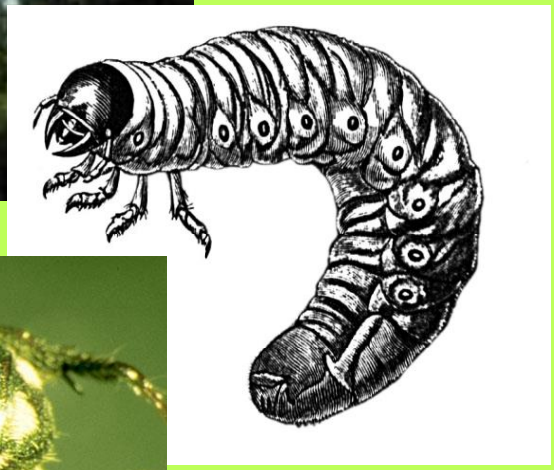

Exotics vs. native pests

Dr. Vera Krischik,
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Native vs. introduced (exotic) pests

Today's discussion

Asian long-horned beetle (Cerambycidae, Coleoptera)

Japanese beetle (Scarabeidae, Coleoptera)

Pesticide choice

Kills egg laying adult

Kills larvae or grub

Biological control (BC)

Classic

Augmentation

Conservation BC

Native vs. introduced (exotic) pests

Adelgids (aphids, scales, adelgids, Homoptera)

Hemlock Wolly adelgid, exotic

Euonymous scale, exotic discussed in lecture

Leaf and scarab beetles (beetles, Coleoptera)

Elm leaf beetle, exotic discussed in lecture

Japanese beetle, exotic

Leaf-chewing moths (moths, Lepidoptera)

Spongy moth, exotic discussed in lecture

Forest tent caterpillar, native

Clearwing borers, native

Leaf-chewing sawflies (sawflies, Hymenoptera)

Birch leaf miner, exotic

European pine sawfly, exotic

Yellowheaded spruce sawfly, native

Native vs. introduced (exotic) pests

Lady beetles (beetles, Coleoptera)
Asian lady beetle, exotic
Convergent lady beetle, native

Buprestid borers (beetle, Coleoptera)
Emerald ash borer, exotic
Two-lined chestnut borer, native
Bronze birch borer, native

Cerambycid borers (beetle, Coleoptera)
Asian long-horned beetle, exotic
White spotted sawyer, exotic
Linden borer, native

Native vs. introduced (exotic) pests

Four stages of invasion

- **arrival (accidental or deliberate introduction)**
- **establishment (reproduction)**
- **integration (adaptation)**
- **spread (dispersal)**

Native vs. introduced (exotic) pests

- How do invasions of exotics occur?
- What makes a species a successful invader?
- Preventing/treating invasions

How do invasions occur?

Import/export of agricultural products

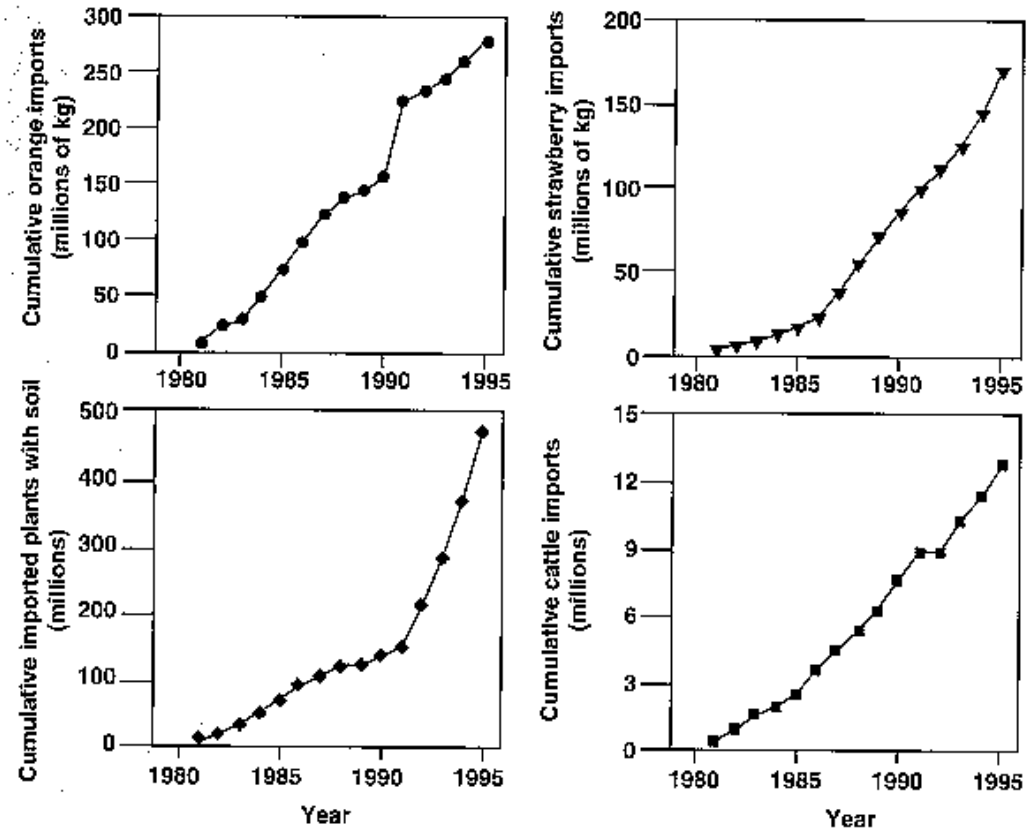


Fig. 2. Cumulative U.S. Imports of select agricultural commodities since 1981 (Source: Census Bureau, U.S. Department of Commerce).

