

Invasives of the Insect and Disease World

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The Federal **Executive Order 13112 of February 3, 1999** defines an invasive species as “an alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health.” The term alien means a species that is not native to here, and for our purposes, 'here' refers to Pennsylvania, but it can be an area as small as a remote pond or as big as a continent. Native species are those that have historically existed in an area such as Pa. Because these species exist here naturally, they have co-evolved predator and disease relationships that keep the native populations in check.

Some of these predator species are parasitoids. A parasitoid - unlike a parasite that lives off a host plant or animal, not doing the host any good but not killing it - actually kills its host. Parasitoid populations prey upon the host species, laying eggs on their eggs, their larvae and their adults. The eggs hatch and the parasitoids burrow into the host, living off it and eventually killing the host prior to pupating, becoming adults and starting the parasitoid cycle all over again. This condition is a very simplified version of the balance of nature that we have heard so much about.

When a native population of host species has a very successful reproduction year, due to temperature, moisture, food, lack of predators or otherwise, the population very quickly increases. The co-evolved parasitoid species now have greater access to egg laying sites. Depending upon how many generations the parasitoid species has per year, the parasitoid population can grow very quickly, overwhelming the native host population. The native host population crashes and the parasitoid population crashes immediately afterwards because of a lack of egg laying sites. The populations of both the native host and the parasitoid are again in an endemic or naturally-occurring, balanced population. These are called population boom and bust cycles and they are normal.

With invasive alien species, there are no co-evolved parasitoids, predators or diseases to hold the alien species in check. When an alien is introduced and has a successful reproduction year there are no parasitoid

species to attack the alien species and cause the important bust part of the population cycle. The alien species population continues to grow until it runs into some other limiting factor such as food or space to grow. For invasive forest insects, such as the emerald ash borer, the invasive insect continues to attack and kill ash trees until there are no more ash trees upon which to feed.

Invasive species are by their nature highly competitive and are capable of reproducing very rapidly. Here is a sample of some invasive insects and diseases in Pennsylvania.

The **gypsy moth** (*Lymantria dispar*) is one of our best known invasive insect species. The gypsy moth was introduced into Massachusetts in 1869 by an amateur entomologist who was attempting to cross gypsy moths with silk moths from Asia. Some of the gypsy moths escaped and have been expanding their range ever since; it is now as far west as Minnesota. A single egg mass laid by a female gypsy moth can have 500 to 1,000 eggs in it, making it possible for gypsy moth populations to explode very rapidly. It continues to have outbreaks which defoliate hundreds of thousands of acres. Countless millions of oak trees, a favorite of the gypsy moth, have been weakened and killed during the 141 years that the gypsy moth has been with us.



Gypsy moth females laying eggs on yellow birch tree trunk.

"Invasives of the Insect and Disease World" continued...

The **emerald ash borer** (EAB), *Agrilus planipennis*, was inadvertently introduced to Detroit, Michigan from China in the early 1990s. EAB attacks only ash trees. Since its introduction, the EAB has killed more than 40 million ash trees in the U.S. Each female lays approximately 250 eggs. The EAB eggs hatch into larvae that eventually girdle the trees, killing them within 3 to 5 years of infestation. Since the introduction of EAB, it has expanded into at least 12 states and a couple Canadian provinces. North American ash trees have no resistance to this insect. Scientists are working hard studying the biology of the insect and its parasitoids to look at possible ways to control the insect. Without some effective natural controls, virtually all native ash trees will be removed from America's woodlands as this invasive spreads.

Adult emerald ash borer ready to emerge from its D-shaped exit hole.



Hemlock woolly adelgid (HWA) and **elongate hemlock scale** (EHS) are tiny alien insects partnering to destroy our state tree, the eastern hemlock. HWA was introduced to the west coast in the 1920s and was moved to the east coast in the early 1950s on landscape plants from the west. More than one half of Pennsylvania is already infested with HWA, while EHS is still mostly confined to the eastern half of the state. Both HWA and EHS live almost their entire lives attached to new hemlock twigs at the base of needles. They attach to the tree by a feeding tube through which they drink the sap, causing the trees to weaken and eventually die. PA DCNR is cooperating in a study to develop a spray using a naturally occurring fungus to control HWA.



Elongate hemlock scale insects on the underside of eastern hemlock needles.

Hemlock woolly adelgids covered by a white, waxy coating.



