
# -Forest Environment-

# A Healthy Forest

Adapted from the on-line Teachers Guide
*http://mff.dsisd.net*

MICHIGAN STATE
UNIVERSITY
EXTENSION

# FOREST HEALTH IN MICHIGAN

**Insects & Diseases**
**Fire – Wildfire and Prescribed**
**Exotic Species**

Some people will argue about the difference between "forest" health and "tree" health. One of the main issues is that poor tree health sometimes enhances overall forest health, to a limited degree. It does this by providing more habitat for species that benefit from trees in poor physical condition. This is often an argument made against forest management. For the most part, this section of the Teachers Guide will fall in line with the concept that forest management can never eliminate those elements of an ecosystem dependent upon trees in poor health, even if that were the only management objective. Forest management will increase the number of healthy trees growing vigorously, but will not significantly reduce ecosystem stability in the process. In fact, forest management generally enhances stability.

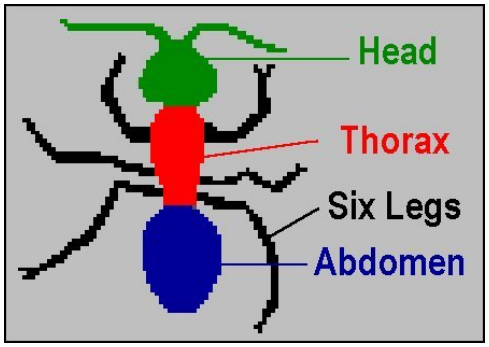
## Insects & Diseases

There are multitudes of insect and disease species that affect trees. Insects can be both beneficial and harmful. Diseases, by definition, are always harmful to trees, even if the harm is minor.

**What is an insect?**
**What is a disease?**

## Insect Fundamentals

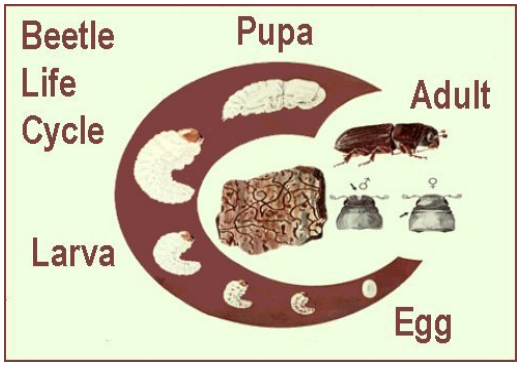
All ADULT insects have the following characteristics:




- Three-segmented body, head, abdomen, and thorax.
- Exoskeleton.
- Six legs, jointed.
- Breathe through spiracles (small holes along the side of the abdomen).
- Compound eyes.
- *Usually* two pair of wings.

Immature insects are segmented and often worm-like (maggots, larvae, caterpillars, etc.).

The basic life cycle of an insect goes from an egg, to a larval stage, the formation of a pupa or cocoon, and lastly an adult. The transition from immature to adult, inside the pupa or cocoon, is called ***metamorphosis***. There are four kinds of metamorphosis, complete (butterflies), gradual (grasshoppers), incomplete (dragonflies), none (lice). We are usually most familiar with complete metamorphosis, made well-known through monarch butterfly studies.




*Complete metamorphosis of a beetle.*
*Image from ForestryImages.org*

Insects have more species that all other taxa combined. Their variety of structure and function in the ecosystem make them fascinating targets for study. A few interesting notes about insects . . . some . . .

- made paper long before humans could write,
- domesticated plants and animals,
- have highly developed social systems,
- have tremendous strength for their size,
- have adapted to the harshest environments on Earth,
- do great damage to our food supplies and other resources,
- are highly beneficial to humans.

