

Landscape Insects

This laboratory session covers selected insects of trees and shrubs. To provide some structure for a very broad range of plants and insects, the specimens and materials provided in this lab session are arranged in broad categories -- **defoliators, sap-sucking insects, gall-makers, wood borers, and bark beetles**. Within these groups a few common examples are presented as representatives of many, many more species with similar life histories. In the other labs on field crop, fruit and vegetable insects, specific sampling methods and thresholds are summarized because the damage and the economic impact of that damage are moderately well established. Well defined thresholds for control of landscape insects are much less common.

Defoliators

- eastern tent caterpillar, *Malacosoma americanum* (Fabr.) (Lepidoptera: Lasiocampidae), and fall webworm, *Hyphantria cunea* (Drury) (Lepidoptera: Arctiidae)
- gypsy moth, *Lymantria dispar* (L.) (Lepidoptera: Lasiocampidae)
- bagworm, *Thyridopteryx ephemeraeformis* (Haworth) (Lepidoptera: Psychidae)

Sap-sucking insects

- leafhoppers, including potato leafhopper, *Empoasca fabae* (Harris) (Hemiptera: Cicadellidae)
- aphids (Hemiptera: Aphididae) and adelgids (Hemiptera: Adelgidae)
- scale insects, including cottony maple scale, *Pulvinaria innumerabilis*, (Rathvon) (Hemiptera: Coccidae), pine needle scale, *Chionaspis pinifoliae* (Fitch) (Hemiptera: Diaspididae), and oystershell scale, *Lepidosaphes ulmi* (Linnaeus) (Hemiptera: Diaspididae)

Gall-makers

- hackberry psyllid, *Pachypsylla celtidismamma* (Riley) (Hemiptera: Psyllidae)
- horned oak gall wasp, *Callirhytis cornigera* (Osten Sacken) (Hymenoptera: Cynipidae)
- maple bladder gall and maple spindle gall mites, *Vasates* spp (Acari: Eriophyidae)

Wood borers and bark beetles

- Longhorned beetles (Coleoptera: Cerambycidae): Asian longhorned beetle, *Anoplophora glabripennis* (Motschulsky) and pine sawyers, *Monochamus* spp.
- Metallic wood boring beetles (Coleoptera: Buprestidae): emerald ash borer, *Agrilus planipennis* Fairmaire, and bronze birch borer, *Agrilus anxius* Gory
- Clearwing moths (Lepidoptera: Sesiidae): ash/lilac borer, *Podosesia syringae* (Harris)
- bark beetles (Coleoptera: Curculionidae: Scolitinae): smaller European elm bark beetle, *Scolytus multistriatus* (Marshall), and mountain pine beetle, *Dendroctonus ponderosae* Hopkins

In addition to these pest species, a few other insects of common interest are presented with this lab:

- Honey bees, bumble bees, carpenter bees, and sweat bees
- Yellow jackets and bald-faced hornets

Defoliators

Station 1. Eastern Tent Caterpillar and Fall Webworm

Among the most common defoliators of trees and shrubs in Illinois are the eastern tent caterpillar and the fall webworm.



Left: ETC egg mass. Center: ETC on webbing. Right: Fall webworm webbing.

Life history

ETC and fall webworm have a lot in common, but there are some important differences in their life histories and behavior:

Eastern tent caterpillar	Fall webworm
<ul style="list-style-type: none">• Hatch in the spring from overwintered eggs• Larvae begin feeding in early spring at leaf-out• Make their nests in the crotches of branches	<ul style="list-style-type: none">• Overwinter as pupae• Larval nests become evident in late summer• Make their nest at the tips of branches

Impact

Eastern tent caterpillar and fall webworm can damage the aesthetic value of ornamental and street trees by defoliating them and “decorating” them with unsightly webs. With the exception of the example below, the economic and ecological impact of these two species is minor.

Tent caterpillar outbreaks have been linked to something called **mare reproductive loss syndrome**. Mares accidentally consume the larvae, and the larval hairs become embedded in the lining of the alimentary canal. This triggers bacterial infections which can lead to miscarriage.

Control

Control methods for Eastern tent caterpillar and fall webworm include manual removal of nests and webbing, and application of Lepidopteran-specific Bt pesticides.

