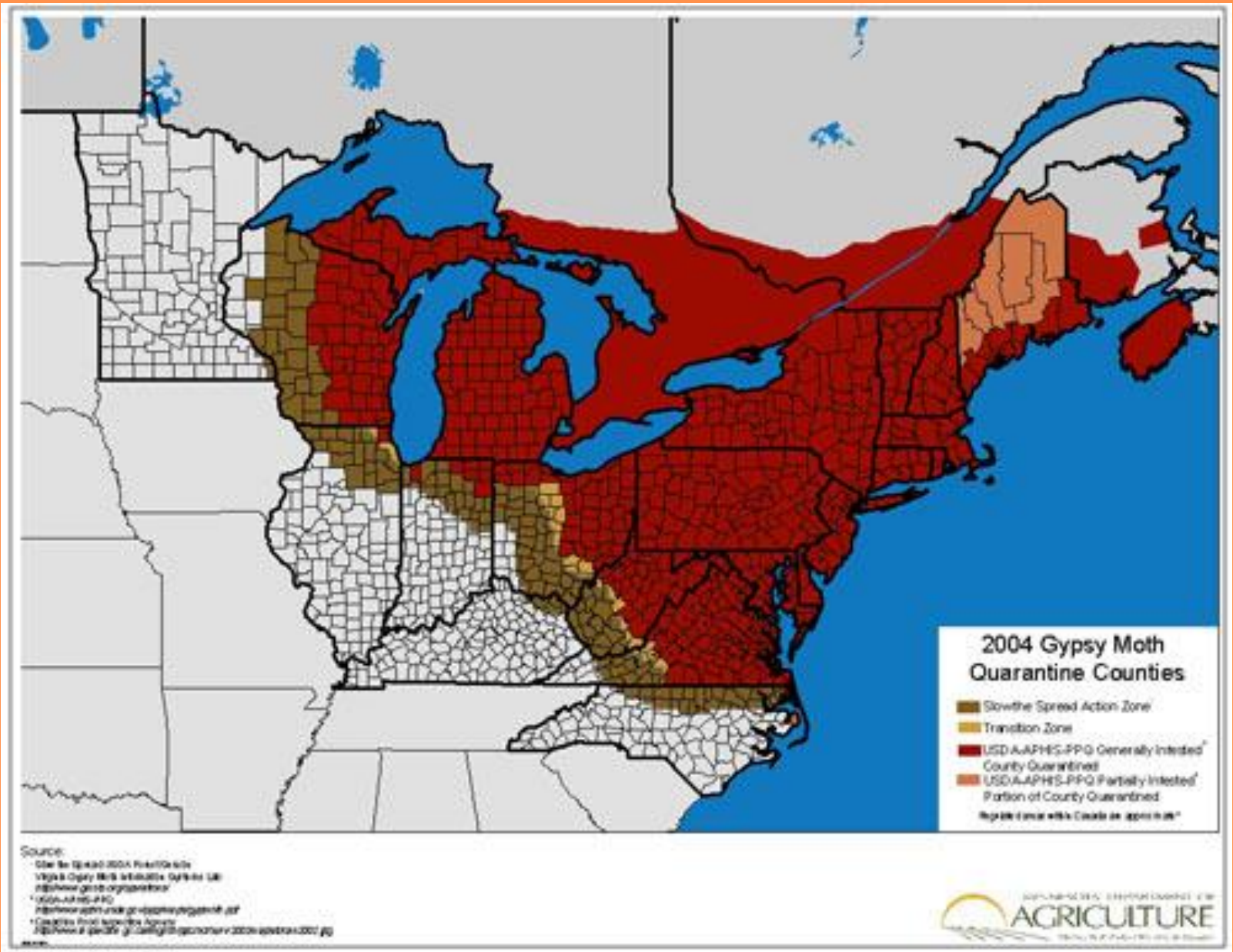
Slow the spread program (STS) Chemical management

The goal of the STS project is to determine the feasibility of using IPM strategies to slow the spread of the Spongy moth over a large geographic area. The objectives for STS are to:

1) demonstrate that new and current technology can slow the rate at which Spongy moth populations are spreading,

2) assess the technological, economic, ecological, and environmental viability of implementing an operational STS program.

2004 Spongy moth infested quarantine counties



Spongy moth virus and fungus

NPV: Nucleopolyhederosis virus

A naturally occurring virus called the “wilt” has resulted in massive mortality of caterpillars causing populations to collapse in areas of severe defoliation.

Although the virus is always present, it seldom affects the larval stage until they are under stress, due to overcrowding or reduced food availability.

PATHOGENS

NPV virus death

The bodies of dead caterpillars are soft, filled with a brown liquid and disintegrate rapidly. Usually, they hang limply in an inverted “V” position.

