Extension Bulletin E-2811 • June 2002 • New

Directory of Exotic Forest Insect and Disease Pests

Deborah G. McCullough
and
James E. Zablotny

MICHIGAN STATE
UNIVERSITY
EXTENSION

Cover photo:
Eastern white pine with dieback
caused by white pine blister rust.

Cover photo provided by J. O'Brien, USDA Forest Service.

All photo credits with an asterisk (*) provided by
Forestry Images — http://www.forestryimages.org/

Directory of Exotic Forest Insect and Disease Pests

Compiled by
Deborah G. McCullough[1, 2]
and
James E. Zablotny[1]

Table of Contents

[1]Dept. of Entomology and [2]Dept. of Forestry
Michigan State University

Introduction

Exotic insect and disease pests can have major effects on the productivity, biological diversity and health of forest and urban forest ecosystems. Early detection of a newly established insect or disease organism is an essential aspect of managing exotic pests effectively.

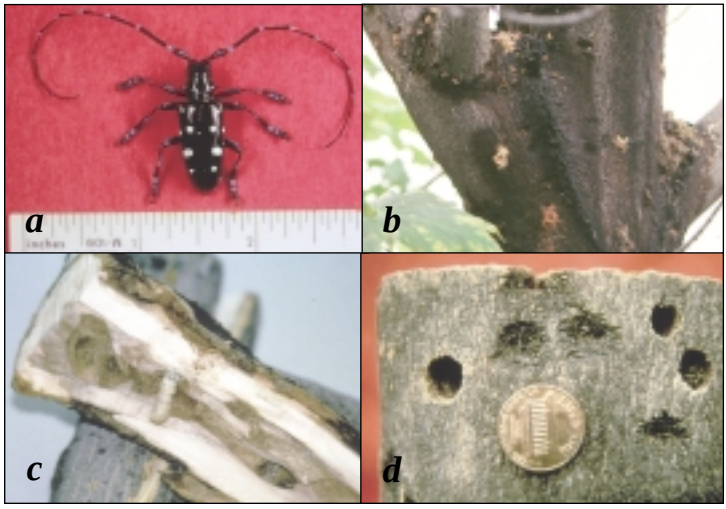
The purpose of this directory is to help you identify important exotic insect and disease pests that you might find on forest or shade trees. These pests are of particular interest to foresters and arborists in the north central region. Some of the species included in the directory have not yet become established in the United States. Other species are established in some areas but have not yet expanded throughout the region. The directory includes photographs and brief descriptions of the biology and damage caused by each pest.

Carry the Exotic Forest Pest Directory in your vehicle. If you suspect that you have discovered an exotic pest that is new to your area, please contact an appropriate state, university or county office.

There are 18 forest pests included in this directory. We expect that more exotic pests will be introduced and become established in the United States as global trade expands. Stay in touch with the universities, federal and state natural resource agencies, and county Extension offices in your area. They can provide you with up-to-date information about new forest pest problems in your region.

Asian Longhorned Beetle

Anaplophora glabripennis (Motchulsky)



Photos provided by USDA Forest Service.

(a) Adult female. (b) Sawdust-like frass is expelled by feeding larvae. (c) Larva and tunnel in a maple branch. (d) Adult exit holes.

Hosts: Asian longhorned beetle prefers Norway maple and other maple species (*Acer* spp.) but will also infest willow (*Salix* spp.), birch (*Betula* spp.), poplars (*Populus* spp.), elm (*Ulmus* spp.) and other hardwoods.

Background: Asian longhorned beetle is native to China, Korea and other Asian countries. Established populations of this wood borer were discovered in New York City in 1996 and in Chicago in 1998. In summer, female beetles lay individual eggs in niches on the bark of branches or the tree trunk. Larvae feed at first in

Asian Longhorned Beetle

the phloem, then tunnel into the sapwood, where they overwinter. Beetles pupate in spring and adults can emerge throughout the summer. Tunnels excavated by feeding larvae can cause branches to die or break in heavy wind. If a tree is repeatedly infested, larval tunnels in the stem can kill the entire tree. Beetles likely entered the United States in infested wood packing material from China. Efforts continue to locate infested trees and to eradicate the populations in New York and Chicago.

Identification: Adults are large (roughly 3/4 to 1 inch long), active beetles that are shiny black with irregular white spots. Antennae are long and have alternating white and black bands. Native longhorned beetles such as the pine sawyer (*Monochamous scutellatus*) are often mistaken for Asian longhorned beetle. Most native longhorned beetles are smaller and do not have the alternating black and white bands on the antennae.

Symptoms: Sawdust-like frass may collect on the ground or at branch crotches of infested trees. Holes left by emerging adults are 1/4 inch in diameter. Infested trees often have dying and dead branches in the canopy.

Balsam Woolly Adelgid

Adelges piceae (Ratz.)

S. Tunnock*

W. Brewer*

R. Billings*

(a) Woolly adelgids on subalpine fir stem. (b) Gouting on fir shoots. (c) Dead fir trees in Great Smoky Mountains National Park.

Hosts: True firs (*Abies* spp.) are hosts, although vulnerability varies among species. Balsam fir (*A. balsamea*) and Fraser fir (*A. fraseri*) are highly vulnerable and may be killed in less than five years when adelgid populations are high. Other fir species such as white fir (*A. concolor*) are somewhat resistant. Douglas-fir (*Pseudotsuga menziesii*) is not a host.

Balsam Woolly Adelgid

Background: Balsam woolly adelgid is a European forest pest that was accidentally introduced into Maine in 1900 on imported nursery stock. It has caused decline and mortality of extensive areas of fir in the Appalachian Mountains and eastern Canada. It has become established in the Pacific Northwest and western Canada, where it affects many true firs in forest and urban settings. It is not yet known to be established in the north central region of the United States.

Identification: Adults are tiny (1 mm), wingless, sap-feeding insects that are similar to aphids. They have a complex life cycle with multiple generations in a year. Some stages can be carried in the wind to new host trees. Adelgids settle on the bark of the trunk or branches. As they feed on sap, they excrete fluffy, white, waxy filaments around their bodies that cause the "woolly" appearance.

Symptoms: Heavily infested trees appear to have masses of white cotton or wool on the bark of the trunk or branches. Adelgids can also be found in the crown or around new buds on shoots. Feeding on twigs causes new shoots to swell and appear gouty, and affected shoots may die. Heavy feeding on the tree trunk alters the structure of wood cells, interfering with water transport and eventually causing trees to die.