How do invasions of exotics occur?
Mobility of people

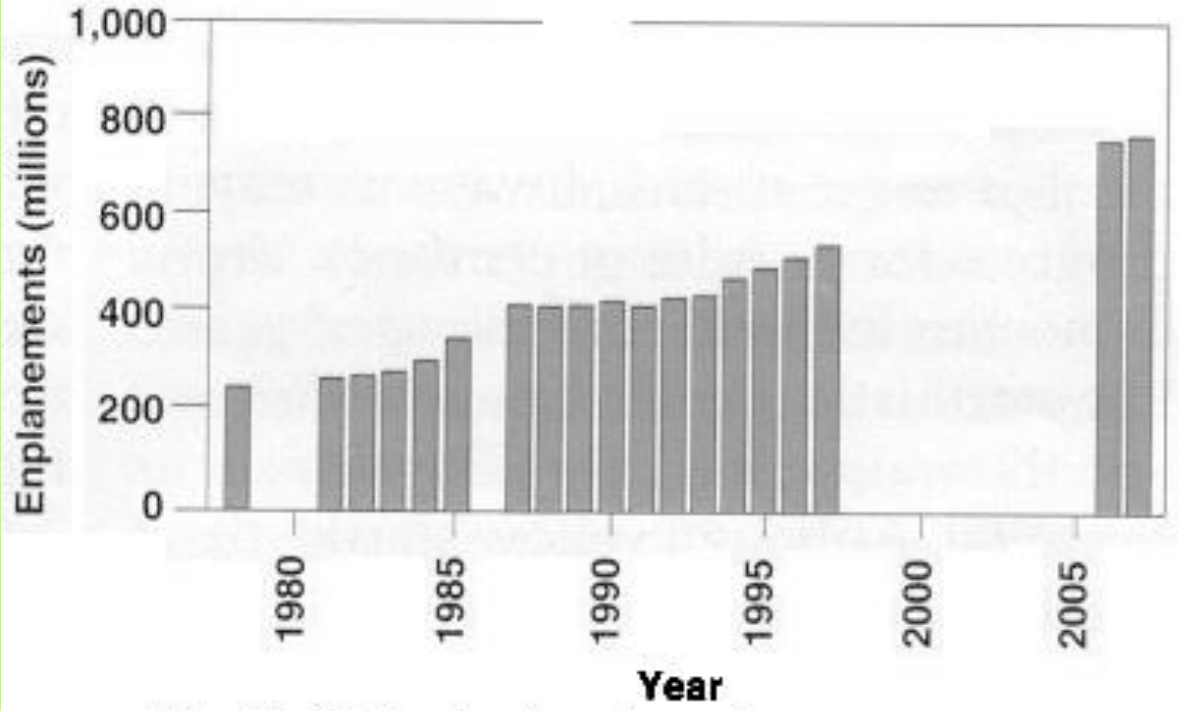


Fig. 3. Historical and projected number of annual enplanements, people boarding aircraft, in the United States (Source: Federal Aviation Administration—data not available for some years.).

What makes a species a successful invader?

- High population growth rate (r-strategists) (early reproduction, high number offspring)
- High mobility
- Able to tolerate climate, plant resources

Preventing/ treating invasions

Control at borders on import of agricultural products or other products that may harbor pests (APHIS)

Quarantine

Quarantine measures may be taken to limit the spread of introduced pests. Usually include a ban on transporting materials that may harbor the pest from infested to non-infested areas.

Native vs. introduced (exotic) pests

- **Exotic species: over 50,000 present in the US accidental introductions in soil, on plants or other agricultural products, in water ballast**
  ~ 95% of introductions are accidental

- **Deliberate introductions for biological control of pests**

Why worry about exotic species?

- Damage to native plants
- Damage to food crops/ other products
- Cost of pest control
- Health problems: vectoring diseases

Number of Nonindigenous Species in North America

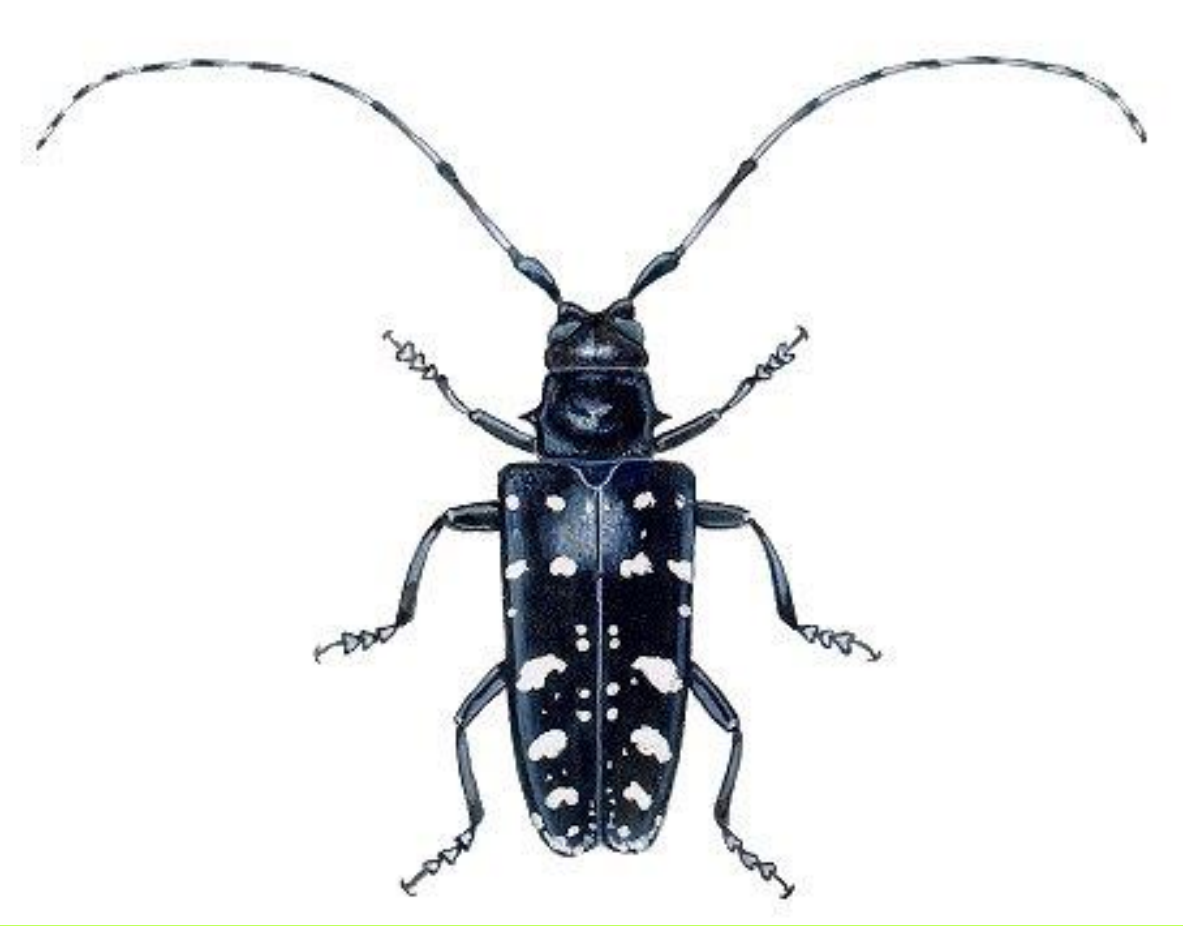
Plants	25,000
Microbes/Plant Pathogens	20,000
Livestock Diseases	9,000
Arthropods	4,500
Fish	138
Birds	97
Mollusks	88
Reptiles and Amphibians	53
Mammals	20
Human Diseases	??

Data from Pimentel et al. 1999

The Exotic Invasion of Florida

Immigrant Taxa 1986-2000

Asian long horned beetle, *Anoplophora glabripennis* (Coleoptera: Cerambycidae) Exotic: Asia



Adults are glossy black beetles with about 20 irregular white spots on each wing cover. The antennae are alternately striped white and black. Adults measure 20-35 mm long and 6-12 mm wide.