Entomophaga maimaiga fungus

Although *Entomophaga maimaiga* was introduced in the United States from Japan in 1910 and 1911, its 1989 appearance in Connecticut, New Hampshire, Vermont, northeastern Pennsylvania, New Jersey, southeastern New York, and Massachusetts is a mystery:

If its presence is due to the original introduction, why wasn't it detected during the years between 1911 and 1989?

Entomophaga maimaiga fungus

E. maimaiga **passes the winter as a tough, thick-walled "resting spore" in the soil and on tree bark. In May or June, resting spores germinate and produce sticky spores at the end of a stalk that grows just above the soil surface. Spongy moth caterpillars come into contact with these spores as they search for suitable leaves to feed on. The fungus digests its way through the exoskeleton of the caterpillar and grows inside the body of the caterpillar. Infected caterpillars may die within one week.**

Entomophaga maimaiga fungus

When young caterpillars are affected early in the summer, the fungus will produce a second type of spore called conidia. These microscopic spores are spread by the wind and can infect other caterpillars. The cycle of conidia production and infection may occur four to nine times during the summer. When the fungus develops in large caterpillars, it produces the overwintering resting spores.

Entomophaga maimaiga fungus

In recent years during wet spring weather, the fungal insect pathogen, *Entomophaga maimaiga*, has caused collapse of heavy infestations of Spongy moth.
It is moved from state to state by state and federal officials through cadavers or infected larvae.

Entomophaga maimaiga fungus

Soil can contain spores, but it can contain other pathogens, so cadavers are the best choice for transporting the fungus.

Entomophaga maimaiga fungus

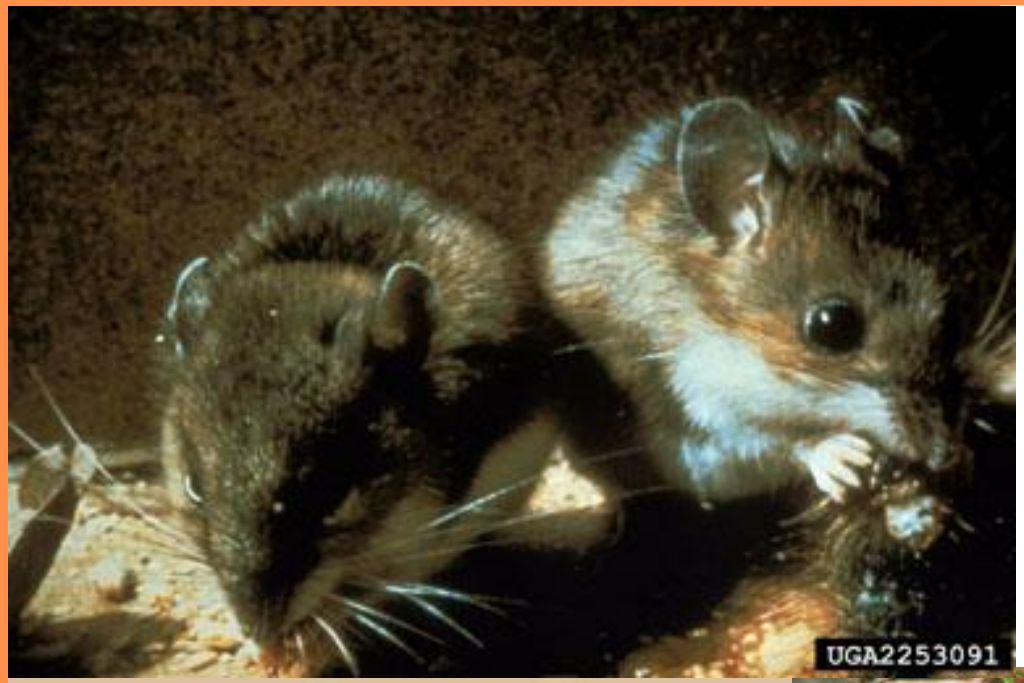
Right: *E. maimaiga* conidia.