Sirex wood wasp (*Sirex noctilio*) is an invasive insect from Europe that was discovered in New York in 2004 and found in Pennsylvania in 2006. *Sirex* wood wasp acts in concert with a fungus to attack many species of pine trees, particularly those that are overcrowded and weakened. The female *sirex* wood wasp introduces the spores of the fungus into the pine tree when she lays her eggs. The fungus grows from the spores, killing the pine tree. The wood wasp then eats the fungus. Thinning is used as a preventative for attack by the *Sirex* wood wasp.



Photo of female *Sirex* wood wasp. (Photo: www.bugwood.org)

The **Asian longhorned beetle** (*Anaplophora glabripennis*) came to North America in the 1990s from solid wood packing material in China. This insect does not kill its host tree directly; the eventual end of the infested trees occurs when the trees literally fall apart during wind or ice events as a result of structural weakening caused by the large larval galleries honeycombing the stem and branches of the trees. This beetle is very large and is very limited in its ability to fly, but it can easily travel 500 miles in a day in infested firewood, transported in the back of a pickup truck. According to the US Forest Service, if this insect escapes into the country's forests at large, it will be more destructive than the chestnut blight, Dutch elm disease and the gypsy moth combined.



Asian Longhorned beetle female. (Photo: www.Bugwood.org)

"Invasives of the Insect and Disease World" continued...

Remember the stories of the American Indians for whom entire tribes were wiped out by smallpox disease introduced into North America by the Europeans? The Indian people had no immunity to smallpox. They had no resistance to the disease because their bodies had not co-evolved with the disease. Plants have the same problems with alien diseases. Without co-evolved resistance mechanisms, all species have problems with alien diseases. Some of the effects can be catastrophic. Here are some of these invasive culprits.

The American chestnut was the dominant tree species in Eastern North America. **Chestnut blight** (*Endothia parasitica*) was introduced into North America in the early decades of the 20th century. The American chestnut had no native resistance to the chestnut blight, and as a result, adult American chestnut virtually disappeared from America's forests. However, there are still living root systems from the original trees that still push up saplings, but they cannot grow to maturity because the chestnut blight fungus is still in the forests, living on oaks which are not bothered by it.



American chestnut sapling.

Oak wilt (*Ceratocystis fagacearum*) is a vascular wilt disease that attacks all oaks, although red oaks are more strongly affected than the white oaks. Red oaks can die as a result of oak wilt in a single year. This wilt was recognized as a problem in 1944. The disease is spread by sap, bark feeding beetles and root grafts. Once a tree is infected there is no remedy. Symptoms include water soaked looking leaves and leaf discoloration progressing from the leaf tips inward. Discoloration is brown, yellow or gold.

Center of an oak wilt infestation.
(Photo by D. W. French, Univ. of Minn., www.bugwood.org)



Originating in the far southwest, the **thousand canker disease** has jumped to introduced black walnuts in Colorado. There is a fear that this disease complex will reach the native range of the black walnut, threatening the entire species. Thousand canker disease of black

walnut is caused by an association between a tiny bark beetle, *Pityophthorus juglandis*, and a fungus, *Geosmithia* sp. The bark beetle attacks the black walnut tree and introduces the fungus at the same time. The fungus causes an elliptical shaped canker. When hundreds of beetles have attacked the tree, the associated cankers become so numerous that they kill the tree, hence the name thousand canker.

Individual cankers caused by each bark beetle attack.
(Photo: Whitney Cranshaw, Colorado State Univ., www.bugwood.org)



Beech bark disease is killing off most of the beech trees in Pennsylvania. Mortality of the beech trees is caused by a combination of two factors: The initial injury to the thin smooth beech bark is caused by the beech scale insect, *Cryptococcus fagisuga*. The injuries caused by the beech scale insect are then infected by a fungus, *Nectria ditissima*. The *Nectria* causes small cankers. Great numbers of the scale insect cause many cankers, which eventually coalesce into cankers large enough to girdle and kill the tree.



Dark gray areas are beech scale cankers caused by *Nectria ditissima*.

Close-up image of beech bark. Inside the white woolly masses are the beech scale insect, *Cryptococcus fagisuga*.



Our forests and urban trees are under attack from numerous invasive insects and diseases, like those listed above, but work is underway to determine ways to protect these trees and prevent invasives from spreading. You can do your part by buying and burning firewood locally, not transporting it across township, county or state lines. If everyone follows that simple rule we will have fewer invasive insect and disease pests to worry about in the future. For more information on forest pests go to www.dontmovefirewood.org. ✓

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