References:

- Bessin, R. 2003. Eastern Tent Caterpillar. <http://www.ca.uky.edu/entomology/entfacts/ef423.asp>
- Mazzey, K., and M. Maziuk. Undated. Fall Webworm. <http://ento.psu.edu/extension/factsheets/fall-webworm>

Station 2. Gypsy moth



Left: gypsy moth egg mass. Center: gypsy moth larva. Right: gypsy moth adult

Life history

Gypsy moths lay their eggs in crevices under bark, or even on trailers and cars which inadvertently aid in dispersal by transporting the “hitch-hiking” egg mass from one place to another. This hitch-hiking dispersal is especially important because adult females do not fly (even though they have wings). These moths overwinter in the egg stage. The larvae hatch in late April, and young larvae disperse by crawling to the tops of trees, where they spin a silken thread and are picked up by a wind current. Gypsy moths pupate in midsummer and fly as adults in late summer.

Impact



The photo above shows the widespread defoliation and tree death that can occur as a result of gypsy moth infestation. Defoliation can change the complexity of understory growth, resulting in an increase or decrease of plant and animal populations. In addition, defoliation may facilitate infestation by other pests or diseases. Substantial tree dieback means significant economic losses for forest landowners, loggers, and sawmills.

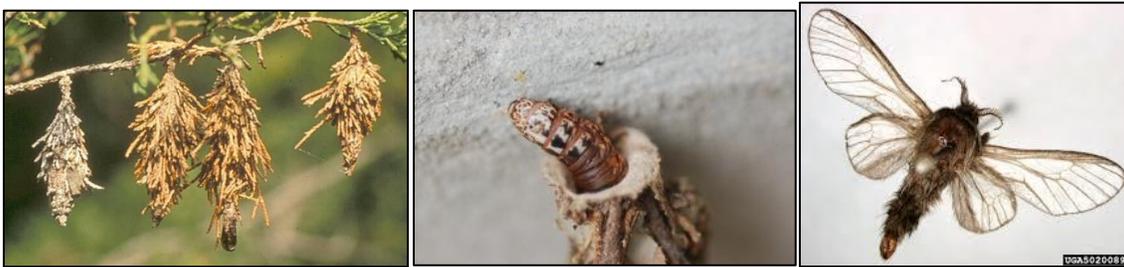
Control

Control of gypsy moth includes foliar/trunk sprays of Lepidopteran-specific Bt pesticides and the use of “sticky bands” around trunks of trees to limit movement of larvae. Another method uses the gypsy moth nucleopolyhedrosis virus (NPV), “Gypcheck”, as a biological pesticide.

Reference:

- Liebold, S. 2003 and updates. Gypsy Moth in North America. <http://www.fs.fed.us/ne/morgantown/4557/gmoth/>

Station 3. Bagworm



Left: bagworm bags. Center: bagworm larva. Right: bagworm adult (male).

Life history

Bagworms overwinter as eggs. Larvae hatch in late spring. Young larvae spin thread to attach to passing animals or be picked up by the wind (“ballooning”). The larvae construct cases of foliar debris and feed from within them. Bagworms pupate and emerge as adults in late summer. Adult females remain “larvaiform” and mate at the bag opening, where they lay their eggs. Alternatively, females will die in their bags with their eggs still inside them, and the eggs will still hatch.

Impact



Bagworm damage

Bagworms can kill ornamental trees in parks or on private property.

Control

Bagworms are less susceptible to pesticide sprays than some other insects because they are protected by their bags. Hand-picking of bags is a common method of control. Bt sprays are also used and timed with larval feeding.

References:

Mazzei, K., and M. Masiuk. Undated. Bagworm. <http://ento.psu.edu/extension/factsheets/bagworm>

Sap-sucking insects

Station 4: Leafhoppers



Potato leafhopper

Life history

Leafhoppers do not overwinter in the Midwest. They are carried northward every year by spring winds. Adults first appear in the Midwest in early May, but high populations don't occur until midsummer. Leafhoppers go through three or four generations in the Midwest every year.