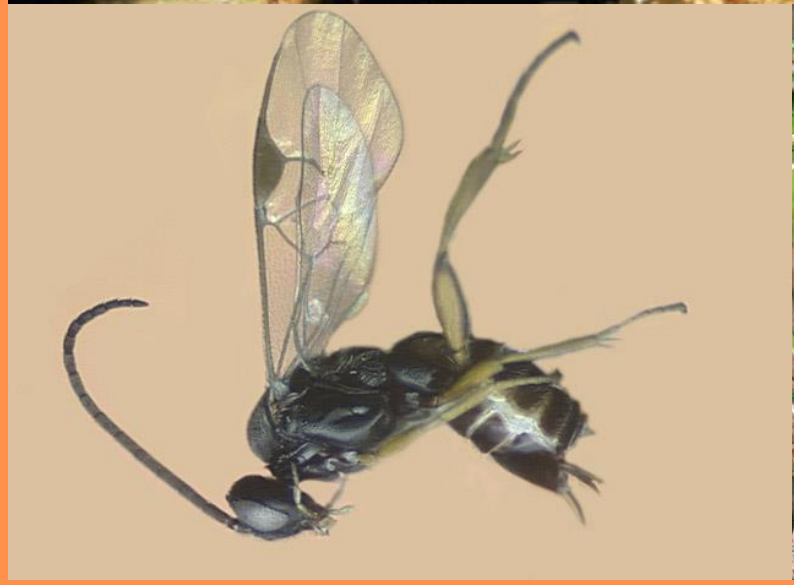
Left: *E. maimaiga* resting spores.

Entomophaga maimaiga fungus

***Entomophaga maimaiga* death**
Caterpillars killed by *E. maimaiga* will also remain attached to tree stems or branches. However, the bodies tend to be stiff and straight, and the legs extend stiffly from the body. Some of the dead caterpillars may have tiny white conidia attached to the hairs on the body. The cadavers may remain on the stem well into the winter.

Spongy moth parasitoids, predators, and deer mice





Spongy moth parasitoids: *Compsilura concinnata*

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Compsilura concinnata **(Diptera: Tachinidae) is a parasitoid native to Europe. This parasitoid is an extreme generalist, attacking over 200 different hosts from three insect orders, including Lepidoptera, Coleoptera and Hymenoptera.**

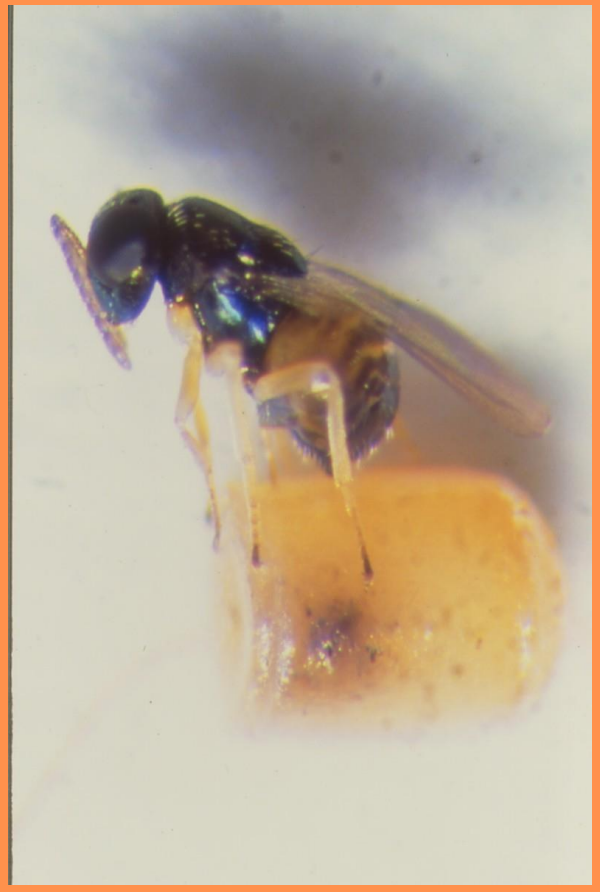
Spongy moth parasitoids: *Compsilura concinnata*

Compsilura **was initially introduced into North America in 1906 to combat Spongy moth. Numerous releases of this parasitoid were made thereafter for a variety of lepidopteran pests. In Minnesota,** ***Compsilura*** **was released, dating back to 1937, for biological control of the fall cankerworm,** ***Alsophila pometaria*****.**