Beech Bark Disease

Beech scale *(Cryptococcus fagisuga* Lind*)* and *Nectria* fungi *(Nectria coccinea* var. *faginata)*

D. McCullough

D. McCullough

D. McCullough

USDA Forest Service

(a) Beech tree infested with beech scale. (b) Beech snap. (c) Beech scale is usually found on rough areas of bark. (d) Fruiting bodies of Nectria coccinea *var.* faginata *fungi.*

Hosts: American beech (*Fagus grandifolia*) and European beech (*F. sylvatica*).

Background: Beech scale was introduced into Nova Scotia in 1890 on imported nursery stock. Since then, beech bark disease has spread throughout much of eastern Canada and the northeastern United States. Affected beech trees were discovered in Michigan in 2000. Beech bark disease begins when trees are colonized by beech scale, a tiny, sap-feeding insect that excretes

Beech Bark Disease

white, waxy material as it feeds. Wounds created by the scale insects eventually enable *Nectria* fungi to infect the tree. *Nectria* infection causes cankers to form under the bark, which can eventually coalesce and kill the tree. Large, old trees are most vulnerable, and the loss of these trees may affect many wildlife species.

Symptoms: Scales initially infest rough areas of beech bark such as old branch scars on the trunk. Large, old trees are more likely to be colonized by beech scale than young trees with smooth bark. Tar spots can often be found on beech trees infected with the *Nectria* pathogen. Fruiting bodies of *Nectria* fungi are sometimes seen on bark of heavily infested trees. Trees with beech bark disease produce ragged, yellowish foliage and will eventually die. Infected trees sometimes break off in windy conditions, a condition known as beech snap.

Identification: Beech scales excrete white, waxy material as they feed, causing heavily infested trees to appear “woolly” or whitewashed. Trees that have been infected by *Nectria* may have long linear cankers under the bark and dead branches in the canopy. Immature scales and fungal spores can be windblown or carried by birds or people into new areas.

Brown Spruce Longhorned Beetle

Tetropium fuscum (Fabr.)

S. Sopow, Canadian Forest Service.

S. Sopow, Canadian Forest Service.

Canadian Forest Service - Atlantic Forestry Centre.

(a) Female beetle. (b) Larvae. (c) Heavy pitch flows on infested red spruce.

Hosts: Spruce (*Picea* spp.) trees are preferred hosts. In North America, primarily red spruce (*P. rubens*) has been attacked, but other spruce species are also vulnerable. Pines (*Pinus* spp.), true firs (*Abies* spp.), larch (*Larix* spp.) and occasional hardwoods have been attacked in the beetle's native range.

Brown Spruce Longhorned Beetle

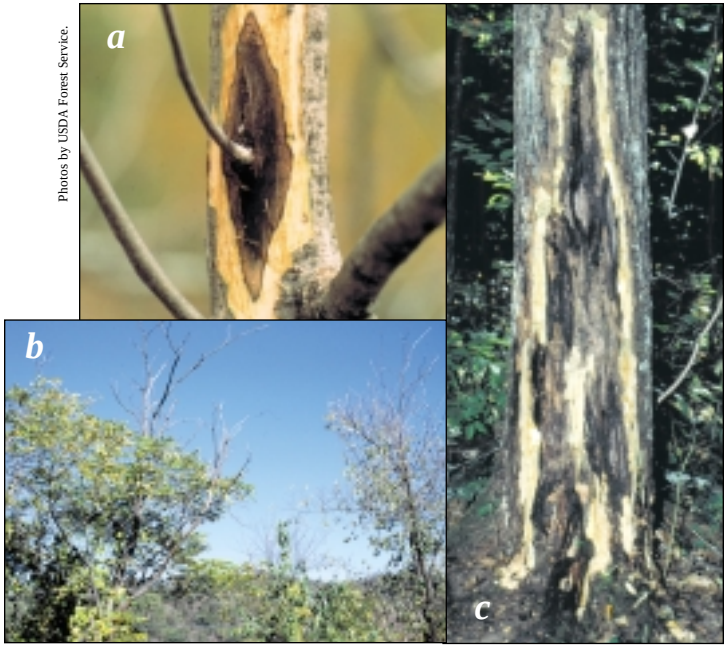
Background: This wood-boring beetle is native to Europe and Japan. It was first collected in 1990 in Point Pleasant Park, in Halifax, Nova Scotia, but was mistaken for a native species. Damage to red spruce trees in the park led to the correct identification of this exotic species in March 1999. Infested trees appear to be restricted to the Halifax park and surrounding areas. Efforts to eradicate the beetle are underway.

Identification: Brown spruce longhorned beetles are small, elongate beetles. The head and thorax (neck) are dark brown to shiny black, while the wingcovers are tan, brown or reddish brown. The reddish brown antennae are about half as long as the body.

Symptoms: Unlike most native longhorned beetles, this species attacks apparently healthy spruce trees, as well as stressed or dying trees. Adult beetles are active in the spring and summer. Larvae feed at first in the cambium. Older larvae bore about 2 inches across the grain into the wood, then bore down toward the ground. In cross-section, the tunnels in the wood are L-shaped. Most beetles have one generation a year, but two generations could occur in southern Canada or in the United States. Beetles may prefer to colonize large trees, perhaps because they have thicker bark. Heavy streams of pitch flow down the trunk and branches of infested trees. Beetle exit holes are 4 mm and are most common near the base of infested trees.

Butternut Canker

Sirococcus clavigignenti-juglandacearum



(a) Dead cambium on infected branch. (b) Dieback and declining trees. (c) Multiple perennial cankers on a dead tree.

Host: Butternut (*Juglans cinerea*).

Background: The fungus that causes butternut canker is thought to be exotic. It was first reported in Wisconsin in 1967, but it has probably been present much longer. It has affected

Butternut Canker

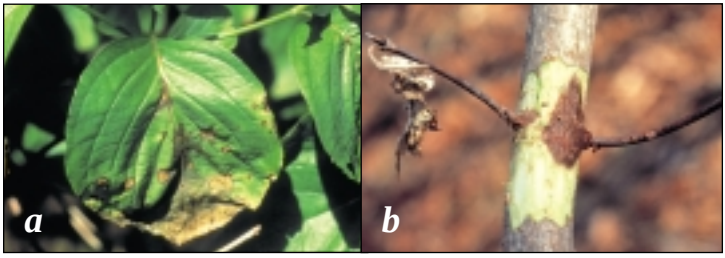
trees throughout much of the butternut range in the midwestern and northeastern regions of the United States. In some states, it has killed up to 80 percent of the butternut trees.