Leafhoppers can damage plants in four ways:

- 1) Feeding results in direct removal of cell contents.
- 2) They can carry and transfer plant pathogens (i.e., they can be a **vector**)
- 3) They can inject salivary toxins which kill plant cells.
- 4) They produce a honeydew secretion that can promote the growth of sooty molds.

For example, potato leafhopper injects salivary toxins while feeding which can cause leaf cupping and curling as well as the cessation or distortion of growth in new shoots. This type of damage is known as hopperburn.



potato leafhopper damage on maple

Impact (using potato leafhopper as an example)

Despite its name, potato leafhopper has a multitude of hosts. Among trees, its hosts are maple, apple, ash, birch, dogwood, elm, hickory, oak, redbud, and more. While potato leafhopper is a significant pest of field crops, its damage to ornamental trees is primarily aesthetic. While hopperburn and other symptoms of leafhopper feeding can decrease the value of ornamental trees, it doesn't kill them.

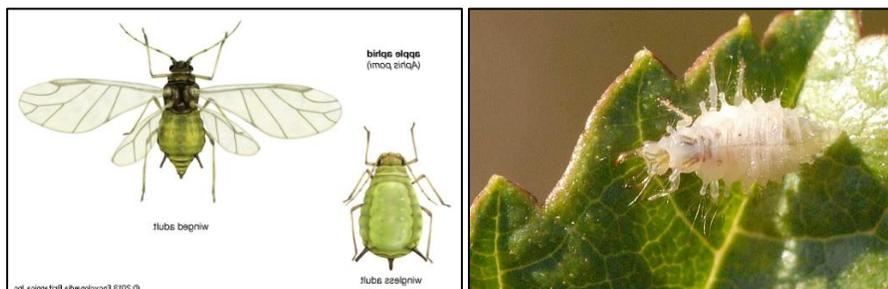
Control

Adult leafhoppers are very difficult to control due to their high mobility. Natural enemies can sometime be used in biocontrol efforts (more on biocontrol in lecture soon). Insecticidal soap can be applied to foliage to reduce nymph population, but it doesn't reduce virus transmission.

Reference:

- Anon. Undated. Leafhoppers <http://ipm.ucanr.edu/PMG/GARDEN/VEGES/PESTS/leafhopper.html>
- Bowers, Heather. Undated. Potato Leafhopper <https://extension.tennessee.edu/publications/Documents/W289-J.pdf>

Station 5. Aphids and Adelgids



Left: aphids. Right: an adelgid

Life history

Aphids overwinter as eggs, which hatch into females. Adult females then reproduce without males via parthenogenesis, resulting in more female offspring. Many aphid species develop on a tree or shrub for a few generations before migrating to an annual plant for the summer (think soybean aphid).

Hemlock woolly adelgid is similar to aphids in that it is parthenogenetic. A first instar “crawler” stage disperses by hitching a ride on an animal or via wind. These adelgids produce wax-like filaments (“wool”) to protect themselves and their eggs from natural enemies and dessication. These insect feeds on the stored starches of plants, rather than on nutrients in sap as most sap-sucker do.

Impact



Hemlock woolly adelgid damage in the Great Smoky Mountains

Hemlock woolly adelgid outbreaks negatively affect timber markets by killing valuable trees. They also have a recreational and aesthetic impact, for example in campgrounds or state parks. Hemlock is considered a “foundation” tree in eastern forests. Where hemlock populations are decimated by hemlock woolly adelgid, ecosystem functions including water, carbon, and nutrient cycles are altered.

Control

Control methods for aphids and adelgids include foliar insecticide sprays and systemic insecticides (these are injected into the base of the tree and translocated throughout the entire tree). There is ongoing work that shows potential for biological control with predators, pathogens, and parasitoids.