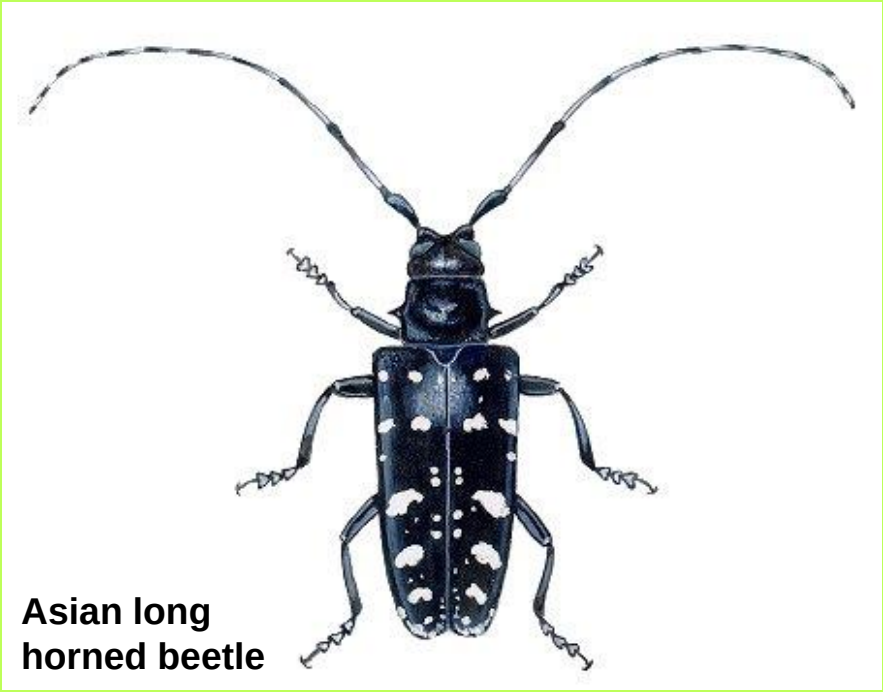
Asian long horned beetle and emerald ash borer

Sign of infestation: dieback of the upper third of a tree, followed by a large number of shoots or branches arising below the dead portions of the trunk.

Emerald Ash borer, *Agrilus planipennis* (Coleoptera: Buprestidae)

Native to Asia
1-to 2 year lifecycle
Larve feed on phloem
Adults emerge mid to late May.

Adults are dark metallic green in color, 1/2 inch in length and 1/16 inch wide.



Asian long horned beetle

Larvae are elongate, cylindrical and pale yellow in color, attaining a maximum length of 50 mm.

In the United States the beetle prefers maple species (*Acer* spp.), including boxelder, Norway, red, silver, and sugar maples. Other known hosts are alders, birches, elms, horsechestnut, poplars, and willows.

Asian long horned beetle

Asian long horned beetle larva

Emerald ash borer larva

Asian long horned beetle

Round pits chewed out by females to oviposit.

Accumulation of sawdust, produced by the larvae as they bore into the stem.

Also sap flow usually visible.

Emerald ash borer

Larvae are creamy white in color and are found under the bark.

Callus tissue produced by the tree causing vertical fissures.

Asian long horned beetle

Exit holes where adult beetles emerged from the tree

Asian long horned beetle

Asian long horned beetle

Emerald ash borer larva
“D” shaped exit holes
on lower part of tree

Asian long horned beetle

Adults are weak flyers, but, like other wood borers, ALB can be transported as eggs, larvae and pupae in logs, tree trimmings, firewood and untreated lumber.

Quarantine prohibits movement of these materials from infested areas to non-infested areas

Asian long horned beetle

Natural enemies and cultural methods for controlling ALB are recorded from China, but ALB remains a serious pest except where susceptible trees (poplars) are replaced with resistant varieties.

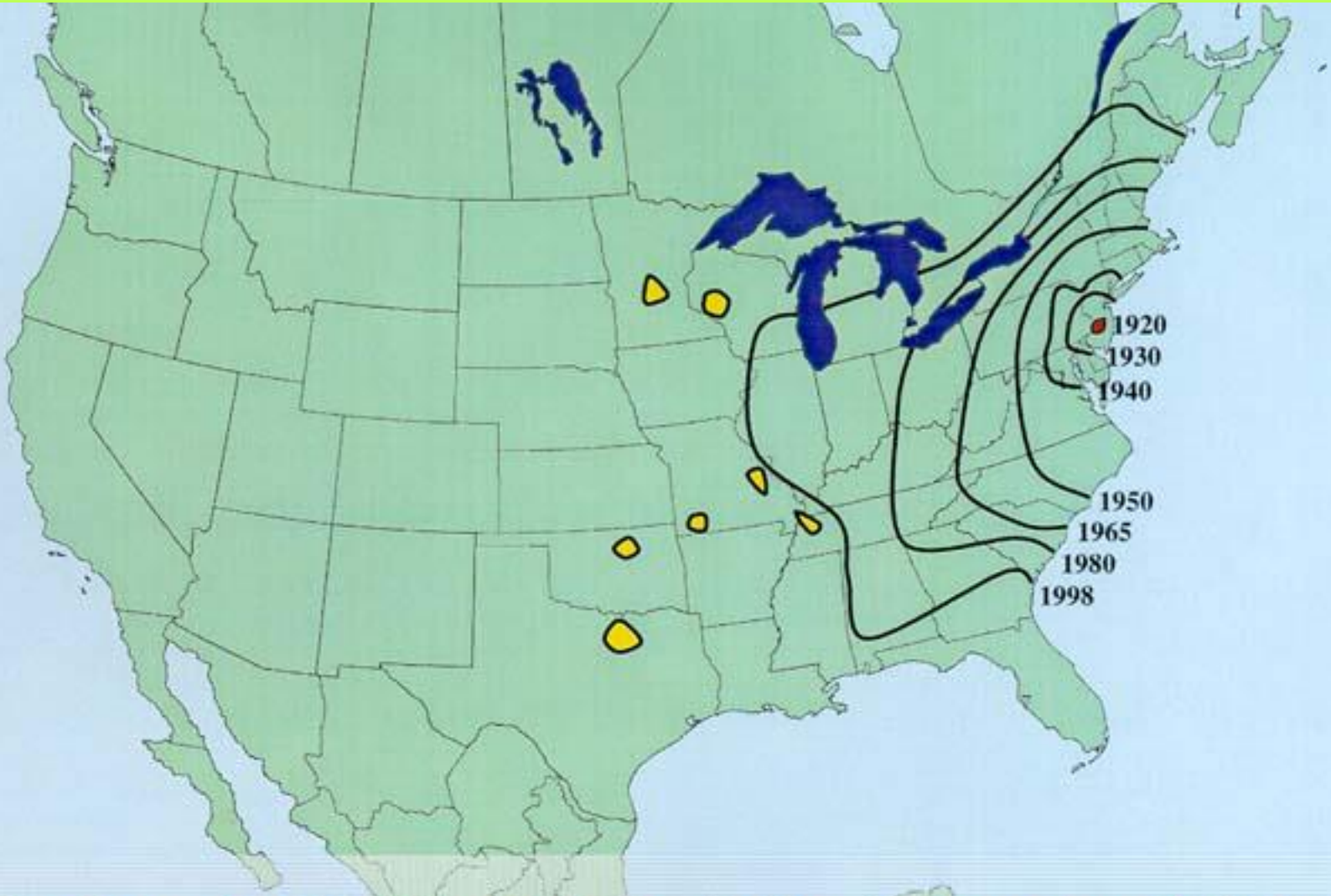
For suppressing populations of ALB in the North American environment, tree removal may remain a primary technique for some time, and chemical controls may become necessary should large scale natural controls remain ineffective.

Turf pest: Japanese beetle

Identification:

Japanese beetle

Family Scarabeidae, Order Coleoptera



The Spread of Japanese Beetle in North America, 1908-1998

Turf pest: Japanese beetle

Identification:

The Japanese beetle is an exotic scarab originally established in New Jersey. Japanese beetles are approximately 7/16 inch long. The front of the beetle is dark metallic green and the wing covers are dark tan. There are five small, white patches of short hairs along each side of the dorsal abdomen on the beetle. These white patches are a key characteristic for identification. If it does not have these white hair patches, it is the False Japanese beetle.