Identification: Fungal spores are believed to enter trees through buds, leaf scars and perhaps wounds on the bark caused by insects, hail or other agents. Small branches are cankered and killed initially, then rainwater carries spores down the stem. This leads to multiple perennial cankers on the stem that eventually girdle and kill the tree. Cankers are most common on the main stem of the tree, at the base of the tree and on exposed roots.

Symptoms: Young annual cankers appear as elongated, sunken areas around leaf scars and buds. These cankers may have white margins and an inky black center. Pegs formed by the fungus break through the outer bark, exposing the fungal spores. Carefully peeling away the bark reveals elliptical areas of dead cambium. Older perennial cankers on the stem or large branches may occur in bark fissures or can be covered by bark and layers of callus. Crown dieback becomes apparent as cankered trees decline.

Dogwood Anthracnose

Discula destructiva



Photos by USDA Forest Service.

(a) Lesions on infected leaf. (b) Canker and dead twig.

Hosts: Native and select cultivars of flowering dogwood (*Cornus florida*) in the eastern United States and Pacific dogwood (*C. nuttallii*) in the Northwest.

Background: Dogwood anthracnose is a destructive fungal disease that infects and kills flowering dogwoods. The origin of the fungus is not known, but it was first encountered in the United States in 1978. It is now established in many eastern and midwestern states and continues to spread into the north central region. It is also present in the Pacific Northwest and British Columbia.

Identification: In wet weather, white to salmon-colored conidia may ooze from reddish to dark brown fruiting bodies on leaves or bark. Abundant conidia that are produced on infected leaves and twigs can infect plants in the following year.

Dogwood Anthracnose

Symptoms: Leaf symptoms develop in the lower crown and progress upward on the tree. Affected leaves may have tan spots with purple rims, and necrotic blotches, veins and leaf margins. Shot holes appear on some trees. Infected leaves drop early if leaves are infected in the spring. Leaves that are entirely blighted, however, do not abscise in autumn. Infections can progress down leaf petioles into shoots, resulting in cankers at leaf nodes that kill twigs. Twig dieback leads to a proliferation of epicormic shoots on the lower trunk and main branches. These shoots are likely to become infected, and the infection may then progress into the stem. Brown, elliptical cankers often form at the bases of dead branches, and the bark over cankers may be split or swollen. Cankers can girdle branches or kill entire trees.

European Spruce Bark Beetle

Ips typographus L.

S. Passoa*

R. Haack*

W. Ciesla*

(a) Adult. (b) Larvae feeding in phloem of infested spruce. (c) Egg and larval galleries in phloem.

Hosts: This bark beetle attacks spruce (*Picea* spp.), along with larch (*Larix* spp.), pine (*Pinus* spp.) and fir (*Abies* spp.).

Background: This European species is not yet known to be established in North America, but it has been frequently intercepted in wood packing material at ports of entry. It is considered one of the most destructive pests of Norway spruce (*Picea abies*) in Europe. The European spruce beetle usually develops in recently felled logs or dying trees, but populations

European Spruce Bark Beetle

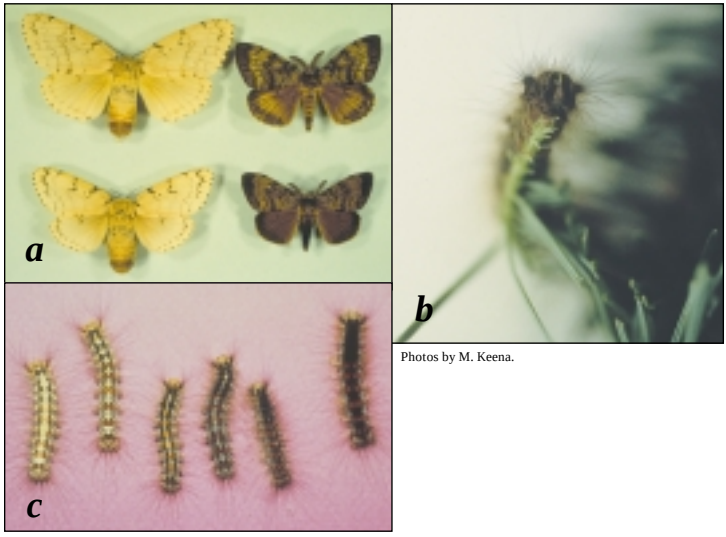
can build to high numbers following drought, windthrow or similar events. Mass attacks by high numbers of beetles overwhelm tree defenses and cause extensive mortality.

Identification: Distinguishing between this beetle and native bark beetles species is difficult. Suspect beetles should be submitted to a specialist for identification. European spruce beetles are roughly 4.5 mm long and shiny black. There are long, yellowish hairs on areas of each wing cover. Egg galleries in the phloem are roughly 12.5 cm long and run parallel to the grain. Larval feeding galleries radiate out perpendicularly from each egg gallery.

Symptoms: Feeding by larvae in the phloem girdles the tree. Fungi introduced by adults as they colonize trees disrupt the xylem, interfering with water transport. Trees that have been mass attacked fade from green to yellow to red. Larvae, pupae or other life stages may be present under the bark of recently infested or dying trees.

Gypsy Moth - Asian

Lymantria dispar L. - Asian biotype



Photos by M. Keena.

(a) Asian gypsy moth adults (top) are very similar to European gypsy moth adults (bottom). Female moths are white (left) and male moths are brown (right). (b) Asian gypsy moth larva feeding on Douglas fir. (c) Asian gypsy moth larvae vary in color.

Hosts: The host range of Asian gypsy moth larvae is even broader than that of European gypsy moth. Asian gypsy moth larvae readily feed on larch (*Larix* spp.), Douglas-fir (*Pseudotsuga menziesii*) and several other conifers, as well as many hardwood species.