References:

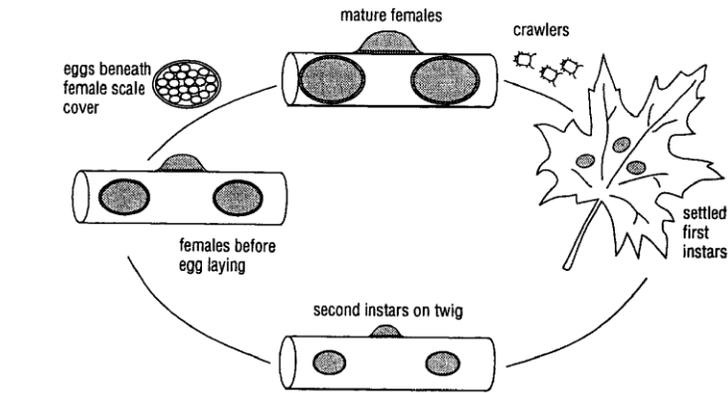
- Cranshaw, W. 2004. Aphids on Shade Trees and Ornamentals. <http://extension.colostate.edu/topic-areas/insects/aphids-on-shade-trees-and-ornamentals-5-511/>
- USDA Forest Service. 2005. Hemlock Woolly Adelgid. http://na.fs.fed.us/spfo/pubs/pest_al/hemlock/hwa05.htm

Station 6. Scale insects



Left: Cottony maple scale. Center: Oystershell scale. Right: Pine needle scale

Life history



Above: a simplified version of a scale insect life cycle

Impact

Scale infestations weaken plants and cause them to grow slowly. Severe infestations can kill limbs and sometimes entire trees.

Control

Control methods include pesticide sprays where application is carefully timed (when a large percentage of the population is in the crawler stage), and systemic insecticides which move inside the plant and kill the scales as they feed. Dormant oils have also been used to suffocate the insects under the scales.

Reference:

- Wawryynski, R., and M. Ascerno. 2009. Scale Insects of Trees and Shrubs. <http://www1.extension.umn.edu/garden/insects/find/scales/>

Gall Makers

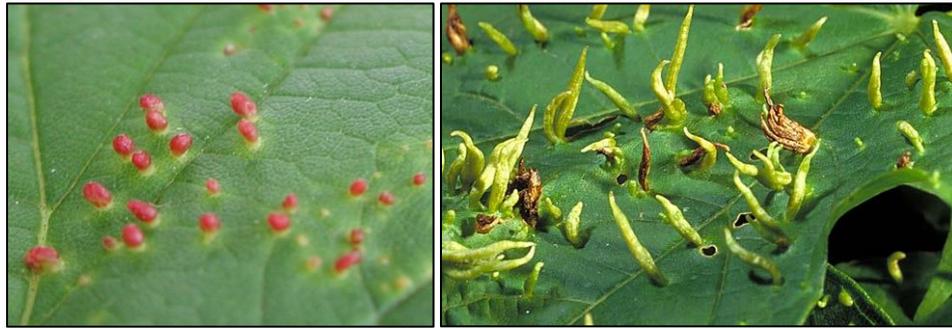
Station 7. Hackberry Psyllid, Horned Oak Gall Wasp, Maple Bladder, Gall Mite and Maple Spindle Gall Mite

Galls are plant tissues that are produced in response to injury or infection. Insects and other arthropods trigger gall production by feeding on or laying eggs into plant tissue. Homopterans (adelgids and psyllids) and Hymenopterans (especially cynipids) are among the most common insects that are gall inducers. Mites in the family Eriophyidae also cause a variety of leaf galls.

Here are some common gall types:



Left: hackberry psyllid gall Right: horned oak gall wasp



Left: maple bladder gall. Right: maple spindle gall mite.

Impact and control

Galls don't usually harm the plant much, so there are no real management practices in place for them.

References:

University of Minnesota Extension. 2016. Insect and mite galls.
<http://www.extension.umn.edu/garden/insects/find/insect-and-mite-galls/>

- Dixon, W.N. 2006. Gall Wasps, *Callirhytis quercusclaviger* (Ashmead) and *Callirhytis cornigera* (Osten Sacken) (Insecta: Hymenoptera: Cynipidae). <http://edis.ifas.ufl.edu/in664>

Wood Borers and Bark Beetles

Station 8. Longhorned beetles (Coleoptera: Cerambycidae)