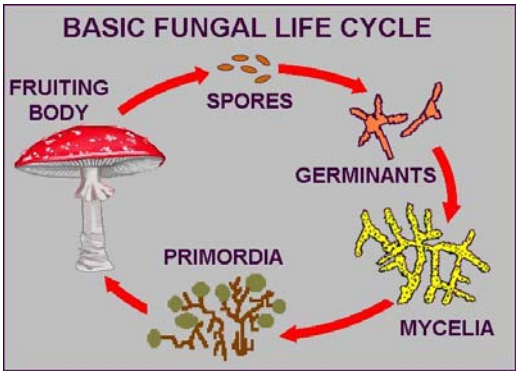
In the forests, insects have a full range of roles, or niches, to play. There are species both harmful and helpful to trees, and many that don't affect trees in one way or another. Harmful insects attack trees in one or more places. Helpful insects might parasitize harmful species, or serve to fertilized flowers, or perform other direct or indirect helpful functions.

## Disease Fundamentals

Diseases of trees are a little more difficult to visualize than insects. Most tree disease organisms are fungi. Most of these fungi can be divided into two major classes, the ***ascomycetes*** and ***basidiomycetes***, although there are other taxonomic units for fungi. The differences are based on fruiting bodies that produce and release ***spores***. Fungal life cycles have many variations. Most of a fungus, however, is underground or in a host. This "hidden" portion consists of filaments called ***hyphae*** that form masses called ***mycelia***. It's this part of the fungus does the damage, usually by digesting living and/or non-living parts of the tree. Destroyed tissue interrupts tree function. If enough damage is done, the tree will die.

Chestnut blight, Dutch elm disease, oak wilt, and powdery mildews are examples of ascomycetes, or sac-fungi. So are morel mushrooms, truffles, bakers yeast, and *Pencillium spp.* (penicillin is derived from one species). Ascomycetes form tiny sac-like bodies that contain either four or eight spores. Usually, there are many of these structures in a single fruiting body. For the most part, ascomycetes decompose non-living organic matter.

Most of our common mushrooms, toadstools, and puffballs are members of the basidiomycetes, or club-fungi. So are many of the rusts that infect trees and food crops. The spores are released from tiny clubs. The fruiting bodies are often conspicuous and sometimes very colorful. Bracket fungi on trees are examples of basidiomycetes.




Spores are very tiny. They float on the wind and water, or can be transported by other organisms, especially insects. Spores cannot germinate and survive on the bark of trees. A wound is required for entry. Once in a tree, the degree of spread will depend on many factors, including overall tree vigor, the species of tree, and the species of fungus.

## Non-fungal Diseases

Disease symptoms can be caused by agents other than fungi. Bacterial and viral disease sometimes afflict trees. Mineral or chemical deficiencies can stress a tree. Sun scorch, frost-cracking, winter kill, and toxins (natural and human-made) can all cause damage to bark or leaves. Sometimes the effects of insects or other animals appear to be diseases. Witches brooms and mistletoes are parasitic plants.

## Disease Symptoms

***Anthracnose:*** A very common ailment of leaves, especially during wet/humid weather. Dead areas appear on leaves that might follow the leaf veins or a random pattern. Typical on maples, ashes, and oaks.

***Bleeding or Sap Drip:*** Many times a simple mechanical injury (bark rubbed off by something or a broken branch) will cause bleeding in a tree. Other times, such drips may be evidence of a disease, such as white pine blister rust or wood borer injury.

***Blights:*** These are diseases that kill young living tissue, particular leaves, twigs, and shoots. Fire blight of apples is a good Michigan example. Sometimes in the fall, the yellowing of conifer needles is mistaken for a disease, when it it the normal fall "leaf" drop.

***Cankers:*** These fungal organisms that cause cracks or dead areas on trunks and branches. Oftentimes, the canker will ooze sap. *Nectria spp*., *Hypoxylon spp*. and *Eutypella spp*. are common cankers in Michigan.

***Damping-off:*** This occurs with new seedlings, evidenced by the seedling wilting and falling over. Certain soil fungi attack the seedling at ground level, killing the vascular tissue.

***Galls:*** Galls are usually malformations caused by insects and can be found on leaves, needles, twigs, and small branches. A small larva produces chemicals that force the tree to grow these odd-looking growths. They are not usually harmful to the tree, but are visually unattractive to most people. Galls are a particular problem in the Christmas tree business. Other gall-like malformations may be caused by bacteria and can be fatal.