Gypsy Moth - Asian

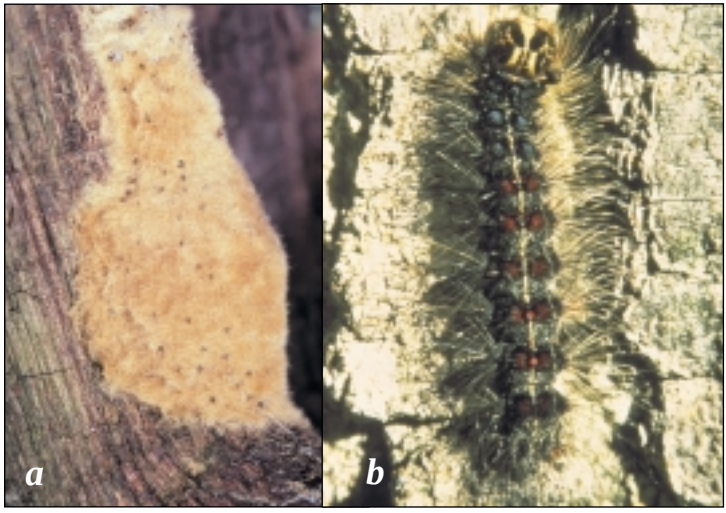
Background: Asian gypsy moth occurs in much of eastern Europe and Asia but is not known to be established in North America. Major eradication programs, however, have been necessary in recent years in North Carolina and the Pacific Northwest after Asian gypsy moths were accidentally imported on cargo ships. The Asian gypsy moth is quite similar to the European gypsy moth, an exotic pest that has caused extensive defoliation and nuisance in oak-dominated forests and urban forests in many eastern states. Unlike European gypsy moth, Asian gypsy moth females are strong fliers. This means that, once established, populations could expand relatively rapidly across North America.

Identification: Asian gypsy moth closely resembles European gypsy moth, although female moths of the Asian biotype fly and European female moths do not. It is difficult to distinguish between Asian and European gypsy moth eggs, larvae or moths based on appearance. Examination by specialists and identification using DNA markers may be necessary to distinguish Asian gypsy moth biotypes.

Symptoms: In its native range, Asian gypsy moth larvae cause extensive defoliation during outbreaks.

Gypsy Moth - European

Lymantria dispar L. - European biotype



M. Higgins

D. McCullough

(a) Egg masses are covered with fine hairs. (b) Gypsy moth larvae have red and blue spots.

Hosts: Preferred hosts include oaks (*Quercus* spp.), aspen (*Populus tremuloides, P. grandidentata*), birch (*Betula* spp.), willow (*Salix* spp.) and basswood (*Tilia americana*). Caterpillars can feed on more than 300 other species of deciduous trees and woody shrubs. Pines (*Pinus* spp.) and spruce (*Picea* spp.) may occasionally be defoliated when they are near or mixed with oak or other preferred hosts.

Gypsy Moth - European

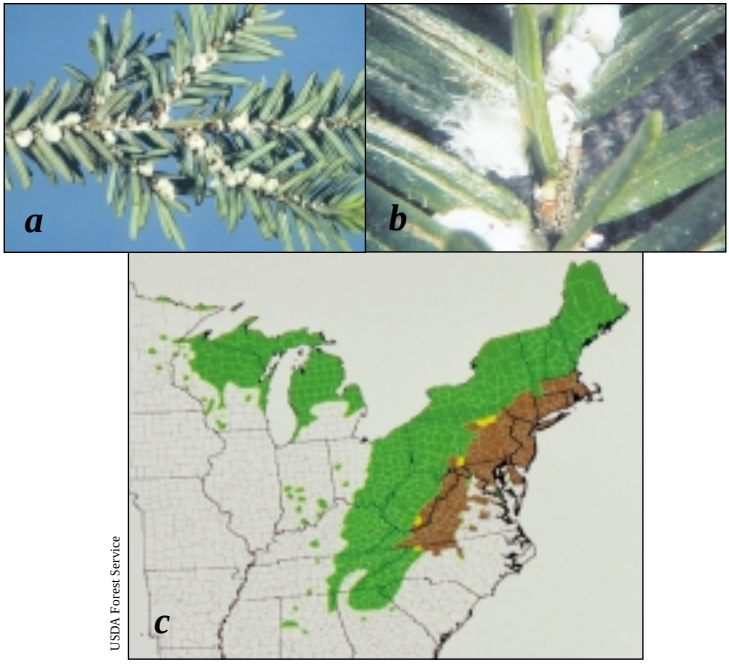
Background: The European biotype of the gypsy moth became established in Massachusetts in 1869. Despite many eradication efforts, gypsy moth populations have continued to spread through much of the eastern United States and the upper Midwest. Gypsy moth larvae feed on the leaves of oaks, aspen and many other tree species. Outbreaks of gypsy moth occur in urban forests as well as traditional forest settings. Large numbers of gypsy moth larvae cause severe defoliation and considerable annoyance for people living in affected areas.

Identification: Egg masses are tan, 1 to 3 inches long and covered with fine hair. They are present from late summer until the following spring. Eggs may be laid on outdoor items such as vehicles, patio furniture and firewood, as well as trees. Gypsy moth caterpillars feed on foliage for roughly six weeks in early to midsummer. Young caterpillars are dark colored, but older larvae have pairs of red and blue spots and long, yellowish hairs. Pupae are reddish brown and often found under bark flaps or in bark crevices. Female moths are white with irregular black markings on the wings. Males are smaller with gray-brown wings with dark markings. Male moths are active fliers; female moths do not fly.

Symptoms: During outbreaks, gypsy moth caterpillars heavily defoliate oaks and other preferred hosts in forest, rural and urban areas. Outbreaks often persist for two to four years before disease and other factors cause the population to collapse.

Hemlock Woolly Adelgid

Adelges tsugae Annand



K. Shields

USDA Forest Service

USDA Forest Service

(a) Hemlock woolly adelgid on eastern hemlock shoot. b) Hemlock woolly adelgid ovisacs. (c) Distribution of eastern hemlock (green) and the adelgid (brown and yellow).

Hosts: In eastern North America, hemlock woolly adelgid is a serious pest of eastern hemlock (*Tsuga canadensis*) and Carolina hemlock (*T. caroliniana*). In the Pacific Northwest, it attacks western hemlock (*T. heterophylla*) and mountain hemlock (*T. mertensiana*) but rarely causes significant damage.

Hemlock Woolly Adelgid

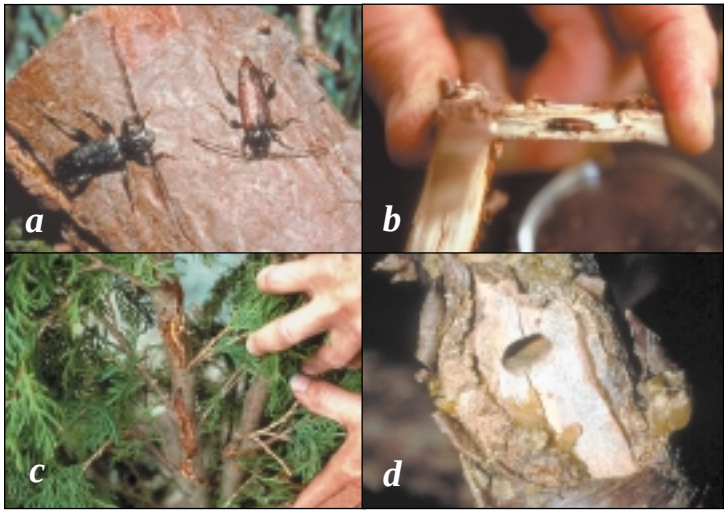
Background: This tiny, sap-feeding insect is native to China, Japan, India and other Asian countries. It was accidentally introduced into North America around 1924. Feeding by the adelgids will reduce tree growth and vigor. High mortality of eastern hemlock has occurred in areas of southern New England down through the Appalachians. This adelgid is also found in western states but is rarely an important pest there.