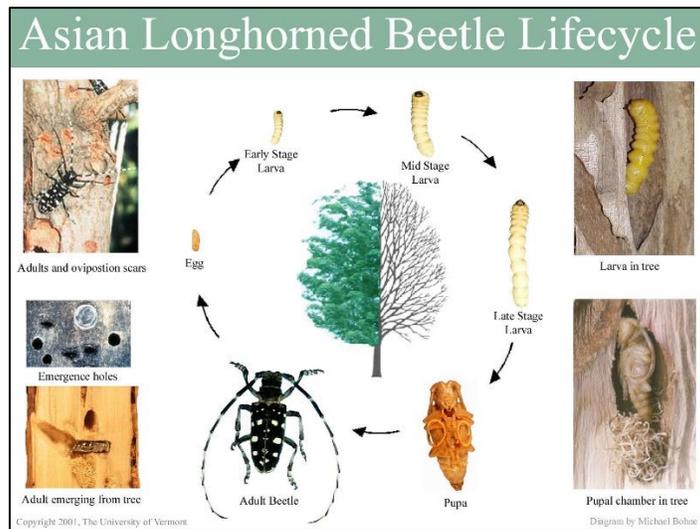


Left: Asian Longhorned Beetle (ALB). Right: *Monochamus* spp (pine sawyer)

Life history

ALB is an introduced species and was first detected in 1996. These beetles are generalists that infest maple, birch, poplar, willow, ash, elm and other species. Most cerambycid species attack trees that are already stressed, dead or dying, but ALB attacks healthy trees. ALB can overwinter as eggs, larvae or pupae.

Pine sawyers are native to the U.S. They use coniferous trees as their larval hosts; usually trees that are already stressed or dying. Pine sawyers overwinter as larvae.



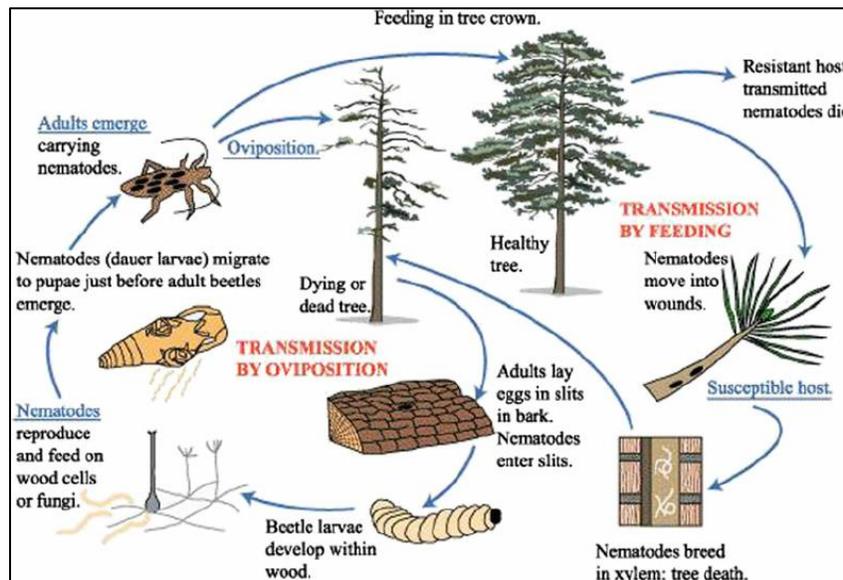
Impact

Larvae tunnel deep into the wood of trees, disrupting the flow of xylem and phloem within the tree. When infestation is heavy, this kills trees. Pine sawyers can also vector the pine wood nematode, leading to pine wilt disease, which can be devastating to pine forests.

ALB infestations lead to costly removal and replacement of street and park trees.



A Connecticut street before (left) and after (right) ALB infestation.



Transmission of the pine wilt nematode by pine sawyers



A stand of red pine killed by pine wilt nematode via pine sawyer

Tree death caused by pine sawyers and pine wilt nematode results in huge losses for the logging industry.

Control

Control of ALB has involved citizen scientists who scout for evidence of infestation. Susceptible trees in the infested area are cut down and chipped or burned in efforts to eradicate this pest. Thus far, eradication efforts in the Chicago area appear to be successful.

Control of pine sawyers includes monitoring with traps baited with a blend of aggregation pheromone (“mono-chamol”) and host plant volatiles. Trees are treated with systemic pesticides to target larvae. Biological control methods are still being researched, but look promising.