***Leaf spots:*** Generally circular patches of dead leaf tissue. Spots might be brown, yellow, or translucent. The can even become holes. Fungi are often responsible, but certain insects will cause a similar appearance. Irregular spots are called "blotches".

***Mildews:*** Not very common with trees, a powdery coating, often white, gray, or bluish, is caused by the fruiting bodies of fungi. You may have seen similar mildews in your bathroom or on damp clothing after a few days.

***Mistletoes:*** Somewhat similar in appearance to witches brooms, a mistletoe is a parasitic plant that produces seeds. It's most common black spruce, but also grows on white spruce and tamarack.

***Rots:*** These might be the most common of tree diseases. Fungi invade and consume the dead wood in a tree, causing structural weakness and opens the tree to other invaders, such as woodpeckers, squirrels, etc. Conks are usually the first sign of rot, but by the time conks occur, the rot is already well-established in the tree. Stands with 20-30% of the trees bearing conks often have infection rates in over 50-60% of the trees.

***Rusts:*** Orange or reddish-brown color on leaf tissue or other living tissue is named "rust" because of the color. Rusts are a group of "basidiomycete" fungi.

***Scorch:*** Tissues, especially leaves, that brown and curl from the edges are called scorch. Very hot sunny days may scorch leaves and needles, but so will very cold, windy winter days. A scorched appearance also be caused by disease agents or certain environmental pollutants, especially salt injury along main travel routes. Sometimes in the fall, the yellowing of conifer needles is mistaken for a disease, when it it the normal fall "leaf" drop.

***Wilt:*** Withering of leaves, often with discoloration can be caused by many things, from a lack of water during a dry spell, or from a disease organism preventing the transport of water to tree crowns. Dutch elm disease and oak wilt are two good examples.

***Witches Brooms:*** An excessive and dense amount of branching is caused by a rust fungus. Resembles dwarf mistletoes.

## Insects and Diseases in the Forest

Insects and diseases are often evolved to affect only a certain part of a tree. Wood borers chew through the wood. Shoot beetles attack the young shoots of pine, leaf miners eat leaves, a fungus may attack only phloem, etc. Diseases, alone, are responsible for more wood loss than any other damaging agent, including timber harvest. Often times, a species of insect or disease is specific to a species or genus of tree.

The life cycles of insects and disease are fascinating and quite variable. Population levels are often strongly influenced by weather, seasons, parasites & predators, and the overall vigor of trees in the forest. In dry years, wood borers are usually more numerous because conifers are stressed and more vulnerable to wood borer attack. Some insects are cyclical. Forest tent caterpillar outbreaks occur about every ten years. Spruce budworm reaches epidemic proportions every 40 or 50 years, about the time balsam fir becomes mature and starts to lose vigor.

Damaging insects are often grouped by the kind of damage they cause or the part of the tree they attack.

| | |
|---|---|
| Defoliators | Leaf eaters, either the whole leaf or just the interior layers of a leaf. |
| Bark Beetles | Tunnels under bark, consuming live tissue. |
| Bark Borers | Tunnels in wood, consuming dead tissue. |
| Terminal Feeders | Eats the young growing tissue of twigs and roots. |
| Sucking Insects | Have specialized mouth parts to penetrate tissues and suck sap. |
| Gall Insects | Produces chemicals causing the tree to from an abnormal swelling, within which the insect carries out part of its life cycle. |

Diseases, too, are sometimes specialized in where they attack a tree. Most diseases are fungi, but some can be viral or bacterial. Decay is a normal and essential part of forest ecology and most of the fungi are key players in this vital role. For example, white rots attack the cellulose of wood, but leave most of the lignins and other components behind. The brown rots then move in, and decompose the lignins. Most

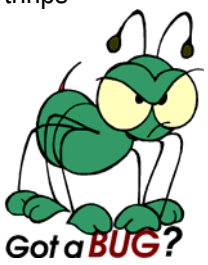
fungi are not harmful to trees, or at least not healthy, vigorous trees. In fact, ***mychorrhizal fungi*** are beneficial and possibility critical to tree health. Generally, the spores and hyphae (living filaments) of fungi cannot penetrate the protective bark layers. A number of different fungi consume particular components of wood. Others may attack foliage or ***cambium*** tissues. Interestingly, trees *cannot* heal wounds like animals. Once wounded, the wound remains throughout the life of the tree. The best a tree can do is grow over the wound. Open wounds are not protected by bark and are open to infection by diseases.