Identification: Hemlock woolly adelgids are tiny, aphid-like insects (1 mm long) with piercing and sucking mouthparts. They feed at the bases of hemlock needles. Adelgids produce white, cottony ovisacs in spring and again in summer. Each ovisac may contain up to 300 eggs. Crawlers, the mobile immature stage of the adelgids, hatch in spring and summer and can be moved or windblown into new areas.

Symptoms: White, cottony ovisacs on shoots are very apparent and an obvious sign of infestation. Infested trees may take on a grayish cast as needles become desiccated. Needles often drop from the tree, and infested shoots produce few new apical buds. Branches can begin to die within two years of infestation, usually progressing from the lower canopy upward. Some trees survive but have only a sparse amount of foliage at the top. Trees with heavy infestations can be killed outright, and mortality rates can be high if infested trees experience defoliation, drought or other stresses.

Japanese Cedar Longhorned Beetle

Callidiellum rufipenne (Motschulsky)



Photos by Connecticut Agricultural Experiment Station.*

(a) Dark male (left) and brown female beetles. (b) Adult in twig. (c) Damage in northern white cedar. (d) Exit hole.

Hosts: In the United States, only northern white cedar (*Thuja occidentalis)* (also called American arborvitae) and eastern red cedar (*Juniperus virginiana*) have been infested. In the beetle's native range, stressed or recently killed cypress trees (*Chamaecyparis* spp.) and other cedar and arborvitae species have been attacked. Firs (*Abies* spp.) and pines (*Pinus* spp.) are listed as hosts in Asia.

Japanese Cedar Longhorned Beetle

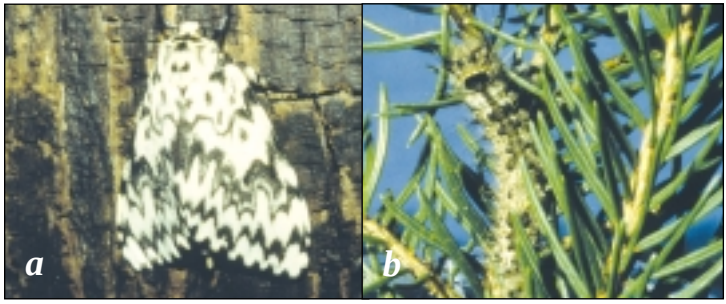
Background: This wood-boring beetle is native to Japan, China, Korea and other east Asian countries. It has also become established in Italy, Spain and New Zealand. In its native range, it acts as a secondary pest of dying or newly dead trees. In the United States, it was recovered from dead eastern red cedar trees in North Carolina in 1997. In 1998, however, beetles developed successfully in more than 40 healthy northern white cedar trees in a Connecticut nursery. In 2000, it was trapped in at least six locations in New Jersey, including natural stands of eastern red cedar.

Identification: Adults are 6 to 14 mm long and appear slightly flattened in profile. Adult males are blue-black with reddish areas on the upper corners of the wing covers. Adult females have brownish yellow wing covers, a reddish abdomen and brown legs. Antennae are at least half as long as the body.

Symptoms: Adult beetles are active in spring. Females lay eggs in bark crevices, and young larvae feed just below the bark on cambium and phloem. Older larvae bore into the sapwood in late summer, pupate in tunnels that run parallel to the wood grain and overwinter as adults. Exit holes left by emerging adults are oval and 2 to 4 mm in diameter. Tunnels excavated by feeding larvae are sinuous. They increase in width from beginning to end and are eventually about as wide as a pencil eraser. Galleries may be visible on branches in late summer or may be invisible until bark is removed. Tunneling can girdle and kill branches and even the stem of the tree.

Nun Moth

Lymantria monacha L.



Photos by M. Keena.

(a) Female moth. (b) Nun moth larvae feed on many conifers.

Hosts: Nun moth prefers to feed on conifers but can develop on numerous deciduous trees. Hosts include Douglas-fir (*Pseudotsuga menziesii*), pines (*Pinus* spp.), larch (*Larix* spp.), spruce (*Picea* spp.), oaks (*Quercus* spp.), maples (*Acer* spp.), birch (*Betula* spp.) and many others.

Background: Nun moth is a serious forest defoliator in northern Europe and Asia, especially in eastern Siberia and down to Vladivostok, Russia. Outbreaks in this region have caused extensive mortality of spruce, pine and deciduous trees. Nun moth is not known to be established in North America. The nun moth is a close relative of the European gypsy moth, a major pest in areas of the eastern United States, and the Asian gypsy moth. Nun moth females fly, much like Asian gypsy moth females. The fact that adult nun moths are attracted to light has

Nun Moth

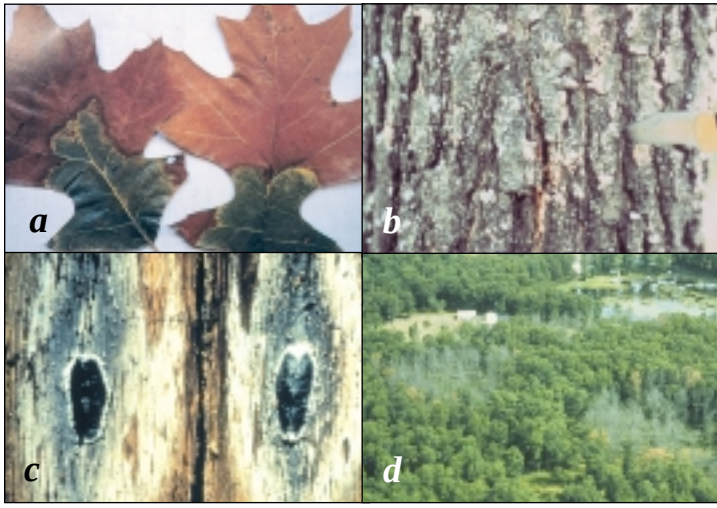
led to concerns that this pest may be introduced as a stowaway on cargo ships that are loaded at night under floodlights.