Turf pest: Japanese beetle

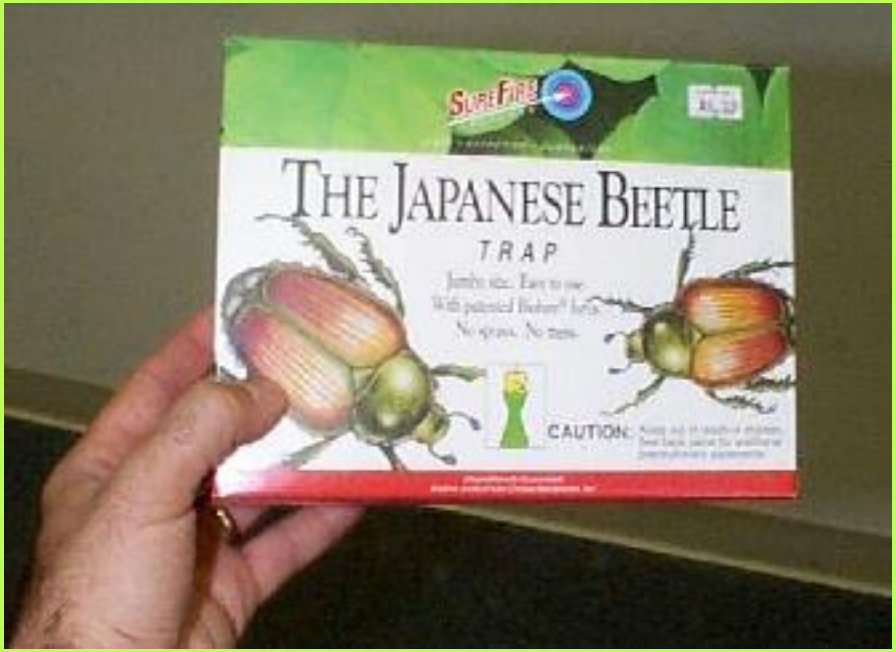
Damage, scouting, and management:

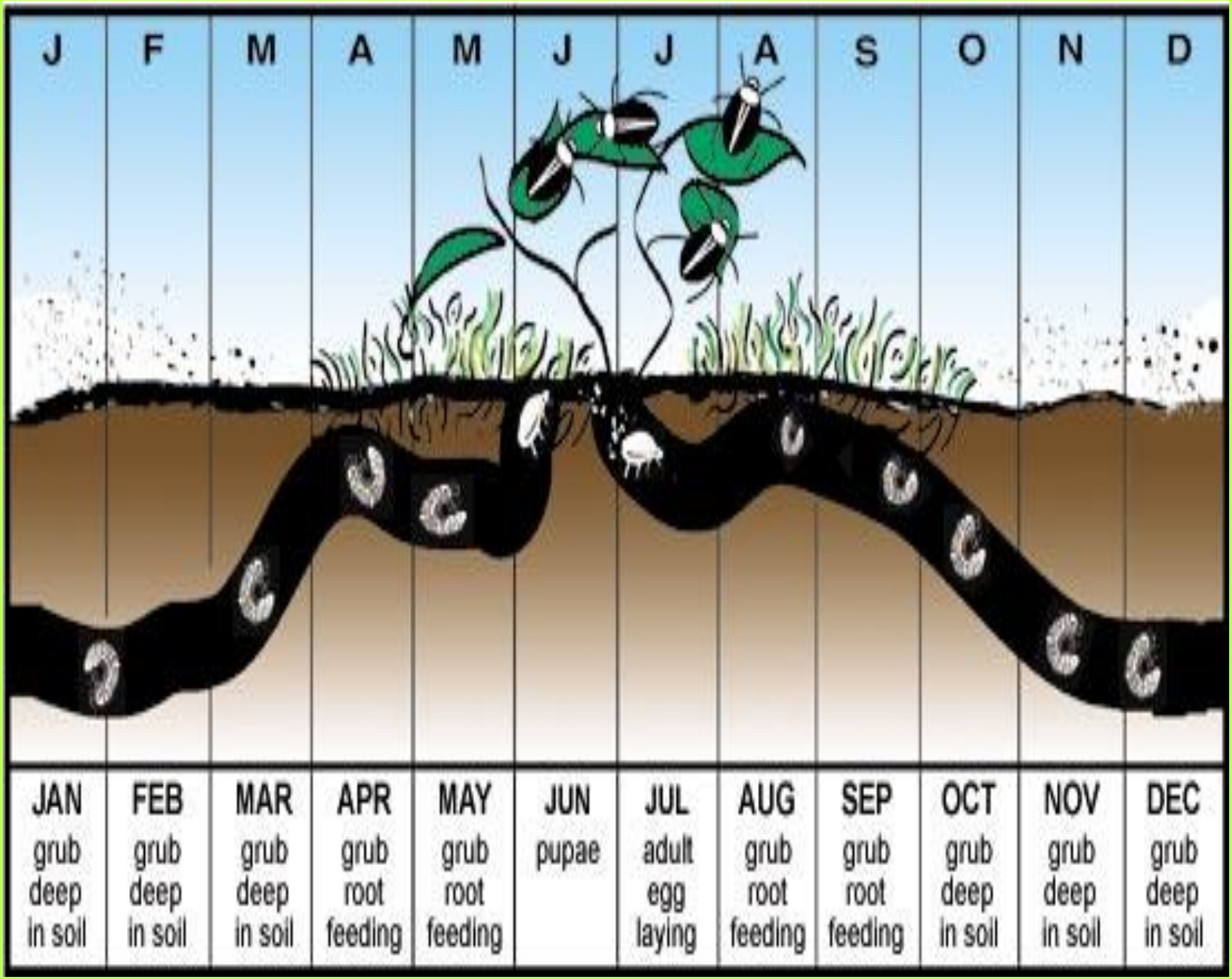
One of the favored foods of adult Japanese beetles is rose, grape, Norway maple, and linden foliage. Adults feed on over three hundred species of plants. Inspect your plants for skeletonized leaves and the presence of adult beetles.

Larvae feed on the roots of grasses.

Turf pest: Japanese beetle

Damage, scouting, and management:
Pheromone traps use a rose-scented lure to attract the adult beetles and can be purchased in garden centers.




J F M A M J J A S O N D
JAN grub deep in soil
FEB grub deep in soil
MAR grub deep in soil
APR grub root feeding
MAY grub root feeding
JUN pupae
JUL adult egg laying
AUG grub root feeding
SEP grub root feeding
OCT grub deep in soil
NOV grub deep in soil
DEC grub deep in soil

Turf pests

Pesticides:

***Steinernema glaseri* nematodes,**
***Heterorhabditis bacteriophora* nematodes,**

halofenozide, imidacloprid, trichlorfon

Parasitic nematodes

Steinernema carpocapsae

Heterorhabditis bacteriophora

Elm Leaf Beetle Pupa Infected With Nematodes

Pesticide choice: Preventative

Imidacloprid - is NOT fast acting, so use as a preventative control, not as a rescue treatment.

Apply imidacloprid after May 15 and before August 15. It has minimal risk to birds and fish.