*Cambium: These thin tissues are found between the bark and woody tissues of a tree. Bark cambium produces new bark and wood cambium produces more wood. Other growth tissues in a tree are* meristems*, located in the tips of twigs and roots.*

*Mycorrhizae: Pronounced "my-core-hi-zee", this a group of beneficial fungi associated with most tree roots. It represents an ecologically symbiotic relationship where the fungi receive food from the tree and the trees receive greatly enhanced nutrient and water absorption. Mycorrhizae will also protect tree roots from other invading fungi. There tends to be very specific species relationships*

Some of the more common or important forest-damaging insects are:

| | | |
|---|---|---|
| jack pine budworm | pine sawyer beetle | larch casebearer |
| spruce budworm | bronze birch borer | Saratoga spittlebug |
| sawflies | sugar maple borer | scale insects |
| loopers | two-line chestnut borer | thrips |
| spanworms | white pine tip weevil | |
| cankerworms | pine shoot borer | |
| large aspen tortrix | beech bark scale | |
| forest tent caterpillar | aphids | |
| gypsy moth | spruce gall adelgid | |
| leafminers | bark beetles | |
| two-spotted sawyer beetle | carpenter ants | |




Some of the more common or important forest-damaging diseases are:

| | |
|---|---|
| Anthracnoses | Attacks leaves and twigs during moist periods. |
| Armillaria | A common root rot. The famous "humungous fungus" of Crystal Falls. |
| Black Knot of Cherry | Charcoal-black swelling common on species of cherry. |
| Dutch elm disease | Attacks the cambium tissue, girdling the tree. |
| Eutypella | Causes cankers on tree trunks. |
| Heart Rots | Decomposes wood tissue and forms large "conks" on trees. |
| Nectria | Cause cankers on tree trunks, similar to Eutypella. |
| Oak Wilt | Related to Dutch elm disease and kills the same way. |
| White Pine Blister Rust | Attacks cambium tissue, can girdle and kill tree. |
| Mistletoe | A parasitic plant. |
| Needlecasts & blights | Attacks conifer needles, sometimes the young, sometimes the old. |
| Beech Bark Disease | Combination of exotic scale insect and exotic canker. |
| Emerald Ash Borer | Newly identified in 2002, this exotic insect poses threats to trees. |

A great website that has detailed information about many of our most common forest-damaging insects and diseases is maintained by the U.S. Forest Service, located at [*http://na.fs.fed.us/pubs/fidl_hp.shtm*].

In addition to insects and disease, there are other pests and damaging agents that affect trees and forests, such as air and salt pollution, especially along major travel routes, browsing by deer and other animals, girdling by porcupines, nematodes (a group of worms), frost, hail and ice, wind, freezing, and sun scorch. As our forests age and mature, certain forest types will become much more vulnerable to forest health problems.

## Fire

***Wildfire*** is considered a bad thing because it destroys standing timber, buildings, and radically changes the face of the landscape in an uncontrolled manner. Ever since the huge fires in the late 1880s and early 1900s, fire suppression has been a major objective in forest management. That has not changed. However, fire has long been a part of the forest ecosystem. Forests, and in particular some tree species, have adapted to the presence of fire. Despite a negative image and negative effects, fire actually provides many benefits to certain forest types.

Some forest management practices (especially clearcutting) have filled the role of wildfire in many ways, but not all ways. Because management cannot use non-fire practices to imitate all the beneficial aspects of fire, foresters will ***prescribe*** fire in certain circumstances.