Identification: Adult nun moths are larger than gypsy moths, with wingspans of 35 to 45 mm (males) and 45 to 55 mm (females). Males and females are strong fliers. Moths usually have whitish wings with dark, transverse bands and patches, although dark-colored moths occasionally occur. Orange-brown eggs are laid in bark crevices, under bark flaps or in other protected locations. Eggs are laid in clusters but not in a single mass like those of European gypsy moth, and there are no hairs protecting eggs. Newly hatched caterpillars have pairs of small, raised, dark-colored spots along the back, a trait that European gypsy moth larvae lack. Nun moth caterpillars may be tan, green or dark gray, and difficult to see on tree bark. Caterpillars are hairy and have a pair of light-colored patches behind the head.

Symptoms: Larval feeding causes widespread defoliation of conifer and deciduous trees. Severely defoliated conifers are likely to die.

Oak wilt

Ceratocystis fagacearum (Bretz) Hunt



Photos by G. Adams and the USDA Forest Service.

(a) Discolored red oak leaves. (b) Crack in bark caused by pressure pad. (c) Pressure pads under bark. (d) Pockets of oak mortality.

Hosts: Oak wilt infects oaks (*Quercus* spp.). Red oaks are infected more frequently and succumb more rapidly than white oaks.

Background: Oak wilt behaves much like an exotic pathogen but is currently thought to be native to areas of North America. First identified in Wisconsin in 1944, it is now established in at least 21 states and appears to be spreading. The fungus invades the vascular system of trees, disrupting water transport from the roots to the canopy. Infection may pass from infected trees to adjacent or nearby oak trees via root grafts. Long distance

Oak wilt

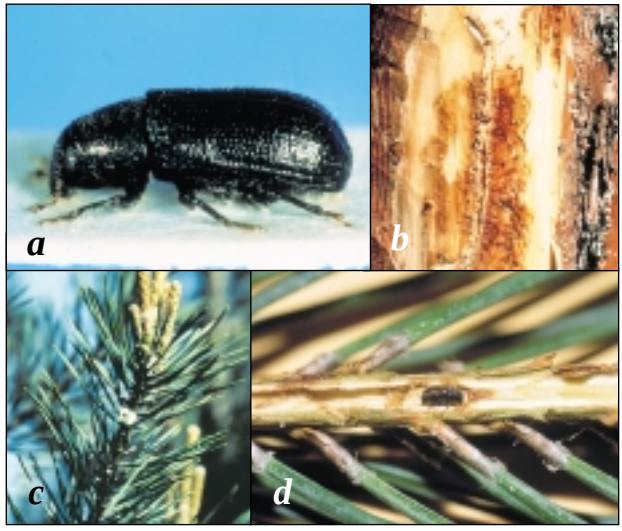
spread of oak wilt occurs when picnic beetles and other small, sap-feeding beetles carry spores from an infected tree to trees in a new area.

Identification: Red oaks generally experience extensive wilt and defoliation in midsummer. Brownish streaking occurs in the xylem tissue, just below the bark. Oval pressure pads may be found under the bark on the stems of red oak trees that have died within the past year. Identification of oak wilt on white oaks is more difficult. Samples should be submitted to specialists for culture and confirmation.

Symptoms: On red oaks, symptoms typically develop within weeks, and infected trees die within the year. Leaf symptoms are most common in July. Leaves of infected red oaks wilt and curl around the midrib. Leaves may be reddish to bronze at the edges, with a distinct boundary between green and discolored tissue. Leaves at branch tips often drop in midsummer; other leaves may turn dark brown and remain attached. Wilting usually progresses from the top of the tree downward. Brownish streaking occurs just beneath the bark on the sapwood is typically most apparent near the tree base. On dead trees, the newest ring of sapwood will be stained brown. These trees often have a stale beer smell, which attracts sap-feeding beetles. On some red oaks, oval pressure pads with dark centers form between the bark and wood on the stem and may cause the bark to crack or split. Oak wilt often results in pockets of mortality in red oak stands because the fungus is transmitted through root grafts.

Pine Shoot Beetle

Tomicus piniperda L.



Photos by USDA Forest Service.

(a) Adult. (b) Egg gallery on Scotch pine log. (c) Pitch tube on Scotch pine shoot. (d) Beetle feeding inside Scotch pine shoot.

Hosts: Pine shoot beetle can develop and feed in shoots of most North American pines (*Pinus* spp.), although resinous trees such as loblolly pine (*P. taeda*) and eastern white pine (*P. strobus*) may be less preferred. Scotch pine (*P. sylvestris*) is a favored host. High populations of this bark beetle in North America have been consistently associated with declining Scotch pine stands.

Background: This Eurasian bark beetle was discovered in Ohio in 1992, but populations had likely been established for at least 10 years. On-going surveys indicate that pine shoot beetle is

Pine Shoot Beetle

distributed throughout much of the north central region of the United States, several northeastern states, and the provinces of Ontario and Quebec. This is a secondary beetle that colonizes recently cut, dying or severely stressed pine in spring. Progeny beetles typically emerge in June and tunnel into shoots of live pines. Each beetle may kill two to six shoots during summer before moving to the base of a tree to overwinter. If populations build to high levels, damage caused by shoot-feeding beetles can severely stress live trees. These trees may then be killed by pine shoot beetle or other secondary pests the following year.

Identification: Pine shoot beetles colonize freshly cut or dying pine early in spring, usually a few weeks before most native bark beetles are active. Egg galleries, found in the phloem and cambium, run parallel to the wood grain and have a small bend at one end. Small, white, legless larvae feed in the phloem for several weeks but can rarely be distinguished from other bark beetle larvae. New pine shoot beetle adults are 2 to 4 mm long and reddish brown upon emergence from brood material. After shoot feeding for a few weeks, they darken to a shiny black.

Symptoms: Beetles tunnel into shoots and feed down the pith of the shoot toward the shoot tip. Tunneled shoots are hollow and do not contain frass or sawdust. Two to four short tunnels may be in a single shoot. Pitch tubes are sometimes found on the outside of infested shoots. A tunneled shoot fades from green to yellow to brown and eventually breaks off at the base of the tunnel.

Red-haired Bark Beetle

Hylurgus ligniperda Fabr.

(a) Adult beetle.