Pesticide choice: Preventative

Halofenzide - is NOT fast acting, so use as a preventative control, not as a rescue treatment. Halofenzide mimics an insect hormone and is best applied when adults are active and laying eggs from June to the beginning of August. Minimize thatch since it will prevent the insecticide from penetrating to the roots.

Pesticide choice: Rescue

Trichlorfon - is a fast-acting material, but is susceptible to alkaline hydrolysis. One-half of the active ingredients will be degraded in 30 minutes at a pH of 9. Trichlorfon can be used as a rescue treatment when damage is observed.

Pesticide choice: Rescue

No longer available for turf.
bendiocarb, chlorpyrifos, diazinon, isofenophos, oftanol

Ecosystem Management

AVOID

Norway maple
gray birch
hollyhock
black walnut
mountain ash
horse chestnut
roses
linden
grapes
elm

flowering fruits: crabapple, apple cherry, black cherry, plum

Ecosystem Management

BETTER CHOICE

red maple
box elder
red oak
white ash
lilac
spruce
silver maple
white oak
poplar
green ash
euonymus
yew

Ecosystem Management

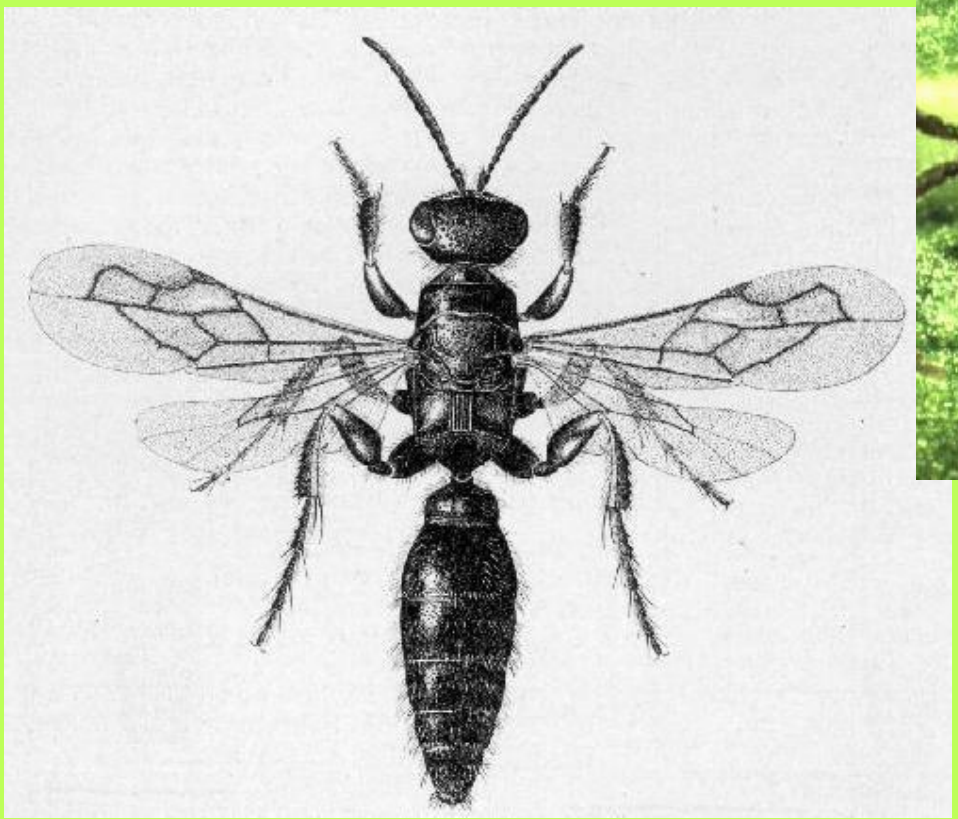
The Japanese beetle parasites *Tiphia vernalis (*Hymenoptera) and *Istocheta* sp., known to be active in Massachusetts and Connecticut, were absent in Michigan.

Ecosystem Management

Istocheta aldrichi
Tiphia vernalis
Ovavesicula popilliae
***Stictospora* sp.,**
entomopathogenic nematodes