*Case Study: Jack pine is often used as a classic beneficiary of fire. About 75% of jack pine cones are "serotinous", meaning that they are "glued" shut. A temperature around 120 degrees will "melt" the glue and allow seeds to fall from the cones. Within a day or two of a fire, jack pine cones open and release their seeds. The seeds require the exposed mineral soil created by the fire. Jack pine are quite intolerant of shade, so the open, fire-killed canopy allows the light that the new trees need to grow.*

Prescribed fires can reduce the amount of fuel, therefore reducing the chance of a catastrophic wildfire. Also, smoke intensity from lighter fires will be less than with a major fire. Fire can burn off the dead leaves and expose mineral soil that some tree seeds need to germinate. Burning the dead leaves also eliminates habitat for some kinds of tree-damaging fungi and insects. The ash provides a short-term boost in potassium and other nutrients needed by trees. Fire can increase the amount of herbs, providing better browse for some species of wildlife.

Sometimes a prescribed fire will be used *after* a timber harvest. This way, the benefits of fire can be realized without destroying the standing timber. Of course, the downside is the perception of wanton forest destruction. Other times, prescribed fire will be used under a living canopy. For example, larger red pine have thicker bark, which a light fire cannot penetrate. A light fire will kill the smaller trees and shrubs. The living shrubs provide a "ladder" for a cone-boring beetle that destroys the seed of red pine while it is

still in the cone. Foresters may prescribe one or two light underburns to prepare a mature red pine stand for partial harvest, and at the same time, create the kind of forest conditions to naturally regenerate red pine.

## Exotic Species

An ***exotic species*** is one that has been introduced from somewhere else and was not part of the natural development of the ecosystems in question. So, a species from Europe or Asia that is surviving in North America would be an exotic. The same would be true of a species from Colorado that now grows in Michigan.

An ***invasive species*** is one that aggressively colonizes new areas. It usually refers to exotic species that can rapidly overtake and disrupt native habitats. However, Pennsylvania sedge, a native, rapidly dominates the ground flora as deer, in high densities, eat just about everything else. Purple loosestrife (an exotic) has a beautiful flower but the plant overtakes wetlands. Common and smooth buckthorn (exotics) dominate sunny understories preventing the regeneration of most native species. Chestnut blight (an exotic) virtually eliminated the chestnut tree from the eastern forest where it once was a dominant native species.

To become a problem, an exotic species must reach new territory, become established (growing & breeding), and then spread. This is difficult to do in a foreign ecosystem. The overwhelming majority of introductions fail. Nevertheless, scientists estimate over 40,000 species have been introduced to North America.

Many exotics are not considered problematic and most are not damaging, such as cattle or carrots. How many realize that Great Lakes salmon are exotic? Or, pheasants?

| Exotic | Date Found | Origin |
|---|---|---|
| Chestnut Blight | 1904 | Asia |
| Dutch Elm Disease | 1930 | Europe |
| White Pine Blister Rust | 1906 | Europe |
| Beech Scale | 1890 | Europe |
| Birch Leafminer | 1923 | Europe |
| Larch Sawfly | 1880 | Eurasia |
| Gypsy Moth | 1869 | Europe |
| Pine Shoot Beetle | 1992 | Europe |
| Asian Longhorned Beetle | 1996 | Asia |
| Emerald Ash Borer | 2002 | Asia |
| Hemlock Woolly Adelgid | 2006 | Europe |

About 400 insects and 20 diseases are exotic pests of trees. Most exotics have historically come from Europe. Mushrooming trade with China and other east Asian countries present an entirely new threat on the horizon.

Why are some exotics so bad? In terms of forests . . .

1. Negative effects on native species diversity.
2. Altered diversity can disrupt ecological processes, such as food chains, habitat quality, etc.
3. Major outbreaks can reduce forest productivity across a wide geographical region.

4. Can further threaten endangered species.
5. Necessary quarantines and regulations can significantly reduce economic growth.
6. Control measures cost millions of dollars each year.

Many natural resource professionals consider exotics species one of the top threats to our forests and other native ecosystems.

For more information, try the **Michigan Invasive Plant Council**.