Hosts: This bark beetle colonizes pines (*Pinus* spp.). It has developed successfully in Scotch pine (*P. sylvestris*) and several pines native to North America, including eastern white pine (*P. strobus*).

Background: The red-haired bark beetle, also called the golden-haired bark beetle, is native to Europe. It has become established on five continents, including countries in Africa, Asia and South America, as well as Australia and New Zealand. It continues to be intercepted frequently in solid wood packing material arriving at U.S. ports. One beetle was trapped in New York in 1994 and another in 1995, but there was no evidence of a breeding population at that time. In 2000, however, an established population was found in a Christmas tree plantation

Red-haired Bark Beetle

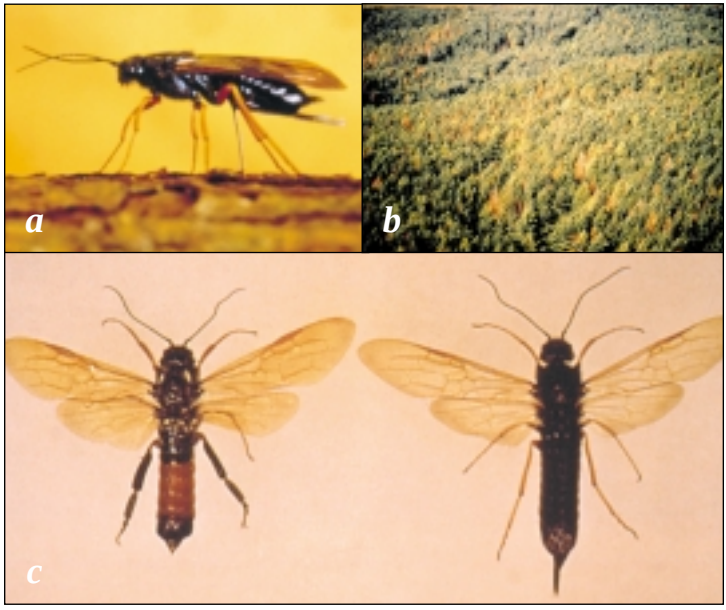
near Rochester, New York. Adult beetles are strong fliers, and populations may expand relatively quickly. This secondary bark beetle colonizes recently cut or killed pine or severely stressed trees. However, it is an efficient vector of fungi that cause blackstain root disease, including *Leptographium wagneri*. Blackstain root disease can lead to tree mortality and decrease lumber value.

Identification: Adult beetles are 3 to 4 mm long and golden brown with reddish hairs on the body and wingcovers. Egg galleries are 10 to 20 cm long and parallel the grain of the wood, but they may be difficult to distinguish from galleries excavated by other species. Groups of adult beetles can overwinter in tunnels in the bark of stumps or at the root collar on large trees. This species may also overwinter as larvae in the inner bark. Newly emerged adult beetles sometimes complete maturation by feeding at the root collar area of pine seedlings, where they often form a spiral feeding gallery. This beetle may have one generation per year in northern regions and up to three generations each year in warmer areas.

Symptoms: Beetles breed in recently cut, newly dead or highly stressed pine, often in stumps or near the base of the trunk. It will likely be difficult to distinguish between the red-haired bark beetle and native bark beetle species. Suspect beetles should be collected for identification by an expert.

Sirex Woodwasp

Sirex noctilio Fabr.



Photos by EMBRAPA-Florestas.

(a) Female wasp preparing to lay an egg. (b) Damage in a pine plantation in Australia. (c) Adult male (left) and female (right) wasps.

Hosts: *Sirex* woodwasps attack many species of pine (*Pinus* spp.), including North American pines growing in plantations in South America and Australia. Pines growing under stressful conditions are most susceptible to attack.

Background: This woodwasp is native to Asia, Europe and northern Africa. It has never been found in North America, but

Sirex Woodwasp

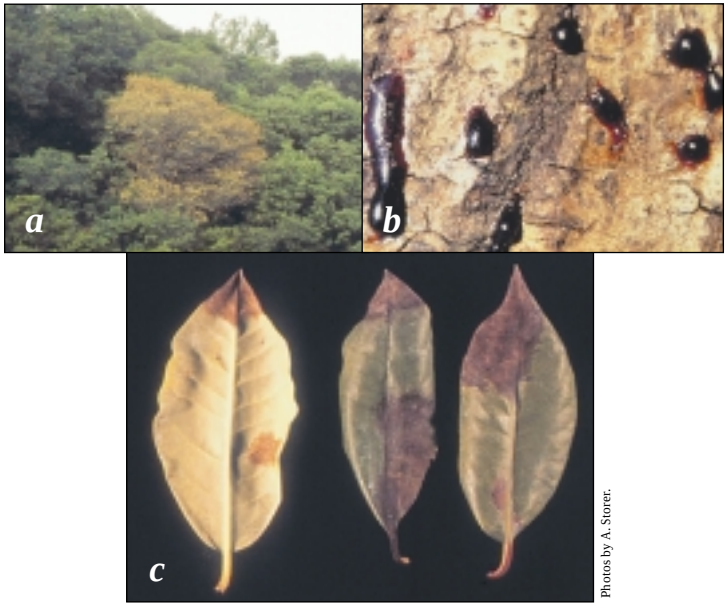
it has become a major pest in South America, Australia and New Zealand. *Sirex* woodwasps can cause significant mortality in overstocked or otherwise stressed pine plantations. Scientists are concerned that this wood borer could be introduced into North America via importation of logs, lumber or solid wood packing material. Adult female wasps are attracted to stressed trees. They drill their ovipositor into the outer sapwood, lay up to three eggs in a single drill site, and inject a fungus and toxic mucus. The fungus and mucus act together to kill the tree and create a suitable environment for the larvae. Larvae feed on the fungus as they tunnel through the sapwood.

Identification: Adults are large (2.5 cm), metallic blue wasps and are strong fliers. Females have a prominent ovipositor (egg-laying structure) that looks like a stinger (up to 2 cm long) on the end of the abdomen. Males have a wide, orange band on the abdomen. The larva is a white, legless grub with a sharp pointed tip on the tail. It is difficult to distinguish between this species and native horntail wasps. Suspect wasps must be examined by a specialist to confirm identification.

Symptoms: Foliage of infested pines fades from green to yellow to reddish brown as trees die. Droplets of resin oozing from oviposition wounds may be visible on the bark of the stem. If the bark is cut away, a dark fungal stain in the cambium is evident. The stain runs vertically from each oviposition site. Larval galleries can occur throughout the sapwood and are packed with sawdust-like frass. Exit holes are round and 3 to 8 mm in diameter.