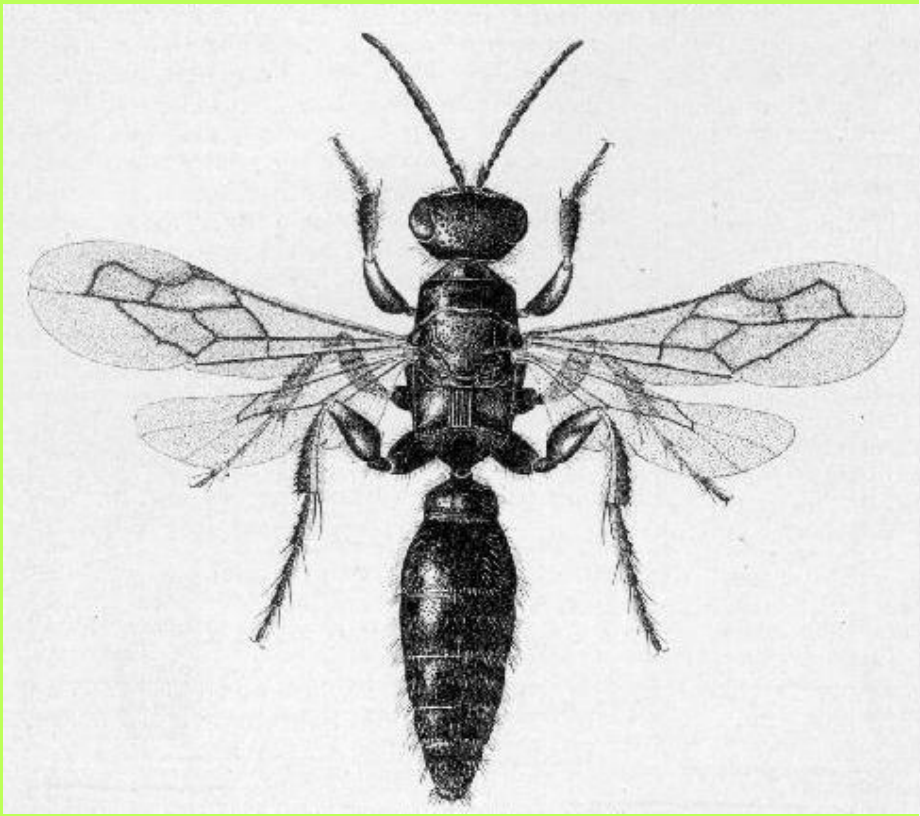
Ecosystem Management

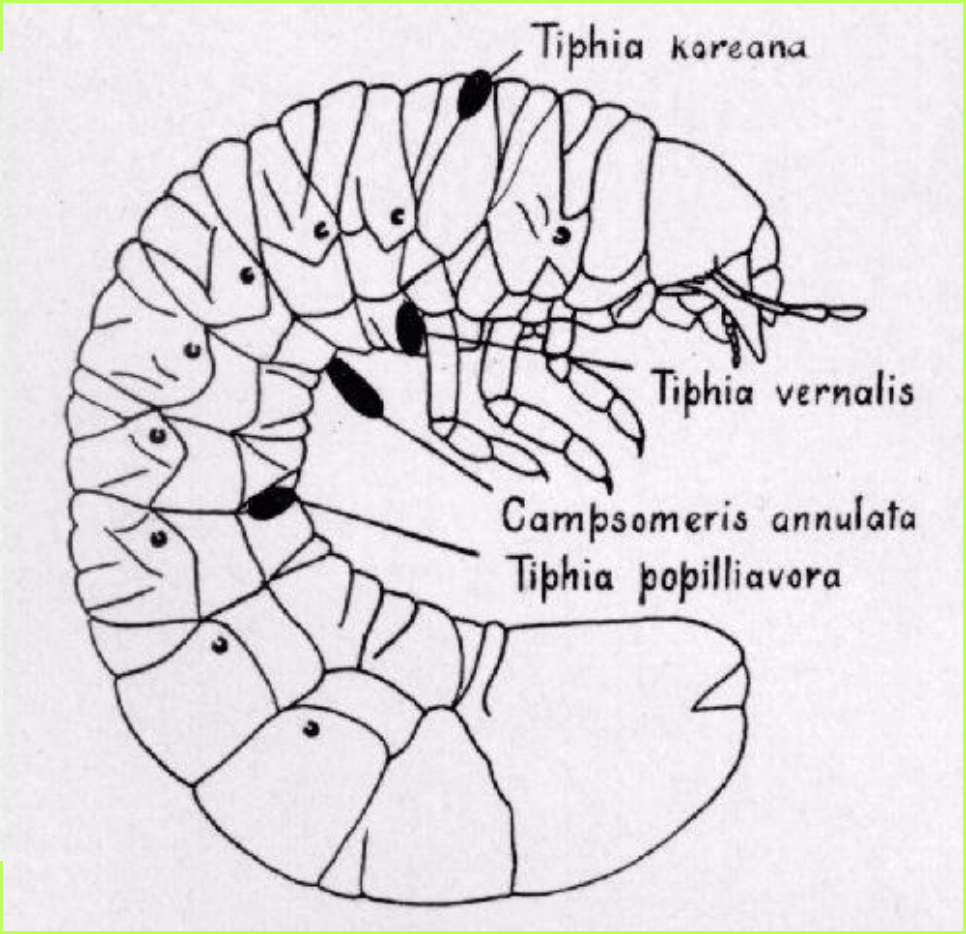
Tiphia vernalis



Ecosystem Management

Tiphia vernalis





Ecosystem Management

Tiphia vernalis

In the northeastern U.S., adult spring *Tiphia* wasps feed primarily on the honeydew exuded from aphids, scale insects, and leafhoppers.

The adult wasps were found feeding on the shaded foliage of maple, elm, cherry, tulip and pine trees, and some broad-leafed shrubs. The wasp will also feed on the nectar of blossoms, such as forsythia, and on the extra-floral nectaries of peonies.

Ecosystem Management

Tiphia vernalis

In China the knowledge of food plants to increase the rates of *Tiphia* parasitization of white grubs to an average of 85%.

Ecosystem Management

***Isotecha aldrichi* tachnid fly**

Forest Tent Caterpillar

Malacosoma disstria
Family Lasiocampidae
Native pest

Hosts: Alder, aspen, ash, basswood, birch, cherry, elm, hawthorn, maple, oak, peach, poplar, willow and flowering fruit trees.

Life History: Larvae appear in May and feed gregariously. Pupae and adults occur in summer, and eggs are laid on twigs in late summer. One generation a year.

Forest Tent Caterpillar

Overwintering: Black egg masses on twigs.

Damage: Shot holes, defoliation.

Monitoring: Look for shot holes in May.

Left: Young larvae and hatched eggs
Below: Adult male

Forest Tent Caterpillar

Physical Control: **Physically remove egg masses and groups of larvae.**

Chemical Control: **Residual insecticides.**

Biological Control: ***Bacillus thuringiensis*** **var.** ***kurstaki*** **for young larvae, several hymenopteran and dipteran parasitoids, nuclear polyhedrosis virus,** ***Entomophaga maimaiga*** **fungus.**

Cocoon

Forest Tent Caterpillar

Biological Control: *Sacrophagous aldrichi*,

Friendly fly

haw

Spongy Moth

Lymantria dispar
Family Lymantriidae
Introduced pest

Hosts: Oak, apple, crabapple, aspen, poplar, basswood, birch, blue spruce, and over 300 other species.

Spongy Moth

Life History: Eggs laid in masses in July and August, larvae emerge the following spring and pupate in June and July. One generation a year.

Overwintering: Egg masses.

Male (left) and female

Female with eggs

Spongy Moth

Damage: **Shot holes, defoliation.**

Monitoring: **Pheromone traps, look for damage and egg masses.**

USDA Forest Service Archives, USDA Forest Service
Bugwood Network, University of Georgia