References:

- USDA APHIS, 2007. Asian Longhorned Beetle: Questions and Answers. http://www.aphis.usda.gov/publications/plant_health/content/printable_version/faq_alb_07.pdf.
- Oklahoma State University. Undated. <http://www.ento.okstate.edu/ddd/insects/pinesawyerbeetle.htm>.

Station 9. Flat-headed wood borers (Coleoptera: Buprestidae)



Left: Bronze Birch Borer. Right: Emerald Ash Borer

Life history

The bronze birch borer is a native insect pest of birch. It deposits eggs in cracks or crevices in bark. When the larvae hatch they begin tunneling into the tree, disrupting the flow of xylem and phloem in the tree (just like other wood boring insects). This species overwinters in the larval stage.

The emerald ash borer (EAB) is an introduced pest of ash and was first detected in Michigan in 2002. Like the bronze birch borer, EAB larvae feed on the inner bark of the tree. EAB Probably arrived in the US via solid wood packing material carried in cargo ships from Asia.

Impact

The bronze birch borer kills valuable landscape trees. In birch-dominated forests, extensive tree death caused by the bronze birch borer can change the structure of the forest community.

Since 2002, EAB has killed *hundreds of millions* of ash trees in North America. This has cost municipalities, property owners, nursery operators, and forest product industries hundreds of millions of dollars.

Control

Bronze birch borer control includes planting resistant tree species and sanitation (infested trees are cut and destroyed). Some insecticides are applied to the surface of trees to kill larvae as they emerge from eggs, before they tunnel into the wood.

A large component of EAB management is quarantine. This entails regulations against movement of wood products out of infested areas. This has a large impact on forest product industries (loggers, sawmills, etc.). Sanitation is also a key component of EAB control. Systemic insecticides are also used, but this is too costly and labor-intensive to work on a large scale. Lastly, current research is looking into biocontrol using a parasitoid wasp.

References:

- Gibb, T., and C. Sadoff. 2007. Bronze Birch Borer. <http://extension.entm.purdue.edu/publications/E-50.pdf>
- Emerald Ash borer. <http://www.emeraldashborer.info/index.cfm>

Station 10. Clearwinged moths; Lepidoptea: Sesiidae): ash/lilac borer



Ash borer adult

Life history

These moths emerge from their tunnels in the spring and lay eggs on or near wounds in the tree. The larvae chew into the bark, attacking the sapwood. Mature larvae overwinter and pupate in the spring before emerging.

Impact

The ash/lilac borer attacks healthy trees and typically damages street trees and ornamentals.

We will talk more about the peach tree borer and lesser peach tree borer in the fruit and vegetable pest lab.

Control

Insecticides can be applied as trunk sprays, but must be done before larvae have entered the tree. Infested branches can be pruned and destroyed.

Reference:

- Clearwing borers. <https://entomology.ca.uky.edu/ent43>

Station 11. Bark beetles (Coleoptera: Cucurlionidae)



Life history

Bark beetle larvae tunnel just beneath the bark of trees, destroying the cambium. They usually attack weak or dead trees, but sometimes attack healthy trees. These beetles carry fungi that grow in their tunnels to use as a food source, but sometimes those fungi are tree pathogens, making the bark beetle a...

The European elm bark beetle, an introduced species, was first detected in the U.S. in 1909. These beetles carry the fungus that is the Dutch elm disease pathogen. Mountain pine beetles, which are native to the U.S., are an important part of ecosystems in the western U.S. However, large drought-related outbreaks of mountain pine beetle can be devastating to forests. This species also transmits the bluestain fungus, which can kill trees.

Impact

By the 1970's, Dutch elm disease had wiped out virtually all American elms in North America. Mountain pine beetle outbreaks have led to the devaluing of natural recreation areas (campgrounds, state and national parks) and timber industry losses. Outbreaks also have many ecosystem impacts. For example, tree death means that more sunlight gets to the forest floor, which creates light and temperature changes in the understory, which can negatively impact plants and animals.

Control

Methods of control for the European elm bark beetle include sanitation (removal of affected trees), insecticides to target spring feeding sites, and elm cultivars that are resistant to Dutch elm disease.