Sudden Oak Death

Phytophthora ramorum



Photos by A. Storer.

(a) Dead oak in California. (b) Bleeding canker on oak stem. (c) Spots on infected rhododendron leaves.

Hosts: In California, tanoak (*Lithocarpus densiflorus*), coastal live oak (*Quercus agrifolia*), black oak (*Q. kelloggii*) and Shreve's oak (*Q. parvula* var. *shrevei*) have been affected. Scientists are continuing to assess the host range of this pathogen. Laboratory tests with seedlings indicate that other oaks such as northern red oak (*Q. rubra*) are susceptible. Shrub species including rhododendrons (*Rhododendron* spp.), huckleberry (*Vaccinium*

Sudden Oak Death

ovatum) and bay laurel (*Umbellularia californica*) exhibit leaf spots or twig dieback but are not killed.

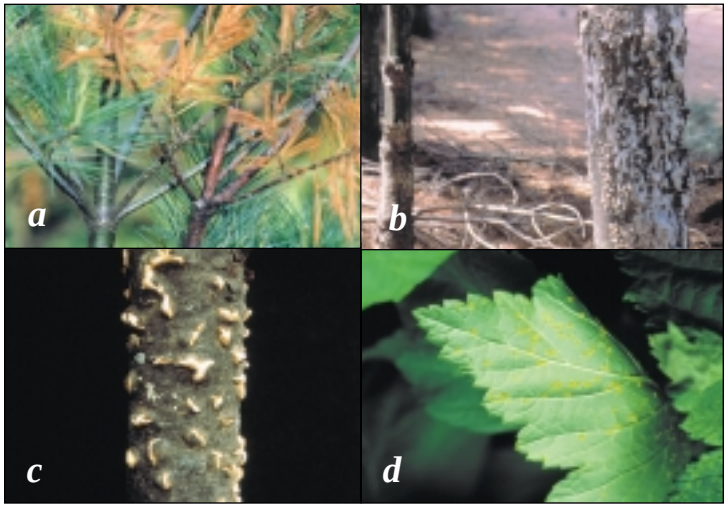
Background: Sudden oak death refers to a disease that has caused mortality of black oaks, tanoaks and coastal live oaks in areas of California since 1995. The fungus responsible for sudden oak death was identified in 2001 and is probably exotic. It was first identified on rhododendrons in Germany and was recently found in the United Kingdom. This pathogen is currently known to be established in seven counties in coastal California and one county in southwestern Oregon. Research suggests that spores of this fungus may be spread through infected wood, soil and rainwater. Several ornamental shrubs that are hosts for this fungus exhibit only minor symptoms, and shipments of infected plants or plant parts could introduce the disease into new areas.

Identification: Confirmation of this pathogen must be done by specialists.

Symptoms: On true oaks, the earliest symptom is a bleeding canker on the stem that usually occurs on the lower 6 feet of the trunk. Thick, burgundy-red to black sap oozes from the canker. On tanoaks, the first symptom is wilted new growth throughout the canopy. Bark beetles, ambrosia beetles and decay fungi (*Hypoxylon* spp.) often invade dying trees. Foliage color fades rapidly from green to yellow to brown. On shrub species, this fungus causes leaf spots or black leaf tips and some twig dieback.

White Pine Blister Rust

Cronartium ribicola



Photos by USDA Forest Service.

(a) Infected shoot with canker. (b) Stem canker with characteristic pitch. (c) Spore-producing aecia on young tree. (d) Orange spores on infected Ribes *spp. leaf.*

Hosts: White pine blister rust affects five-needled pines, including eastern white pine (*P. strobus*) and several western and exotic pines. Currants and gooseberries in the genus *Ribes* are alternate hosts for this fungus.

Background: White pine blister rust is an Asian pathogen that was introduced into Europe and from Europe into North America between 1898 and 1910. This pathogen had major impacts on eastern white pine forests. Concerns about blister

White Pine Blister Rust

rust have historically limited efforts to reestablish large tracts of white pine in the Great Lakes region, but recent evidence suggests that blister rust pockets may be relatively localized. Identifying areas with affected trees can help managers interested in restoration of white pine stands.

Identification: White pine blister rust has a complex life cycle. Reproductive structures called pycnia appear on swollen or cankered areas of white pine two to four years after a pine branch was infected. Pycnia ooze sticky yellow or honey-colored drops of fluid in spring. Other structures called aecia develop in spring in the same area three to six years after branch infection. Aecia are pale yellow to bright orange blisters that produce spores to infect *Ribes* plants. Cankers grow in size each year. Cankers have dead centers surrounded by pustules of aecia, which are surrounded by drops of pycnia and then a yellowish zone.

Symptoms: Dead branches and dead, reddish brown needles (flagging) on white pine trees are the earliest symptoms of blister rust. Flagging occurs when a canker girdles and kills the branch. Most infections occur on lower branches, often within a few feet of the ground. Branch cankers can be either depressed or slightly swollen and spindle-shaped. Older cankers may exude resin. In spring, masses of powdery orange spores (aecia) are produced on branch and stem cankers. If infected branches are not removed, cankers will progress along the branch to the main stem of the tree. Once cankers move down the branch to within 4 inches of the stem, the tree will eventually die.

More Information

Cooperative Extension programs at land-grant universities in each state are a good source of information on exotic forest insects and pathogens. Federal agencies such as the USDA Forest Service and state resource management agencies also have information on many exotic forest pests. Photos and information on specific exotic pests can be found on Web sites developed by universities and federal agencies such as the USDA Forest Service and the USDA Animal and Plant Health Inspection Services (APHIS).

If you find a tree that has been attacked by what you think might be an exotic insect or pathogen, be sure to note the exact location of the affected tree. If insects are involved, try to collect at least a few individuals. It's best if you can put the insects into a small glass container with a tight lid, to be sure that they won't be able to chew their way out or escape. Then contact the county Extension office, the university plant pest clinic, the office of the state Department of Agriculture, or the office of the Department of Natural Resources in your county or state for further assistance.

Acknowledgements

Design and editorial assistance provided by Alicia Burnell and Leslie Johnson, ANR Communications, is gratefully acknowledged. Funding to develop this directory was provided by the USDA Forest Service, Northeastern Area, State and Private Forestry Focus Fund grant, in cooperation with the Michigan Department of Natural Resources.

Notes:

Scott Roberts*

MICHIGAN STATE UNIVERSITY EXTENSION

New 6/02 - 5M - KMF - LAW, Price $4.00, for sale only.