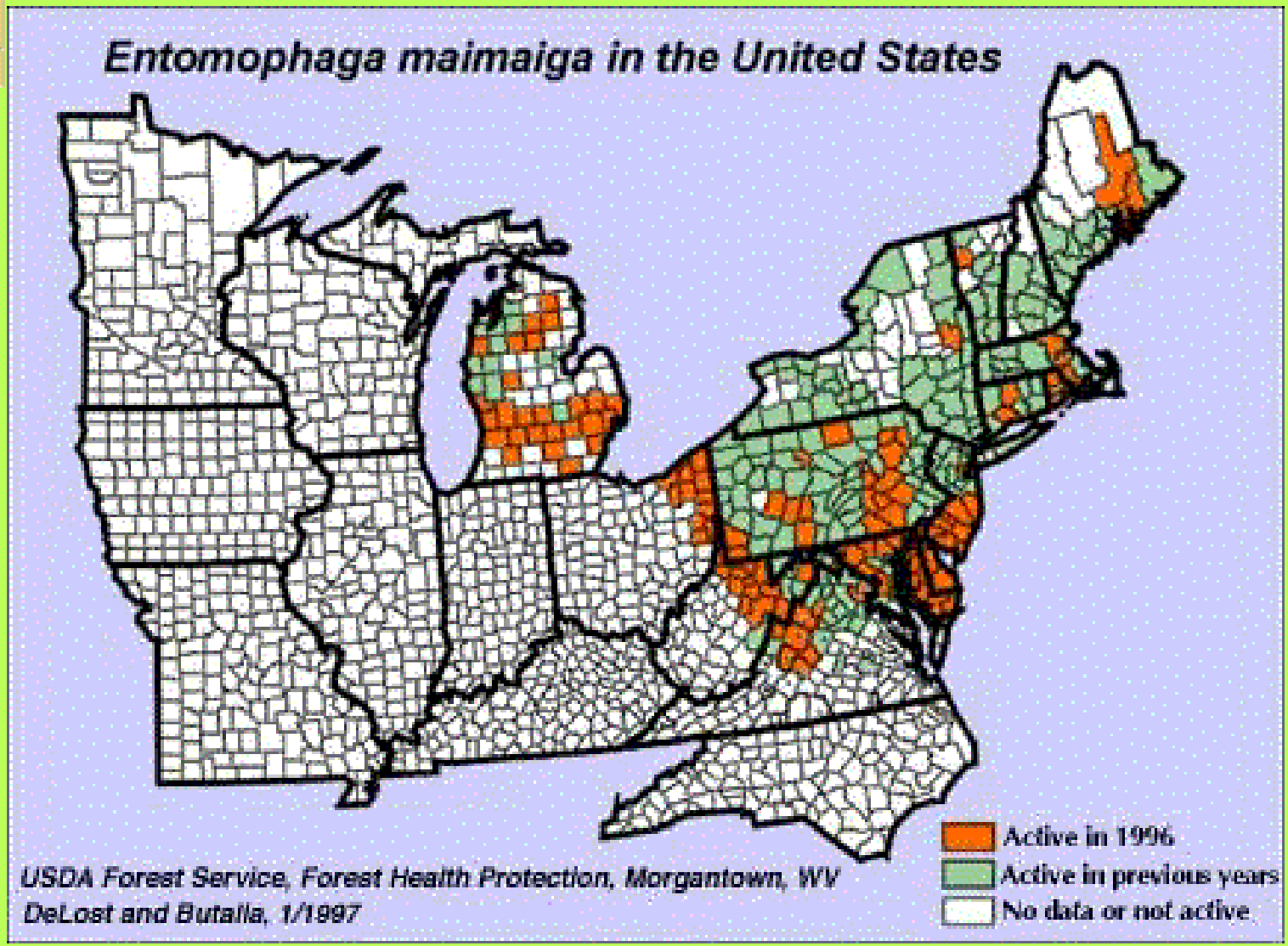
Spongy Moth

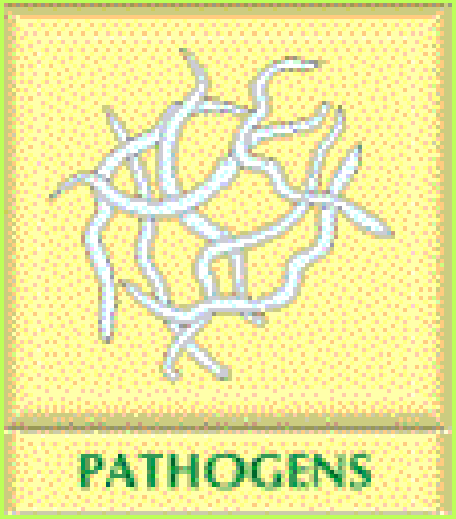
Chemical Control: **Diflubenzuron in May.**

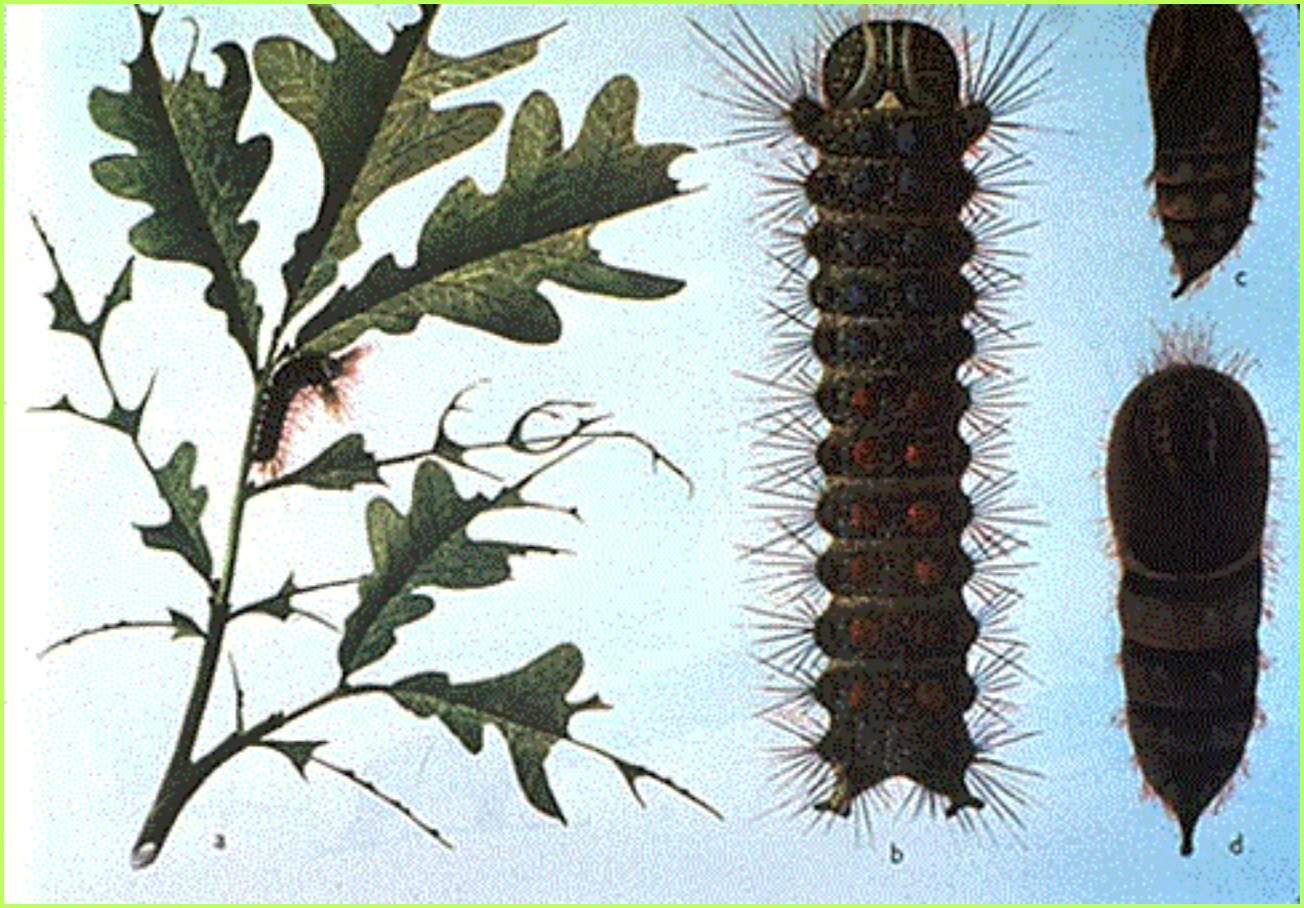
Biological Control: ***Bacillus thuringiensis*** **var.** ***kurstaki*** **for young larvae, several hymenopteran and dipteran parasitoids, carabids, rodents, nuclear polyhedrosis virus,** ***Entomophaga maimaiga*** **fungus.**

Larva killed by nuclear polyhedrosis virus

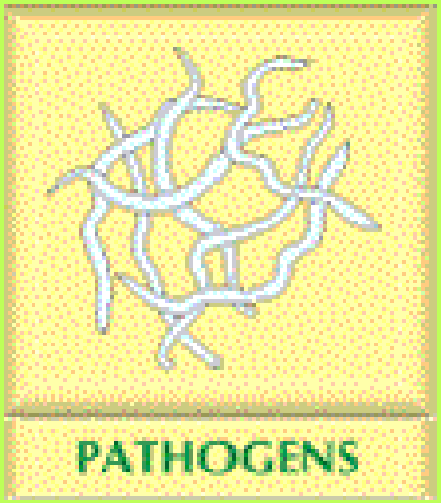
PATHOGENS


Entomophaga maimaiga in the United States
Active in 1996
Active in previous years
No data or not active
USDA Forest Service, Forest Health Protection, Morgantown, WV
DeLost and Butalla, 1/1997

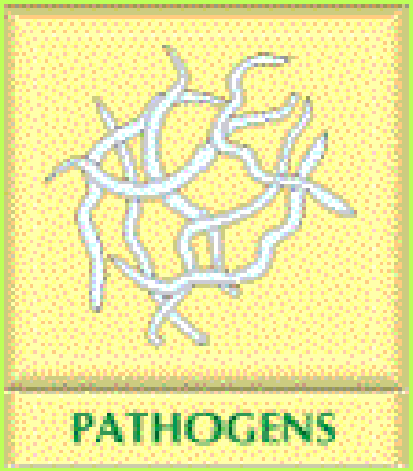




Entomophaga maimaiga
Entomophthorales: Family



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?