Spongy moth parasitoids: *Compsilura concinnata*

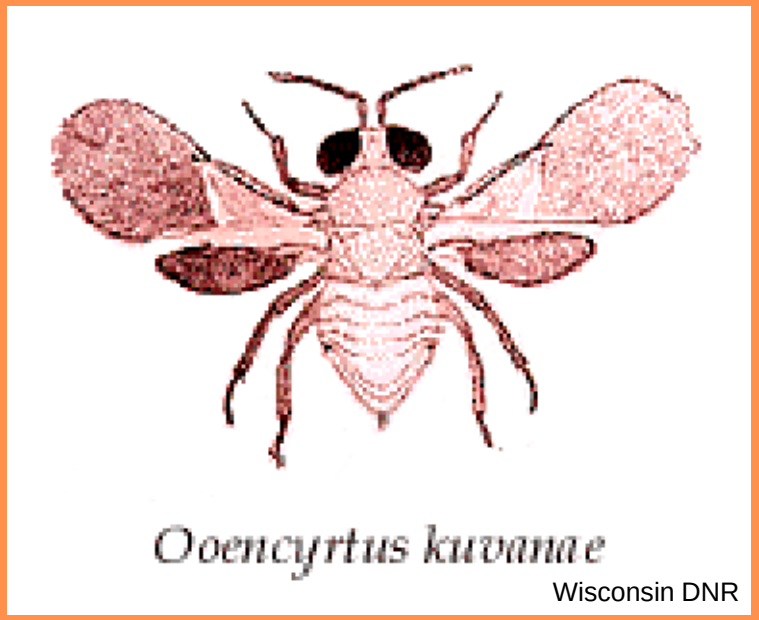
These early releases allowed for a sort of "anticipatory" biological control for the Spongy moth.
What this means is that, since *Compsilura* has the ability to attack so many different host species, *Compsilura* could become established on alternate hosts before the Spongy moth arrived in Minnesota. Furthermore, the biological control offered by *Compsilura* has "spilled over" from the forest systems into other habitats such as agricultural crops, including cabbage. Unfortunately, *Compsilura* appears to be attacking native, non-pest insects too.

Spongy moth parasitoids: *Ooencyrtus kuvanae*



***Ooencyrtus* sp.**

http://www.daapv.unipd.it/promoth/parasitoids.htm



Wisconsin DNR

Spongy moth parasitoids: *Ooencyrtus kuvanae*

Ooencyrtus kuvanae **(*Hymenoptera*: *Encyrtidae*) is a small encyrtid wasp that was first introduced to the eastern United States in 1909 from Japan as an egg parasitoid for control of the Spongy moth.**

Females overwinter in the leaf litter, and become active around mid-April. Each oviposits on Spongy moth egg masses for about 4 to 6 weeks, with each female laying an average of 200 eggs.

Spongy moth parasitoids: *Ooencyrtus kuvanae*

Females are good fliers, and they actively search out Spongy moth egg masses on tree trunks and tree branches. The females may locate the egg masses through scents released from the egg masses themselves, or they may be able to detect pheromones of Spongy moth females, and therefore locate egg masses as they are being laid.

Field rates of parasitism by *O. kuvanae* average around 20-30%. Parasitoid presence is noted by a tiny round emergence hole.

Spongy moth parasitoids: *Cotesia melanoscela*

Spongy moth parasitoids: *Cotesia melanoscela*

This braconid wasp (Hymenoptera: Braconidae) was one of the first parasitoids introduced from Europe early in this century to control the Spongy moth. There are actually two strains of the wasp in the U.S. now. The European strain was brought from Italy in 1912, while the Asian strain was introduced from India in 1977 and from South Korea in 1983. This species is now widespread and abundant where Spongy moth is established, and is one of the principal parasitoids attacking early-instar Spongy moths in North America.

Spongy moth parasitoids: *Cotesia melanoscela*

Adults emerge when Spongy moth caterpillars start hatching from their overwintering eggs. Each female lays 500 to 1,000 eggs, which she places singly in first and second instar Spongy moth larvae. Oviposition itself may be enough to kill small caterpillars. During the second generation, the females oviposit in third instar caterpillars as well, but later instars are not easily parasitized because of their long hairs and vigorous defensive movements. When the larvae complete their development, they tear a hole in the side of the caterpillar and emerge from their hosts.

Spongy moth parasitoids: *Cotesia melanoscela*

They spin silken cocoons on the foliage, tree bark, or any other objects the caterpillars crawled onto before dying.

The overwintering generation of *C. melanoscela* is attacked by many hyperparasites, which reduce the effectiveness of this wasp. These other parasitoids can parasitize up to 80-90% of the overwintering *C. melanoscela* cocoons. Although this high mortality does not prevent the wasp from establishing and sustaining a population, it does reduce the ability of *C. melanoscela* to suppress Spongy moth populations.

Spongy moth predators: *Calosoma sycophanta* beetles

***Calosoma sycophanta*, (Coleoptera: Carabidae) a large, bright metallic green beetle, was imported from Europe to New England for the biological control of the Spongy moth in 1905.**

Spongy moth predators: *Calosoma sycophanta* beetles

The larva feeds day and night, consuming 50 caterpillars during its two-week developmental period. The adult will eat several hundred caterpillars during a life span of two to four years. A native species, *Calosoma scrutator,* also feeds on caterpillars.

Spongy moth predators: *Calosoma sycophanta* beetles

Unfortunately predators don’t exist in sufficient numbers to have a large impact on the Spongy moth caterpillars’ numbers.

Spongy moth predators: deer mice

Most birds avoid Spongy moth caterpillars, but small rodents will feed on them, especially when populations are high. Unfortunately predators don’t exist in sufficient numbers to have a large impact on the Spongy moth caterpillars’ numbers.