Preventative management of the mountain pine beetle entails treating tree trunks with pesticide and a change in forest management practices. The mountain pine beetle prefers old, dense stands, so forests should be managed to be more diverse with more space between trees. During an outbreak, control includes destruction of infested logs, "attracticides" (beetles are attracted to a trap by pheromone and then destroyed), and peeling back bark to expose larvae to the elements.

References:

- Cornell University. 2005. Dutch Elm Disease. <http://plantclinic.cornell.edu/factsheets/dutchelmdisease.pdf>
- Leatherman, D. 2005. Mountain pine beetle. Colorado State University,

<http://extension.colostate.edu/topic-areas/insects/mountain-pine-beetle-5-528/>

Other landscape insects (non-pests)

Station 12. Honey bees, bumble bees, carpenter bees, sweat bees

Honey bees



Honey bees, though very common in the U.S. were originally imported from Europe. They are economically important because of commercialized honey production, and the roughly \$20 billion they bring in each year by pollinating more than 120 types of crops. They build large hives for their brood and pollen and nectar storage. Usually, whole colonies can survive the winter.

Sweat bees



The sweat bees are actually a large and diverse family of bees. Most nest in the soil, while others nest in wood. They overwinter as larvae or pupae in burrows in the soil. Oddly enough, they are attracted to perspiration (maybe a sodium requirement?)

Bumble bees



Bumble bees have a fuzzy abdomen that is yellow and black, a fuzzy black thorax with a yellow band, and no head spots. They nest in the ground in small colonies and only fertilized queens overwinter.

Carpenter bees



Carpenter bees have a shiny, hairless abdomen and a fuzzy yellow thorax with a shiny black spot. Unlike bumble bees, male carpenter bees have a white head spot. Carpenter bees nest in wood (hence the name), and adults overwinter in abandoned tunnels.

Reference:

- Wright, R., P. Mulder, and H. Reed. Honey Bees, Bumble Bees, Carpenter Bees, and Sweat Bees. Oklahoma State University. <http://pods.dasnr.okstate.edu/docushare/dsweb/Get/Document-2292/EPP-7317web%20color.pdf>
- Bumble bees of Illinois: <http://beespotter.mste.uiuc.edu/topics/key/illinoisfieldguide.html> .
- Colony Collapse Disorder: A Descriptive Study. <http://www.plosone.org/article/info:doi/10.1371/journal.pone.0006481>.

Station 13. Yellow jackets and baldfaced hornets

Yellow jackets



Yellow jackets nest in the ground. Mated queens overwinter and emerge in the spring to start a new colony.

Bald-faced hornets



Bald faced hornets construct aerial nests. Like yellow jackets, mated queens overwinter and then emerge in spring to start new colonies.

Fill out the table on the next page while you are at stations 12 and 13.

References:

- Yellowjackets. http://en.wikipedia.org/wiki/Yellow_jacket.
- Oswalt, D., E. Benson, and P. Zungoli. 2003. Baldfaced hornets. http://www.clemson.edu/cafls/departments/esps/factsheets/medvet/baldfaced_hornets_mv15.html
- Hahn, J., P. Pelletteri, and D. Lewis. 1996. Wasp and bee control. <http://www.extension.umn.edu/distribution/horticulture/DG3732.html>

	Carpenter bee	Bumble bee	Honey bee	Sweat bee	Yellow Jacket	Bald faced hornet
Appearance						
Nesting behavior						
Overwintering						

Study questions

- 1) What orders are represented as pests in the stations presented in this lab?
- 2) Which of the pests covered in this lab or introduced / exotic?
- 3) Which of the pests covered in this lab do not overwinter here?
- 4) In what portions of the year are eastern tent caterpillars and fall webworms actively feeding on trees and shrubs?
- 5) What name is given to the mobile first-instar of scales (before they “settle” and become sedentary)?
- 6) What taxa (orders and or families) are common gall inducers?
- 7) Write a paragraph that tells the similarities and differences (morphological, behavioral, and/or ecological) in honey bees, bumble bees, carpenter bees, yellow jackets, and baldfaced hornets.
- 8) Which insects covered in this lab are vectors of pathogens that cause plant diseases? (And what is a vector?) Name the insect and the pathogen it vectors.
- 9) Pick two pests and describe their impact and the management methods used to control them.