Right: *E. maimaiga* conidia

Left: *E. maimaiga* resting spores

PATHOGENS

Larva killed by
E. maimaiga

Clearwing Borers

Cottonwood Borer

Several species
Family Sessiidae
Native pests

Hosts: Alder, ash, birch, dogwood, fir, lilac, hawthorn, mountain-ash, maple, oak, pine, poplar, sycamore, viburnum, willow, and fruit trees such as apricot, cherry, peach, and plum.

Clearwing Borers

Life History: Most adults emerge in May and June (banded ash borer emerges in August). Larvae mine sapwood during the summer and pupate in the following spring. One generation a year.

Dogwood Borer

Clearwing Borers

Overwintering: Mature larvae in tunnels under bark.

Damage: Gnarled or rough bark, weakened branches.

Clearwing Borers

Monitoring: **Look for frass, tunnels, and pupal skins around tree wounds, loose bark, and cracks. Use pheromone traps.**

Cultural Control: **Avoid damage to trees and minimize tree stress. Do not band trees.**

Chemical Control: **Permethrin on bark in spring.**

Biological Control:
Several parasitic wasps, nematodes.

Larva killed by nematodes

Hemlock Wooly Adelgid

Adelges tsugae,
Family Adelgidae
Introduced pest

Hosts: Eastern hemlock, Carolina hemlock.

Life History: Overwintered immatures feed on needles. Two generations a year.

Overwintering: Immatures on twigs.

Hemlock Wooly Adelgid

Damage: White wax, needle yellowing, needle drop, defoliation, and tree death.

Monitoring: Look for cottony wax masses and damage symptoms.

Hemlock Wooly Adelgid

Cultural Control: **Choose resistant varieties: Western hemlock, mountain hemlock, and Japanese hemlock.**

Chemical Control: **Dormant oil, horticultural oil or soap, soil applications of imidacloprid**

Hemlock Wooly Adelgid

Biological Control: *Pseudoscymnus tsugae*

(Coleoptera: Coccinellidae)

Birch Leafminer

Fenusa pusilla
Family Tenthredinidae
Introduced pest


John Davidson

Hosts: **Birch.**

Life History: **Larvae pupate in spring, adults emerge in May. Eggs laid in slits in young leaves. Larvae mine in leaves. Two to four generations a year; second generation in June.**

Overwintering: **Mature larvae in soil.**

Birch Leafminer

Damage: Kidney-shaped mines and brown, irregular, wrinkled blotches; browning of leaves and trees.

Monitoring: Look for adults on new leaves. Sticky traps on terminals. Look for mines.

Birch Leafminer

Cultural Control: **Plant resistant species:**
Betula davurica,
B. schmitii, B. costata,
B. maximowiczana.

Chemical Control:
Imidacloprid

Birch Leafminer

Biological Control:

Ichneumonids *Lathrolestes nigricolis* and *Grypocentrus albipes.*

Yellowheaded Spruce Sawfly

Pikonema alaskensis
Family
Tenthredinidae
Native pest

Hosts: **White, black, and blue spruces.**

Life History: **Females lay eggs in current year's needles and larvae feed in loose groups from May to June. Development is complete in July.**

Overwintering: **Prepupae in soil.**

Yellowheaded Spruce Sawfly

Damage: Defoliation, first of new needles, then of old needles.

Monitoring: Look for damage and groups of larvae from May to July.

Yellowheaded Spruce Sawfly

Physical Control: Prune out small populations.

Chemical Control: Horticultural oil for young larvae, residual insecticides for aggregations of older larvae.

Biological Control: 32 hymenopteran and 9 dipteran parasitoids including the tachinid fly *Bessa harveyi*.

European Pine Sawfly

Neodiprion sertifer
Family Diprionidae
Introduced pest

Hosts: **Pines.**

Life History: **Larvae feed from May to June and pupate in soil. Adults emerge in September through late fall. One generation a year.**

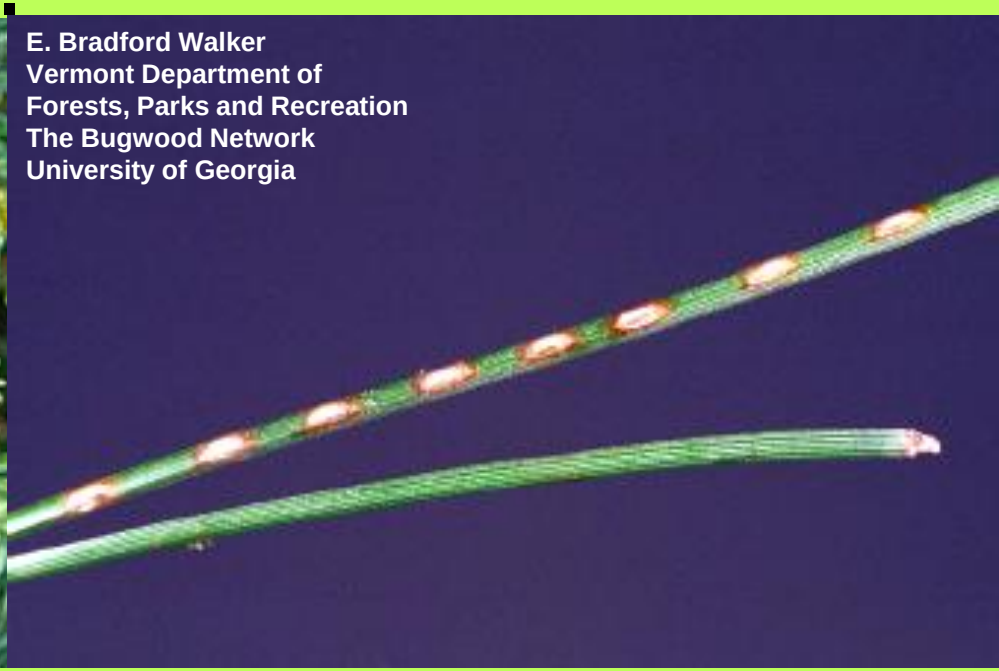
Overwintering: **Eggs in needles.**

European Pine Sawfly

Damage: **Defoliation of previous year's needles.**

Monitoring: **Monitor newly plants and plants in poor health. Look for branches stripped of needles and for larvae.**

Feeding damage



Eggs and oviposition damage

European Pine Sawfly

Physical Control: **Remove larvae by hand or dislodge with water spray.**

Chemical Control: **Insecticidal soap for young larvae.**

Biological Control: **Parasitoids, native birds, nuclear polyhedrosis virus, rodents.**